

NATURAL RESOURCES



Fall 1999

a Study and Inventory

Chatham Township Environmental Commission

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FOREWORD

This Natural Resources Inventory updates and enhances the original 1974 Chatham Township Natural Resources Inventory. The Inventory describes the environmental factors of Chatham Township and its environs, an inventory of the undeveloped land of the Township, and the methodology and sources of information employed in the course of assembling the inventory.

This Inventory contains information to aid the Planning Board in its Master Plan review function. It is intended to aid both the Planning Board and Board of Adjustment with their development review functions. Its information will aid applicants to the Planning Board and Board of Adjustment as they complete stormwater plans, grading plans, or environmental impact statements for their development applications.

EXECUTIVE SUMMARY

Geology

Chatham Township's geological history is a critical factor in shaping its land area. The Wisconsin glacier receded from the area approximately 15,000 years ago. It left behind glacial Lake Passaic, part of which evolved into the Great Swamp among other Passaic River wetlands. The glacier was responsible for creating valley aquifer systems, areas of which include Chatham Township. In the mid-1980's, the Environmental Protection Agency designated the Buried Valley Aquifer in northern New Jersey as a sole source aquifer because it supplied water to over half a million people in thirty-one municipalities. Chatham Township is one of these towns.

Recent research by the New Jersey Geologic Society also identifies an important aquifer recharge area running across the northerly part of the town, roughly, between Shunpike and Southern Boulevard and westward along Shunpike and Woodland Roads. This recharge zone supplies the Chatham Valley aquifer.

Water

Chatham Township is water resource rich with a little under one third of its land area dominated by the Great Swamp. Because of concerns regarding negative impacts to the swamp from increasing development and expanded sewer facilities, in 1989 the Commissioner of the New Jersey Department of Environmental Protection issued an administrative order establishing the Great Swamp Watershed Advisory Committee (GSWAC). The committee was created to study and make recommendations regarding the Great Swamp. One of the studies was a hydrologic budget, completed by hydrologic consultants. The results of the study indicate increased volumes of stormwater runoff flow into the swamp, but not necessarily through it. Increased annual volumes of surface runoff from land use changes between 1963 and 2000 were seen to be mostly the result of decreased evapotranspiration and, to a lesser degree, decreased groundwater recharge. Should this continue, flooding in and around the Great Swamp may increase. The importance of evapotranspiration in the water budget strongly suggests that retention of shade trees is extremely important in controlling stormwater runoff.

Another study in 1997 on stormwater runoff establishes that developed areas in the watershed are creating much higher than expected stormwater runoff volumes. The conclusion was that the extensively disturbed soils in the 1/2 acre density residential area studied were responsible.

Open Space

Chatham Township's privately owned open space dropped from 1,915 acres in 1978 to 1,260 acres in 1997 (a 34% decrease) according to data from the Township planning consultant. Since the original Natural Resource Inventory was published in 1974, Chatham Township has sustained substantial losses in three of the ten inventoried sites. One area called "the Orchard" (Long Hill above Meyersville Road) now has 3 new streets: Tree Top Lane, Molino Drive and Jodi Lane. The second, called "Southern Boulevard", has a new road and the stream crossing under Southern Boulevard near Jay Road has been partially contained in a large pipe. The third area, the "Averett Site," south of river Road, now supports 900 townhouses, tennis courts, swimming pools, and a small sewage treatment plant. Its natural streams are now drainage ways and the pond that used to be in a wooded setting is now a detention facility.

INTRODUCTION

Chatham Township is located in Morris County, New Jersey, which lies in the north-central part of the State. It is primarily a residential community with a small amount of commerce and no industry. Railroad and road connections provide access to Morristown, Summit, Murray Hill, Newark, and New York.

Since 1920, the Township's population has increased from 736 people to approximately 9831 in 1997 (Figure 1). Most of that growth occurred in the 1950's and created the need for wastewater facilities for the increased population.

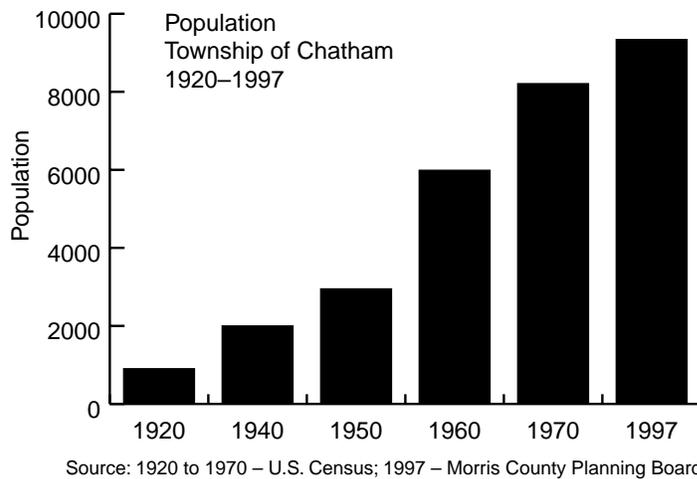


Figure 1—Chatham Township Population

Development in Chatham Township is concentrated in the eastern portion of the Township and along the slopes of Long Hill. A significant portion of the Township is owned by the U.S. Government's Great Swamp National Wildlife Refuge or by the Morris County Park Commission (Figure 2). Chatham Township is located in an area of considerable geologic and topographic diversity. The configuration of the land, composition of the soils, movement of water, and the amount and types of vegetative cover shape how the Township has developed and will continue to develop in the future.

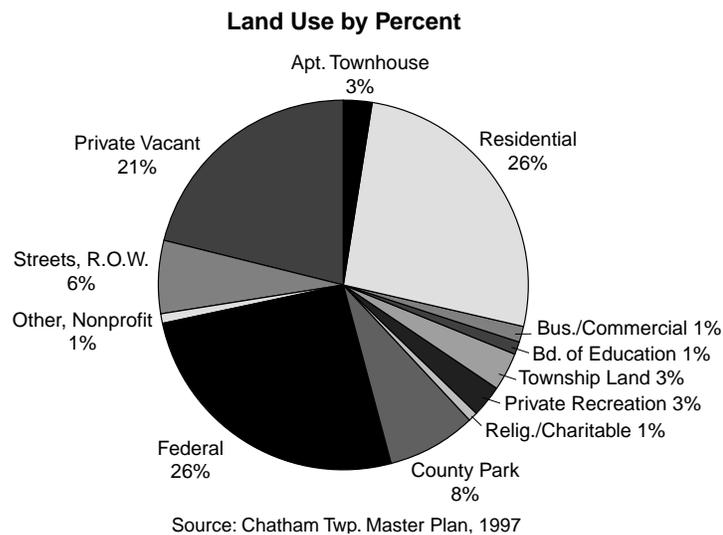


Figure 2 — Chatham Land Use by Percentage

Chapter 1

BRIEF HISTORY

The geologic structure underlying Chatham Township's land area coupled with glacial activity determined how the town developed.

Physical Character

Chatham Township is part of the Upper Passaic River watershed, with 90% of the Township in the Great Swamp watershed and 10% draining to the Passaic River. Its 9.2 square miles extend from the Passaic River, which forms the southern border, up over Long Hill and across the eastern end of the Great Swamp. The Great Swamp is the dominant physical feature, occupying approximately 25% of the land area in Chatham Township.

Development Pattern

Chatham Township developed primarily on the high, well drained ground around and above the flood zones of the Passaic River and the Great Swamp. In the 1700's, extensive drainage ditches were excavated to make the Great Swamp accessible for farming and wood harvesting activities. An early 1800 map drawn by Littell shows the whole swamp surveyed into wood lots with the first lot plotted from a "bull's head" stone located behind the Green Village post office. William Penn supposedly was responsible for the survey.

Green Village, a crossroads settlement, developed in the westerly section of town on the edge of the Great Swamp. Scattered farms characterized the rest of the town. In the 1800's, greenhouses dominated the agricultural efforts in the town and immediate region. Morristown, Madison and Chatham Borough were the commercial centers.

As time went on, development took place primarily near roads on easily worked land that had few physical constraints. Housing, dependent on septic systems and wells, was located for the most part on the well-drained soils. Since the early 1960's and the availability of sewers, housing has moved down into areas that once could not have supported septic systems. One hundred apartment units were constructed on slopes above the Passaic River on River Road and two hundred twenty apartment units were built adjacent to the Great Swamp in the Hickory Tree area. Two shopping centers were built at Hickory Tree (at the Shunpike / Green Village / Southern Boulevard crossroads). In the 1980's, nine hundred condominiums were constructed along the Passaic River and are serviced by a small wastewater treatment plant. Areas outside the sewage service area have remained settled much as they were long ago.

Jetport Fight

No account of Chatham Township is complete without a brief description of the fight the town and the region fought to keep the Great Swamp from becoming a metropolitan jet port. In the early 1960's, the New York / New Jersey Port Authority made what many call "stealth" plans to locate a third major airport in the region's backyard. The plans were leaked to the New York Times and caused an uproar. A cross section of people launched a campaign and successfully worked together to defeat the plan.

The citizen's efforts resulted in neighboring towns working together to save a regional resource not only for its flood control value, but also for its aesthetics, its wildlife, and its ecological value. The newly found appreciation of the Great Swamp's treasures led the U.S. Fish and Wildlife Service to agree to establish a Wildlife Refuge here and the first National Wilderness Area east of the Mississippi River.

Saved But Not Safe

Efforts continue to "save" the Great Swamp, this time from the impacts of development. With up-to-date engineering technology, public sewage systems allow construction in areas previously unsuitable for housing and roads.

The Future

Concern about the impact from development led the New Jersey Department of Environmental Protection (NJDEP) to conditional approval of a sewage plant expansion. The conditional approval required Chatham Township to enact very strict stormwater controls. The Township is also being required by the DEP to institute a stormwater management plan that will include land use considerations, such as stream buffers, development location, and density.

Chatham Township is currently working formally with the nine other towns of the Great Swamp watershed to develop land use ordinances that all towns in the region can agree to enact. This regional effort should continue to foster cooperative efforts to protect the Great Swamp.

Chapter 2

GEOLOGY

Geologically, the State of New Jersey is comprised of four physiographic provinces running roughly from north to south: the Appalachian Valley and Ridge, the Highlands, the Piedmont, and the Coastal Plain. Chatham Township lies within the Piedmont in the mid-state region (Figure 3).

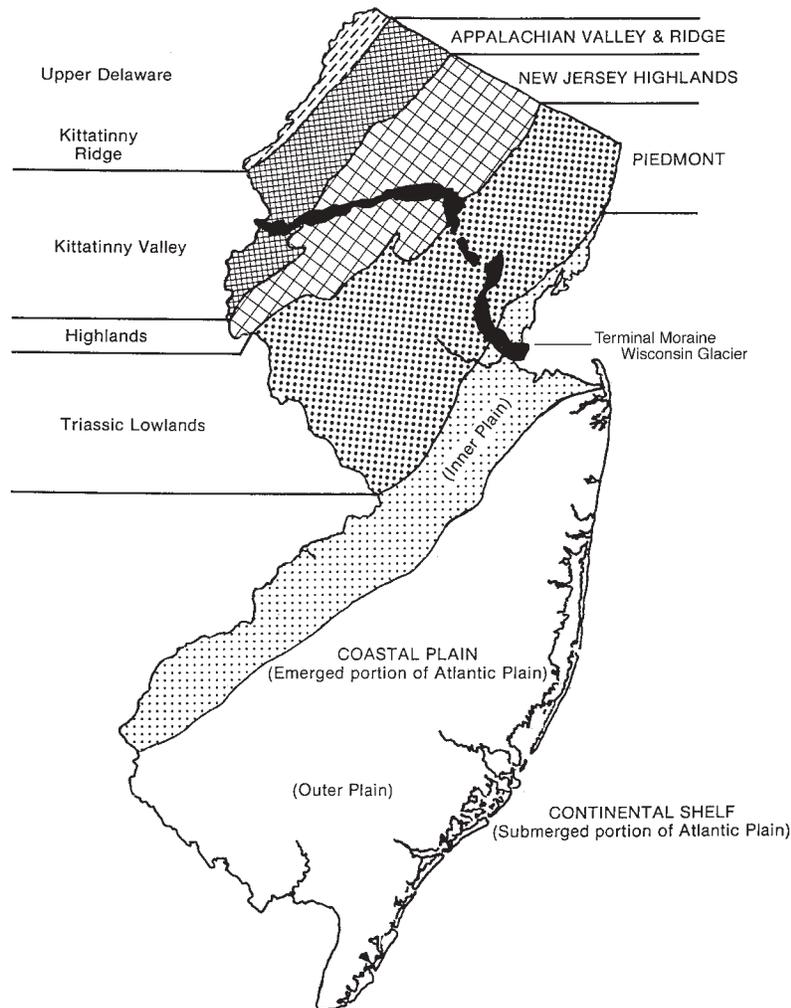


Figure 3—Physiographic Map of New Jersey

Source: Adapted from Map of Geomorphic Provinces of New Jersey, Peter E. Wolfe

Bedrock Geology

Chatham Township's physical features are dominated by Long Hill, the third and westernmost of three parallel ridges known as the Watchung Mountains, which rise from 200 to 400 feet above the neighboring terrain. These were formed during the Triassic Period of geological history. There were once extensive swamps and lakes in this area which were part of a general system extending from eastern Pennsylvania through northwestern New Jersey. Over time, thousands of feet of sediment settled in these lakes and swamps, eventually compressing into red colored sandstones and shales. From time to time, lava flowed from volcanic activity, which cooled into hard, dark colored rock called basalt, was extruded over the sedimentary material, and then was covered by more sediment. The whole complex of softer layers of sandstone and shale and harder layers of basalt were slowly uplifted

along one side so that it now slopes downward 8-10 degrees towards the northwest to a fault close to the present alignment of Route 202. The softer layers of sandstone and shale have weathered and eroded more quickly, leaving long broad valleys between the three ridges formed by the more resistant basalt. Long Hill, as it passes through Chatham Township, rises 250 to 300 feet directly and steeply up from the Passaic River floodplain, then slopes more gently down its north side toward the Great Swamp (Figure 4).

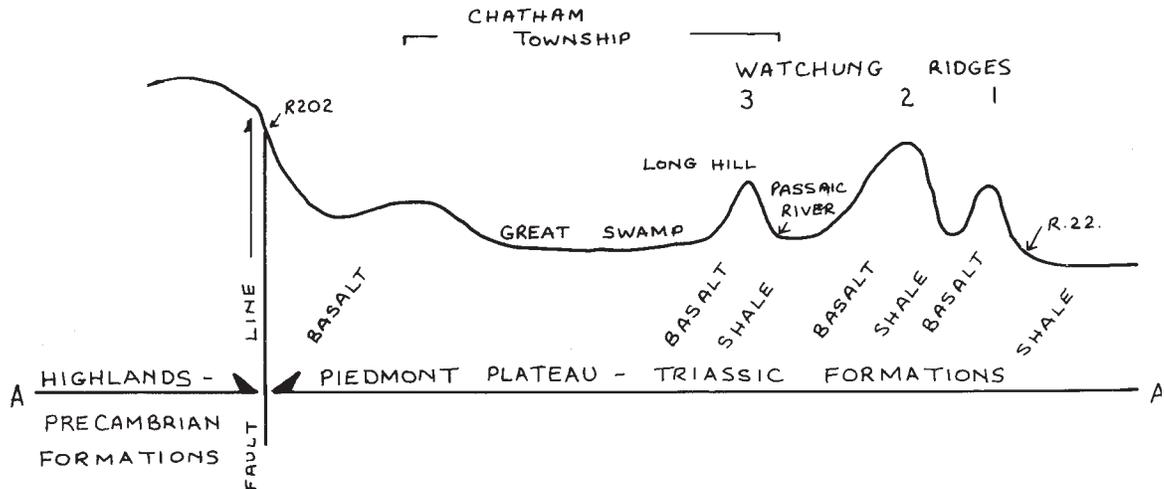


Figure 4—Geologic Cross-Section

The Wisconsin Glacier

Superimposed on this bedrock foundation of basalt, shale, and sandstone are extensive deposits left by the last glaciation. The “Wisconsin Stage” of the glacial epoch, which lasted 56,000 years, is largely responsible for much of our current topography. The Wisconsin, or most recent glacier, reached its southernmost advance in Chatham Township.

Temporary lakes were formed during this period, the largest of which was the Glacial Lake Passaic. Our Great Swamp is a vestige of this lake, which drained long ago. The forward edge of the advancing glacier brought enormous amounts of rocky rubble and finer material, which the melting ice then deposited as a long, low ridge of debris called a “moraine.” Present day Route 124 now runs through Chatham Borough, Madison, and into Morris Township along, or close to, the top of this terminal moraine (Figure 5). The moraine’s surface appearance is now that of a wide, gently rolling, wooded hill or ridge with occasional deep potholes, often filled with water, where glacial ice blocks melted while material was being deposited around them. Kelly’s Pond, in the eastern part of the Township, is an example of such a pond.

