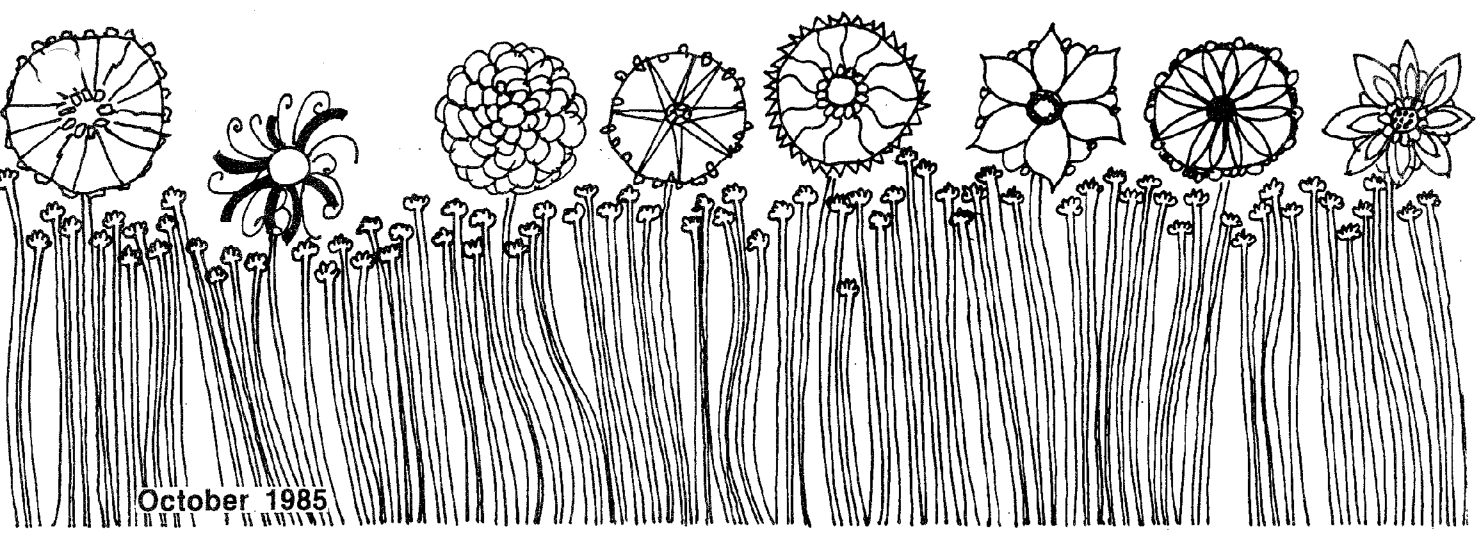
Dutchess County, New York

Natural Resources



October 1985

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Dutchess County Department of Planning
and the
Dutchess County Environmental Management Council

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To Readers of this Natural Resource Inventory

Dutchess County is growing. Each year its population increases by more than 2,200 people and eighteen hundred acres of forests and farmlands are converted to shopping centers, industrial parks and home sites. Such growth has brought an unprecedented era of prosperity to the county. Growth has not, however, been without costs. Some of our important natural resources have been lost to development. Significant wetlands have been filled, homes have been constructed in areas that flood and ground water resources have been abused. Remedies for such problems have been costly-far more costly than prevention.

Many of the environmental problems associated with growth in Dutchess County have resulted from a lack of information about the county's natural resources. We cannot act in an environmentally responsible way without knowledge of natural systems and how they are affected by land use activities. In response, we have placed the highest priority on the development of this Natural Resource Inventory as a means of reducing this information gap. The inventory is intended to provide decisionmakers with the resources needed to make sound economic and environmental decisions thereby protecting and enhancing the county's environment.

We will continue to encourage growth in Dutchess County. We believe a healthy environment is a necessary condition for continued economic growth. We urge you to work with us in a way that will secure our rich natural heritage for those generations to come.

Douglas A. McHoul
Chairman, County Legislature

Lucille P. Pattison
County Executive

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Introduction

Definition and Purpose

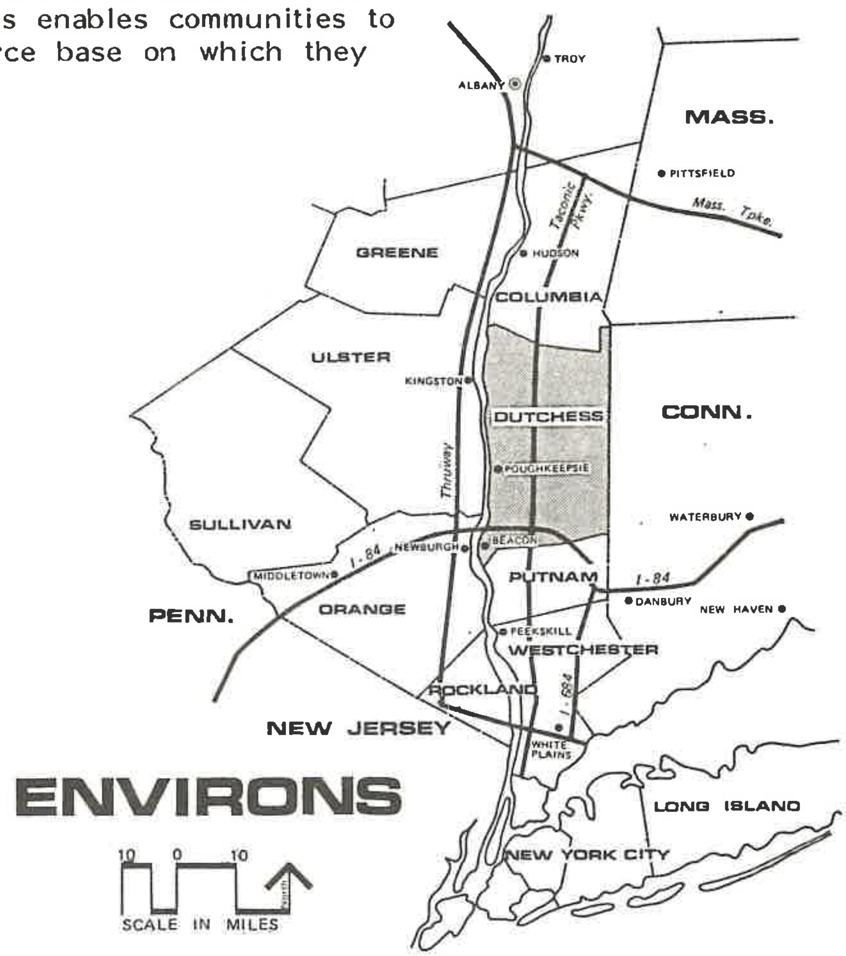
Natural resources are materials and organisms, such as groundwater, wildlife, soil, and air, that sustain or contribute to life. Together they make up a continually changing ecosystem that both influences and is influenced by human activities.

All natural resources are interdependent. Soil, for example, sustains vegetation while vegetation builds up and protects the soil. Similarly, surface water and groundwater resources both depend on and affect climate, topography, soils, and geology. All of these interrelationships shape the natural environment.

A natural resources inventory is a list and description of the physical and biological characteristics of an area, a collection of data useful in identifying and evaluating environmental features, limitations, and impacts. The purpose of such an inventory is to help citizens, community leaders, planners, and developers incorporate environmental concerns into land use decisions. A better understanding of natural resources enables communities to both use and preserve the resource base on which they depend.

Environs

This inventory describes the natural resources of Dutchess County, New York. Dutchess County lies in the heart of the Hudson River Valley, and is bordered by Connecticut to the east, Putnam County to the south, Columbia County to the north, and Orange and Ulster counties across the Hudson to the west. The county seat is the city of Poughkeepsie, which is located on the shore of the Hudson River. Poughkeepsie is approximately equidistant from Albany and New York City, and is centrally located within the Hudson Valley region.



Format and Use

Each chapter of this Natural Resources Inventory describes one of the eight major resources of Dutchess County: Climate, Geology, Topography, Hydrology, Soils, Vegetation, Wildlife, and Significant Areas. Each chapter has three components: a definition of the resource, a description of the resource as it exists in Dutchess County, and a discussion of how that resource could be properly managed. The importance of the resources, their vulnerability to destruction or misuse, and their interactions with human communities are stressed throughout the text.

A natural resources inventory should be a working document. The looseleaf format of this inventory is designed to allow users to insert any additional information that might prove valuable in understanding the county's resource base. Most chapters contain one or more maps of the resources discussed, as well as numerous figures, tables, and photographs. An appendix at the end of the document contains more detailed data. The bibliography lists both sources used in preparing this inventory and selected additional readings on particular subjects.

The Natural Resources Inventory can be used in several ways. As an educational text and reference document it should prove useful to all interested citizens. As a decision-making tool it can be instrumental in:

- assessing the environmental impacts of proposed activities;
- developing land use plans and zoning policies that protect the natural features of an area while furthering community development goals;
- designing development projects to take advantage of certain resources without overtaxing them;
- selecting recreational or open space areas for preservation;
- identifying and regulating critical areas such as wetlands, floodplains, or prime aquifer recharge areas;
- judging the development suitability of a given tract of land; and,
- anticipating resource management problems and implementing corrective measures before crises develop.

without deteriorating or being consumed beyond its ability to replenish itself. If pushed beyond its capacity, the resource will eventually be unable to satisfy the user's demand, and may be permanently harmed or destroyed. The users will also suffer if they cannot find an alternative supply of the resource, as in the case of deer herds that starve when their populations exceed the capacity of their wintering grounds to provide enough food and shelter. As shown previously, human beings exceed the carrying capacity of a critical resource--groundwater--when they draw more well water from an area than is naturally replenished, and when they install septic systems too close together. The eventual results of such overuse are water shortages as water tables drop and the contamination of groundwater by inadequately treated septic wastes.

The fourth concept that should be kept in mind in using this document and in developing resource management programs is that natural resources are dynamic. Natural forces continually alter the environment, often at an imperceptibly slow rate. Seasons change, stream levels fluctuate, fields grow into forests, and lakes evolve into dry land. Over longer periods of time geological processes and weathering reshape the land; glaciers advance and recede.

Many significant effects that human activities have on the environment involve disrupting or accelerating these dynamic natural processes. For example, disturbed, exposed soils erode much more quickly than undisturbed soils. Soil lost from cropfields and construction sites finds its way into lakes and ponds, filling them at accelerated rates, shortening their useful lives as open water.

These four concepts--that all resources and resource uses are interrelated, that natural resources are limiting factors, that they have specific carrying capacities, and that they are dynamic--can be used in land use decisions to help communities use natural resources while preserving their quality, diversity, and abundance.

Conclusion

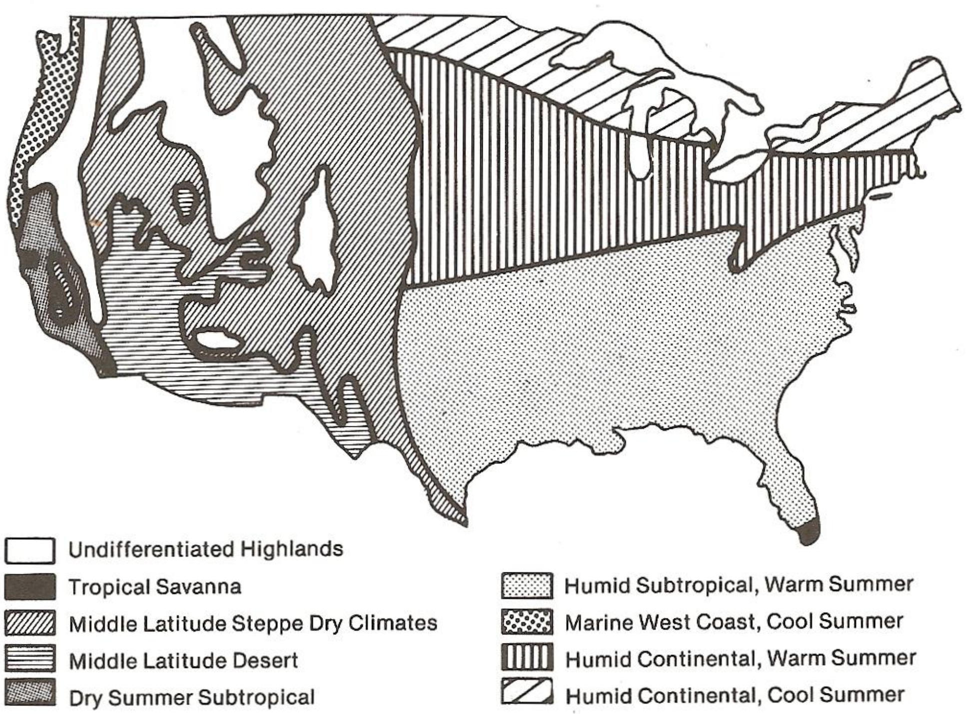
Dutchess County is endowed with a wealth of natural resources that have enabled the county to prosper. As the population grows, more and more pressure is being brought to bear on many of these resources. The risks and consequences of damaging the resource base through abuse and mismanagement grow as this pressure increases. For this reason it is important to develop land use policies, plans, and regulations that respect environmental limits. It is

Climate

Climate, the characteristic long-term weather pattern of an area, affects all components of the natural environment and human activities. Temperature, winds, humidity, precipitation, and other climatic factors continually shape land and water resources and their uses.

Dutchess County is located in the north temperate climatic zone. Its climate is humid continental (see Figure 1.1), characterized by strong seasonal contrasts and highly variable weather. Major weather systems that move up the Atlantic Coast or across the continental United States contribute to this variety. Ample year-round precipitation is supplemented in late summer by tropical maritime air masses. Polar air masses from Canada move southeast through the area to dominate the winters.

Climatic Regions



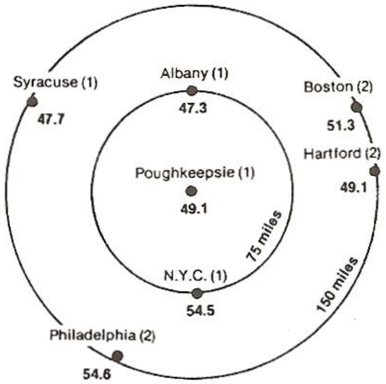
Redrawn and adapted from Trewartha, Elements of Physical Geography, 1957.

Figure 1.1

Continental areas are the source of the predominant air flow, but Dutchess County and the entire Hudson Valley also enjoy the moderating effects of air masses from the Atlantic Ocean. This maritime influence results in milder winter temperatures and longer freeze-free seasons than those found at the same latitude farther inland. The Catskill Mountains to the west and northwest also partly shield the county from cold polar air.

Moderate temperatures and sufficient precipitation make Dutchess County an excellent location for farming, while seasonal variations help to attract tourists and recreational users. The county's relatively warm summers and cold winters result in substantial heating and cooling costs for homes and businesses.

Average Annual Temperatures
Major Cities near Poughkeepsie



Source: U.S. Dept of Commerce, NOAA
(1) 1951 - 1980 Data
(2) 1975, 1976, or 1977 Data

Figure 1.2

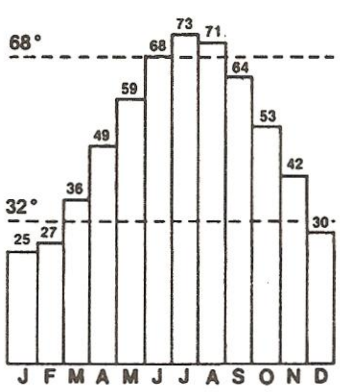
Temperature

Temperature is a measure of the intensity of heat. The county's average annual temperatures for the four coldest months, December through March, and four warmest months, June through September, are 30.8 and 70.6 degrees Fahrenheit, respectively. The lowest and highest temperatures ever recorded at the Poughkeepsie weather station were 21 degrees below zero in February 1897, and 107 degrees in July 1966. The average annual temperatures of Poughkeepsie (49.1 degrees), and of six major cities within 150 miles of Dutchess County can be compared in Figure 1.2.

The temperature in Dutchess County usually exceeds 90 degrees between 25 and 30 days a year. Cool summers may have fewer than 15 days of 90 degree temperatures, while hot summers may have more than 40 such days. Brief hot spells with uncomfortably high humidity occur during most summers.

Four to seven days of zero or below zero degree weather usually occur between mid-December and early March. During unusually mild winters, temperatures may fall to zero only once. Temperatures colder than 15 below zero are recorded approximately once in 20 years.

Normal Temperatures
Dutchess County
(Degrees Fahrenheit)



Temperatures are averaged for four weather stations in the County. Data from each station are listed in the Appendix.

Source U.S. Dept. of Commerce, NOAA.

Figure 1.3

The average monthly temperatures in Dutchess County are shown in Figure 1.3. These temperatures are averages of data collected at the four official weather stations in the county: Glenham, Millbrook, Poughkeepsie, and the Dutchess County Airport (Poughkeepsie FAA Flight Service Station). The actual monthly temperatures at each of these stations, along with the station coordinates and elevations, are listed in the appendix.

County weather information has been gathered only at the four locations listed above, and in Millerton. It is difficult to assess accurately the local micro-climates of areas whose topographic features differ from these locations. It is apparent, however, that fruit orchards and vineyards thrive in the relatively mild temperatures along both sides of the Hudson River. Cooler temperatures prevail in the higher elevations and the northeastern section of the county. The Harlem Valley is also usually colder than western Dutchess County because of the valley's distance from the moderating influence of the Hudson River and from the leeward protection of the Catskill Mountains.

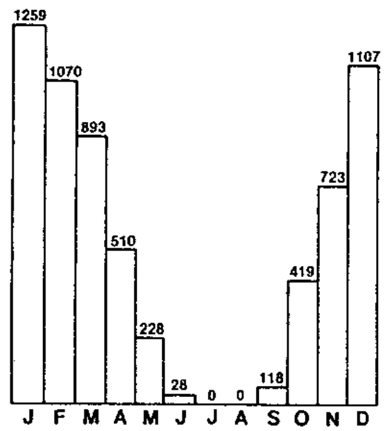
Heating Degree Days

Heating degree days are a measure of the number of days the average daily temperature is below 65 degrees. This measure is important to homeowners and the heating industry because space heating is normally required at temperatures below this level. A day with an average temperature of 65 degrees or more is said to have zero heating degree days, while a day with an average temperature of 50 degrees has 15 heating degree days (65-50=15 degrees). As the number of heating degree days increases, so does the use of energy to heat homes and businesses.

The number of heating degree days in Dutchess County ranges from 5,000 in the south to 7,000 in the north and northeast. Poughkeepsie has an annual average of 6,366 heating degree days. As shown in Figure 1.4, the summer months of June, July, and August require little or no heat. Each of the months of December, January, and February has more than 1,000 heating degree days.

Heating Degree Days
Poughkeepsie, New York

65°Base



Source: U.S. Dept. of Commerce, NOAA
Based on 1951 - 1980 data.

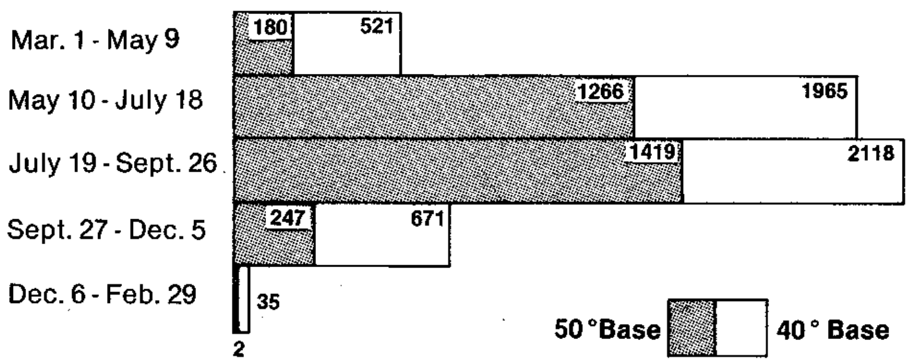
Figure 1.4

Growing Degree Days

Growing degree days are a measure of the amount of solar energy an area receives, based on temperature accumulations above a selected threshold temperature. They relate plant development and insect emergence to environmental air temperature to indicate which plants may be grown in a particular area. For example, most varieties of peas need 1,200 to 1,800 growing degree days (based on a 40-degree threshold) to reach maturity, so they can usually be grown only in areas that accumulate that many growing degree days or more.

The most common threshold temperatures for measuring growing degree days are 40 degrees and 50 degrees. These are generally accepted as temperatures required for growing economically important plants. Using a 40-degree base, annual growing degree days total approximately 5,300 near the Hudson River and 4,750 in the eastern part of the county. Using a 50-degree base, the total is about 3,100 near the Hudson River and 2,850 to the east. Average weekly growing degree day totals are listed in the appendix and summarized in Figure 1.5.

Growing Degree Days - Poughkeepsie, New York



Source: Dethier and Vittum, "Growing Degree Days in New York State," 1967.

Figure 1.5

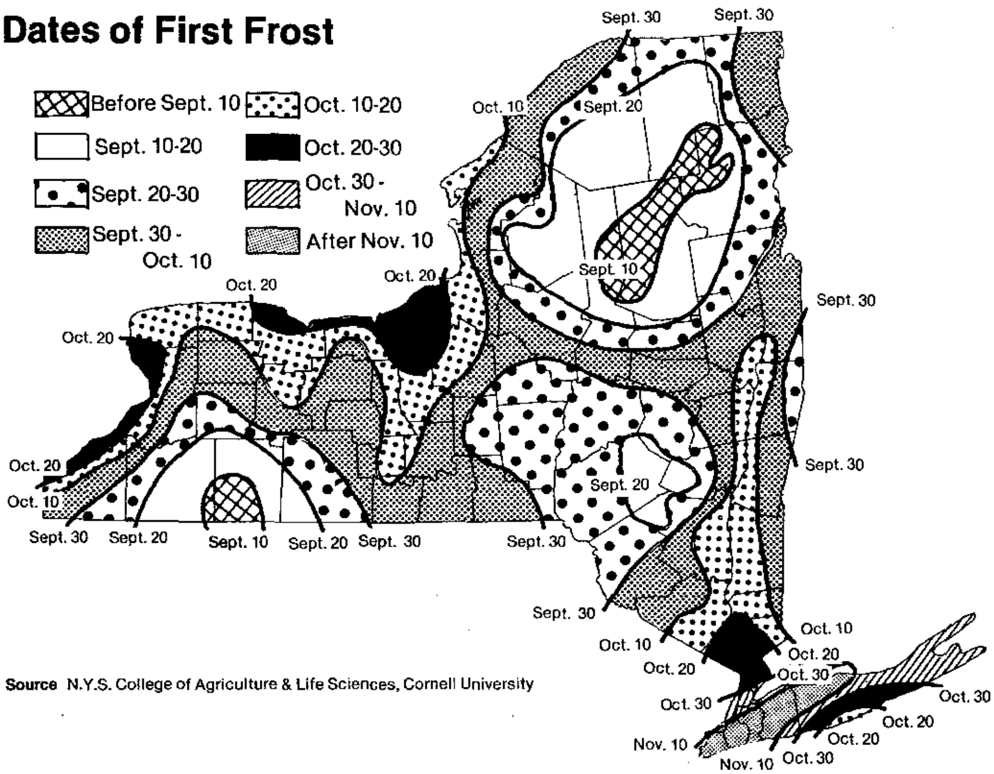
Information about growing degree days is useful to farmers, nurseries, research and extension specialists, and home gardeners. It is especially helpful in crop selection and in determining schedules for planting, pesticide application, and harvesting.

Freeze Data

Freeze data include the dates of the latest spring and earliest fall freezing temperatures (32 degrees F), and the period between them, known as the freeze-free season. This information is valuable in determining what types of plants are most suitable for an area and when freeze-sensitive crops can be planted.

The freeze-free season along Dutchess County's Hudson River shoreline is between 163 and 183 days long, and usually begins sometime between mid-April and early May. Farther east of the river, the season is shorter. Generalized maps of first frost and last frost for New York State are shown in Figures 1.6 and 1.7. Table 1.1. gives more specific freeze data for three locations in the county.

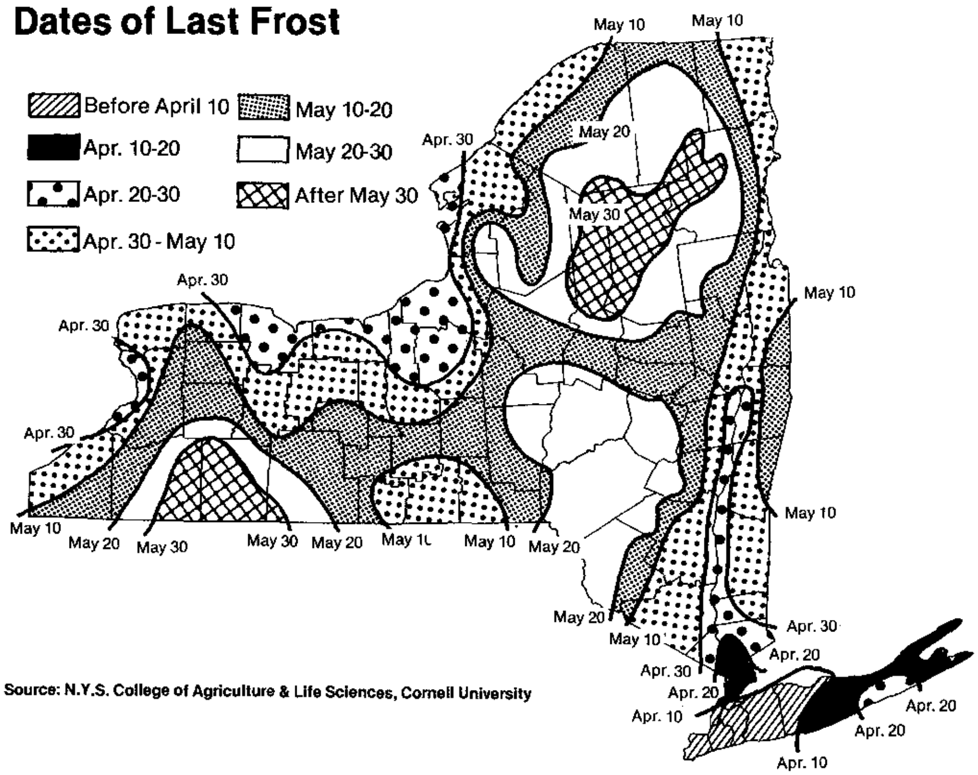
Dates of First Frost



Source N.Y.S. College of Agriculture & Life Sciences, Cornell University

Figure 1.6

Dates of Last Frost



Source: N.Y.S. College of Agriculture & Life Sciences, Cornell University

Figure 1.7

Table 1.1 Freeze Data
Dutchess County, New York

Station	Mean Date of Last Frost	Mean Temp.	Mean Date of First Frost	Mean Temp.
Glenham	April 13	27°	Oct. 12	28°
Millbrook	May 19	28°	Sept. 25	30°
Poughkeepsie	May 9	32°	Oct. 11	30°

Source: U.S. Department of Commerce, NOAA

Winds

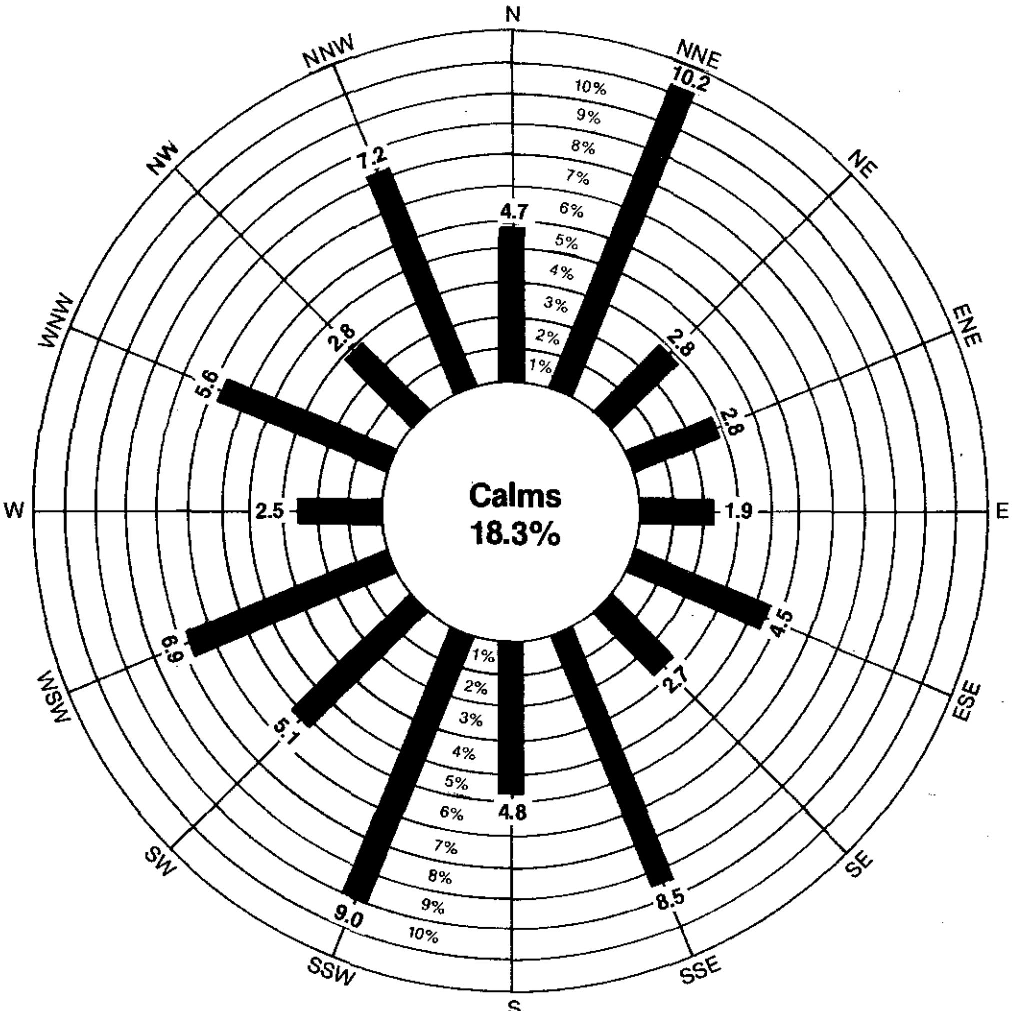
Wind patterns are produced by the rotation and solar heating of the earth and the buoyancy of warm air. Westerly and northerly winds prevail in Dutchess County in the winter and early spring, with average speeds ranging from 9 to 11 miles per hour (mph). Summer winds come from a more southerly direction with average velocities between 5 and 6 mph.

During a five-year testing period that ended in 1954, 70 percent of wind measurements fell in the 1 to 11.5 mph range. Wind speeds greater than 11.5 mph were recorded only 12 percent of the time, while 18 percent of the time the air was calm.

Wind speeds are generally higher during the day, and they begin to decrease as sundown approaches unless a storm system is passing through. Severe winds are not a common hazard in Dutchess County, but they occasionally occur in association with thunderstorms and other storm systems. The strongest winds blow predominantly from the west with speeds ranging from 25 to 30 mph and gusts of 40 to 65 mph or more. Wind speeds exceed 24 mph less than 0.5 percent of the time. Small tornadoes have struck the county, but such occurrences are rare.

The windrose in Figure 1.8 shows the distribution of surface wind directions in Poughkeepsie, as recorded at Dutchess County Airport from 1950 through 1954. The length of each black bar reflects how often wind came from a particular direction during that five-year testing period. For example, wind came from the north-northeast (NNE) 10.2 percent of the time, and from the east (E) only 1.9 percent of the time.

Windrose: Surface Wind Direction Frequencies
Poughkeepsie, New York



Source: U.S. Dept. of Commerce, NOAA

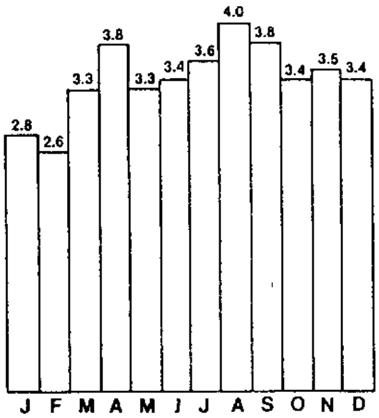
Figure 1.8

Figure 1.8 shows that the most common wind directions are north-northeast, north-northwest, south-southeast, and south-southwest. Winds come from the general direction of the west more frequently than from the east, and from the southwest quarter more than any other. Monthly wind direction and velocity data are included in the appendix.

Precipitation

Precipitation is condensed water vapor that falls to earth as rain, sleet, snow, or hail. Annual precipitation in Dutchess County normally ranges from 36 to 44 inches. Extremes of 27 and 60 inches have been recorded.

Normal Precipitation in Dutchess County
(inches)



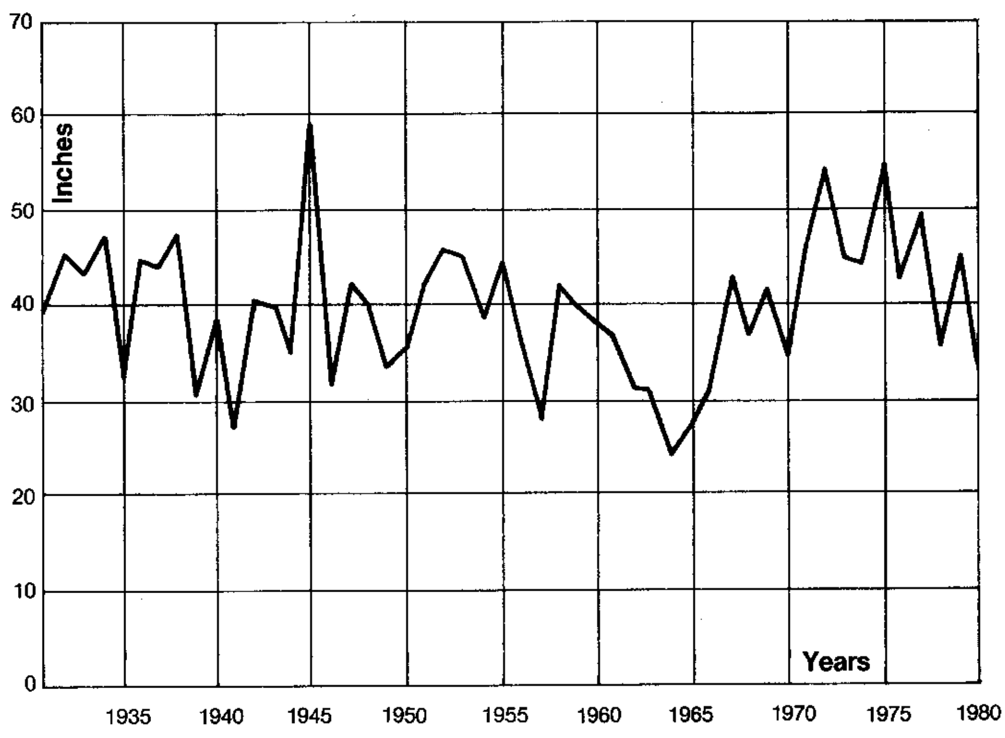
Source: U.S. Dept of Commerce, NOAA
Precipitation is averaged for five weather stations in the County.

Figure 1.9

During the May to September growing season, total precipitation is usually between 15 and 25 inches, with extremes of 9 and 35 inches recorded. Precipitation during these months is generally sufficient to support crops, home gardens, lawns, flowers, and shrubs. One or more short periods of no rainfall occur during most summers. Total monthly precipitation in the county, calculated by averaging data from five locations, is shown in Figure 1.9. The actual precipitation totals for each of the five weather stations are listed in the appendix.

The graph in Figure 1.10 traces the pattern of annual precipitation in Poughkeepsie since 1931. Precipitation for this period is also listed in the appendix. The graph clearly shows the extended drought that affected the county from 1963 through 1966. This is the only drought in the 50 years shown that persisted for several consecutive growing seasons and reached severe levels before normal rainfall returned.

Annual Precipitation - Poughkeepsie, New York



Source: U.S. Dept. of Commerce, NOAA
1931 to 1959 Data collected in Poughkeepsie, 1960 to 1980 Data collected at the Dutchess County Airport.
1977 and 1978 Data collected in Millbrook.

Figure 1.10

Much of the precipitation in the Northeast comes from the Gulf of Mexico and the Atlantic Ocean, and is transported by major atmospheric storm systems. These systems develop less frequently during the summer, but local convective activity in the form of thunderstorms produces significant amounts of summer rain. Local topographic variations also influence precipitation.

Most of Dutchess County receives moderately heavy amounts of snow from late November through March, with 40 to 50 inches falling each year. The northeast section of the county may receive 60 inches of snow annually. Few winters have fewer than 30 inches or more than 60 inches of snow. During most winters, at least one storm will leave more than six inches. The ground is usually snow-covered from mid-December to mid-March.

Evaporation rates must be considered in designing reservoirs and other open water storage systems. Oceans are the main supply of atmospheric moisture through evaporation, but lakes, rivers, moist soil, and vegetation also make important contributions. Most of the lakes in Dutchess County lose 28 to 30 inches of water a year due to evaporation; this amount decreases slightly at higher elevations.

Relative humidity is the ratio of the amount of moisture present in the atmosphere to the amount that the air can hold at any given temperature. A combination of high relative humidity and high temperatures is uncomfortable. Relative humidity at mid-afternoon during summer months in Dutchess County usually ranges from 50 to 60 percent, with maximum humidity in the morning and minimum humidity in the afternoon. Relative humidity is generally lowest during the late winter and early spring and highest during the summer.

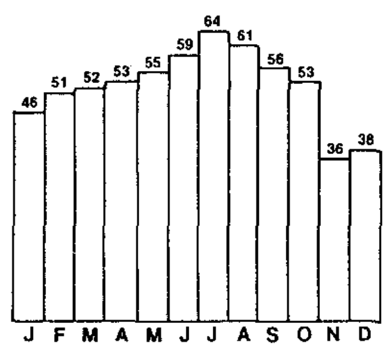
Sun/Cloud Cover

Total possible sunshine is the amount of sunshine that an area would receive annually or monthly if clouds never interfered. Dutchess County and the Hudson Valley enjoy among the highest percentages of total possible sunshine in New York State. The annual county average is between 56 and 58 percent, increasing from 45 percent during November and December to approximately 65 percent in the summer and early fall.

Within the Hudson Valley the amount of sunshine is greatest in the south. Albany annually receives 54 percent of the total possible sunshine, while the average in New York City is 59 percent. The monthly percentages for Albany are given in Figure 1.11.

Average Monthly Sunshine
Albany, New York

Percentage of Possible Sunshine



Source: U.S. Dept. of Commerce, NOAA
Based on 37 years of record through 1975, for the Albany County Airport.

Figure 1.11

The annual hours of sunshine in Dutchess County range from 2,400 to 2,600. The county averages 90 clear days, 120 partly cloudy days, and 150 cloudy days each year. At least 15 cloudy days occur during each December, January, and February.

Severe Weather Events

Thunderstorms, hurricanes, blizzards, tornadoes, floods, and droughts are all severe weather events that have struck or affected Dutchess County. They result from the interactions of temperature, wind, and precipitation.

Thunderstorms

Thunderstorms occur an average of 30 days a year, most of them during the summer. They may be accompanied by hail, strong winds, and heavy rains, which in turn can cause flooding and soil erosion, crop and tree damage, and local blackouts. Dense fog sometimes follows thunderstorms. Independent of thunderstorms, dense fog occurs between 25 and 30 days a year, most often during September and October.

Hurricanes

Dutchess County is not in the normal path of hurricanes, but at least three major hurricanes have affected the county in the past 50 years. Occasional hurricanes passing Long Island cause local high winds and heavy rains, but these storms rarely move inland through New York State.

Blizzards and Freezing Rain

Blizzards of the type common to the Midwest are rare in Dutchess County, but heavy snowstorms are not unexpected. Storms with freezing rain usually occur at least once a year, and they may precede snowstorms.

Tornadoes

Tornadoes do occur in the county. Although none have been reported in the Poughkeepsie urban area, several small tornadoes of limited duration have passed through the county's rural sections.

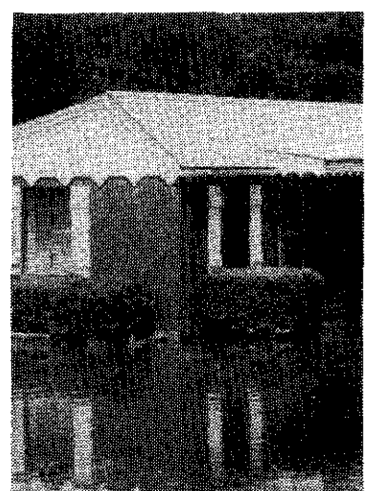
Floods

Each major stream in Dutchess County has a significant number of floodprone areas, shown on the Floodplains Map discussed in Chapter Four. Certain areas are known for annual flooding.

The probability of flooding is greatest from December to April. Runoff from melting snow and ice often causes minor spring floods. Ice flows and heavy rainfall sometimes aggravate spring runoff conditions, producing severe floods in low-lying areas.

Floods can also occur during the summer and early fall, when severe rainstorms are most likely to strike. Storms that shed more than one inch of rain in 24 hours are expected between 6 and 12 days a year, and are most common from May to October. Accumulations exceeding two inches per day have been responsible for several major county floods.

Three of the largest floods ever recorded in Dutchess County were triggered by coastal storms in September 1938, August 1955, and October 1955. In 1955, Hurricane Diane inundated major portions of the Wappinger Creek, the Tenmile River, and the Fishkill Creek basins with a severe flood that caused millions of dollars in damage. Some reports state that this was an 80-year flood, while others indicate that it was a 100-year flood.



Another significant flood developed when four to seven inches of rain fell on the county between June 28 and 30, 1973. On June 30, the Wappinger Creek between Rochdale and Pleasant Valley rose at the rate of six inches per hour, closing roads, washing out bridges, and causing local property damage amounting to hundreds of thousands of dollars. Flood damage was reported in 12 towns, and more than 1,000 acres of cropland were severely damaged by top soil losses from gullying and erosion. The county was subsequently declared a flood disaster area.

The most recent major flood occurred May 29 to 31, 1984. Up to eight inches of rain fell in a three-day deluge that caused a 25- to 30-year flood in the Tenmile River Valley. Significant flooding also occurred along the Fishkill, Sprout, and Wappinger Creeks. The county was declared a State Disaster Emergency area after suffering an estimated five million dollars worth of damage to crops, private property, and public facilities.

Droughts

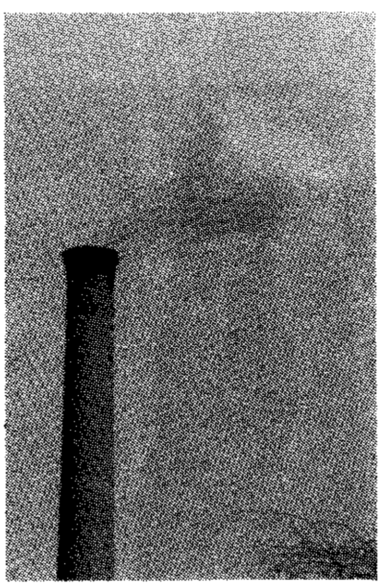
The county's major drainage basins have sufficient capacity to sustain some flow even during severe droughts, such as those of the early 1960s. Serious droughts are rare; brief dry spells are far more common. Dry periods temporarily place crops under stress and often force restrictions in the recreational uses of forested lands because of fire hazards.

Air Resources

The quality of air resources is determined by human activities and natural climatic factors. Air pollution seriously affects human, plant, and animal health. It also causes economic losses by accelerating the deterioration of materials, structures, and machines.

Natural air pollution resulting from volcanic eruptions, fires, forest fires, and dust storms, is usually dispersed before reaching the county, and rarely causes significant problems by itself. The long-term effects of combining natural pollution with emissions from industry, automobiles, and electric power plants, and other human activities are not completely understood.

Air Quality Monitoring



Dutchess County is included in the Hudson Valley Air Quality Control Region for the measurement of national air quality levels. Four air monitoring stations were operated in the county until 1978, in Poughkeepsie, Rhinebeck, Fishkill, and LaGrange. They collected data on levels of sulfur dioxide and carbon monoxide, total suspended particulates, and dustfall to determine whether the County's air met federal Ambient Air Quality Standards (AAQS). The Poughkeepsie station is still in use.

The results of the AAQS monitoring show that Dutchess County's air quality is generally good. The level of total suspended particulates (TSP) recorded in Poughkeepsie has been well below the AAQS of 65 milligrams per cubic meter since 1968. According to the New York State Department of Environmental Conservation (DEC), which is responsible for administering the state's air quality program, carbon monoxide, sulfur dioxide, and dustfall levels also meet the federal standards. The concentrations of these pollutants are well within the federal standards, in part, because utilities, soil mining, cement manufacturing, and quarrying are the only heavy industries in the county's airshed.

Elsewhere in the Hudson Valley, concentrations of ozone and total suspended particulates still occasionally exceed state and federal air quality standards. In most cases they present much less of a problem than in years past, but continued vigilance is necessary to ensure that air quality continues to improve.

Ozone is of particular concern because it is a poisonous form of pure oxygen. As the major component of smog, ozone is created when hydrocarbons and nitrogen oxides produced by fossil fuels combine in the presence of sunlight. Ozone irritates eyes, air passages, and lungs, makes breathing difficult, and causes headaches. It is also toxic to plants and weakens materials such as rubber and fabric.

Airborne Toxics

Few standards exist for airborne toxic pollutants. Ambient concentrations of asbestos, beryllium, mercury, vinyl chloride, and arsenic are regulated by the federal Environmental Protection Agency. New York State DEC guidelines for the control of hazardous ambient air contaminants cover 40 high toxicity substances, such as benzene, polychlorinated biphenyls (PCB's), and nickel, and 150 compounds of moderate toxicity. The guidelines are used in reviewing emission permit applications under the state's air quality program; they do not, however, serve as strict limits on toxic emissions. For many of these contaminants, no recommended limits have been established.

The total number of compounds covered by the New York State guidelines--approximately 200--represents a fraction of the number of toxic pollutants that enter the air. Little is known about the ambient concentrations of many of these substances, how they combine and interact, or the long-term health and environmental problems their presence may cause.

Acid Rain

Acid rain is a major air and water quality problem that affects Hudson Valley residents. The term "acid rain" applies to acidic rain, snow, sleet, and dry falling particles. The acids are formed when sulfur dioxide and nitrogen oxide gases, both products of fossil fuel combustion, are oxidized in the atmosphere and react with water to form sulfuric and nitric acid. These acids can travel great distances before falling to earth.

The average pH of rainfall in much of the northeastern United States is 4.3. Normal rain has a slightly acidic pH of 5.6; distilled water is neutral, with a pH of 7.0. Each change of one unit on the pH scale represents a 10-fold change in acidity, so the difference between 5.6 and 4.3 means northeastern rain is often more than 10 times as acidic as it should be.

Rain as much as 50 times more acidic than normal rain has been officially recorded in many locations in New England and New York. At the Mohonk Preserve in Ulster County, the average pH of rain has ranged from 4.0 to 4.2 in recent years. Rainfall measured by Scenic Hudson, Inc. in Poughkeepsie in late 1983 averaged pH 3.95.

There are many questions about the health and environmental effects of acid rain. It is widely believed that acid rain has been responsible for the disappearance of all plant and animal life from hundreds of lakes and streams in Canada and the Adirondacks. It has also been documented that acid rain and other air pollutants are causing millions of dollars worth of corrosion damage to buildings, monuments, and other structures in the northeast. Acid rain is implicated in the declining health of forests in New York, New England, the Appalachian Mountains, and eastern Canada. It is also feared that acid rain's tendency to leach nutrients, such as calcium and magnesium, and toxic metals, such as aluminum, from the soil poses a threat to drinking water quality and soil fertility in sensitive areas.

Soils and bedrock that are rich in lime can help buffer the effects of acid rain on surface waters and soils. High lime concentrations are characteristic of much of the Hudson Valley. How long lime can be counted on to shield such areas from the effects of acid rain is unknown. Some scientists believe that the buffering capacity of many areas may be nearly exhausted.

The Hudson Highlands, like the Adirondacks, have no lime buffer to protect them. In addition, preliminary studies have indicated that 25 percent of the lakes tested in Dutchess, Orange, Putnam, and Rockland counties are highly sensitive to acid and have no natural buffering capacity.

Noise Pollution

Pollution in the form of annoying noise levels can result in physical and psychological damage. Low noise levels constitute an annoyance; louder noise levels affect home, work, and community activities, reduce recreation and relaxation values, cause hearing damage, and interfere with sleep. In Dutchess County, traffic, vehicles, lawnmowers, and household appliances are the most common sources of noise pollution.

Research has shown that prolonged exposure to sound levels higher than 80 decibels causes hearing damage. The noise produced by lawn mowers, snowmobiles, and chainsaws ranges from 95 to 110 decibels at the operators' ears; freeway traffic and vacuum cleaners produce close to 80 decibels. Background noise levels in a quiet residential area may equal 40 decibels, while in offices and department stores levels of 60 decibels are typical.

Noise can often be limited at the source by designing and using quieter products and restricting the use of noisier ones. Its impact can be reduced by using sound insulating materials, buffer zones, acoustical barriers, and other devices to limit noise transmission, and by using appropriate protective gear when noise cannot be avoided.

Resource Management Implications

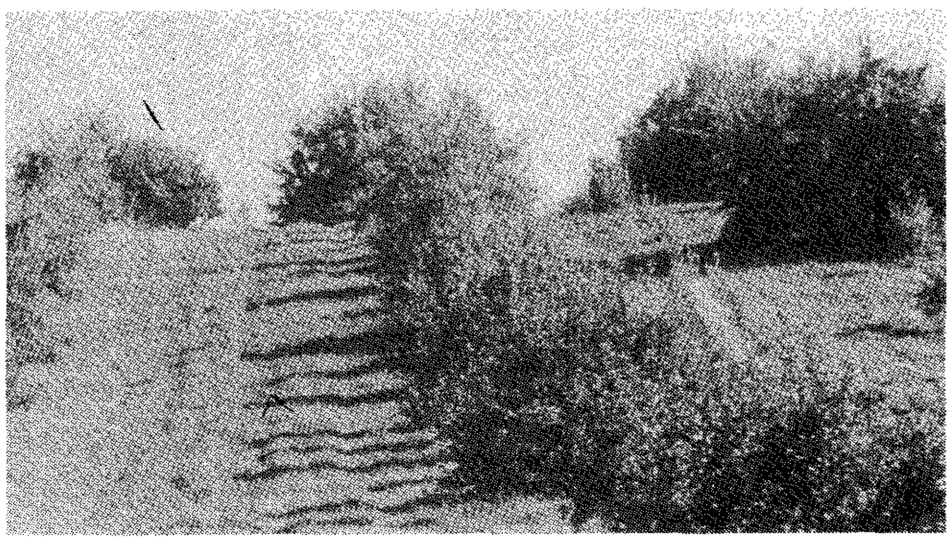
Climate affects all natural resources and land uses. Precipitation, wind, temperature, sunshine, and weather extremes determine water supply abundance, agricultural viability, energy costs for heating and cooling, and patterns of development. Climate also shapes the land, affecting topography, drainage, soils, and vegetation. Despite its significance, however, climate is usually overlooked in land use decisions. Often viewed only as a large-scale phenomenon that affects all areas of a community equally, climate actually can vary a great deal within a small geographic region. Differences in temperature, rainfall absorption, wind exposure, humidity, and access to sunlight are among the climatic factors that should be considered in the land use decision-making process.

Agriculture

Agriculture is one land use that obviously depends on local and regional climate conditions. At the regional level, Dutchess County's humid continental climate usually provides ample rainfall, sunshine, and warmth for a variety of farm uses. Short-term weather patterns, however, are less predictable; drought years, exceptionally wet seasons, and late spring frosts or winter storms occasionally disrupt growing cycles.

The western part of the county is slightly warmer and more moist than the eastern part because of the moderating influence of the Hudson River and the shielding effect of the Catskill Mountains. The milder climate is conducive to fruit farming, which is concentrated in the towns of Red Hook and Rhinebeck. Dairy and field crop farming is prevalent in the cooler portions of the county, where commercial orchards are limited by climatic constraints.

Good farmland is an irreplaceable resource. If farming is to thrive in the county, land use policies must recognize that climate restricts the amount and location of orchard and fertile cropland available, and that urban encroachment on that land permanently takes it out of agricultural production. Zoning laws, open space preservation programs, development rights transfers, and taxation policies that discourage the development of good orchard lands and prime agricultural soils should be adopted throughout the county.

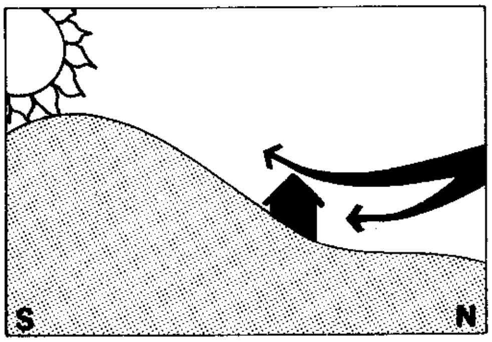


Energy Conservation

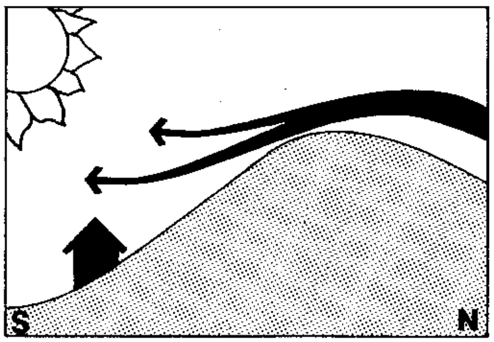
Energy use is directly related to climate. Cool winters and warm summers are typical of the entire county, but local conditions vary considerably with such factors as elevation, slope, and orientation.

Energy costs, conservation options, and access to renewable energy resources should be major considerations in selecting development sites, designing site plans, orienting buildings, and choosing construction techniques and materials. Site plan review procedures and zoning regulations should encourage energy efficient design. Prevailing winds, airsheds, and solar orientation should be considered during the design phase of each project.

Climate and Building Site Suitability



Buildings on north-facing slopes receive less sunlight and face the cold northerly winds that prevail during the winter. This combination can add substantially to heating bills.



Buildings on south - facing slopes can benefit from the southerly winds of summer while being shielded from winter's cold north winds. They also receive more sunlight, which can be collected as solar energy and used for heating purposes.

Figure 1.12

Residential developments, for example, as shown in Figure 1.12, should take advantage of prevailing winds for summer cooling, while relying on slopes, vegetative buffers, and insulation for protection from northwestern winter winds.

The proper use of sunlight could greatly reduce heating costs. In the summer, deciduous trees and overhangs can be used to shade buildings oriented to catch the winter sun. Taking better advantage of the county's 2,400 to 2,600 annual hours of sunshine by maximizing solar access in new development projects could measurably reduce dependence on fossil fuels.

Air Quality

The county's relatively good air quality should not be taken for granted. Almost 40 percent of the wind recorded in the county comes from the western half of the compass. These winds can carry pollution eastward into Dutchess from as far away as the midwest, as well as from neighbors such as Ulster and Orange counties. Dutchess County should, therefore, participate in regional planning efforts and review industrial or energy development proposals to prevent activities outside the county from causing air quality to deteriorate. At the same time, Dutchess should cooperate with the air quality protection efforts of neighboring states to the east. The establishment and enforcement of comprehensive state and federal standards for the emission of toxic air pollutants should be encouraged.

It is becoming increasingly clear that acid rain is damaging critical components of the ecosystem over a vast area. The effects of acid rain on Dutchess County are not well documented, but it is known that rainfall pH in the county, as in most of the northeast, is abnormally low. Dutchess County's air cannot be considered clean until the nationwide emission of the sulfur dioxide and nitrogen oxide gases that form acid rain is drastically reduced, and normal rainfall returns. The county should, therefore, support national and state efforts to reduce power plant emissions that produce acid rain, and should monitor acidity levels and their impacts in the Hudson Valley.

Air pollution concerns are equally relevant at a site-specific level. Prevailing winds should be considered, for example, in siting industrial projects. Heavy industries which may produce smoke, dust, odor, or noise should be situated on the leeward side of residential areas.

Water Resources and Flooding

The county is fortunate to receive an annual average of 40 inches of precipitation, and to have enough groundwater and surface water storage capacity to sustain most land uses during moderate droughts. Such droughts are not infrequent, and severe droughts have been known to occur.

As discussed in more detail in Chapter Four, land use and water management policies should be designed to preserve the water retention capacity of the county's drainage basins. Drainage systems, for example, should permit stormwater to filter back into the groundwater supply instead of discharging runoff into streams and rivers. Measures such as these can enable the county to cope with continued growth and existing land use patterns without increasing the damage droughts cause, and without jeopardizing the balance between water demand and supply.

Although severe floods are rare, floods significant enough to cause considerable damage are not infrequent. To minimize this damage, floodplains along the county's streams and rivers should not be developed for residential purposes or for other uses that floods would harm.

The obstruction or extensive filling of floodplains should also be prevented, to avoid increasing flood damage on adjacent or downstream properties.

Upland Areas

The wooded uplands of eastern Dutchess County are cooler and drier than other areas, making them attractive sites for seasonal homes, camps, and recreational facilities. These areas are often environmentally sensitive because of steep slopes, erodible or shallow soils, and aesthetic features discussed in subsequent chapters. Their use for resort purposes can preclude other land uses, such as timber production, year-round residential settlements, or wildlife habitat, while overdeveloping them can destroy the resources and community characteristics that are responsible for their popularity. Local decision makers should be mindful of the economic and environmental trade-offs involved in the development of these upland areas, and of the destructive consequences of allowing them to be inappropriately used.

Recreation and Tourism

Developers of recreation areas should consider the moderating influence of the Hudson River in evaluating potential outdoor recreation sites. For example, the northeastern part of the county receives more snowfall than the western part, making it a potentially more attractive location for winter sports facilities. Sunlight access, rainfall, and wind exposure are other locally-variable climatic features that should play a part in siting recreation areas, farms, seasonal homes, and other weather-dependent uses.