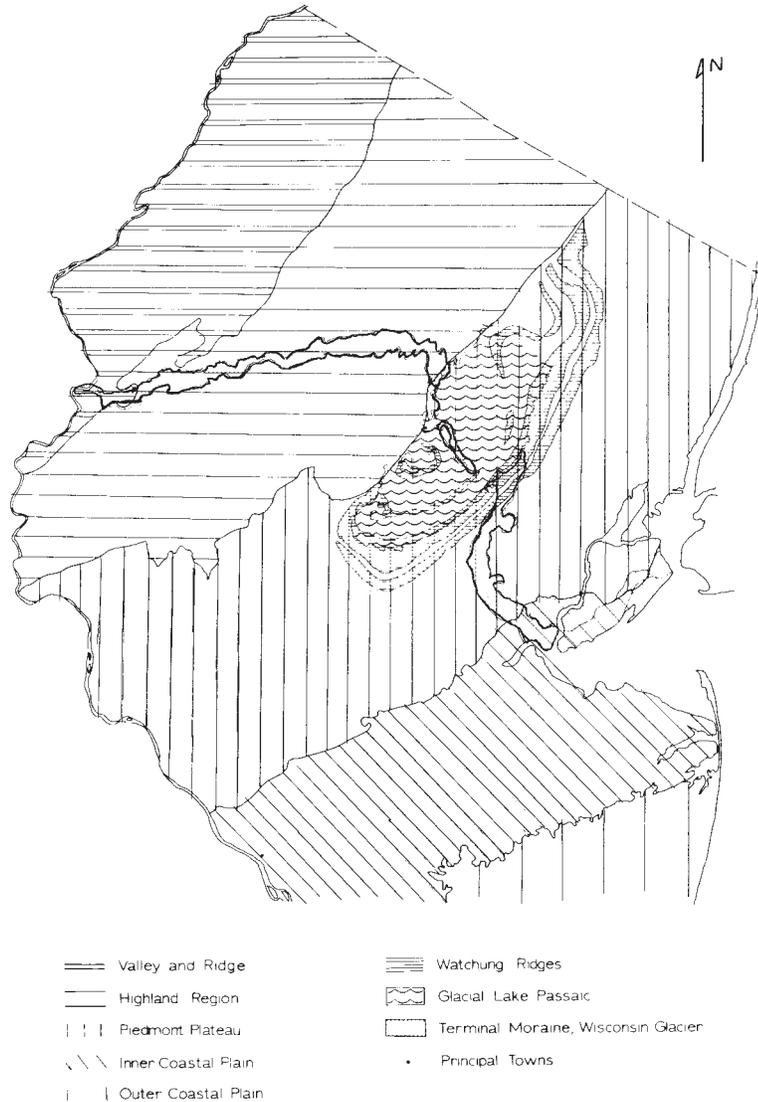


Figure 5—Geologic Map of Northern New Jersey

The meltwater of the glacier washed material from the terminal moraine into the basin to the west, now known as the Great Swamp. Coarser stones and sands were deposited in irregularly shaped patches and mounds near the moraine. The meltwater was caught in a natural basin formed by the Second Watchung Ridge and eventually filled in. For thousands of years the region was inundated by a lake whose size and depth fluctuated with time. Fine particles of sediment carried by the water settled to the bottom of the lake, forming a thick layer of clay (Figure 6).

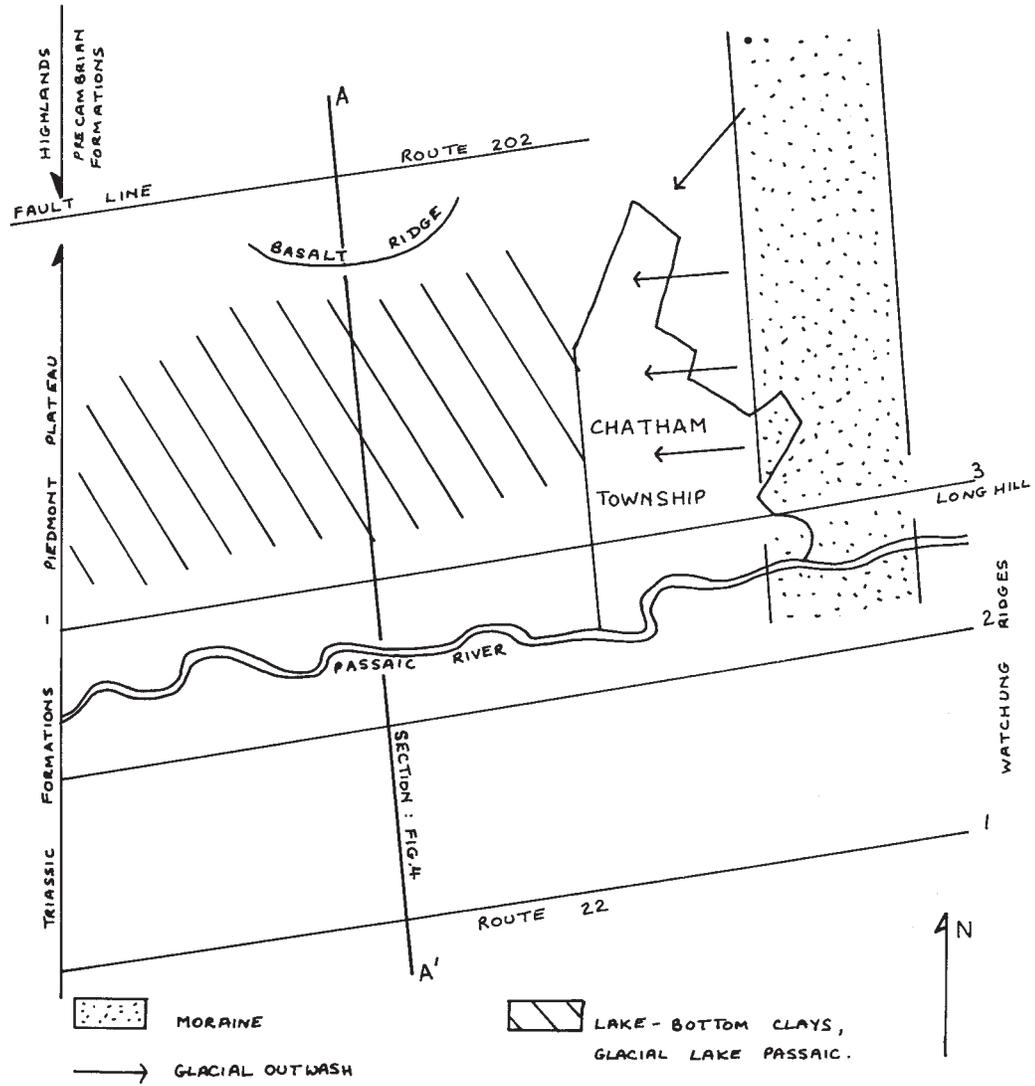


Figure 6—Geologic Map of Chatham Township

These geologic occurrences have determined the shape and form of the local landscape. The flow and storage of water on and beneath the surface of the land and the physical properties of the local soils also result from them.

Buried Valley Aquifer

Chatham Township is one of the thirty-one towns that are in the 80 square mile area of the Buried Valley Aquifer. This is one of the valley fill aquifers created by glacial action. The valley aquifer systems are composed of buried, pre-glacial valleys filled with sediments of glacial and postglacial origin that contain large quantities of water. (See Figure 7.) This aquifer system is extremely productive. As of 1996, pumpage from the system amounted to over 40 billion gallons per year.

Because over half a million people, or ninety percent of the thirty-one municipalities in the Buried Valley Aquifer region, rely on the aquifer for their water supply, the U.S. Environmental Protection Agency designated it as a sole source aquifer. This designation recognizes the primary dependence of these towns on this drinking water source. Towns depending on the Buried Valley Aquifer include Madison, Chatham Borough, Florham Park, and East Orange.

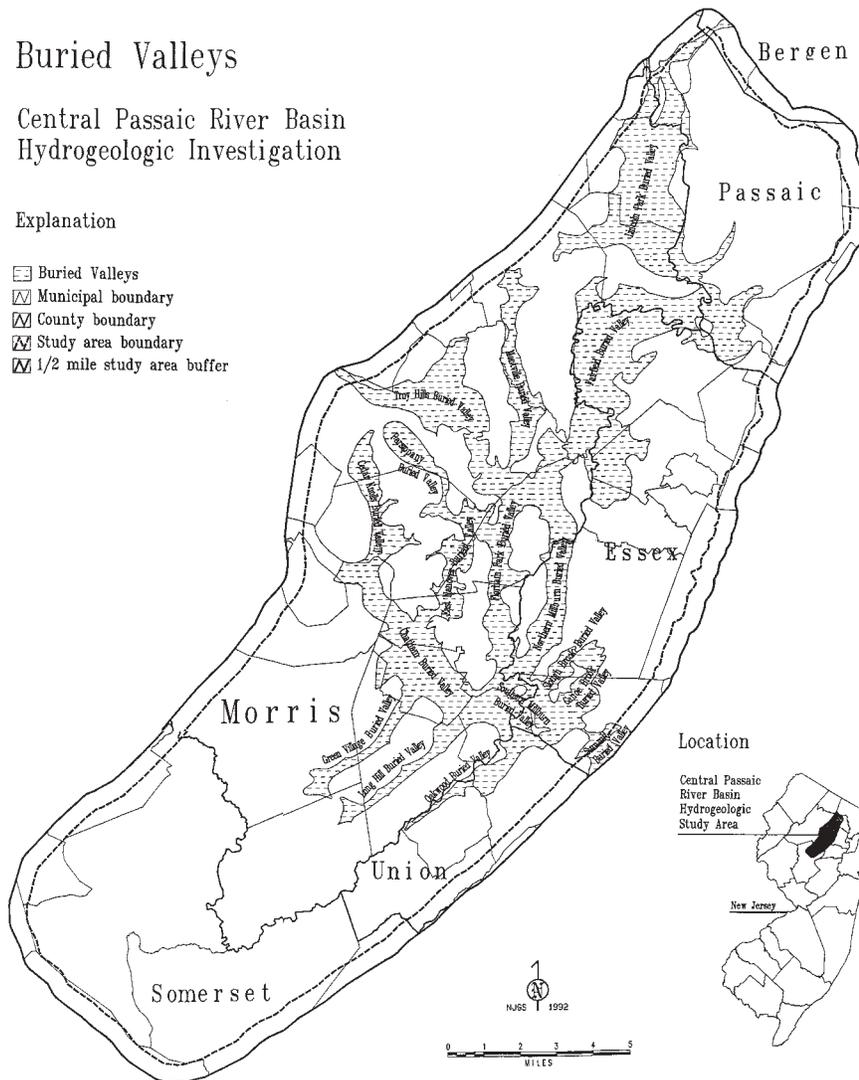


Figure 7 — Buried Valleys

Recharge for the Buried Valley Aquifer

In the early 1990's, the New Jersey Geologic Survey conducted studies to locate the recharge area where precipitation infiltrates the surface for the Buried Valley Aquifer. Locally, the Survey identified, as a prime recharge area, a band of land running roughly across the northerly part of Chatham Township

between Southern Boulevard and Shunpike Road, extending to the west, on either side of Woodland Road. (See Figure 8.)

Chatham Township and Madison have designated a 50 acre tract of land bounded by Woodland Road and Loantaka Way as the "Loantaka Moraine" that is located in the recharge zone. The area contains recharge soils as well as wetlands and both towns have worked for its preservation. The twenty-six acres in Madison was purchased by the Morris County Park Commission. The twenty-four acres in Chatham Township remain in private hands as of 1999.



Figure 8 - Recharge Area, Buried Valley Aquifer

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Chapter 3

HYDROLOGY

Introduction

Water is probably the natural resource we know best, since all of us have had firsthand experience with rain, hail, snow, ice, and dew. Yet water is also the natural resource we least understand. The science dealing with the properties of water, the distribution of water on earth, and the effects of that distribution is known as hydrology.

All the water on earth — rainfall, waves pounding on a beach, the flow from a faucet, a still lake in the morning, or a drop of dew — is part of a continuous physical process known as the hydrologic cycle (Figure 9). Water evaporates into the air from bodies of water and land, cooling as it rises. When the water vapor reaches the condensation point, clouds form. Eventually precipitation in the form of rain or snow occurs, often many miles from the area of evaporation. When the water falls back to earth, it may evaporate, transpire back into the atmosphere through trees and plants, infiltrate into the soil, or flow across the surface of the land into a stream, river or lake. Ultimately the water will flow back to the ocean.

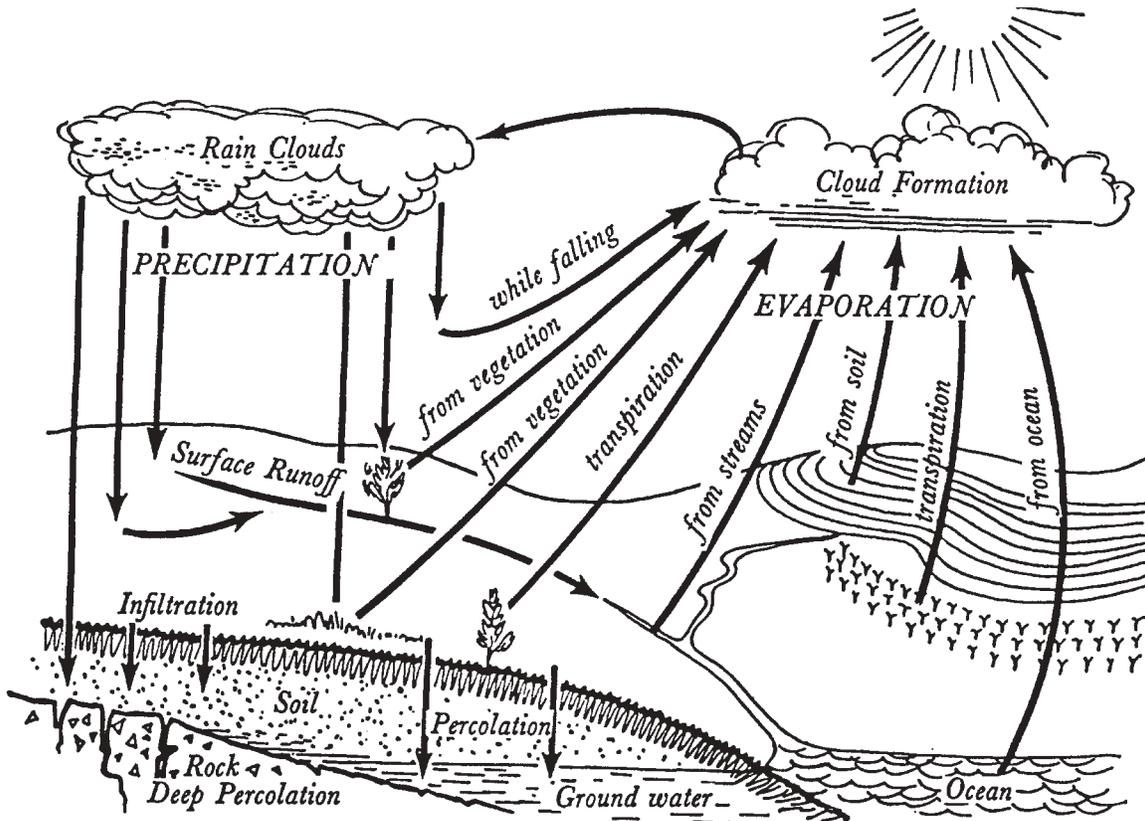


Figure 9—Hydrologic Cycle

Source: The Yearbook of Agriculture, 1955, U.S. Dept. of Agriculture

The source of most atmospheric water is the ocean. The continuous movement of water from ocean to atmosphere to land and back to the sea is the major flow path of the hydrologic cycle. In the subterranean portion of the cycle, underground stores of water called aquifers may discharge some water directly to rivers and some directly to the sea.

Groundwater and surface water are the major sources of water supply. Groundwater is water stored in the ground and is the largest single source of fresh water on earth. Surface water is stored in ponds, streams, rivers, lakes, and reservoirs. Both sources are recharged directly or indirectly through precipitation, and both can serve as sources of drinking water. In New Jersey, sixty percent of our drinking water comes from underground sources.

Groundwater

Nearly all the ground water in Morris County originates from local precipitation. A large part of the precipitation either flows overland directly to the streams or is retained in the soil from which it is returned to the atmosphere by evapotranspiration. The remaining precipitation percolates through the soil to the zone of saturation, where it is called ground water.

Ground water occurs under unconfined or water table conditions throughout Morris County. However, in much of the lowland areas, the consolidated rocks are covered by unconsolidated deposits that contain one or more relatively impermeable clay and silt beds. The impermeable layers confine the water in the underlying permeable zones which consist of sand and gravel deposits and the consolidated rocks. Hence, wherever such confinement occurs, water beneath the confining layers is under hydrostatic pressure. In many places, the resulting artesian head is above land surface as indicated by numerous flowing wells. This is particularly true of the extensive swampland areas through which the Passaic River meanders.

The movement of ground water is in response to hydraulic gradients. In Morris County, the direction and magnitude of the natural gradients are controlled largely by the topography, and the resulting water-table profile approximates the local topographic profile except that it has less relief. Water that enters the ground water body in the interfluvial areas (upland recharge areas) where the water table is at relatively higher elevations moves slowly toward the intervening stream channels lying at lower elevations. Ground water is discharged directly to the streams wherever they intersect the water table and supports stream flow during periods of no precipitation.

In the Great Swamp areas that are underlain by clay and silt, such as those along the Passaic River, discharge of ground water to the streams is restricted by low permeability of the materials and the slight hydraulic gradients. During the vegetative growing season, most of the groundwater discharge occurs in these areas as evapotranspiration and very little is discharged to the streams. Consequently, dry weather stream flow is not augmented significantly by these areas and is reduced by the high rate of evapotranspiration during the growing season.

Shallow Groundwater Levels Around The Great Swamp

In 1969 the U.S. Fish and Wildlife Service established shallow groundwater observation wells of from 8 feet to 15 feet around the Refuge perimeter at 9 locations. They monitored the water elevation in these wells 27 times from 1969 to 1974. Another set of monitoring data was collected 25 times during 1995 and 1996. The results show that water levels in the shallow aquifer below the Great Swamp have remained fairly level. There has been no appreciable increase despite observations by residents of Green Village who believe the water table is rising. Some of the change residents are observing could be caused by old drainage tiles that previously drained open fields falling into disrepair.

Chatham Township's Wells and Water Supply

According to the 1990 U.S. Census, 70 housing units in Chatham Township rely upon private water wells as the source of water. The remainder of the housing units in Chatham Township, 2870, obtain water from the New Jersey American Water Company (NJAWC), an investor-owned, private water utility.

All of the public drinking water supply in Chatham Township comes from three primary sources. From the north, a recently constructed thirty-inch supply line brings treated water from the Passaic Valley Water Commission plant located on the Passaic River in Little Falls, NJ. On occasion, this water supply may be supplemented from the North Jersey Water Supply Commission plant located in Wanaque, NJ. The Chatham Glen development in the southeastern portion of the Township receives water from the New Jersey American Canoe Brook Treatment Plant in Millburn. This supply can be a blend of well water from the Canoe Brook and Passaic River well fields along with surface water supply from the Passaic River and Canoe Brook. The well fields draw from the Buried Valley Aquifer. From the southwest - the third major water supply for the Township comes from an interconnection with the Elizabethtown Water Company at Diamond Hill Road in Berkeley Heights. The Elizabethtown Water Company supply is all surface water and originates at the Round Valley / Spruce Run reservoir systems in the vicinity of Clinton, NJ.

One water storage tank, a 1.42 million gallon standpipe, is located in Chatham Township on Huron Drive. Additional storage capacity for the Township is also provided by a 1.0 million gallon tank on the Sisters of Charity property in Florham Park and a 3.0 million gallon tank at Benders Corner in Berkeley Heights.

There are seven additional water system interconnections with Madison and Chatham Borough to provide service reliability. For public fire protection, there are approximately 292 public fire hydrants located throughout the Township. Chatham Township pays an annual fee of approximately \$110,000 to the New Jersey American Water Company to maintain the public fire hydrants in the Township.

HYDROLOGICAL FEATURES

Chatham Township has two watershed areas - the Great Swamp and the Passaic River. Stormwater runoff from most of the Township flows into the Great Swamp watershed. The other runoff flows from the crest of Long Hill directly into the Passaic River watershed. The water in the Great Swamp flows westward into the main channel of the Passaic River at Millington Gorge.

Several miles downstream, the Passaic River, as it enters Chatham Township, is a small, slowly-flowing river whose immediate environs indicate considerable variation in water level. For 3-1/2 miles, it flows through a wide, nearly flat stretch of woods and fields extending from low muddy banks across to the steeply rising slope of Long Hill. Many houses are built close to the river along the south bank, while the Chatham Township side is in a more natural state. The drainage area on the Chatham Township side, from the ridge top to the river, is of sufficiently small size that the ditches and brooks entering the river are small. Two small sewage treatment plants on the Chatham Township side, serving the one hundred-unit Cardinal Hill apartments and the nine hundred-unit Chatham Glen condominium development, discharge into the river. The New Providence and Berkeley Heights municipal treatment plants discharge from the south side of the river.

In its final mile of passage through the Township, the river and its environs change character completely. The effects of glaciation are immediately apparent as the river flows through the moraine and into the glaciated portion of New Jersey in the vicinity of Mt Vernon Avenue. Muddy banks and channels, bordered by a well-developed floodplain, are replaced by a gravelly river bottom with small beaches and mounds of rounded stones of granite and other foreign material. The floodplain narrows and then disappears. The banks become high, with steep cliffs on the south side and a wooded hillside on the Chatham Township side. The river flows more swiftly through this section, riffing around randomly located stones. It passes under Stanley Bridge and, once out of the Township, is soon encroached upon by industry and other development.

Passaic River

The Passaic River is northeastern New Jersey's largest source of water supply. The river is the source of water supply for over 500,000 people. The natural quality of water in the river as it enters Chatham Township has been altered by the discharge of at least six municipal sewage treatment plants located upstream, as well as leachate from dump areas, and agricultural enterprises. Dumping, treatment plant outflow, industrial waste, and the salt and petroleum residue of street runoff are added to the river from the Chatham Township / Berkeley Heights / New Providence area. As a result of diminished water quality, people along the Chatham Township portion of the river forego some of the pleasures and amenities the river used to offer, such as swimming. Because the ability of aquatic life to live in the river is controlled by the conditions it experiences, there is less abundance and variety of river-dwelling and plant life in the Chatham Township stretch of the river than is found further upstream.

All along the river channel the proportion of effluent and other wastes increases during periods of dry weather. These concentrations become more diluted with increased amounts of direct precipitation and runoff. Even so, the lower Passaic River used to be notoriously polluted. Over the last decade several sewage treatment plants have upgraded their treatment processes and recent studies by the New Jersey DEP show substantial improvements in the river.

Floods

The river receives water from precipitation that falls in its watershed and flows above or below ground to the stream channel. Many factors, both natural and man-made, complicate this process so it can become very difficult to predict the height of water in the river at any given moment. The Great Swamp and the Millington Gorge, increasing development within the watershed, and additional water introduced from outside the watershed for water supply are all factors in the dynamics of water flow in the Passaic River.

The highest flood ever recorded at the Millington Gorge gauge occurred in January, 1903. The flow was measured at 2000 cubic feet per second (Water Resources Data for New Jersey, 1972).

This watershed area, if it did not contain the storage area provided by the Great Swamp, could have been expected to discharge 6500 cubic feet per second (computation based on the method developed by Stankowski, 1973). However, while the Gorge is large enough to allow free passage of average flows, it restricts passage of flood levels. The detention provided by the Great Swamp substantially prolongs the time of higher-than-average water levels downstream from the Gorge, but reduces the highest level of the flood peak (Ebasco Services, Inc.).

Peak flow from any design storm will increase with increased development in the watershed. Precipitation, which would have evaporated directly from leaf surfaces or been retained in the natural mulch of the forest floor, or retarded in its rate of runoff by natural conditions (and thereby be given more opportunity to sink into the ground and enter the water table), runs off the paved and roofed surfaces with no absorption into the ground and no time delay or interception by vegetation. A greater volume of water arrives at the stream in a shorter period of time, raising the height of floods and shortening the time that elapses between the onset of rainfall and the peak flow.

The proportion of runoff to rainfall increases during long wet periods when the soil remains saturated and cannot absorb more precipitation. When a higher percentage of precipitation becomes runoff, less water is retained in the ground to replenish the river during periods of low flow.

Floods are natural phenomena that occur whenever the amount of water exceeds the capacity of the channel that must carry it. Floods on the Passaic River are not limited to particular seasons, but may happen at any time because of the generally even distribution of rainfall throughout the year. When the defined river channel overflows, water spreads out into the floodplain adjacent to the river. The effects of flooding are intensified when the floodplain becomes restricted by filling and construction. Increased stormwater runoff also increases flooding. When sediment is deposited in the river channel, the capacity of the channel to carry floodwater is decreased.

The New Jersey DEP has compiled a variety of historic data on local flooding between 1903 and 1971. These data have been used to delineate the area on either side of the channel of the Passaic River and its principal tributaries that are necessary to allow for the storage and passage of floodwater. About 190 acres of this delineated floodplain lie in Chatham Township. Any development in the floodplain is regulated by the New Jersey DEP under the Stream Encroachment Permit program.

Loantaka Brook

The valley of Loantaka Brook in the northern part of the Township is also subject to flooding. This primarily affects houses along Green Village Road. Most recently, the road was closed because of the October 1996 nine-inch (approximate) rainfall and 1999 Hurricane Floyd which caused severe flooding. A tributary of the Passaic, Loantaka Brook flows from Morris Township through Chatham Township and enters the Great Swamp. There it joins Great Brook and flows southwest into the Passaic River.

Loantaka Brook's valley in Chatham and Morris Townships descends from gently rolling hillsides and open fields to the mostly wooded environs of the brook itself. Most of the brook's adjacent flood area is preserved as the Morris County Loantaka Brook Reservation. From 1954 to 1974 approximately 18% of the watershed had been developed. Since 1974, some large multi-density housing developments have been built, one on Madison Avenue and one on Woodland Avenue, both in Morris Township. In addition, office buildings and site improvements on Giralda Farms all drain to Loantaka Brook.

Increased stormwater runoff from the new development augments natural flow in the brook. An additional 1.6 million gallons per day is added by treated sewage effluent from the Woodland Road Treatment Plant in Morris Township, which began operations in 1968.

A prolonged severe drought during the mid-1960's lowered water tables and stream levels throughout the northeastern United States. This was followed by record precipitation in the early 1970's. Since then, development and periodic extremes in weather have changed significantly the shape of the stream channel as well as the amount of water carried by Loantaka Brook. These changes include serious erosion with the resultant sedimentation and broader, shallower channels. In addition to increased flooding, the stream has suffered from the loss of wetlands and the recharge they provide which has resulted in lower base flows during dry periods

Black Brook

A number of streams of varying size drain from the terminal moraine in the area of the shopping centers on Shunpike Road and the north side of Long Hill down into Black Brook. The 1972 U.S.G.S. quad shows three major branches of Black Brook. The brook also receives effluent from the Chatham Township Tanglewood Wastewater Treatment Plant. The Black Brook branch receiving substantial drainage from the Shunpike area - shopping centers, roads, and the Chatham Hill Apartments - flows into the Swamp, then directly into the Rolling Knolls Landfill, a 200 acre sanitary landfill shut down in the 1960's. The status of impacts to the landfill and potential leachate problems are currently under investigation. All branches of Black Brook join before meeting the Passaic River in Long Hill Township.

The Great Swamp

The Great Swamp is the focus of the natural systems of much of Chatham Township. A major portion of the swamp is protected as the 7,454 acre Great Swamp National Wildlife Refuge. Established in 1964, the Refuge is divided into two major areas - the Wilderness area and the management area. The 3,660 acre Wilderness area is located in the eastern part of the Great Swamp in Chatham, Harding, and Long Hill Townships, east of Long Hill Road. It was created by an act of Congress in 1968 to preserve and restore the area in its pristine uniqueness for future generations. The U.S. Fish and Wildlife Service manages the other 3,794 acres of the Refuge for the protection of migratory waterfowl, the preservation of the diverse vegetation and wildlife, to provide a program of interpretation and education to the public, and to provide an outdoor laboratory for observation by the people of the heavily populated surrounding area.

From the crest of Long Hill northward, almost all of the Township's water flows into the Great Swamp. Its alternations of wet and drier areas, open and wooded sections, flowing water and ponded water provide extensive and varied habitat for most kind of wildlife found in the Township. The swamp acts as a modifier of local climate, as well as an air and water purifier. It serves important flood control functions. It is of aesthetic and recreational value to people.

Water is an essential element in all of these functions. In combination with geologic and soil conditions, it has given rise to a further dependent complex of vegetation and wildlife. For the swamp to maintain its multiplicity of function, its natural state as a swamp is essential. Construction of a jetport and building a dam across the Millington Gorge are plans for the swamp that have been rejected as too destructive of its integrity. Similarly, impure water, too much water, rapid changes in water level and other conditions often created by a developing watershed can also be destructive of its functioning.

Like the river, the Great Swamp must be viewed in terms of its whole watershed. In addition to the precipitation that falls on it directly, water flows into the swamp in major brooks, through 77 stormwater outfalls, intermittent streams, wastewater treatment plant discharge, and by seepage from shallow groundwater. Loantaka Brook flows into Great Brook in Harding Township. Great Brook is also joined by Primrose Brook. Further to the west, Black Brook drains the terminal moraine area by the Green Village / Shunpike Road intersection area to the north side of Long Hill. For many decades, surface drainage in the swamp was augmented by an extensive system of man-made ditches that reduced the time required for water to reach an established channel.

The usual result of development in a watershed is to increase peak flows from storms and decrease low flows due to loss of recharge. (See Figure 10.) Streams in the watershed also carry an increased amount of salt, petroleum and rubber residue from streets, as well as sediment from construction projects. Vegetation and animal life of the Great Swamp are sensitive to these factors and cannot live with variable water levels, long periods of too much water, reduced water quality, or inundations of sediment. Changes in the Great Swamp caused by watershed development could be interpreted as being in conflict with the spirit of the federal government's designation of the east end of the Great Swamp National Wildlife Refuge as a Wilderness Area.

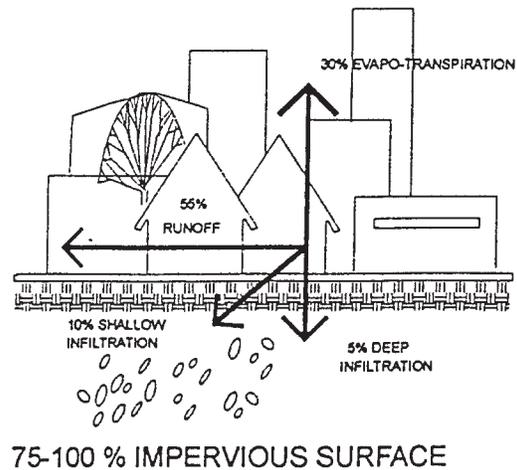
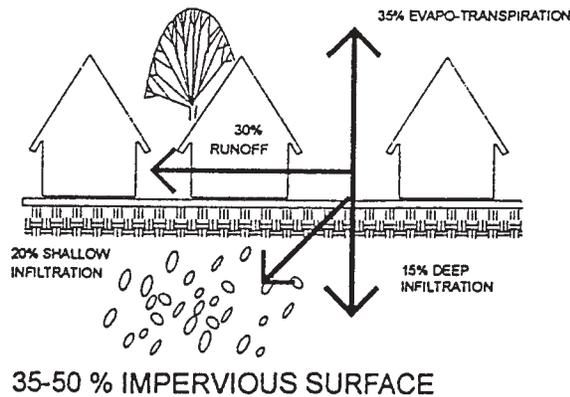
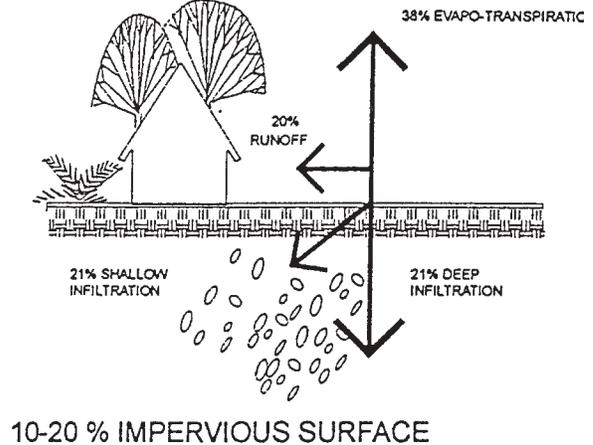
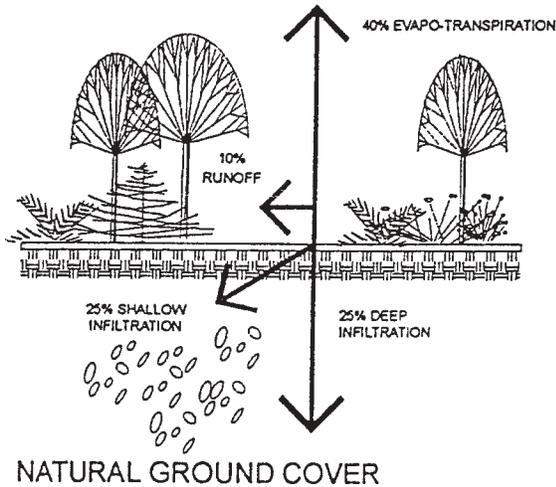


Figure 10—Evapotranspiration Chart

Source: U.S. Environmental Protection Agency

The swamp is a composite of natural features and must be defined from that viewpoint. Chronically wet soils (Soil Conservation Service definition) and vegetation that reflects a requirement for water (information obtained from infrared photographs) delineate the natural entity of the swamp. The swamp is made up of contiguous wetlands as defined in the New Jersey Freshwater Wetlands Protection Act as:

“areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation...”