Seasonal Variations

Seasonal changes contribute immeasurably to Dutchess County's beauty and quality of life, and enhance its tourism, recreational, and residential potential. Autumn colors, for example, provide a stunning backdrop for the historic sites along the Hudson River, and for the farmlands and forests of the rural towns. Summers are warm and long enough to support many forms of outdoor recreation as well as agricultural activities. Spring rains usually provide enough water to replenish needed supplies. Winters are seldom severe enough to limit transportation for long periods.

The seasons help keep Dutchess County's environment interesting, productive, and enjoyable. Promotional efforts, land use plans and resource management strategies should reflect an awareness of these climatic assets.

Geology

Geology is the science of the composition of the earth's crust, including the study of rock structure and formation. The natural processes that shape the land--uplifting, erosion, sedimentation, and cracking--are as vigorous today as in the past. Because they affect physiography, topography, quality and quantity of groundwater, drainage patterns, mineral resources, soil content and depth to bedrock, understanding these geologic processes is essential to sound resource management.

The rock base of Dutchess County consists of younger unconsolidated materials (glacial and recent deposits) overlying older consolidated material (bedrock). A study of the county's geological history reveals how these materials were formed and what types of bedrock and glacial deposits are present today.

The geologic structure of Dutchess County is complex. Its history extends over one billion years as a continuous process that has included several periods of major mountain building, ocean invasion and retreat, and glaciation. These events are part of the dynamic evolution of the earth's crust. Externally, natural elements of weather and water continually erode the surface; internally, heat creates pressure to further change the shape of the land.

Dutchess County's geological development can be discussed in terms of four eras: Proterozoic, Paleozoic, Mesozoic, and Cenozoic. The activities and formations that occurred in the county during each of these eras are listed in the appendix.

Bedrock

The bedrock of the county is divided into five groups:

- Hudson and Housatonic Highlands gneisses and uprooted blocks of gneiss,
- Wappinger group,
- Poughquag quartzite,
- Austin Glen graywacke and shale, and
- Pelitic rocks.

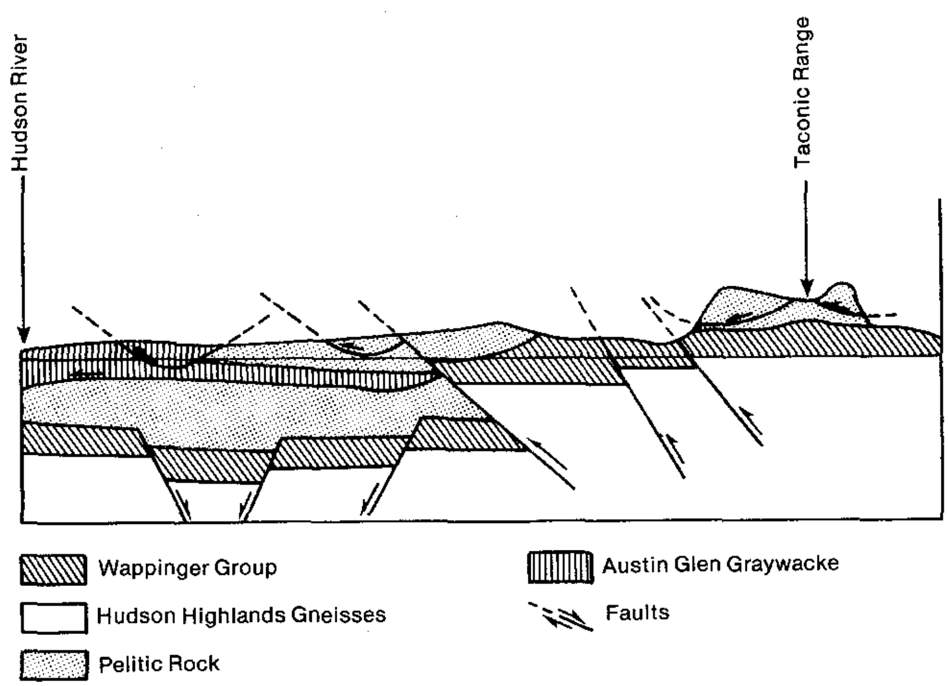
Most of the bedrock types are metamorphic or sedimentary rocks ranging in age from the Proterozoic Era (more than

1,100 million years ago) to the Ordovician Period of the Paleozoic Era (about 450 million years ago).

Metamorphic rocks are those that have been changed in texture and composition by heat, pressure, or chemically active solutions. Sedimentary rocks are stratified rocks composed of rock particles and other cementing materials deposited in water. The older Proterozoic rocks consist primarily of metamorphic rocks formed from granite, including the coarsely banded gneisses. The younger Paleozoic rocks are sedimentary and metamorphic and include quartzite, limestone, dolostone, marble, phyllite, shale, slate, and schist. Older rocks are generally found in southeastern Dutchess County, with a progression to younger rocks in the northwestern part of the county. A simplified view of bedrock in Dutchess County is shown in the Bedrock Map. The cross section diagram in Figure 2.1 illustrates how complex these bedrock patterns can actually be.

Bedrock Patterns:

Cross Section Across Northern Dutchess and Southern Columbia Counties

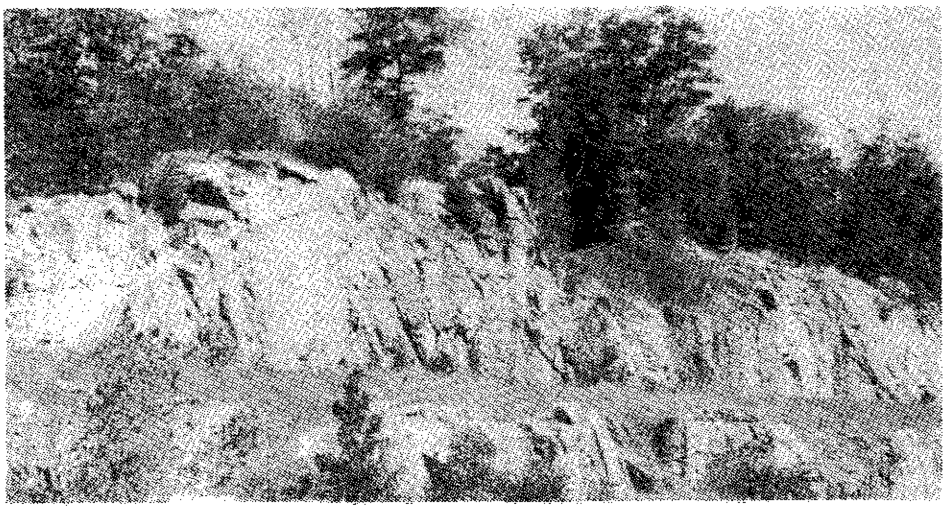


Adapted from Woodward-Clyde Consultants, 1979

Figure 2.1

Hudson and Housatonic Highlands Gneisses and Uprooted Blocks of Gneiss

The oldest rocks in Dutchess County are in the Hudson Highlands, an upland area composed primarily of various gneisses. These rocks, which were formed during



the Proterozoic era, are most common along the southern border of Dutchess County, between the Hudson River and the western border of the town of Pawling. The second largest occurrence of these rocks underlies a group of prominent hills, the Housatonic Highlands, east of Dover Plains. Isolated, uprooted blocks of gneiss crop out at Todd Hill in the town of LaGrange, Corbin Hill north of the village of Pawling, Stissing Mountain in the town of Pine Plains, and in a series of small fault slivers between the city of Beacon and the town of Fishkill. The orientation of this bedrock is northeast to southwest.

Most of the gneiss consists of light and dark colored minerals arranged in layers with a banded, streaky, or speckled appearance. Gneisses containing light colored minerals such as quartz, feldspar, and white mica or muscovite predominate. Various types of gneisses containing dark minerals such as hornblende, garnet, and black mica or biotite also occur.

Extensive outcrops of gneiss are generally more resistant to weathering than younger Paleozoic rocks. Gneiss outcrop areas are usually part of more rugged terrain and exist at higher elevations. Granite gneiss, which occurs at North Beacon Mountain, is the most durable of these types and is sometimes quarried for crushed stone and building stone. The weaker gneisses form the lower hills and tributary valleys to the Hudson River. They follow crushed areas along faults or softer carbonate belts. The yield of drilled wells tapping gneiss is usually small, averaging about 11 gallons per minute of soft water.

Poughquag Quartzite

A compact, hard quartzite with a quartz content greater than 90 percent occurs in a few areas in Dutchess

County. Poughquag quartzite rests on Proterozoic gneisses and form the flanks of the Hudson and Housatonic Highland and Stissing Mountain. Wells tapping this formation produce only a small amount of water, averaging 10 gallons per minute.

Wappinger Group

The Wappinger group, an elongated mass of carbonate rocks, occurs along the Wappinger Creek for which it was named. It also appears beneath the Fishkill Creek valley north of and adjacent to the Hudson Highlands, beneath the Harlem Valley along the Tenmile River and its tributaries, and in the north central parts of Dutchess County.

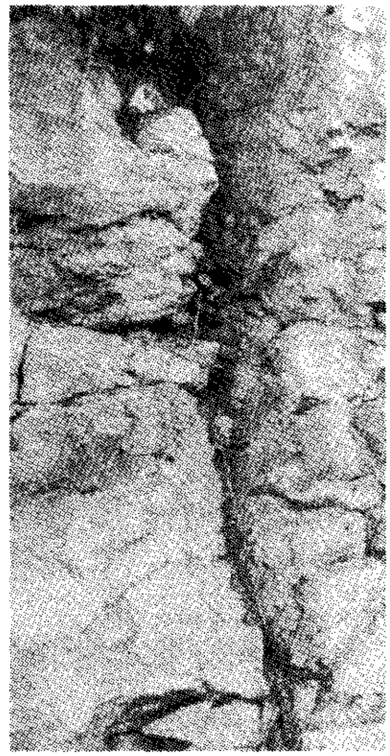
The carbonate rocks range from almost pure calcium carbonate (calcite) to almost pure calcium magnesium carbonate (dolomite) and include:

- Copake limestone,
- Rochdale limestone,
- Halcyon Lake calc-dolostone,
- Briarcliff dolostone,
- Pine Plains dolostone,
- Stissing dolostone, and
- Stockbridge limestone.

The chemical content of the Wappinger group and associated unconsolidated deposits is well suited to agriculture. The lime component also has economic value as crushed stone or agricultural limestone. One of the largest quarries in New York State is located south of Poughkeepsie at Clinton Point. The dolostone in this quarry has an average magnesium carbonate content of 38.16 percent. Stones of all sizes are produced, ranging from large rock fragments (riprap) and aggregate sizes used in construction, to stone sand used for fill and masonry work. The Wappinger group is also mined in the towns of Pleasant Valley, near the Wappinger Creek, and Dover, in the Lake Ellis area. The Lake Ellis bedrock has a high magnesium content that makes it valuable for agricultural uses. These economically important limestones and dolostones were mostly formed from direct precipitation of calcium and magnesium carbonate in sea water.

The metamorphism of the Wappinger group generally increases in intensity from the northwest to the southeast.

In the town of Milan and the valley of the Wappinger Creek, the original bedding is readily visible because the area is relatively undisturbed. Farther east, in the Harlem Valley, the formation has been metamorphosed into marble and the beds are severely folded. The marble in the southeastern part of the county has been deformed several times by plastic flow so that it appears to be wrapped around stronger rocks. South of Pawling, masses of schist have been folded and vaulted into the carbonate, appearing as inclusions.



It is difficult to determine the exact thickness of the carbonate rocks because of the amount of deformation and metamorphism that has occurred. These rocks are believed to be approximately 1,000 feet thick in most places in the county. A thickness of 2,800 feet has been measured in the north-central part of the County, near Stissing Mountain.

The Wappinger group is often overlain by a thin layers of Balmville limestone and conglomerate, particularly in the Harlem Valley and at Rochdale in the town of Poughkeepsie. The Balmville layer is known for its fossils.

Rocks in the Wappinger group weather readily and are commonly found deposited in valleys and lowland areas. Internal erosion occurs within this formation as the movement of groundwater dissolves the carbonate deposits. Solution channels and voids are consequently formed, providing storage cavities for groundwater supplies. This stored water can easily be polluted by contamination sources, such as septic tanks, where there are not enough unconsolidated deposits on top of the carbonate bedrock to filter the waste materials. Although cave-ins sometimes occur in carbonate rocks, they are rare in Dutchess County. Wells in the Wappinger group average 22 gallons per minute and the water is hard.

Austin Glen Graywacke and Shale

The Austin Glen formation was deposited on an ancient, unstable continental shelf. Few fossils can be found in the formation because its original environment was not hospitable to living things. It is a poorly sorted rock type that displays many of the features of a rapidly deposited sediment, including ripple marks and cross bedding. Geologists theorize that the material was originally deposited 60 miles to the east and carried westward during a period of rapid uplifting known as the Livingston Gravity Slide. The formation consists of thin- to medium-bedded, coarse, dark gray sandstone, or fine-grained conglomerate composed of firmly-cemented, rounded fragments.

Austin Glen graywacke and shale are found in a wide band along the Hudson River from Poughkeepsie to Columbia County, in the towns of Wappinger, Fishkill, and LaGrange, along the uplands between the Wappinger and Sprout Creeks, and along an arm extending from Poughkeepsie into the towns of Clinton and Milan. Wells in this formation produce approximately 16 gallons per minute of moderately hard water.

Pelitic Rocks

The most extensive bedrock formations in Dutchess County are included among the pelitic rocks. These formations are listed below, from oldest to youngest:

- Everett schist, quartzite;
- Elizaville argillite, quartzite;
- Nassau shale, quartzite;
- Germantown shale, limestone, congolomerate;
- Stuyvesant Falls shale, quartzite, chert;
- Indian River and Mount Merino shales and cherts;
- Snake Hill shale with areas of Poughkeepsie melange; and,
- Snake Hill shale with Walloomsac slate.

All of the pelitic units have low porosity and low permeability. They extend from the Hudson River to the Connecticut state line, with metamorphism--from shales to slates to phyllites to schists--increasing in intensity from the northwest to the southeast. Phyllite is chiefly found between the headwaters of the Fishkill Creek and the Wappinger Creek valley. A garnet-bearing schist predominates between the Fishkill Creek and the Harlem Valley farther to the southeast. Gneissic schist is found east of Pawling. Only a few relatively narrow limestone belts are intermixed with these formations. Glacial deposits of till and outwash cover the surfaces of the various units.

The mineral composition and structure of these bedrock units also change from the northwest to the southeast. Quartz and mica are found chiefly in the northwest and central parts of Dutchess County. Feldspar is an additional component in the southeast. Bedding plane openings that serve as channels for the storage and movement of groundwater are apparent between the Fishkill Creek and the Wappinger Creek valley. Also between the two creeks, slaty cleavage has resulted in numerous small, closely-spaced parallel joints within the rock. Such cleavage is absent and the rocks are more massive in the southeastern part of the county. The shales and clays north of the city of Beacon have been used in the past to make bricks. Few of the other materials from the formations are used commercially, except locally as fill. Pelitic rocks produce an average of 16 gallons per minute of soft water.

Geologic Faults

Faults are fractures in the earth's crust, often accompanied by movement of one side of the fracture relative to the other. They form a tight network covering the entire county and are often identifiable directly from ground-level topography or high-level aerial photographs.

As depicted in the Geologic Faults Map, fault lines generally run in a northeast to southwest direction, roughly parallel to the grain of the bedrock structures imposed on the region by the geologic deformation of the Paleozoic Era. A weaker trend towards the northwest is also evident, but fault lines favoring this direction tend to be short. Significant concentrations are found along a line running between Beacon and Pine Plains. A similar line of faults exists between Pawling and the northeast corner of Amenia.

Over 300 faults have been identified on NASA Skylab satellite photographs of the county. They range in length from a few hundred feet to many miles. Most are thrust faults formed where the earth is compressed or pushing together. Normal faults, where the earth's surface is pulling apart, predominate in the southern part of the county. Both types of faults are illustrated in Figure 2.2.

Types of Faults

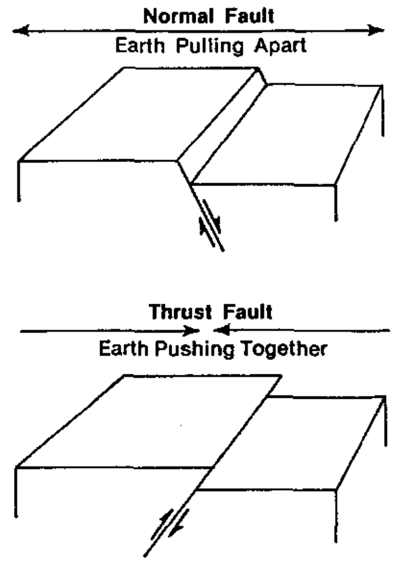


Figure 2.2

The quantity of groundwater found along these fault lines is difficult to determine due to a lack of field information. In general, however, the fracturing and crushing that occurs along fault lines forms channels that can carry large volumes of groundwater.

Glacial and Recent Sediment Deposits

During the last Pleistocene Glaciation, which occurred from 20 to 10 thousand years ago, Dutchess County was covered by a thick blanket of ice that stretched southward to the present site of New York City. Topographic variations resulted in local southeasterly and southwesterly advances, but on the whole, the glaciers moved in a southerly direction. During the course of their advances, the glaciers picked up soil and rock, smoothed down weak bedrock, abraded and polished hard bedrock and, at the same time, left widespread areas of thick sediments. Pre-existing valleys such as the Hudson were widened and deepened, while others were completely filled with these sediments.

Approximately 15 thousand years ago the melting of the glaciers accelerated and the ice blanket began to break up. In the process, layers of till consisting of clay, sand, pebbles, and boulders were left covering much of the bedrock. In some of the lowland areas south of the receding glaciers, clay deposits were formed in temporary meltwater lakes. As the ice continued its retreat and the weight of the great ice masses lessened, the land to the north began to rise an average of 2.25 feet per mile. This uplifting helped to renew and reshape the drainage pattern, and it brought about the further deposition of sands and gravels in low-lying areas.

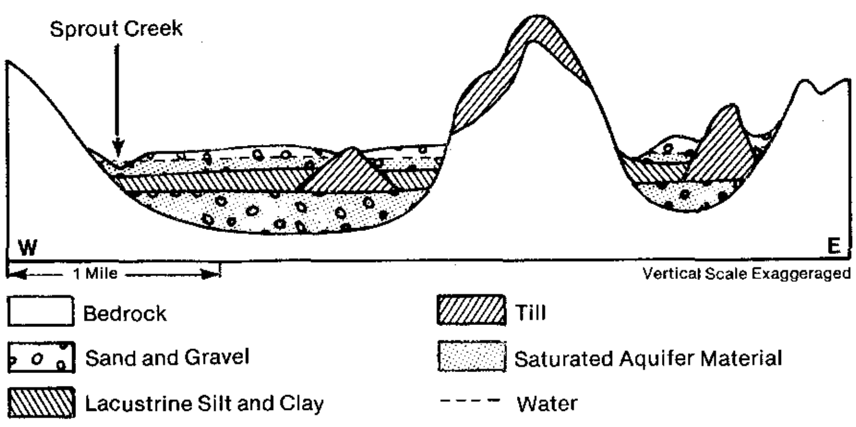
As indicated by the Glacial Deposits Map, unconsolidated material deposited by glaciers and glacial meltwater still overlies much of the bedrock in Dutchess County. These deposits are widespread and relatively thick in lowland areas. They are divided into three types:

- till, consisting of a heterogeneous mixture of poorly-sorted rock materials deposited directly by the glaciers, often having a high clay content;

- lacustrine deposits, consisting of silt and clay laid down in glacial lakes; and

Surficial Deposits

Cross Section of Sprout Creek Area, Town of East Fishkill



Redrawn from U.S. Geological Survey, Atlas of Eleven Selected Aquifers in New York, 1982.

Figure 2.3

- sand and gravel, left in lowlands by glacial meltwater.

These three units are not distinct entities in nature. Rather, there is usually a gradual horizontal and vertical transition from one unit to another. Sand and gravel deposits are often underlain by lacustrine silts and clays. Figure 2.3 is a simplified cross section of the many layers of surficial deposits typically found in the county.

Till

Till is a heterogeneous mixture of rock fragments ranging in size from microscopic clay particles to boulders several feet in diameter. It is the most widespread of the glacial deposits in Dutchess County and is predominant in uplands, where it was laid down by glaciers thick enough to pass over the county's highest peaks. Today, the cover of glacial debris in the highest areas is usually thin or absent because of erosion. In lowlands, where the eroded materials are deposited, the layers of till are relatively thick. Thicknesses over bedrock range from 0 to 20 feet on hilltops and from 20 to 40 feet on the slopes. In a few areas glaciers left till in the form of elliptical hills known as drumlins, as high as 100 feet or more. Osborne Hill, just north of the village of Fishkill, is a drumlin.

The rock fragments in till are primarily derived from local bedrock, but some are from areas many miles away. In places underlain by limestone, slate, and schist, the till consists of clay mixed with grains, pebbles, and cobbles of the parent material. Most of the till in the County is clayey. In some locations it has been cemented or compacted into a tough aggregate known as hardpan. Gneisses are generally overlain by sandy till containing an abundance of large boulders. Clean sand lenses are usually thin and cover only small areas.

Glacial till is usually only slowly permeable because of its high clay content. The movement of water into and through till deposits, to regenerate the groundwater supply or to dissipate septic tank wastes, is extremely slow. Most precipitation on areas underlain by till runs off the surface into drainage channels or is absorbed by plants. The average groundwater recharge capacity of till deposits is estimated to be 0.17 gallons per minute (gpm) per acre.

Water in usable quantities can be obtained only from large diameter wells that provide sufficient area for infiltration and storage. During dry periods such wells, which are necessarily shallow, often go dry or fail to yield the required supplies. Recorded yields from wells drilled into till deposits in Dutchess County range from 1 to 180 gpm with a mean of 22 gpm.

Lacustrine Deposits

Lacustrine deposits are stratified sediments that consist primarily of silt and clay deposited in glacial lakes. These glacial lakes were largely restricted to areas adjacent to the Hudson River. Consequently, lacustrine deposits predominate in western Dutchess County, especially north of Crum Elbow Creek, and are either absent or obscured in the eastern part of the county. Silt and deposits once underlay numerous small areas between Poughkeepsie and the Hudson Highlands in the southwest, but the brick industry has exhausted many of these locations. Lacustrine deposits are generally less than 50 feet thick, although depths of 125 feet border the Hudson River south of Rhinebeck. In some instances sand and gravel deltas overlie the silts and clays.

The permeability of clay and silt is extremely low. Wells that tap lacustrine deposits usually do not yield water in usable quantities. In areas where no other glacial deposits are present, groundwater supplies must be obtained from underlying bedrock. Such water supplies are not certain to yield an adequate supply.

On terraces adjacent to the Hudson River in northwestern Dutchess County, clay and silt layers retard or prevent the infiltration of groundwater into the bedrock. The clay and silt also retard the upward movement of water from underlying sources, sometimes causing natural underground water pressure to build up enough to force water to the surface without pumping. The average rate of groundwater recharge for lacustrine sediments in Dutchess County is 0.12 gallons per minute per acre. Estimates of well yields from these deposits are not available.

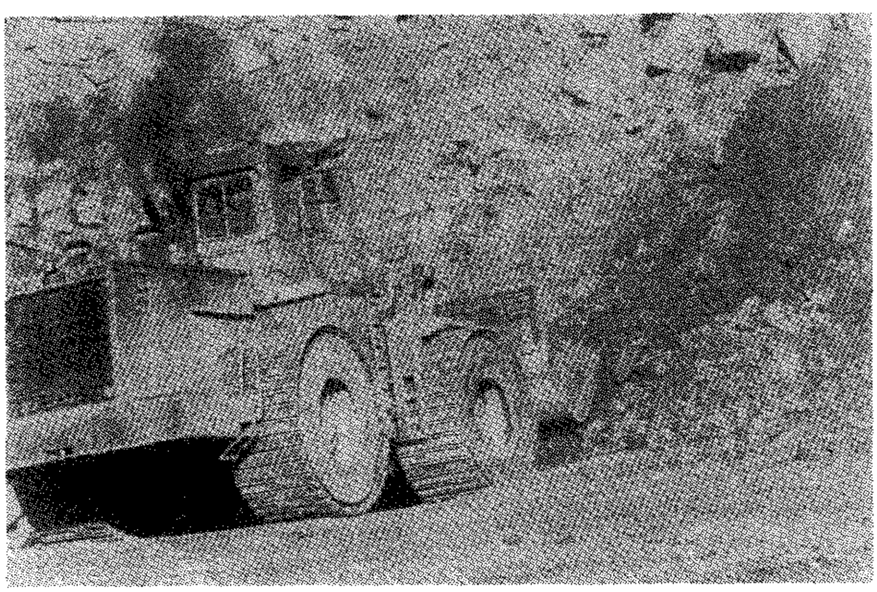
Sand and Gravel

Stratified sediments consisting principally of sand and gravel underlie extensive areas in the valleys of the county's major streams and tributaries. As shown in the Glacial Deposits Map, the most extensive beds are in the valleys drained by the Fishkill Creek, Sprout Creek, Swamp River, Tenmile River, and Wappinger Creek. The deposits range from layers of relatively clean sand to layers of mixed sand and gravel, and are usually underlain by thinner layers of silt and clay.

Stratified sand and gravel occurs in four principal forms in the county: kames, kame terraces, valley trains, and deltas. Kames are small conical hills found in southern Dutchess along the base of the Hudson Highlands, and in Wappinger and Fishkill between the Hudson River and Route 9. Kame terraces, relatively flat-topped deposits on the sides of valleys, are prominent in the Swamp River valley in Pawling and along the Hudson River in the town of Poughkeepsie, south of the city of Poughkeepsie. Valley trains are long, narrow deposits underlying stream valleys including those of the Wappinger, Fishkill, Crum Elbow, and Webatuck Creeks, as well as the Tenmile River. Delta deposits, laid down where streams once entered glacial lakes, have been mapped at New Hamburg near the mouth of Wappinger Creek, and in the lowlands near the Swamp River. Large deltas also exist at Rhinebeck and Red Hook.

Silt and clay deposits underlie sand and gravel almost everywhere. Some wells have penetrated two or three distinct layers of sand and gravel interbedded with layers of silt and clay. The sand and gravel layers are generally less than 25 feet thick, although in some areas they are as thick as 50 feet. This sand/gravel and silt/clay layering is characteristic of terraces along the major stream valleys of the county. Such terraces can slip when the underlying clay layers become saturated with water, and slide away with their overburden of deltaic sand and gravel.

The sand and gravel mixture is by far the most productive water-bearing deposit in Dutchess County, and it is used extensively as a source of potable water.



Small-diameter driven wells with screened drive points generally yield sufficient water for farm, home, and commercial uses. Large diameter wells can usually furnish moderate-to-large quantities of water for municipal and industrial systems. The reported yields of wells tapping sand and gravel range from 2 to 1400 gpm, with a median of 20 and an average of 136. Largely due to their porosity, the average groundwater recharge capability of sand and gravel deposits is 0.74 to 0.93 gallons per minute per acre.

In addition to their water-bearing properties, sand and gravel deposits provide materials vital to the building and road construction industries. Sand and gravel mines, also called soil mines, are found in all areas of the County, with concentrations in southeastern Dutchess, the Harlem Valley, and along the Wappinger Creek. A 1982 map of sand and gravel operations is included in the appendix.

In 1976, almost 3,000 acres in Dutchess County were used by active sand and gravel mines and hard rock quarries. The towns with the largest mining acreages were Poughkeepsie, where the county's largest rock quarry is located, Dover, Beekman, Pleasant Valley, and Amenia. Fishkill, LaGrange, and Washington also support substantial mining operations.

Numerous inactive and abandoned mines dot the county. Many of these have been reclaimed and converted to municipal parks, lakes, or development sites. Many more, however, have never been restored to useful or attractive condition.

Soil mining can alter the recharge capability and potential yield of groundwater supplies by gradually reducing the size and thickness of sand and gravel deposits. In addition, many mining operations dig down below the water table, exposing the groundwater to surface runoff and silt that sometimes cause changes in water quality.

Resource Management Implications

Dutchess County is endowed with a complex array of bedrock types and glacial deposits, which are legacies of more than a billion years of geologic change. Drainage patterns, soil characteristics, microclimates, groundwater and surface water supplies, scenic areas, and patterns of vegetation all depend on the county's geologic features. These features give the county its physical shape and shape its land use as well. Consequently, the location, values, and limitations of various geologic resources have broad implications for land use planning and resource management.

Groundwater Resources

Bedrock formations that cannot be relied on for large, steady supplies of groundwater underlie most of Dutchess County. Developments that draw their water from these formations can exhaust the available groundwater supplies. The land use decision-making process should ensure that the types and densities of developments using bedrock wells do not exceed the carrying capacities of these limited resources.

Limestone bedrock tends to form solution channels as water flowing through the bedrock dissolves the rock material. This characteristic enables limestone to store and transmit large quantities of water, making it the most prolific bedrock water source in the county. However, this characteristic also allows pollutants to move quickly through these underground channels and contaminate the stored water supplies. To prevent such contamination, developments located atop limestone bedrock, particularly where surface deposits are thin, should either be connected to central sewer systems or built at densities low enough to protect groundwater quality. Facilities that handle or store hazardous or toxic substances should not be located over such formations. Similar precautions should be taken in fault zones, which are often capable of supporting uses with heavy water demands. The fissures and fractures in fault zones enable both groundwater and pollutants to travel quickly, making it particularly important to avoid land use practices that could threaten water quality.

Land use decisions should reflect the limiting characteristics of surficial deposits. The large expanses of lacustrine deposits along the Hudson River in the northwestern part of the county should not be developed for intensive uses without central water systems that tap outside water sources, such as the Hudson itself. Because lacustrine deposits have extremely slow permeability, central sewage treatment should also be required for intensive developments in these areas. Similar policies should be employed in areas covered by glacial till. In all areas, data about surficial geology should be considered in determining which land uses and utility systems are appropriate.

The county's most critical groundwater resources are its thick sand and gravel deposits. These areas can yield large volumes of water and can support a variety of uses; they are also vulnerable to contamination, if they are improperly developed or overused. The importance of these deposits should be recognized by local and county governments, and steps should be taken to ensure they are managed wisely. At a minimum, detailed protection strategies and appropriate aquifer protection regulations should be developed by each municipality for those aquifers being tapped or considered for use as municipal water supplies.

Mining

In many cases, different uses of geologic features may conflict. For example, the demand for sand and gravel for construction projects may ultimately conflict with the need to protect the integrity of the county's most productive groundwater storage areas. A balance must be struck between the use and preservation of these geologic resources. To resolve conflicts, the following issues should be addressed at local and county levels:

1. how much mining should be allowed, and where;

2. how mines should be reclaimed so that they become community assets when they are no longer active;

3. how mines should be designed and shielded so as not to detract from the visual quality of their surroundings;

4. how mines should be located and controlled so that their impacts on groundwater and surface water supplies are minimized; and,

5. how state and local mining laws should be better enforced so that violators are caught, while conscientious mine operators are rewarded for their environmental concern.

The answers to these questions are critical to the safe, economical use of the county's bedrock and surficial deposits.

The economic value and land use impacts of limestone bedrock quarries should be recognized. Hardrock quarries provide jobs and materials that contribute to the county's economic well-being. Quarries can also, however, produce large-scale changes in the landscape and can adversely affect adjacent neighborhoods; this has been particularly evident in the town of Poughkeepsie. Intensive development, in turn, can block access to extractable resources, requiring local users of bedrock products to depend more heavily on expensive non-local sources. Such trade-offs and conflicts raise significant questions about how mineable land should be managed.

Faults

Numerous faults run through Dutchess County. Although major earthquakes are not expected in the fault zones, smaller tremors and shifts in the earth's crust are not unlikely. Accordingly, facilities that must maintain their structural integrity at all times, or which require absolutely stable foundations, should not be constructed on top of faults. Such facilities include power plants, chemical storage areas, landfills, fuel tank field, dams, reservoirs, and high-rise buildings.

Scenic Values and Community Identity

Bedrock and surficial deposits play an important role in visually defining, and even isolating, communities. For example, many people in the Harlem Valley feel separated from the rest of Dutchess County, at least partly because of the high bedrock ridges that form the valley's western wall. Bedrock characteristics are also responsible for the scenic landmark qualities of the Hudson Highlands, Stissing Mountain, the eastern wall of the Harlem Valley, and the Hudson River bluffs. Stissing Mountain, in particular, is unique because it is an

ancient rock "floating" on a younger formation. Its natural beauty and geological significance merit careful preservation.

Many of Dutchess County's significant geologic features are upland areas with shallow, highly erodible soils and steep slopes. They support fragile ecological communities that are easily scarred by erosion, clear-cutting, excavation, earthmoving activities, and careless or inappropriate development techniques. To preserve these scenic resources, greater use of selective clearing, erosion controls, careful grading, viewshed analysis, and strict development density limits should be encouraged.

Development Constraints

Bedrock and surface geology affect the location, development, maintenance, and cost of public services such as sewers, water supply sytems, and roads. Geological features should, therefore, be considered in all comprehensive plans and capital projects, particularly those using public funds.

The presence of bedrock once limited construction activities. Modern technology, however, in the form of large, powerful earthmoving equipment, has made it possible to develop almost any piece of land. This ability has important implications for the visual environment. It makes it feasible to obliterate the natural variability of of the terrain, at a social and environmental cost that is often incalculable. In areas with sensitive or valuable geological features, landscape changes should be limited to what is absolutely necessary for particular development projects, and should be undertaken in ways that minimize environmental harm.

Topography

Topography, the physical contour of the land, is shaped by the interaction of climate and geology through processes such as glaciation and erosion. In Dutchess County, these forces have sculpted the land into small hills, mountains, and valleys.

The shape, character, and location of landforms can be assets or liabilities, depending on how they are used. For example, many of the hilltops and steep hillsides in the county offer fine scenic vistas; yet, developers who wish to build homes on these hillsides to take advantage of their attractive views can face unusually high construction costs for roads, foundations, water supplies, sewer lines, drainage systems, and erosion controls. Communities often face increased costs for maintaining and servicing these hillside developments.

Relief and slope are two characteristics of the landscape that significantly affect the use of land. Relief refers to the pattern of elevations or irregularities on the land surface. The slope of an area is its gradient, or degree of steepness. Both of these attributes are described below.

Relief

Dutchess County's land surface is irregular with an almost continuous alternation of hills and valleys. The relative elevation of the land divides the county into two topographic regions, apparent in the Elevations Map on the following page. The general area west of the Taconic State Parkway and north of Interstate 84, and including significant areas of Lagrange, Beekman, and East

Fishkill east of the parkway, is characterized by numerous small hills whose heights range from 20 to 300 feet above the intervening valleys. Elevations range from 40 feet above sea level at the Hudson River to 900 feet in the interior of this region.

The second area, to the east of the parkway and south of Interstate 84, is characterized by rounded hills and low mountains that are larger and generally higher than those in western Dutchess. Many of the hills rise 500 to 1,000 feet above the adjacent valleys. The highest elevations occur in the Hudson Highlands to the south and the Taconic Mountains to the east. South Beacon Mountain in the Hudson Highlands rises to 1,602 feet, and the elevation of Brace Mountain north of Millerton, in the Taconic Range, is 2,311 feet. These high elevations form natural separations between Dutchess County and its neighbors to the south and east, Putnam County and Connecticut. They also physically separate communities within Dutchess.

Dutchess also has extensive lowlands. The valley of the Fishkill Creek near the county's southern boundary, the Harlem Valley that runs parallel to its eastern boundary, the Clove Valley in Beekman and Unionvale, the glacial lake plain on the western edge of Red Hook and Rhinebeck, and the valley along the Wappinger Creek are the largest lowland areas. They range from 400 to 600 feet above sea level.

$$\text{Slope} = \frac{\text{30 Foot rise}}{\text{100 foot distance}} = 30\%$$

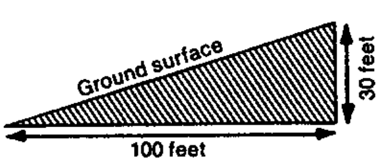


Figure 3.1

Slope

Slope is expressed as a percentage of incline from the horizontal. Land that rises five feet over a horizontal distance of 100 feet is said to have a five percent slope; if the land rises 50 feet over a 100-foot distance, the slope is 50 percent. A 45-degree incline has a 100-percent slope. This relationship is illustrated in Figure 3.1.

Slope limits the use of land and influences rates of stormwater runoff and soil erosion. The slope classifications in Figure 3.2 are commonly used in gauging the development suitability of land. Although there are limitations to development on all gradients, level land is usually most suitable and steep land least suitable for residential, agricultural, or industrial purposes. On level land the problem of building structures and roads is comparatively straightforward. If soil and other land characteristics are compatible with the proposed use, roads and buildings can be placed and grouped almost anywhere. Grading, controlling drainage, installing utilities, constructing foundations, and providing services are relatively easy. This is not the case on steeply sloping land.

Development constraints increase as slope increases. Slopes greater than 15 percent present severe development constraints for three reasons. First, steep slopes shed more surface water at higher velocities than level areas do. These runoff characteristics accelerate erosion when the land is disturbed or cleared, stripping the slopes of valuable soil and adding to the sediment load of downstream waters. Second, steep slopes in Dutchess County tend to be covered by shallow soils that cannot filter septic wastes properly. The tendency of the effluent to flow downslope can combine with the poor filtering capacity of the soil to produce serious health hazards.

A third factor limiting the use of steep slopes is cost. Developing and maintaining such areas in ways that limit erosion, provide adequate waste treatment, and preserve natural features, is expensive. Roads, utilities, and building construction in rough terrain can require excessive cutting, filling, and grading. Maintenance costs also increase in steeply sloped areas. Road surfaces deteriorate, roadside ditches erode, and downstream culverts fill with sediment. These conditions can be fixed only temporarily, and at public expense.

Dutchess County contains approximately 97,000 acres of land that have slopes greater than 15 percent. This equals almost 20 percent of the county's total area. Table 3.1 lists steep slope acreages for each municipality. All of the towns with more than 6,000 acres of steep slopes are located in the northern half of the county. They include Hyde Park, Clinton, Stanford, and Northeast. Hyde Park and Clinton also have the highest percentages of steep land, followed by Milan, Red Hook, Northeast, Stanford, Poughkeepsie, Rhinebeck, and Pine Plains. Aside from the villages and the city of Poughkeepsie, the towns of Unionvale, Pawling, Wappinger, and Dover have the smallest percentages of steep land.

Slope Categories

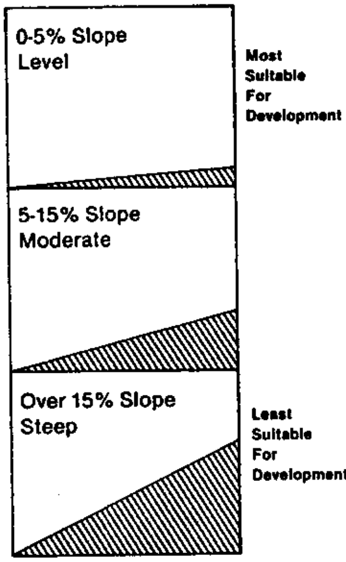


Figure 3.2

Table 3.1 Steep Slope Acreages by Municipality

Municipality	Acres of Slopes Over 15 Percent	Steep Slopes as Percentage of Total Acreage[1]
Amenia	4,368	15.7
Beacon City	628	19.6
Beekman	3,217	16.4
Clinton	7,678	30.9
Dover	5,036	14.1
East Fishkill	5,383	14.6
Fishkill	2,580	15.1
Fishkill V.	--	--
Hyde Park	8,335	35.1
LaGrange	3,978	16.0
Milan	6,608	28.4
Millbrook V.	52	4.4
Millerton V.	--	--
Northeast	6,158	22.4
Pawling	3,085	11.2
Pawling V.	149	11.6
Pine Plains	4,046	20.5
Pleasant Valley	4,138	19.5
Poughkeepsie	3,940	21.1
Poughkeepsie C.	161	4.8
Red Hook	5,578	25.4
Red Hook V.	43	6.4
Rhinebeck	4,533	20.5
Rhinebeck V.	22	2.3
Stanford	6,769	21.1
Tivoli V.	86	8.8
Unionvale	2,463	10.3
Wappinger	2,031	11.9
Wappingers Falls	50	6.4
Washington	5,706	15.6
DUTCHESS COUNTY	96,649	18.7

Source: Physiography and Land Use, Dutchess County Planning Board, 1965.

[1]Total Acreage Excluding Hudson River

Both Table 3.1 and the accompanying Slope Map clearly show the distribution of steep slopes in Dutchess County. A broad band dominated by the Hudson Highlands extends along the county's boundary with Putnam County. Steep slopes are also found on both sides of the Harlem Valley, along the Clove Valley in Unionvale, and on

Stissing Mountain in Pine Plains. Smaller steep areas are scattered throughout the county, with concentrations in Pleasant Valley and LaGrange along the Taconic Parkway and at the boundary between Milan and Pine Plains.

Steep slopes provide a scenic backdrop to the county's valley floors and contribute to people's sense of place. Because they tend to be less developed than more level areas, steep hillsides support much of the county's wildlife and natural vegetation, and recreational facilities such as the Appalachian Trail. Their forests contribute immeasurably to the county's beauty, recreational values, and tourism industry.

Erodible, shallow soils and other limiting factors do not make steep slopes uniformly undevelopable. In many areas, careful builders working with well-informed local officials can use hillsides attractively without significant environmental harm. Such development is likely to be costly, but the damage caused by careless development on such sensitive areas is at least equally costly, and often irreparable.

Extensive areas of level land are located in the valley lowlands of the Fishkill Creek, Tenmile River, and Wappinger Creek in Pine Plains, and at the Astor Flats along U.S. Route 9 in Rhinebeck. The southwestern part of the county, particularly the towns of Wappinger, Fishkill, and East Fishkill, contains the greatest amount of level land. A comparison of the Elevations Map and Slope Map reveals how closely the level and low areas coincide.

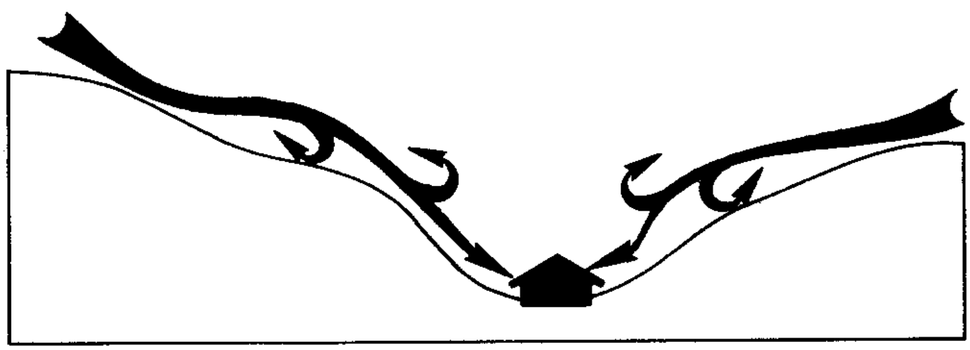
Resource Management Implications

The varied slopes and elevations of Dutchess County contribute greatly to the diversity of the county's land uses and the beauty of its landscapes. They influence the distribution and development of soils, vegetation, water resources, and identifying features such as scenic vistas and physical landmarks. Topographic features also influence the county's growth; by placing physical limits on the possible uses of different landforms, topography determines where activities such as intensive development or agriculture can occur.

On a community and county-wide basis, zoning and land use policies based on an awareness of topographic constraints can prevent costly development mistakes and environmental damage. Such awareness can also help decision-makers anticipate where competition for developable land will be keenest, enabling communities to make fundamental land use choices with long-term goals in mind.

On a site-specific basis, there are distinct advantages to considering site topography. Landowners can work with the contours and orientation of their land to avoid hazardous building sites, keep construction costs low, and take advantage of solar energy access and wind protection. For example, dense, cold air and runoff water collect in small basins surrounded by hills, as shown in Figure 3.3. These low areas, or hollows, often have limited access to sunlight. The combination of cold temperatures, drainage problems, and limited sunlight makes some hollows unsuitable for home sites and crops, but adequate for activities such as livestock grazing. An awareness of these topographic influences can make the difference between a sensible use of the land and an expensive mistake. Good development proposals always reflect a sensitivity to slope, orientation, and relief.

Hollows are usually colder than hillsides because cold air collects in them to form "frost pockets." They also often receive less sun. Heating costs for buildings situated in such pockets can be very high.



Adapted from: Hendler, Bruce, Building in the Wildlands of Maine.

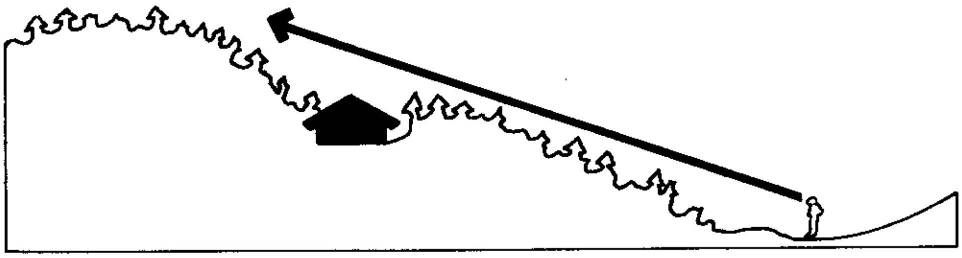
Figure 3.3

Uplands

Upland soils are often shallow and steep. These features make them highly erodible, poorly equipped to filter septic wastes or store water, and unable to recover quickly from development practices that scar the land. Uplands can support only low density uses; the steeper the slope, the more precautions are needed to enable the land to accommodate those uses.

Local governments should not permit slopes between 10 and 25 percent to be developed, unless extreme care is taken to protect these upland areas. Specific design standards should be required of such developments, and strictly enforced, to prevent soil erosion, septic failures, slope subsidence, water pollution, and other forms of environmental degradation. Slopes greater than 25 percent should not be disturbed.

A dwelling set below the crest of a hill is more private and has a more varied view than a hilltop dwelling. The lower site also better preserves the natural appearance of the hill as seen from below.



Adapted from: Hendler, Bruce, Building In the Wildlands of Maine

Figure 3.4

Buildings should be built below ridge tops and hill crests to preserve the scenic value of upland terrain. As shown in Figure 3.4, hillside sites can enjoy vistas and privacy without interfering with scenic views from below. Upland vegetative communities should be protected through selective cutting and natural landscaping. Clearcutting should be discouraged.

The importance of Dutchess County's higher elevations to wildlife habitat, forest production, community identity, surface waters, and scenic beauty, should be recognized at county and local levels. Preventing development of the steepest, most fragile slopes, and carefully managing the use of buildable slopes and upland plateaus will help preserve these areas and the natural and economic benefits they provide.

Lowlands

Low-lying valleys and plains have historically been the focus of development and agricultural activity. In Dutchess County, they contain the most fertile farmlands, the most productive groundwater reservoirs, the largest surface water supplies, the most abundant sand and gravel deposits, the most accessible, easily buildable land, and the most people, buildings, and roads. This concentration of positive features can lead to land use conflicts as residential needs, industry, and agriculture compete for the best land.

Lowlands also contain features that require special care and land use practices. Floodplains are found along all major streams and most tributaries. Wetlands are located in the stream valleys, and in hollows at all elevations where suitable soil and drainage conditions exist. Lowland sand and gravel deposits form the county's best groundwater supplies and are vulnerable to pollution and overuse.

The development constraints and natural values of floodplains, wetlands, and groundwater resources are described in Chapter Four. Here it is sufficient to say that thoughtful land use policies are needed in low-lying areas to ensure that development pressures do not result in the inappropriate use of hazardous, fragile, or unique natural resources.

Community Choices

Communities must learn to balance competing land uses and growth in ways that maintain environmental quality. Sound land use policies must address upland and lowland features equally. Otherwise, policies designed to protect slopes will encourage development of level areas; such development, in turn, will reduce the amount of fertile land available for agricultural use or may encroach on wetlands, floodplains, and groundwater recharge areas. Similarly, one-sided regulations that discourage development of prime soils and sensitive lowland areas increase development pressures on the hillsides. Local land use policies should, therefore, contain a combination of regulations that preserve the most naturally valuable lowland and upland areas, and mandate environmentally sound densities and construction practices wherever the communities decide that development should occur.

More specific land use strategies for each category of natural resources are discussed in subsequent chapters.

Hydrology

Hydrology is the study of the properties, distribution, and circulation of water in the atmosphere, on the earth's surface, and underground. This chapter describes the surface water and groundwater resources of Dutchess County. Atmospheric water is discussed in the Climate chapter.

Water is a renewable resource that is continuously recycled through a process referred to as the hydrologic cycle, depicted in Figure 4.l. Within this cycle, water enters the atmosphere by evaporating from large water bodies, streams, and ponds, and by transpiring from plants. This water vapor condenses into clouds and eventually falls back to earth as precipitation in the form of rain, snow, sleet, or hail. In this manner, water that evaporates from the Great Lakes can be transported to New York State to fall as a warm spring rain.

The Hydrologic Cycle

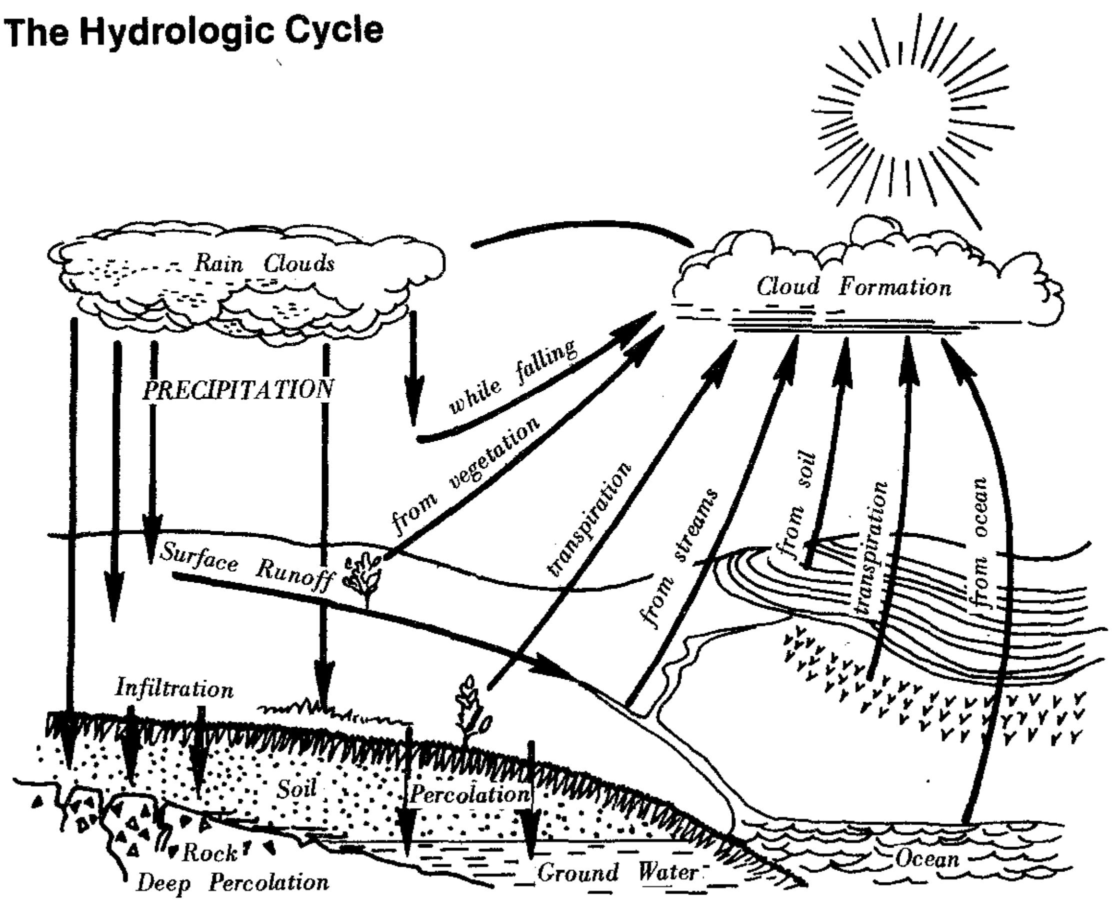


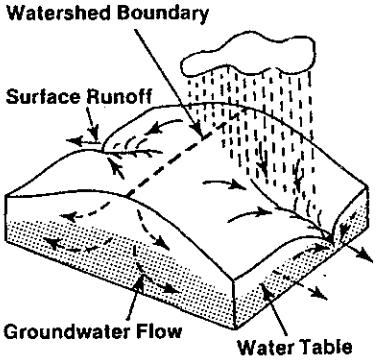
Figure 4.1

Some of this rain water may evaporate immediately. Plants will take part of it into their roots. The rest will run off into brooks, streams, and rivers or seep into underground water storage areas, called aquifers, where it can be tapped for human use. Some may find its way into deep aquifers through cracks in the underlying bedrock. It may be stored there for centuries before working its way to the surface to evaporate, thus closing the cycle. In effect, the hydrologic cycle is an enormous distillery, powered by the sun and gravity, which renews our water resources.

Human activity can have a profound impact on this natural cycle. Our water resources are increasingly threatened by pollution and misuses that can be related to the way we use our land. For example, urban development commonly results in paving over large areas of land. This increases water runoff, decreases infiltration to groundwater, and aggravates downstream flood problems. One result is an annual toll in human lives and property damage from flooding; diminishing groundwater supplies can be another. Water quality is increasingly threatened by pollution from pavement runoff, excessive use of fertilizers and pesticides, failing or inadequate septic systems and landfills, erosion from poor farming and land clearing practices, and improper disposal of hazardous wastes. Understanding the county's water resources is essential if they are to be protected from these threats.

Drainage Basins and Watercourses

Water Flow at the Watershed Boundary



Redrawn from Marsh, Environmental Analysis for Land Use and Site Planning 1978, page 65.

Figure 4.2

Water drains from the land surface through drainage features ranging from rivulets in shopping center parking lots to large rivers like the Hudson. The entire area drained by a particular rill, creek, stream, or river is called a drainage basin or watershed. The ridge that nearly encircles a drainage basin and separates one basin from another is called the basin or watershed boundary. Figure 4.2 illustrates how this boundary affects the direction of water flow in adjacent basins.

A hierarchy of drainage basins covers any land area. For example, each small tributary of the Little Wappinger Creek has its own drainage basin, and is included in the 33.4 square-mile watershed of the Little Wappinger Creek. This watershed is considered part of the 210 square-mile Wappinger Creek basin. The Wappinger watershed, in turn, is included in the lower Hudson subdivision of the Hudson River watershed, shown in Figure 4.3.

All of the water within a given watershed is part of the same hydrologic system. Watersheds, therefore, are the most appropriate geographic area for the study of water resources, the development of water resource management strategies, and the development of comprehensive waste treatment plans. Because all land uses both depend on and influence the quality and quantity of water supplies, watersheds are also the most logical physical units for natural resource management and land use planning.

Table 4.1 Major Drainage Basins in Dutchess County

Basin	Size (square miles)	Percent of County Area
Hudson River	140	17
Wappinger Creek	210	26
Fishkill Creek	194	24
Tenmile River	209	26
Croton River and Roeliff Jansen Kill	54	7
Total	807	100

Source: Ayer and Pauszek, <u>Streams in Dutchess County</u>, 1968.

Most of Dutchess County is within the Hudson River drainage basin. As shown in Figure 4.3, a portion of the Harlem Valley drains into the Housatonic River in Connecticut. Within these two major basins, as indicated on the Drainage Basin Map, there are four primary watersheds in the county: the Wappinger, the Fishkill, the Hudson, and the Tenmile. Wappinger Creek, the Fishkill Creek, and numerous smaller streams that feed directly into the Hudson drain approximately 67 percent of the county's 807 square miles. The Tenmile River basin, which is part of the Housatonic basin, covers nearly 210 square miles or 26 percent of the county, including all of Dover and Amenia and most of Northeast and Pawling. The remaining 7 percent of the county is divided between two other watersheds. A small area in the southeastern corner drains into the Hudson River via the Croton River, through Putnam and Westchester counties. Part of the northeastern section of the county drains into the Hudson River via the Roeliff Jansen Kill and its tributaries. The appendix contains a detailed list of the lengths, drainage areas, and elevations of most of the streams in Dutchess County.

Hudson and Housatonic Drainage Basins

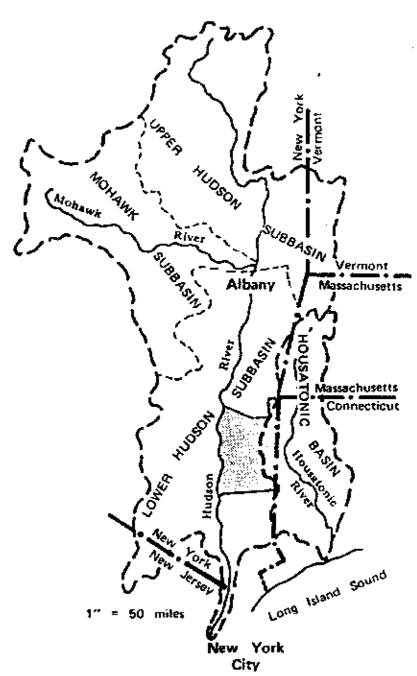
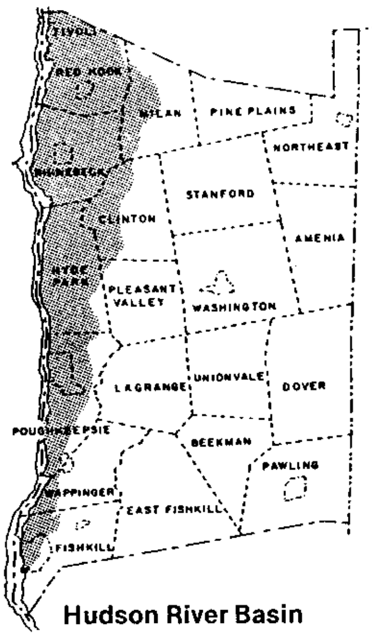


Figure 4.3



Hudson River Basin

Hudson River Basin

The Hudson River basin covers a relatively small area and discharges a low volume of water compared to other major river basins in North America. The river is tidal from its mouth in New York City to the locks at Troy. Fresh water meets salt water in a transition zone generally found below Chelsea, in the town of Wappinger.