The 240-foot contour line which reflects the flood hazard area for the Great Swamp in Chatham Township also helps to define the limits of the swamp. The swamp is also dotted with higher lands, a legacy of ancient Lake Passaic.

Development occurred in parts of the Great Swamp before the federal and state wetlands laws were enacted. High water tables and poorly drained soils have resulted in flooding or wet basement problems for structures there. Runoff from higher lands has traditionally been directed to the Great Swamp. A stormwater study completed in 1997 identified 77 stormwater outfalls carrying substantial quantities of runoff that otherwise would have reached the swamp more gradually as flow over land and from groundwater replenishment from infiltration.

Hydrology in the Great Swamp Basin

The Great Swamp is critically affected by the five major streams flowing into and through it. From east to west they are: Black Brook and Loantaka Brook in Chatham Township, Great Brook, Primrose Brook and the Passaic River. (See Figure 11.) The Great Swamp reduces extremes of streamflow from the four major feeder streams caused by weather and seasonal changes in two ways: by holding peak flows from storm events and discharging stored groundwater during dry periods. Land use changes in the watershed affect the swamp to various degrees depending on the nature and the location of the change.

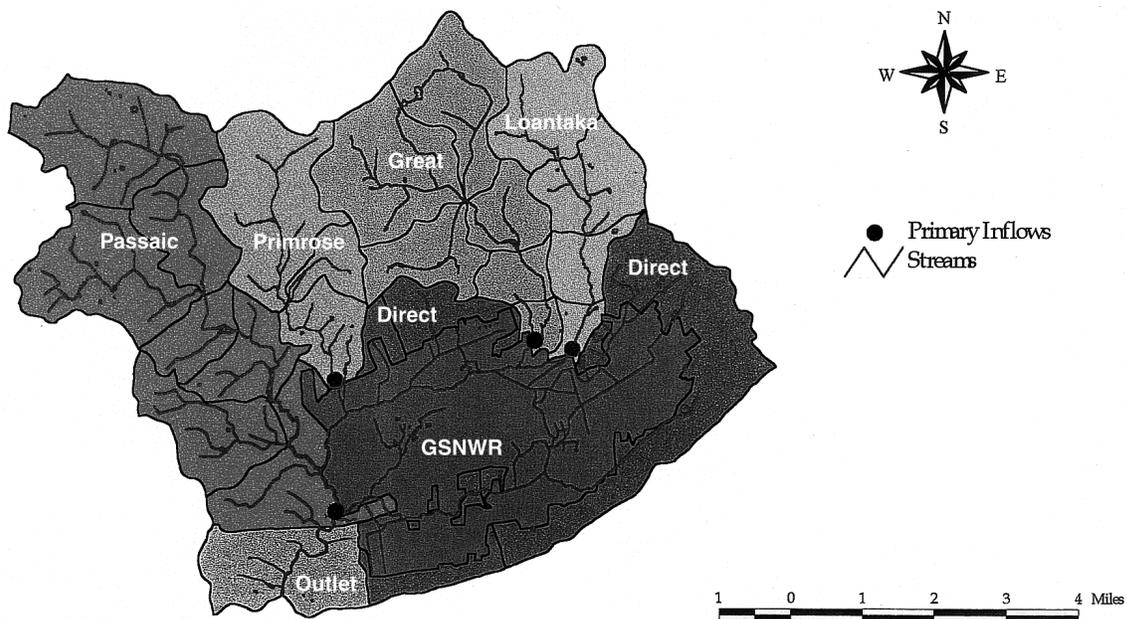


Figure 11 - Subwatersheds Tributary to the Great Swamp

Observations by the U.S. Fish and Wildlife Service, the Soil Conservation District, consultants and residents include increased frequency of road flooding, flooded basements, an increase in the frequency and magnitude of peak stream flows causing erosion of stream banks and downstream deposition of sediment. The U.S. Fish and Wildlife Service is experiencing difficulties in managing the water levels in the refuge. There is concern that increasing development will increase flooding.

Because of concerns regarding negative impacts to the swamp from increasing development and expanded sewer facilities, the Commissioner of the New Jersey Department of Environmental Protection in 1989 issued an administrative order establishing the Great Swamp Watershed Advisory Committee (GSWAC). The committee was created to study and make recommendations regarding the Great Swamp. CH2M Hill, hydrologists, evaluated the hydrology of the Great Swamp by developing a hydrologic budget to study water flow into and out of the swamp. The budget helps us to understand the problems identified above and the effects that future land use changes will have on the swamp's hydrologic process. The water that enters the system (inflow) minus the water that leaves the system

(outflow) equals the change of storage of water within the basin. On an annual basis, a change in storage could be caused by depletion of groundwater which would lower groundwater levels. Another mechanism for changing the annual storage would be to construct or remove a surface water reservoir, changing the volume of surface water that can be stored within the system.

The inflows to the basin and the outflows from the basin can be summarized by the following terms:

Inflows

- Precipitation – average annual precipitation
- Subsurface Inflow – regional groundwater flow into the basin
- Imported Water – water supply from outside the basin and transferred into it, e.g., sewage treatment plant discharges)
- Flow from Surface Storage – flow from draining wetlands
- Flow from Groundwater Storage – depletion of groundwater

Outflows

- Surface Outflow – total runoff / stream flow leaving the basin
- Evapotranspiration –water leaving the basin via evaporation from all water, soil, snow, ice, vegetation, and other surfaces, plus plant transpiration
- Consumptive Use – domestic, commercial, and industrial use
- Flow to Surface Storage – increase in surface water storage, such as flooding wetlands, raising reservoir levels, or forming new impoundments
- Flow to Groundwater Storage – artificial recharge

CH2M Hill conducted the hydrologic budget study in 1991. The results of the study indicate that increased volumes of runoff flow into the swamp, but not necessarily through it. Increased annual volumes of surface runoff from land use changes between 1963 and 2000 were assumed by the study to be mostly the result of decreased evapotranspiration, and, to a lesser extent of decreased groundwater recharge. Should this continue, the duration and depth of water ponded within the Great Swamp may increase over present levels for the same amount of rainfall. Available data are insufficient to quantify these changes directly; however, various methodologies were used to investigate the impacts of land use changes. For example, past land use changes from open or forested sites to less pervious land coverage have probably resulted in the bulk of the change in runoff volumes and peak flows. However, less intensive land use changes, such as substantial large-lot residential development, may have a long-term impact on the budget through changes or loss of evapotranspiration. This strongly suggests that retention of shade trees is extremely important to help control stormwater runoff

A more recent study completed in 1997 by environmental consultants verifies that developed areas in the watershed are contributing much higher than expected stormwater runoff volumes to the swamp. The results were from monitoring in Chatham Township at a 42" diameter pipe draining a 269.8 acre area of 1/2 acre zoning with 20% impervious cover in Wickham Woods. The study pointed out that this must be due to the fact that 75% of the area is composed of extensively disturbed soils, disturbed by the 1/2 acre density residential development.

New Jersey Department of Environmental Protection Surface Water Quality Classifications in Chatham Township

The New Jersey Department of Environmental Protection (DEP) establishes classifications for water bodies in the state. These classifications are in place to protect designated uses and give DEP a basis for regulating discharges to these waterbodies. The state also assigns an antidegradation category to all waters.

Loantaka and Black Brooks are classified as Non-trout, Category Two waters. This means that all discharges must meet certain standards and must also establish that the discharge will create minimal, if any, degradation. The Great Swamp National Wildlife Refuge is classified as a Non-trout, Category One water. This means that any discharge to the refuge cannot cause a measurable or calculable change to its water quality. In addition, any discharge to Loantaka Brook or Black Brook or any tributary must result in no measurable or calculable change to the downstream Refuge.

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Chapter 4

CLIMATE

The drainage, vegetation, and wildlife patterns of a region are largely determined by climate interacting with the geology and soils of the region. The most important climatic factors are wind velocity and direction, temperature variations, and precipitation.

Many environmental problems are associated with the atmosphere and climate. Extremes in weather can have disastrous effects — floods, storm damage to vegetation and man-made structures, wildlife destruction, and droughts. Air pollution can also have detrimental effects.

New Jersey is in the same north-south position as Northern California, Salt Lake City (Utah), Boulder (Colorado), Portugal, Southern Italy, Turkey, Mongolia's Gobi Desert, and North Korea. Clearly, climatic conditions in these places are quite different. Latitudinal position, then, is only one of a number of factors that determine the climate of a region. In addition to the angle of the sun's rays and the length of daylight (factors determined by the latitude), an area's altitude and nearness to oceans and mountain ranges have an influence on its climate. Also important are the source and direction of air masses that flow over a region.

New Jersey has a humid continental climate, similar to the midwestern states. A continental climate is characterized by significant variations between the temperatures of summer and winter, specifically, by a range in temperature of 40 degrees or more from the coldest month of the year to the warmest month. This climate also displays relatively large daily and day-to-day temperature fluctuations.

These cold winters and near-tropical summers result from the direction of the seasonal prevailing winds. Our latitudinal position places us within the global wind system known as the Prevailing Westerlies. Due to the influence of these winds, weather in the mid-latitudes generally moves from west to east.

Winter

In wintertime the prevailing winds are from the northwest, subjecting us to the regular invasion of cold air masses moving down from Canada. These outpourings of polar air are warmed slightly in their passage across the Midwest and eastern mountains, but not enough to protect us from bone-chilling temperatures. All weather monitoring stations in the northern part of the state have experienced -15°F (-26°C) or lower.

For the month of January, which is the coldest month, temperatures at the National Weather Service station at Canoe Brook in Millburn Township range from a mean low of 20°F (-7°C) to a mean high of 41°F (5°C). According to the New Jersey Almanac, the record low temperature for that station is -26°F (-32°C). The average annual degree days recorded at Newark Airport are 5,067, with 4,205 of them, or 83%, occurring between November 1 and March 31. Degree days are the measurements for space heating. They are computed by determining for each day the number of degrees that the median temperature falls below 65°F (18°C).

Summer

During the summer, warm tropical air masses move into New Jersey from the Southwest and South. Many of these moist, hot air masses originate over the Gulf of Mexico, flow inland, and then travel over very warm land before reaching New Jersey. At Canoe Brook, the average temperature for July, the warmest month, is 73°F (23°C). July temperatures average higher than 70°F (21°C) throughout the entire state, although shore and mountain areas are colder than inland and northeastern locales. Occasional heat waves elevate the mercury to the nineties and sometimes over 100°F (38°C), especially during July and August. The highest recorded temperature at Canoe Brook is 106°F (41°C).

Of special interest to gardeners is the average length of the frost-free season. For a ten-year period, the mean date of last spring occurrence of a temperature of 32°F (0°C) or below was May 4, and the mean date of the first fall occurrence was October 10, giving, on the average, 159 days free of frost.

Precipitation

New Jersey's precipitation is well above the national average of 20 inches per year. The southeast coast of New Jersey receives about 40 inches, and the north central part of the state receives up to 51 inches. Chatham's average annual precipitation is 49.35 inches.

The number of days a month with measurable precipitation averages 8 for each of the months of September, October, and November and 9 to 12 for the other months of the year. In total, almost 120 days a year have measurable precipitation. Rainfall is well distributed throughout the year, but is heavier during the summer. Average monthly precipitation varies from a low of 3.17 inches in February to a high of 5.25 inches in August.

The snowfall recording station nearest to Chatham is in Morris Plains, which averages about 31 inches a year. Stations at Plainfield, Elizabeth, and Little Falls average a few inches less. New Jersey occasionally experiences snowfalls of 10 or more inches in a single storm. Snow seldom occurs in Northern New Jersey before mid-October or after April 20.

Drought

Not all years are equally wet, however. Yearly rainfall may be 15 inches less than average - 30 inches less than in a wet year. Brief periods of drought during the growing season are not uncommon, but prolonged droughts are relatively rare, occurring, on the average, once in 15 years. The drought of early to mid-1960's was very severe. While Chatham Township residents have had to put up with water use restrictions in such times, they have not suffered as much as towns in the state with a less adequate water supply.

During the 1960's, many towns allowed development to take place on soil that appeared dry and stable only to find, in later years when rainfall returned to normal, that those subdivisions had serious problems with drainage and water-related building characteristics. Such mistakes can be avoided by making use of the Soils Maps prepared by the Soil Conservation Service.

Floods

At the other extreme is the flooding which results from the severe storms which converge on New Jersey from three directions. Polar storms originate in Canada, cross the Great Lakes region, and then move down the St. Lawrence Valley, the southern fringes of these storms have an important influence on the weather of the northern part of the state. Continental disturbances begin over western U.S. land areas and move eastward. Our heaviest rains, however, come from storms of tropical origin. Storm systems may be born in the Gulf of Mexico, the Caribbean, or off the Carolinas, and travel northerly across ocean or land. Some of these storms may be of sufficient strength to be classified as hurricanes, but storm systems of less intensity may still dump considerable rain on our state.

The centers of these tropical disturbances often pass some distance off the coast of New Jersey. Occasionally, though, tropical storms move inland on the southern Atlantic coast and move northward either through or to the west of New Jersey. Finally, a tropical disturbance may decay south of the state, before its center can reach us. Any of these situations may produce very heavy rainfall over all or part of New Jersey.

While most occurrences of very heavy rainfall are associated with tropical disturbances, it is important to realize that cloudburst-type rainfall in a limited area can produce very heavy rainfall also.

From the standpoint of flooding, we have been very fortunate during the last six decades; actual flooding has been far below potential. At any time, we in New Jersey could experience floods of great magnitude. The following table indicates the degree of severity of storms which have hit New Jersey in the past 130 years.

Some Past Heavy Rainfalls in New Jersey

<i>Date</i>	<i>Location Cited</i>	<i>Rainfall</i>	<i>Remarks</i>
Aug. 5,	1843 Newark	15"	
Sept. 21-23,	1882 Paterson and South Orange	11"- 17.9"	Hurricane just touching the southern New Jersey coast
Sept (month)	1882 Paterson	25.98"	Total monthly rain fall
July 30-31,	1889 South Orange	8.40"	Heavy flood damage
Oct 8-9,	1903 Newark, Paterson & Perth Amboy	10+"	Decaying tropical storm off coast
Sept 17-21,	1938 New Jersey	6-11"	Passage of hurricane off New Jersey coast
Aug. 19-20,	1939 Tuckerton	14.81"	Decaying tropical storm
Sept 1,	1940 Clayton	10.52"	Heavy thunderstorm actively along with a tropical storm centered 150 miles east of the New Jersey coast
Aug. 11-16,	1955 Sussex County	8.10"	Hurricane Diane traversed Central New Jersey in a northeasterly direction
Aug. 26-28,	1971 New Jersey Chatham	3.05-11.43" 9.33"	Hurricane Doria
Sept 11-14,	1971 Northeastern New Jersey	4.54"-7.50"	Tropical storm Heidi moving north northeastward, passing well off the New Jersey Coast
Aug. 3-7,	1978 Morristown	8.1"	Four day continuous rainfall
July 26,	1981 Madison	4.0"	
October	1993 Madison	8.0"	High intensity storm
September	1999 Madison	+10.0"	Hurricane Floyd

Source: Floods of August and September, 1971, in New Jersey, New Jersey Department of Environmental Protection with USGS and NJDEP NJGS Daily Precipitation Charts, 1982.

Air Quality

The New York City Metropolitan Area, of which Morris County is a part, is one of the worst air pollution and smog zones in the nation. New York City and Newark invariably appear on lists of the 20 cities with the worst air quality.

This is not to suggest that Chatham does not have vastly superior air quality than its larger, more densely-populated neighbors. Clearly, these highly urbanized areas have greater numbers and concentrations of major air pollution sources: automobiles, industries, electric power plants, and residential and commercial heating units.

Fortunately, the prevailing winds that blow over Chatham come from the northwest or southwest, not from the urbanized east. A concentration of pollution sources to the northwest or southwest of the Township would have an adverse effect on the air that Chatham residents breathe.

Chatham also benefits from the relatively high percentage of tree cover in and around town which helps to cleanse the air of pollution. Multiplying this benefit are the “islands of green” that are found in surrounding areas: the Great Swamp, the Watchung Reservation, the New Jersey American Water Company lands, the Morris County Park System, the East Orange Water Reserve, and the low-lying area north of the Borough between Passaic Avenue and the river known as The Freshet. These natural areas help in diluting and dispersing air pollutants, thus contributing substantially to the quality of life we enjoy.

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Chapter 5

SOILS

Formation of the Soils

Soil is a natural body on the earth's surface in which plants grow. It is a mixture of varying proportions of rock, minerals, organic matter, water and air. The main constituents are rock and mineral particles produced by the weathering process from the parent material of the soil. The parent material of soil is either local bedrock or material brought to its location by glacial ice, water, wind or environmental forces. These particles become mixed with decaying vegetables and animals that have fallen to the ground. The spaces between the combination of organic and inorganic particles fill with air and water and the end result is soil.

Soil Characteristics

Soils differ from one to the other in different localities and within short distances. The chemical composition and physical structure of the soil at any given location is determined by the kind of geological material from which it originates, by the vegetation cover, length of time that soil has been weathered, by the topography and by artificial changes caused by human activities.