Surface water from the Hudson River shore towns of Poughkeepsie, Hyde Park, Rhinebeck, and Red Hook drains directly into the Hudson River via streams that serve small secondary watersheds. These secondary basins within the Hudson basin include Stony Kill, Saw Kill, Landsman Kill, Crum Elbow, Fallkill, and Casper Creeks.

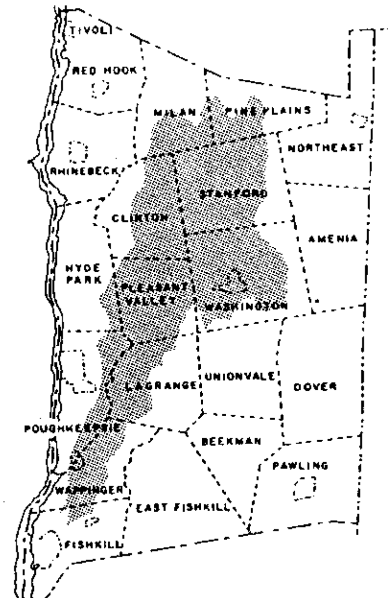
The sizes of the secondary watersheds within the Hudson River drainage basin range from one-half square mile to 30 square miles, averaging 20 square miles. Many of these watersheds include areas in more than one town. In times of heavy precipitation the relatively small size of these basins results in fairly uniform distributions of stormwater runoff. Flooding in these small watersheds is localized, therefore, and less severe than that which can occur along major waterways, such as the Tenmile River. However, poorly planned development in the urban and suburban portions of the basins could cause drainage and flooding problems in the future.

As previously described, the Wappinger and Fishkill Creeks are within the Hudson River basin. However, because of their size and significance in the county's hydrologic system, these two creeks are discussed separately below.

Wappinger Creek Basin

The Wappinger Creek and its tributaries drain approximately 210 square miles, roughly one-fourth of Dutchess County. The drainage area is 30 miles long, extending southwest from the town of Pine Plains toward New Hamburg at the southern tip of the town of Poughkeepsie. The width of the basin ranges from ten miles in the north to four miles in the south. Three primary branches--the Little Wappinger, the Main Branch, and the East Branch--drain the northern area before converging near Salt Point in the town of Pleasant Valley. The Wappinger drainage basin includes large parts of the towns of Pleasant Valley, Washington, Pine Plains, Milan, Stanford, and Clinton, as well as portions of the towns of Wappinger, Poughkeepsie, and LaGrange. In the lower basin the creek receives runoff from the county's most intensely developed areas.

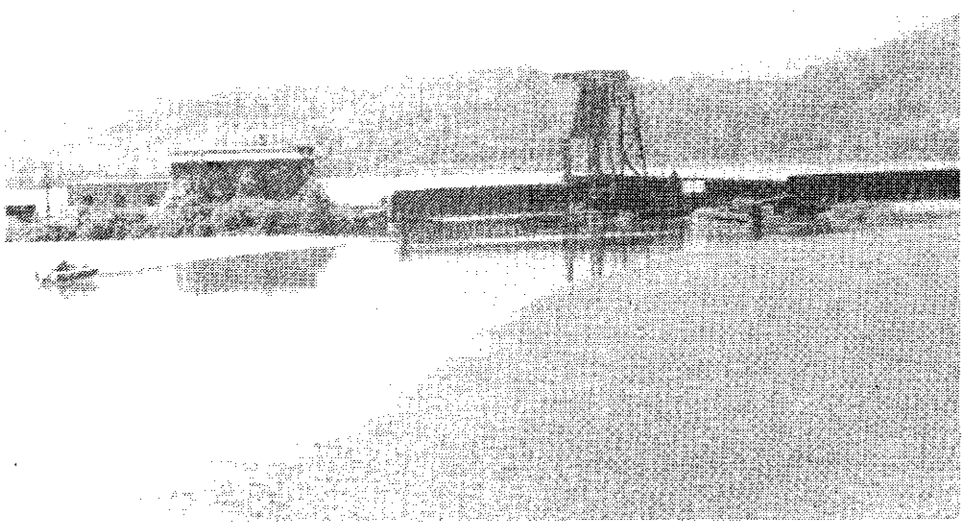
The topography of the Wappinger Creek drainage basin is varied, ranging from nearly flat meadows along the creek to the rocky slopes of Stissing Mountain, the highest point in the watershed at 1,403 feet above sea level. Most of the principal tributaries are permanent streams with elevations of 400 to 600 feet and average gradients of 10 to 15 feet per mile. The water rarely descends, however, at the average rate. Instead, it falls fastest along the steep upstream portion of the creek, especially where hard rock ridges in the stream bed have resisted erosion and created waterfalls.



Wappinger Creek Basin

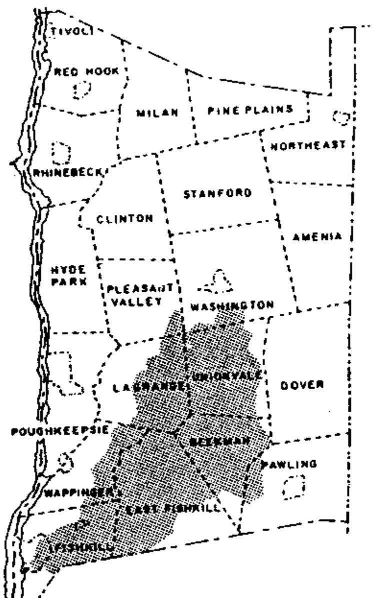
Much of the land along Wappinger Creek and its major tributaries is subject to flooding. The section downstream of the confluence of the Little Wappinger and the East Branch, at Salt Point, is especially floodprone. The entire flow from the expansive upper basin, which is three times as large as the lower portion of the watershed, funnels through this section of the creek.

The lower portion of the Wappinger basin is more urban than the upper basin, and contains large expanses of land sealed by pavement or buildings. This urbanization aggravates flood hazards by increasing the volume and speed of storm runoff; this increase, in turn, often overloads the storm drainage capacity of lowlands along the creek. Several settlements in these floodplain lowlands, including the hamlet of Pleasant Valley, the Overlook section of the town of LaGrange, and the Shady Brook Trailer Park in the town of Poughkeepsie have suffered severe flood damage in the past.



Fishkill Creek Basin

The Fishkill Creek basin covers approximately 194 square miles. Like the Wappinger basin to its north, it is long and narrow. Stream gradients are also similar. Fishkill Creek, the basin's primary stream, begins in the

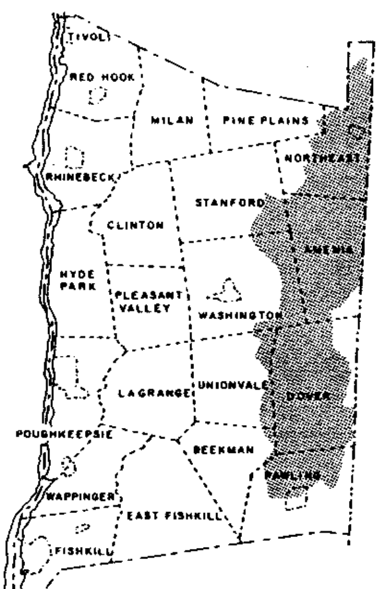


Fishkill Creek Basin

center of the county in Unionvale. From there it flows southwest, entering the Hudson River at Beacon. It drains a large part of Unionvale, Beekman, East Fishkill, and Fishkill. Sprout Creek, Fishkill Creek's primary tributary, drains major sections of LaGrange and Unionvale and small portions of Wappinger and East Fishkill.

The creeks in the Fishkill basin drain comparatively flat farm land and wetlands. In the upper reaches of the basin the stream drops slightly more than 200 feet in 10 miles. In the lower portion, where Fishkill Creek falls over slate and limestone ledges, the gradient is 200 feet in 5 miles. Most of the Fishkill Creek is 1 to 2 feet deep and less than 50 feet wide during periods of moderate flow. Tributaries funnel runoff from the upstream portion of the Fishkill Creek basin into the main stem at Lomala, along the Fishkill-East Fishkill boundary. As in the Wappinger Creek basin, this funneling effect increases the burden on downstream lowland areas during periods of heavy runoff, and can lead to flooding. The problem of inappropriate land uses in floodprone areas is not as evident in the Fishkill basin as in the Wappinger.

Tenmile River Basin



Tenmile River Basin

The Tenmile River drains 210 square miles in the eastern section of Dutchess County, from the Columbia County line south to the town of Pawling. The basin ranges from 5 to 8 miles wide, is 33 miles long, and is served by four principal watercourses: the main stream, Swamp River, Webatuck Creek, and Wassaic Creek. The Tenmile River falls an average of 16 feet per mile as it travels its narrow path southward from the town of Northeast, through the Harlem Valley lowlands in Amenia and Dover, to enter Connecticut near Dogtail Corners. The Swamp River, which flows north from the heart of Pawling, joins the Tenmile River south of Dover Plains.

The Tenmile River and its tributaries wind through extensive floodplains and wetlands. During periods of increased runoff these areas retain flood waters, helping to minimize downstream flooding. Because the Tenmile River basin is not as developed as other drainage basins in the county, there are still many opportunities to preserve the functional and wildlife values of these wetlands and floodplains while accommodating agricultural activity and growth. Homesites have, however, been developed within the Tenmile River floodplain along Lime Kiln Road, south of Dover Plains. The results of such development have been property damage to residents of flood prone areas and increased public costs for flood relief and flood management efforts.

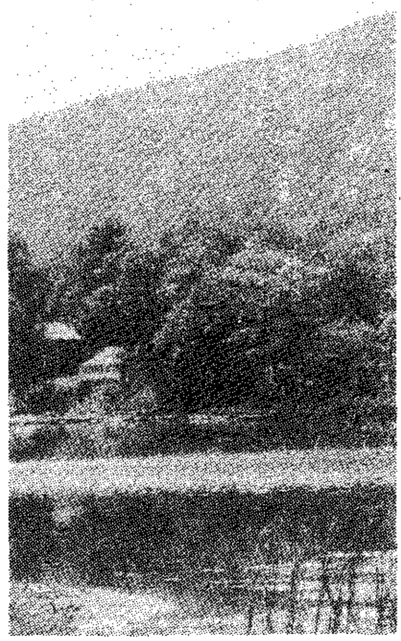
Surface Water Quantity

Dutchess County is fortunate to have abundant surface water resources. More than 600 miles of named streams traverse the county, as listed in the appendix. Unnamed streams and tributaries bring the total to more than 800 miles.

Table 4.2 Lakes and Ponds
Dutchess County, New York
(25 Acres or Larger)

Name	Location	Approximate Size in Acres
Abel's Lake	Unionvale	39
Black Pond	East Fishkill	176
Bontecou Lake	Washington	113
Lake Carvel	Pine Plains	38
Cobalt Lake	Poughkeepsie	29
Crane Pond	Dover	38
DeFlora Bros. Lake	Hyde Park	43
Dieterich Pond	Millbrook	32
Lake Dutchess	Pawling	51
Ellis Pond	Dover	61
Green Mountain Lake	Pawling	35
Halcyon Lake	Pine Plains	26
Hillside Lake	East Fishkill	26
Hunns Lake	Stanford	68
Indian Lake	Northeast	194
Little Whaley Lake	Pawling	52
Long Pond	Clinton	66
Nuclear Lake	Pawling	55
Quaker Lake	Pawling	64
Round Pond	Amenia	49
Round Pond	Milan	40
Rudd Pond	Northeast	76
Sepasco Lake	Rhinebeck	26
Sharpe Reservation Pond	Fishkill	26
Shaw Pond	Washington	26
Silver Lake	Clinton	113
Spring Lake	Milan	26
Stissing Lake	Pine Plains	78
Swift Pond	Amenia	61
Sylvan Lake	Beekman	116
Thompson Pond	Pine Plains	68
Twin Island Lake	Pine Plains	62
Tyrrel Lake	Pleasant Valley	45
Upton Lake	Stanford	43
Lake Walton	East Fishkill	42
Wappingers Lake	Wappingers Falls	122
Lake Weil	Dover	34
Whaley Lake	Pawling	287

Source: Dutchess County Department of Planning.



Unlike Putnam County to the south, Dutchess County is not well-endowed with large lakes and reservoirs. There are, however, 93 named lakes and ponds in Dutchess and dozens that are unnamed. Many were artificially created. Lakes larger than 25 acres are listed in Table 4.2. The largest lake in the county is Whaley Lake in the town of Pawling.

The Hudson River is by far the county's largest supplier of drinking water, providing more than 11.7 million gallons per day (mgd) to the city and town of Poughkeepsie and the village of Rhinebeck. With an average outflow of nearly 19,700 cubic feet per second (cfs), the Hudson remains the largest and last undeveloped surface freshwater source in southeastern New York. It has the capacity to supply drinking water to all of the county's urban and suburban areas.

The 1980 census indicates that 60 percent of the county's total population of 245,055 is served by community surface or groundwater systems; the remaining 40 percent relies on private domestic wells. Approximately 70,000 people in the county use Hudson River water; another 24,000 draw at least part of their water from surface supplies. In addition to the 11.7 mgd from the Hudson, community surface and groundwater systems provide 10.4 mgd to county residents.

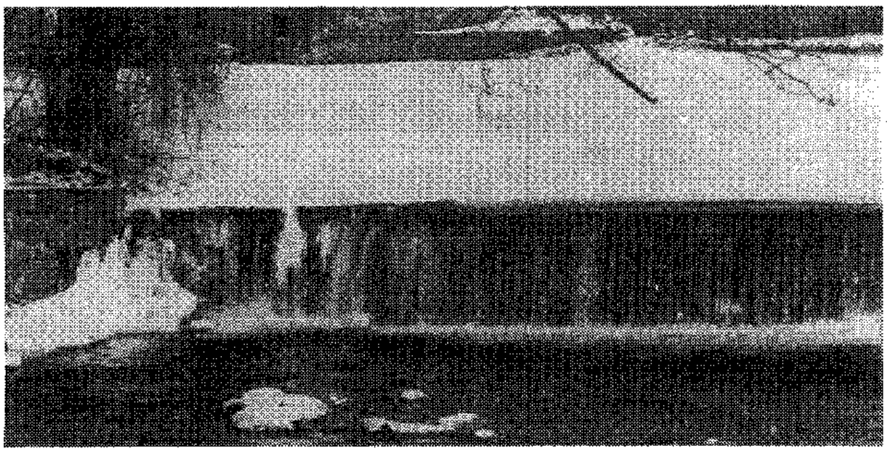
New York City has established a Hudson River tap and pumping station at Chelsea in the town of Wappinger as a precaution against water shortages in its upstate system. Although the Chelsea tap has not been used for many years, it could draw significant quantities of freshwater from the river if the need arose.

The salt front of the Hudson River shifts regularly and predictably along the southwestern border of the county. It moves with the balance between the upstream inflow of freshwater and the downstream forces of the ocean tides. Increased use of the upper Hudson River for water supplies and power plant cooling water could increase the likelihood of the salt front advancing north of Chelsea. Under such conditions the suitability of Hudson River water as a source of drinking water for Dutchess County and as an emergency source for New York City could deteriorate.

If precipitation remains constant and water quality improves, the three major streams in the county could accommodate substantial increases in demands for drinking water. However, precipitation is not constant; variations produce stream flow fluctuations which, in turn, affect both the quantity and quality of water available. Wide stream flow fluctuations have occurred in the past.

From 1928 to 1965, the flow of the Wappinger Creek near the village of Wappingers Falls ranged from 0.9 to 18,600 cfs, with an average of 236. The flow of the Tenmile River near Gaylordsville, Connecticut ranged from 7 to 17,400 cfs during the same period, with an average of 287 cfs. From 1944 to 1965, the flow of the Fishkill Creek at Beacon ranged from 0.4 to 8,800 cfs, with an average of 279 cfs. Even under severe drought conditions the three major streams sustained some flow.

The combined average flow of the Tenmile River, Fishkill Creek, and Wappinger Creek today is 840 cfs, or 543 million gallons per day. The flow may be below average 70 percent of the time. Excessive stream flow and flooding occur after severe storms, such as the hurricanes that struck the county in 1938 and 1955, and during spring runoff periods.



Little information has been collected about recent flow rates of the county's streams and rivers. At one time, the U.S. Geological Survey monitored water flow rates at 13 stream locations in the county, and once participated in a study of flow rates at 24 stream sites. Today, the USGS operates only two gaging stations: one on the Tenmile River near the Connecticut line, and another on the Wappinger Creek near Wappingers Falls. The scarcity of up-to-date information about surface water flow rates makes it difficult to assess the hydrological impacts of recent land use changes on the county's watersheds.

Many public wellfields tap aquifers adjacent to the county's major interior waterways. At present no public water supplies are drawn directly from these larger streams and rivers. Several smaller streams or reservoirs, however, do provide water for community systems in Beacon, Hyde Park, and the village of Pawling as well as for large institutions in Dover, Beekman, and Red Hook.

Table 4.3 Runoff Coefficients for Uniform Level Surfaces

Surface Type	Approx. Fraction of Rainfall that Runs Off Surface[1]
Asphalt or concrete paving, roofing, other waterproof surfaces	.90
Bituminous macadam	.85
Compacted earth and gravel without vegetation	.70
Impervious soil with vegetation	.50
Gravel	.30
Gardens and lawns	.20
Farmland and meadows	.15
Woodlands	.10

Source: Kelly, H., Planning Guidelines for Dutchess County Drainage, 1968, and

Lynch, K., Site Planning, 1971.

[1]Coefficients should be adjusted to reflect land use of entire tributary area, site slopes, soil characteristics, and other variable factors.

Land use has a dramatic effect on the amount of water that finds its way into the county's streams and rivers. The conversion of forest and agricultural land to urban and suburban uses increases the number of water users while decreasing the amount of open land available to absorb, store, and filter surface and groundwater supplies. The fraction of total rainfall that runs off a site increases rapidly as the permeability of the site surface decreases. This relationship is indicated by the runoff coefficients listed in tables 4.3 and 4.4. Woodlands, for example, usually absorb 90 percent of the rainfall they receive; the percentage may be lower on steep wooded hillsides, and considerably higher in nearly level, dense woods with highly porous soils. When woodlands are cleared and developed for commercial uses, the portion of rainfall absorbed can drop to 1 to 10 percent, leaving 90 to 99 percent to run off the site.

A normal amount of runoff is necessary to sustain the county's lakes, ponds, wetlands, and streams, and the

Table 4.4 Runoff Coefficients for Composite Land Uses

Land Use Type	Approx. Fraction of Rainfall that Runs Off Surface[1]
Residential lots	
2 acres and larger	.15
1/2 - 2 acres	.25
15,000 ft.^{2}, (.34 acre) to 1/2 acre	.30
7,000 ft.^{2}, (.16 acre)	.40
40 dwelling units per acre (1,089 ft.^{2}, each)	.50-.70
Industrial uses	.60
Commercial uses	.75
Dense urban commercial use	.70-.90

Source: Kelly H., Planning Guidelines for Dutchess County Drainage, 1968, and

Lynch, K., Site Planning, 1971.

[1]Coefficients should be adjusted to reflect land use of entire tributary area, site slopes, soil characteristics, and other variable factors.

uses and natural communities they support. The large volumes of runoff shed by developed sites, however, can adversely affect drainage systems, surface water volume and quality, flood patterns, soil erosion rates, and groundwater supplies. Careful land use practices play an essential role in minimizing these impacts and ensuring that adequate supplies of clean water will be available in the future.

Surface Water Quality

Both natural processes and human activities affect water quality. The types of rocks and soils that water passes through, the length of time it remains in contact with them, and the amount of soil that water carries in suspension are all natural factors that influence water quality. Erosion is one form of natural "pollution" that can be greatly increased by poor land use management practices. Other human activities may adversely affect water quality by discharging physical, chemical, or thermal pollutants into water bodies.

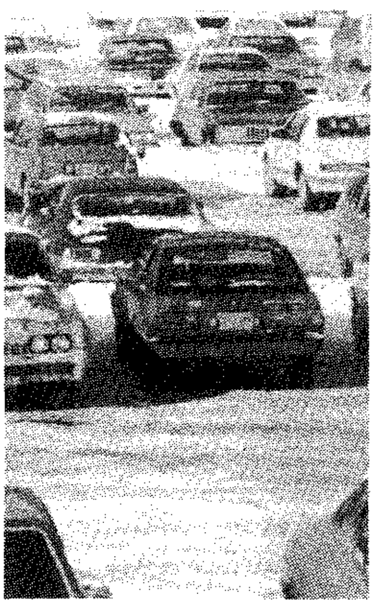
Natural Factors

The type and quantity of minerals in solution determine water hardness. For example, large concentrations of magnesium and calcium make water hard. Hardness is often recognized by its soap-consuming character and by the tendency of the minerals to form solid deposits, called precipitates, in the water. Many streams in Dutchess County have hard water. Some of the minerals in such water have beneficial effects. Fluoride concentrations of one milligram per liter (mgl), for example, are known to reduce the incidence of dental cavities. Water in Dutchess County was found to have significant natural fluoride content during a sampling period from 1970 to 1975.

Groundwater usually has a higher dissolved mineral content than surface water because of its increased contact with rocks and soil. Because most streams are fed by ground sources, they often show some of the hard-water characteristics of groundwater. This phenomenon is most pronounced during dry periods; after a heavy rainfall, or during snowmelts, the concentration of dissolved minerals in these streams is diluted.

Human Influences

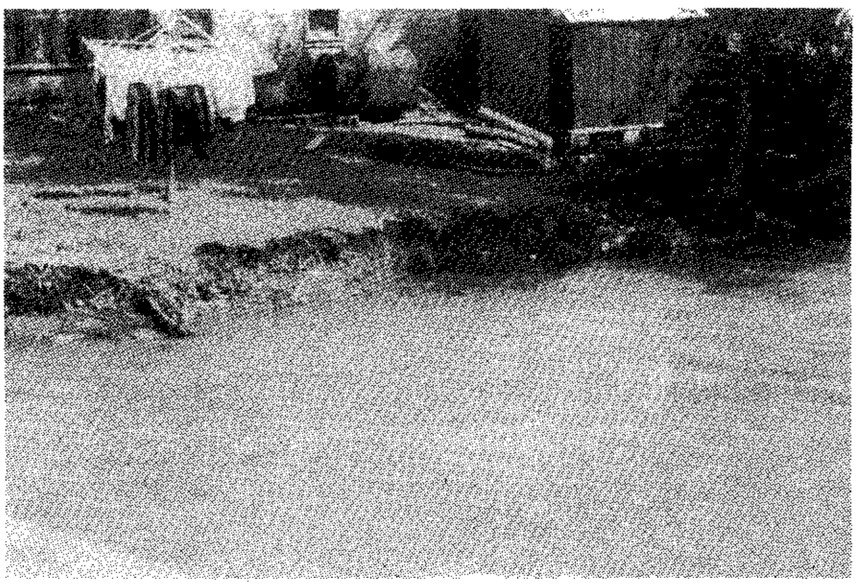
Water pollution caused by human actitivies may appear in the form of dissolved and particulate solids, biodegradable and non-biodegradable organic materials, infectious agents, nutrients, toxic substances, or unnatural changes in heat, taste, odor, and color in ground and surface waters. Selected sources of these pollutants, their effects on water, and ways to prevent and abate such pollution are listed in the appendix.



Information about Dutchess County's surface water quality is spotty and inconsistent. A 1981 report by the New York State Department of Environmental Conservation (DEC) examined 19 county streams, lakes, and ponds considered to be under stress from various pollutants. The major suspected pollution sources named in the report were landfills, petrochemical-laden runoff from parking lots and streets, and failing septic tanks. Industrial waste discharges, sediment, agricultural chemicals, and sewage treatment plant discharges have also been identified as sources of water pollution. The DEC report was based on past tests or observations by government officials. No large-scale program for systematically monitoring the quality of the county's surface waters is currently in place.

The flow rate is a major factor in determining a stream's ability to absorb wastes. With increased flow this assimilation capacity increases if other factors affecting purification, such as waste type and quantity and water temperature, are held constant. Low flow periods, therefore, are critical times for maintaining water quality.

Upstream erosion and pollution are gradually choking many of the county's lakes and ponds. Materials carried downstream fill the lakes with silt and accelerate the natural eutrophication process through which lakes evolve into dry land. Eutrophic lakes are of limited use for recreation or water supply. Controlling erosion and pollution discharges is an essential step in prolonging the useful life of these water resources.



Acid rain is gaining recognition as a serious pollution problem. As a result of the combustion of tremendous quantities of fossil fuels, such as coal and oil, the United States annually discharges approximately 50 million metric tons of sulfur and nitrogen oxides into the atmosphere. Through a series of complex chemical reactions some of these pollutants are converted into acids, which return to earth in rain or snow. As discussed in more detail in the Climate chapter, investigators have concluded that acid rain and the chemical changes it seems to induce in soil and runoff water are responsible for the destruction of plant and animal life in hundreds of Adirondack lakes. Studies report that acid rain has damaged buildings, significantly increased the acidity of surface waters, and affected forests throughout the midwestern and northeastern United States and Canada, but the true magnitude of the problem is still under debate. Studies of the impact of acid rain on the Hudson Valley are underway.

Hudson River water is known to contain at least 26 toxic chemicals, including federal priority pollutants such as PCBs, DDT, arsenic, cadmium, mercury, and cyanide. Recent studies indicate that 225 facilities in four states, including 208 permited facilities in New York, discharge toxic chemicals into the river. The most commonly discharged pollutants are oil and grease, which contain carcinogenic benzene and lead.

The Hudson is considerably cleaner than it was in the 1960s and early 1970s, before major water pollution control laws were passed. The presence of toxic chemicals in discharges and in river-bottom sediments, however, fuels a continuing debate about the river's suitability as a drinking water source, and raises questions about the need for more extensive water and waste treatment systems.

Water Quality Standards

The federal and New York State governments have developed water quality and purity standards. The Federal Water Pollution Control Act of 1972, as amended, imposes strict standards on water quality and pollutant levels. Part 701 of the 1974 New York Environmental Conservation Laws outlines the water quality and priority classifications and standards for New York State.

Under New York State law, fresh surface waters are classified according to their present quality and the "best" or most pollution-sensitive uses for water of that quality. The New York State Department of Environmental Conservation (DEC) applies standards that correspond to these classifications when reviewing stream disturbânce or pollutant discharge permit applications. This is to prevent the existing water quality from deteriorating. The major classifications are listed in Table 4.5.

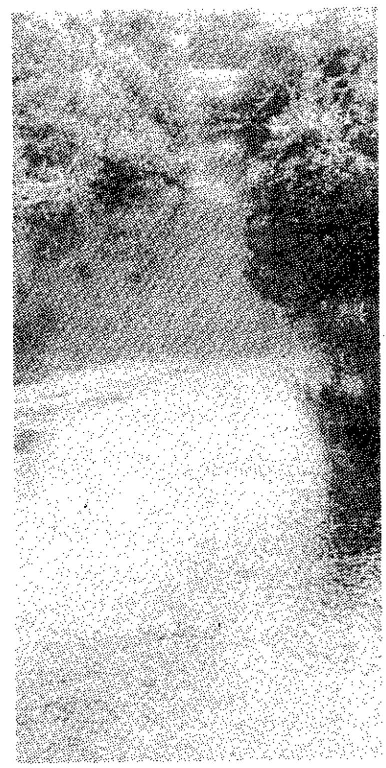
Table 4.5 Stream Classifications

Class	Best Use
AA	Drinking (after chlorination)
A	Drinking (after chlorination and filtration)
B	Bathing
C (t)	Fishing (trout)
C	Fishing
D	Secondary contact recreation

Source: NYS Department of Environmental Conservation.

Most of the streams, rivers, lakes, and ponds within Dutchess County are Class B, C, or D. Some of the more significant AA and A streams and lakes are listed below:

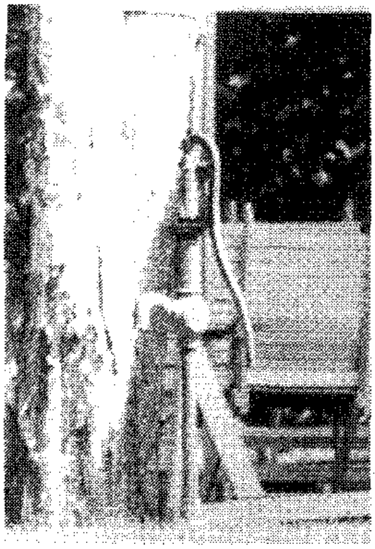
- Clove Creek - at Fishkill water supply
- Crum Elbow Creek and tributaries - upstream of Hyde Park Fire and Water District intake
- Ellis Pond
- Fishkill Creek - at Beacon water supply
- Gardiner Hollow Brook - at Green Haven State Prison water supply
- Green Mountain Lake
- Hiller Brook and tributaries - at Pawling Village water supply.
- Indian Kill - at Staatsburg water supply
- Long Pond
- Pawling Reservoir
- Silver Lake
- Swamp River - at Harlem Valley Hospital water supply
- Tenmile River, wells, stream, and tributaries - at at Dover Plains auxiliary water supply
- Tributaries of Cargill Reservoir



These classifications affect, but do not unduly restrict, land uses along waterways. If wastes are treated to satisfy the appropriate standards, they can be discharged under permit. The standards protect the rights and property values of landowners along water courses by protecting them from water pollution. Stream classifications are periodically revised by the New York State Department of Environmental Conservation. Public hearings are an integral part of the reclassification process.

Groundwater Resources

Groundwater is the supply of water beneath the earth's surface. After precipitation is absorbed by soil, it travels beneath the surface and is stored in a water-saturated underground layer of earth, unconsolidated deposits, or porous stone. Aquifers are natural groundwater reservoirs that recharge surface streams, support plant life, and provide water for drinking, home, and industrial use.



The importance of the county's groundwater is often underestimated because aquifers are out of sight and difficult to measure. Yet, at least 60 percent of the county's population relies on community or individual wells. Wells serve as back-up or auxiliary supplies for another 15 to 25 percent of county residents. Many of these wells draw on groundwater supplies that lie outside sand and gravel or limestone aquifers, and they often give yields that are low compared to the volumes of water that the major aquifers can provide.

The largest and most productive aquifers occur along the county's major stream and river valleys, where thick glacial deposits of sand and gravel overlie limestone. As shown on the following Groundwater Occurrences Map, these aquifers are found in the Harlem Valley along the Tenmile and Swamp Rivers, along the Wappinger Creek, and along the Fishkill Creek. Extensive sand and gravel deposits also exist along the Sprout Creek in East Fishkill and LaGrange, the east branch of the Wappinger Creek in Washington, and the Sawkill Creek in Red Hook. Relatively little is known about the boundaries and interrelationships of these aquifers, their capacity, their quality, or their sensitivity to development pressures.

As explained in the Geology chapter, the water-bearing characteristics of unconsolidated deposits vary widely because of differences in porosity and permeability. Permeability is a measure of the ability of a material to transmit water. In unconsolidated deposits, permeability depends on the size of the pores between the particles of sand, gravel, silt, or clay. In bedrock, permeability depends on the degree of fracturing and how well the rock fractures, crevices, and cavities interconnect. The higher the permeability of a material, the greater its potential yield as a water supply.

Porosity is a measure of how much pore space a given volume of material contains; this amount determines how much water the material can hold. The more pores there are and the larger they are, the more water can be held in storage.

Sand and gravel are especially valuable aquifer materials because they are highly porous and permeable. The pores in sand and gravel deposits are large enough to hold considerable volumes of water, while allowing water to flow easily toward wells, springs, and other discharge points. Known yields from sand and gravel aquifers in Dutchess County range from 2 to 1,400 gallons per minute (gpm). Clay, on the other hand, is an extremely dense, impermeable material whose microscopic pores and particles inhibit groundwater flow. Glacial till falls between clay and sand in porosity, permeability, and water yield. Till contains an assortment of particle types and sizes. Reported yields from wells tapping glacial till range from 1 to 180 gpm. The water storage characteristics of the county's unconsolidated deposits are discussed in more detail in Chapter Two. Reported well yields are summarized Table 4.6.

The consolidated deposits of limestone and dolostone, called the Wappinger Group, are the most productive bedrock formations in the county, with an average yield of 22 gpm from drilled wells. This productivity is due to the fact that limestone dissolves easily, allowing water to flow into the numerous channels, caverns, and fissures that characteristically develop in the rock. Water from these sources is hard, with a median mineral content of 229 parts per million (ppm), and relatively high in dissolved solids, at 316 ppm.

Table 4.6 Reported Well Yields
Dutchess County
(gallons per minute)

Formation	Range	Median	Mean
Unconsolidated Deposits			
Glacial Till	1 to 180	10	22
Clay and Silt	not available	not available	not available
Sand and gravel	2 to 1400	20	136
Bedrock			
Pelitic Rock	0 to 135	9 to 15	16
Poughquag Quartzite	2 to 30	8	10
Wappinger Group	1 to 220	13	22
Austin Glen Graywacke	0 to 135	10 to 15	16
Hudson Highlands and Housatonic Gneiss	1 to 45	8	11

Source: Unconsolidated deposit yield figures and bedrock median yields:
Gerber, Water Resources Study for Dutchess County, 1982.

Bedrock range and mean yields:
Simmons, et al., Groundwater Resources of Dutchess County, 1961.

As described in Chapter Two, much of Dutchess County's bedrock is composed of pelites, primarily shales and slates. All of the pelitic units in the county have low porosity and low permeability. The bedding planes and fissures in these rocks serve as channels for the storage and movement of groundwater. Studies by the United States Geological Survey show that yields from drilled wells in pelitic rock units and in Austin Glen Graywacke average 16 gpm, with hilltop wells yielding 14 gpm and valley wells yielding 17 gpm. The water from pelitic rock wells is relatively soft, with a median of 138 ppm, while the median content of dissolved solids is comparatively high at 234 ppm. Hydrogen sulfide affects some of the water drawn from this bedrock, resulting in a "rotten egg" odor. Water in the Austin Glen formation is moderately hard.

The more mountainous parts of Dutchess County are underlain by crystalline types of bedrock such as Hudson Highlands Gneiss and Poughquag Quartzite. Because these are denser than pelitic bedrock, there are fewer openings for water infiltration. Well yields are relatively low, averaging 11 gpm for the gneiss and 10 gpm for the quartzite. Like the pelitic rock, water from these formations is relatively soft at 138 ppm, and the median content of dissolved solids is 234 ppm.

Although Dutchess County has made considerable progress in mapping and gathering information about its aquifers, little is known about the detailed characteristics of these groundwater supplies. What is known is that improper land use practices can deplete and pollute aquifers, leaving them unfit or inaccessible for human use. The processes through which such damage can occur are described below.

Depletion

Groundwater supplies are replenished by precipitation that gradually percolates through the soil, into deposits of sand, gravel, clay, till, or bedrock formations. This process of replenishment is called groundwater recharge. Groundwater travels through subsurface deposits and into wells, streams, lakes, springs, and other discharge points.

Aquifers exist in a state of equilibrium when the rate of recharge matches the rate of water withdrawal. As water is drawn off into surface water supplies, it is replaced through groundwater recharge so that the volume of water in the aquifers remains stable. This equilibrium can persist as long as water use does not over-tax the ability of the groundwater reservoir to replenish itself.

Wherever development densities become great enough to disrupt the groundwater recharge process, groundwater supplies diminish. Water tables subside and, eventually, wells go dry. If such groundwater "mining" is allowed to continue, water supplies can permanently disappear over large areas.

Three interrelated land use practices contribute to aquifer depletion. The first is overcrowding. If the homes, businesses, industries, and institutions using wells in any area demand more water than the area's groundwater receives from rainfall and other sources, the amount of groundwater available will decrease. Often it takes many years before such steady depletion is noticed. The effect of residential overcrowding on groundwater supplies is depicted in Figure 4.4.

Effects of Overcrowding on Groundwater Supplies

1) Low Density: Plenty of water

2) Higher Density: Lower water table, but still adequate water supplies.

3) Overcrowding: Water table dropping and wells going dry.

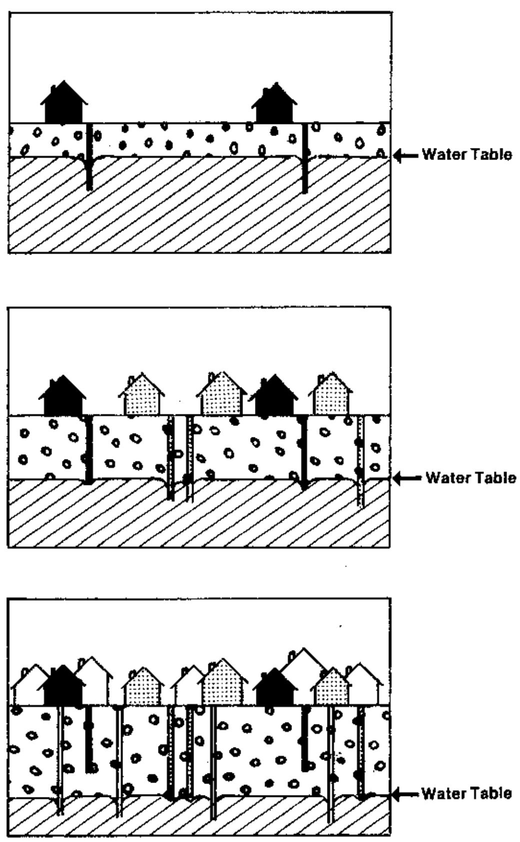


Figure 4.4

A second cause of groundwater depletion is the common practice of converting groundwater into surface water. This happens in communities and industries that depend on wells for their water supplies, and discharge their waste water into surface streams or rivers. These waterways carry the treated waste water downstream, away from the source aquifers, and prevent it from recharging the underground supplies. Individual septic systems are designed to return well water to the ground, but community sewers and industries usually discharge wastes into surface waters.

The third contributor to aquifer depletion is reduction of the aquifer recharge area. The recharge area absorbs rainfall, floodwaters, and snowmelt and allows them to filter down into the aquifer to replenish groundwater supplies. Covering the recharge area with buildings, parking lots, roads, and other impervious materials reduces the soil acreage available for recharge; rain that previously would have soaked into the soil runs off into streams and rivers instead.

The ability of groundwater supplies to sustain different land uses depends on the recharge rate of the subsurface materials as well as the land uses themselves. Thick sand and gravel deposits have an estimated natural recharge rate of 0.93 gallons per minute per acre, compared to a rate of 0.12 gpm per acre for clay and silt. These rates reflect differences in porosity and permeability that enable sand and gravel to absorb and transmit water more quickly than clay can. Recharge rates also depend on the slope of the land, the surface vegetation, and the intensity and amount of precipitation.

Table 4.7 Recharge Rates and Recommended Maximum Densities
(For Homes on Septic Systems)

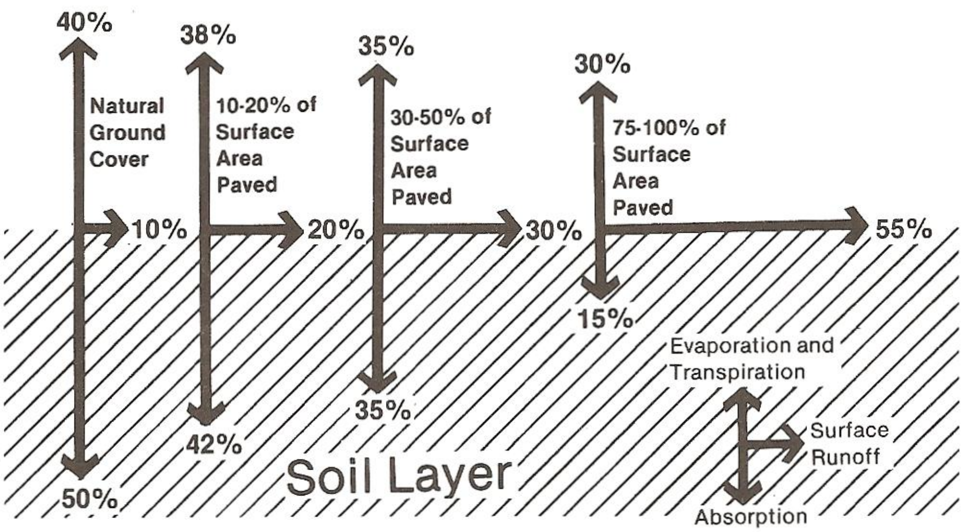
Surficial Deposit	Natural Recharge Rate (gpm/acre)	Maximum Dwellings per Acre[1]	Minimum Acres per Dwelling[1]
Thin sand and gravel	0.74	1.45	0.70
Thick sand and gravel	0.93	1.80	0.55
Thin soil over bedrock	0.35	0.70	1.40
Thick silty till	0.17	0.30	3.30
Clay-silt	0.12	0.24	4.20

Source: Hauser, E., for Dutchess County Department of Planning. Adapted from Gerber, R.G., Water Resources Study For Dutchess County, 1982.

The recharge rate decreases below the "natural rate" shown in Table 4.7 as the impervious area increases. If the total impervious area over an aquifer becomes too large in proportion to the aquifer's size and volume, or if the impervious area is located on top of the best natural recharge area, the aquifer cannot sustain itself. In residential areas, recharge rates decline sharply when densities exceed two dwelling units per acre. Densities of two or more acres per dwelling unit usually cause no appreciable reduction in recharge rates.

Figure 4.5 illustrates the relationship between the percentage of land surface that is paved and the amount of precipitation that can filter down into the groundwater. This relationship is also shown in Tables 4.3 and 4.4, discussed in the previous section. The variability of natural recharge rates underscores the importance of assessing the effects of impervious surfaces on groundwater supplies as land use decisions are made.

Effect of Paving on Rainfall Absorption, Runoff and Evaporation.



Source: Tourbier and Westmacott, Water Resources Protection Technology, 1981.

Figure 4.5

Pollution

Dutchess County's aquifers are vulnerable to contamination as well as depletion. Road deicing salts, overcrowded septic systems, landfills, and leaky petroleum or chemical storage tanks contribute to the risk of aquifer contamination. The innumerable household, commercial, and agricultural chemicals that find their way into

groundwater via septic fields, dumpsites, or direct application to the land also pose significant threats to groundwater quality.

The same characteristics that enable the county's best aquifers to absorb, store, and yield large amounts of groundwater allow them to absorb, store, and transmit pollutants. The fissures, channels, and caverns that develop in limestone bedrock, for example, make limestone highly susceptible to contamination and enable contaminants to travel great distances through the bedrock deposits. The crevices in shale and the pores in sand and gravel also permit pollutants to migrate rapidly.

Many cases of groundwater pollution have appeared in recent years. The most common pollutants fall into one of six categories:

- road deicing salts, e.g., sodium chloride, from roads and stockpiles;
- organic solvents, e.g., trichloroethylene, carbon tetrachloride, from dump sites, industrial sites, household products;
- fertilizers;
- pesticides;
- petroleum products, e.g., gasoline and heating fuel, from spills, leaking tanks, and pavement runoff; and,
- septic wastes.

In residential areas the most common groundwater contaminant is the nitrate-nitrogen discharged into leach fields. The Federal Safe Drinking Water Limit for nitrate-nitrogen in drinking water is 10 milligrams per liter. Concentrations in septic tanks usually range from 30 to 70 milligrams per liter. In soils capable of treating septic wastes, one-half of this amount is eliminated before the wastes reach the water table. The remainder enters the groundwater supply without being treated, and must be diluted to bring its concentration down to safe levels. As illustrated in Figure 4.6, overcrowding that prevents this dilution can cause serious health problems by contaminating groundwater supplies.

Maximum tolerable residential densities have been estimated for Dutchess County, based on groundwater quality considerations and geological characteristics. These densities are shown in Table 4.7. For areas that depend on septic systems and wells, recommended maximum densities range from 4.2 acres per dwelling over clays and silts, to 0.55 acres per dwelling over thick sand and gravel. These numbers are general guidelines, however, and vary with annual rainfall, slope, existing land use, surrounding topography, and other factors.

Effects of Overcrowding on Groundwater Quality

Low Density: Adequate room to filter septic wastes without contaminating wells.

Overcrowding: Septic wastes contaminating nearby wells and groundwater supply.

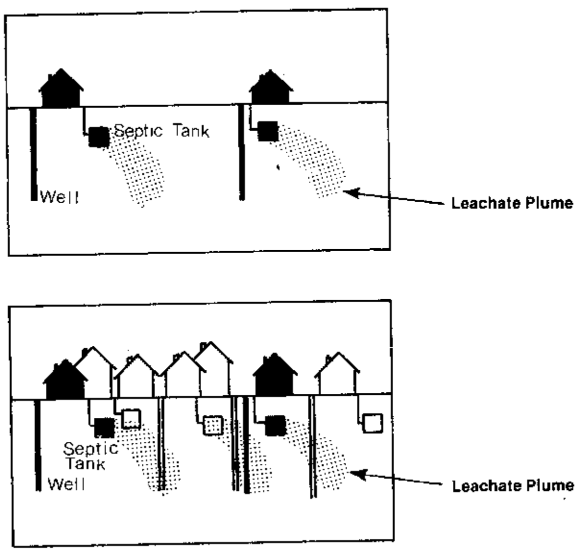
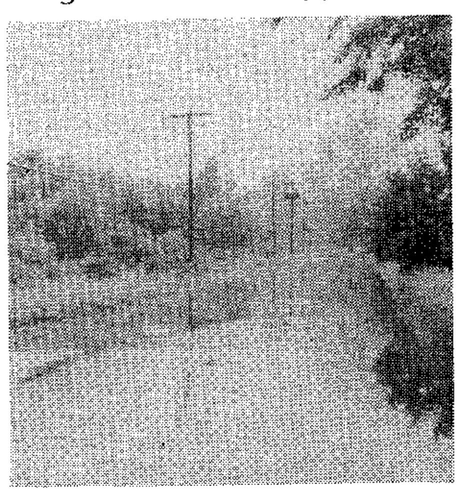


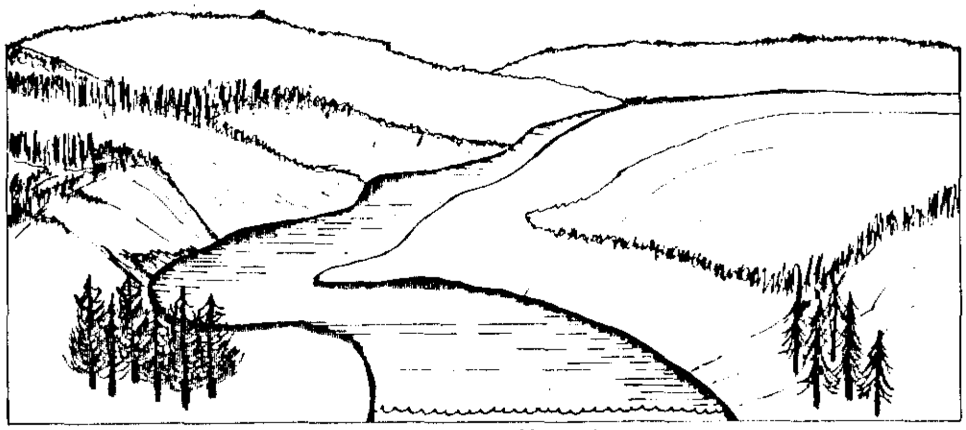
Figure 4.6

Floodplains

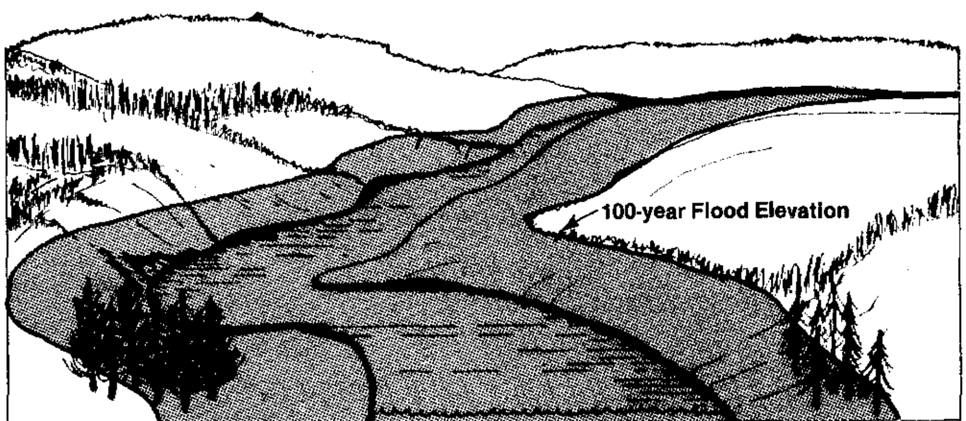
Floodplains are low-lying areas, normally adjacent to streams, which are inundated in times of heavy rains or severe snow melts. As shown in Figure 4.7, they act as shock absorbers in a drainage system by providing space for excess runoff. Left undisturbed, floodplains can also serve as recharge areas for groundwater supplies.



The 100-year Floodplain



Normal Flow



100-Year Flood

Figure 4.7

Floodplains that have a one percent chance of being completely inundated in a given year are called 100-year floodplains. Such floodplains line the river, stream, and major tributary valleys of Dutchess County. Most of them appear on the following Floodplains Map; more detailed maps of the 100-year floodplains in communities outside the county's southwestern core area are being developed. In reviewing floodplain maps, however, it is important to note that the locations of floodplain boundaries are not static. Floodplain filling, changes in the amount of developed land area, and other activities that alter the drainage characteristics of a watershed can affect the shape and size of floodplains within that watershed.

Table 4.8 100-Year Floodplain Acreages

Dutchess County Municipalities

Municipality	Approximate Floodplain Acreage	Percentage of Municipality
CITIES:		
Beacon	463	14.5
Poughkeepsie	147	4.4
TOWNS:		
Amenia	981	3.5
Beekman	944	4.8
Clinton	1,227	4.9
Dover	2,549	7.1
East Fishkill	5,436	14.8
Fishkill	1,862	10.9
Hyde Park	1,440	6.1
LaGrange	4,779	19.2
Milan	345	1.5
North East	1,102	4.0
Pawling	2,086	7.6
Pine Plains	955	4.8
Pleasant Valley	3,930	18.5
Poughkeepsie	2,260	12.1
Red Hook	1,051	4.8
Rhinebeck	760	3.4
Stanford	977	3.0
Union Vale	492	2.1
Wappinger	3,563	21.0
Washington	393	1.1
VILLAGES:		
Fishkill	96	18.1
Millbrook	121	10.3
Millerton	37	10.2
Pawling	224	17.4
Red Hook	Not available	Not available
Rhinebeck	70	7.3
Tivoli	44	4.5
Wappinger Falls	110	14.1
COUNTY TOTAL	38,444	7.5

Source: Dutchess County Department of Planning, January, 1985

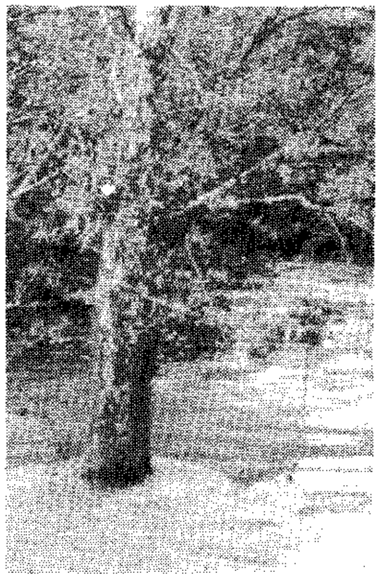
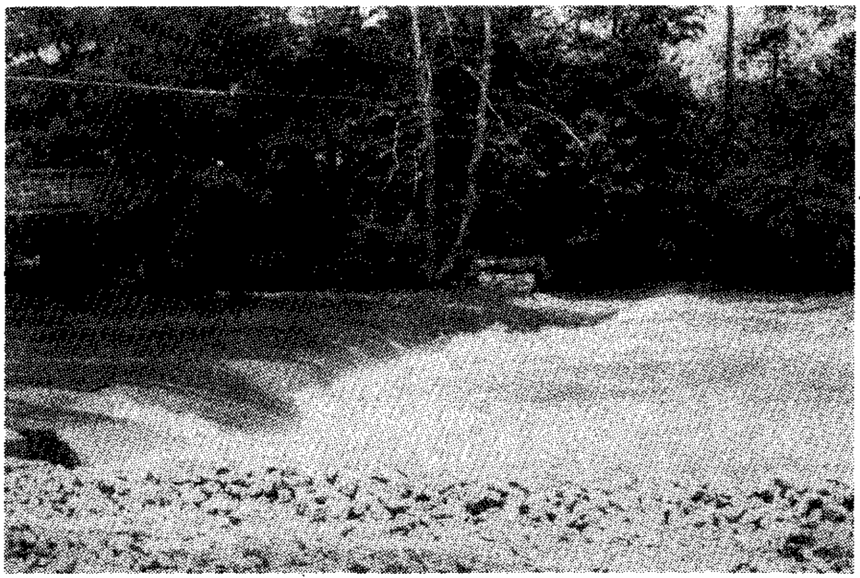


Table 4.8 indicates that 7.5 percent of Dutchess County is flood-prone, equalling approximately 38,444 acres. The floodplain acreages listed in the table, which are based on the accompanying Floodplain Map,

show that the percentage of flood-prone land ranges from zero in the village of Red Hook to approximately 21.0 in the town of Wappinger.

As previously discussed, a floodplain's ability to carry floodflows safely depends both on the types of development within the floodplain and on the land use characteristics of the watershed that the floodplain is within. The amount of runoff within a watershed increases with the amount of developed area. All of the runoff from a given watershed eventually funnels through a series of channels to the major stream or river at the watershed mouth. The floodplains along these channels become inundated more frequently and with greater volumes of water as upstream development intensifies.

Floodplain filling often increases stream velocity and level, which, in turn, endangers downstream development and erodes the stream channel. Structures such as shopping centers, industrial sites, and residential complexes that are located in floodplains often suffer water damage and, in some cases, are destroyed. Severe floods can also take lives. Proper floodplain zoning can minimize the property damage and safety hazards that inappropriate floodplain development can cause.



As described in the Climate chapter, several significant floods have occurred in Dutchess County. Flooding frequently occurs in the early spring when melting snow cannot be absorbed by the still-frozen ground. Serious floods are often the result of hurricanes or coastal storms that strike in the late summer or fall, such as those that occurred in 1938 and 1955.

Floodplain soils in the county consist of sand and silt mixtures with some gravel. The floodplains are usually fertile and flat, and often deceptively attractive development sites. The floodplains most susceptible to serious flood damage during the August and September storm season are along the lower Wappinger and Fishkill Creeks where development has already occurred. In the Harlem Valley, extensive flooding has occurred along the Webatuck Creek, the Swamp River, and the Tenmile River.

The Federal Emergency Management Administration (FEMA) has prepared detailed maps of most of the 100-year floodplains in Dutchess County. These maps are used to determine low-cost federal flood insurance rates and to develop local land use controls that comply with FEMA's requirements.

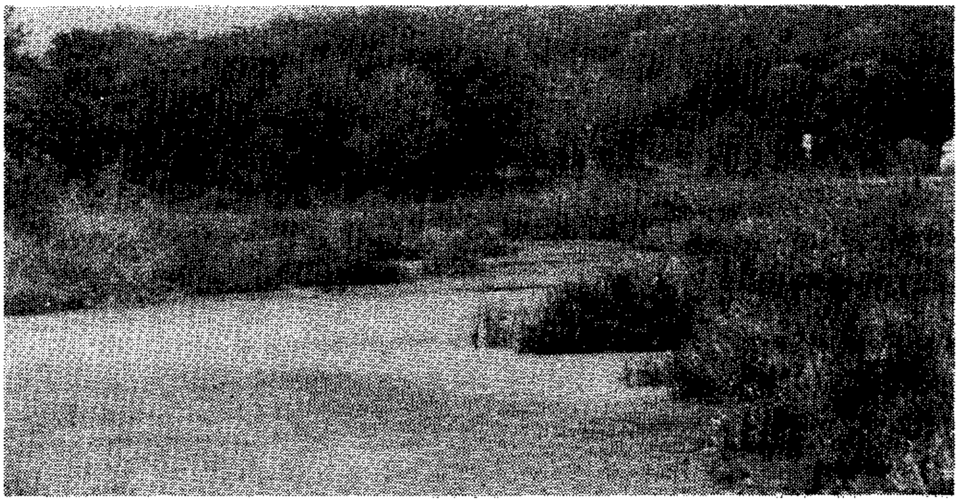
Wetlands

Wetlands are found where the water table is at or near the surface of the land for most of the year and plants suited to wet conditions have a competitive edge over dry land species. Different kinds of wetlands can exist depending upon location, topography, geology, hydrology, vegetation, and type of water (salt, fresh, or brackish). Wooded swamps, sphagnum bogs, lily ponds, cattail marshes, tidal estuaries, and wet meadows are examples of wetland types.

Freshwater wetlands cover 6.4 percent of Dutchess County, or approximately 33,000 acres. As shown in the following Wetlands Map, many of the wetlands in the county are small and scattered about the county without any discernible pattern. There are concentrations, however, along many of the major waterways, including the Swamp River in the towns of Pawling and Dover, the Tenmile River in Amenia and Northeast, and the Fishkill Creek in East Fishkill. The Great Swamp, which extends along the Tenmile and Swamp Rivers from Dover well into Putnam County, is one of the largest and most diverse wetlands in the state. Several large tidal wetlands border the Hudson River.

Historically, wetlands have been regarded as waste lands, useful only if they could be filled or drained for development or agricultural purposes. Because of this attitude at least half of New York State's wetlands have been destroyed since colonial times. Recently, however, wetlands have begun to be recognized for the many benefits they provide.