The general texture of a soil depends on the proportions of particles of various sizes of which it is constituted. Soil particles are arbitrarily divided into sand, silt and clay. Particles of sand range in size from 2 to 0.05 mm. in diameter those of silt from 0.05 to 0.002 mm.; and those of clay smaller than 0.002 mm. In general, sand particles can easily be seen by the naked eye and feel pronouncedly rough or gritty to the touch. Silt particles can scarcely be seen without the aid of a microscope and feel like flour when rubbed through the fingers. Clay particles are invisible to the naked eye and form a gummy mass when wet.

Soils are classified according to the proportions of sand, silt and clay. Single soil classes seldom exist alone. Soil scientists use terms like sandy clay, silty clay, clay loam, sandy clay loam, silty clay loam, sandy loam, silt loam and loamy sand. Loam soils, for example, contain 7 to 27 percent clay, 28 to 50 percent silt and less than 52 percent sand.

The texture triangle shown in Figure 12 gives the names of the soil classes and the percentage of different particle sizes in each class.

The texture of a soil greatly affects its productivity. Soils with a high percentage of sand are usually incapable of storing water to provide the best plant growth and lose large amounts of plant-nutrient minerals by leaching to the subsoil. Soils containing a larger percentage of finer particles, for example, the clays and loams, are excellent reservoirs for water and contain readily available mineral materials. Heavy clay soils composed largely of clay particles, however, tend to contain a water excess; these soils have a gummy texture rendering them resistant to cultivation and are frequently inadequately aerated for normal plant growth. The chemical composition of clay also allows the water to bond to the individual particles. The effectiveness of the bonding is increased by the unusually high surface-to-volume ratio of the clay particles. As a result, clay expands when wet. As it dries, it shrinks and cracks.

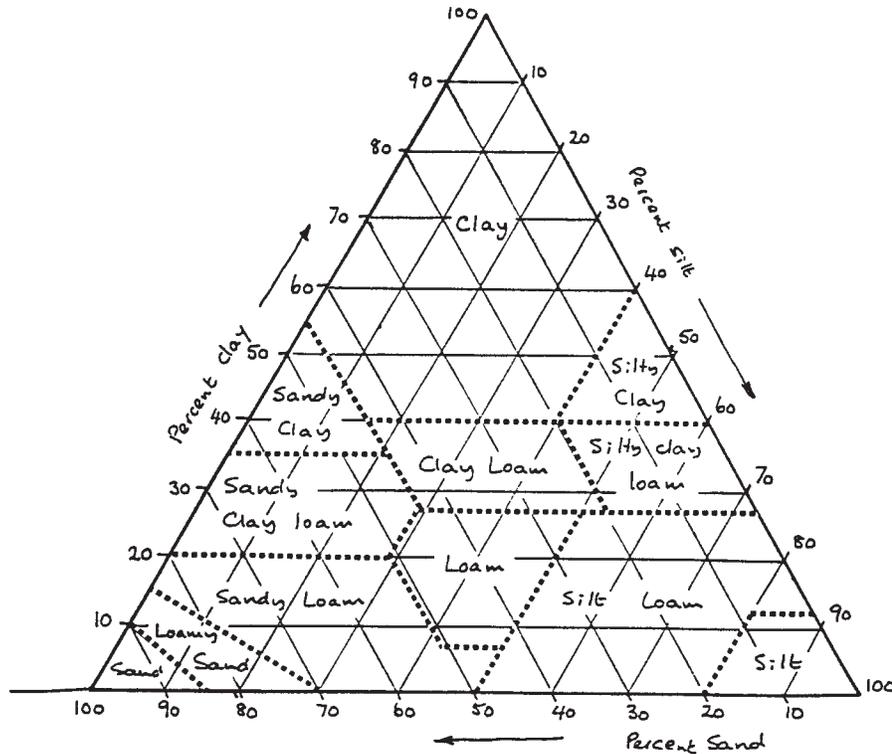


Figure 12—Soil Texture Triangle

Source: Getting It All Together, 1980.

The organic fraction of soils is composed of undecayed plant and animal debris, together with variable amounts of an amorphous organic material called “humus”. The organic fraction makes up 2 to 5 percent of the surface soils in humid regions, but may be less than 0.5 percent in and soils or more than 95 percent in peat soils. Peat soils or muck are located particularly in swamp and marsh areas. An unusual characteristic of muck soil is its ability to burn when dried and ignited because of its high carbon content. A rough estimate can be made by observing the color of the soil; usually the darker the soil, the higher the percentage of organics.

The spaces between the minerals and organic materials are occupied by water or air. The relative amount of water and air in soil depends on local precipitation and on the properties of the soil itself. Water flows through the soil under the force of gravity until it reaches a depth at which all of the interparticle space is filled with water. This level is called the “water table”. The depth of the water table below the surface of the ground varies with time, depending on precipitation level. In general, the water table reaches a high point in the late spring. The long-term average level of this high point is called the “seasonal high water table”. It can be determined at any specific location by color changes in the soil. Long-term presence of water gives the soil a grayish color, whereas soil that has fairly steady exposure to air is a brownish or reddish color due to oxidation of iron in the soil particles. Red color in a soil, therefore, is generally an indication that the soil is well-drained, not excessively humid and fertile. This generalization is particularly true in the southeastern United States but is not always true in other parts of the world, where reddish color in the soil may be the result of freshly formed mineral materials not chemically available for plant use. Almost all yellow or yellowish soils are low in fertility. They owe their color to iron oxides that have reacted chemically, thus a sign of poorly drained land. Grayish soils may be deficient in iron or oxygen, or these soils may have an excess of alkaline salts such as calcium carbonate. The gray discoloration is also present in soils which are flooded regularly.

Soil Profiles

Water, which infiltrates into soil, sorts the soil materials by carrying the finer particles into deeper pore spaces and leaving the coarser particles in place. The simultaneous process of accumulation of material and differentiation of that material into layers is called "soil horizons" which takes place over a long period of time. The soil horizon structure shown in Figure 13 can often be seen in road cuts and other sites where excavation has exposed the soil. The surface layer, or "A" horizon, is referred to the topsoil or zone of leaching. The farmer is primarily interested in the properties of the "N" horizon, while the engineer is concerned with deeper layers that remain after the "A" horizon has been removed from a construction site. The "B" horizon is called the sub-soil or zone of accumulation of material leached from the "A" horizon or formed in places as a result of weathering. Most soils in Morris County have a "B" horizon in which clays and associated oxides of iron and aluminum leached from "A" horizon have accumulated. The "B" horizon is generally firmer and lighter colored than the "A" horizon but darker colored than the "C" horizon. Most younger soils have a weakly developed "B" horizon. The "C" horizon is below the "A" and "B" horizons. It consists of material that is little altered by the soil forming process but may be modified by weathering. The "C" horizon is commonly called "parent material". This layer varies in depth from just a few feet to tens of feet

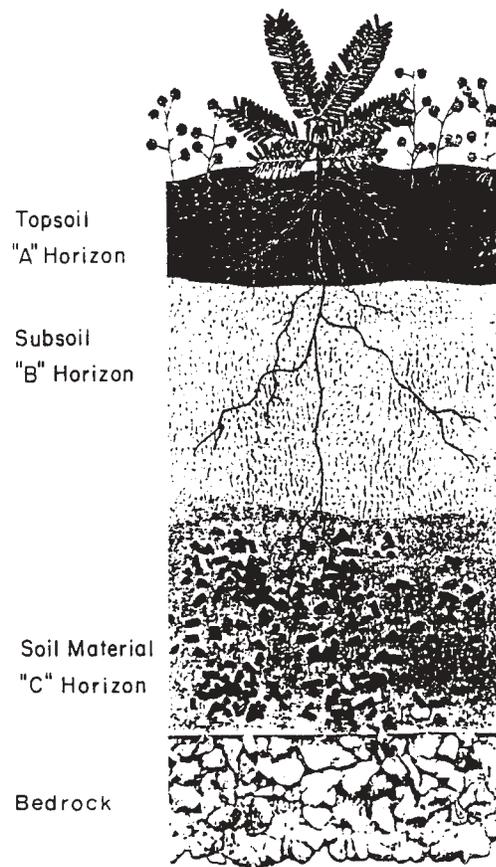


Figure 13—Soil Horizon Structure

Source: Getting It All Together., 1980.

Most of the soils in Morris County have a distinct subsoil. It is believed that some of the lime and other soluble salts were leached before the translocation of iron and clay took place. Well drained and moderately well drained soils in Morris Country have a yellowish-brown or reddish-brown subsoil. These colors are mainly caused by thin coatings of iron oxides or sand and silt grams.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. Hydrologic soil groups (HSG) are used to estimate runoff from precipitation. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long duration storms. The four hydrologic soil groups are:

- Group A Soils having a higher filtration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sand or gravely sand. These soils have a high rate of water transmission (greater than 0.30 in/hr).
- Group B Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission (.15—.30 in/hr).
- Group C Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission (0.05-0.15 in/hr).
- Group D Soils have a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay that has high shrink-swell potential, soils that have a permanent high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission (0-0.05 in/hr).

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply, In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred:

HSG Soil Textures

- A Sand, Loamy Sand or Sandy Loam
- B Silt Loam or Loam
- C Sandy Clay Loam
- D Clay Loam, Silty Clay Loam, Sandy Clay, Silty Clay or Clay

Some soils in the list are in Group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in different groups. Well drained, coarse texture soils with high infiltration capacity minimizes surface runoff. Extensive root development in the surface layer also increases infiltration; bare, compacted soil increases runoff.

The physical characteristics of soils vary greatly. Analysis of Morris County soils is found in a soil survey completed by the US Department of Agriculture's Soil Conservation Service (S.C.S) and published in 1976. This study was done by soil scientists using geological and topographical maps and aerial photographs. On-site investigations were also made by the soil scientists going through the different areas observing the length and shape of slope of the terrain, the texture, color, mineralogy, permeability, water level and depth of soils. In order to analyze the soil characteristics, samples were taken using auger borings; to a depth of 5 feet, or observations were made in pits by a backhoe to a depth of 8 to 10 feet. In developed areas, road cuts and foundation holes were observed.

Detailed descriptions of each soil series found in the area are given as well as interpretations about the potential use of each soil for farming, roads, dwellings, recreation, septic systems, engineering and other uses. Engineering properties such as depth of bedrock, seasonal high water table percolation rate, drainage potential, shrink-well potential etc. are also included. Limitations for soil uses are expressed as slight, moderate and severe. These terms are defined as follows:

- | | |
|----------|--|
| Slight | Soils are relatively free of limitations affecting the intended use, or with limitations that are easy to overcome by use of normal equipment and/or methods. |
| Moderate | Soil properties are unfavorable but can be overcome by careful planning, design and management at somewhat greater costs |
| Severe | Soil properties are so unfavorable resulting from the effects of steep slopes, high water table, stream flooding, unfavorable soil texture, acidity, large numbers of stones, rock, etc. The limitations are such that they can be overcome only by exceptional, costly or complex measures. |

Chatham Township Soils

The Soils Map of Chatham Township is taken from the Morris Country Soil Survey. It shows the location of the different soil series and their relation to other landscape features. A soil series consists of all of those soils which are essentially alike in all major profile characteristics except the texture of the surface layer. Each area on a soil layer is identified by a series of letters and numbers. The first capitalized letter and any lower case letters that may follow are abbreviations for the name of the soil series (Pt for Pompton). The second capital letter signifies the average percent of slope of the area—nearly flat land is classified as A, and as the slope increases the lettering progresses from A to E or F. If the digit 2 is appended to the slope category, it denotes eroded soil. “No A” is Norton soil nearly flat. “No C2” is Norton Soil with a slope from 6% to 12% which has undergone prior erosion. The soil series plus its slope designation is called a “soils type”. Soil series names like “Norton” usually derive from the place where a soil with a particular set of characteristics was first analyzed. These names have been systematized on a national basis by the SCS.

The General Soil Map of Morris County shows that Chatham Township soils fall into several soil associations. A soil association is a landscape with a distinctive pattern of soils, consisting of one or more major soils and several minor soils. Almost 14% of the Great Swamp is located in Chatham Township and categorized as Carlisle Muck (Cm) on the SCS map. This soil is in low swampy areas. The Carlisle series consists of deep, nearly level, very poor organic soils. Over a period of thousands of years, this swamp has gradually been filled by the accumulation of organic material or a mixture of a mineral sediment and organic material. In a representative profile, the surface layer is black, highly decomposed muck about 18 inches thick. Below this and extending to a depth of 60 inches, is a very dark, grayish-brown, decomposed mulch that contains many fibers and pieces of wood. Permeability and available water capacity is high. The water table is at or above the surface most of the time. These soils are compressible and unstable under load. Carlisle Muck is poorly suited to the community development.

As of a 1988 survey, 40% of Chatham Township is mapped as Riverhead, Neshaminy or Penn Complex. Riverhead complex (Up) consists of well drained, nearly level to strongly sloping sandy and gravelly soils. Slopes range from 0 - 20 percent but are typically 5 to 12 percent. The underlying material is loose, unweathered, sorted sand and gravel out wash, most of which is granite material. Permeability and runoff is moderate (Group B). Neshaminy complex (Uk) consists of well-drained, gently sloping stony soils. Slopes commonly range from 3 to 8 percent. Depth of bedrock is variable, ranges from 1 foot to more than 10 feet This complex is deep over a water table and has moderate permeability (Group B), rapid runoff, moderate to severe hazard of erosion. Perm complex (Um) consists of well-drained soils that are underlain by red shale bedrock. Slopes commonly range from 0 to 10 percent. The soil material is residuum weathered from the underlying shale bedrock. On the

sloping soils rapid runoff (Group C) causes a moderate hazard of erosion.

Surrounding areas of the Great Swamp and also certain areas spread inside the Great Swamp consists of Pompton sandy loam, 3 to 8 percent slopes (PtB). This soil is in swales and waterways in relatively low positions and receives runoff from the surrounding uplands.

The section of Chatham Township that drains directly into the Passaic River dominantly consist of Ellington fine sandy loam, loamy subsoil variant 3 to 8 percent slope (EIB), 8 to 11 percent slopes (EIC) and 15 to 25 percent slopes (EID). The Ellington variant consists of gently sloping to steep, moderately well drained and somewhat poorly drained soils. This series formed gravelly material derived from shale, siltstone and sandstone and contains a small amount of other materials including granite gneiss. They are underlain at a depth of 36 to 72 inches by finer textured residual material weathered from trap or shale bedrock. Permeability is moderately slow and available water capacity is moderate. The high content of fine sand limits the capability and workability of the soils.

One of the significant soils in Chatham Township is Riverhead gravelly sandy loam with 3 to 8 percent slopes (RmB) and 8 to 15 percent slopes (RmC). This type of soil covers Hickory Tree and certain sections of Green Village. The Riverhead series consists of well drained, nearly level to strongly sloping gravelly soils. This series of soils, formed in sandy and gravelly outwash, is derived mainly from granite material containing a small amount of shale, sandstone, quartzite and conglomerate. In a representative profile the surface layer is very dark, grayish-brown, gravelly sandy loam and about 2 inches thick. Permeability is moderately rapid (Group C), and available water capacity is moderate. It exhibits excellent recharge capability.

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Chapter 6

VEGETATION

General

The vegetation of a natural area is an expression of its soils, topography, geology and climate. The eastern part of the United States enjoys thick deep humus soils, when compared to the geologically newer western coast Eastern soils can support heavy vegetation, forests, understory trees, shrubs, and herbaceous material. Rutherford Platt, self-taught naturalist, wrote about the singularity of the eastern United States' vegetation. Because the Appalachian Mountains run from the northeast to the southwest, the glaciation of our area brought seeds from the arctic into the temperate zone. Plants dwarfed by weather conditions in the arctic, flourish further south.

Local conditions bring vegetative variety. Where bedrock is close to the surface, pioneer plants such as birch, andropogon grasses, and mosses can predominate. Where wetlands and floodplains prevail, cattails, rushes, swamp maple, and spice bush are common.

Climate Modification

Vegetation is an important climate modifier. Vegetation can decrease wind velocities and turbulence, cool slowly, warm slowly, conserve moisture, produce oxygen for air replenishment and produce a clean air shed (Figure 14). The presence of vegetation is also a key factor in tempering climate on a smaller scale such as a house lot. A single tree transpiring 100 gallons-of water a day is equivalent to the cooling effect of five average room air conditioners, each of which runs 20 hours a day (Federer, 1970). Temperatures over grass are 10 degrees to 14 degrees cooler than over exposed soil on a sunny summer day. Vegetation can also play a variety of other climate-related roles, many of which are discussed in *Plants, People and Environmental Quality* by G.O. Robinette (1972).

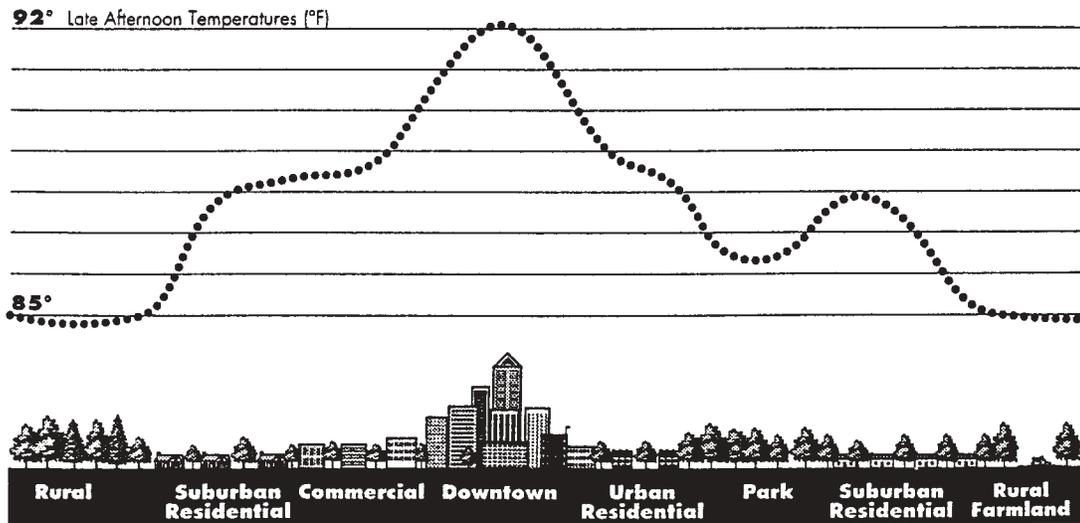


Figure 14—Temperatures by Vegetation Cover

Source: U.S. Environmental Protection Agency, 1992.

Social and Aesthetic Values

“Vegetation softens lines and brings out the beauty of architectural forms. Seasonal changes of color continually renew every day scenes” (Madison Environmental Resource Inventory). It is vegetation that provides the picture frame for our built areas. It is not surprising that cities and towns take pride when they are honored with the title of being a Shade Tree City. Comparing a raw subdivision with no trees to a mature subdivision that is softened and shaded tells us much about the aesthetic importance.

Chatham Township's Naturally Occurring Vegetation

Chatham Township lies in the Piedmont physiographic region of New Jersey which is part of the vegetational formation known as the Eastern Deciduous Forest. This region is typified by the list of trees, shrubs and plants listed in Appendix A.

Vegetation by Area

The floodplain along the Passaic River and the Loantaka Brook contains typical floodplain vegetation - red maple, white ash, pin oak, white oak, and grey birch. Native floodplain shrubs found here are spice bush, arrow-wood, witch hazel, some varieties of viburnum, dogwood, and blueberry. The western slopes of Long Hill were characterized by oak forest - remnants of which remain on the developed streets. The Great Swamp and Black Brook area contain typical wetland as well as floodplain vegetation. Areas of wetland can be identified by a predominance of skunk cabbage - only growing in wetlands. Other wetland vegetation includes cattails, spice bush, swamp azalea, and reeds. Other upland areas on lands surrounding the Great Swamp contain typical piedmont vegetation. One area across the northerly section of the Township is characterized by sandy soils. Vegetation here is characterized as pioneer because of the poor nutrient content of the soil. Andropogon grass, grey birch, and horsetail are commonly found.

Vegetation and Deer

Vegetation, both native and ornamental, never before threatened, has become the favorite forage for an increasing population of white-tailed deer. Touch-me-not, azalea, day lily, rhododendron, and many perennials must be fenced if they are to survive. Shrinking habitat and absence of predators all contribute to the imbalance represented by the deer herds in the area -vegetation is not the only victim. Our area is now recognized as a hot spot for lyme disease.

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Chapter 7

WILDLIFE

Almost 26% of Chatham Township is Great Swamp land. This is an asset to be treasured and preserved by careful management of the lands surrounding the Great Swamp. This results in an abundance of wildlife species that is much greater than in the adjoining communities. It is an asset that contributes to the special character of Chatham Township.

Animals

Large animals, such as bison, elk, cougar, and bobcat, disappeared from New Jersey by the mid- 19th century. The beaver, marten, river otter, and porcupine also succumbed to the pressures of civilization at about the same time. The white-tailed deer, on the other hand, while almost annihilated by 1890, has since increased in population to the extent that it is now necessary to manage the size of the herd to the availability of range and food supply.

Chatham Township's Animal Wildlife

Wild animals in Chatham Township today are limited to those native species which have been able to adjust to a people-oriented environment. They tend to be furtive creatures, many of them nocturnal in habit. They always keep a safe distance between themselves and man and his domesticated animals.

Threatened and Endangered Species

Specific sightings of threatened and endangered species in Chatham Township have been recorded by the New Jersey DEP, mostly in the Great Swamp. However, they have also been found outside the Swamp. Blue spotted salamanders have been found in the vicinity of the Tanglewood Wastewater Treatment Plant and Recycling Center as well as in Green Village. Wood turtles have been reported in the Loantaka Brook valley as well as along the Passaic River. Barred owls, great blue herons, bog turtles, and red shouldered hawks add to the special species sighted in Chatham Township.

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Chapter 8

OPEN SPACE

Open space in Chatham Township is without a doubt its most valuable natural resource. Open space is defined in the Morris County Master Plan Open Space Element as undeveloped land that serves a variety of functions and that provides essential character to a particular region. Open space can protect the quality and quantity of surface and groundwater resources, preserve distinctive natural, cultural, and historic resources, and provide space for developing facilities to satisfy the recreation needs of citizens. Open space can also provide visual relief in densely populated areas and preserve natural beauty. The Morris County Open Space Plan recommends that local governments ensure a proper balance between natural resource protections, adequate recreation space, and other competing land uses through open space planning. Planning for future open space is urgent. Development interests are placing escalating pressures on these undeveloped areas. Opportunities to preserve open space are rapidly diminishing.

Publicly Owned Open Space

Nine municipal parks comprising approximately 90 acres are located throughout the Township. The parks range in size from the 0.2 acre Green Village Park to the 33.3 acre Shunpike Park. All of the municipal parks contain active recreational facilities, such as ballfields, playground equipment, tennis courts, and picnic areas. The federal government is the largest landholder in Chatham Township with 26% of the total land area, 1549 acres. Morris County Parklands account for 476 acres of open space with the Great Swamp Outdoor Education Center and portions of the Loantaka Brook Reservation and the Passaic River Park.

Privately Owned Open Space

Chatham Township's privately owned open space dropped from 1,915 acres in 1978 to 1,260 in 1997 (a 34% decrease) according to information from the Township planning consultant. Privately owned open space accounted for 20% of the Township's land area (6008 acres) in 1997. In contrast, it accounted for 32% in 1978 (see Figure 15).

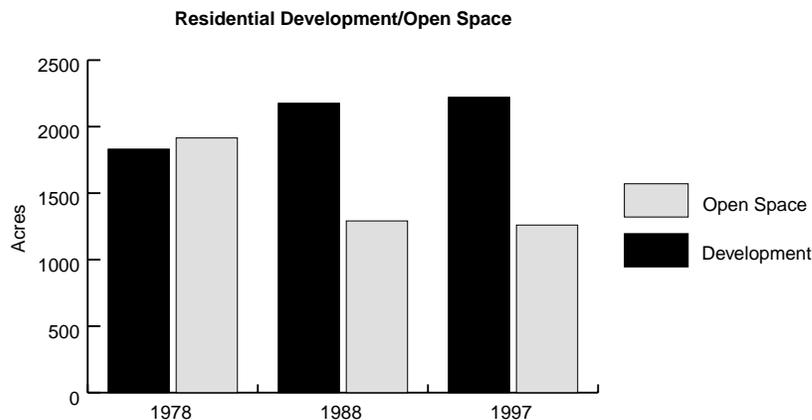


Figure 15: Chatham Township Land Use by Acres

Source: Chatham Township Master Plan, 1999

Commercial recreation facilities and non-profit organizations within the Township provide 209 acres of open space. These include a private golf course and a private swimming club. The fire departments have ballfields; and an ice rink.

The privately owned open space lies in three principal locations: along Loantaka Brook, between developed areas and the Great Swamp, and between developed areas and the Passaic River.

Decreases in Open Space

Since the original Natural Resource Inventory was published in 1974, Chatham Township has sustained substantial losses of 3 of the 10 inventoried sites (see Appendix K for maps of the 1974 Inventoried Open Space). One area, then called "The Orchard" (Long Hill above Meyersville Road), now has 3 new streets: Tree Top Lane, Molino Drive, and Jodi Lane — all lined with many new homes. The second, called "Southern Boulevard," has a new road. The stream under Southern Boulevard near Jay Road has been partially contained in a large pipe and homes have been built along the new Geoffrey Court. The third area, the "Averett Site," south of River Road, now supports 900 townhouse units, tennis courts, swimming pools, and a small sewage treatment plant. The area is presently called "Heritage Greene," "Chatham Glen," and "Sutton Woods." Its natural streams are now drainage ways and the pond that used to be in a wooded setting is now a detention facility.

For purposes of the Open Space Index, Open Space is defined as all the lots or parcels of land in Chatham Township owned publicly, privately, or commercially which either contains no habitable dwelling, or which is subdividable even though it contains an inhabitable dwelling. The properties containing no inhabitable dwellings are called "class I" properties. A current list of class I properties in Chatham Township is maintained by the Morris County Tax department and is available upon request for a small fee. The subdividable properties have been determined by an inspection of the current Chatham Township Tax Maps with the assistance of the Planning Board Manager, who has personal knowledge of all the subdividable properties.

See Appendix E for a listing of all lots in Chatham Township which do not have a dwelling on the site. These lots are listed on the County tax roles as Class 1 properties. They are listed by Block, Lot, Owner Classification, and Page Number of the Township tax map book. See Appendix F for a listing of all lots in Chatham Township which have a dwelling and are of such size that they could be subdivided to create two or more homesteads. These lots are listed by Block, Lot, Acreage, Owner Classification and Tax Map Page Number.

For further information, see the Chatham Township Open Space Element

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Open Space Element, Morris County Planning Board, 1988

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Chapter 9

REGIONAL RELATIONSHIPS AND RECOMMENDATIONS

Chatham Township's municipal boundaries bear little relationship to the physical relationship it shares with other municipalities in the region. The physical relationship of our towns is important because we share natural resources like the Great Swamp. We also share responsibility for the impact each town causes. These impacts are most commonly caused by zoning and development decisions which affect our physical resources. The water resource is the resource of most concern in this region. It is a shared resource that is critical both as water supply, as quality of life, as open space, and as habitat for a large diversity of life.

Chatham Township's land use decisions can contribute to downstream flooding and water quality changes just as our upstream neighbors can affect the level of flooding and water quality for us. Chatham Township's land use decisions can affect the water supply for towns dependent on the Buried Valley Aquifer system for water supply. Chatham Township's land use decisions can affect air quality.

Great Swamp

Chatham Township is one of eleven municipalities (Figure 16) that share the 55.4 square mile watershed of the Great Swamp in the Upper Passaic River Basin. All precipitation that falls in the watershed flows through the municipalities and into the Great Swamp. Most of the Great Swamp is protected as a federal wildlife refuge. The U.S. Fish and Wildlife Service is actively pursuing a land acquisition program from willing homeowners to buy private lands of the swamp to be included in the refuge. The eastern most part of the refuge is the first Wilderness Area in the United States. This status gives it special protection from encroachment.

Streams

Two of the swamp's four major feeder streams flow through Chatham Township. Loantaka Brook originates in Morristown, flows through Morris, Harding, and Chatham Townships and into the Great Swamp. In the Great Swamp, the brook joins Great Brook and flows into Harding and Long Hill Townships before exiting into the Passaic River.

Black Brook receives stormwater drainage from part of Madison as well as Chatham Township. The Brook had two major tributaries until a drainage ditch was built in the easterly side of the Great Swamp in the 1950's. This easterly ditch carries stormwater and wastewater effluent for about two miles to Black Brook in the Great Swamp. From there it joins the Passaic River through Harding and Long Hill Townships.

Passaic River

The Passaic River forms the southerly border of Chatham Township. On the opposite banks of the river, we share borders with Berkeley Heights, New Providence, and Summit.

Geological

Chatham Township shares with Madison in being the terminus of the Wisconsin Glacier in this area. Part of that regional geological relationship carries over into the Township's being in the Buried Valley Aquifer system.

Chatham Township lies in the Buried Valley Aquifer recharge area and stream zone. The aquifer is designated as a Sole Source Aquifer by the U.S. EPA. The neighboring towns of Madison, Chatham Borough, and Florham Park rely solely on wells that draw from the Buried Valley Aquifer for their water supply.

The New Jersey Geologic Survey identified a band of land running across northerly Chatham Township, just beyond the terminus area of the Wisconsin glaciation as a prime recharge area for the Chatham Valley Buried Valley Aquifer, part of the Buried Valley Aquifer system.

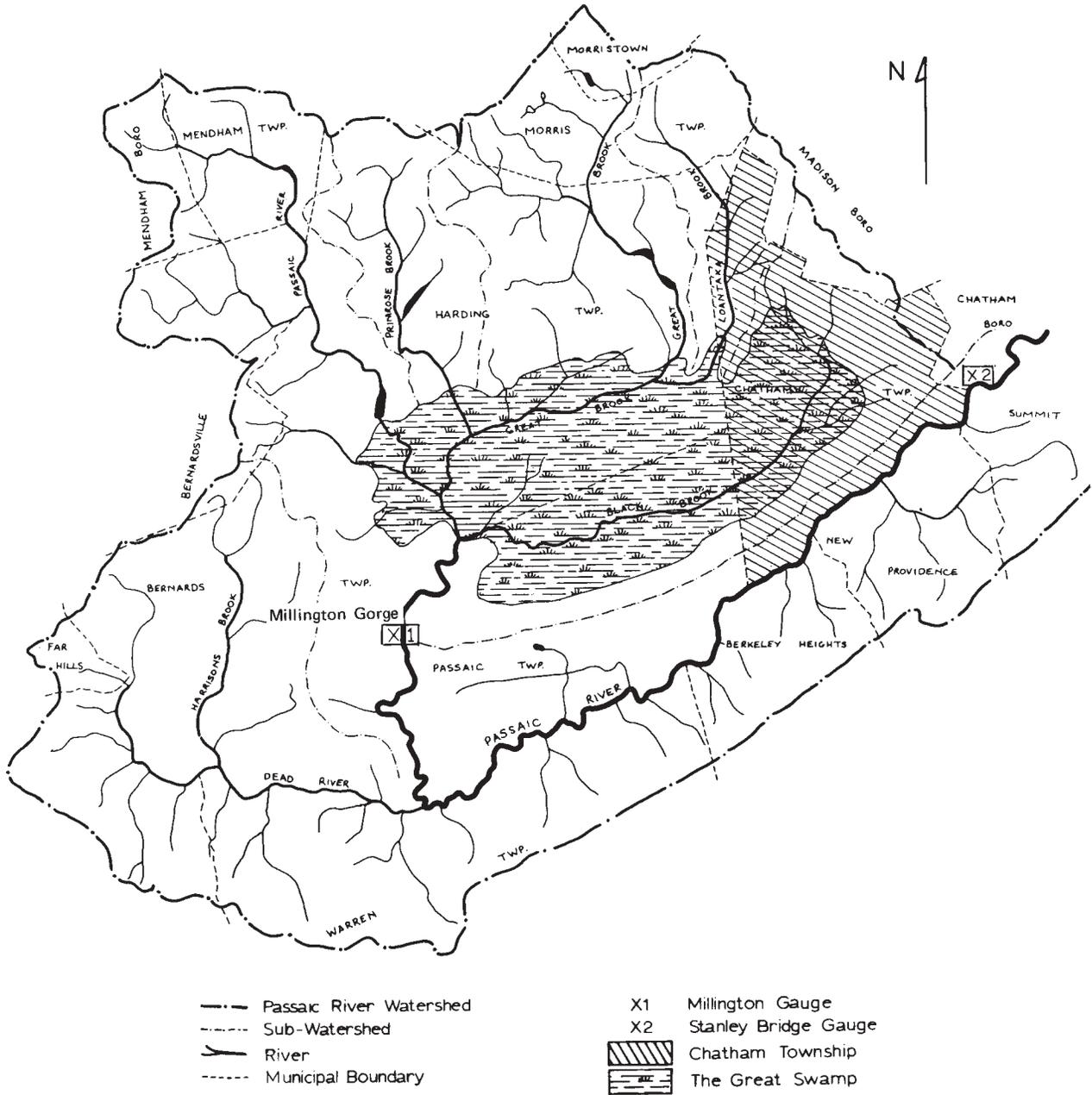


Figure 16—Upper Passaic River Watershed

Source: Natural Resource Inventory, Chatham Township, 1974.

Topography

Long Hill is the remains of an ancient volcanic eruption that extends into Chatham Borough in the north and through Long Hill Township to the south. This ridge is the third ridge from the coastal plain, called the Third Watchung Range. It stopped the meltwaters of the glacier and was a critical element that caused the formation of Ancient Lake Passaic, the present day Great Swamp.