Wetlands are unique resources at the interface between water and land. Hydrogeologic studies have shown that wetlands are often important regulators and purifiers of surface water and groundwater supplies. They trap sediments, filter certain pollutants, and reduce flood hazards by acting as storage areas for extra runoff. Flooded wetlands can, in turn, recharge groundwater supplies or surface waters. Water stored in wetlands helps maintain continuous stream flows during droughts.



In addition to these valuable water management functions, wetlands provide food, cover, and breeding grounds for water fowl and other wildlife. They support unusual plant life and diverse ecological communities, and provide recreational, educational, and aesthetic benefits.

As development pressures increase, corresponding pressures to fill, drain, or build in wetlands also increase. At such times, it is particularly important to keep the limiting characteristics of wetlands in mind. Wetlands are not suitable locations for landfills, basements, septic systems, or other structures and uses that function poorly in wet soils or destroy natural wetland functions.

Concern about the destruction of wetland resources led to the passage of the New York State Freshwater Wetlands Act in 1975. This act requires permits for all non-agricultural activities that could change the quality of wetlands 12.4 acres or larger and smaller wetlands of unusual local importance. It also requires the State Department of Environmental Conservation to inventory and evaluate the wetlands of the state. The act applies to 4.4 percent of Dutchess County, and approximately 70 percent of the county's total wetland acreage. The approximate numbers of regulated and total wetland acres in each town are listed in Table 4.9. A list of large and significant wetlands is given in the appendix.

Table 4.9 Freshwater Wetlands
Dutchess County

	State-Regulated Wetlands		Total Wetlands	
Area	Acres	Percent of Area	Acres	Percent of Area
Amenia	1,350	4.9	1,547	5.6
Beekman	458	2.3	756	3.8
Clinton	1,016	4.1	1,516	6.1
Dover	1,835	5.1	2,363	6.6
East Fishkill	3,179	8.6	3,921	10.7
Fishkill	508	2.9	603	3.4
Hyde Park	844	3.6	2,063	8.7
LaGrange	1,684	6.8	2,242	9.0
Milan	613	2.6	1,030	4.4
Northeast	1,460	5.2	1,665	6.0
Pawling	1,360	4.7	1,550	5.4
Pine Plains	1,207	6.1	1,533	7.8
Pleas. Valley	750	3.5	1,204	5.7
Poughkeepsie	315	1.7	787	4.2
Red Hook	911	4.0	2,118	9.4
Rhinebeck	672	2.9	1,323	5.7
Stanford	1,264	3.9	1,798	5.6
Unionvale	925	3.9	1,185	5.0
Wappinger	695	4.1	1,387	8.1
Washington	1,538	4.1	2,303	6.1
C. Beacon	0	0.0	26	0.8
C. Poughkeepsie	13	0.4	54	1.6
COUNTY TOTAL	22,597	4.4	32,974	6.4

Source: Dutchess County Environmental Management Council

Note: Village figures are included in town wetland totals.

Resource Management Implications

Dutchess County's surface water and groundwater supplies support a large human population and sustain a diverse natural resource base. The abundance of water in the county has made it easy to take these resources for granted, and to treat land and water use as if they were unrelated. In recent years, however, the interdependence of land use, water quality, and water quantity has become obvious as reports of water shortages, groundwater contamination, and drainage problems have multiplied. It is now clear that allowing water supplies to be damaged by overuse and pollution can threaten the county's environmental, social, and economic well-being. Well-integrated land and water management plans are needed to restore water supplies that are showing signs of misuse, and to prevent further damage from occurring.

Drainage Basins

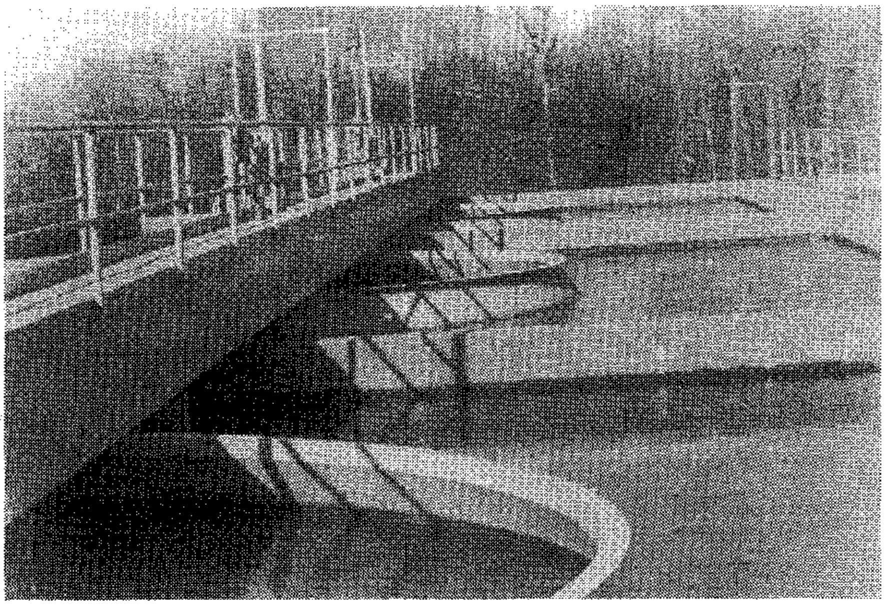
Drainage basins define the geographic limits of natural water systems. Land use changes within a basin affect water quality, flow, and use. Therefore, drainage basins should be adopted as the basic units for planning central utilities, managing groundwater resources, and protecting surface water quality. Where this requires intermunicipal and intercounty cooperation, mechanisms that foster such cooperation should be established.

The amount of runoff leaving an area increases dramatically as development intensifies. The cumulative results of such land use changes are usually more serious flooding of downstream land, greater demands on culverts, storm sewers, and other drainage system components, and more rapid erosion of stream channels and soils. To prevent these problems, new developments should be designed so that the amount of runoff from the developed site is no greater than the amount that left the site before it was developed.

Erosion and sedimentation are gradually robbing the soil of valuable nutrients and choking many of the county's surface waters. Sedimentation also clogs artificial drainage features, so that they require more frequent maintenance or replacement. Erosion and sedimentation should be minimized through strict runoff control programs on construction sites, crop fields, and other areas where soil is exposed or disturbed.

Hudson River

The importance of the Hudson River cannot be overemphasized as a source of drinking water, a drainage channel, a tidal estuary, a transportation corridor, a significant wildlife habitat, and a major element of the county's visual and historical identity. Major changes in how the Hudson River is used could significantly affect the quantity and quality of river water available to county residents. For example, withdrawing large quantities of freshwater could cause the Hudson River salt front to move northward. If it were to move far enough, the salt front could threaten Poughkeepsie's water supply.



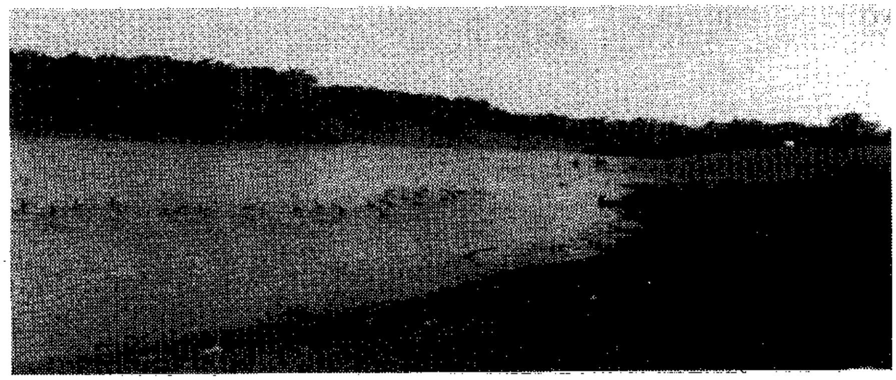
The potential for competition among those who use the Hudson for power plant cooling, drinking water, sewage and industrial waste disposal, transportation, recreation and fish production must be acknowledged. To ensure that the Hudson River resource is equitably shared and protected, Dutchess County communities should be actively involved in discussions of all issues that affect the river. Furthermore, the county should participate in regional planning efforts that affect the Hudson basin.

Surface Water

In addition to the Hudson River, Dutchess County contains 800 miles of streams and numerous lakes and ponds. All of these resources have been mapped, but relatively little is known about their quality, rates of flow, and responses to land use change. Without such information, it is difficult to assess the effects of development activities and runoff control measures on the amount of water flowing through the county's drainage basins, or to evaluate how land use trends are affecting surface waters. An effective surface water quality and quantity monitoring system to collect this necessary information should be developed as a first step in a long-range effort to manage and protect the county's surface water resources.

Significant amounts of pollutants are finding their way into the county's surface waters through seepage and runoff. Examples of such pollutants are agricultural chemicals, oil and grease, and wastes from inadequate septic systems. Finding the sources of such materials is often difficult because they are not usually discharged from a particular point or outfall pipe. Decision makers should, therefore, support efforts to identify and control non-point source pollution, and should encourage more responsible use of potential pollutants by owners and users of the land.

Community leaders should also support local efforts to control pollution from specific discharge points, such as industrial outfall pipes and sewage treatment plants. Supporting ongoing monitoring programs and aggressive enforcement of state pollution control laws is a logical first step. Through such efforts, county residents can work to restore all of the county's waters to levels of cleanliness that can support healthy wildlife and vegetative communities and a broad range of recreational uses.



Groundwater

More than 60 percent of Dutchess County residents depend on groundwater, as do many of the county's major industries and commercial enterprises. Despite this dependency, however, land use practices have reflected little understanding of the groundwater resource and its vulnerability to pollution and depletion. This "invisible" resource has usually been taken for granted. Only recently have a growing number of groundwater contamination problems and water shortages brought enough attention to this resource to make the need for better information and protection clear.

Overcrowding, loss of recharge area, and surface disposal of water withdrawn from aquifers contribute to the depletion of groundwater supplies. In many areas, residential neighborhoods that have been overcrowded for years are beginning to experience water shortages and pollution problems. Wells have also been contaminated by fuel spills, leaking gasoline tanks, wastes fron landfill sites, and industrial discharges. Protective measures are needed to ensure that today's land use decisions will not cause additional water problems in the future.

Groundwater protection programs should include a variety of approaches to managing the quantity and quality of groundwater. Components of this program should include:

1) density controls in areas dependent on groundwater and septic systems;

2) analysis of soil and groundwater characteristics during the review of all new development proposals:

3) elimination of all subsurface discharges of untreated or inadequately treated waste chemicals;

4) requirements that new developments produce no increases in runoff above natural levels;

5) strict enforcement of laws governing above-ground and underground chemical storage and spill control;

6) public education programs concerning the effects of common household chemicals on groundwater quality;

7) better management of salt stockpiles and road salt application to prevent salt from contaminating surface and groundwater supplies;

8) improved septic system maintenance;

9) use of alternatives to land disposal of municipal wastes;

10) development of central sewer systems in areas developed at greater densities than what the soils and groundwater can tolerate;

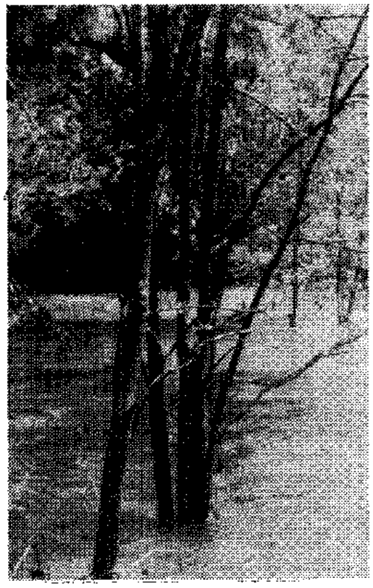
11) identification and special protection of the county's best aquifers and recharge areas; and,

12) comprehensive and effective collection of information about the county's groundwater supplies.

Groundwater management efforts should emphasize increasing everyone's awareness of the importance of the county's water resources, and their interrelationship with all resources and land use activities.

Floodplains

Floodplains exist along most of the county's major creeks, steams, and rivers. Inappropriate development decreases the ability of floodplains to carry flood waters and to absorb runoff from developed areas, and increases floodwater velocity. These phenomena, in turn, result in damage to downstream development, place floodplain occupants at risk, and can impose significant costs on affected communities. It is in the best interest of those communities to preserve the natural functions of the 100-year floodplain, permitting in them only flood-resistant accessory uses that do not interfere with floodplain functions.



Floodplains are uniquely suitable for recreational uses that do not require extensive filling because they border attractive waterways and form greenbelts through communities. They can serve as utility corridors or wildlife habitat, and their fertile soil often makes floodplains valuable cropland. Other appropriate uses might include parking lots designed to permit stormwater infiltration, bikeways, hiking trails, and required yards or residential buffers. Floodplains are not appropriate sites for extensive filling, residential buildings, mobile homes, or large, impervious surfaces often associated with commercial or industrial complexes.

Dutchess County and its municipalities must also become aware of the relationships within watersheds among land uses, runoff, and flood susceptibility. As development pressures increase throughout the county's watersheds, it becomes increasingly important to limit runoff and erosion from development sites so that flooding does not become more severe, and to leave floodplains undisturbed so they can carry floodwaters safely.

Wetlands

Wetlands cover only 6.4 percent of Dutchess County, yet they play a crucial role in regulating the quality and quantity of water supplies and in managing stormwater runoff. They are also the county's most productive wildlife habitat, and as open space they support diverse recreational uses. Although their qualities vary, wetlands are usually not appropriate development sites because of their hydrological characteristics and environmental values. Their destruction imposes significant economic costs on society. Therefore, except in cases where their values are clearly shown to be negligible, wetlands should be protected from development.

Soils

Soil is the mixture of rock and mineral particles, organic matter, and water that covers the surface of the earth. It makes the cultivation of food crops possible, supports building foundations, filters groundwater resources and waste materials, and sustains vegetation and wildlife habitats. An understanding of soil properties and limitations contributes to the intelligent use and preservation of all natural resources.

Composition of an Average Soil

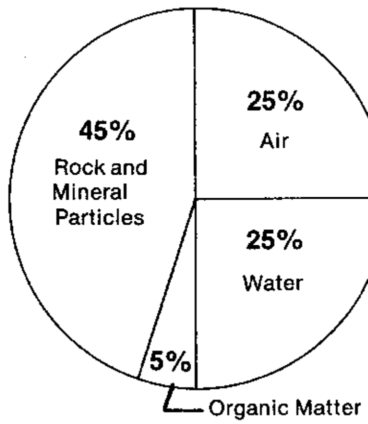


Figure 5.1

As depicted in Figure 5.1, an average soil consists of 45 percent rock and mineral fragments, 25 percent air, 25 percent water, and 5 percent organic matter. Few real soils actually match this description. The composition and proportions of soil components vary from place to place and give rise to differences in color, depth, texture, and the types of vegetation that the soil can support. Factors contributing to these differences include:

- parent material
- climate
- organic matter
- topography
- time

Parent material is the mixture of rock and organic matter from which soil is formed. Its structure, texture, and chemical and mineral composition determine many of the characteristics of soils derived from it.

Soil parent materials are often formed from the underlying bedrock. Over time, daily and seasonal temperature changes and water weather this rock into fragments that form the basis of the soil. In many instances, however, the parent material is derived from bedrock found far away. As described in the Geology chapter, many of the surficial deposits in Dutchess County were left here by glaciers, which deposited them hundreds of miles from their places of origin. Wind and water are also capable of carrying soil-building materials over long distances.

Dutchess County soils are derived primarily from glacial till, glacial outwash, organic matter, and lacustrine and alluvium sediments. These are briefly defined below, and more fully discussed in the Geology chapter.

- Glacial till consists of unstratified, mixed deposits of clay, silt, sand, and rock fragments deposited by glacial ice.

- Glacial outwash is material swept out, sorted, and deposited beyond the ice front by streams of glacial meltwaters. These deposits are usually stratified and made up of sands and gravels.

- Organic matter such as decomposed plant and animal residue forms the basis of muck soils. Many of these soils are the direct result of glaciation, which, by impeding drainage, caused wetlands to form. Wetland vegetation flourished as the climate became warmer, resulting in the accumulation of vegetative materials that ultimately became organic or muck soils.

- Alluvium sediments consist of material moved and redeposited by streams. They can appear in terraces well above normal stream beds or in the normally flooded bottoms of existing streams.

- Lacustrine sediments consist of very fine sands, silts, and clays that have settled out of the still water of lakes.

The nature of parent material has a profound effect on soil characteristics. For example, the different mixtures of source materials left in Dutchess County by the various glacial processes have produced soils with textures ranging from fine-grained clay to coarse sand. These textures, in turn, are responsible for such characteristics as water-holding capacity, fertility, and strength in supporting foundations.

Many interrelationships are apparent among the factors that shape soils. Climate, especially temperature and precipitation, contributes to soil formation through constant weathering and periodic glaciation. Plants and animals also affect the physical and chemical characteristics of soils. Their activities mix, aerate, and enrich the soil, while the organic matter they produce combines with weathered parent material to build the soil gradually. Topography is important because it can modify climate, determine drainage patterns, affect rates of erosion, and influence the location and type of vegetative cover. Time is another critical variable in the process of soil formation. Soil depth, for example, can be directly related to the amount of time bedrock is subjected to the forces of weathering. It can take thousands of years for a well-developed soil to form.

Soil forms layers, called horizons, over time. A typical soil contains four horizons, illustrated in Figure 5.2: organic layer, topsoil, subsoil, and parent material. The thickness and composition of each horizon vary with location, time, and disturbance.

Typical Soil Profile

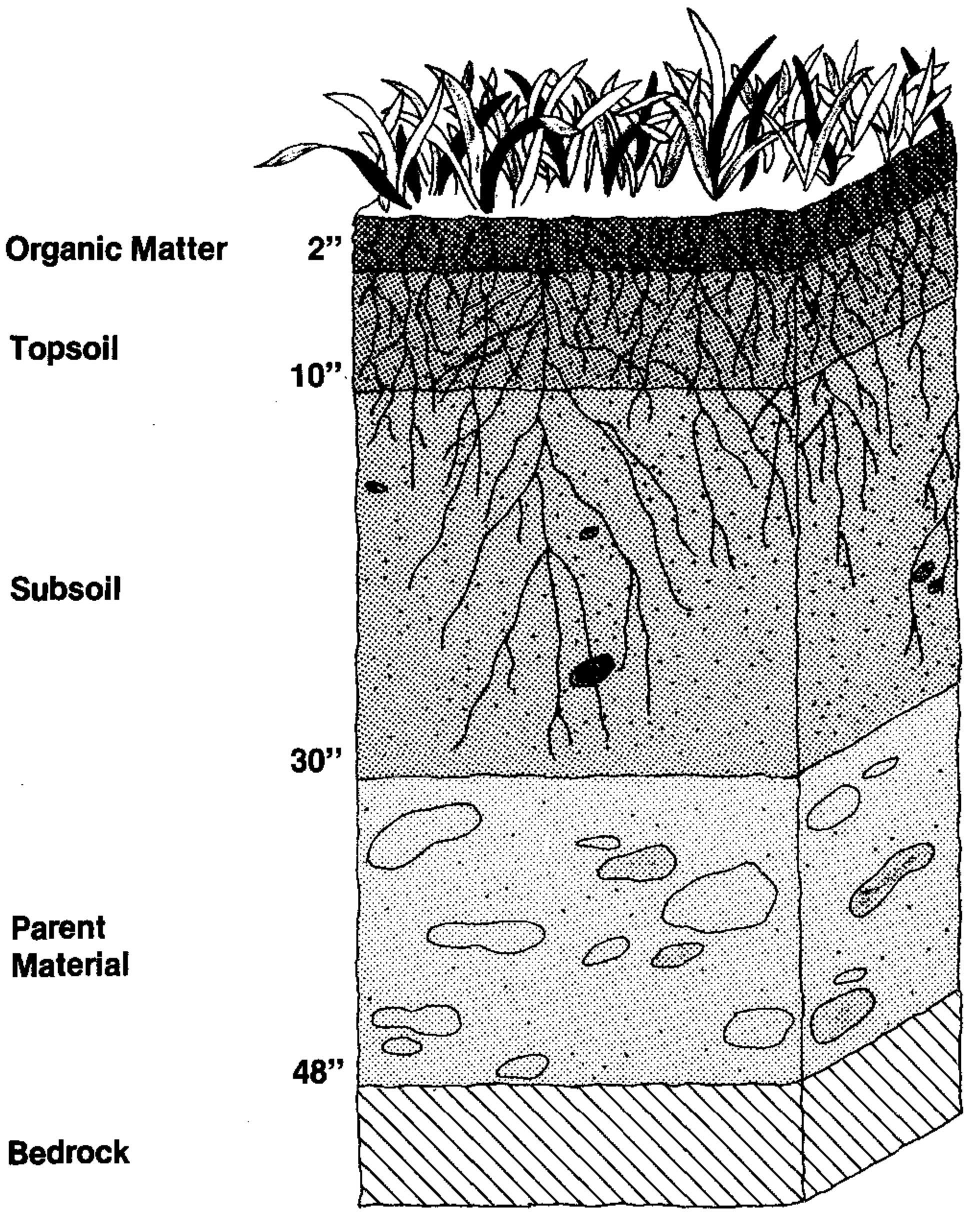


Figure 5.2

Redrawn from USDA Soil Conservation Service, Conserving Soil.

Surveys

Soil surveys are inventories used to interpret the best uses for the particular soil series that occur in a given area. Each series consists of all soil types whose layers or horizons have nearly the same characteristics, thickness, and arrangement. Soil texture is usually the only feature that can vary considerably within one series.

The Soil Survey of Dutchess County, prepared in 1955 and updated in 1972, lists, describes, and maps 134 different soil series, each with distinct characteristics and qualities. No single soil series covers more than three percent of the county.

Dutchess County soils vary greatly. Silt loam textures dominate, although textures vary from gravelly, sandy loam to fine, silty clay. Most of the soils that have been cultivated are moderately eroded, except in certain nearly level areas. More than 70 percent of county soils are well-drained, but small areas of poorly- and very poorly-drained soil can be found in complex associations that limit the use of the well-drained soils.

Major Soil Areas

The Generalized Soils Map presents an overview of soil types in Dutchess County. The eight soil areas shown are general groupings of the more numerous and detailed soil series listed in the county soil survey. Large areas of land are usually dominated by two to five soil series that differ in drainage capacity but are derived from the same type of parent material. Such groups of soil series are called catenas.

On the Generalized Soils Map, a map unit that contains one dominant catena, such as the Nellis area, is named for the soil series that covers the largest portion of that unit. If two catenas are major components, the names of the most extensive series in each catena are combined to produce the map unit name, as in Bernardston and Nassau. In all cases, other minor soil groups are also present in the map units.

Each soil area is associated with certain characteristic landscapes. As a result, each map unit indicates something about the drainage and landscape character of a particular portion of the county. Table 5.1 summarizes the differences among the map units by indicating the percentages of each soil area that are steep, wet, very stony, and shallow. Any of these characteristics can severely limit the use of land.

Soils in the lowland and valley portions of the county tend to have the most favorable topography and the highest potential for intensive uses. These areas are also usually the best for agricultural purposes. The highland areas contain poorer soils and, consequently, are more conducive to sparse development and less intensive agricultural uses. Descriptions of each soil area are given below. More detailed information about the series within each map unit is available in the Dutchess

County Soil Survey, prepared in 1955, and the Manual of Soil Survey Interpretations of Soils in New York State, published in 1972.

Table 5.1 Interpretation of Generalized Soils Map

Dutchess County, N.Y.

Map Unit	Percentage Steep	Wet	Very Stony	Shallow	Use Restrictions
Nellis	0-25	5-30	0-10	0-20	--
Hollis	35-85	1- 5	20-95	50-85	Slope and depth limit use
Nassau	10-45	2-15	0-15	35-80	Depth limits use
Bernardston-Nassau	10-25	5-15	0-10	10-35	--
Bernardston-Hoosic	5-40	5-30	0-20	5-15	--
Hoosic	0- 5	0-35	0- 5	0- 5	Droughtiness limits use
Hudson	15-50	20-40	0	0	Wetness and slope limit use
Rock outcrop, steep	45-95	0-20	0-95	40-95	Depth and slope limit use

Nellis

Nellis areas occur in the eastern and southern parts of the county, where they make up the till-mantled, lower portions of valley sides. Nellis and Amenia groupings, which overlie limestone and are derived from glacial till, cover 40 to 55 percent of most of these areas. Elsewhere within this unit in the eastern part of the county, Copake or Stockbridge groups appear instead of the Nellis-Amenia soils. The Copake group overlies stratified sand and gravel and is derived from glacial outwash. The Stockbridge group overlies slate and is derived from glacial till.

More than 75 percent of the Nellis unit has deep, gently sloping, moderately stony soils. These are usually moist and have only moderately or slowly permeable subsoils, which restricts their value for uses requiring rapid internal drainage. Dairy farming is prevalent on many of the Nellis areas.

Hollis

The Hollis unit occupies hilly or steep, mostly wooded areas in eastern Dutchess County. Shallow Hollis soils make up 50 to 85 percent of the unit. Deeper Charlton and Paxton soils occupy 5 to 25 percent of each Hollis area. Thirty to 85 percent of this unit is steep, and 20 to 95 percent is stony. Rock outcrops are common on the steep slopes. Soils in this unit are most suited to recreational, wildlife, and forestry uses.

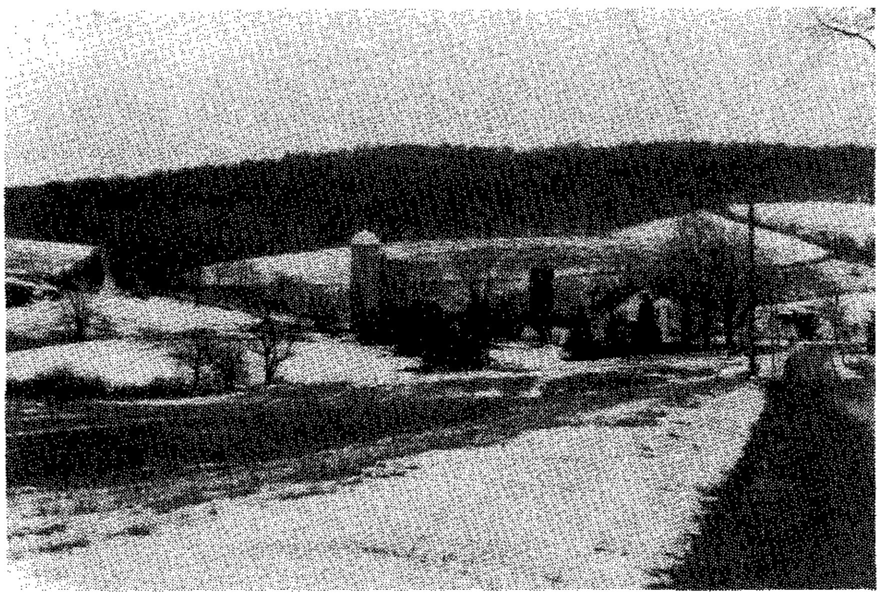
Nassau

The Nassau unit contains large tracts of shallow Nassau soils (50 to 80 percent) intermingled with smaller areas of deeper soils, such as the Bernardston-Pittstown group (20 to 40 percent). The unit can be found in the northwestern and central regions of the county. The Nassau soils have many rock outcrops. The deeper soils usually occur in tracts of a few hundred to several thousand acres in size and can support viable farm units. Steep and shallow areas account for 25 to 40 percent of the unit. Fragipans (hard, slowly permeable layers) in some of the deeper soils make them poorly suited to septic systems and other uses that require the internal disposal of water.

Bernardston - Nassau

The Bernardston-Nassau unit covers large parts of the Hudson Valley uplands. In Dutchess County it forms a wide band extending from the town of Northeast to the city of Beacon, and contains a mixture of two highly contrasting soil associations. Drumlins, which are cigar-shaped hills formed by glaciers, often dominate the Bernardston-Nassau landscape. They have deep soils that are usually farmed, and are chiefly composed of Bernardston soils (50 to 70 percent) with small areas of Pittstown. Around the drumlins are idle lands, forests, or pastures with surface irregularities that indicate the presence of slate bedrock at shallow depths. Shallow Nassau soils dominate these areas, accounting for 10 to 35 percent of the total acreage. Wet Stissing and droughty Hoosic soils may make up another 5 to 15 percent.

The Bernardston-Pittstown portions of this unit are particularly good for dairy farming. Parts of these areas have moderately steep slopes that present tillage and erosion control problems. The shallow Nassau portions are untillable. Fragipans limit drainage in some Bernardston areas, but drainage is less restricting here than in areas where wetter soils dominate.



Bernardston - Hoosic

The Bernardston-Hoosic unit, in the northwest corner of the county, includes two contrasting soil associations. The Bernardston and Pittstown soil association accounts for 40 to 55 percent of the total acreage. Glacial outwash terraces, dominated by moderately droughty Hoosic soils and interspersed among the Bernardston-Pittstown areas, account for another 20 percent. In Dutchess County, the Bernardston portion is an undulating glacial till plain with low drumlins. The Hoosic areas are interspersed, and appear in relatively flat outwash terraces. Approximately 5 to 10 percent of the acreage in this unit is steep.

Most of the areas in this unit are farmed or used for housing, with orchards especially important on the Hoosic soils. Only 10 to 40 percent of the acreage is affected by steep, wet, very stony, or shallow soil conditions. Bernardston areas have fragipans, which may cause problems for uses requiring rapid internal drainage.

Hoosic

Hoosic areas are found east of Wappingers Falls and in the northwestern corner of the town of Milan. This unit is nearly level to undulating, and includes moderately broad glacial outwash plains and narrower outwash terraces in valleys. Soils derived from coarse glacial outwash comprise 45 to 90 percent of the Hoosic unit, with Hoosic as the dominant series. Hamlin, Tioga, and related alluvial soils appear on floodplains and comprise 5 to 30 percent of the unit. Bernardston and Nassau soils on till, and Rhinebeck or Hudson soils derived from lake sediments occupy up to 10 percent of any Hoosic areas.

On 50 to 90 percent of the land in the Hoosic unit a low water-holding capacity causes droughtiness. The dry soil makes it difficult for many annual crops to thrive; perennial plants with deeper roots fare better. Although the rapid permeability is considered an asset for non-farm uses, it has the potential for readily transmitting groundwater pollution from areas used for waste disposal. Only in small areas is hilly, wet, very stony, or very shallow soil a problem.

Hudson

Hudson soils are concentrated along the Hudson River in the northwestern quarter of the county. They include landscapes where glacial lakes deposited clayey sediments on what are now valley walls. In some places streams have cut channels into the underlying bedrock, and now flow down through these channels to the Hudson River. Close to the Hudson, narrow remnants of the original surface are interspersed among these stream valleys. The original gently-sloping surface, largely uncut by streams, is found farther inland at the higher elevations.

An association of Hudson and Rhinebeck soils, dominated by Hudson soils, covers 30 to 70 percent of the unit. Rhinebeck soils occur primarily on the higher elevations that have not been disturbed by streams. Large tracts of the Rhinebeck soils are often used for crops that can tolerate wetness. Varysburg and Arkport soils that overlie sand or gravel glacial deltas account for 5 to 25 percent of most areas in the Hudson unit. Glacial till soils and rock outcrops cover another 5 to 20 percent, particularly where erosion has removed the Hudson sediments.

Steep slopes restrict the use of 20 to 40 percent of the unit. Wetness and slow permeability cause problems on an additional 20 to 40 percent. The sand and gravel delta areas have few limitations. Moderately steep and steep

Hudson soils are often pastured. These soils are subject to landslides, and for that reason alone are not suitable for many uses.

Rock Outcrops

Rock outcrop areas are common at high elevations in the southern and eastern portions of the county. Two types of rock outcrops can be found. A Hollis rock outcrop-Charlton soil association occurs in the southern part of the Hudson Valley. Exposed rock and shallow Hollis soils cover 50 to 90 percent of this portion of the unit. Deep charlton soils and others cover 5 to 40 percent of it. The second type of outcrop is an association of Nassau outcrop areas and Bernardston soils. Rock and shallow Nassau soils cover 65 to 85 percent of this association, and Bernardston accounts for 5 to 20 percent. Most rock outcrop areas are forested and are uniquely suited to recreational uses and wildlife. Between 45 and 90 percent of them are hilly or steep. Many of the deep soils around rock outcrops contain stones or boulders.

Depth and Permeability

Permeability

Permeability rates, which are usually given in inches per hour, measure the ease with which water flows downward through the soil layers. Septic fields, farming, and other uses requiring good internal soil drainage may not function properly in slowly permeable areas. This characteristic can also place severe restrictions on development densities in areas not served by central water and sewer systems.

The Soil Permeability Map indicates where soils with relatively poor internal drainage occur in the county. The permeability rates of these soils are generally less than 0.63 inches per hour, which is the level considered by the Dutchess County Soil Survey a severe limitation on the soil's suitability for septic tanks. Such soils are extensive, covering most of the western half of the county. However, in many of these areas, septic systems have been functioning adequately for years. Local variations in soil or slope features, the use of fill in creating septic fields, and the non-intensive use of the waste disposal systems enable these septic systems to operate properly.

Rapidly permeable soils can also limit the suitability of land for development, because they allow pollutants to move quickly into groundwater supplies.

The Relationship Between Soil Texture and Water Runoff

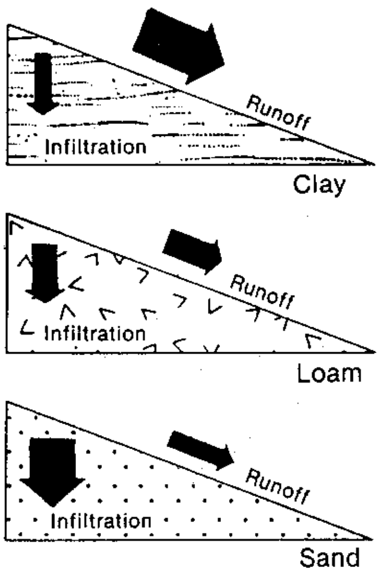


Figure 5.3

This characteristic is of particular concern in siting landfills and other facilities that generate potentially harmful wastes.

Soil texture influences permeability. Soils with a high concentration of sand or gravel particles and organic matter tend to drain more rapidly than soils with a high clay content. Clay particles, defined as particles smaller than 0.002 millimeters in diameter, cannot be seen with the naked eye. They pack together so tightly that there is little room for air or water to filter through the microscopic pore spaces around them. Sand, on the other hand, ranges from .05 to 2 millimeters in diameter, up to 10,000 times the size of the clay. The pore spaces around the sand, gravel, and stones found in permeable soils allow water and air to pass through more freely. The relationship between such variations in soil texture and the absorption of rainfall is illustrated in Figure 5.3.

Depth

Depth to bedrock is another characteristic that can affect the development suitability of soils. Shallow soils limit the placement of wells, septic systems, foundations, and agricultural uses. Because they are often found on steep slopes, such soils can also be highly vulnerable to erosion. Pollutants can pass quickly through shallow soils and contaminate groundwater supplies.

The Soil Depth Map shows where bedrock lies within three feet of the surface, placing a severe constraint on the suitability of the soil for streets, buildings, and septic systems. The largest concentrations of such shallow soils are in upland areas in the county's higher elevations.

Erosion and Sedimentation

Erosion studies conducted in 1974 revealed that an average of 1.34 tons per acre of soil were lost every year from watersheds totally or partly within Dutchess County. As summarized in Table 5.2, the rate of erosion was greatest in the Roeliff Jansen Kill watershed that extends into Columbia County, and least within the Wappinger Creek basin and the small portions of the Upper Housatonic River watershed that reach into Dutchess County near the Connecticut state line.

Since 1974, federal and county soil conservation programs have made significant progress in reducing erosion from croplands in Dutchess County, particularly within the Tenmile River, Roeliff Jansen Kill, Crum Elbow-Hudson River, and Hunns Lake watersheds where agricultural uses are concentrated. How much cropland erosion rates have been reduced has not yet been determined. Considerable erosion problems are known to persist, however, on construction sites and croplands where no soil conservation measures are in place.

Table 5.2 Erosion in Dutchess County Watersheds, 1974

Watershed Name	Erosion rate (tons/acre/year)	Watershed size (acres)	Total soil loss tons/year
Croton river	.96	232,699	223,172
Crum Elbow Creek-Hudson River	1.01	109,314	110,541
Fishkill Creek	1.30	129,671	168,705
Hunns Lake	1.61	5,681	9,173
Jansen Kill	2.54	145,716	370,258
Tenmile River	1.70	98,071	166,585
Wappinger Creek	0.84	128,329	107,849
Upper Housatonic River	0.51	1,199	616

Source: USDA Soil Conservation Service, Erosion and Sediment Inventory, New York, 1974.

Soil loss remains a significant threat to the quality of the county's land and water resources. By stripping topsoil from the land, erosion robs the land of valuable natural nutrients and washes soil, pesticides, and fertilizers into waterways. It also undermines soils and structures and chokes streams, lakes, rivers, and drainage systems with sediment.

The rate of soil loss varies dramatically with land use. In New York State, erosion rates from construction sites are as many as 25 times those from cropland, and as many as 75 times those from pastures and woodlands. Proper conservation procedures can drastically reduce these rates. The average erosion rates observed in New York State for several different land uses are listed in Table 5.3. Erosion rates for eight major Dutchess County watersheds are listed by land use in the appendix.

Table 5.3 Erosion Rates for Major Land Uses

	Average Soil Loss (tons/acre/year)	
Land Use	New York State	Dutchess County
Construction sites	31.58	9.61
Cropland without conservation measures	7.38	11.88
Orchards, vineyards, bush fruits	3.28	1.21
Urban land	1.69	0.59
Cropland with conservation measures	1.26	0.74
Pasture	0.99	0.79
Woodland	0.43	0.48
Streambanks (tons/bank-mile/yr.)	73.10	6.54
Roadbanks " "	29.25	31.80

Source: USDA Soil Conservation Service, Erosion and Sediment Inventory, New York, 1974, and USDA Soil Conservation Service, Dutchess County Office.

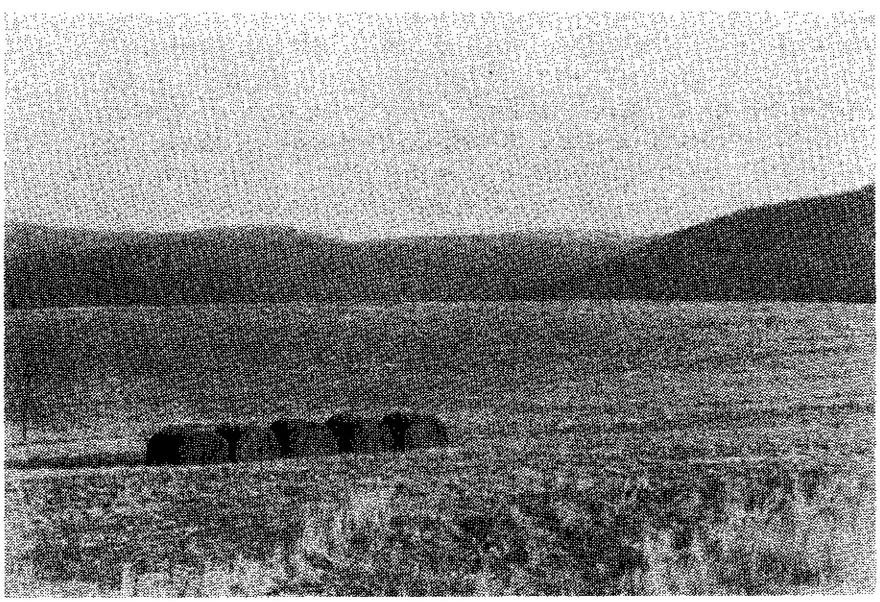
The figures given in Table 5.3 are approximate. Actual soil loss rates vary considerably from site to site, depending on such characteristics as slope, soil type, vegetation density, and rainfall. The scale of the differences among the erosion rates is, however, an accurate indication of the relationship between soil loss and land use.

Prime and Important Agricultural Soils

The best, most potentially productive soils are called prime soils. Classified by the U.S. Soil Conservation Service (SCS), they are suited to a wide variety of farm crops with relatively few limitations, and represent an irreplaceable agricultural resource. Prime soils tend to be well-drained, nearly level, fertile, stable, and deep. These characteristics make them both ideal for farming and easy to develop.

Prime soils once covered 15 percent of Dutchess County. Significant concentrations occurred along the major stream valleys and throughout the towns of Red Hook and Rhinebeck, as well as major portions of Clinton and Pleasant Valley. High quality soils also used to be abundant in the southwestern quarter of the county. In the last 40 years, however, this area has become the county's urban core as a result of sustained development activity. How much prime agricultural land remains is unknown, but it has been estimated that as much as 50 percent of the county's best soil acreage has been developed for residential, commercial, or industrial use.

"Important" soils usually support good crop fields, but unlike prime soils they have limitations that require special conservation measures and are suited to a smaller variety of crops. According to SCS inventories, they once covered 32 percent of the county, and can still be found near the remaining prime agricultural soils and throughout Stanford, Washington, and Hyde Park. Smaller tracts of important soils are found in much of the county. Important and prime soils are noticeably absent from the Hudson Highlands, the ridges along the Harlem Valley, and other steeply sloping uplands where soils are characteristically shallow.



Resource Management Implications

Soil is a fundamental resource that is often taken for granted because of its abundance, low cash value, utilitarian functions, and lack of aesthetic charm. Soil makes it possible to use and live on the land. Without ample supplies of good, arable soil, food production would be vastly more difficult.

Soils have several characteristics, such as permeability, depth, erodibility, and wetness, that limit the land uses they can support. All of these limiting characteristics should be considered during the land use decision-making process. Development proposals and local land use controls should be well-matched to soil features to ensure that the type, density, location, intensity, and design of all land uses are appropriate to the soils and other natural resources that must sustain them.

Permeability

Soil permeability is an important measure of the development potential of land. Highly permeable soils drain well and rapidly transmit rainwater into groundwater supplies. Soils with permeability rates of 0.63 inches per hour or less are considered to have poor internal drainage, and are usually not suitable for septic systems or other uses that depend on water infiltration. They also are less valuable for groundwater recharge than more permeable soils are, because rainwater travels down through them so slowly.

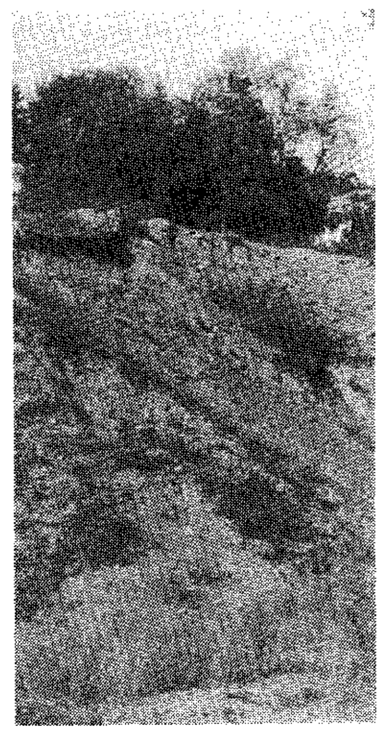
Development densities and waste management practices should reflect the severely limited ability of impermeable soils to absorb and filter wastes. Otherwise, intensive development without central sewage treatment facilities will saturate soils with wastes, causing untreated wastes to spread into nearby surface waters and groundwater supplies. In areas where such contamination occurs, expensive construction of central sewage and water treatment facilities and pipelines may be the only remedy.

Highly permeable soils should also be used carefully, because of their ability to transmit hazardous materials into groundwater supplies. Landfills, petroleum storage tank farms, chemical manufacturers, and other facilities that handle such materials should not be located on top of the most permeable soils.

Depth

Like permeability, depth-to-bedrock affects the development suitability of soils and should be considered when development proposals and land use policies are reviewed. Shallow soils limit the placement of wells, septic systems, foundations, agricultural uses, roads, and utilities. Expensive blasting is often needed for construction on shallow soils, and the likelihood of erosion and septic failures is much greater than in areas with deeper soil. At the same time, shallow soils with bedrock outcrops on steep slopes often offer spectacular views, making them tempting sites for recreational developments and homes. They are ideal sites for natural recreation areas such as hiking trails, forest preserves, and open space.

To prevent costly mistakes, local governments should use soil features such as permeability and depth to determine allowable land uses and development densities, and to prepare central utility plans. Intensive development should not be encouraged on shallow soils without central sewage systems and stringent erosion control measures.



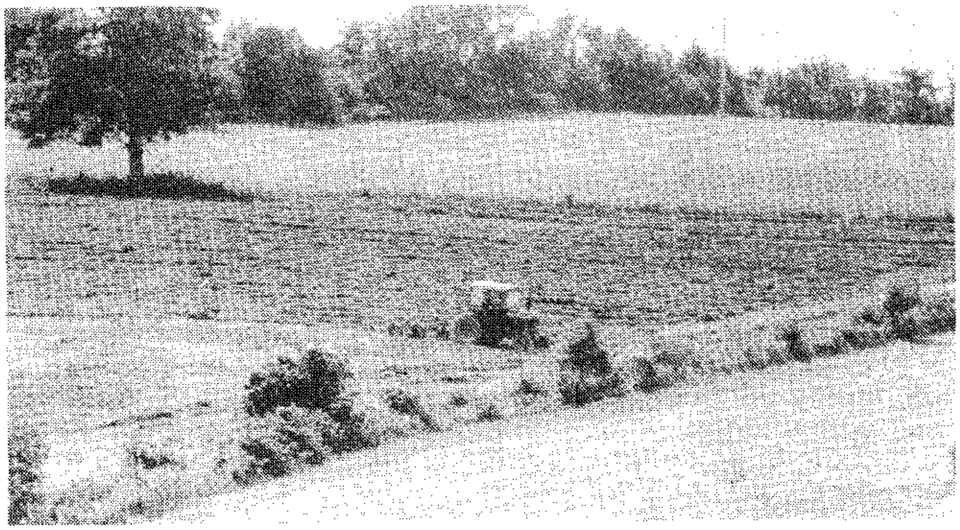
Erosion and Sedimentation

Although federal and county soil conservation programs have helped reduce cropland erosion significantly since the mid-1970s, erosion continues to damage the county's soil and water resources. Erosion rates are especially severe on construction sites, roadbanks, and croplands that are not using erosion control methods.

Erosion not only destroys an irreplaceable resource; it also adds to the public costs of maintaining drainage systems, roads, and waterways. Soil eroded from poorly managed construction sites, for example, chokes drainage culverts and sediment traps, which must be cleaned frequently at public expense. Local governments should develop and enforce effective erosion control standards for construction sites, roads, and croplands and should support county and federal programs that help landowners reduce soil loss.

Prime and Important Soils

Much of Dutchess County's prime and important soil acreage has been developed since World War II, and is no longer available for agricultural or open space use. The best remaining soils, located mainly outside the southwestern core area, form a critical resource on which Dutchess County's current agricultural industry and its future food producing capability depend.



Agriculture is a significant and highly valued component of Dutchess County's economy and visual identity. Prime and important soils support active farms throughout the northern and eastern communities, as well as a handful of farming operations within the urban area. Many of these farms are under intense development pressures which threaten their continued viability. It is necessary, therefore, to devise ways to preserve the county's best soils even where farming activity declines.

If land uses that can function satisfactorily on less valuable soils are allowed to continue to consume the best soils in Dutchess County, the county's agricultural community will weaken and its ability to respond to future changes in the nation's food production system will be severely impaired. The loss of agricultural open land also threatens one of the most traditional and aesthetically pleasing contributors to the county's high quality of life.

Aggressive measures are needed to protect the soil resource. Communities must find equitable, effective ways to divert development to less valuable sites, to encourage open space preservation, to support agricultural activities, and to institute effective erosion control measures.

Vegetation

Vegetation is the total plant cover of an area, including all individuals of every plant species present. Patterns of vegetation are determined by the physical features of the landscape, climate, hydrology, soil, wildlife, and human influences, as well as by chance and competition among plant species. Vegetation, in turn, provides food, lumber, and fuel, moderates the climate, buffers the hydrological cycle, helps form and protect the soils, and creates wildlife habitat. It also reduces the velocity of flood waters, absorbs noise, detoxifies certain pollutants, helps filter sanitary wastes, and enhances the visual environment.

The vegetation chapter was prepared by Erik Kiviat, an Ecologist with Hudsonia Limited of Annandale, New York.

The interrelationships among vegetation and other natural resources are reflected in plant communities, which are recognizable patches of plant cover characterized by one or a few predominant species that recur wherever the influencing factors are similar. The field corn community that occurs on many farms and the red oak - chestnut oak community common on the county's hills are examples of plant communities. Each acts on, and is acted on by, all other natural resources and forms part of Dutchess County's resource base.

There is no comprehensive list of the county's flora. Many of the references included in the bibliography include species lists for small areas of the county. The scientific and common names of plants mentioned in this chapter are provided in the appendix.

History

Vegetation began to take hold of and modify the county's environment after the glacial ice melted about 10,000 years ago. Before Europeans arrived, oak-dominated forests and white pine probably covered 50 to 75 percent of the county. Indian tribes located along major streams and the Hudson River used fire to clear land for crops and settlement sites. This practice restricted fire-sensitive trees, such as hemlock, to ravines and wetlands.

The Dutch, German, and English settlers of the 17th century altered the county's vegetation by damming streams, clearing land for crops and pasture, logging extensive areas, and introducing grazing livestock. The older forests found today were probably cut once early in this period and not again.

During the 19th century more than 90 percent of the county was cleared and planted or grazed. Intensive wheat cultivation eroded soils on the slopes and hill-tops, in some places exposing bedrock that remains exposed today.

Small-diameter wood was cut and burned to produce charcoal needed by the iron smelters in the eastern and southern portions of the county. The demand for wood to heat homes and fuel steam engines put additional pressure on the forests.

Agriculture began to decline in the late 19th century. American chestnut probably took over many of the drier pastures that were no longer grazed. The same sequence of cultivation, grazing, and abandonment encouraged American elm to grow on moist lowlands. Small wetlands formed in silted mill ponds and where road construction blocked drainage outlets.

The turn of the century was a time of vegetation change. Agriculture began to give way to homes and industries in the western part of the county but persisted in the eastern lowlands, while forests re-established themselves on the hillsides. Abandoned farmlands that were not developed were taken over first by brush, and then by forest. Many wetlands were drained or filled for building sites and new types of agriculture.

Early in the 20th century chestnut blight killed the stems of the American chestnut trees; red oak and chestnut oak apparently replaced them. Root sprouts of a few chestnut trees can be seen today, especially in the eastern part of the county. During the droughts of the 1930s and 1940s forest fires burned many areas littered with dead chestnut trees.

Today, timber cutting takes place in all parts of the county except for the densely-settled residential south-west. Seven to ten million board feet are cut annually, selectively harvested on about 5,000 acres, or one percent of the county's land. Red oak is the most important commercial species, but white and chestnut oaks, white ash, sugar maple, red maple, and black birch are also harvested.

Few statistics are available on the amount of wood cut annually for fuel in Dutchess County. This harvest is known to be increasing, however, due to the increased use of woodstoves for heat. The small-scale cutting of timber and fuel wood continues to produce woodlots characterized by many-stemmed trees grown from stump and root sprouts.

Agriculture remains an important activity in the county. More than 20 percent of the county's land is producing food crops, fruit, pasturage, or fodder. Wild animals such as deer and beaver, however, have gradually replaced cattle as a major selective force in vegetation development. Deer and beaver were extirpated from Dutchess County in the 19th century, but since then have returned in significant numbers. Beaver dams create ponds and wetlands. Selective feeding by deer and beaver discourages some plant species while encouraging others.

The present mixture of conifer and hardwood forests, oldfields, and active farmland provides abundant habitat for wildlife that favor forest edges and open lands. Cavities in dead and large live trees are especially important to many birds and small mammals. The diversity of vegetation also contributes to the county's scenic qualities. Flowering dogwood and mountain laurel in the spring, purple loosestrife, asters, and goldenrod in the summer and early fall, and the multicolored leaves of autumn immeasurably enhance the beauty of the county.

Types of Vegetation

Today more than 50 percent of Dutchess County is covered by forest, brush, or inactive land. As shown in Figure 6.1, roughly one-fourth of the county is developed, 18 percent is actively used for agriculture, and 6 percent is wetland. Vegetation in the county can be more specifically grouped into six land use - vegetation types. As shown on the Vegetation Map, these types are forest, brushland, plantations, wooded wetlands, nonwooded wetlands, and agricultural and developed land.

The distribution of vegetation types shown on the Vegetation Map follows the predominant north-south and northeast-southwest axes of the county's ridges and valleys. Farmland, recently abandoned farmland, wetlands, and development concentrations are most common in the valleys where soil is relatively deep. Forests are more prevalent on the hillsides where soil is thin. Many of the largest farms and wetlands are located on limestone or sand and gravel deposits in the Harlem Valley and the southern portion of the county (see Bedrock and Surficial Deposits Maps in Chapter 2). Forest tracts are more extensive in the eastern and southernmost sections of the county, where much of the land is steep and rocky and the soil acidic, making it less amenable to farming and residential development. The relationships among geology, topography, soils, and vegetation can be seen by comparing the Vegetation Map to the maps of bedrock, surficial deposits, steep slope, soil types and groundwater occurrences in the preceding chapters.

Vegetation Type as Percent of County Area

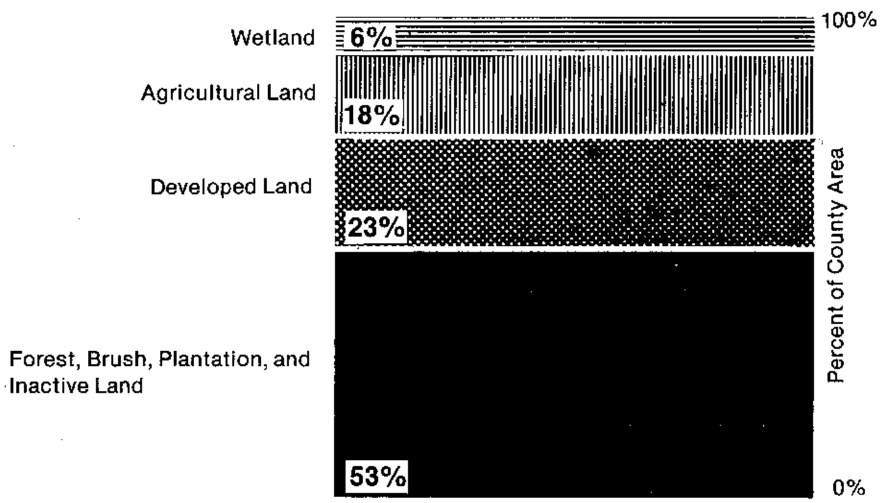


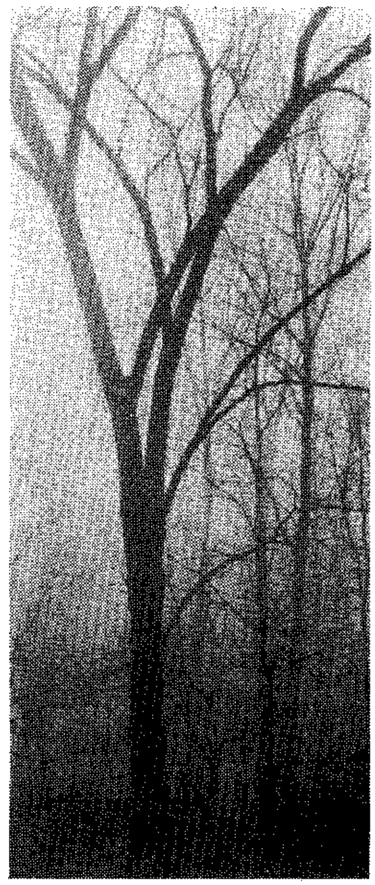
Figure 6.1

A quick look at the Vegetation Map conveys the impression that half of Dutchess County is forested, but the vegetation is considerably more complex. The most common plant communities and their characteristic species are listed in Table 6.1. The species are arranged by "sites" or topographic positions as well as by land use. Figure 6.2 illustrates the topographic positions of the plant communities and suggests how environmental conditions such as moisture and rockiness differ at each position.

Plant communities vary locally depending on geology, human uses, history, and other factors, and comprise a complicated mosaic. Historic patterns of land ownership and land use have divided the county into thousands of "use lots" separated by stone walls and fences. These fence lines sometimes cut across, and at other times delineate, the natural community boundaries.

Table 6.1 Characteristic Plants of Major Site/Use Types

Type	Canopy	Lower Layers
Forests (terrestrial)		
Lower slopes	Sugar maple	Striped maple L
	Hemlock	Flowering dogwood
	Red oak	American hornbeam
	Black oak	Mapleleaf viburnum
	Tuliptree	Spicebush
	Beech	Witch-hazel
	Black birch	Virginia creeper
	Yellow birch L	Grape
	White ash	
	White pine	
	Shagbark hickory	
Mid-slopes	Red oak	Hop hornbeam
	Black oak	Mountain-laurel
	Chestnut oak	Shadbush
	White oak	Witch-hazel
	Sugar maple	Mapleleaf viburnum
	Hemlock L	Bladdernut L
	Black birch	Low blueberry
	White ash	Virginia creeper
	Red maple	Grape
	Black cherry L	Flowering dogwood
	Paper birch L	American chestnut (sprouts)
	Gray birch L	
	Black locust L	
	Pignut hickory	
Upper slopes	Red oak	Staghorn sumac
	Chestnut oak	Scrub oak
	White oak	Chokecherry
	Red cedar	Low blueberry
	White ash	Huckleberry
	Pignut hickory	Downy arrowwood L
	Gray birch L	American chestnut (sprouts)
	Red maple	Gray dogwood
	Sassafras L	Witch-hazel
	Quaking aspen L	Mountain-laurel L
	Pitch pine L	Chokeberry
	Pin cherry L	Sweetfern L
	Shadbush	Bush-honeysuckle
		Little bluestem
		Sedges
Brushland (oldfields)	Gray dogwood	Little bluestem
	Red cedar	Goldenrods
	Gray birch	Asters
	Staghorn sumac	Smooth sumac
	Black locust L	Poison ivy
	White pine L	Dewberry
	Quaking aspen L	Blackberry
	Black cherry	Black raspberry
	Red maple	Multiflora rose
	Arrowwood	Bell's honeysuckle
	American prickly-ash L	Sassafras L
		Sweetfern L
		Chokecherry
		Japanese barberry L
		Common juniper L and many other species



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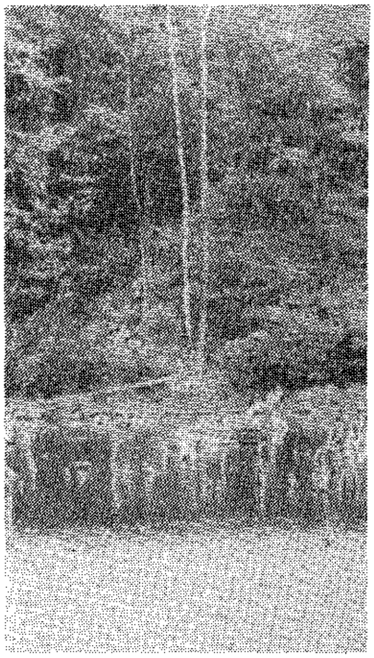


Type	Canopy	Lower Layers
Plantations	Red pine	
	Scotch pine	
	White pine	
	Norway spruce	
	European larch	
	and self-sown	
	trees and shrubs	
Wetlands		
(non-tidal)	Red maple	Willows
Swamps and	Red ash	Alders
Stream Slides	Black ash L	Spicebush
	American elm	Silky dogwood
	Yellow birch L	Red-osier dogwood L
	Willows	Buttonbush
	Silver maple L	High blueberry
	Sycamore L	Swamp azalea
	Tamarack L	Nannyberry
		Arrowwood
	Swamp white oak	Purple loosestrife
	Pin oak L	
		Cinnamon fern
		Skunk-cabbage
		and other herbs
Marshes		Purple loosestrife
		Cattails
		Bulrushes
		Tussock sedge
		Other sedges
		Rushes
		Reed canary grass
		Reed
		Other grasses
		and scattered woody plants
Ponds, etc.		Pondweeds
		Naiads
		Waterweed
		Bladderworts
		Stoneworts
		Duckweeds
		White water lily
		Yellow water lily
		Water-shield
Wetlands (tidal)		Narrowleaf cattail
Hudson River	Red maple	Spatterdock
	Red ash	Pickerelweed
	Black ash	Reed L
	(woody plants	Broadleaf arrowhead
	may be absent)	Arrow arum
		Dotted smartweed
		River bulrush
		Wild rice
		Rice cutgrass
		Purple loosestrife
		Silky dogwood
		Buttonbush
		Eurasian watermilfoil
		Wild-celery
		Water-chestnut
		and other herbs and shrubs

Table 6.1 Cont.

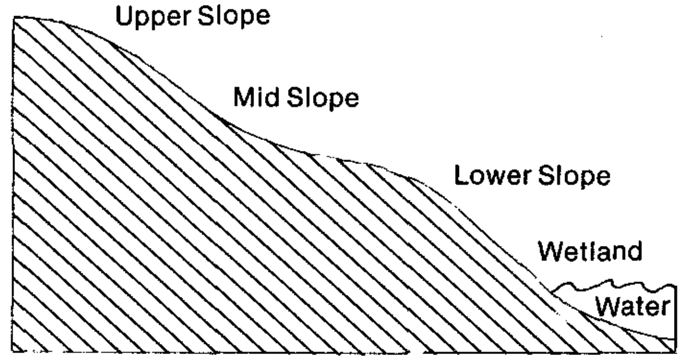
Type	Canopy	Lower Layers
Waste ground	Staghorn sumac Red cedar Tree-of-heaven Black locust Quaking aspen L Cottonwood	Poison ivy Smooth sumac Bell's honeysuckle Japanese honeysuckle Brambles Bittersweet False indigo L Ragweed
	Many other trees, shrubs, herbs	
Mowed fields and pastures		Orchard grass Timothy Sweet vernal grass Other grasses Goldenrods Asters Clovers Other herbs Woody plants

*Note: Not all species listed for a type necessarily occur together. L = local.

Forests

Forests, brushland, inactive lands, and plantations cover approximately 53 percent of the county. Forests can be defined as areas where trees over 30 feet tall cover at least half of the acreage. Environmental conditions that influence forest growth vary with elevation to produce lower slope, mid-slope, and upper slope site types (see Figure 6.2). Elevation, however, is not the only factor that determines forest type. For example, a sheltered pocket or north-facing ravine at a high elevation may support trees normally found on lower slopes, while a dry rocky knoll or outcrop with thin soil at a low elevation may support upper slope (crest) vegetation.

Site Types, Relative Elevations, and Environmental Gradients.



Soil Moisture	**Less**	→	**More**
Soil Depth	**Less**	→	**More**
Soil Fertility	**Lower**	→	**Higher**
Exposure to wind, sun, etc.	**More**	←	**Less**
Rock at soil surface	**More**	←	**Less**
Fire Frequency	**Higher**	←	**Lower**

Figure 6.2

Lower Slope Forests

Lower slope forests are frequently composed of mixed hardwoods, sometimes with hemlock or white pine. Sugar maple and red oak are frequently abundant, as are other oaks, tulip, and beech. These forests tend to have the largest trees and the greatest variety of tree species. The canopy height, measured as the height that most of the larger trees have reached, is often 50 to 60 feet. Lower slope forests are found on moist, highly sheltered sites, usually at low elevations.

Mid-Slope Forests

Mid-slope forests are typically dominated by oak, most often red oak. Chestnut oak, sugar maple, black birch, and other species occur, as do hemlock or white pine in some locations. Tree size and species variety tend to decrease as elevation increases from lower slope to upper slope. These forests occur on upland sites that are not unusually dry or moist.

Upper Slope Forests

Red oak or chestnut oak is usually the predominant species in upper slope forests. White oak, pignut hickory, red maple, and many other species may be locally important. Before chestnut blight struck the county early in the 20th century, American chestnut grew abundantly in many upper slope and mid-slope forests.

The trees of upper slope forests are larger and healthier in low spots and pockets of deeper soil, and stunted on the more exposed or rockier locations. The forest floor can be open or interspersed with shrub-covered or grassy clearings. Areas of nearly-bare soil or rock may occur. Such clearings are less common in mid-slope and lower slope forests.

Upper slope forests occur on ridge crests and exposed rock shoulders, as well as on rocky knolls at low elevations. These knolls include rocky islands in the county's lakes and on the Hudson River.

Upper slope forests sometimes resemble brushland or old fields. Like mid- and lower slopes, most were cleared and cultivated or pastured during the last century. The upper slopes, however, are developing into forest more slowly than the others. The small size and low density of their trees reflect the influence of shallow soil and exposure to winds, rapid temperature changes, and fire. Vegetation on many of these sites will remain stunted and open.

Other Forest Communities

Hemlock stands are examples of forest communities that have particular aesthetic and wildlife habitat interest. Hemlock is more common on glacial till or sandy soils than on clay soils, and is usually found near water or in cool, moist areas. Young hemlocks are quite sensitive to fire and deer browsing, and grow slowly. Many hemlock stands, as well as hardwood stands, are losing seedlings to heavy deer browsing. These losses are most apparent in large areas where deer hunting is prohibited.

Unusual soils can support patches of distinctive forest vegetation. Black locust is often abundant on disturbed sandy soils; old gravel pits frequently support colonies of quaking aspen. Flowering dogwood is common in clay areas along the Hudson River in northern Dutchess County, where hemlock is scarce. Limestone till soils and outcrops provide habitat for many uncommon species, such as roundleaf dogwood, hackberry, and American prickly-ash.

Brushland

The term "brush" often connotes undesirable vegetation, but brushland communities are valuable for soil protection and wildlife habitat. Brush covers less than 20 percent of the county. It includes vegetation that ranges from weed and shrub-covered fields to areas with scattered 30-foot trees. Brushland plant communities include the shrub patches, small trees, and coarse herbs that represent the period of regeneration between agricultural abandonment and closure of the forest canopy. Most of these "oldfields" are between 3 and 50 years old. Brushland vegetation is usually patchy (horizontally diverse), but not many-layered (vertically complex); it is composed of numerous species that may occur as scattered individuals, small patches, or large stands.

Although some oldfield species start from seeds, many develop from root systems that have persisted from an earlier forested stage. These sprout hardwoods develop from the root or stump sprouts that grow after forests are cut or agriculture is abandoned. Sprout hardwoods are common in Dutchess County and southern New England.

Root-suckering plant species, which spread under or along the soil surface to form colonies, are especially important in oldfields. They include sumacs, aspens, brambles, gray dogwood, and black locust, all of which often persist despite cutting, animal damage, and fire. By browsing and digging, or by eating and scattering seeds, animals such as meadow voles, cottontail rabbits, woodchucks, deer, and birds play an important role in determining which plant species appear and survive in oldfield development.

Red cedar, gray birch, and gray dogwood are among the most typical brushland species in Dutchess County. Red cedar is common in many oldfields. It grows vigorously on limestone soils, lending a distinctive, partly evergreen character to the vegetation. White pine is not as typical an oldfield species in the county as it is in southern New England, but it does appear near where parent trees stood, and it is occasionally abundant. White pine and red cedar are unpalatable to cattle; this enables their seedlings to survive the last stages of grazing before pastures are abandoned.

Old orchards and hedgerows are distinctive types of brushland. Hedgerows are linear plant communities, 5 to 20 feet wide, located along fence lines and stone walls. They often contain large spreading trees scattered among more typical brushland plants. Apple trees are found among naturally occurring woody plants in many areas.

Plantations

Plantations, which are stands of planted trees of any size, cover seven percent of the county. They are numerous but usually small, and typically consist of pure stands or alternating patches of conifers. Certain popular plantation species, such as Norway spruce and European larch, are not native to this area. They do not commonly reproduce from seed or "volunteer" here. Most plantations are composed of trees of the same age planted in rows. Stands of naturally-occurring white pine sometimes resemble plantations. A variety of volunteer species may be found in unmanaged plantations, including white pine and elm.

Wetlands

Wetlands, both wooded and non-wooded, cover six percent of the county and are significant for the recreation, wildlife habitat, water management, and other benefits they provide. They range from damp or seasonally-flooded areas to lands that are permanently covered with a foot or more of water. Wooded wetlands (swamps) cover approximately three percent of the county; non-wooded wetlands (marshes) account for another three. The county's wetland resources are more fully described in the Hydrology Chapter.

Communities of submerged aquatic plants usually contain patches of one or a few species. They grow in lakes, ponds, and wetland pools where water continuously covers the bottom and enough light penetrates for photosynthesis. Submerged plants are limp-stemmed, and may have parts that float on the water surface. Rooted plants with floating leaves, such as water lilies, or free-floating plants, like duckweed, may also be present. Non-vascular plants, such as mosses or attached algae, often grow in wetlands. Drifting microscopic algae, called plankton, are present in almost all waters.

Wooded Wetlands

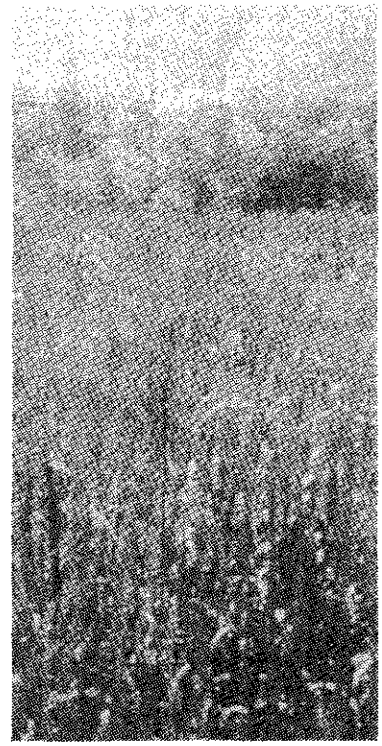
Trees or shrubs dominate wooded wetlands. Red maple is the most common wetland tree species in Dutchess County. Red ash is also important, and American elm was a common wetland tree before Dutch elm disease decimated the elm population. Many swamps in Dutchess County contain ditches that remain from past attempts to drain the wetlands and transform them into drier land.

Most woody plants in wetlands grow on raised root-crowns, called hummocks. Hummocks allow the plants access to sufficient water and air, regardless of the water level, and are best developed where water levels fluctuate.

Non-Wooded Wetlands

Grasslike plants, such as bulrushes, tussock sedge, reed, and cattail, or non-woody broad-leaved plants, such as purple loosestrife, are characteristic of marshes.

Marsh vegetation is heavily influenced by the calcium content of the soil. Limy soils, high in calcium, support the larger stands of cattails as well as other characteristic plant communities.



Wetlands that overlie peat soil, which is rich in organic matter and often acidic, are called bogs. Typical bog plants include sphagnum moss, cranberry, leatherleaf, pitcher plant, sundew, cottongrass, and conifers. Bogs are relatively rare in Dutchess County. Some occur on limy, rather than acidic, soils. Patches of swamp, marsh, and bog are often interspersed.

Tidal wetlands and shallows along the Hudson River are affected twice a day by three- to four-foot tides. Their water is either fresh or seasonally brackish. Submerged and floating aquatic plants, such as wild celery, Eurasian watermilfoil, and water-chestnut, occur in subtidal shallows. Patches of spatterdock and pickerelweed appear in the lower portion of the area between high tide and low tide, known as the lower intertidal zone. Large expanses of grasslike plants, patches of mixed broad-leaved plants, and sometimes shrubs or hardwood swamps occur in the upper intertidal zone.

Agriculture and Developed Land

Agricultural, urban, suburban, and industrial areas cover large portions of Dutchess County. Vegetation types characteristic of these areas include crop and pasture lands, managed grounds, and waste ground.

Agriculture

Farming is a vital industry in Dutchess County. More than 600 farms produce more than $42 million worth of goods each year, on approximately 140,000 acres of land. Milk and dairy products account for $21 million of the total, crops for close to $10 million, and livestock or non-dairy live stock products for the remaining $11 million.

According to the 1982 Census of Agriculture, crops and non-wooded pasture land cover 93,000 acres, equal to 18 percent of the county's land area. Hay and feed corn account for 60 percent of this acreage. Apple orchards take up 2,500 of the 3,000 acres devoted to fruit. These acreage figures are summarized in Table 6.2.

Most of Dutchess County's commercial dairy farms are located in the central and northeastern towns. Apple orchards and vineyards are concentrated in the towns of Red Hook and La Grange, where the terrain and microclimates are suitable for fruit crops.

Few large tracts of farmland remain in the southwestern quarter of the county. The majority of farms that were in this area have been developed for residential, commercial, or industrial purposes. Concern about preserving what remains of the county's best farmland is increasing as development pressures spread.

Table 6.2 Farmland in Dutchess County

Agricultural Use		Total Acreage
Cropland		80,000
corn	20,000	
hay	34,000	
cropland used for pasture	18,000	
orchards	3,000	
vegetables	2,000	
miscellaneous crops (nurseries, sod, oats, wheat, etc.)	3,000	
Woodland (including wooded pasture land)		30,000
Other Pasture Land		13,000
Other Land (farm ponds, and roads, buildings, idle land)		15,000
TOTAL		138,000

Source: U.S. Dept. of Commerce, 1982 Census of Agriculture.

Managed Grounds

In the developed portions of the county, intensive management with planting, fertilizers, herbicides, irrigation, and pruning creates the plant communities typical of yards, estate grounds, campuses, and many urban streets. These managed grounds are usually composed of ornamental trees and lawns that form artificial savannas. Stresses such as dry soil, salt and air pollution, and selective management reduce the number of species that can thrive. Ornamental trees are often large and spreading. Non-native trees, shrubs, and herbs outnumber natives in managed areas.

Formerly managed grounds that have been abandoned include overgrown yards and estates and old garden sites or house lots. Such areas are usually surrounded by forest or brushland. Planted native and non-native trees, shrubs, and herbs persist (often without reproducing), and gradually become mixed with wild species. Patches of day lily, periwinkle, European buckthorn, tree-of-heaven, and other ornamentals planted in years past identify these sites after other signs of management have been obscured.

Mowed fields are maintained on many properties for ornamental purposes. In these areas grasses and broad-leaved plants partly conceal the woody plant shoots that survive repeated cuttings.

Corridors for roads, railroads, powerlines and other utilities are called rights-of-way. Ranging from 50 to 300 feet wide, rights-of-way cover a significant number of acres in the county. Right-of-way vegetation is usually shorter than adjacent vegetation because it is mowed, brush-hogged, hand cut, or sprayed with herbicides. The plants are also often exposed to pollutants from vehicles. Depending on soil characteristics and disturbance, right-of-way communities vary from forest to brushland, low-growing herbs, or bare soil. Where topsoil has been removed, rights-of-way resemble waste ground.

Waste Grounds

Numerous sites in Dutchess County have been stripped of topsoil. These waste grounds resemble oldfields, but their vegetation is usually smaller, shorter, and sparser. Bare soil or subsoil is common; woody plants usually are not. Waste grounds include dumps, fills, roadcuts, parking lots, dikes, vacant lots, surface mines, and areas around construction and industrial sites. Climate, chemical and mechanical stress, and deficiencies of moisture and soil nutrients contribute to their simplified vegetation.

Uses of Vegetation

Plants provide food, building materials, fuel, and wildlife habitat; these uses are widely recognized and appreciated. Vegetation also provides many benefits that tend to be overlooked. One of the most valuable functions of wild, landscaped, or agricultural vegetation is ecological or land use buffering. Vegetation slows flood flows, builds up the soil and holds it in place, replenishes oxygen supplies, absorbs noise, gives privacy, and moderates air temperatures and wind exposure near the ground. As they grow, reproduce, die, and decompose, plants regulate the movement and concentrations of dissolved nutrients and minerals in soil and water. Plants help the soil filter and absorb human wastes and certain pollutants, settle dust and sediment from air and water, serve as visual transition zones between land uses, provide shelter and food for wildlife, and make the landscape beautiful and diverse.

The multi-faceted buffering ability of vegetation is especially useful between developed areas or agricultural land and sensitive natural areas, such as lakes and rivers. Ecological buffer zones--areas of undisturbed vegetation--can help minimize the impact of human land use activities on nearby sensitive resources by reducing runoff and catching sediment, providing shelter, food, and trail corridors for wildlife, and reducing noise and visual impacts. In addition to protecting the environment, vegetation buffers enhance the value of developed or agricultural land. They do this by providing windbreaks, natural air conditioning, shade, privacy, erosion control, and aesthetic charm. Vegetation buffers can bring nature into an urban landscape, and tie together the natural elements of that landscape so that visual amenities and wildlife can survive.

Changes in Vegetation

Vegetation is dynamic. Although mature forests and tidal marshes, for example, may remain stable for many years, all vegetation communities eventually change. Such change may occur slowly or suddenly, in response to environmental influences that may be subtle or traumatic. Subtle environmental factors include climatic variations, such as wet or dry years or unusually low or high temperatures; fluctuating animal populations; changes in air quality; gradual increases in wood harvesting; and other conditions that affect the germination, growth, survival, and competition of plant species.

Traumatic environmental stresses, such as fire, floods, clear-cutting, plowing new farm fields, and urban development kill or inhibit certain species. Such stresses cause sudden changes that are followed by a period of recovery. The recovery period, in turn, may produce a totally different vegetation landscape.

Small-scale stresses, such as confined brush fires, increase landscape diversity by creating a mosaic pattern of vegetation in various stages of recovery. Stress applied over a large area, such as large forest fires or air pollution, simplifies the landscape by eliminating sensitive species or entire plant communities.

Human Activities

Farming, clearing land for development, harvesting wood for lumber or fuel, and introducing non-native, highly competitive "weed" species are the major human activities that directly alter vegetation. Different wood harvesting practices, such as cutting particular species or sizes, thinning crowded stands, removing unmarketable trees, clear-cutting, and harvesting whole trees, have significantly different effects on forest composition and regrowth.

Clearing land for residential, commercial, and industrial use permanently takes it out of forest or brushland production, and in most cases replaces the natural vegetation with artificially landscaped grounds and impermeable surfaces. This, in turn, usually increases the amount of fertilizers, herbicides, and pesticides applied to the land, and decreases the amount of rainfall that filters down into groundwater supplies.

Agriculture also maintains vegetation in an unnatural state. Crop farming involves the large-scale cultivation of a relatively few plant species that would probably not survive on their own, and the suppression of diverse, unwanted native species that have a natural competitive advantage over the chosen crops. Crop fields are artificially simple communities, highly susceptible to diseases and pests. In most cases, fertilizers, pesticides, and herbicides are used to maintain the growing conditions that crops require. Pasture lands are also unnatural to the extent that brush and trees would quickly replace low-lying herbaceous plants if grazing livestock were not present.

Although agriculture remains a significant component of the Dutchess County economy, many farm fields have been abandoned and allowed to revert to native vegetation since the late 19th century. Many of the woodlands present in the county today occupy former pasture land.

Certain introduced plants proliferate in disturbed areas and gradually replace patches of native vegetation. This phenomenon is insignificant in forests, but has had a major impact on herbaceous and some brushland communities. Purple loosestrife has replaced cattail, sedges and other wetland plants at many Dutchess County locations. Water-chestnut and Eurasian watermilfoil are abundant in Hudson River shallows, and are potential invaders of ponds and lakes. Multiflora rose, planted for erosion control and wildlife food, is difficult to eradicate and has become troublesome in oldfields, pastures, and wet meadows. Bell's honeysuckle has spread from ornamental plantings and is very abundant in old fields, wet meadows, and open woods.

These "weeds" tend to replace native plants whose growth forms differ from their own. The weeds increase diversity when present in small numbers and scattered among native species, but when they dominate entire plant communities, the diversity of both the species and the communities is reduced. Exotic species do support some wildlife species, but native plants in extensive wild communities are necessary to maintain natural and diverse populations of native animals. All of the weeds mentioned above spread readily and will probably become much more abundant in the near future. Additional vegetation pests will undoubtedly appear occasionally as new species are introduced for ornamental purposes or other uses.

Pollution of air, water, and soil is one by-product of human activity that significantly affects vegetation. Roadside conifers have been injured at many locations in the county, apparently by road salts and vehicle exhaust. Many ponds and lakes have become eutrophic because of excess nutrients from sewage and agricultural runoff. Several plant species have declined or disappeared from the Hudson River since the 1940s; water pollution is believed to be one of several contributing factors. The effect of acid rain on vegetation in the Hudson Valley is under study.

Natural Events

Natural events that shape vegetation development include fire, disease, defoliation by insects, fluctuations in wildlife populations (especially deer and beaver), and climatic variations. Climate is described in Chapter One; the rest of these natural influences are discussed briefly below.

Large forest fires rarely strike Dutchess County. Most of the vegetation fires that do occur do little damage to the tree canopy, and burn leaf litter, aboveground parts of herbs and shrubs, and small trees. Vegetation usually regenerates quickly after such burns. Oaks and hickories have thick corky bark that makes them fire resistant. Red cedar, white pine, red maple, and hemlock are vulnerable, especially when small.

Disease has almost eliminated chestnut and American elm trees. Beech, white ash, and sugar maple have also been attacked during the last two decades and their numbers could be declining. With the exception of beech bark disease, trees in the interior of forests have been less affected than trees in more exposed locations. The highest disease mortality rates occur where trees are stressed by water or nutrient shortages, salt, or mechanical damage along roadsides, in parks, or on managed grounds.

Insect damage continuously affects vegetation. However, certain pests, such as gypsy moths, go through population cycles that peak at intervals of several years. At their peak in 1980 and 1981, gypsy moth caterpillars defoliated hardwood forests and ornamental trees throughout Dutchess County. Damage was particularly severe where trees lacked sufficient water. Most trees survived the defoliation, even though many were stripped in both 1980 and 1981. Some species suffered more than others. Further studies are needed of the effects of insect outbreaks on forest morbidity and productivity.

Deer, beaver, and other wildlife greatly influence plant growth. Deer are probably more common now in Dutchess County than ever before. Wherever they concentrate, browsing heavily on seedlings and twigs and consuming acorns, their eating habits can restrict the reproduction of all but the most unpalatable trees and shrubs. The species composition of areas affected in this way eventually shifts as young trees most sensitive to deer damage, such as oak and hemlock, die.

Beaver populations in the county appear to be increasing, particularly in the eastern towns. Beaver enhance landscape diversity by constructing ponds and felling trees, replacing patches of forests with aquatic vegetation and herbs or shrubs. Wetlands usually develop after beaver leave a site. The high values of beaver ponds and wetlands for wildlife habitat, hydrological buffering, and vegetation diversity offset the timber damage they cause. Fur trapping and the removal of "nuisance" animals keep the county's beaver population below its potential level.

Resource Management Implications

Both natural and human activities place vegetation under stress. Damage caused by fire, drought, disease, insects, wildlife, and nuisance plant species is aggra-vated by misguided resource management and land use practices. Farming, timber harvesting, clearing land for development, and modifying wetlands directly alter plant communities. If such activities are undertaken carefully, in appropriate locations, they can maintain environmental diversity while meeting human needs. If they are undertaken carelessly, they can do irreparable environmental harm by eroding soil, eliminating plant species and wildlife habitat, and reducing the capacity of the environment to assimilate wastes and absorb rainfall. Road salts, agricultural and urban runoff, acid rain, and other air, water, and land pollutants can further weaken plant life and disrupt the natural balance that sustains a healthfully diverse and productive ecosystem. Thoughtful management is needed to maintain this balance as development alters more and more of the county's landscape.

Forest Management

More than 90 percent of the land in Dutchess County was cleared and planted or grazed sometime during the 1800s. Intensive wheat cultivation caused serious soil erosion on slopes and hilltops. Forest removal reduced the available wildlife habitat so much that deer and beaver were virtually eliminated. Since that time, brushland and woods have reclaimed much of the land that once was farmed. However, the county's forests remain under pressure. Development, not agriculture, now encroaches on the woodland resource base. Overdevelopment for urban and suburban uses could cause the county to repeat the cycle of erosion, wildlife loss, and related impacts experienced in the 1800s.

To prevent such damage and to maintain the health and abundance of the county's forests landowners, woodland users, and local and county governments should encourage forest uses that are compatible with forest conservation and enhancement. Wood harvesting should conform to sound forest management practices. The quantities of lumber and fuel wood cut--and of land cleared for development--should be monitored so that appropriate steps can be taken if the total wood supply begins to diminish. Uncommon or especially sensitive forest resources, such as hemlock groves, forests with large trees, beech woods, and woodland buffers around water bodies or wetlands should be protected. Brushland should not be indiscriminately cleared because it supports numerous wildlife species and is tomorrow's forest resource.

Farmland

Agriculture, when balanced with natural vegetation, greatly enchances the appearance, diversity, and productivity of the county's land resources. The more diverse the county's agricultural base is, the healthier it is, both economically and environmentally.

Efforts to strengthen and diversify agricultural activity in Dutchess County should be supported. These efforts should focus on crops, livestock, and farming practices that are compatible with the county's soils and climate. The use of effective alternatives to chemical fertilizers and pesticides and erosion-causing cultivation practices should be encouraged.

Buffer Vegetation

Buffer vegetation is an important part of the developed and natural landscape. It controls runoff rates and volumes, improves air and water quality, moderates site temperatures and sun exposure, provides wind breaks, limits erosion and sedimentation, attenuates noise, screens unattractive landscape elements, and provides plant and wildlife habitat. Well-managed natural buffers can also accommodate a variety of recreational and educational uses while contributing to environmental health and community property values.

Every effort should be made to incorporate buffer vegetation in site development designs and land use plans. Local decision makers and landowners should link buffer zones of vegetation wherever possible, to create greenbelts and natural corridors through their communities. Floodplains and waterways are ideal greenbelt corridor sites. Buffers adjacent to sensitive resources, such as wetlands, streams, and steep slopes, should not be disturbed.

The importance of preserving unusual plant communities is discussed in Chapter 7.

Wildlife

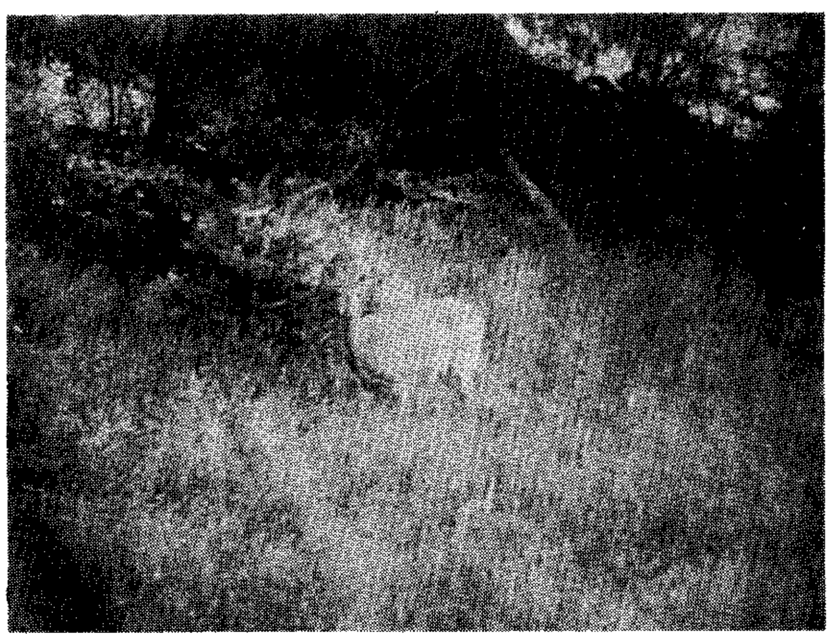
Knowledge of wildlife can increase people's understanding of environmental relationships. Wild animals are a source of enjoyment, recreation, and food, offering outlets for activities such as bird-watching, hunting, fishing, trapping, photography, sketching, and sculpting. They contribute to the diversity on which the health and resilience of the natural environment depend. Animal populations are also sensitive indicators of environmental health, often responding to subtle changes in pollution levels, land uses, and other stresses in observable ways.

The wildlife chapter was prepared by Erik Kiviat, an Ecologist with Hudsonia Limited of Annandale, New York.

The interaction of natural resources and human activities determines which wild animals thrive in an area. Vertebrates (animals with a backbone), such as mammals, birds, reptiles, amphibians, and fishes, and invertebrates (animals without a backbone), such as insects, snails, and worms, comprise this wildlife community. This chapter reviews the wildlife habitats and vertebrate species of Dutchess County.

Habitat Types

The place where a species lives is its habitat. The type and amount of habitat determine the animal species and the number of individuals of each species that can successfully find food and shelter and reproduce in a given area. Some types of habitats are common while others are scarce. The quality of a given type may also vary, due to the interaction of human influence and environmental factors.



Common habitats in Dutchess County include farm ponds, warm-water streams, weed fields, shrub land, young woodlots, residential yards, and pastures. Scarce habitats include caves, cliffs, talus slopes (rock slides), dry rocky hilltops, large hayfields, large-tree forests, extensive cattail marshes, tidal wetlands, tidal stream mouths, cool-water streams, and natural lakes and bogs. Still other habitats are moderately common but have special significance to wildlife. For example, intermitent woodland pools are critical breeding areas for certain amphibian species. Damage caused by dumping, filling, and spraying is reducing the number of woodland pools available to these species.

Habitat Changes

In the 1600s Dutchess County was extensively forested. Clearings created by Indian fires and agriculture dotted the landscape. By the mid-1800s most of the county had been converted into farmland. Today, over a quarter of a million people live in Dutchess County on land that includes farmland, redeveloping forest, and large residential, commercial, and industrial areas.

Wildlife species have reacted in various ways to the changing patterns of vegetation and land use. A few, such as the timber wolf and passenger pigeon, have disappeared completely. Beaver and pileated woodpecker disappeared at one time but have now returned. Some species, such as the bobcat, osprey, and Atlantic sturgeon, are less common now than they were in the 1600s, while other species, such as deer, raccoon, red fox, robin, and painted turtle are more common today. The wild turkey, which disappeared from Dutchess County during the 1840s, was reintroduced in 1974 and is now a naturally reproducing resident.

Several species are relative newcomers to the county. Coyotes moved into Dutchess County about 20 years ago and are now permanent residents. The Canada goose, now a moderately common breeder, was formerly only a migrant in the county.

Not all wildlife has fared well; natural and human factors threaten several species. Animals that need large, continuous, or interconnected habitat units often have trouble maintaining populations as their habitats become increasingly fragmented by land use changes. Important specific factors that are adversely affecting wildlife species include the following:

- Change in the water, soil, and vegetation that make up species' habitats.

- Pollution of water by sewage, PCBs (polychorinated biphenyls), pesticides, and other toxic substances.

- Disturbance by noise, capture and release, and household pets.

- Competition from or predation by tolerant species whose populations have increased.

Cold-water fish like brook trout and sculpin have had some of their habitats ruined by the removal of bank vegetation and the silting and warming of streams. The habitats of cattail-nesting birds, such as the marsh wren, are reduced as purple loosestrife replaces cattail in disturbed marshes. Certain species of the tidal waters and wetlands of the Hudson River are scarce or absent due to environmental contaminants and adjacent land use. Introduced starlings have displaced eastern bluebirds from natural nesting cavities. Rattlesnakes have declined in range and number as a result of commercial collection and wanton killing.

Troubled Species

In 1983, the New York State Department of Environmental Conservation developed a new, expanded endangered species list with three categories (in order of decreasing concern): endangered, threatened, and special concern. Species classified as endangered or threatened are protected under the Environmental Conservation Law. The species on the new state list are noted in the list of vertebrate species in Dutchess County provided in Table 7.1.

Very few fishes and invertebrates have been included on the New York State endangered species list. Some biologists believe there are many additional species, both invertebrates and vertebrates, that are in serious trouble in New York and merit listing as endangered, threatened, or of special concern. A few of the unlisted Dutchess County vertebrates whose numbers are declining or whose habitat is seriously threatened, and that appear to be in trouble, are the marsh wren, ribbon snake, and marbled salamander. Detailed study would reveal that many additional species are similarly vulnerable.

Important Species

Many wildlife species thriving in Dutchess County are major influences on the landscape or have significant economic value. Deer are abundant and affect vegetation by selective feeding. Heavy browsing of seedlings and saplings and consumption of acorns can prevent all but the

least palatable trees and shrub species from reproducing. Affected areas may eventually show a shift in tree species composition.

Beaver, which are fairly common in eastern Dutchess County, affect forests and wetlands. They cut and girdle many trees and shrubs to feed on the bark. Beaver dams raise water levels temporarily, triggering the development of vegetation from forest to pond to marsh or swamp, and sometimes back to forest. The ponds and wetlands that beaver create are habitat for waterfowl, turtles, fish, and other animals. Beaver-created habitats enhance landscape diversity.

Muskrats influence wetland vegetation by selectively eating certain plants, notably cattails. Muskrats make small clearings in the marsh vegetation, which may either return to the predominant plant community after a few years or be invaded by a different community, such as shrubs or purple loosestrife. Like beaver, muskrats increase the diversity of plant communities.

Deer, eastern cottontail, and gray squirrel are important game animals in Dutchess County. Muskrat, beaver, red fox, and gray fox are valuable furbearers. Game birds include ruffed grouse, ring-necked pheasant, wild turkey, and a number of waterfowl species. Some of the important game and food fish of non-tidal waters are brown trout, largemouth bass, pumpkinseed, bluegill, and brown bullhead. Hudson River fishery species include American shad, alewife, blueback herring, white perch, American eel, and striped bass. Eel and striped bass are still off-limits for commercial fishing because of their high PCB content.

Vertebrate Species

All vertebrate wildlife species recorded in Dutchess County are listed in Table 7.1. Relatively little is known about where many of these species are concentrated within the county.

Key to Annotations

The symbols listed below are used in Table 7.1 to indicate the abundance and protection status of wildlife species reported in Dutchess County. Whether or not a species is known to breed in the county is also noted.

C   Common: A common species is found wherever there is suitable habitat, probably in all towns, by an observer familiar with its behavior and sign. A common species often occupies more than one habitat type.

U Uncommon: The abundance of an uncommon species is intermediate between common and rare. Such a species may be unevenly distributed. It is likely to be found in several towns, and perhaps in all towns, but in smaller numbers than a common species of similar size.

R Rare: A rare species is usually very uneven or local in occurrence, and may be found in only one or a few towns. It may be restricted to a single--often scarce--habitat type. Overall numbers are low.

H Hudson River: Such species are confined, or very nearly confined, to Hudson River tidal habitats.

b Breeder: Such species are known or believed to reproduce (rear young) in the county, and may also be present outside of the breeding season.

n Nonbreeder: Nonbreeding species are present part of the year or occasionally, but probably do not reproduce in the county. (Breeding and nonbreeding populations of the same species may be noted separately in Table 7.1 if the status of the two populations differs greatly.)

unv Unverified: Unverified species have been reported in the county, but their presence has not been proven. The reports are probably correct. In addition, a few species that have been found very close to Dutchess County but have not yet been found in the county are listed as unverified.

per Peripheral: Such a species is at the edge of its geographic range. It is likely to be rare, and its numbers are likely to fluctuate. Marine or coastal species that barely penetrate as far inland as Dutchess County are also listed as peripheral.

acc Accidental: Accidental species are well outside their normal range and have been recorded in Dutchess County only once or a few times.

int Introduced: Such species are not native to Dutchess County, but in most cases are established and reproducing here. Aquatic species that arrived through canals are considered introduced. Escaped species that are not established in the county, such as the red-eared turtle, are not included in Table 7.1.

ext Extirpated: Such species were formerly present in the county but are now extinct here. They may still exist outside the county.

EE Endangered: Such species appear on the federal and New York State endangered species lists. They are automatically protected under state and federal law, but their habitats are not.

E Endangered, New York: Such species appear on the New York State list of endangered species, but not on the federal list. They are in danger of being completely eliminated or have already been extirpated from the state. They are automatically protected under state law, but their habitats are not.

T Threatened, New York: Such species appear on the New York State list of threatened species, and are likely to become endangered in the foreseeable future. Threatened species are automatically protected under state law, but their habitats are not.

S Special Concern, New York: These species appear on the New York State list of species that have not been recognized as endangered or threatened but are of special concern because available evidence raises questions about their continued welfare in New York State. Special concern species are not automatically protected as endangered and threatened species are. Some, however, have other legal protection under state law.

! or # Completely or Partially Protected: These species have some protection in Dutchess County under federal or New York State law. The degree of protection for these species may vary from year to year in Dutchess County, or from region to region in New York State. Completely protected species found in the wild may not be pursued, killed, hunted, fished, trapped, or otherwise harrassed at any time, for any purpose, except by special permit. Partially protected wildlife may be harvested in the wild during open seasons, established by order of the New York State Department of Environmental Conservation or by legislative action. (See Bergstrom, 1979, and the 1983 New York State Endangered Species List.)

* Blue List for 1982: These bird species have undergone apparent population declines over large portions of their ranges, and are included on "The Blue List for 1982" (Tate and Tate, 1982).

Table 7.1 Vertebrate Wildlife of Dutchess County

Species	Notes
Fishes	
American brook lamprey, Lampetra appendix	R H
Sea lamprey, Petromyzon marinus	R H b
Shortnose sturgeon, Acipenser brevirostrum	R H n EE !
Atlantic sturgeon, Acipenser oxyrhynchus	R? H #
American eel, Anguilla rostrata	C n
Blueback herring, Alosa aestivalis	C H b
Alewife, Alosa pseudoharengus	C H b
American shad, Alosa sapidissima	C H b #
Atlantic menhaden, Brevoortia tyrannus	R H n per
Gizzard shad, Dorosoma cepedianum	RH per int?
Bay anchovy, Anchoa mitchilli	U H b
Cisco (lake herring), Coregonus artedii	unv per int ext?
Rainbow trout, Salmo gairdneri	U? n int #
Brown trout, Salmo trutta	U b int #
Brook trout, Salvelinus fontinalis	R? b #
Lake trout, Salvelinus namaycush	unv int #
Rainbow smelt, Osmerus mordax	R? b (int inland)
Central mudminnow, Umbra limi	R b per
Redfin pickerel, Esox americanus	C b #
Northern pike, Esox lucius	H n unv per #
Chain pickerel, Esox niger	C? b #
Goldfish, Carassius auratus	C b int
Carp, Cyprinus carpio	C b int
Cutlips minnow, Exoglossum maxillingua	U? b
Eastern silvery minnow, Hybognathus regius	U? H b per?
Golden shiner, Notemigonus crysoleucas	C b
Comely shiner, Notropis amoenus	H n acc? int?
Satinfin shiner, Notropis analostanus	H n acc int?
Emerald shiner, Notropis atherinoides	R? H b per int
Bridle shiner, Notropis bifrenatus	ext?
Common shiner, Notropis cornutus	C b
Spottail shiner, Notropis hudsonius	C b
Spotfin shiner, Notropis spilopterus	R H per
Bluntnose minnow, Pimephales notatus	unv
Fathead minnow, Pimephales promelas	R b int ?
Blacknose dace, Rhinichthys atratulus	C b
Longnose dace, Rhinichthys cataractae	U b
Creek chub, Semotilus atromaculatus	C? b
Fallfish, Semotilus coporalis	C? b
White sucker, Catostomus commersoni	C b
Creek chubsucker, Erimyzon oblongus	unv
Northern hogsucker, Hypentelium nigricans	R b? per?
White catfish, Ictalurus catus	U? H b per
Black bullhead, Ictalurus melas	unv per int?
Yellow Bullhead, Ictalurus natalis	R per (int inland?)

Table 7.1 Cont.

Species	Notes
Brown bullhead, Ictalurus nebulosus	C b
Trout-perch, Percopsis omiscomaycus	unv
Atlantic tomcod, Microgadus tomcod	U? H b
Atlantic needlefish, Strongylura marina	R H n per
Banded killifish, Fundulus diaphanus	C b (R inland?)
Mummichog (saltwater killifish), Fundulus heteroclitus	C H b
Fourspine stickleback, Apeltes quadracus	U? H b
White perch, Morone americana	C H b
White bass, Morone chrysops	H unv int
Striped bass, Morone saxatilis	C H b #
Rock bass, Ambloplites rupestris	C b int
Redbreast sunfish, Lepomis auritus	C b
Green sunfish, Lepomis cyanellus	R b int
Pumpkinseed, Lepomis gibbosus	C b
Warmouth, Lepomis gulosus	R b int
Bluegill, Lepomis macrochirus	C b int
Smallmouth bass, Micropterus dolomieui	U b int #
Largemouth bass, Micropterus salmoides	C b int #
White crappie, Pomoxis annularis	R H b? int
Black crappie, Pomoxis nigromaculatus	U b int
Tessellated darter (eastern johnny darter), Etheostoma olmstedi	C b
Yellow perch, Perca flavescens	C b int #
Walleye (pikeperch), Stizostedion vitreum	H acc (int ext inland)#
Bluefish, Pomatomus saltatrix	U? H n per #?
Crevalle jack, Caranx hippos	R H n per
Silver perch, Bairdiella chrysoura	H unv per
Weakfish, Cynoscion regalis	H unv per
White mullet, Mugil curema	R H n per
Slimy sculpin, Cottus cognatus	R b per?
Hogchoker, Trinectes maculatus	U? H n

Amphibians

Mudpuppy, Necturus maculosus	H unv int ext?
Marbled salamander, Ambystoma opacum	R? b per
Jefferson salamander, Ambystoma jeffersonianum	R? b per? S
Silvery salamander, Ambystoma platineum	R b
Blue-spotted salamander, Ambystoma laterale	R b per S
Tremblay's salamander, Ambystoma tremblayi	R b
Spotted salamander, Ambystoma maculatum	C b S
Eastern newt (red-spotted newt, red eft), Notophthalmus viridescens	C b
Dusky salamander, Desmognathus fuscus	R? b

Table 7.1 Cont.

Species	Notes
Redback salamander (leadback salamander), Plethodon cinereus	C b
Slimy salamander, Plethodon glutinosus	R? b per
Four-toed salamander, Hemidactylium scutatum	R b
Red salamander, Pseudotriton ruber	unv per
Two-lined salamander, Eurycea bislineata	C? b
American toad, Bufo americanus	C b
Fowler's toad, Bufo woodhousii	R b per
Spring peeper, Hyla crucifer	C b
Gray treefrog, Hyla versicolor	U b
Bullfrog, Rana catesbeiana	U b #
Green frog, Rana clamitans	C b #
Wood frog, Rana sylvatica	C b #
Northern leopard frog (northern meadow frog), Rana pipiens	R per #
Pickerel frog, Rana palustris	C b #

Reptiles

Species	Notes
Snapping turtle, Chelydra serpentina	C b
Stinkpot (musk turtle), Sternotherus odoratus	U b
Mud turtle, Kinosternon subrubrum	unv T !
Spotted turtle, Clemmys guttata	U b S
Bog turtle (Muhlenberg's turtle), Clemmys muhlenbergii	R b E !
Wood turtle, Clemmys insculpta	U b S !
Eastern box turtle, Terrapene carolina	R b per? !
Diamondback terrapin, Malaclemys terrapin	H unv per S
Map turtle, Graptemys geographica	R b H per? int?
Painted turtle, Chrysemys picta	C b
Blanding's turtle, Emydoidea blandingii	R b T !
Spiny softshell turtle, Trionyx spiniferus	unv int
Eastern fence lizard, Sceloporus undulatus	R b per
Five-lined skink, Eumeces fasciatus	unv per
Northern water snake, Nerodia sipedon	C? b
Brown snake, Storeria dekayi	U? b
Redbelly snake, Storeria occipitomaculata	R b?
Eastern ribbon snake, Thamnophis sauritus	R b
Common garter snake, Thamnophis sirtalis	C b
Eastern hognose snake, Heterodon platyrhinos	R b per S
Ringneck snake, Diadophis punctatus	R? b
Worm snake, Carphophis amoenus	unv per S
Black racer, Coluber constrictor	U? b
Smooth green snake, Opheodrys vernalis	R? b
Black rat snake (pilot blacksnake), Elaphe obsoleta	U? b per?
Milk snake, Lampropeltis triangulum	U b
Copperhead, Agkistrodon contortrix	U b per?
Timber rattlesnake, Crotalus horridus	R b T !

Table 7.1 Cont.

Species	Notes
Birds	
Red-throated loon, *Gavia stellata*	n acc !
Common loon, *Gavia immer*	R n S !
Pied-billed grebe, *Podilymbus podiceps*	R b, U n !
Horned grebe, *Podiceps auritus*	R n !
Red-necked grebe, *Podiceps grisegena*	n acc !
Eared grebe, *Podiceps nigricollis*	n acc !
Northern gannet, *Sula bassanus*	H n acc !
Great cormorant, *Phalacrocorax carbo*	H n acc !
Double-crested cormorant, *Phalacrocorax auritus*	R H n !
American bittern, *Botaurus lentiginosus*	R b * !
Least bittern, *Ixobrychus exilis*	R b S * !
Great blue heron, *Ardea herodias*	R b, U n !
Great egret (American or common egret), *Casmerodius albus*	R n !
Snowy egret, *Egretta thula*	R n !
Little blue heron, *Egretta caerulea*	n acc !
Cattle egret, *Bubulcus ibis*	n acc !
Green-backed heron (green heron), *Butorides striatus*	U? b !
Black-crowned night-heron, *Nycticorax nycticorax*	ext b, R n !
Yellow-crowned night-heron, *Nycticorax violaceus*	n acc !
Glossy ibis, *Plegadis falcinellus*	n acc !
Fulvous whistling-duck (fulvous tree duck), *Dendrocygna bicolor*	n acc !
Tundra swan (whistling swan), *Cygnus columbianus*	n acc !
Mute swan, *Cygnus olor*	R b int !
Greater white-fronted goose, *Anser albifrons*	n acc #
Snow goose, *Chen caerulescens*	R n #
Ross' goose, *Chen rossii*	n acc !
Brant, *Branta bernicla*	U n #
Canada goose, *Branta canadensis*	U? b int? C n native #
Wood duck, *Aix sponsa*	U b, C n #
Green-winged teal, *Anas crecca*	R b per, C n #
American black duck, *Anas rubripes*	R b, C n #
Mallard, *Anas platyrhynchos*	U b int?, C n #
Northern pintail, *Anas acuta*	R n #
Blue-winged teal, *Anas discors*	R b, C n #
Northern shoveler, *Anas clypeata*	R n #
Gadwall, *Anas strepera*	n acc #
Eurasian wigeon, *Anas penelope*	n acc #
American wigeon, *Anas americana*	R n #
Canvasback, *Aythya valisineria*	U n #
Redhead, *Aythya americana*	R n #
Ring-necked duck, *Aythya collaris*	U n #
Greater scaup, *Aythya marila*	U? n #

Table 7.1 Cont.

Species	Notes
Lesser scaup, Aythya affinis	U? n #
Common eider, Somateria mollissima	n acc #
Oldsquaw, Clangula hyemalis	n acc !?
Black scoter, Melanitta nigra	R n !?
Surf scoter, Melanitta perspicillata	n acc? !?
White-winged scoter, Melanitta fusca	R n !?
Common goldeneye, Bucephala clangula	U n #
Barrow's goldeneye, Bucephala islandica	n unv acc #
Bufflehead, Bucephala albeola	U n #
Hooded merganser, Lophodytes cucullatus	unv b, R n #
Common merganser, Mergus merganser	U n #
Red-breasted merganser, Mergus serrator	R n #
Ruddy duck, Oxyura jamaicensis	n acc #
Black vulture, Coragyps atratus	n acc !
Turkey vulture, Cathartes aura	unv b, U n !
Osprey, Pandion haliaetus	acc b, R n T !
Black-shouldered kite (white-tailed kite), Elanus caeruleus	n acc !
Bald eagle, Haliaeetus leucocephalus	ext b, R n EE !
Northern harrier (marsh hawk), Circus cyaneus	ext b, R n T * !
Sharp-shinned hawk, Accipiter striatus	R b per?, U? n * !
Cooper's hawk, Accipiter cooperii	R b, R n S !
Northern goshawk, Accipiter gentilis	R b, R n !
Red-shouldered hawk, Buteo lineatus	R b, R n T * !
Broad-winged hawk, Buteo platypterus	R? b, C n !
Red-tailed hawk, Buteo jamaicensis	C b, C n !
Rough-legged hawk, Buteo lagopus	R n !
Golden eagle, Aquila chrysaetos	R n E !
American kestrel (sparrow hawk), Falco sparverius	C b, C n !
Merlin, Falco columbarius	n acc !
Peregrine falcon, Falco peregrinus	acc ext b, R n EE !
Gyrfalcon, Falco rusticolus	n acc !
Gray partridge (Hungarian partridge), Perdix perdix	int ext
Ring-necked pheasant, Phasianus colchicus	U b int #
Ruffed grouse, Bonasa umbellus	C b #
Wild turkey, Meleagris gallopavo	R b #
Northern bobwhite, Colinus virginianus	T b per #
King rail, Rallus elegans	R b? per? * #
Virginia rail, Rallus limicola	R b #
Sora, Porzana carolina	R b per?, U n #
Common moorhen (common gallinule), Gallinula chloropus	R b #
American coot, Fulica americana	U n #
Sandhill crane, Grus canadensis	n acc !
Black-bellied plover, Pluvialis squatarola	R n !
Lesser golden-plover, Pluvialis dominica	n acc !

Table 7.1 Cont.

Species	Notes
Semipalmated plover, *Charadrius semipalmatus*	R n !
Killdeer, *Charadrius vociferus*	C b !
Greater yellowlegs, *Tringa melanoleuca*	U n !
Lesser yellowlegs, *Tringa flavipes*	U n !
Solitary sandpiper, *Tringa solitaria*	R n !
Willet, *Catoptrophorus semipalmatus*	n acc !
Spotted sandpiper, *Actitis macularia*	R b, C n !
Upland sandpiper, *Bartramia longicauda*	R n S * !
Marbled godwit,*Limosa fedoa*	n acc !
Ruddy turnstone, *Arenaria interpres*	n acc !
Red knot, *Calidris canutus*	n acc !
Sanderling, *Calidris alba*	n acc !
Semipalmated sandpiper, *Calidris pusilla*	R n !
Western sandpiper, *Calidris mauri*	n acc !
Least sandpiper, *Calidris minutilla*	C? n !
White-rumped sandpiper, *Calidris fuscicollis*	n acc !
Baird's sandpiper, *Calidris bairdii*	n acc !
Pectoral sandpiper, *Calidris melanotos*	R n !
Dunlin, *Calidris alpina*	R n !
Stilt sandpiper, *Calidris himantopus*	n acc !
Buff-breasted sandpiper, *Tryngites subruficollis*	n acc !
(Short-billed?) dowitcher, *Limnodromus ?griseus*	n acc !
Common snipe, *Gallinago gallinago*	R b per, U n #
American woodcock, *Scolopax minor*	U b #
Wilson's phalarope, *Phalaropus tricolor*	n acc !
Red-necked phalarope (northern phalarope), *Phalaropus lobatus*	n acc !
Long-tailed jaeger, *Stercorarius longicaudus*	n acc !
Laughing gull, *Larus atricilla*	R n per !
Bonaparte's gull, *Larus philadelphia*	R H n !
Ring-billed gull, *Larus delawarensis*	C n !
Herring gull, *Larus argentatus*	C n !
Iceland gull, *Larus glaucoides*	H n acc !
Glaucous gull, *Larus hyperboreus*	H n acc !
Great black-backed gull, *Larus marinus*	U H n !
Black-legged kittiwake, *Rissa tridactyla*	H n acc !
Caspian tern, *Sterna caspia*	H n acc !
Common tern, *Sterna hirundo*	H n acc T !
Sooty tern, *Sterna fuscata*	n acc !
Black tern, *Chlidonias niger*	R n S * !
Dovekie, *Alle alle*	n acc !
Thick-billed murre, *Urie lomvia*	H n acc !
Atlantic puffin, (common puffin), *Fratercula arctica*	n acc !
Rock dove (pigeon), *Columba livia*	U b int
Mourning dove, *Zenaida macroura*	C b !
Passenger pigeon, *Ectopistes migratorius*	ext
Monk parakeet, *Myiopsitta monachus*	n acc int ext?

Table 7.1 Cont.

Species	Notes
Black-billed cuckoo, *Coccyzus erythropthalmus*	R? b !
Yellow-bellied cuckoo, *Coccyzus americanus*	R? b !
Common barn-owl, *Tyto alba*	R b S !
Eastern screech-owl, *Otus asio*	U? b !
Great horned owl, *Bubo virginianus*	U b !
Snowy owl, *Nyctea scandiaca*	R n !
Barred owl, *Strix varia*	R b !
Long-eared owl, *Asio otus*	R b !
Short-eared owl, *Asio flammeus*	R n S * !
Boreal owl, *Aegolius funereus*	n acc !
Northern saw-whet owl, *Aegolius acadicus*	R n? per !
Common nighthawk, *Chordeiles minor*	ext b, U n S !
Whip-poor-will, *Caprimulgus vociferus*	R b !
Chimney swift, *Chaetura pelagica*	U b !
Ruby-throated hummingbird, *Archilochus colubris*	R? b, U n * !
Belted kingfisher, *Ceryle alcyon*	U b !
Red-headed woodpecker, *Melanerpes erythrocephalus*	ext? per? b, R n !
Red-bellied woodpecker, *Melanerpes carolinus*	R b per? !
Yellow-bellied sapsucker, *Sphyrapicus varius*	U n !
Downy woodpecker, *Picoides pubescens*	C b !
Hairy woodpecker, *Picoides villosus*	U? b * !
Black-backed woodpecker (black-backed three-toed woodpecker), *Picoides arcticus*	n acc !
Northern flicker (yellow-shafted flicker), *Colaptes auratus*	C b !
Pileated woodpecker, *Dryocopus pileatus*	R b !
Olive-sided flycatcher, *Contopus borealis*	R n !
Eastern wood-pewee, *Contopus virens*	C b !
Yellow-bellied flycatcher, *Empidonax flaviventris*	R n !
Acadian flycatcher, *Empidonax virescens*	R b per !
Willow flycatcher (Traill's flycatcher in part), *Empidonax traillii*	R b per? * !
Least flycatcher, *Empidonax minimus*	U? b !
Eastern phoebe, *Sayornis phoebe*	C b !
Great crested flycatcher, *Myiarchus crinitus*	U b !
Western kingbird, *Tyrannus verticalis*	n acc !
Eastern kingbird, *Tyrannus tyrannus*	U b !
Horned lark, *Eremophila alpestris*	R b !
Purple martin, *Progne subis*	R b !
Tree swallow, *Tachycineta bicolor*	C b !
Northern rough-winged swallow, *Stelgidopteryx serripennis*	R b !
Bank swallow, *Riparia riparia*	U b !
Cliff swallow, *Hirundo pyrrhonota*	ext? b, R n !
Barn swallow, *Hirundo rustica*	U b !
Gray jay, *Perisoreus canadensis*	n acc !
Blue jay, *Cyanocitta cristata*	C b !
American crow (common crow), *Corvus brachyrhynchos*	C b #

Table 7.1 Cont.