RECOMMENDATIONS

Because of Chatham Township's location almost surrounding the Wilderness Area of the Great Swamp National Wildlife Refuge, in the recharge area of the Buried Valley Aquifer and in the upper Passaic River basin, planning and development decisions have the potential to impact a far greater area beyond Chatham Township's borders. The potential impacts relate to open space and water resources and include:

- loss of open space that provides forested areas and groundwater recharge to the Buried Valley Aquifer
- contamination of groundwater recharge to the Buried Valley Aquifer in already developed areas
- increased flooding due to stormwater runoff from increased development
- increased flooding due to loss of open space and loss of trees with their evapotranspiration function

To address these potential undesirable impacts, Chatham Township Environmental Commission recommends that Chatham Township:

- aggressively pursue preservation of privately owned open land through outright purchase or broad encouragement and acceptance of conservation easements
- include natural features that enhance stormwater control as a criteria for open space acquisition
- classify lawn as impervious surface for purposes of stormwater runoff calculations (Najarian Study, see page 22)
- institute an educational drive to promote preservation of mature trees and consider formation of a Shade Tree Commission

CHAPTER 10

INVENTORY OF UNDEVELOPED LAND

In 1973, as part of the investigation for the original Chatham Township Natural Resources Inventory, 35 volunteers, working under the guidance of professionals, inspected and described the undeveloped land in Chatham Township. This was an unprecedented effort, and made our town's Natural Resources Inventory unique.

All of Chatham Township was divided into four principal regions, each of which has similar characteristics of soil, topography and drainage and the following basic information:

- A table of statistics relating to land use in the Principal Region.
- An outline map of the Township with the Principal Region marked.
- A cross-section of the region is presented, with certain features marked. A line showing the position of the cross-section is marked on the outline .
- Under the cross-section, there is a table giving the past and present land use in acres, the drainage characteristics, the vegetative cover and the kind of soil. Because of the limitation of space, this table is coded. The full legend may be found on page 00.

The inventoried sites are then presented in the context of these regions:

PRINCIPAL REGION: SOUTH OF RIDGE

- Site 1 The Ridge and Shale Pit (Esternay)
- Site 2 The Passaic River

PRINCIPAL REGION: NORTH OF RIDGE

- Site 3 The Orchard
- Site 4 Mountainview

PRINCIPAL REGION: MORaine

- Site 5 Southern Boulevard (Geoffrey Court)
- Site 6 Averett (Chatham Glen)

PRINCIPAL REGION:

- Site 7 Dodge (Giralda Farms)
- Site 8 Loantaka
- Site 9 Hickory
- Site 10 Delta

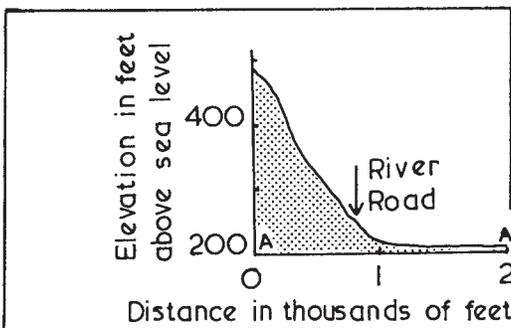
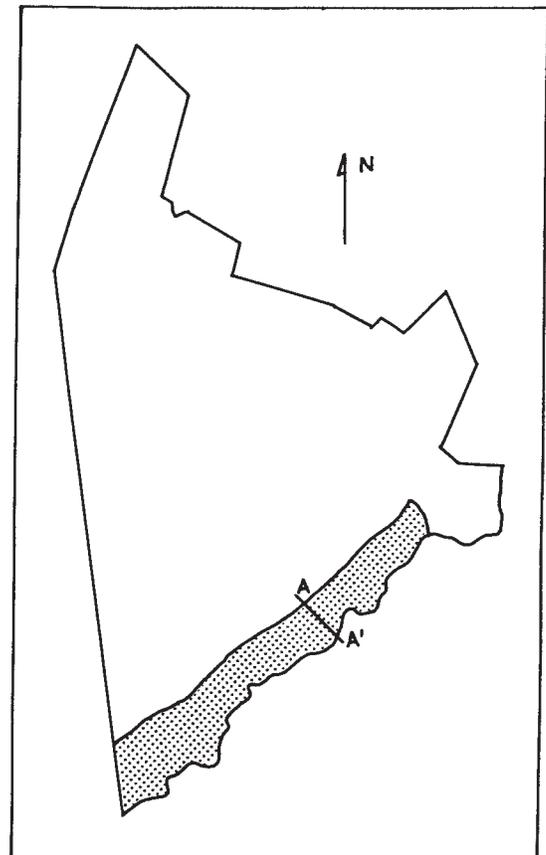
The descriptions have been amended for four areas due to their development since 1973. These four areas are:

- Site 3 The Orchard (Tree Top Lane, Jodi Lane and Molino Dr.)
- Site 4 Mountainview (Stoneyck, Pembroke Road and Karlin Dr.)
- Site 5 Southern Boulevard (Geoffrey Court)
- Site 6 Averett (Chatham Glen townhouse development)

Several undeveloped areas of Chatham Township were omitted from this survey: small properties in developed regions, municipally owned lands set aside for specific uses, the Fairmount Country Club and the Noe Pond Club, the sanitary landfill at the end of Britten Road and the Great Swamp National Wildlife Refuge.

Figure 17
PRINCIPAL REGION: SOUTH OF RIDGE

ACREAGE	1974	1999	% CHANGE
HOUSE	196	210	+7%
APT/COMMERC	12	12	0%
PUBLIC/SEMI-PUB	18	18	0%
RECREATION	126	126	0%
G.S.N.W.R.			
UNDEVELOPED	<u>330</u>	<u>316</u>	- 4%
TOTAL	682	682	



DEVELOPMENT	H	H
DRAINAGE - SCS	M.G	P
VEGETATION	S	W
SOIL	Bt	Bh

LEGEND

- H House Environs
- PsP Public/Semi Public
- R Recreation
- P Poor
- M Moderate
- G Good
- O Open
- S Scrub
- W Woodland
- A Alluvial
- Bh Beach
- Bt Basalt
- G° Glacial Outwash
- L Lacustrine
- M Muck
- Mo Moraine
- S Shale
- U Urban

SITE 1. ESTERNAY (FORMERLY KNOWN AS THE RIDGE AND SHALE PIT)

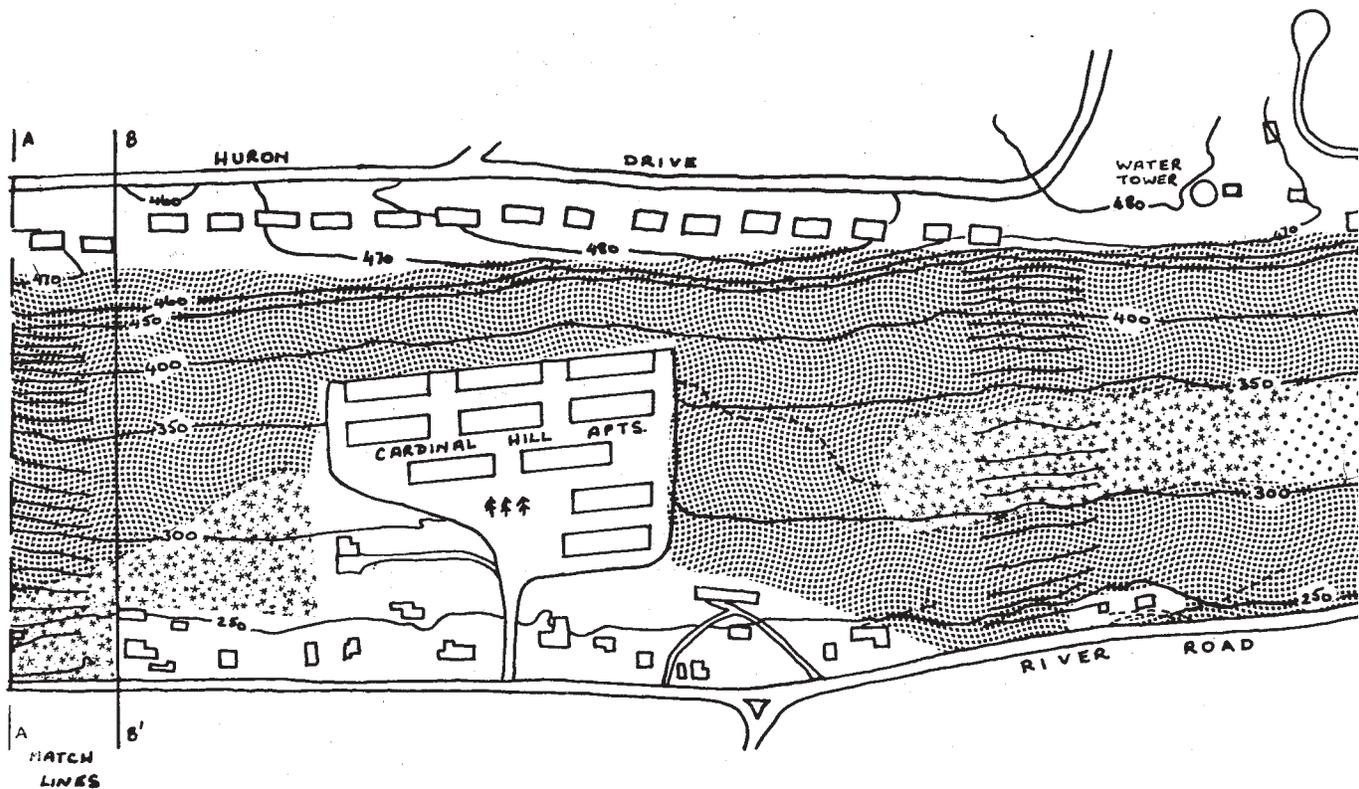
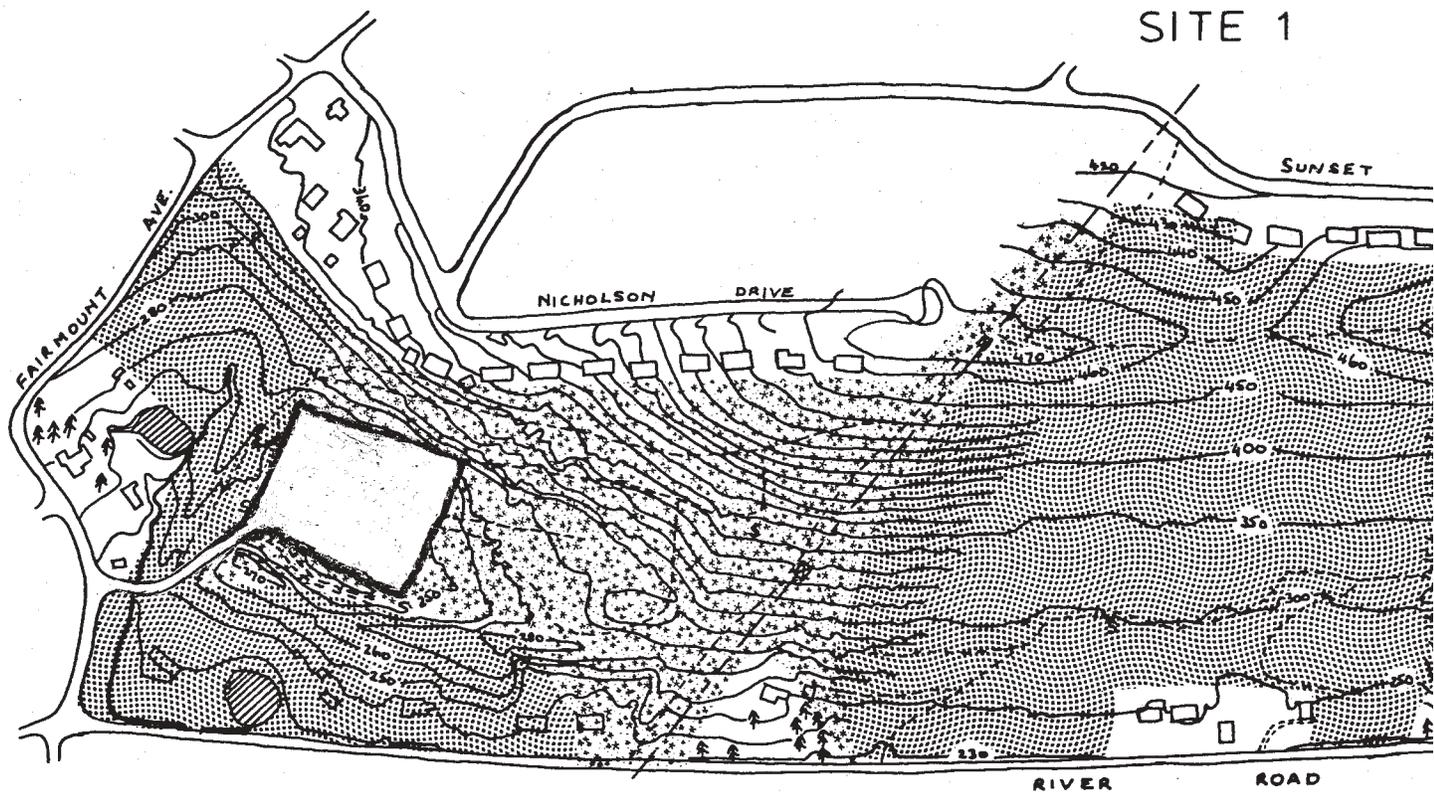
This site to the west of the power lines on easterly facing slopes has two distinct sections. The first section, formerly known as the Ridge along Fairmount Avenue, includes one of Chatham Township's historic houses (pre-1800). This property contains a pond, stream, many old trees, and several flowering trees and shrubs. The second section, formerly known as the Shale Pit, was created years ago when the red shale on the south side of Long Hill was excavated. The excavated site currently appears as a large outdoor theater with overgrown vegetation. The southern exposure supports wildflowers and plants, and produces some unusual vegetative patterns. A soccer field was constructed in 1974 and the area was renamed Esternay Field. The field where children play soccer is surrounded by steep slopes, narrow terraces, and dense thickets. People have been known to hunt for fossils that may be embedded in the loose shale that litters the area surrounding the field. Visitors to this site are struck by its unique formation. Esternay Field cannot be seen from surrounding roads resulting in a secluded setting. Esternay Field is now owned by Chatham Township.

The land to the east of the power lines in this site is a steep southern slope from the crest of Long Hill to River Road. With the exception of the Cardinal Hill Apartments, residential development is located near the base of the hill. Toward the crest of the site the vegetation is mature woodland of beech, oak, maple, ironwood, a few pines and unusually large numbers of flowering dogwood trees. As the land drops abruptly, the woods are filled with huge vines, which climb the trees, giant thorny bushes and dense undergrowth. There is much erosion of the rocky slopes in the western section and below Huron Drive. There are many shale outcroppings and basalt boulders on the hillside. An exception to these general conditions is the open area at the eastern end, which is a gently sloping meadow, now being developed for an eight house subdivision. The Ridge contains a path near the crest that is used for walking.