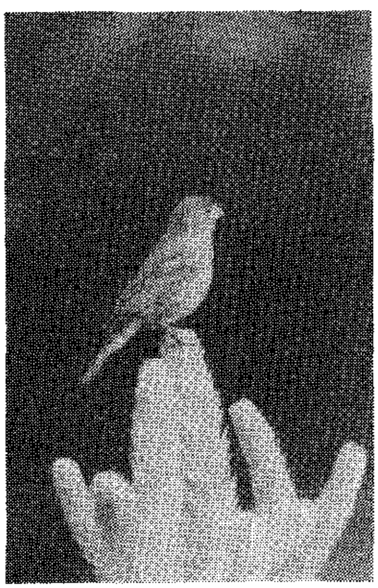
Species	Notes
Fish crow, Corvus ossifragus	R b per !
Common raven, Corvus corax	n acc S !
Black-capped chickadee, Parus atricapillus	C b !
Boreal chickadee, Parus hudsonicus	n acc !
Tufted titmouse, Parus bicolor	U b per? !
Red-breasted nuthatch, Sitta canadensis	b unv, R n !
White-breasted nuthatch, Sitta carolinensis	U b !
Brown creeper, Certhia americana	R? b, U n !
Carolina wren, Thryothorus ludovicianus	R b per !
Bewick's wren, Thryomanes bewickii	n unv * !
House wren, Troglodytes aedon	C b !
Winter wren, Troglodytes troglodytes	R b per, U n !
Sedge wren (short-billed marsh wren), Cistothorus platensis	ext? b, R n S !
Marsh wren (long-billed marsh wren), Cistothorus palustris	R b !
Golden-crowned kinglet, Regulus satrapa	U n, R b !
Ruby-crowned kinglet, Regulus calendula	C? n !
Blue-gray gnatcatcher, Polioptila caerulea	R? b, U n !
Northern wheatear, Oenanthe oenanthe	n acc !
Eastern bluebird, Sialia sialia	R b S * !
Mountain bluebird, Sialia currucoides	n acc !
Townsend's solitaire, Myadestes townsendi	n acc !
Veery, Catharus fuscescens	U b !
Gray-cheeked thrush, Catharus minimus	R n !
Swainson's thrush, Catharus ustulatus	U n !
Hermit thrush, Catharus guttatus	R b, U n !
Wood thrush, Hylocichla mustelina	C b !
American robin, Turdus migratorius	C b !
Gray catbird, Dumetella carolinensis	C b !
Northern mockingbird, Mimus polyglottos	U b per? !
Brown thrasher, Toxostoma rufum	U b !
Water pipit, Anthus spinoletta	R n !
Bohemian waxwing, Bombycilla garrulus	n acc !
Cedar waxwing, Bombycilla cedrorum	U? b !
Northern shrike, Lanius excubitor	R n !
Loggerhead shrike, Lanius ludovicianus	R n E * !
European starling, Sturnus vulgaris	C b int
White-eyed vireo, Vireo griseus	R b per !
Solitary vireo, Vireo solitarius	R b per !
Yellow-throated vireo, Vireo flavifrons	U b !
Warbling vireo, Vireo gilvus	U? b !
Philadelphia vireo, Vireo philadelphicus	R n !
Red-eyed vireo, Vireo olivaceus	C b !
Blue-winged warbler, Vermivora pinus	U? b per? !
Golden-winged warbler, Vermivora chrysoptera	R b * !
Tennessee warbler, Vermivora peregrina	R n !
Orange-crowned warbler, Vermivora celata	n acc !

Table 7.1 Cont.

Species	Notes
Nashville warbler, Vermivora ruficapilla	R b per !
Northern parula (parula warbler), Parula americana	R n !
Yellow warbler, Dendroica petechia	C b * !
Chestnut-sided warbler, Dendroica pensylvanica	U? b !
Magnolia warbler, Dendroica magnolia	U nb !
Cape May warbler, Dendroica tigrina	U nb !
Black-throated blue warbler, Dendroica caerulescens	R b per, U n !
Yellow-rumped warbler (myrtle warbler), Dendroica coronata	R b per, C n !
Townsend's warbler, Dendroica townsendi	n acc !
Black-throated green warbler, Dendroica virens	R b, U n !
Blackburnian warbler, Dendroica fusca	R b unv, R n !
Yellow-throated warbler, Dendroica dominica	n acc !
Pine warbler, Dendroica pinus	b ext?, R n !
Prairie warbler, Dendroica discolor	U b !
Palm warbler, Dendroica palmarum	U? n !
Bay-breasted warbler, Dendroica castanea	R n !
Blackpoll warbler, Dendroica striata	U n !
Cerulean warbler, Dendroica cerulea	R b !
Black-and-white warbler, Mniotilta varia	R? b, C n !
American redstart, Setophaga ruticilla	C b !
Prothonotary warbler, Protonotaria citrea	n acc !
Worm-eating warbler, Helmitheros vermivorus	R b per !
Ovenbird, Seiurus aurocapillus	U b !
Northern waterthrush, Seiurus noveboracensis	R b per !
Louisiana waterthrush, Seiurus motacilla	U b per !
Kentucky warbler, Oporornis formosus	n acc !
Connecticut warbler, Oporornis agilis	R n !
Mourning warbler, Oporornis philadelphia	R n !
Common yellowthroat (Maryland yellowthroat), Geothlypis trichas	C b !
Hooded warbler, Wilsonia citrina	R b unv !
Wilson's warbler, Wilsonia pusilla	R n !
Canada warbler, Wilsonia canadensis	R b !
Yellow-breasted chat, Icteria virens	R b per
Summer tanager, Piranga rubra	n acc !
Scarlet tanager, Piranga olivacea	U b !
Northern cardinal, Cardinalis cardinalis	C b !
Rose-breasted grosbeak, Pheucticus ludovicianus	U b !
Black-headed grosbeak, Pheucticus melanocephalus	n acc !
Indigo bunting, Passserina cyanea	U b !
Dickcissel, Spiza americana	n acc * !
Rufous-sided towhee Pipilo erythrophthalmus	C b !
American tree sparrow, Spizella arborea	C n !
Chipping sparrow, Spizella passerina	C b !
Clay-colored sparrow, Spizella pallida	n? acc !
Field sparrow, Spizella pusilla	C b !
Vesper sparrow, Pooecetes gramineus	R b S !

Table 7.1 Cont.

Species	Notes
Lark sparrow, Chondestes grammacus	n acc !
Lark bunting, Calamospiza melanocorys	n acc !
Savannah sparrow, Passerculus sandwichensis	R b !
Grasshopper sparrow, Ammodramus savannarum	R b S * !
Henslow's sparrow, Ammodramus henslowii	b ext, R n S !
Sharp-tailed sparrow, Ammodramus caudacutus	H n acc !
Fox sparrow, Passerella iliaca	R n !
Song sparrow, Melospiza melodia	C b !
Lincoln's sparrow, Melospiza lincolnii	R n !
Swamp sparrow, Melospiza georgiana	U b !
White-throated sparrow, Zonotrichia albicollis	C n !
White-crowned sparrow, Zonotrichia leucophrys	R n !
Harris' sparrow, Zonotrichia querula	n acc !
Dark-eyed junco (slate-colored junco), Junco hyemalis	R b per, C n !
Lapland longspur, Calcarius lapponicus	R n !
Snow bunting, Plectrophenax nivalis	R n !
Bobolink, Dolichonyx oryzivorus	R b !
Red-winged blackbird, Agelaius phoeniceus	C b !
Eastern meadowlark, Sturnella magna	U b * !
Western meadowlark, Sturnella neglecta	b? acc !
Yellow-headed blackbird, Xanthocephalus xanthocephalus	n acc !
Rusty blackbird, Euphagus carolinus	U n !
Common grackle (purple grackle, bronzed grackle), Quiscalus quiscula	C b !
Brown-headed cowbird, Molothrus ater	C b !
Orchard oriole, Icterus spurius	R b, R n per !
Northern oriole, (Baltimore oriole), Icterus galbula	C b !
Brambling, Fringilla montifringilla	n acc !?
Pine grosbeak, Pinicola enucleator	R n !
Purple finch, Carpodacus purpureus	R b per, U n !
House finch, Carpodacus mexicanus	U b int !
Red crossbill, Loxia curvirostra	R n !
White-winged crossbill, Loxia leucoptera	n acc !
Common redpoll, Carduelis flammea	R n !
Hoary redpoll, Carduelis hornemanni	n acc !
Pine siskin, Carduelis pinus	R n !
American goldfinch, Carduelis tristis	C b !
Evening grosbeak, Coccothraustes vespertinus	R b?, U n !
House sparrow, Passer domesticus	U b int !



Mammals

Virginia opossum, Didelphis virginiana	C b
Masked shrew, Sorex cinereus	R? b
Water shrew, Sorex palustris	unv per
Smoky shrew, Sorex fumeus	R b
Short-tailed shrew, Blarina brevicauda	C b

Table 7.1 Cont.

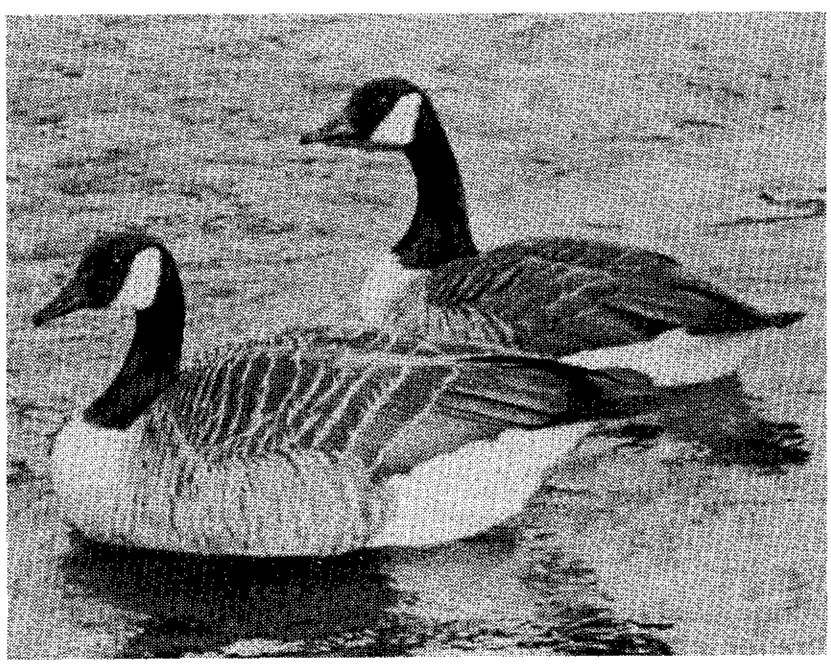
Species	Notes
Hairy-tailed mole, Parascalops breweri	R b
Eastern mole, Scalopus aquaticus	R b per
Star-nosed mole, Condylura cristata	U b
Little brown bat (little brown myotis), Myotis lucifugus	C b
Keen's bat (Keen's myotis), Myotis keenii	R b?
Indiana bat (Indiana or social myotis), Myotis sodalis	unv per EE !
Eastern pipistrelle, Pipistrellus subflavus	R b?
Big brown bat, Eptesicus fuscus	U b
Red bat, Lasiurus borealis	U n
Hoary bat, Lasiurus cinereus	unv
Eastern cottontail, Sylvilagus floridanus	C b #
New England cottontail, Sylvilagus transitionalis	unv S #
Snowshoe hare, Lepus americanus	R b? per #
European hare, Lepus capensis	R b int #
Eastern chipmunk, Tamias striatus	C b
Woodchuck, Marmota monax	C b
Gray squirrel, Sciurus carolinensis	C b#
Red squirrel, Tamiasciurus hudsonicus	U b
Southern flying squirrel, Glaucomys volans	U b
Beaver, Castor canadensis	U b#
Deer mouse, Peromyscus maniculatus	R b per?
White-footed mouse, Peromyscus leucopus	C b
Eastern woodrat, Neotoma floridana	ext? per T !
Southern red-backed vole, Clethrionomys gapperi	R b
Meadow vole, Microtus pennsylvanicus	C b
Woodland vole (pine vole), Microtus pinetorum	U b
Muskrat, Ondatra zibethicus	U b #
Southern bog lemming, Synaptomys cooperi	R b?
Norway rat, Rattus norvegicus	C b int
House mouse, Mus musculus	U b int
Meadow jumping mouse, Zapus hudsonius	C? b
Woodland jumping mouse, Napaeozapus insignis	R b? per?
Porcupine, Erethizon dorsatum	R b per?
Common dolphin, Delphinus delphis	H acc
Coyote, Canis latrans	U? b? #
Gray wolf (timber wolf), Canis lupus	ext EE !
Feral dog, Canis familiaris	R? b? int (1)
Red fox, Vulpes vulpes	U b int? #
Gray fox, Urocyon cinereoargenteus	C b #
Black bear, Ursus americanus	acc !
Raccoon, Procyon lotor	C b #
Fisher, Martes pennanti	R or acc !
Ermine (short-tailed weasel), Mustela erminea	U? b
Long-tailed weasel, Mustela frenata	U? b
Mink, Mustela vison	U? b #
Striped skunk, Mephitis mephitis	C b
River otter, Lutra canadensis	R b #

Table 7.1 Cont.

Species	Notes
Harbor seal, Phoca vitulina	H acc? per? !
Mountain lion (cougar), Felis concolor	ext? E !
Bobcat, Felis rufus	R b #
Feral cat, Felis catus	C? b int (1)
Elk, Cervus elaphus	ext
White-tailed deer, Odocoileus virginianus	C b #
Human, Homo sapiens	C b !

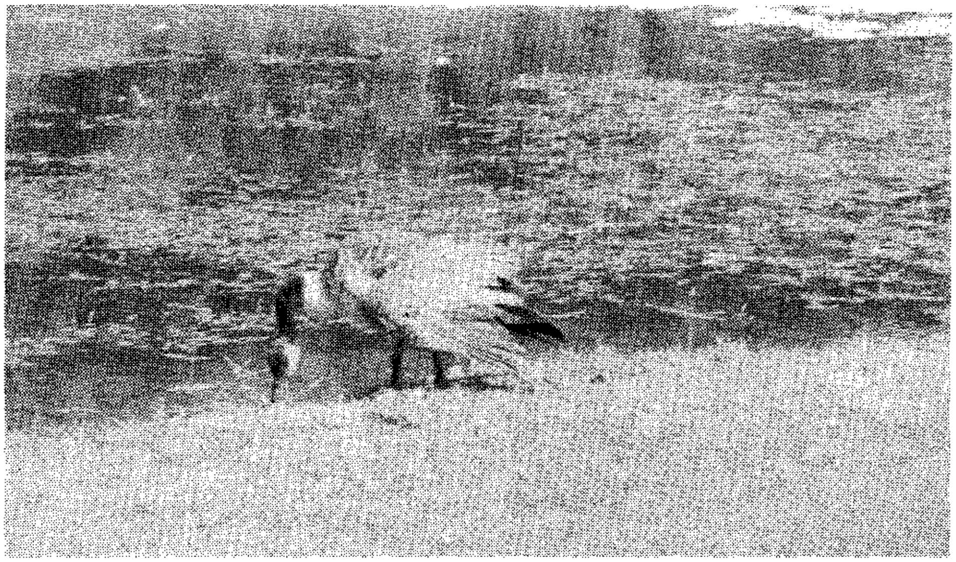
Source: The Ralph T. Waterman Bird Club, New York State Department of Environmental Conservation, Cary Arboretum, Rockefeller University Center for Field Research, Bard College Field Station, Hudsonia Limited, published literature and personal communications from individual observers. Scientific and common names are currently-recommended usage (with a few older names in parentheses) from: Jones et al. (1979), mammals; Eisenmann et al. (1982), birds; Collins, et al. (1982), reptiles and amphibians; and Robins et al. (1980), fishes. For seasons of occurrence of birds, see Ralph T. Waterman Bird Club (1977).

1) The status of feral (ownerless, self-sufficient) dogs and cats is uncertain; in particular, feral dogs, eastern coyotes, and their hybrids are difficult to tell apart.



Resource Management Implications

Wildlife species play an essential role in natural processes, and contribute to the well-being of the environment and of all human communities. Many common wildlife species can tolerate some alteration of environmental conditions. Other species, however, are extremely sensitive to changes in their habitats. Such species require careful habitat protection in order to survive.



Wildlife Diversity

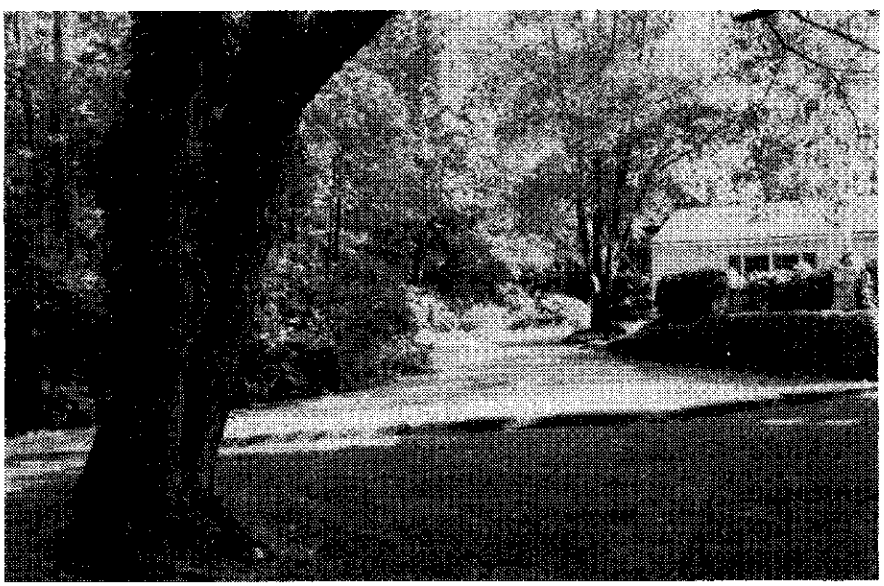
Actions that reduce wildlife and vegetation diversity, such as the large-scale intensive development of land and the loss of particular habitat types, reduce environmental stability and resilience. They also reduce the quality of life by depriving people of the opportunity to interact with, learn about, enjoy, and understand their role in maintaining the natural world.

In the past, resource management efforts have focused on game animals and the wildlife of rural areas; little attention was paid to wildlife in urban and suburban settings. Today, as more and more land is developed and the Dutchess County landscape changes, more thought should be given to the contribution wildlife can make to urban and suburban as well as rural communities. A greater awareness is needed throughout the county of the harmful impacts that careless--and often unnecessary--land use practices have on wildlife resources.

Habitat Conservation

Many of the adverse effects that human land uses have on wildlife can be ameliorated by incorporating a commitment to wildlife habitat protection into the land use planning and development process. For example, systematically reserving sizable open space corridors along steams, floodplains, and ridgelines in developing areas preserves habitat for many wild species while permitting orderly growth. Identifying and steering development away from the habitats of endangered, threatened, or otherwise sensitive species can improve such species' chances of survival.

Creatively using vegetation buffers in developed areas can minimize runoff, noise, dust, visual intrusions, and other traces of human activity that can disturb wildlife. Such buffers provide shelter for the wildlife and enhance the appearance of developed land. Wildlife can also be protected through such simple measures as making sure that road maintenance crews refrain from felling or trimming trees during the spring nesting and rearing season.

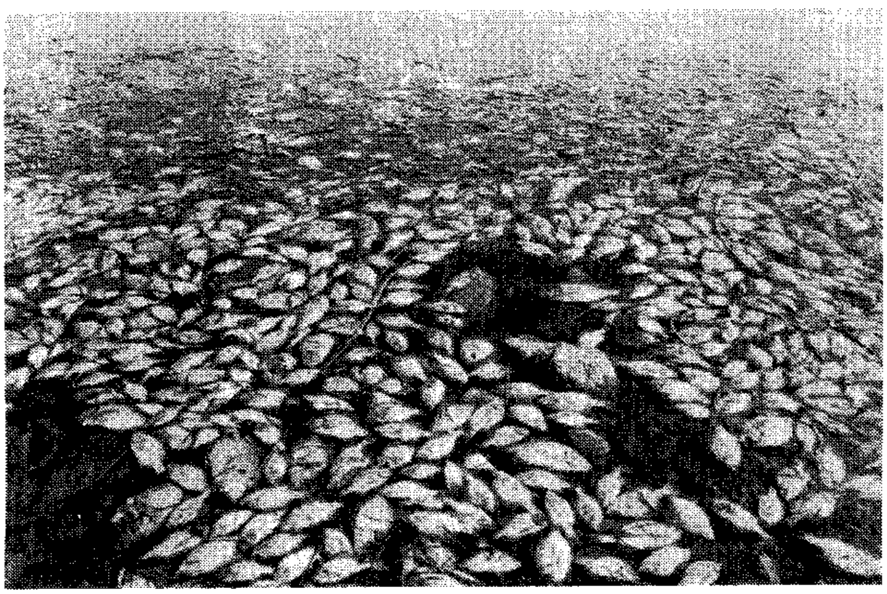


Relatively little is known about what many uncommon, sensitive, or threatened species need to maintain viable populations. Local and county governments should support efforts to study such species, and to develop management approaches that will increase their chances of survival. Important habitat areas should be mapped, and techniques developed to ensure that they are adequately protected.

In some cases, preserving a small habitat area may be sufficient protection for a rare species. More often, however, it is necessary to set aside a mosaic of interconnected habitat areas to support wildlife species. For example, bog turtles, which are endangered, need systems of wet meadows and beaver ponds connected by streams in order to thrive. Preserving only the scattered wet meadows or beaver ponds where bog turtles happen to be seen will not adequately protect them.

Sufficiently diverse and abundant habitat "mosaics" can be preserved through well-thought-out, effectively implemented zoning, site planning, and open space policies. Some significant habitats can be used with proper planning and management; others are so sensitive that they should not be used to any degree for human activities.

Wildlife suffer from habitat pollution as well as habitat encroachment. Inadequately treated septic wastes, leachate from dump sites, air pollution, stream sediment, and salts, oils, and chemicals in surface runoff degrade the environment and can make it intolerable to sensitive species. Pollutants affect the health of wildlife and, in the case of sport and commercial fish, can render them unsafe for human consumption. To be effective, wildlife protection efforts must be supported by aggressive pollution control programs at all levels of government.



Wildlife habitat management programs do not have to be labor-intensive. Beaver activity, natural fires, floods, vegetation development, and livestock grazing are examples of phenomena that diversify the environment, "managing" it so that it can support healthy and complex biological communities. Land use practices that allow such phenomena to continue without interference go far toward maintaining diverse wildlife populations.

It is important to recognize that land use policies that are sensitive to the needs of wildlife species accomplish several objectives. Open space tracts and vegetation buffers reserved for wildlife habitat also enhance the visual environment, recharge groundwater supplies, reduce erosion, filter air, soften noise, increase nearby property values, help protect surface and groundwater quality, offer privacy, and in many instances meet agricultural or recreational needs. Protecting wildlife habitat, therefore, is one of the many goals of responsible environmental management efforts that can benefit all community members.

Significant Areas

Dutchess County is endowed with many significant natural areas and scenic resources. Significant natural areas are valued for their environmental importance and beauty, and include unusual geological formations such as scenic mountain ridges, steep ravines, and caves, hydrological features such as certain rivers, lakes, springs, and wetlands, and areas that support threatened or endangered species or unusually diverse plant and animal communities.

Scenic resources are panoramic vantage points, road corridors, and open space areas that offer particularly good opportunities to see and enjoy the natural features that contribute to the county's visual identity. Both significant natural areas and scenic resources enhance environmental health and the quality of life in Dutchess County.

Significant Natural Areas

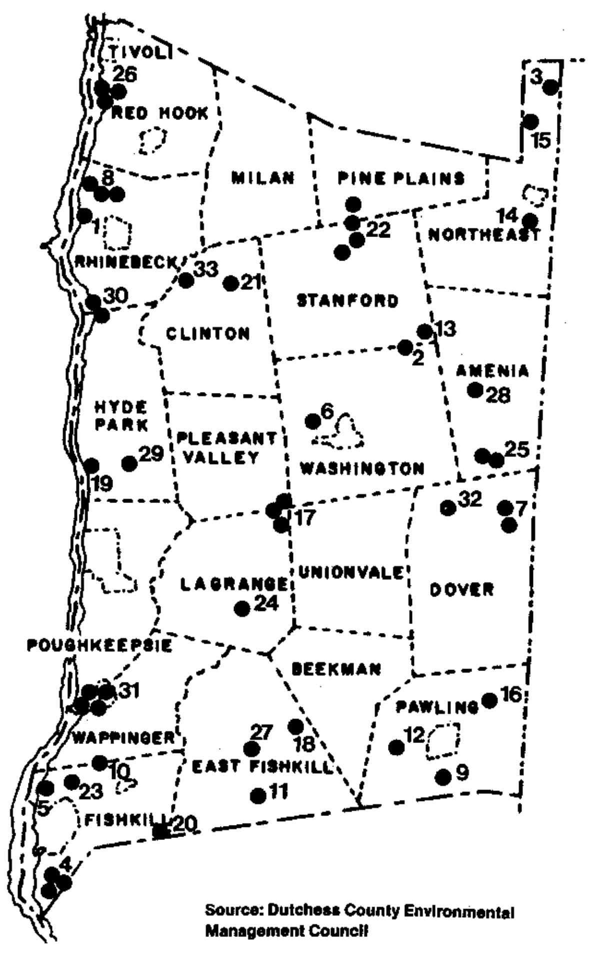
Wildlife habitat, water supply protection, recreational space, and opportunities for outdoor research are among the environmental benefits that significant natural areas provide. The beauty of such areas offers a welcome contrast to the appearance and mood of urban and suburban life.

The Dutchess County Environmental Management Council (EMC) has adopted a list of 34 areas that significantly contribute to the health, diversity, and enjoyment of the county's resource base. The purpose of designating these sites as "Significant Areas" is to encourage the recognition and protection of their unique qualities. The list and a map showing the locations of the designated areas appear in Figure 8.1. Each of the areas is breifly described in the following pages. Table 8.1, which appears at the end of the description section, indicates whether the areas are publicly or privately owned.

Dutchess County's significant natural areas are not limited to those described by the EMC and listed below. Many more areas possess unusual natural characteristics and values. The list of 34 could be considerably expanded in the future.

Significant Areas of Dutchess County

1. Astor Cove
2. Bontecou Lake
3. Brace Mountain
4. Breakneck Ridge, Scofield Ridge, Hell's Hollow and North and South Mount Beacon
5. Brockway Road Woods
6. Cary Arboretum Institute of Ecosystem Studies
7. East and West Mountain Areas
8. Ferncliff Forest, Snyder Swamp, and the Mudderkill Creek
9. The Great Swamp
10. Greenfly Wetland
11. Hosner Mountain
12. Little Whaley Lake
13. Millbrook Meadow
14. Millerton Wetland
15. The Panhandle Wetlands
16. The Pawling Nature Reserve
17. Pond Gut, Rockefeller University Field Research Center and Innisfree
18. Reedy Bog
19. Roosevelt Cove and Wetland
20. Sharpe Reservation
21. Silver Lake, Mud Pond, and Long Pond
22. Stissing Mountain, Thompson Pond, Stockbriar Wetlands, and Buttercup Sanctuary
23. Stony Kill Farm and Environmental Education Center
24. Stringham Wetland Complex
25. Swift Pond and Cleaver Swamp
26. Tivoli Bays, Cruger Island, and Montgomery Place Woods
27. Townsend Swamp
28. Turkey Hollow
29. Val-Kill
30. Vandenburgh Cove and ridges, Jones Island, and Suckley Cove
31. Wappinger Creek and Lake, Putnam Audubon Sanctuary, and Reese and Bowdoin Parks
32. West Mountain
33. Zipfelberg Bog
34. Clove Valley and Clove Mountain



Source: Dutchess County Environmental Management Council

Figure 8.1:

1. Astor Cove, a 25-acre tidal marsh south of the Rhinecliff Bridge, is an area of wildlife habitat that supports Hudson River fish and bird life. This largely undisturbed cove has a unique stand of wild rice and is a valuable feeding area for ducks. It lies within the Mid-Hudson Historic Shorelands Scenic District designated by the New York State Department of Environmental Conservation.

2. Bontecou Lake (Tamarack Lake) in the towns of Stanford and Washington is one of the largest lakes in Dutchess County. Measuring approximately 113 acres, it is a privately-owned, man-made lake that supports a wide variety of wildlife. This lake is well-known for sheltering large numbers of geese and ducks.

3. Brace Mountain, rising more than 2,300 feet above sea level in the town of Northeast, is the highest point in Dutchess County. The summit, which can be reached by trails beginning in New York, Connecticut, and Massachusetts, offers outstanding views of three states, with the western view to the Catskill Mountains being particularly spectacular. The interconnecting trail system along Brace Mountain and the Taconic Ridges provides excellent hiking through several special habitats.

4. Breakneck Ridge, Scofield Ridge, Hell's Hollow, and North and South Mount Beacon make up a large ridge area bordering the Hudson River near the southern edge of Dutchess County. Well-known for spectacular views of the Hudson River and Hudson Highlands, this mountainous area supports a large variety of plant and animal life, particularly nesting birds. The area also affords unique research opportunities on rare plant and animal communities. It has been nominated for recognition as a National Natural Landmark by the United States Department of the Interior.

5. Brockway Road Woods in the town of Fishkill is a privately-owned, well-developed hardwood forest along a stream which supports a variety of uncommon plants. This area has been cited by the Nature Conservancy in its Unique Natural Areas Survey as worthy of protection.

6. The Cary Arboretum Institute of Ecosystem Studies in the town of Washington is a 2,000-acre research and educational facility owned by the New York Botanical Garden. County residents have the opportunity to attend programs and courses offered by the arboretum and to use the property in a variety of ways. Hikers and bird watchers enjoy a great diversity of plants and animals in this area.

7. East and West Mountain Areas in Dover are considered significant because of their scenic beauty and abundant wildlife. Designated as a New York State Significant Habitat, East Mountain provides habitat for species that are rare in the county and offers excellent views of the Harlem Valley. The West Mountain area contains distinctive and beautiful geological formations that provide habitat for fragile vegetation.

8. Ferncliff Forest, Snyder Swamp, and the Mudderkill Creek in the towns of Rhinebeck and Red Hook form a complex of open space areas. Ferncliff Forest, 192 acres owned by the Rotary Club of Rhinebeck that contain trails and a picnic shelter, is open to the public for recreational purposes. Adjoining Ferncliff is Snyder Swamp, a privately-owned 111-acre wetland containing hardwood trees and diverse wildlife. Snyder Swamp is the headwater for the Mudderkill Creek, which runs north through private property to enter the Hudson River in Red Hook. The mouth of the Mudderkill Creek contains unusual plant and animal species.

9. The Great Swamp in the town of Pawling (and extending into Putnam County) is over 400 acres in size. Located in the Harlem Valley, the swamp is an excellent example of a glacial valley floodplain. The Great Swamp is especially significant because of its extensive and well-developed floodplain forest and associated wildlife. The U.S. Department of Interior has nominated the swamp for designation as a National Natural Landmark.

10. Greenfly Wetland is a 185-acre area in the towns of Wappinger and Fishkill which provides flood control, groundwater protection, and wildlife habitat in a heavily populated area. Greenfly consists of marsh as well as bog areas, and provides habitat for diverse wildlife. Hikers, birdwatchers, and ice-skaters particularly enjoy this area.

11. Hosner Mountain is a rocky ridge area in East Fishkill that is partly owned by the U.S. Department of the Interior for use as the new route of the Appalachian Trail. This mountainous area provides open space, scenic beauty, and wildlife habitat on the periphery of a densely-settled area. Uncommon wildlife have been observed on Hosner Mountain.

12. Little Whaley Lake in the town of Pawling is the focal point of a 1,300-acre property owned by the Boy Scouts of America New York Metropolitan Council. Surrounded by hardwood and hemlock forest, it is a lake of pristine quality in an area undergoing considerable development, and is a potential source of drinking water.

13. Millbrook Meadow is an eight-acre wetland owned by the Millbrook School, which contains rare, threatened, or endangered plants and animals. This area has been recommended for preservation by The Nature Conservancy.

14. Millerton Wetland, a privately-owned wetland in the town of Northeast, is being considered for nomination as a National Natural Landmark by the U.S. Department of Interior. It has been cited as the best example of a limestone wet meadow in the northeastern United States. Consisting of herbaceous and shrub swamp communities, this unique habitat supports rare, threatened, or endangered species.

15. The Panhandle Wetlands group is a 650-acre complex of privately-owned wetlands in the town of Northeast. The area contains a series of tamarack swamps and open cattail marshes joined by a stream. Beaver ponds and limestone wet meadows provide conditions for unusual plant communities and a rich wildlife population. The Nature Conservancy has recommended this area for preservation.

16. The Pawling Nature Reserve, a 1,114-acre natural area owned and managed by The Nature Conservancy, has been nominated as a National Natural Landmark by the U.S. Department of Interior. The Appalachian Trail passes through the property. The reserve contains an unusually diverse group of ecological associations and includes an excellent cross section of natural habitats characteristic of eastern New York. It supports rare, threatened, or endangered species, and is of special interest due to the large number of songbird species present.

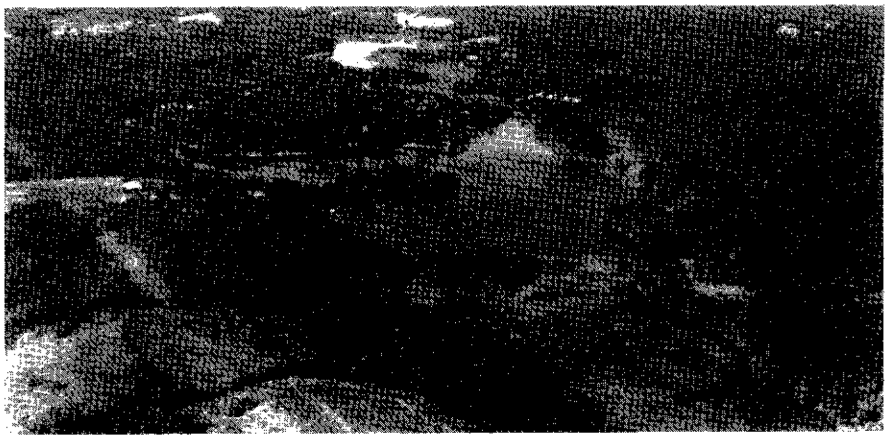
17. Pond Gut, Rockefeller University Field Research Center, and Innisfree cover 2,221 acres owned both privately and by the state through the Taconic-Hereford Multiple Use Area. This open space complex supports a variety of wildlife, particularly nesting ducks and geese, and is designated as a New York State Significant Habitat. Well-known for its natural beauty, this area also supports substantial scientific research.

18. Reedy Bog, a six-acre wetland in the town of East Fishkill, is a limestone wet meadow that supports a variety of unusual plants and animals. Rare, threatened, or endangered species are present. This area has been recommended for preservation by The Nature Conservancy and has been designated a New York State Significant Habitat.

19. Roosevelt Cove and Wetland is a 25-acre tidal marsh, partly within the F. D. Roosevelt National Historic Site and partly privately-owned. This wetland supports a large cattail marsh and shelters a great number of waterfowl.

20. Sharpe Reservation, located in the town of Fishkill, is a 3,000-acre summer camp and environmental education facility owned by the Fresh Air Fund. Located in a heavily-populated sector of the county, the reservation includes large tracts of unspoiled forests and wetlands and three lakes. Numerous trails through the forested ridges offer dramatic vistas. Charcoal pits on the property date from before the Revolutionary War.

21. Silver Lake, Mud Pond, and Long Pond form a chain of bodies of water in the town of Clinton that represents a unique resource. Based on an unusual limestone rock formation called the Milan Window, these small lakes hydrologically influence the nearby Little Wappinger Creek and support a wide variety of wildlife. Rare species inhabit the area.



22. Stissing Mountain and Thompson Pond possess many unusual features. The mountain is geologically unique in that it is a block of one billion year-old gneiss "floating" on a younger rock layer. It rises 1,400 feet above an outwash plain and is depicted in a permanent display in the Museum of Natural History in New York City. At the base of the mountain is a glacial kettle area that has developed into Thompson Pond. The pond is owned by The Nature Conservancy and has been designated a National Natural Landmark. With associated wetland areas to the south, this area provides a varied habitat supporting diverse plant and animal communities.

23. Stony Kill Farm and Environmental Education Center is a 756-acre property in the town of Fishkill owned by the New York State Department of Environmental Conservation. Located in a rapidly developing area, Stony Kill offers opportunities for education and recreation to county residents. A rich variety of plants and animals live in this expanse of mixed habitats.

24. Stringham Wetland Complex is a 20-acre pond and wetland area in the town of LaGrange that shelters a variety of plant life and unusual animals. It supports rare or threatened species, and The Nature Conservancy has recommended its preservation.

25. Swift Pond and Cleaver Swamp, in Amenia, are privately-owned wetlands that provide excellent habitat for a rich variety of plants and animals, including some which are not commonly found in the county.

Numerous bird species have been recorded at Swift Pond, especially during migration periods. Cleaver Swamp is a stable cattail wetland recognized as unique by The Nature Conservancy. It is adjacent to a suspected hazardous waste site listed by the New York State Department of Environmental Conservation.

26. Tivoli Bays, Cruger Island, and Montgomery Place Woods cover a 1,000 acre area in the town of Red Hook and have been widely recognized for their unique qualities and beauty. This area is within the Mid-Hudson Historic Shorelands Scenic District designated by New York State. Owned, in part, by the New York State Department of Environmental Conservation, the Tivoli Bays have been designated by the National Estuarine Sancutary program and nominated for inclusion on the Department of the Interior National Natural Landmarks list. The bays filter pollutants from the Hudson River and offer a rich habitat for wildlife. Rare and threatened species inhabit the area. The Montgomery Place Woods, the oldest forest in the region, is a 100-acre woodland that contains important habitat for "old-growth" plant and animal species.

27. Townsend Swamp, a 177-acre wetland in the town of East Fishkill, has been recommended for preservation by The Nature Conservancy and is a New York State Significant Habitat. It contains rare, threatened, or endangered species.

28. Turkey Hollow is a steep rock ravine in the town of Amenia. The ravine and stream running through it form an unusually scenic area extending over several miles. Its cool, moist environment creates an ideal habitat for unusual plant and animal communities.

29. Val-Kill, the former property of Eleanor Roosevelt, is a 169-acre area in Hyde Park owned by the National Park Service. It has a beautiful natural setting, including the Fallkill Creek, a pond, and a wetland. The many woodland trails are open to the public.

30. Vandenburgh Cove, the surrounding ridges, Jones Island, Suckley Cove, and the nearby shallows of the Hudson River form an important tidal cove area in the town of Rhinebeck. Vandenburgh Cove, which covers approximately 125 acres, is particularly valuable as a spawning ground for fish and a feeding area for waterfowl and is in the Mid-Hudson Historic Shorelands Scenic District.

31. Wappinger Creek and Lake, Putnam Audubon Sanctuary, and Reese and Bowdoin Parks make up a group of important resources in a densely-populated portion of the county. The creek, tidal almost to the Wappinger Falls, was the site of early Indian settlements and is a breeding and feeding area for numerous species of fish and birds. The lake and parks are heavily-used, publicly owned open spaces which enhance the beauty of the area.

32. West Mountain (see number 7.)

33. Zipfelberg Bog is a unique 20-acre bog and wetland owned by The Nature Conservancy. This protected bog is a remnant of glacial activity and contains unusual species of plants and animals.

34. Clove Valley and Clove Mountain are large, scenic open spaces in the town of Unionvale. The top of Clove Mountain, which is the highest point in the town, offers a 360-degree view of the county. New England upland flora and fauna are common on the mountain slopes. Clove Valley, along the east side of Clove Mountain, is a limestone area with several flourishing springs. The valley has been used for outdoor recreation for decades. It contains the headwaters of the Fishkill Creek, which flows through several significant wetlands and a gorge in Tymor forest on its way south.

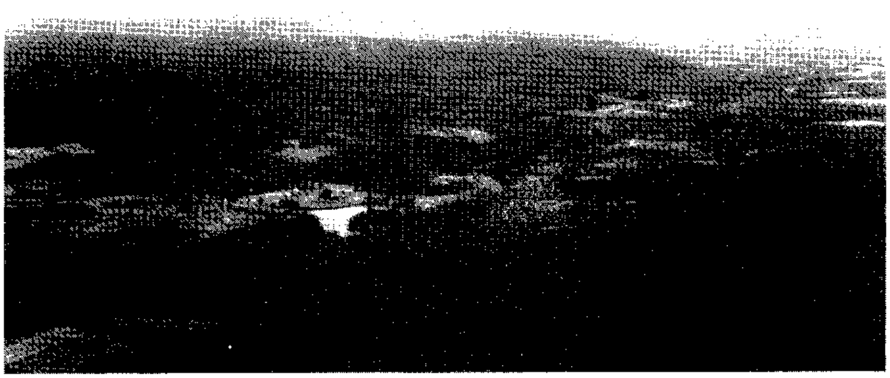


Table 8.1 Significant Area Ownership

Area Name and Number		Ownership
1	Astor Cove	Private
2	Bontecou Lake	Private
3	Brace Mountain	Private and New York State
4	Breakneck, Scofield, Hells Hollow, Mt. Beacon	Private and New York State
5	Brockway Road Woods	Private
6	Cary Arboretum	Private, but open to public
7	East and West Mountains	Private
8	Ferncliff, Snyder, Mudderkill Creek	Private, but Ferncliff is open to the public
9	The Great Swamp	Private
10	Greenfly Swamp	Private and Dutchess County
11	Hosner Mountain	Private and U.S. Dept. of Interior
12	Little Whaley Lake	Private (Boy Scouts of America)
13	Millbrook Meadow	Private
14	Millerton Wetland	Private
15	The Panhandle Wetlands	Private
16	Pawling Nature Reserve	Private, preserved (The Nature Conservancy)
17	Pond-Gut, Rockefeller	Private and New York State
18	Reedy Bog	Private
19	Roosevelt Cove	Private and U.S. Department of Interior
20	Sharpe Reservation	Private (Fresh Air Fund)
21	Silver Lake, etc.	Private
22	Stissing Mountain, Thompson Pond	Private, partly preserved (The Nature Conservancy and National Audubon Society) and New York State
23	Stony Kill Farm	New York State
24	Stringham Wetland	Private
25	Swift Pond, Cleaver Swamp	Private
26	Tivoli Bays	Private and New York State
27	Townsend Swamp	Private
28	Turkey Hollow	Private
29	Val-Kill	U.S. Dept. of Interior
30	Vandenburgh Cove	Private
31	Wappinger Creek and Lake, and Putnam Audubon Sanctuary, Reese and Bowdoin Parks	Private (partly Putnam Audubon), Dutchess County, and Town of Wappinger
32	West Mountain	Private
33	Zipfelberg Bog	Private, preserved (The Nature Conservancy)
34	Clove Mountain and Clove Valley	Private

Source: Dutchess County Environmental Management Council

Scenic Resources

Dutchess County has a varied landscape whose scenic mountains and valleys can be viewed from many locations. The opportunity to enjoy these views greatly enhances the daily experiences of those who live and work in or visit the county.

The Hudson River is the major landscape feature that visually unites Dutchess County with the rest of the Hudson Valley. The valley is the county's chief visual reference point, and includes several noted areas, such as the estates within the Mid-Hudson Historic Shorelands Scenic District that extends from Hyde Park into Columbia County. The Catskill Mountains to the west provide a beautiful backdrop to the river valley.

Mountains of the Hudson Highlands and the Taconic Range visually define the county's borders to the south and east. With these major features in the background, alternating patterns of uplands, lowlands, lakes, open land, farms, forests, and settlements provide beauty and visual diversity throughout the county.

The following tables list places and roads from which the county's scenic resources can be seen and appreciated. The lists include Hudson River vantage points, panoramic views along county roadways, open space areas, and scenic roads. Several of the open space areas are also included in Table 8.1 because of their significant natural values.

Table 8.2 Hudson River Vantage Points
(From South to North)

Place Name	Municipality
State Rte. 9D (South of Beacon)	Fishkill
Mount Beacon	Fishkill
Beacon Ferry Site - Riverfront Park	C. Beacon
Newburgh-Beacon Bridge	C. Beacon
Castle Point Veterans Hospital	Fishkill
Old Castle Point Road	Fishkill,Wappinger
Chelsea	Wappinger
Chelsea River Road	Wappinger
Wheeler Hill	Wappinger
New Hamburg	Poughkeepsie
Bowdoin Park	Poughkeepsie
Pirate Canoe Club	Poughkeepsie
Locust Grove	Poughkeepsie
Poughkeepsie Rural Cemetary	Poughkeepsie
Kaal Rock Park	C. Poughkeepsie
Mid-Hudson Bridge	C. Poughkeepsie
Waryas Park	C. Poughkeepsie
Marist College	Poughkeepsie
Regatta Row	Poughkeepsie
Mauritius Inlet - Riverpoint Road	Hyde Park
Culinary Institute of America	Hyde Park
F.D. Roosevelt National Historic Site	Hyde Park
Hyde Park Railroad Station	Hyde Park
River Road	Hyde Park
Vanderbilt Mansion National Historic Site	Hyde Park
Poughkeepsie Yacht Club	Hyde Park
Margaret Lewis Norrie State Park	Hyde Park
Ogden Mills - Ruth Livingston Mills State Park	Hyde Park
Vandenburgh Cove & Fishing Grounds Road	Rhinebeck
Wildersteen	Rhinebeck
Rhinecliff Dock	Rhinebeck
Kingston-Rhinecliff Bridge	Red Hook
Barrytown	Red Hook
Bard College	Red Hook
Tivoli Bays (North and South)	Red Hook
Tivoli Railroad Station	V. Tivoli
Clermont State Park	Red Hook, Clermont

Note: This list includes the most popular or widely known vantage points.
It is not comprehensive.

Table 8.3 Scenic Vantage Points Along Major Roadways

Roadway	Municipality
U.S. and State Highways	
I-84 at Beacon-Newburgh Bridge	Beacon
I-84 at Scenic Turnout near Rte. 52	E. Fishkill
I-84 at Hosner Mountain Rd.	E. Fishkill
I-84 at Cary Rd.	Fishkill
U.S. Rte. 44/State Rte. 55 at Mid-Hudson Bridge	Poughkeepsie
Taconic St. Pkwy. at Miller Hill Rd.	E. Fishkill
Taconic St. Pkwy. at James Baird St. Park	LaGrange
Taconic St. Pkwy. at Germond Rd.	Clinton
Taconic St. Pkwy. Scenic turnout at Pumpkin Ln.	Clinton
Taconic St. Pkwy. Scenic turnout at North Rd.	Milan
State Rte. 9 at Troopers Barracks	Rhinebeck
State Rte. 44 at DeLavergne Hill	Amenia
State Rte. 52 at Stormville Mountain	E. Fishkill
State Rte. 55 at Pawling Mountain	Pawling
State Rte. 82 north of Verbank	Washington
State Rte. 82 at Conklin Hill Rd.	Stanford
State Rte. 199 near Stark-Tator Sky Park	Red Hook
State Rte. 199 at Kingston-Rhinecliff Bridge	Red Hook
County Highways	
County Rte. 5, (Smithfield Rd.) near Perotti Rd.	Northeast
County Rte. 10, (Sylvan Lake Rd.) at Sylvan Lake	Beekman
County Rte. 21, (Wingdale Rd.) at Blueberry Hill	Dover
County Rte. 60, (Winchell Mt. Rd.) near Ancramdale Rd.	Northeast
County Rte. 64, (McGhee Hill Rd.) near Charlie Hill Rd.	Northeast
County Rte. 66, (Quaker Hill Rd.) south of Mizzentop	Pawling
County Rte. 85, (Fishing Grounds Rd.)	Rhinebeck
County Rte. 89, (Waterbury Hill Rd.) south of Hoxie Corner	Unionvale
County Rte. 98, (N. Mabbettsville Rd.) north of Shunpike	Washington
County Rte. 103, (Annandale Rd.)	Rhinebeck, Red Hook
Town Roads	
High Ridge Rd.	E. Fishkill
All Angels Hill	Wappinger
Bishop Dr.	LaGrange
Johnny Cake Hollow Rd.	Pine Plains
Prospect Hill Rd.	Pine Plains
Schultz Hill Rd.	Pine Plains
Charlie Hill Rd.	Northeast
Deer Run-Quarry Dr.	Northeast
Perrotti Rd.	Northeast

Note: This list contains a selection of roadside scenic vantage points. It is not comprehensive.

Table 8.4 Open Space Resources

Area	Municipality
Federally-owned	
Appalachian Trail corridor	East Fishkill, Beekman Pawling, Dover
Eleanor Roosevelt National Historic Site at Val-Kill	Hyde Park
Franklin D. Roosevelt National Historic Site	Hyde Park
Vanderbilt Mansion National Historic Site	Hyde Park
Nuclear Lake Property	Pawling, Beekman
State-owned	
Wassaic State Forest/Multiple Use Area	Amenia
Depot Hill State Forest/Multiple Use Area	Beekman
Hudson Highlands State Park	Fishkill
Stony Kill Farm and Environmental Education Center	Fishkill
Ogden Mills and Ruth Livingston Mills Memorial State Park & Dinsmore Golf Course	Hyde Park
James Baird State Park	LaGrange
Lafayetteville State Forest/Multiple Use Area	Milan
Roeliff Jansen Kill State Forest/Multiple Use Area	Milan
Taconic State Park	Northeast
Stissing Mt. State Forest/Multiple Use Area	Pine Plains, Stanford
Taconic - Hereford State Forest/Multiple Use Area	Pleasant Valley
Tivoli Bays (North and South)	Red Hook
Clermont State Park	Red Hook, Clermont
County-owned	
Fallkill Park	Hyde Park, Poughkeepsie
Wilcox Park	Milan
Bowdoin Park	Poughkeepsie
Other-Mostly Private	
Bog Hollow	Amenia
Rattlesnake Mountain	Amenia
Turkey Hollow	Amenia
Swift Pond	Amenia
Depot Hill	Beekman
Sylvan Lake	Beekman
Mud Pond	Clinton
Silver Lake	Clinton
West Mountain	Dover
East Mountain	Dover, Unionvale
Hosner Mountain	E. Fishkill
Shenandoah Mountain	E. Fishkill

Table 8.4 Open Space Resources Cont'd.

Area	Municipality
Mostly Private, cont'd.	
Black Pond	E. Fishkill
Bald Hill	Fishkill
Honness Mountain	Fishkill
Mount Beacon	Fishkill
Sharpe Reservation	Fishkill
Sugarloaf Mountain	Fishkill
Doty Hill and Briggs Mountain	Milan
Old Round Top	Milan
Silver Mountain	Northeast
Taconic Highlands (Brace Mountain, Mt. Riga)	Northeast
Panhandle Swamp	Northeast
Millerton Wetland	Northeast
Indian Lake	Northeast
Great Swamp	Pawling
Whaley Lake	Pawling
Hammersly Ridge	Pawling
Pawling Nature Reserve	Pawling
Pawling Mountain	Pawling
Hicks Hill	Pine Plains
Thompson Pond	Pine Plains
Stissing Mountain	Pine Plains
Great Spring Swamp	Pleasant Valley
Vassar College Farm	Poughkeepsie
Turkey Hill	Red Hook
Snyder Swamp	Rhinebeck
Vandenburgh Cove	Rhinebeck
Clove Mountain	Unionvale
Greenfly Swamp	Wappinger, Fishkill
Wappinger Lake	Wappingers Falls
Cannoo Hills	Washington
Cary Arboretum	Washington
Plymouth Hill	Washington
Bontecou Lake	Washington, Stanford

Note: The federal, state, and county properties listed are considered permanent open spaces. Those listed as "other resources" are, for the most part, owned by private citizens or organizations. Only a few of them are permanently preserved. See Significant Areas list, Table 8.1, and Table 4.2 for additional open space resources. Many lakes and ponds, agricultural lands, stream corridors, wetland complexes, parks, institutional facilities, and other private and public land holdings throughout Dutchess County provide significant open space benefits.

Scenic Roads

The Heritage Task Force for the Hudson River Valley has recommended that a list of roads in western Dutchess County, and others throughout the Hudson Valley, be designated scenic roads by the State Department of Environmental Conservation (DEC) under the state Scenic Roads Law of 1981. Such designation would support local and regional efforts to preserve the visual, historic, and natural values of these scenic corridors, and to promote public recognition of the benefits these scenic resources provide.

The list of Dutchess County roads recommended for state designation appears in Table 8.5. It is the product of a study conducted for DEC by the Heritage Task Force, in conjunction with the Dutchess County Department of Planning and Scenic Hudson, Inc. Similar studies have been conducted in several other Hudson Valley counties.

The roads recommended for scenic road designation fall into three classes: A, B, and C. Roads nominated for class A designation are those with the highest scenic quality rating. Class B road corridors possess distinct scenic qualities and historic, cultural, and recreational amenities, but are not as significant as class A corridors. The quantities of positive and negative visual elements within a class B corridor may equal one another. Class C scenic roads primarily function as transitions or links between class A and B roads, and are of less scenic significance than either A or B. Class C corridors may, however, contain important historic, cultural, and recreational amenities.

Suggested policies and maintenance guidelines for preserving and enhancing the scenic qualities of class A, B, and C scenic roads are given in Volumes I and II of the Heritage Task Force report, entitled The Hudson Valley Scenic Roads Program, published in 1983.

Table 8.5 Roads Nominated for Scenic Road Designation
Dutchess County, New York

Roadway Section	Municipality
Class A Road Corridors	
Bear Mountain-Beacon Highway, NY Route 9D	Fishkill
Roads within the "Mid-Hudson Historic Shorelands Scenic District"	
NY Rte. 9 - Co. Rte. 41 to South Mill Rd.	Hyde Park, Rhinebeck
Old Post Rd.	Hyde Park
South Mill Rd. - NY Rte. 9 to Morton Rd.	Rhinebeck
Morton Rd. - South Mill Rd. to Rhinecliff Rd.	Rhinebeck
Rhinecliff Rd. - Morton Rd. to River Rd.	Rhinebeck
River Rd/Annandale Rd.- Morton Rd. to NY Rte. 9G	Rhinebeck, Red Hook
NY Rte. 9 - South Mill Rd to Old Post Rd.	Rhinebeck
Astor Dr. - River Rd. to Old Post Rd.	Rhinebeck
Mt. Rutsen Rd. - River Rd. to Old Post Rd.	Rhinebeck
Hook Rd. - River Rd. to Old Post Rd.	Rhinebeck
NY Rte. 9G - Old Post Rd. to Columbia Co. Line	Rhinebeck, Red Hook
Kidd Lane - NY Rte. 9G to Tivoli Landing Rd.	Red Hook
Woods Rd. - Tivoli Landing Rd. to Columbia Co. Line	Red Hook
Santage Rd. - Woods Rd. to Stony Brook St.	Red Hook
Stony Brook St. - Santage Rd. to NY Rte. 9G	Red Hook
Tivoli Landing Rd. - Kidd Ln. to Woods Rd.	Red Hook
NY Rte. 199 NY Rte. - 9G to Ulster Co. Line	Red Hook
Barrytown & Station Roads - River Rd. to Hamlet of Barrytown Rd.	Red Hook
Co. Rte. 78 - NY Rte. 9G to Tivoli Landing	Red Hook
Kelly Rd. - Whalesback Rd. to River Rd.	Red Hook
Newburgh-Beacon Bridge	C. Beacon
Mid-Hudson Bridge	C. Poughkeepsie
Kingston-Rhinecliff Bridge	Rhinebeck
Class B Road Corridors	
NY Rte. 9D - City of Beacon Line to NY Rte. 9	Fishkill, Wappinger, Wappingers Falls
NY Rte. 9 - Hyde Park/Poughkeepsie Town line to Co. Rte. 41	Hyde Park
Pitcher Lane	Red Hook
Rockefeller Lane	Red Hook
Whalesback Lane	Red Hook
Co. Rte. 78	Red Hook
Co. Rte. 79	Red Hook
Co. Rte. 80	Red Hook
Class C Road Corridors	
NY Rte. 9D	C. Beacon
NY Rte. 9 - southern C. Poughkeepsie line to Hyde Park line	C. Poughkeepsie, T. Poughkeepsie

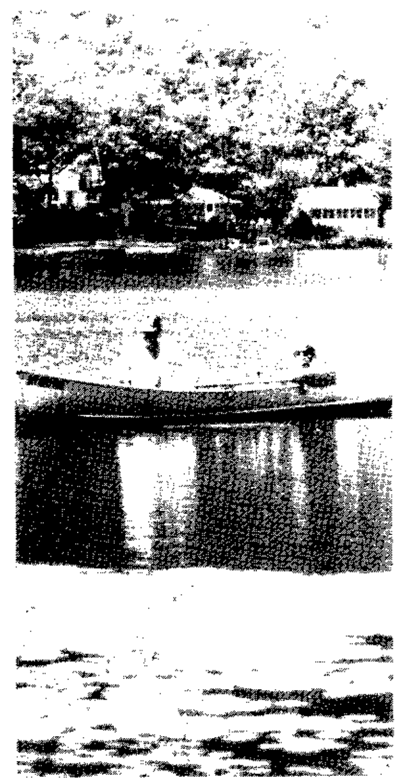
Source: The Heritage Task Force for the Hudson River Valley, The Hudson Valley Scenic Roads Program, 1983

As shown in Table 8.5, many of the Dutchess County roads recommended for scenic roads designation are within the Mid-Hudson Historic Shorelands Scenic District. This district is a 25-mile long area on the east shore of the Hudson River. It extends from just south of West Market and Dock Streets in Hyde Park, to just north of the Germantown Landing Road on Route 9G in Columbia County. The eastern boundary runs parallel to Route 9G from this crossroad south to Weys Corners; from there it follows Route 9 south to West Market Street in Hyde Park. The centerline of the Hudson River forms the western boundary of the district.

The Mid-Hudson Historic Shorelands Scenic District is the first scenic district designated under Article 49 of the Environmental Conservation Law. It encompasses close to 40 riverfront estates, extensive public parklands, farms, hundreds of structures of historic significance, and numerous streams, ravines, bluffs, wetlands, and other important natural features. A variety of techniques and recommendations for preserving the unique benefits that these cultural and natural features provide are set forth in the Mid-Hudson Historic Shorelands Scenic District Management Plan, which was prepared for DEC by the Hudson River Shorelands Task Force in 1983. Suggested protection measures include revisions to local zoning regulations and roadway management practices, local promotional efforts designed to enhance public awareness of what the district can offer both residents and tourists, methods for encouraging increased implementation of local waterfront revitalization programs and access to the Hudson River, and other techniques for enchancing community identity, design, and enjoyment.

Resource Management Implications

Dutchess County's population has doubled in the past 35 years, and is still growing. It is expected to reach 320,000 by the year 2000. To accomodate this growth, open land is being converted to roads, homesites, industrial centers, government facilities, and commercial uses at the rate of 1,800 acres per year. This rate of development is exerting increasing pressure on many of the county's scenic resources and significant natural areas, pressures that could destroy or degrade their environmental quality. To protect the county's natural heritage, the benefits that these resources provide must be recognized and preserved.



Significant Natural Areas

The significant natural areas inventoried by the Dutchess County Environmental Management Council deserve special consideration by state and local governments and landowners. Many of these areas are unique and irreplaceable elements of the county's landscape.

In some cases, significant areas can tolerate the increased public use that could result from promotional efforts. Several significant areas, however, particularly those which support endangered or threatened species, could be severely damaged by increased use. Greater use inevitably brings changes and disturbances that can drive sensitive species away or destroy their habitat. It may, therefore, be counterproductive to draw attention to the most unusual and sensitive features of significant areas. Concerned citizens and landowners should instead be en-couraged to explore more subtle means of ensuring that the natural values of these areas are appropriately recognized and preserved.

Most of the significant natural areas listed in Table 8.1 are privately owned. Access to them is, in most cases, restricted. Nevertheless, everyone benefits from the role these areas play in maintaining environ-mental diversity and from the scenic qualities they offer, even from a distance. Increased public access to privately-owned significant areas should be encouraged only when the landowner is clearly willing to assume the responsibility that such public use entails, and when public access will not threaten the significant natural features of the site.

Many publicly-owned significant natural areas also contain fragile natural communities that can be damaged by overuse. A balance must be achieved between promoting public recognition and enjoyment of these areas and protecting their environmental quality.

Scenic Resources

Dutchess County's scenic resources contribute greatly to the quality of the visual environment, as well as to the tourism industry that plays a growing role in the county economy. Views of rural valleys, the Hudson River, and the mountains to the south, east, and west enhance the beauty and diversity of the landscape. The variety of these vistas adds to the enjoyment of residents and visitors, and defines the physical self-image of communities throughout the county. Smaller-scale scenic resources, such as tree-lined roads, waterfalls, streams, wetlands, lakes, farm lands, historic hamlets and structures, well-landscaped grounds, and parks also contribute to community identity and enjoyment.

The visual impacts of development have immediate and profound effects on the quality of life. Despite these effects, however, decision makers are often reluctant to make judgements on aesthetic issues. As a result, unnecessary damage to scenic resources is frequently permitted or overlooked, causing the entire visual character of a community or area to deteriorate over time.

To reverse this tendency, strong community support is needed for preserving scenic resources and enhancing the visual environment through careful and comprehensive land use management. Every effort should be made to increase public awareness of the environmental and cultural significance of scenic resources, and of the means that can be used to protect them.

Open Space Preservation

Dutchess County's open space resources support diverse vegetation and wildlife communities, agricultural activities, outdoor recreation, and forest uses, and help store and replenish critical surface and groundwater supplies. They give much of Dutchess County its beauty and rural character. In urban and suburban communities, open spaces such as stream corridors and parks also help define community and neighborhood boundaries, serve as common meeting places and buffers between land uses, and offer relief from congestion and noise.

The supply of open space is diminishing as the county population grows and more and more land is developed. Numerous open spaces with valuable scenic, natural, or agricultural qualities have been converted to residential, commercial, or industrial uses. In many cases these uses would have been more appropriately located on less sensitive sites, or could have been better designed to protect more natural features of the land.

Several mechanisms for preserving open space should be examined by local and county governments, concerned citizens, and interest groups. Among them are the following:

- conservation easements which, through deed restrictions, remove or limit the development potential of portions of property that have the greatest scenic or agricultural values or environmental sensitivity;

- transfer of development rights, whereby an owner of land in a designated open space district can transfer the right to develop that land to a parcel in another district where permitted by local law;

- agriculture preservation methods, such as agricultural zoning agricultural districting, and farmland assessments;

- land trusts, involving organizations that acquire and hold land for permanent preservation or release it with easements to ensure that it will be developed within site-specific management guidelines;

- floodplain, wetland, and aquifer protection regulations that prohibit the inappropriate use of critical natural areas;

- cluster development techniques, which concentrate building on specific portions of a property so that the remaining land is left undisturbed or used as recreation space;

- imaginative site designs that recognize how developments will benefit from the protection of natural amenities.

All of these techniques and others should be reviewed carefully for their potential contributions to conserving the best open space in Dutchess County.

Scenic Roads

Considerable effort has gone into evaluating the scenic qualities of roads within the Mid-Hudson Historic Shorelands Scenic District. Roads farther south in the county that offer views of the Hudson River, or which serve as important links between scenic areas, have also been evaluated. The Heritage Task Force for the Hudson River Valley has recommended that these roads be designated scenic roads by the NYS Department of Environmental Conservation, and has developed extensive recommendations concerning how the scenic qualities of these roads corridors can be maintained by local governments and landowners. The use of land use control techniques, road maintenance quidelines, and public education programs that help implement the Task Force recommendations should be encouraged.

All of the roads evaluated by the Heritage Task Force are visually tied to the Hudson River. Elsewhere in Dutchess County are many road corridors equally deserving of recognition, which visually relate to the Harlem Valley, the Catskills, the Hudson Highlands, the rolling terrain of the county's agricultural lands, or other landscape features. Local efforts to inventory and preserve these scenic amenities can help maintain a balanced appreciation of the beauty the entire county has to offer.

Appendix

A.1: Mean Temperature and Total Precipitation

Dutchess County, New York

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean Temperature (Degrees Fahrenheit):[1]													
Glenham	26.2	28.1	37.6	49.6	60.2	69.3	74.1	72.4	65.0	53.7	42.9	30.9	50.8
Millbrook	23.2	25.5	34.5	46.5	56.8	65.2	69.7	68.2	60.9	50.7	39.9	27.9	47.4
Poughkeepsie	26.2	28.7	37.4	50.5	60.6	69.8	74.7	72.5	65.3	54.8	43.4	30.7	51.2
Poughkeepsie FAA AP	24.4	26.8	36.2	48.0	58.3	67.5	72.4	70.6	62.7	51.5	40.9	29.3	49.1
Total Precipitation (Inches):[1]													
Glenham	3.24	2.87	3.58	3.70	3.49	3.77	3.84	4.12	3.93	3.40	3.69	3.78	43.41
Millbrook	2.79	2.40	3.23	3.50	3.38	3.69	3.65	3.95	3.71	3.36	3.43	3.51	40.60
Poughkeepsie	2.55	2.65	2.94	3.59	3.00	2.95	3.31	3.81	3.46	3.00	3.47	3.29	38.02
Poughkeepsie FAA AP	2.75	2.42	3.28	3.66	3.62	3.43	3.50	3.77	3.66	3.30	3.57	3.20	40.16
Millerton[2]	2.88	2.83	3.74	4.63	2.81	2.98	3.71	4.62	4.32	3.95	3.34	3.01	42.82

Source: U.S. Department of Commerce, NOAA

Notes: 1. Mean temperature and total precipitation for every station except Pougkeepsie are based on the period 1951-1980. Data for the Poughkeepsie station are from the 1951-1970 period. Millbrook figures are partially estimated.

2. Millerton Station equipped with recording rain gages only, 1951-1960, and figures are partially estimated.

A.2: Weather Station Locations

Dutchess County, New York

Station	Latitude	Longitude	Elevation Above sea level
Glenham	41° 31'	73° 56'	275
Millbrook	41° 51'	73° 37'	815
Millerton (2 stations)	41° 57'	73° 31'	690,720
Poughkeepsie	41° 41'	73° 56'	103
Poughkeepsie FAA AP	41° 38'	73° 53'	154

Notes: The U.S. Department of Commerce, Weather Bureau, maintains or has maintained meteorological stations at Glenham (near Beacon), Millbrook, Poughkeepsie, and the Dutchess County Airport (Poughkeepsie FAA AP). Millerton has had a station equipped with rain gages only. These stations are indexed above.

A.3: Growing Degree Days

Poughkeepsie, New York

	Climatological Week Number	40° Base Mean	40° Base S.D.*	50° Base Mean	50° Base S.D.*
Mar. 1-7	1	5	7	0	0
	2	7	10	1	2
	3	15	24	2	8
	4	31	29	6	11
	5	38	30	9	15
	6	47	27	10	13
	7	59	40	18	25
	8	89	42	34	30
	9	103	33	41	28
May 10-16	11	132	28	63	27
	12	153	29	83	28
	13	163	32	93	31
	14	186	29	116	29
	15	194	24	124	24
	16	206	31	136	31
	17	222	27	152	27
	18	233	23	163	23
	19	237	24	167	24
July 19-25	21	243	22	173	22
	22	249	18	179	18
	23	235	26	165	26
	24	233	24	163	24
	25	223	22	153	22
	26	209	29	139	29
	27	212	31	142	31
	28	191	30	121	30
	29	173	28	103	28
Sept. 27-Oct. 3	31	127	26	59	24
	32	123	31	57	28
	33	108	35	46	30
	34	91	33	32	23
	35	67	33	19	20
	36	59	33	16	17
	37	36	25	7	9
	38	36	31	7	11
	39	17	21	3	6
Dec. 6-12	41	7	11	0	1
	42	2	3	0	0
	43	4	9	0	2
	44	3	6	0	1
	45	4	9	1	2
	46	2	7	0	1
	47	1	3	0	0
	48	2	4	0	1
	49	1	2	0	0
	50	1	1	0	0
	51	3	6	0	1
Feb. 21-27	52	5	12	1	3

Source: Cornell University Agricultural Experiment Station.
*S.D.: is the range of deviation from mean.

A.4: Average Wind Speeds (Knots[1])

Direction	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Avgs.
N	5.9	6.1	6.7	7.1	5.1	5.7	4.2	4.7	6.1	5.0	4.7	7.0	5.8
NNE	7.6	6.3	7.8	8.1	6.8	5.9	5.6	5.5	6.1	7.3	6.9	7.3	6.9
NE	4.0	4.2	5.8	4.8	4.6	4.3	3.6	4.1	3.8	5.5	5.1	5.8	4.7
ENE	3.1	4.4	5.3	4.1	3.7	3.7	3.6	3.4	3.0	4.4	4.9	3.5	4.0
E	2.5	3.0	3.4	3.8	3.8	3.2	3.0	3.0	2.3	3.4	6.1	4.2	3.5
ESE	3.4	3.7	6.8	5.8	4.8	3.9	3.6	3.8	3.1	3.7	6.1	6.0	4.6
SE	3.7	3.5	6.9	5.1	4.8	3.9	4.4	3.6	4.0	3.9	4.3	3.8	4.4
SSE	6.0	6.1	7.9	7.8	6.0	5.9	5.2	5.6	6.2	5.7	6.3	6.6	6.3
S	4.5	6.1	6.9	7.0	6.3	6.6	5.2	5.3	6.2	5.1	6.0	5.4	5.9
SSW	6.3	6.9	7.2	8.1	7.0	7.3	6.6	6.5	6.3	6.9	8.3	7.3	7.1
SW	5.5	6.2	7.1	7.3	6.7	7.3	6.2	6.2	6.3	7.3	7.3	7.5	6.8
WSW	8.8	8.5	9.8	10.4	8.8	8.0	7.4	7.1	7.3	7.8	9.8	10.0	8.9
W	8.3	7.8	9.5	9.2	6.1	6.6	4.7	5.7	7.2	7.0	6.5	9.2	7.6
WNW	10.7	11.8	12.0	10.6	9.0	9.1	7.6	7.0	8.0	8.0	10.4	11.3	10.3
NW	6.2	8.1	9.7	8.8	6.9	6.8	5.9	3.8	7.1	5.3	6.1	7.2	7.1
NNW	7.4	10.4	9.4	9.2	8.6	7.1	6.7	5.4	6.0	8.2	8.1	7.1	8.0
AVG.	5.9	6.5	7.4	7.1	5.3	5.3	4.4	3.9	4.4	4.7	5.3	6.4	5.5

Source: U.S. Department of Commerce, NOAA. Based on 8 observations per day, 1950-1954, at Station #14757, Poughkeepsie, N.Y.

Note: 1. 1 knot = 1.15078 miles per hour.

A.5: Wind Direction Frequencies

Percent of Total Observations

Direction	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Avgs.
N	7.4	6.3	5.7	4.0	4.1	3.4	3.3	3.7	4.6	4.5	3.2	5.8	4.7
NNE	14.6	10.4	11.7	13.0	10.8	8.6	6.2	9.2	8.5	11.2	8.7	9.2	10.2
NE	1.8	2.9	2.6	4.0	3.9	2.6	1.8	2.6	2.5	3.4	2.7	2.7	2.8
ENE	2.4	3.0	3.6	2.3	3.6	3.2	2.9	3.3	2.3	2.4	2.4	1.6	2.8
E	2.4	2.4	1.5	1.5	2.8	1.3	1.7	1.7	1.7	2.2	2.4	1.1	1.9
ESE	3.4	2.9	4.2	4.9	6.9	5.2	4.6	4.5	4.8	5.3	4.5	3.1	4.5
SE	2.0	1.6	2.7	3.0	3.0	2.9	3.4	3.7	2.8	2.4	2.7	1.9	2.7
SSE	7.7	6.0	7.7	10.6	9.5	10.0	10.6	7.5	9.8	8.5	7.0	6.9	8.5
S	3.5	4.2	3.3	5.7	4.0	6.2	6.3	8.1	5.8	3.3	3.2	4.1	4.8
SSW	9.1	6.3	6.4	9.5	7.3	11.7	11.3	9.1	10.0	7.8	9.6	9.7	9.0
SW	4.6	5.3	4.2	5.0	3.6	5.4	5.9	4.1	4.3	4.7	5.3	8.5	5.1
WSW	7.4	7.1	6.3	8.6	5.6	5.4	6.9	4.0	4.8	6.0	7.9	12.1	6.9
W	3.1	3.8	3.6	2.1	1.9	1.4	1.7	1.6	2.3	1.5	3.3	3.2	2.5
WNW	6.5	11.1	11.5	5.4	4.0	5.4	4.1	2.6	3.1	3.4	3.5	6.2	5.6
NW	3.2	5.5	3.8	2.1	3.5	1.9	2.4	1.6	2.1	1.9	2.8	3.2	2.8
NNW	9.8	9.2	9.9	8.8	8.0	8.1	4.7	5.0	5.4	6.7	5.2	5.4	7.2
CALMS	11.0	12.1	11.3	9.6	17.7	17.1	22.0	27.5	25.2	24.8	25.6	15.5	18.3

Source: U.S. Department of Commerce, NOAA. Based on 8 observations per day, 1950-1954, at Station #14757, Poughkeepsie, N.Y.

A.6: Annual Precipitation 1931 - 1980

Poughkeepsie, New York

	Inches				
1931	39.9	48	39.9	1965	27.7
32	45.9	49	33.9	66	31.0
33	43.9	1950	35.7	67	43.0
34	47.1	51	42.4	68	36.7
1935	32.0	52	46.0	69	41.5
36	45.1	53	45.3	1970	34.4
37	44.1	54	38.3	71	46.1
38	47.9	1955	44.7	72	54.8
39	30.5	56	36.3	73	44.4
1940	39.7	57	28.7	74	44.0
41	27.2	58	42.1	1975	55.2
42	40.7	59	39.9	76	42.3
43	40.1	1960	37.9	77	49.4
44	35.0	61	36.7	78	35.4
1945	60.3	62	31.6	79	45.4
46	31.3	63	31.2	1980	31.8
47	42.6	64	24.5		

Source: U.S. Department of Commerce, NOAA.
1931 to 1959 Data collected in Poughkeepsie.
1960 to 1980 Data collected at Dutchess County Airport.
1977 and 1978 Data collected in Millbrook.

A.7: Climatological Summary

Means and Extremes for Period 1951 - 1970

Poughkeepsie, New York

LATITUDE N41 41
LONGITUDE W73 56

ELEVATION 103

TEMPERATURE (°F)

MONTH	MEANS			EXTREMES						MEAN NUMBER OF DAYS			
										MAX.		MIN.	
	DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90° AND ABOVE	32° AND BELOW	32° AND BELOW	0° AND BELOW
JAN	35.5	16.8	26.2	66	67	24	-15+	61	22	0	11	29	2
FEB	38.6	18.7	28.7	70	53	22	-15+	61	2	0	7	26	2
MAR	47.6	27.2	37.4	80	62	30	-3	67	19	0	1	24	0
APR	62.2	38.8	50.5	94	69	28	17	65	1	0	0	7	0
MAY	73.1	48.0	60.6	102	62	19	25	70	7	1	0	0	0
JUN	82.2	57.4	69.8	102+	64	30	40	64	3	7	0	0	0
JULY	86.8	62.6	74.7	107	66	3	42	63	9	12	0	0	0
AUG	84.6	60.4	72.5	101	54	1	44+	65	31	8	0	0	0
SEPT	77.0	53.5	65.3	103	53	3	29+	63	24	3	0	0	0
OCT	66.4	43.2	54.8	91	59	5	24+	66	31	0	0	3	0
NOV	53.0	33.7	43.4	75+	64	13	14+	58	30	0	0	15	0
DEC	39.3	22.1	30.7	70	70	2	-10+	69	25	0	7	27	1
YEAR	62.2	40.2	51.2	107	66	JUL 3	-15+	61	FEB 2	31	26	131	5

PRECIPITATION TOTALS (INCHES)

MONTH	MEAN	GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW, SLEET						MEAN NUMBER OF DAYS		
							MEAN	MAXIMUM MONTHLY	YEAR	GREATEST DEPTH	YEAR	DAY	.10 or MORE	.50 or MORE	1.00 or MORE
JAN	2.55	5.25	53	1.83	62	6	10.0	39.8	61	36.0	61	22	6	2	D
FEB	2.65	4.66	62	1.93	51	1	11.2	29.0	62	16.0	61	4	6	2	1
MAR	2.94	7.11	53	1.53	51	31	8.5	31.5	67	18.0	63	1	7	2	1
APR	3.59	7.57	52	2.49	52	5	.8	6.0	57	4.0	56	9	7	3	1
MAY	3.00	6.64	68	2.70	68	29	.0						7	2	0
JUN	2.95	6.72	68	2.12	53	27	.0						6	2	1
JULY	3.31	8.68	69	2.75	69	27	.0						6	2	1
AUG	3.81	11.50	55	5.50	55	19	.0						6	3	1
SEPT	3.46	6.85	60	3.51	66	21	.0						5	2	1
OCT	3.00	9.99	55	4.74	55	16	.1	2.0	58				5	2	1
NOV	3.47	6.22	54	2.17	54	3	1.4	7.0	68	6.0	68	12	7	3	0
DEC	3.29	5.68	69	2.04	52	12	10.4	31.0	69	26.0	69	27	6	2	1
YEAR	38.02	11.50	AUG 55	5.50	AUG 55	19	42.4	39.8	JAN 61	36.0	JAN 61	22	74	27	9

+ ALSO ON EARLIER DATES

Source: U. S. Department of Commerce, NOAA

A.8: Major Conventional Air Pollutants

Pollutant	*Sources*	*Health Effects*	*Other Effects*
OZONE and other photochemical oxidants	Secondary reaction products originating largely from motor vehicle use, the chemical industry, fossil fuel combustion byproducts.	Irritates eyes, lungs, nose and throat: causes difficulty breathing.	Toxic to plants, primarily affects leaves. Can weaken materials such as rubber and fabrics.
TOTAL SUSPENDED PARTICULATES	Industrial processes, incinerators, fossil fuel burning plants, especially coal burners: automobile exhaust road and building construction.	Disrupts the lungs normal cleansing mechanism. Additionally the particles can contain or carry materials that exhibit direct toxic effects on living organisms.	Causes haze which reduces visibility and the amount of solar energy reaching the earth. Particles also cause scaling of materials, are corrosive, and can damage buildings.
CARBON MONOXIDE	Internal combustion engines, fossil fuel combustion, and cigarette smoking.	Combines with hemoglobin to reduce the oxygen carrying capacity of the blood which may cause heart and brain damage. At low levels, carbon monoxide causes dizziness, fatigue, headaches and slowed physical reactions.	
SULFUR DIOXIDE	Installations burning fossil fuel such as electric power plants, home heating, industrial processes.	Impairment of breathing and irritation of eyes, throat and lungs.	Corrosion and deterioration of iron, steel, copper, nickel, aluminum and building materials, brittleness in paper, loss of strength of leather, deterioration of natural and synthetic fibers; corrosion of limestone and concrete structures
NITROGEN DIOXIDE	Emitted in approximately equal quantities from motor vehicles and from fossil fuel burning operations, most notably power plants, also from chemical plants and refineries.	Increased respiratory infections in children (particularly bronchitis); inhibition of cilia action and damage to the lung tissue.	Corrosion of metal surfaces, deterioration of rubber, fabrics and dyes; serious injury to vegetation including bleaching and death of plant tissue, loss of leaves and reduced growth; highly toxic to animals; instrumental in smog formation.
LEAD	Gasoline (leaded) vehicles emissions, fuel oil combustion. Manufacturing of batteries, paint, insecticides, etc.	Neurological impairment, brain damage, loss of appetite, loss of alimentory and other systemic functions	

Source: NYS Department of Environmental Conservation. 1981
A Challenge for the 80s. p. 28.

A.9: Geological Activity and Formations

Dutchess County, New York

ERA Duration Outstanding Biological Events	COUNTY ACTIVITY	GEOLOGIC FORMATIONS
PRECAMBRIAN 600 or more million years ago Primitive life begins	In ancient Precambrian times, almost 1300 million years ago (mya), sediments were eroded from older rocks to the north in the Canadian Shield Area. These sediments were subsequently transported and deposited by an ancient drainage system. During the Grenville Orogeny (1100-980 mya), these sediments were subjected to great heat and pressure and underwent deformation, metamorphism, and recrystallization. This event was also accompanied by rock folding and the intrusion of extensive masses of granite. The sediments were metamorphosed to gneiss and the Hudson Highlands came into being. Following the granitic intrusion, a long period of erosion occurred which reduced the area to a low plain. The rifting of a single crystal or tectonic plate during the end of this era and the beginning of the next era brought about the opening of the Proto-Atlantic Ocean.	Isolated uprooted blocks of gneiss Hudson Highlands gneisses
PALEOZOIC 225-600 million years ago Age of invertebrate dominance, rise of fishes, land plants, land vertebrates, large non-flowering plants, reptiles. Appearance of Coniferous trees	The ocean advanced over the county once again during the first period of the era (Cambrian) resulting in sediment deposition on the eastern edge of a broad continental shelf. When the sea returned, the first deposits were usually lime muds which today exist as a thin bed called the Balmville limestone. Other initial deposits were clean quartz sand (Poughquag Quartzite) and younger carbonates (Wappinger Group). Equivalent deposits on the continental slope of the basin were the Germantown (Early Cambrian through Early Ordovician periods), and in the oceanic basin the upper Nassau (Cambrian) and Stuyvesant Falls (Early Ordovician). Fracturing by faults, uplift accompanied by some folding, and subaerial erosion represented the change from an expanding to a contracting ocean at the close of the Canadian Epoch.	Poughquag Quartzite Wappinger Group: Stissing Dolostone Pine Plains Dolostone Briarcliff Dolostone Halcyon Lake-Calc-Dolostone Rochdale Limestone Copake Limstone The formations listed below occurred at about the same time as the Poughquag Quartzite and Wappinger Group: Everett schist, quartzite (east of Beacon-Stissing Mt. fault) Elizaville argillite, quartzite west of Beacon-Stissing Mt. fault)

ERA Duration Outstanding Biological Events	COUNTY ACTIVITY	GEOLOGIC FORMATIONS
PALEOZOIC (cont.)	These dramatic changes resulted in the widespread unconformity above rocks of the Canadian age, and was one of the most significant changes, faunally, sedimentologically, and structurally, on the face of the earth. Additional compressional stresses, which brought about the closure of the ocean, produced welts and troughs to the east. The resultant differences in relief caused a westward movement of previously-formed slope and basin rocks by underwater gravity sliding towards what is now the Hudson Valley. Part of the Snake Hill shales found today is a melange of blocks torn from the ripped-up sole rocks during one of those gravity slides. These processes were part of the mountain-making episode known as the Taconic Orogeny. Two principal gravity slides occurred in Dutchess: Livingston Slide (Austin Glen and Mount Merino Shade) and Van Buren Slide (Austin Glen, Mount Merino, Indian River, Stuyvesant Falls, Germantown, and Nassau formations). Intensified folding and thrust faulting took place with the emplacement of Gallatin (Elizaville argillite) and Clove (Everett Schist) thrust slices, with carbonate slivers along the thrust. Regional metamorphism and cleavage formation accompanied the faulting, and the Taconic Orogeny came to an end during the late Ordovician and early Silurian Periods. The area was subjected to another long period of erosion following the Taconic Orogeny. During the Devonian Period, stresses again set in and the rocks underwent tight folding, thrusting, high angle reverse faulting and metamorphism. The Acadian Orogeny ended at the beginning of the late Devonian time, and the merging of the tectonic plates and the closure of the Proto-Atlantic Ocean were finished. At the close of the Paleozoic Era, the rocks were again folded and raised in the course of the Appalachian Revolution. Consolidated rocks were displaced and fractured along joints and thrust faults due to a series of large-scale crustal movements. Faults are fairly abundant in the southern part of the county and, in many places, control the extent of bedrock formations.	Nassau shale, quartzite Germantown shale, limestone, conglomerate Stuyvesant Falls shale, quartzite, chert Mount Merino and Indian River shale and cherts (lies on top of Stuyvesant Falls) Austin Glen graywacke and shale Snake Hill shale with included areas of Poughkeepsie melange Snake Hill Shale and Walloomsac Slate (east of Stissing Mountain Fault)

A.9 (cont'd)

ERA Duration Outstanding Biological Events	COUNTY ACTIVITY	GEOLOGIC FORMATIONS
MESOZOIC 70-225 million years ago First dinosaurs and primitive mammals, birds, flowering plants, deciduous trees and grasses. Extinction of dinosaurs and climax of reptiles on land, air, and sea	Erosion of mountains to lowlands. About 200 million years ago, the major opening of the Atlantic Ocean began.	
CENOZOIC Last 70 million years First placental mammals, apes, primitive horses and other ungulates, abundance of flowering plants, grains, grasses, and cereals, advent of human beings	The land was re-elevated and eroded again. During Pleistocene times, at the end of the Era, continental glaciers repeatedly advanced across the county in a southerly direction with localized, topographically-induced variations to the southwest and southeast. The highest peaks of the Taconic and Hudson Highlands were probably covered with ice. The glaciers laid down unconsolidated deposits consisting chiefly of clay materials and boulders (glacial till). After the melting and withdrawal of the ice, gravel, sand and silt were deposited in the stream valleys. These latter deposits sometimes blocked preglacial channels, causing the formation of lakes and wetlands in which silt, clay, peat, and other fine-grained materials were laid down. Relieved of its heavy ice burden, the land was partially reelevated an average of 2-1/4 feet per mile northward. Subsequently, rejuvenated streams became the erosion agents of glacial debris and exposed bedrock. Some deposition is presently occurring in lakes and swamps and on floodplains of larger watercourses. Lake deposition is more or less continuous while swamp and floodplain deposition primarily takes place during flood periods. This ongoing process of erosion and sediment deposition largely involves thin layers of clay, silt, sand, and gravel.	Deposits of unconsolidated material: boulders, gravels, sands, silts, and clays

Sources: Simmons et.al. Groundwater Resources of Dutchess County, New York.

Johnsen, J.H.. ed. 1976. Field Guide Book: NYS Geological Association, 48th Annual Meeting.

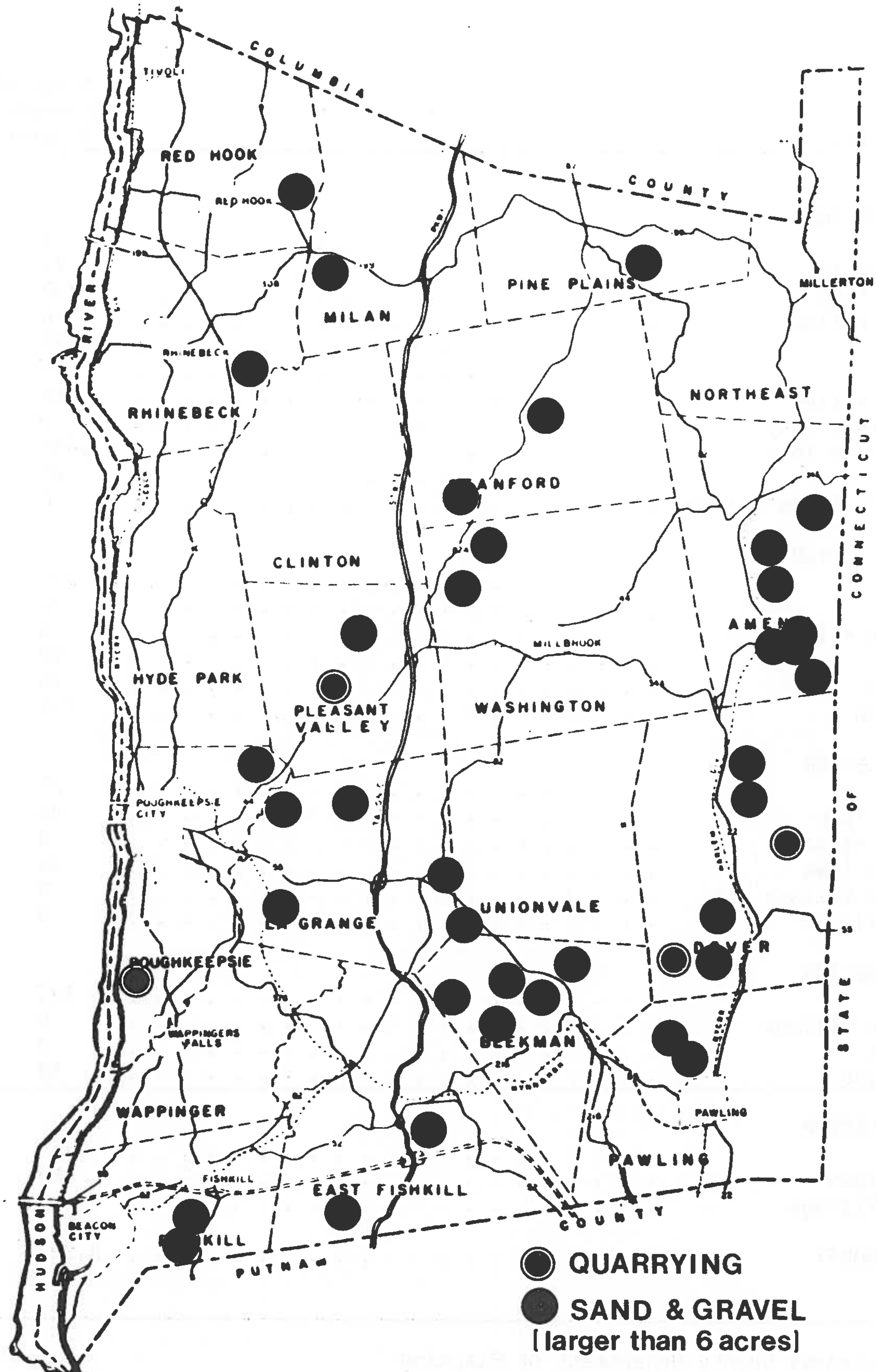
Rutstein, M.S. 1977. The Lithologies and Geologic Evolution of the Mid-Hudson Valley.

A.10: Mined Lands in Dutchess County, 1976

Sector Municipality	Acres of Extractive Industry
SOUTHWEST SECTOR	
Beacon City	0
East Fishkill	73
Fishkill Town	140
Fishkill Village	0
Hyde Park	13
LaGrange	54
Pleasant Valley	28
Poughkeepsie City	0
Poughkeepsie Town	1,013
Wappinger	22
Wappingers Falls Village	0
MID-COUNTY SECTOR	
Beekman	250
Clinton	33
Millbrook Village	0
Stanford	77
Unionvale	15
Washington	151
NORTHWEST SECTOR	
Milan	27
Red Hook Town	96
Red Hook Village	0
Rhinebeck Town	46
Rhinebeck Village	0
Tivoli Village	0
NORTHEAST SECTOR	
Amenia	195
Millerton Village	0
Northeast	0
Pine Plains	12
SOUTHEAST SECTOR	
Dover	353
Pawling Town	85
Pawling Village	0
DUTCHESS COUNTY	2,983

Source: Dutchess County Department of Planning

A.11: Soil Mining and Quarrying 1982



Source: Dutchess County Department of Planning

A.12: Named Streams in Dutchess County

Stream name	Drainage Basin	Location of mouth	
		Tributary to	County
Amenia Brook a/	Tenmile River	Wassaic Creek	Dutchess
Bard Rock Creek	Hudson River	Hudson River	do.
Bean River	do.	Shekomeko Creek	do.
Beaver Brook	Tenmile River	Mill River	do.
Black Pond Brook	Croton River	West Branch Croton	Putnam
Bog Hollow Brook	Housatonic River	b/	--
Brady Brook	Croton River	East Branch Croton River	Dutchess
Burton Brook	Tenmile River	Swamp River	do.
Butts Hollow Brook	do.	Tenmile River	do.
Casper Creek	Hudson River	Hudson River	do.
Clove Brook	Fishkill Creek	Fishkill Creek	do.
Clove Creek	do.	do.	do.
Cold Spring Creek	Wappinger Creek	Wappinger Creek	do.
Cold Spring Creek Tributary c/	do.	Cold Spring Creek	do.
Coopertown Brook	Tenmile River	Mill River	do.
Crum Elbow Creek	Husdon River	Hudson River	do.
Deuel Hollow Brook	Tenmile River	Tenmile River	do.
Doctors Brook	do.	Mill River	do.
Drake Brook c/	Wappinger Creek	Wappinger Creek	do.
Drake Brook Tributary c/	do.	Drake Brook	do.
Dry Brook	Fishkill Creek	Fishkill Creek	do.
East Branch Croton River	Croton River	Croton River	Westchester
East Branch Wappinger Creek	Wappinger Creek	Wappinger Creek	Dutchess
Fall Kill	Hudson River	Roeliff Jansen Kill	do.
do.	do.	Hudson River	do.
Fallsburg Creek	do.	do.	do.
Fishkill Creek	do.	do.	do.
Flat Rock Brook	Fishkill Creek	Frog Hollow Brook	do.
Frog Hollow Brook	do.	Fishkill Creek	do.
Gardner Hollow Brook	do.	Whaley Lake Stream	do.
Gordons Brook	Hudson River	Hudson River	do.
Great Spring Creek	Wappinger Creek	Wappinger Creek	do.
Green Mountain Lake Outlet c/	Tenmile River	Swamp River	do.
Ham Brook	Hudson River	Roeliff Jansen Kill	Columbia
Hiller Brook	Tenmile River	Swamp River	Dutchess
Horse Pond Brook	Croton River	West Branch Croton River	Putnam
Hudson River	Hudson River	Atlantic Ocean	
Hunns Lake Creek	Wappinger Creek	Wappinger Creek	Dutchess

A.12 (cont'd)

Stream name	Drainage Basin	Location of mouth	
		Tributary to	County
IBM Stream c/	Fishkill Creek	Fishkill Creek	do.
Indian Kill	Hudson River	Hudson River	do.
Indian Lake Creek	Tenmile River	Webatuck Creek	do.
Jackson Creek	Fishkill Creek	Sprout Creek	do.
Kelsey Brook	Tenmile River	Webatuck Creek	do.
Kidney Creek d/	Hudson River	Hudson River	do.
Landsman Kill	do.	do.	do.
Lakes Kill	do.	Saw Kill	do.
Leetown Brook	Croton River	West Branch Croton River	Putnam
Little Wappinger Creek	Wappinger Creek	Wappinger Creek	Dutchess
Maritje Kill	Hudson River	Hudson River	do.
Middle Branch Croton River	Croton River	West Branch Croton River	Putnam
Mill Brook	Tenmile River	Webatuck Creek	do.
do.	Wappinger Creek	East Branch Wappinger Creek	do.
Mill Brook School Creek c/	Tenmile River	Wassaic Creek	do.
Mill River	do.	Swamp River	do.
Mountain Brook	Wappinger Creek	Cold Spring Creek	do.
Mudder Kill	Hudson River	Hudson River	do.
North Staatsburg Creek	do.	do.	Dutchess
Noster Kill	do.	Bashbish Brook	Columbia
Punch Brook	Hudson River	Roeliff Jansen Kill	Columbia
Quaker Brook	do.	Haviland Hollow Brook	Putnam
Rhinebeck Kill	do.	Landsman Kill	Dutchess
Roeliff Jansen Kill	do.	Hudson River	Columbia
Saw Kill	do.	do.	Dutchess
Sawmill Brook	Tenmile River	Webatuck Creek	do.
do.	Housatonic River	Candlewood Lake	b/
Seeley Creek	Fishkill Creek	Clove Brook	Dutchess
Shaw Brook	Wappinger Creek	Mill Brook	do.
Shekomeko Creek	Hudson River	Roeliff Jansen Kill	Columbia
Shenandoah Brook c/	Fishkill Creek	Fishkill Creek	Dutchess
Sprout Creek	do.	do.	do.
Squirrel Hollow Brook	Hudson River	Gordons Brook	do.
Stone Church Brook	Tenmile River	Wells Brook	do.
Stony Brook	do.	Mill River	do.
Stony Creek	Hudson River	Hudson River	do.

A.12 (cont'd)

Stream name	Drainage Basin	Location of mouth	
		Tributary to	County
Stump Pond Stream	Croton River	Middle Branch Croton River	Putnam
Swamp River	Tenmile River	Tenmile River	Dutchess
Sweezy Creek	Fishkill Creek	Fishkill Creek	do.
Tenmile River	Housatonic River	Housatonic River	b/
Thayer Brook	do.	do.	b/
Wades Brook	Hudson River	Hudson River	Dutchess
Wappinger Creek	do.	do.	do.
Wassaic Creek	Tenmile River	Tenmile River	do.
Webatuck Creek	do.	do.	do.
Weir Brook c/	do.	Swamp River	do.
Wells Brook	do.	Tenmile River	do.
Whaley Lake Stream	Fishkill Creek	Fishkill Creek	do.
Whaley Lake Stream Tributary c/	do.	Whaley Lake Stream	do.
Whortlekill Creek	do.	Fishkill Creek	do.
Wiccopee Creek	do.	do.	do.
Willow Brook	do.	Sprout Creek	do.
do.	Wappinger Creek	Wappinger Creek	do.

Source: Ayer and Pauszek. 1968. Streams in Dutchess County, New York. p. 100

Notes: a/ From N.Y.S. Department of Health Report (Housatonic River).
b/ In Conn.
c/ Local name.
d/ From N.Y.S. Department of Health Report No. 8.
do: Same as above (ditto)

A:13: Water Pollutant Sources and Effects

WATER POLLUTANTS	SOURCES	EFFECTS ON WATERS	PREVENTION & ABATEMENT
SOLIDS Particulate	Municipal wastewater and effluents from certain industries such as pulp and paper, food and tannery.	Degrades aesthetic appearance— utilizes oxygen resources; interferes with bottom life; prevents adequate disinfection and allows disease-causing organisms to live longer in natural waters.	Primary wastewater treatment; advance wastewater treatment by chemical coagulation and settling; filtration; industrial process modifications.
	Silt in runoff from construction sites and agricultural land.	May cover and destroy valuable fish and wildlife habitat; makes assimilation of oxygen-demanding wastes more difficult; adds to water treatment costs; degrades aesthetic appearance.	Land use control; improved soil conservation practices.
Dissolved	Municipal and industrial wastewater, particularly the mining and chemical industry, road salting.	Interferes with agricultural and industrial water use; increases hardness of water used for domestic purposes; excessive dissolved salts can also cause a laxative action when present in potable water; adds taste to water.	Process changes and in-plant controls in industry; advance wastewater treatment processes, such as reverse osmosis and ion exchange; controlled and effective use of road salting chemicals, or use of substitutes such as sand.
ORGANIC MATERIAL Biodegradable	Municipal wastewater and the wastewater from many industries such as milk, food, pulp and paper. Runoff from areas with high concentration of animals such as zoos, feedlots or barnyards.	Utilizes the oxygen resources of a stream & thus interferes with normal biological life; can cause taste, odors and colors.	Secondary wastewater treatment; in-plant industrial controls; containment, control and treatment of animal land runoff.
Non-biodegradable	" " " " " " " " " " "	Can cause taste, odors and color in water; fish-tainting; foam; can become biodegradable.	Control use of non-biodegradable products; advance waste treatment process such as ozone or activated carbon absorption.
INFECTIOUS AGENTS Bacteria & Viruses	Domestic wastewater; waste from hospitals, research laboratories and some industries such as milk processing and meat packing.	Presents a health hazard to direct and indirect reuse and to water contact recreation.	Secondary wastewater treatment, plus disinfection.
NUTRIENTS such as Nitrogen & Phosphorus	Municipal wastewater; some industrial wastewater; runoff from agricultural and urban land.	Fertilizes the water and thereby stimulates the excessive growth of weeds and algae causing cultural eutrophication.	Advance waste treatment; land use controls; soil conservation practices; control use of products containing phosphorus and nitrogen.
TOXIC AGENTS Metals, acids & alkalides	Industrial wastewater.	Harms surface water ecology; interferes with downstream water reuse; potential health hazard; corrodes piers, boats.	Industrial process changes and controls; industrial waste treatment.
Pesticides & Other exotic organics	Agriculture, forestry, residential and commercial pest control, certain organic chemical industries.	Harms surface water ecology; interferes with downstream reuse; represents potential health hazard.	Controlled agricultural, forestry, residential and commercial pesticide use; prohibition of manufacture of certain particularly harmful organic chemical; industrial, wastewater treatment.
Radioactive waste	Nuclear power plants, radioactive material, reprocessing, industry, medical and laboratory radioactivity material uses.	Potential health hazard; potentially harmful to aquatic life.	Nuclear power plant and industrial process changes and wastewater treatment.
HEAT	Electric generating plants, steel mills, certain industries, large air conditioning systems.	Interferes with normal surface water life by favoring species tolerant to high temperatures; reduces the oxygen saturation concentration of water and increases rate of biological activity thus affecting weed and algae growth.	Reuse of waste heat; cooling towers; cooling ponds; more efficient electrical generation systems; reduce demand for power.
TASTE, ODOR & COLOR	Industrial wastewater.	Interfere with downstream recreation and reuse.	Industrial process changes and wastewater treatment.
Oil	Oil spills during transport or storage, railroad and truck yards, some industry, bilge water and ballast water from boats, urban runoff, waste oil from automobiles.	Aesthetic damage; taints fish; kills or injures fish and wildlife; interferes with recreational use.	Design and construction of failsafe oil transportation and storage facilities; containment and treatment of bilge and ballast water and runoff from areas with high potential for oil pollution; development of a market for waste oils reuse.

Source: NYS Department of Environmental Conservation. 1973.
Environmental Plan For New York State: Preliminary Edition. p. 43

A:14: Some Large and Significant Wetlands of Dutchess County

D.E.C. Code	Common Name	Town(s)	Drainage Basin	Size	D.E.C. Class*	Comments
AM-1		Amenia, North East	Wassaic Creek	230	II	
AM-25	Swift Pond	Amenia	Webatuck Creek	101	II	EMC Significant Area
AM-26	Bog Hollow	Amenia	Tenmile River	124	II	N.Y. Significant Habitat
RC-39	Mud Pond	Clinton	Little Wappinger	113	I	EMC Significant Area
RC-44	Zipfelberg Bog	Clinton	Crum Elbow	20	II	EMC Significant Area
RC-52	Long Pond	Clinton	Little Wappinger	87	II	EMC Significant Area
DP-17	Tamarack Swamp	Dover	Tenmile River	36	III	EMC Significant Area
DP-22	Great Swamp	Dover, Pawling	Swamp River	2000 +	II	Largest D.C. Wetland, EMC Significant Area
HJ-42		E. Fishkill	Fishkill Creek	420	II	
HJ-49, HJ-50		E. Fishkill	Fishkill Creek	410	II	
HJ-54	Townsend Swamp	E. Fishkill	Fishkill Creek	85	I	N.Y. Significant Habitat
WF-13, WF-17, WF-18	Stoney Kill Environ. Center	Wappingers, Fishkill	Wappinger Creek, Hudson River	38 11,19	III III III	EMC Significant Area
	Roosevelt Cove	Hyde Park	Hudson River	25		EMC Significant Area
PV-30	James Baird State Park	LaGrange	Sprout Creek	31	I	
RC-32	Silver Lake	Milan	Little Wappinger	38	II	EMC Significant Area
CP-1, CP-2, CP-3	Panhandle Wetlands	North East	Webatuck Creek	650	III II III	EMC Significant Area
MT-17		North East	Webatuck Creek	13	I	
MT-22	Downy Swamp	North East	Webatuck Creek	160	I	EMC Significant Area
MT-23		North East	Webatuck Creek	42	I	
PP-8, PP-5 PP-34	Thompson Pond Wetlands	Pine Plains, Stanford	Wappinger Creek	1000 +	I, II, II	EMC Significant Area
PV-2		Pleasant Valley, Poughkeepsie	Wappinger Creek	240	II	
SG-3	Tivoli North Bay	Red Hook	Hudson River	400	I	EMC Significant Area
	Tivoli South Bay	Red Hook	Hudson River	300		EMC Significant Area
KE-4	Synder Swamp	Rhinebeck	Mudder Kill	110	II	EMC Significant Area
KE-5	Ferncliff Forest Wetland	Rhinebeck	Hudson River	15	II	EMC Significant Area
	Vandenburgh Cove	Rhinebeck	Hudson River	125		EMC Significant Area
	Suckly Cove	Rhinebeck	Hudson River	30		EMC Significant Area
	Astor Cove	Rhinebeck	Hudson River	25		EMC Significant Area
AM-31		Stanford, Washington	Wassaic Creek	8	I	
MB-18	Bontecou Lake	Stanford, Washington	Wappinger Creek	320	II	EMC Significant Area
VB-17		Union Vale	Fishkill Creek	26	I	
VB-26		Union Vale	Fishkill Creek	240	II	
WF-11	Green Fly Swamp	Wappinger, Fishkill	Fishkill Creek, Wappinger Creek	180	II	EMC Significant Area
MB-37	Cary Arboretum Wetlands	Washington	Wappinger Creek	37	III	EMC Significant Area

*D.E.C. Tentative classification under the Freshwater Wetlands Act.

Source: Dutchess County Environmental Management Council. 1984. Freshwater Wetlands of Dutchess County: Part 1. p. 37

A:15: Erosion Rates for Dutchess County Watersheds, By Land Use Type

(Tons/Acre/Yr)

	Croton River	Crum Elbow Creek	Fishkill Creek	Hunns Lake	Jansen Kill	Tenmile River	Wappinger Creek	Upper Housatonic River
Construction Sites	9.50	14.40	19.00	--	234.00	0.47	3.80	--
Cropland without Conservation	22.42	12.77	12.63	11.58	17.36	11.69	7.39	--
Orchards, Vineyards & Brush Fruits	1.13	2.05	0.64	--	7.12	0.33	2.23	--
Urban Land	1.05	0.79	0.13	0.31	0.85	1.10	0.73	1.15
Cropland with Conservation	0.33	0.74	0.93	0.74	0.91	0.48	0.89	0.24
Pasture	2.29	0.63	0.97	1.00	0.69	0.82	0.76	0.92
Woodland	0.55	0.42	0.78	0.29	0.46	0.37	0.43	0.33
Streambanks (tons/bank-mile/yr.)	0.93	16.95	7.80	--	113.38	10.60	4.50	--
Roadbanks (tons/bank-mile/yr.)	1.14	16.16	38.39	--	5.76	21.70	15.50	60.00

Source: USDA Soil Conservation Service, Dutchess County Office. Data extracted from USDA Soil Conservation Service, Erosion and Sediment Inventory, New York, 1974.

A:16: Selected List of Plants in Dutchess County

Alders	Alnus rugosa, A. serrulata
Apple	Pyrus malus
Arrowwood	Viburnum dentatum
Arrowwood, downy	V. rafinesquianum
Arum, arrow	Peltandra virginica
Ash, black	Fraxinus nigra
Ash, red	F. pennsylvanica
Ash, white	F. americana
Aspen, quaking	Populus tremuloides
Aspens	Populus spp.
Asters	Aster spp.
Azalea, swamp	Rhododendron viscosum
Barberry, Japanese	Berberis thunbergii
Beech	Fagus grandifolia
Birch, black	Betula lenta
Birch, gray	B. populifolia
Birch, paper	B. papyrifera
Birch, yellow	B. lutea
Bittersweet	Celastrus scandens
Blackberry	Rubus allegheniensis
Bladdernut	Staphylea trifolia
Bladderworts	Utricularia spp.
Blueberry, high	Vaccinium corymbosum or near
Blueberry, low	V. vacillans, possibly V. angustifolium
Bluestem, little	Andropogon scoparius
Brambles	Rubus spp.
Buckthorn	Rhamnus cathartica
Bulrush, river	Scirpus fluviatilis
Bulrushes	Scirpus spp.
Bush-honeysuckle	Diervilla lonicera
Buttonbush	Cephalanthus occidentale
Cattail, narrowleaf	Typha angustifolia
Cattails	Typha spp.
Charophytes	Chara, Nitella
Cherry, black	Prunus serotina
Chestnut, American	Castanea dentata
Chokeberry	Aronia spp.
Chokecherry	Prunus pensylvanica
Corn, field	Zea mays
Cottonwood	Populus deltoides
Cranberry, small	Vaccinium oxycoccos
Creeper, Virginia	Parthenocissus quinquefolia
Cutgrass, rice	Leersia oryzoides
Day-lily	Hemerocallis fulva
Dewberry	Rubus flagellaris
Dogwood, flowering	Cornus florida
Dogwood, gray	C. racemosa
Dogwood, silky	C. amomum
Dogwood, red osier	C. stolonifera
Elm, American	Ulmus americana
False-indigo	Amorpha fruticosa
Fern, cinnamon	Osmunda cinnamonea
Goldenclub	Orontium aquaticum
Goldenrods	Solidago spp.
Grape	Vitis spp.
Grass, orchard	Dactylis glomerata
Grass, reed canary	Phalaris arundinacea
Grass, sweet vernal	Anthoxanthum odoratum
Grasses	Gramineae spp.
Hemlock	Tsuga canadensis
Hickory, pignut	Carya glabra
Hickory, shagbark	C. ovata
Hickories	Carya spp.
Honeysuckle, Bell's	Lonicera x bella (hybrid swarm of L. morrowi & L. tatarica)
Honeysuckle, Japanese	L. japonica
Hornbeam, American	Carpinus caroliniana
Hornbeam, hop	Ostrya virginiana
Huckleberry	Gaylussacia baccata
Juniper, common	Juniperus communis
Larch, European	Larix decidua
Leatherleaf	Chamaedaphne calyculata
Locust, black	Robinia pseudoacacia
Loosestrife, purple	Lythrum salicaria
Maple, red	Acer rubrum
Maple, silver	A. saccharinum
Maple, striped	A. pensylvanicum
Maple, sugar	A. saccharum
Mountain-laurel	Kalmia latifolia
Naiads	Najas spp.
Nannyberry	Viburnum lentago
Oak, black	Quercus velutina
Oak, chestnut	Q. prinus
Oak, red	Q. borealis
Oak, scrub	Q. ilicifolia
Oak, swamp white	Q. bicolor
Oak, white	Q. alba
Oaks	Quercus spp.
Periwinkle	Vinca minor
Pickerelweed	Pontederia cordata
Pine, red	Pinus resinosa
Pine, pitch	P. rigida
Pine, scotch	P. sylvestris
Pine, white	P. strobus
Plant, pitcher	Sarracenia purpurea
Poison-ivy	Rhus radicans
Pondweeds	Potamogeton spp.
Prickly-ash, American	Zanthoxylum americanum
Ragweed	Ambrosia artemisiifolia
Red-cedar	Juniperus virginiana
Reed, giant	Phragmites communis
Rose, multiflora	Rosa multiflora
Rush, soft	Juncus effusus
Rushes	Juncus spp.
Sassafras	Sassafras albidum
Sedge, tussock	Carex stricta
Sedges	Carex spp.
Shadbush	Amelanchier arborea
Skunk-cabbage	Symplocarpus foetidus
Smartweed, dotted	Polygonum punctatum
Spatterdock	Nuphar advena
Spicebush	Lindera benzoin
Sundew, roundleaf	Drosera rotundifolia
Sumac, poison	Rhus vernix
Sumac, smooth	R. glabra
Sumac, staghorn	R. typhina
Sweetfern	Myrica asplenifolia
Sycamore	Platanus occidentalis
Tamarack	Larix laricina
Timothy	Phleum pratense
Tree-of-heaven	Ailanthus altissima
Tuliptree	Liriodendron tulipifera
Viburnum, mapleleaf	Virburnum acerifolium
Water-chestnut	Trapa natans
Water-lily, white	Nymphaea odorata
Water-lily, yellow	Nuphar variegatum
Watermilfoil, European	Myriophyllum spicatum
Waterweed	Anacharis canadensis
Wild-celery	Vallisneria americana
Wild-rice	Zizania aquatica
Willows	Salix spp.
Witch-hazel	Hamamelis virginiana
Yew, Canada	Taxus canadensis

Note: Scientific names follow Gleason & Cronquist's Manual of Vascular Plants of Northeastern United States and Adjacent Canada (1963).

Bibliography

General Reference

Burchell, R. W. and D. Listokin. 1975. The Environmental Impact Handbook. Center for Urban Policy Research. Rutgers, the State University. New Brunswick, New Jersey.

Dutchess County Department of Planning. 1983. Development Permit Guide, Dutchess County, New York. Poughkeepsie, New York.

Dutchess County Department of Planning. January 1985. Dutchess County Data Book 1985. Vol. 1. Poughkeepsie, New York.

Dutchess County Department of Planning. April 1985. Directions: The Plan For Dutchess County Review Version. Poughkeepsie, New York.

Dutchess County Environmental Management Council. 1975. Dutchess County Environmental Plan. Millbrook, New York.

Hendler, B. 1977. Caring for the Land: Environmental Principles For Site Design and Review. Planning Advisory Service Report No. 328, American Society of Planning Officials. Chicago.

Hudson Basin Project. 1976. Task Group Report No. 5: Land Use/Natural Resource Management. The Rockefeller Foundation. New York.

Lynch, K. 1971. Site Planning. 2nd ed. The M.I.T. Press. Cambridge, Massachusetts.

Marsh, W. M. 1978. Environmental Analysis For Land Use and Site Planning. McGraw-Hill Book Co. New York.

McHarg, I. L. 1969. Design With Nature. The Natural History Press. Garden City, New York.

N.Y.S. Department of Environmental Conservation. 1981. A Challenge For The 80s. Albany, New York.

Thurow, C. T., W. Toner, and D. Erley. June 1975. Performance Controls for Sensitive Lands: A Practical Guide For Local Administrators Parts 1 and 2. Report Nos. 307 and 308. Planning Advisory Service. American Society of Planning Officials. Chicago.

Climate

Dethier, B. E. and A. B. Pack. September 1964. Climatological Summary: Rurban Climate Series No.2 Poughkeepsie, New York. New York State College of Agriculture. Ithaca, New York.

Dethier, B. E. and M. T. Vittum. 1967. Growing Degree Days in New York State. Bulletin 1017. Cornell University Agricultural Experiment Station. Ithaca, New York.

Foster, R. S. 1978. Homeowner's Guide to Landscaping That Saves Energy Dollars. David McKay Co. New York.

N.Y.S. Department of Environmental Conservation. 1981. A Challenge For The 80. Albany, New York.

______, Division of Air. December 1983. New York State Air Guide - 1: Guidelines For The Control of Hazardous Ambient Air Contaminants. Albany, New York.

Trewartha, G. T. 1957. Elements of Physical Geography. McGraw-Hill Book Co. New York.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Environmental Data Service. August 1971. "Wind Distribution By Pasquill Stability Classes (5) Star Program (Monthly and Annual), Station #14757-Poughkeepsie, N.Y., Period 1950-1954." Job No. 12910. National Climatic Center. Asheville, North Carolina.

______. December 1975. Climate of Poughkeepsie, New York. Climatography of the United States No. 20. National Climatic Center. Asheville, North Carolina.

______. June 1982. Climate of New York. Climatography of the United States No. 60. National Climatic Center. Asheville, North Carolina.

______. September 1982. Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1951-80, New York. Climatography of the United States No. 81 (By State). National Climatic Center. Asheville, North Carolina.

Geology

Broughton, J. G., J. F. Davis, and J. H. Johnsen. 1966. The Hudson Mineral Resources. N.Y.S. Museum and Science Service Geological Survey, for N.Y.S. Hudson River Valley Commission. Bear Mountain, New York.

Gerber, R. G. June 1982. Final Report: Water Resources Study For Dutchess County. Dutchess County Department of Planning. Poughkeepsie, New York.

Johnsen, J. H. 1976. The Hudson River Guide: A Geological and Historical Guide to the Lower and Mid-Hudson Valley Region as Viewed from the River. Vassar College. Poughkeepsie, New York.

______, ed. 1976. Field Guide Book: New York State Geological Association 48th Annual Meeting. Vassar College Department of Geology and Geography. Poughkeepsie, New York.

______ and S. Schaffel. 1967. "The Economic Geology of the Mid-Hudson Valley Region." In Guide Book: New York State Geological Association 39th Annual Meeting. SUNY College at New Paltz. New Paltz, New York.

Rutstein, M. S. 1977. The Lithologies and Geologic Evolution of the Mid-Hudson Valley. SUNY College at New Paltz. New Paltz, New York.

Simmons, E. T., I. G. Grossman, and R. C. Heath. 1961. Ground Water Resources of Dutchess County, New York. Bulletin GW-43, U.S. Geological Survey and N.Y.S. Conservation Department and Water Resources Commission. Albany, New York.

U.S. Geological Survey. 1982. Atlas of Eleven Selected Aquifers in New York. U.S.G.S. Water Resources Investigations Open File Report 82-553. Albany, New York.

Woodward-Clyde Consultants. December 1979. Mid-Hudson Site Studies Phase 1 Report. Consolidated Edison Company of New York. New York.

Topography

Dutchess County Planning Board. 1965. Physiography and Land Use. Poughkeepsie, New York.

Hendler, B. 1973. Building in the Wildlands of Maine. State of Maine Land Use Regulation Commission.

Hydrology

Ayer, G. R. and F. H. Pauszek. 1968. Streams in Dutchess County, New York. Bulletin 63, N.Y.S. Conservation Department and Water Resources Commission. Albany, New York.

Gerber, R. G. June 1982. Final Report: Water Resources Study For Dutchess County. Dutchess County Department of Planning. Poughkeepsie, New York.

Giese, G. L. and J. W. Barr. 1967. The Hudson River Estuary: A Preliminary Investigation of Flow and Water and of Flow and Water Quality Characteristics. Bulletin 61, N.Y.S. Conservation Department and Water Resources Commission. Albany, New York.

Greeson, P. E. and G. E. Williams. 1970. Characteristics of New York Lakes: Part 1A-Gazetteer of Lakes, Ponds, and Reservoirs by Counties. Bulletin 68A, U.S. Geological Survey and N.Y.S. Department of Environmental Conservation.

Hauser, E. December 13, 1983. "Tables of Allowable Dwellings Per Acre and Allowable Acres Per Dwelling." Memorandum to E. W. Gillert. Dutchess County Department of Planning. Poughkeepsie, New York.

Howard A. Kelly, Jr., Associates. 1968. Planning Guidelines for Dutchess County Drainage. Dutchess County Planning Board. Poughkeepsie, New York.

Hudson Basin Project. 1976. Task Group Report No. 6: Water Resources. The Rockefeller Foundation. New York.

The Hudson River Sloop Clearwater, Inc. February 1983. Polluting the Hudson, A Gentlemen's Agreement: A Report on the SPDES Permit Program for the Period October 1979-September 1981. Poughkeepsie, New York.

Jacobs, W. E. 1984. Freshwater Wetlands of Dutchess County: Part I, Inventory and Guide For Local Government Officials. Dutchess County Environmental Management Council. Millbrook, New York.

Lynch, K. 1971. Site Planning. 2nd ed. The M.I.T. Press. Cambridge, Massachusetts.

Marsh, W. M. 1978. Environmental Analysis For Land Use and Site Planning. McGraw-Hill Book Co. New York.

Massachusetts Department of Environmental Quality Engineering, Division of Water Supply and Office of Planning and Program management. May 1982. Groundwater Quality and Protection: A Guide For Local Officials. Reprinted by Dutchess County Cooperative Extension. Millbrook, New York.

New England River Basins Commission. April 1980. Housatonic River Basin Overview: Public Review Draft. Boston.

N.Y.S. Conservation Department, Division of Water Resources. 1966. The Hudson Water Resources. N.Y.S. Hudson River Valley Commission. Bear Mountain, New York.

N.Y.S. Department of Environmental Conservation. June 1973. Environmental Plan for New York State: Preliminary Edition. Albany, New York.

______. March 1977. Draft Water Quality Management Plan for Planning Area 16-01, Housatonic River Basin. Albany, New York

______. 1981. Dutchess County Stressed Segment Analysis. Albany, New York.

______, Division of Water. January 1985. Draft Upstate New York Groundwater Management Program. Report WM P-94 (1/85). Albany, New York.

______, Hudson River Basin Study Group. February 1979. Hudson River Basin Level B Water and Related Land Resources Study: Selected Background Information. Technical Paper 3, 2 vols. Albany, New York.

N.Y.S. Department of Health. June 1976. Occurrence of Natural Fluoride in Community Water Systems in New York State. Albany, New York.

_____, Division of Environmental Health, Bureau of Public Water Supply Protection. 1981. Report on Ground Water Dependence In New York State. Albany, New York.

_____, Division of Environmental Protection, Bureau of Public Water Supply Protection. 1982. New York State Atlas of Community Water System Sources 1982. Albany, New York.

_____, Water Pollution Control Board. February 1960. Drainage Basins of Streams Entering the Hudson River In Orange, Ulster, Dutchess, and Putnam Counties. Lower Hudson River Drainage Basin Survey Series Report No. 8, Albany, New York.

Robinson, F. L., W. N. Embree, and D. Bernard. 1976. Floods In New York 1973 and 1974. Report of Investigation RI-15, N.Y.S. Department of Environmental Conservation. Albany, New York.

Schenectady County Planning Department. December 1984. Groundwater Supply Source Protection: A Guide For Localities In Upstate New York. Schenectady, New York.

Simmons, E. T., I. G. Grossman, and R. C. Heath. 1961. Ground Water Resources of Dutchess County, New York. Bulletin GW-43, U.S. Geological Survey and N.Y.S. Conservation Department and Water Resources Commission. Albany, New York.

Snavely, D. S. 1980. Ground-Water Appraisal of the Fishkill-Beacon Area: Dutchess County, New York. U.S.G.S. Water Resources Investigation Open File Report 80-437. U.S. Geological Survey. Albany, New York.

Temporary State Commission on the Water Supply Needs of Southeastern New York. November 1972. Scope of Public Water Supply Needs. Albany, New York.

Tourbier, J. T. and R. Westmacott. 1982. Water Resources Protection Technology. The Urban Land Institute. Washington, D.C.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management. June 1982. Draft Environmental Impact Statement: Hudson River Estuarine Sanctuary. U.S. Department of Commerce and N.Y.S. Department of Environmental Conservation. Washington, D.C.

U.S. Geological Survey. 1982. Atlas of Eleven Selected Aquifers In New York. U.S.G.S Water Resources Investigations Open File Report 82-553. Albany, New York.

_____. 1984. Water Resources Data New York Water Year 1983: Vol. 1, Eastern New York Excluding Long Island. U.S.G.S. Water Data Report NY-83-1. Albany, New York.

Soils

Cline, M. G. and R. L. Marshall. 1977. Soils of New York Landscapes. Information Bulletin 119. N.Y.S. College of Agriculture and Life Sciences. Cornell University. Ithaca, New York.

Dutchess County Soil and Water Conservation District. February 1985. Soil Erosion and Sediment Control Guidebook. Millbrook, New York.

U.S. Department of Agriculture, Soil Conservation Service. December 1955. Soil Survey: Dutchess County, New York. Series 1939, No. 23. Cornell University Agricultural Experiment Station. Ithaca, New York.

_____. August 1974. Erosion and Sediment Inventory: New York.

_____. February 1978. Soil Interpretation Report: Dutchess County, New York. Dutchess County Soil and Water Conservation District. Millbrook, New York.

________. No Date. Conserving Soil. Washington, D.C.

U.S. Environmental Protection Agency. October 1976. Erosion and Sediment Control: Surface Mining in the Eastern U.S. 2 vols. EPA Technology Transfer Semninar Publication EPA-625/3-76-006. U.S. Government Printing Office. Washington, D.C.

Vegetation

Barnett, R. No date. (Survey of flora and fauna of Taconic Hereford Multiple Use Area.) Natural Resources Conservation, Dutchess Community College. Poughkeepsie, New York.

Damman, A.W.H. and B. Kershner. 1977. "Floristic Composition and Topographical Distribution of the Forest Communities of the Gneiss Areas of Western Connecticut." Naturaliste Canada 104: 23-45.

Davis, J.A. 1977. "An Ecosystem Classification of New York State for Natural Resources Management." New York Fish and Game Journal 24 (2).

Domville, M. and H.F. Dunbar. 1970. The Flora of Ulster County, New York: An Annotated List of Vascular Plants. Bulletin 8, John Burroughs Natural History Society.

Dowhan, J.J. 1979. Preliminary Checklist of the Vascular Flora of Connecticut (growing without cultivation). State Geologic and Natural History Survey and Department of Environmental Protection. Report of Investigations 8. State Library. Hartford, Connecticut.

Dutchess County Department of Planning. June 1977. Land Use Element, Report No. 1: Land Use 1976. Poughkeepsie, New York.

________. June 1977. Land Use Element, Report No. 2: County Plan. Poughkeepsie, New York.

Egler, F.E. 1940. "Berkshire Plateau Vegetation, Massachusetts." Ecol. Monogr. 10 (2): 145-192.

Ferguson, R.H. and C.E. Mayer. 1975. The Timber Resources of New York. U.S. Department of Agriculture Forest Service Resource Bulletin NE-20. Northeast Forest Experiment Station. Upper Darby, Pennsylvania.

House, H.D. 1942. Bibliography of the Botany of New York State 1751-1940. New York State Museum Bulletins 328 and 329. Albany, New York.

Hoysradt, L.H. 1874. "Flora of Pine Plains, Dutchess County, New York." Bulletin No.1, Torrey Botanical Club 5:46-48.

Ketchledge, E.H. 1965. "Changes in the Forests of New York: A Review of the Forces that Shaped Our Forests and How Some Will Continue to Transform Our Woodlands." Conservationist 19(4).

Kiviat, E. 1973. "Down Along the Cove." Bard Review, Spring: 21-23. Reprinted in North River Navigator. Hudson River Sloop Clearwater. Poughkeepsie, New York.

________. 1976. "Goldenclub: a Threatened Plant in the Tidal Hudson River." Paper 21 in Fourth Symporsium on Hudson River Ecology. Hudson River Environmental Society. Bronx, New York.

________ and N. Zeising. 1976. "The Wetland Flora of Thompson Pond, New York." Paper 4 in P.S. Busch, ed. The Ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy. Boston, Massachusetts.

Manly, R.J. et al. 1975. Natural Resource Survey of Lands Formerly Known as Scotland Farm in the Town of Ancram, Columbia County, New York. National Audubon Society, Nature Center Planning Division. New York.

McVaugh, R. 1958. Flora of the Columbia County Area, New York. New York State Museum and Science Service Bulletins 360-360A. Albany, New York.

Moeller, R. and F.E. Egler. 1974. The Natural Area of the Sharon Audubon Center. Sharon Audubon Center. Sharon, Connecticut.

Moody, F.B. and J. Bentley Jr. 1915. "Woodlot Conditions in Dutchess County, New York." Cornell University Agricultural Experiment Station Bulletin 368: 283-301. Ithaca, New York.

Muenscher, W.C. 1937. "Aquatic Vegetation of the Lower Hudson Area." Biological Survey 11, Lower Hudson Watershed. Supplement, 26th Annual Report of the New York State Conservation Department 26:231-248.

Pierce, M.E. (and F.V. Ranzoni). 1976. "Survey of Land Plants of the Thompson Pond Preserve." Paper 3 in P.S. Busch, ed. The Ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy. Boston, Massachusetts.

Raup, H.M. 1937. "Recent Changes of Climate and Vegetation in Southern New England and Adjacent New York." J. Arnold Arboretum 18: 79-117.

Roberts, E. A. and H.W. Reynolds. 1938. The Role of Plant Life in the History of Dutchess County. Privately printed, Vassar College. Poughkeepsie, New York.

Smith, S. J. No date. "List of Flora of Dutchess County." Unpublished. New York State Museum and Science Service. Albany, New York.

Stout, N. J. 1958? Atlas of Forestry in New York. SUNY College of Forestry at Syracuse University. Syracuse, New York.

Svenson, H. K. 1935. "Plants from the Estuary of the Hudson River." Torreya 35 (5): 117-125.

U.S. Department of Commerce, Bureau of the Census. March 1984. 1982 Census of Vol. 1, Geographic Area Series, Part 32, New York State and County Data. AC82-A-32. U.S. Government Printing Office. Washington, D.C.

_______, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management. June 1982. Draft Environmental Impact Statement: Hudson River Estuarine Sanctuary. U.S. Department of Commerce and N.Y.S. Department of Environmental Conservation. Washington, D.C.

Winchell, W. 1851. "Catalogue of Plants Found Growing Without Cultivation in the Vincity of Amenia Seminary, Dutchess County, N.Y." Annual Regents Report, State University of New York 64:256-279.

Wildlife

A bibliography of more than 200 items on Dutchess County wildlife is available from Hudsonia Limited, Bard College, Annandale NY 12504.

Benson, N. 1973. "Rattlesnakes in Dutchess County." Dutchess County Cooperative Extension News 55 (2):30.

Bergstrom, A. S. 1979. New York State Fish and Wildlife: Protected and Unprotected Species. Endangered Species Unit, Wildlife Resources Center, New York State Department of Environmental Conservation. Delmar, New York.

Boyle, R. 1969. The Hudson River: A Natural and Unnatural History. W. W. Norton. New York.

Bull, J. 1974. Birds of New York State. Doubleday. Garden City, New York.

______. 1976. Supplement to Birds of New York State. Special Publication, Federation of New York State Bird Clubs.

Collins, J. T. et al. 1982. Standard Common and Current Scientific Names for North American Amphibians and Reptiles. 2nd ed. Society for the Study of Amphibians and Reptiles, Herpetological Circular 12.

Connor, P. F. In press. (Mammals of New York State.) New York State Museum. Albany, New York.

Eisenmann, E. et al. 1982. "Thirty-fourth supplement to the American Ornitologists' Union Check-list of North American Birds." Auk, Supplement, 99 (3): 1CC-16CC.

Griscom, L. 1933. The Birds of Dutchess County, New York. Transactions of the Linnaean Society of New York 3.

Jones, J. K. Jr., D. C. Carter and H. H. Genoways. 1979. Revised Checklist of North American Mammals North of Mexico, 1979. Occasional Papers. The Museum, Texas Tech University 62.

Kiviat, E. 1975. "Listening to the Cry of the Wilderness." Hudson Valley, Dec.: 8-11.

______. 1977. "Reptiles and Amphibians of the Hudson Estuary." North River Navigator 8 (9): 4-5. Hudson River Sloop Clearwater. Poughkeepsie, New York.

______. 1981. Hudson River Estuary Shore Zone Annotated Natural History Bibliography With Index. Scenic Hudson, Inc. Poughkeepsie, New York.

______. In press. "Natural History of the Fish Fauna of Tivoli Bays." In C. L. Smith and R. Klauda, eds. Hudson River Fisheries Symposium. Hudson River Environmental Society. Bronx, New York.

______ and D. Outlaw. 1983. "Dutchess County's Bobcats." Hudson Valley Studies June: 2 8-30. Bard College Center. Annandale, New York.

Leedy, D. L., R. M. Maestro, and T. M. Franklin. January 1978. Planning For Wildlife in Cities and Suburbs. Planning Advisory Service Report No. 331. American Society of Planning Officials. Chicago.

Petersen, R. C. 1970. "Connecticut's Venomous Snakes: Timber Rattlesnake and Northern Copperhead." State Geologic and Natural History Survey Bulletin 103. State Library. Hartford, Connecticut.

Pink, E. and O. Waterman. 1967. Birds of Dutchess County: 1933-1964. Ralph T. Waterman Bird Club. Poughkeepsie, New York.

______. 1980. Birds of Dutchess County: 1964-1979.

Ralph T. Waterman Bird Club. Ralph T. Waterman Bird Club. 1977. (Revised checklist of Dutchess County birds.) Ralph T. Waterman Bird Club. Moores Mill, Pleasant Valley, New York.

______. Wings Over Dutchess. (Newsletter, 10/year.)

Robins, C. R., et al. 1980. A List of Common and Scientific Names of Fishes from the United State and Canada. American Fisheries Society Special Publication 12.

Romero, Aline B., et al. 1977. Where to Bird in Dutchess County. Ralph T. Waterman Bird Club. Moores Mill, Pleasant Valley, New York.

Tate, J. Jr. and D. J. Tate. 1982. "The Blue List for 1982." American Birds 36 (2): 126-135.

Significant Areas

Dutchess County Department of Planning. 1974. Data Book 1974. Poughkeepsie, New York.

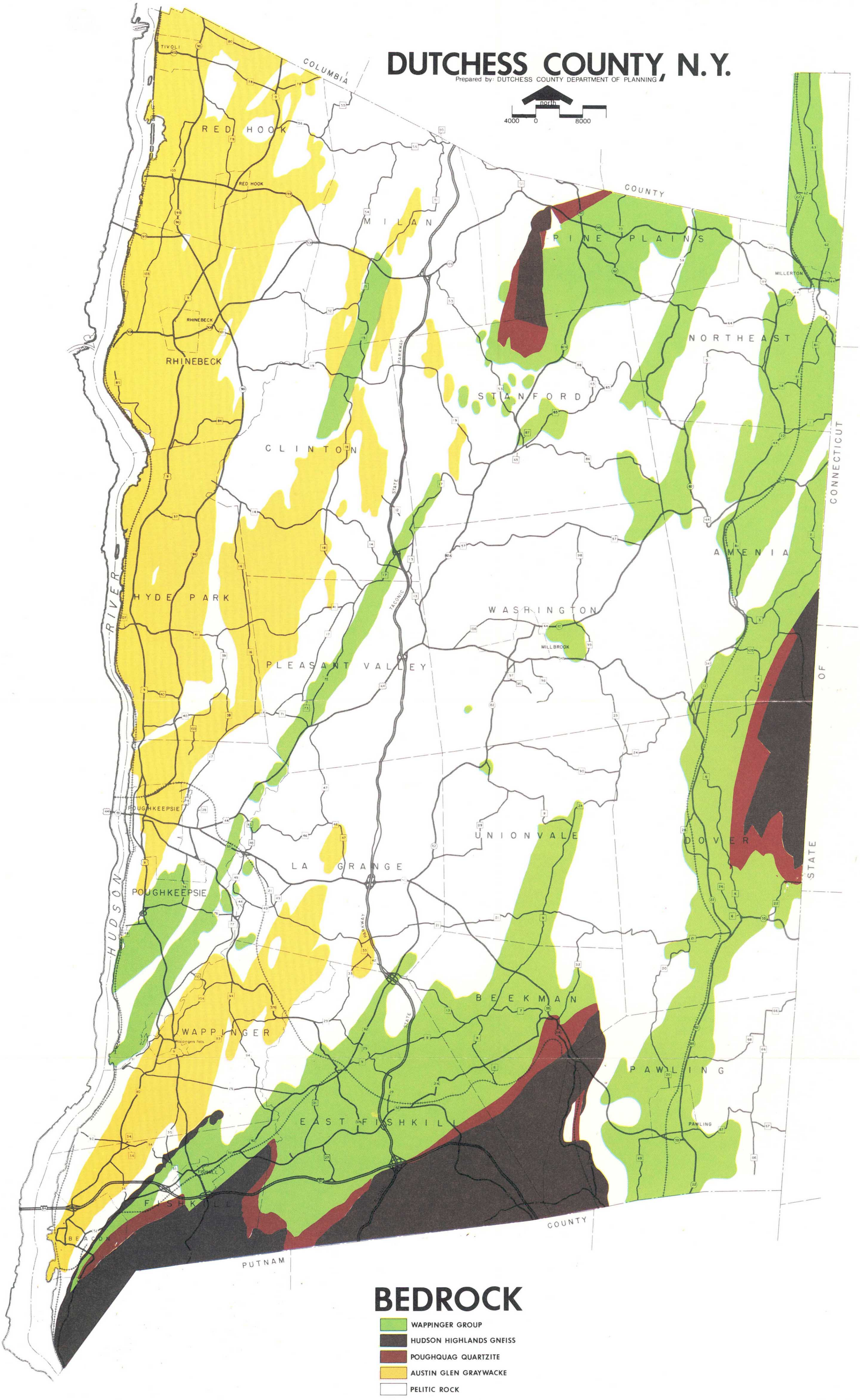
Dutchess County Environmental Management Council. 1983. Significant Areas of Dutchess County. Millbrook, New York.

Dutchess County Tourism Promotion Agency. 1985. Dutchess County Travel Guide: I Love New York, Hudson Valley Regions. Hyde Park, New York.

The Heritage Task Force For The Hudson River Valley, Inc., and N.Y.S. Department of Environmental Conservation. June 1983. The Hudson Valley Scenic Roads Program. Vols. 1-5.

Hudson River Shorelands Task Force. 1983. Mid-Hudson Historic Shorelands Scenic District Management Plan. The Heritage Task Force For The Hudson River Valley, Inc.

The Nature Conservancy, Lower Hudson Chapter. November 1981. Unique Natural Areas Survey. Mt. Kisco, New York.



DUTCHESS COUNTY, N.Y.
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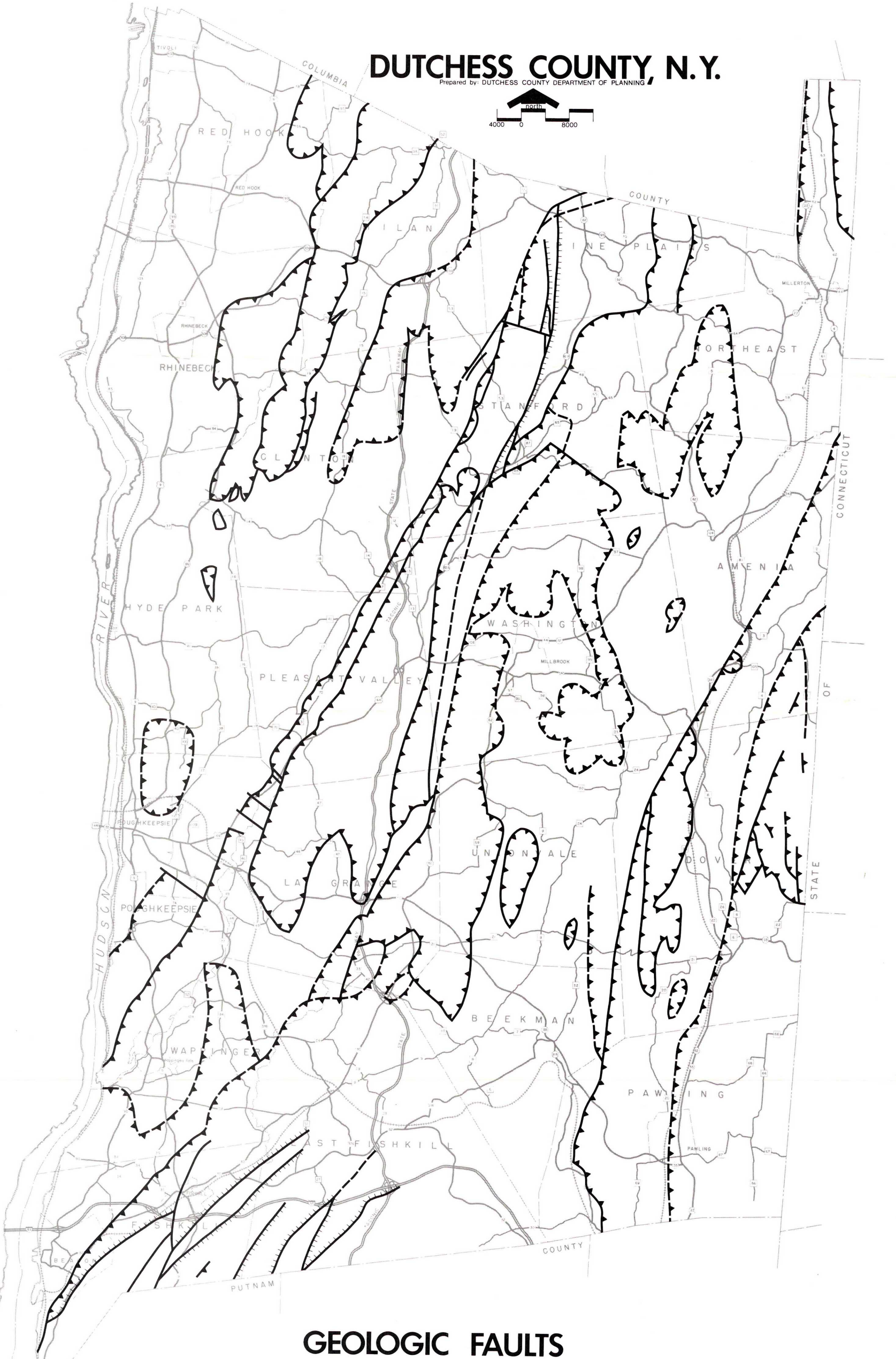
north
4000 0 8000
COLUMBIA
COUNTY
TIVOLI
RED HOOK
MILAN
PINE PLAINS
MILLERTON
NORTHEAST
RHINEBECK
STANFORD
CLINTON
CONNECTICUT
TACONIC STATE PARKWAY
HYDE PARK
HUDSON RIVER
AMENIA
WASHINGTON
MILLBROOK
PLEASANT VALLEY
OF
UNIONVALE
DOVER
STATE
POUGHKEEPSIE
LA GRANGE
BEEKMAN
WAPPINGER
Wappingers Falls
PAWLING
EAST FISHKILL
FISHKILL
BEACON
PUTNAM
COUNTY
BEDROCK
WAPPINGER GROUP
HUDSON HIGHLANDS GNEISS
POUGHQUAG QUARTZITE
AUSTIN GLEN GRAYWACKE
PELITIC ROCK



GEOLOGIC FAULTS

(Assumed) NORMAL FAULT - Hachures on downthrust side

(Assumed) THRUST FAULT - Hachures on overthrust side

SHEAR ZONE

DUTCHESS COUNTY, N.Y.

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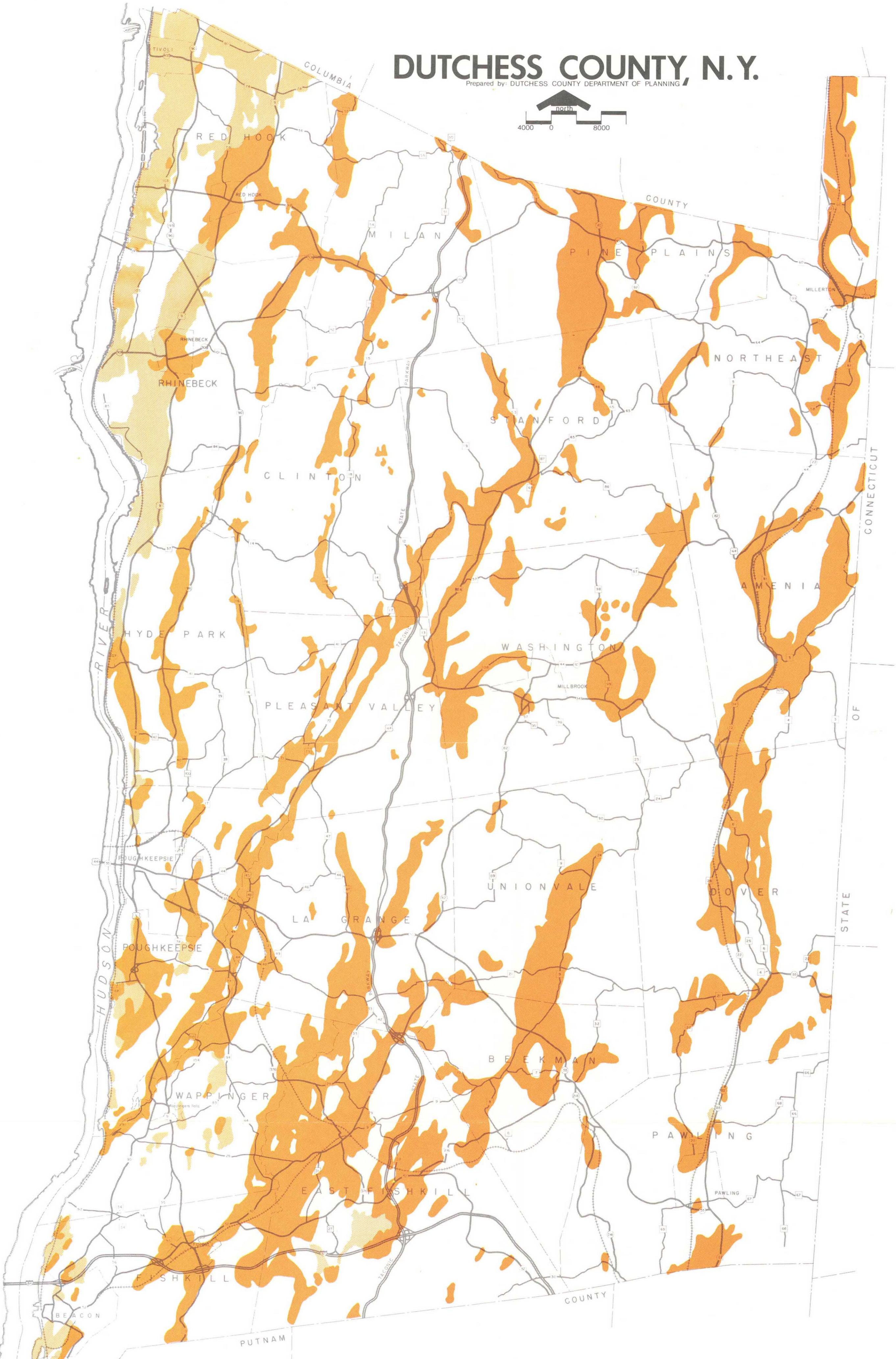
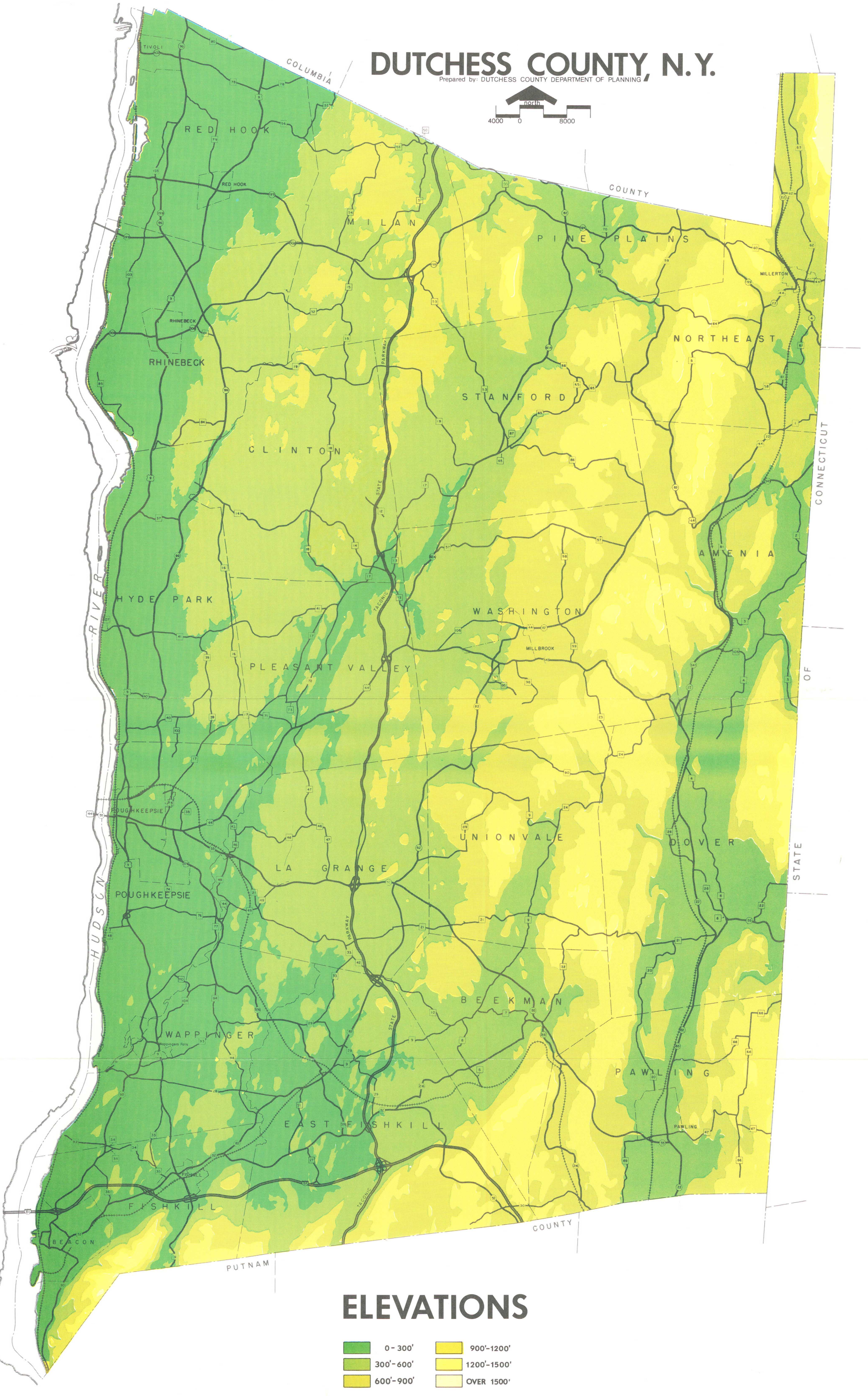


GLACIAL DEPOSITS

- TILL
- LACUSTRINE DEPOSITS
- SAND AND GRAVEL



DUTCHESS COUNTY, N.Y.
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north
4000 0 8000
COLUMBIA
COUNTY
TIVOLI
RED HOOK
RED HOOK
MILAN
PINE PLAINS
MILLERTON
NORTHEAST
RHINEBECK
RHINEBECK
STANFORD
CLINTON
STATE PARKWAY
AMENIA
HYDE PARK
WASHINGTON
MILLBROOK
TACONIC
PLEASANT VALLEY
POUGHKEEPSIE
UNIONVALE
DOVER
LA GRANGE
POUGHKEEPSIE
PARKWAY
STATE
BEEKMAN
WAPPINGER
Wappingers Falls
PAWLING
EAST FISHKILL
PAWLING
FISHKILL
FISHKILL
TACONIC
BEACON
PUTNAM
COUNTY
HUDSON RIVER
CONNECTICUT
OF
STATE
ELEVATIONS
0 - 300'
300'-600'
600'-900'
900'-1200'
1200'-1500'
OVER 1500'


DUTCHESS COUNTY, N.Y.
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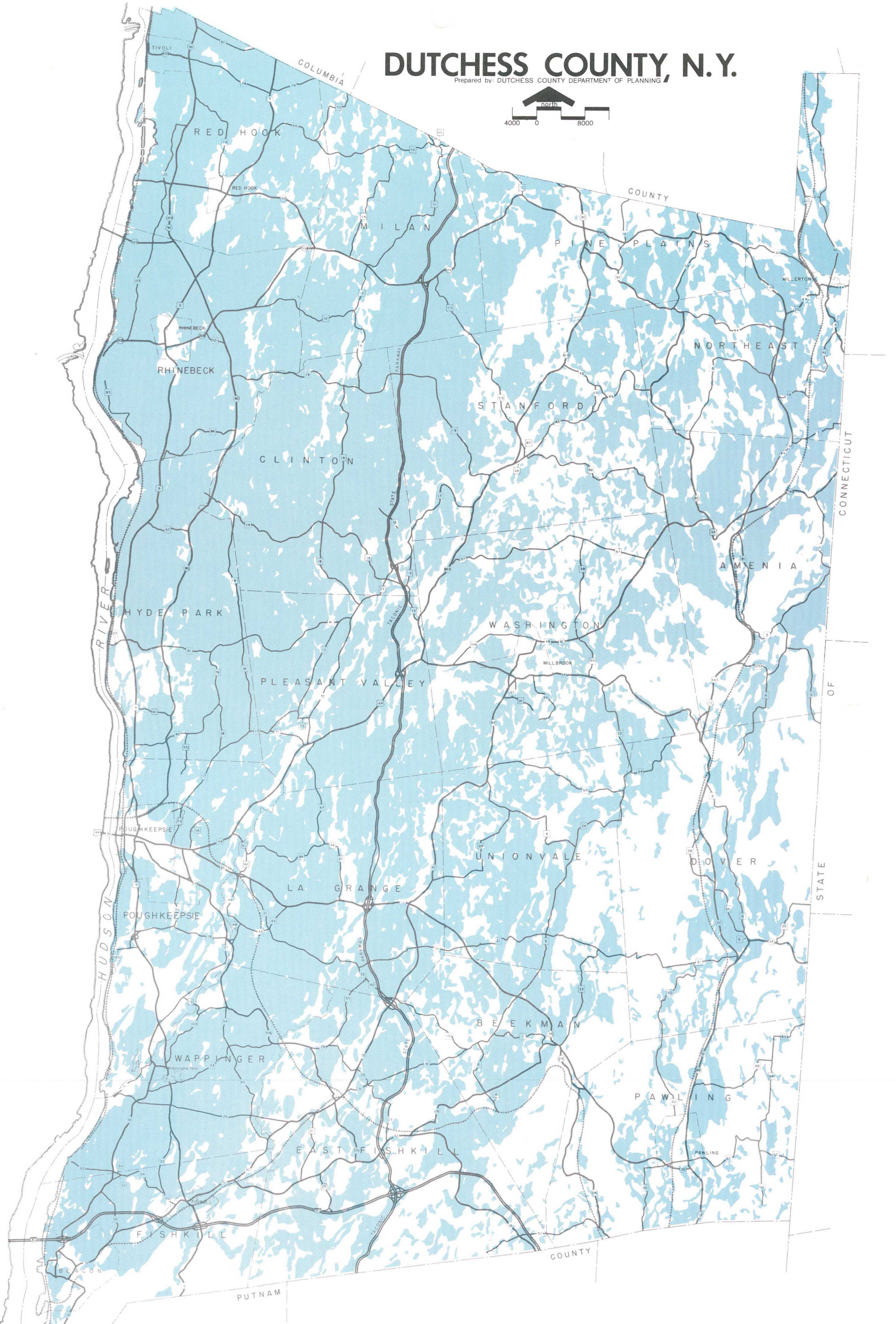
north
4000 0 8000
COLUMBIA
COUNTY
RED HOOK
RHINEBECK
CLINTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
LA GRANGE
WAPPINGER
EAST FISHKILL
FISHKILL
BEACON
PUTNAM
COUNTY
STANFORD
WASHINGTON
BEEKMAN
HUDSON
RIVER
STATE
OF
CONNECTICUT
SLOPE
SLOPES IN EXCESS OF 15 PERCENT



SOIL PERMEABILITY

SOILS WITH PERMEABILITY RATES OF LESS THAN 0.63 INCHES OF WATER PER HOUR

DUTCHESS COUNTY, N.Y.

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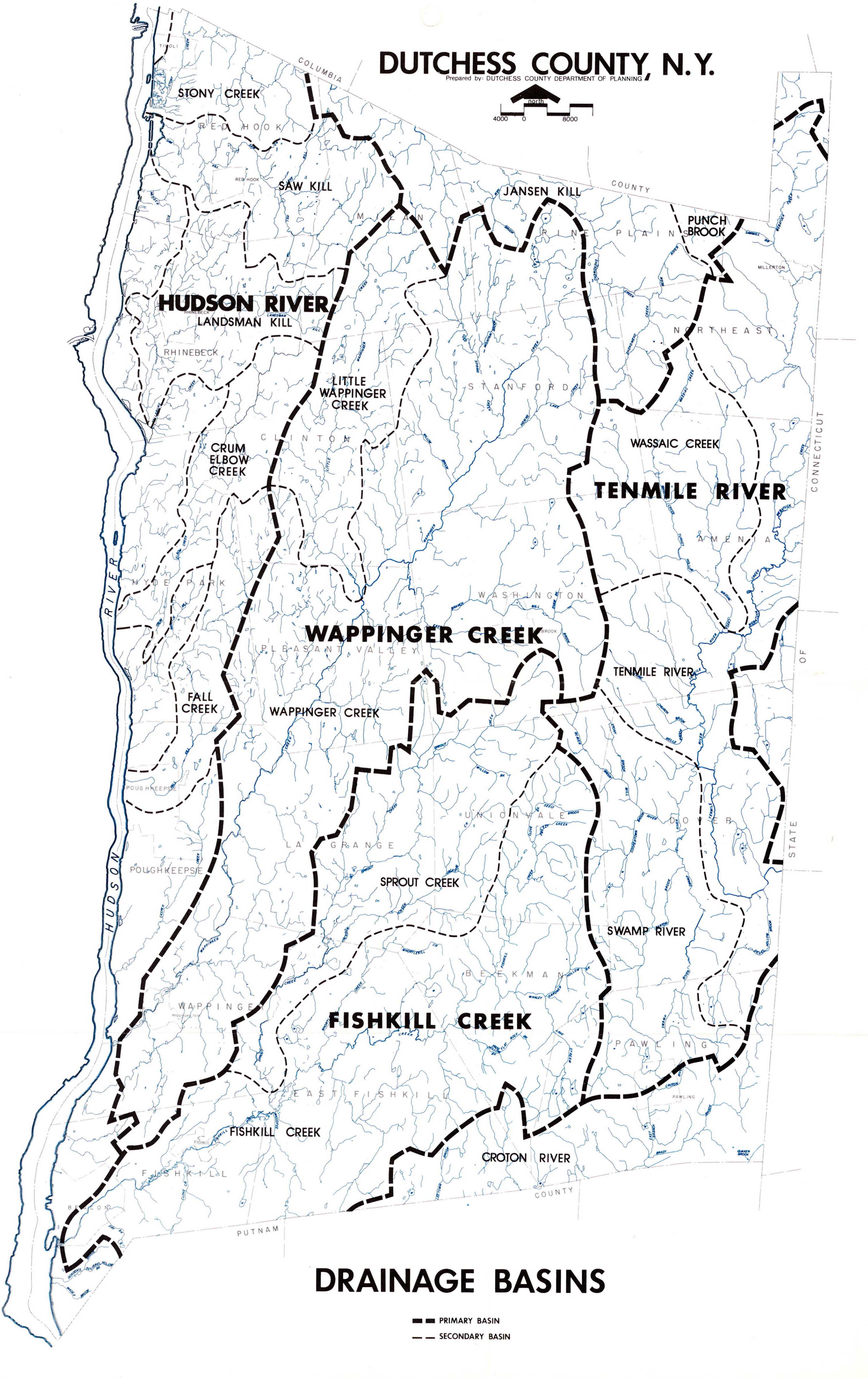
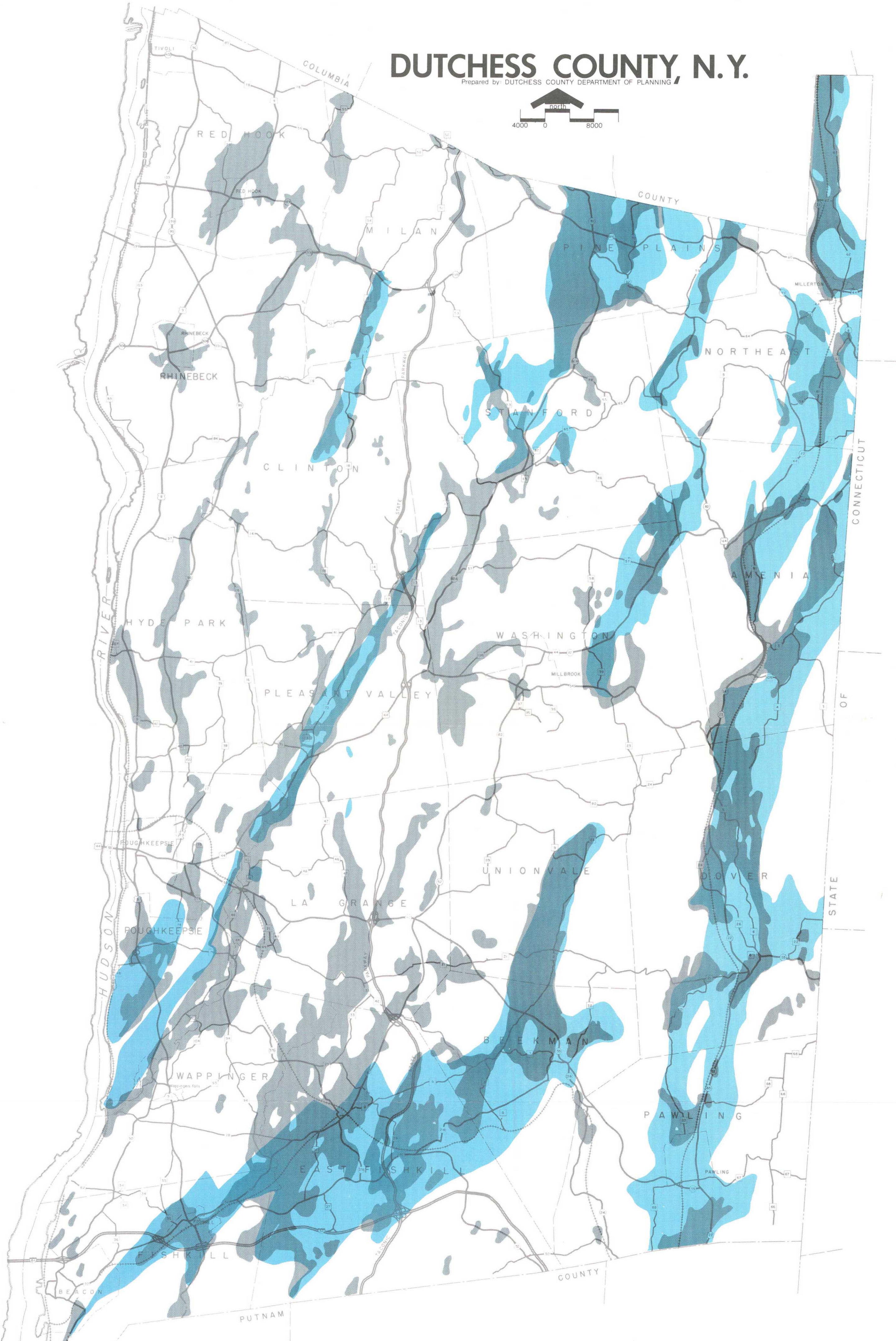


DRAINAGE BASINS

PRIMARY BASIN

SECONDARY BASIN



GROUND WATER OCCURRENCES

- SAND & GRAVEL
- LIMESTONE
- LIMESTONE OVERLAID WITH SAND & GRAVEL

DUTCHESS COUNTY, N.Y.

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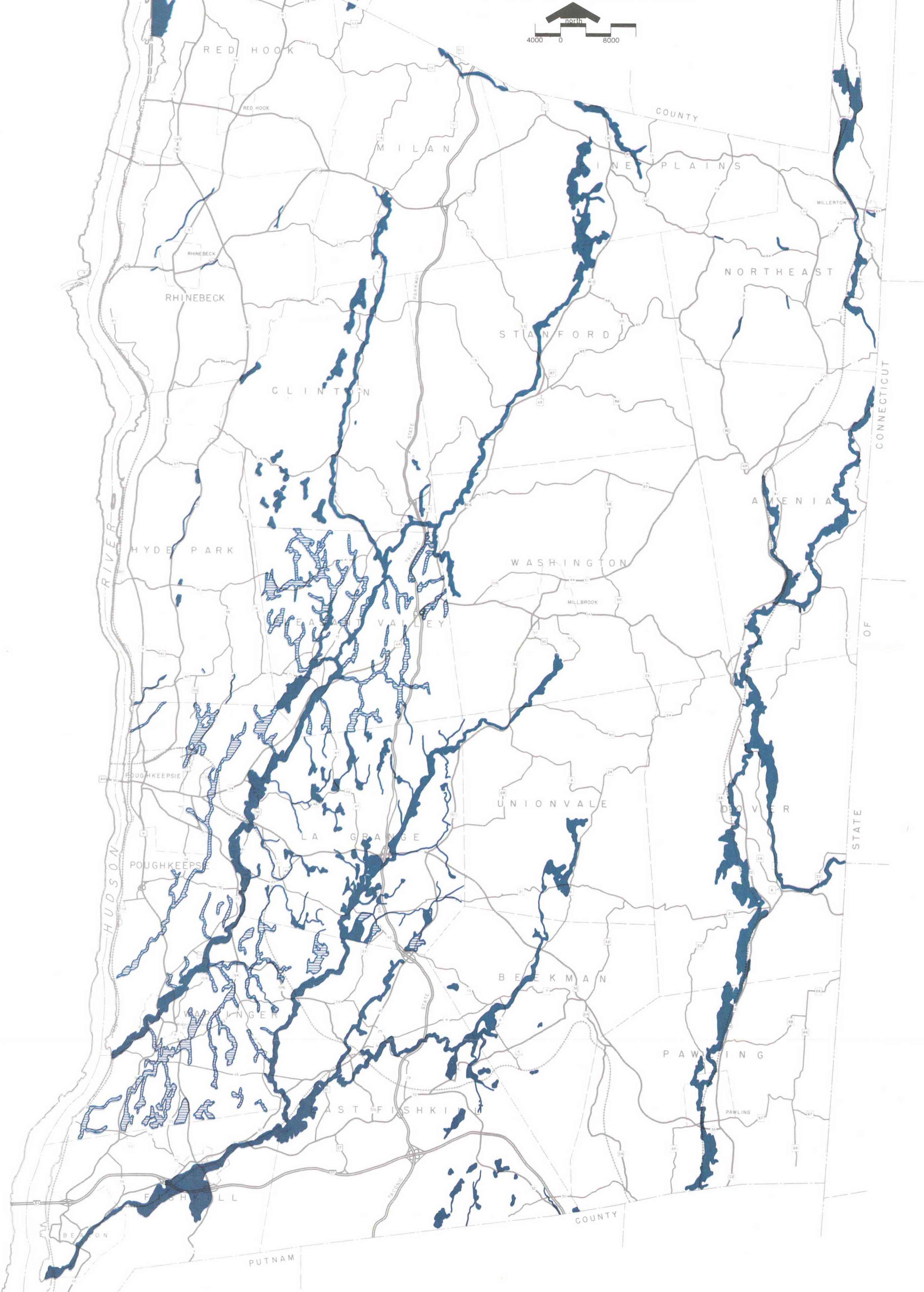

FLOODPLAINS

- AREAS INUNDATED AS THE RESULT OF A 100 YEAR STORM (USGS & HUD INFORMATION)
- AREAS INUNDATED AS THE RESULT OF A 100 YEAR STORM (FIA STUDIES INFORMATION)

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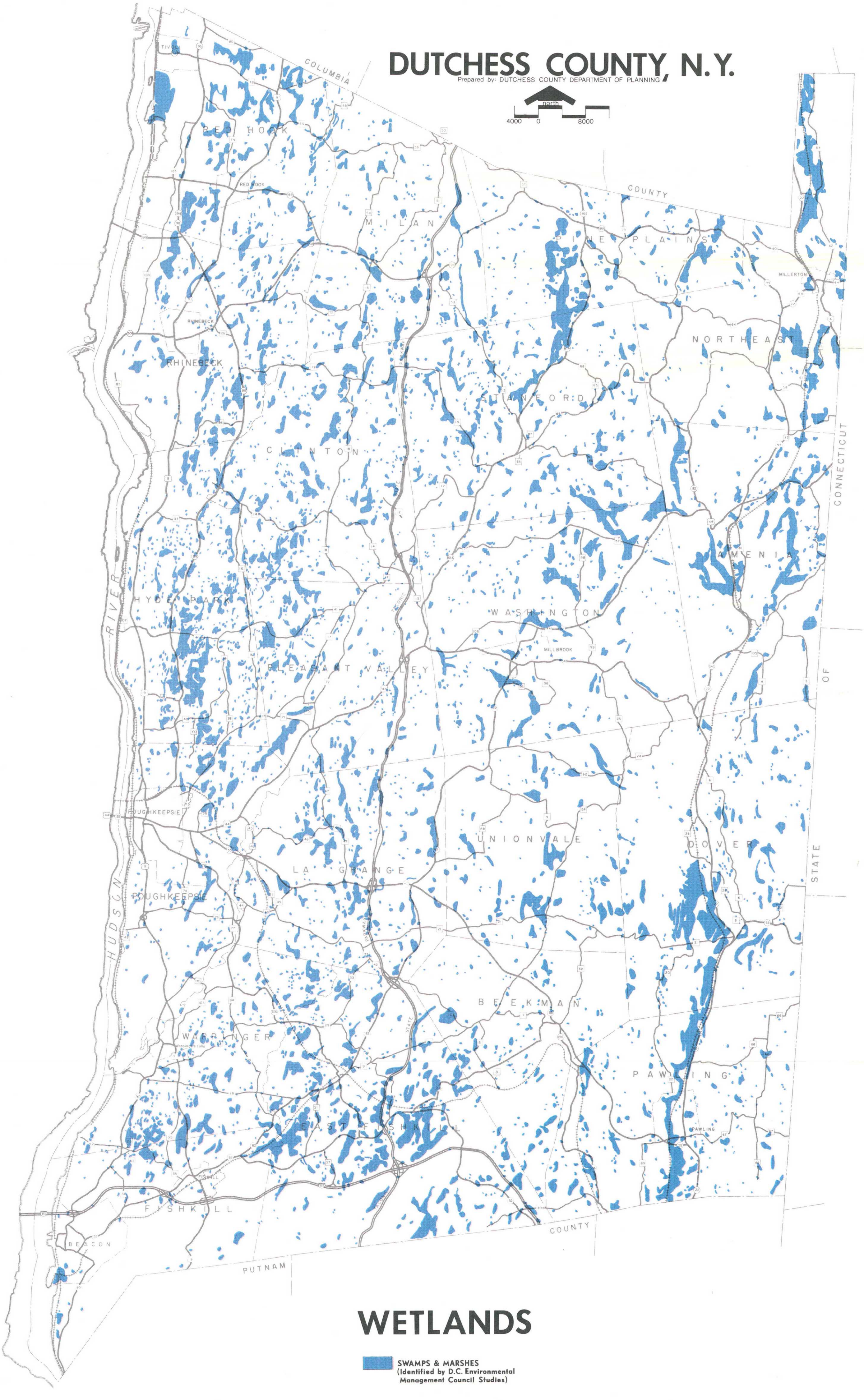

WETLANDS

SWAMPS & MARSHES (Identified by D.C. Environmental Management Council Studies)

DUTCHESS COUNTY, N.Y.

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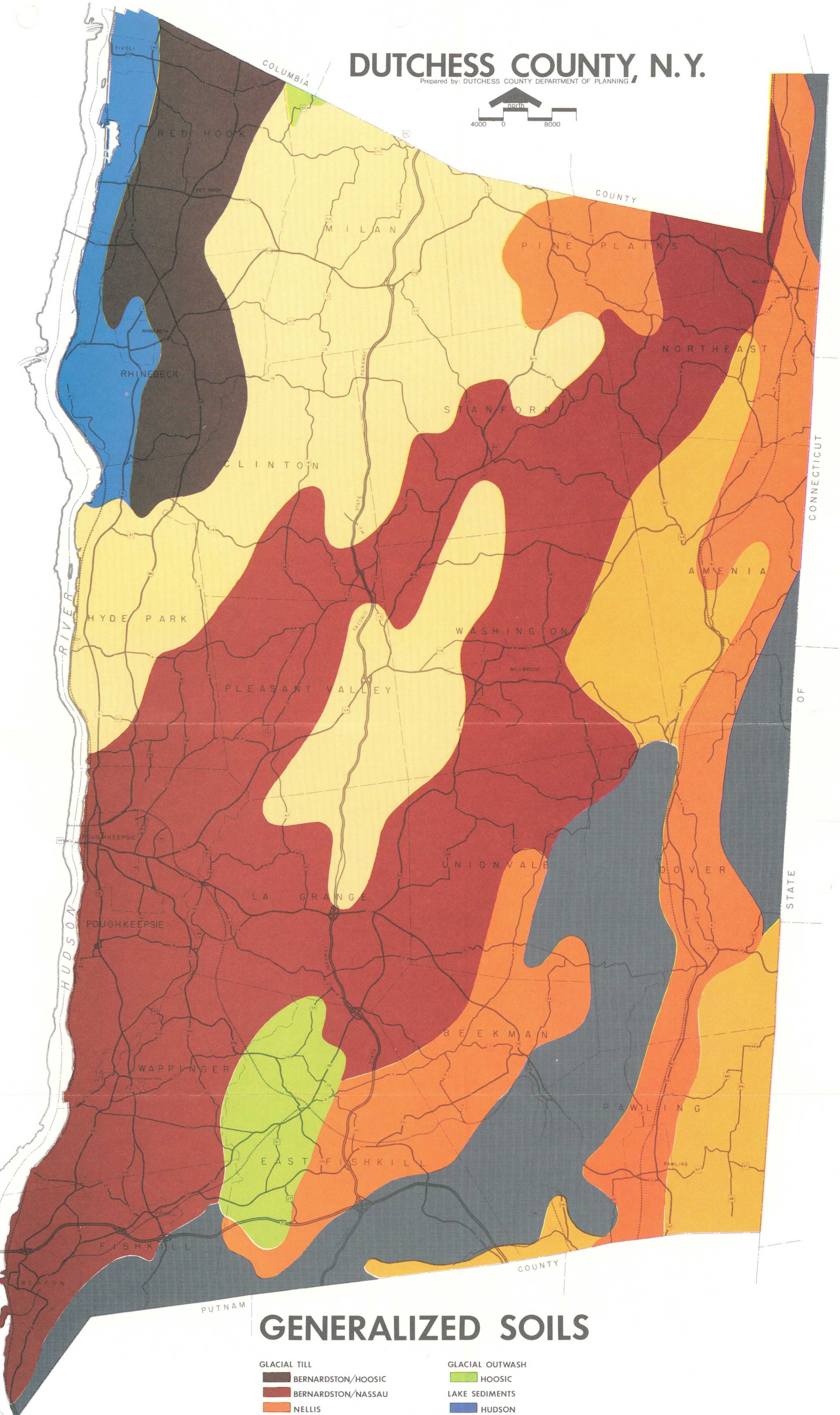

GENERALIZED SOILS

GLACIAL TILL
- BERNARDSTON/HOOSIC
- BERNARDSTON/NASSAU
- NELLIS
- HOLLIS
- NASSAU

GLACIAL OUTWASH
- HOOSIC

LAKE SEDIMENTS
- HUDSON

MISCELLANEOUS UNITS
- STEEP ROCK OUTCROP

SOIL DEPTH

AREAS WHERE BEDROCK IS LOCATED WITHIN 3 FEET OF THE SURFACE

DUTCHESS COUNTY, N.Y.

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VEGETATION

- WOODED WETLANDS
- MARSHES & BOGS
- PLANTATIONS
- FOREST LANDS
- BRUSHLANDS
- AGRICULTURE & DEVELOPED LAND