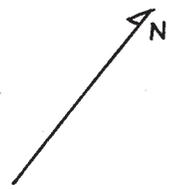
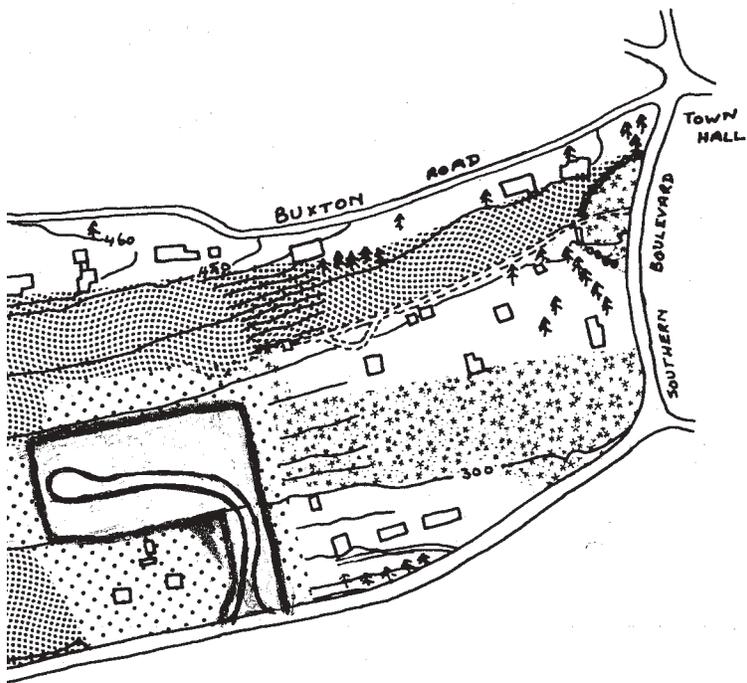
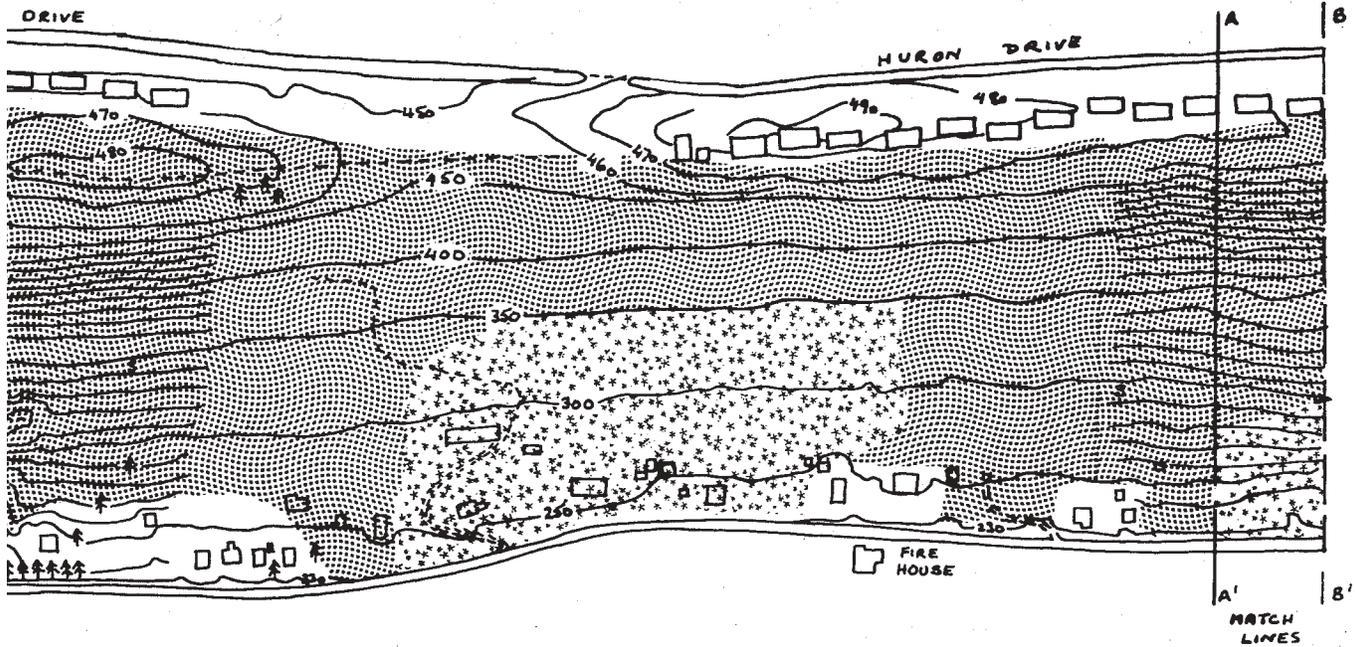
There are scenic views from several places on this site. One of the best spots is at the top of the hill under the power line. From here one can look across the Great Swamp to the hills beyond Morristown, to the Madison-Florham Park areas and in the opposite direction to the valley that lies between Long Hill and the Second Watchung Mountain.

Except where explicitly noted the land described here is private property.

SITE 1



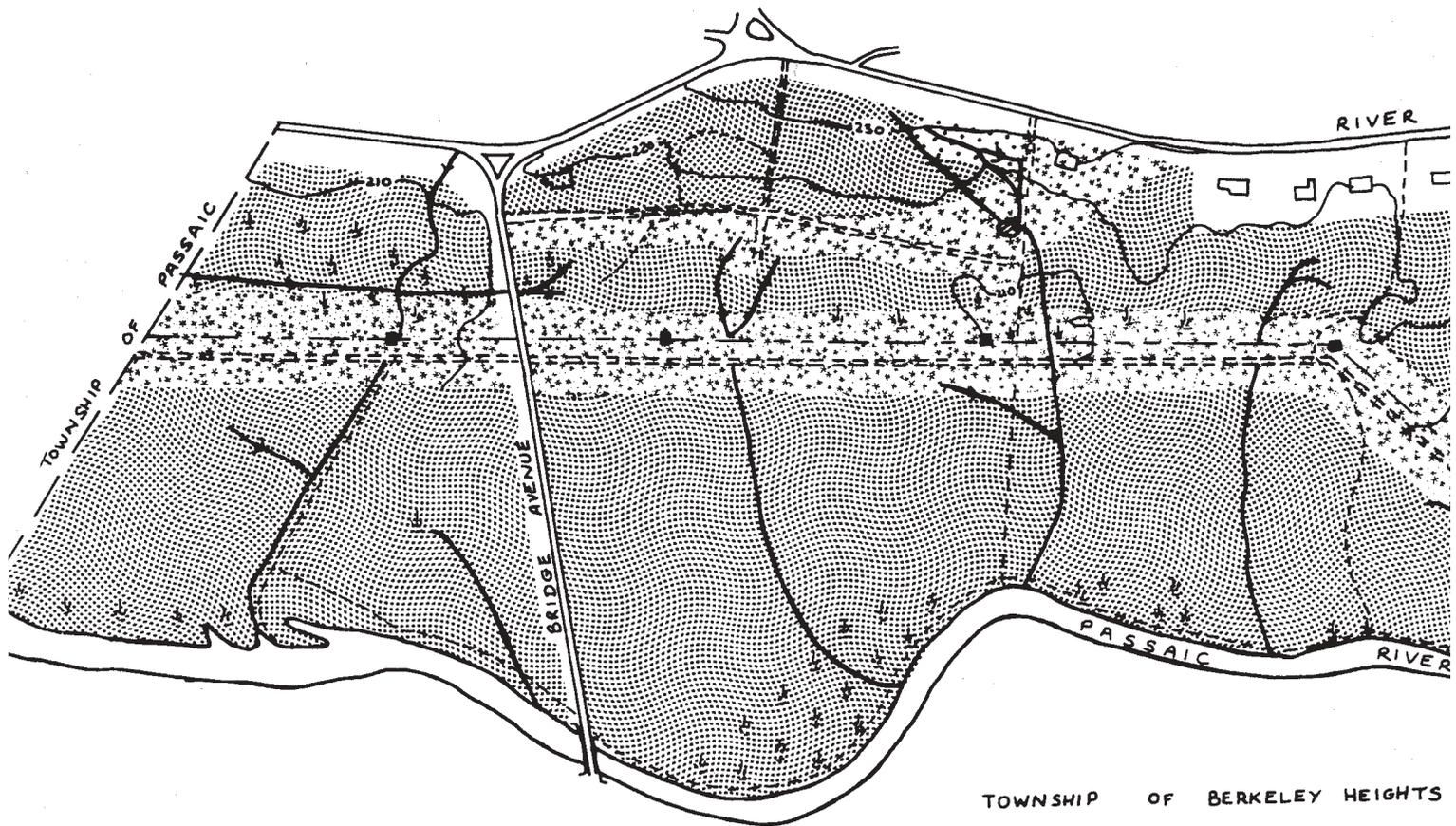
THE RIDGE AND SHALE PIT (ESTERNAY)



1" = 400'

-  New Development
-  Stream
-  Pond
-  Elevation
-  Open
-  Growing back
-  Woodland

SITE 2



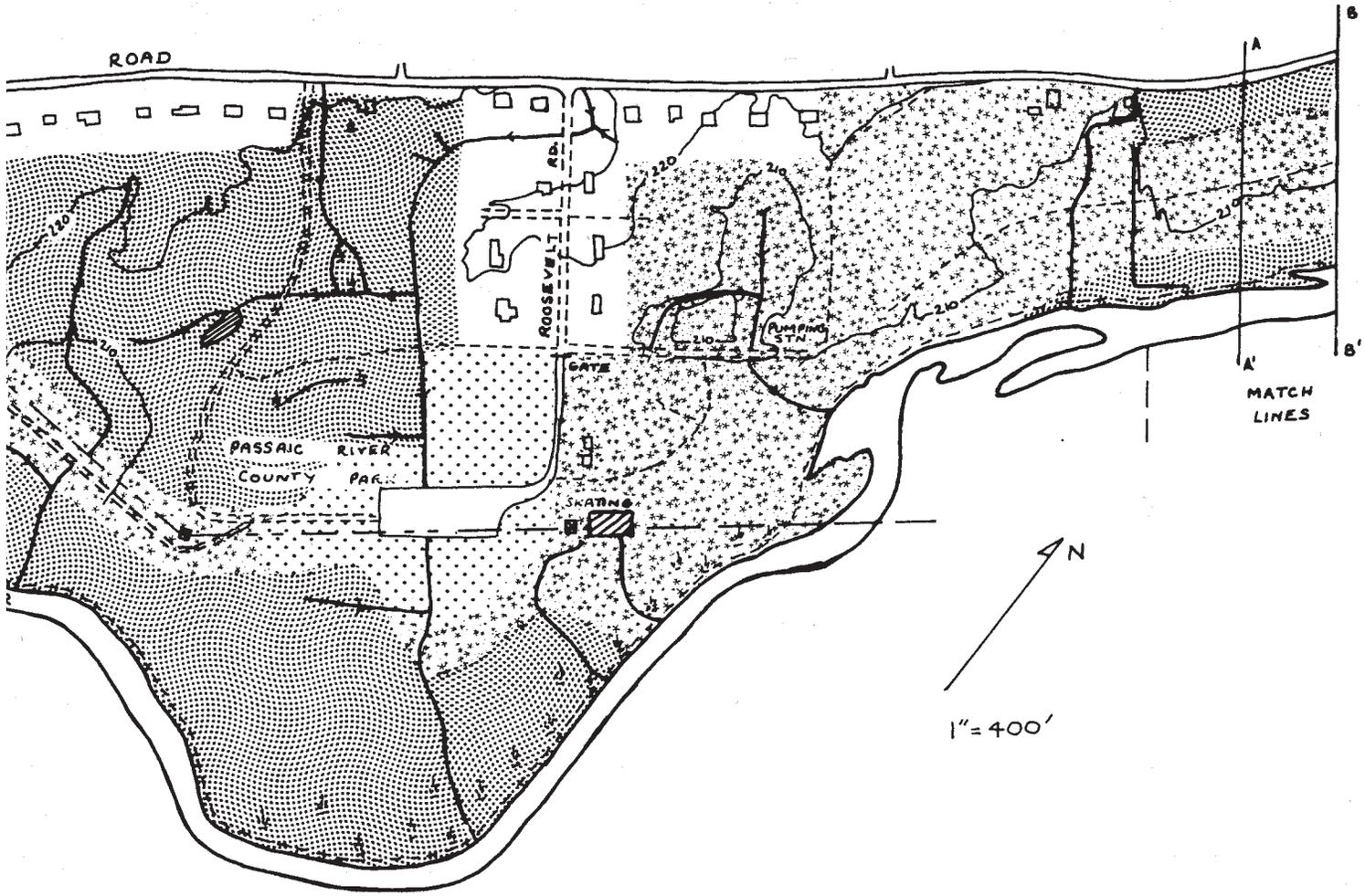
SITE 2. THE PASSAIC RIVER

From the Passaic Township border to this site to the park at the end of Roosevelt Road, this low-lying land supports mostly mature swampy woods. The dominant tree species are pin oak and red maple. Several streams which receive drainage from Long Hill flow straight across the land to the Passaic River. From the park to Central Avenue the land is mainly young woods and fields. The river all along here has a wide, muddy floodplain. When the river is high, the flow of the streams is reversed for a considerable distance upstream. Except for the residential properties shown on the map, most of this section is owned by the Morris County Park Commission. The County has developed a quiet recreation area here with a ball field, skating rink and picnic facilities. Many people take advantage of the park and also use the power lines for walking and horseback riding.

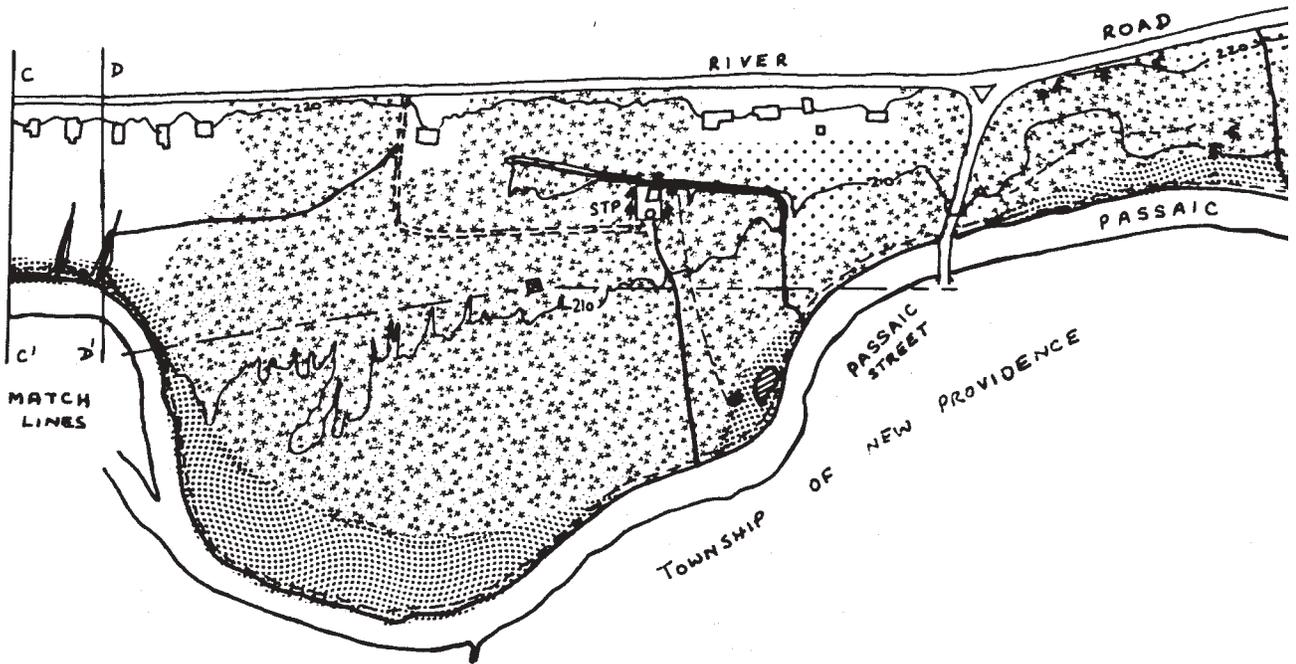
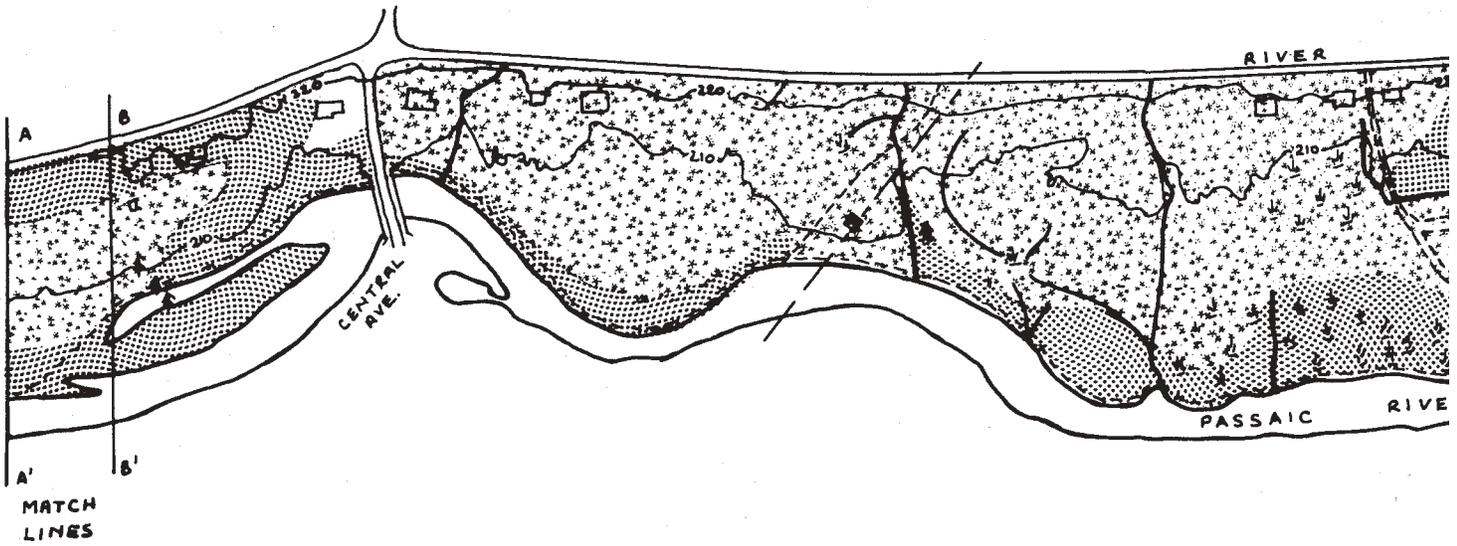
The section of this site between Central Avenue and Passaic Street is also low and wet, but in many ways quite different from the area described above. Except for a border of mature trees along the river, most of the land supports open fields, marsh and brush. There is a great variety of low-growing vegetation such as grasses, reeds, smooth alder, phragmites, cattails, small trees and thorny bushes. The land shows much evidence of use for gardening, dumping and recreation. A section of the river bank just west of the north-south power line is a natural bird sanctuary. The river is eroding its banks just east of the Fire House as if it were trying to join River Road. In places, even during wet Spring conditions, the clay soil is dry, hard and cracked.

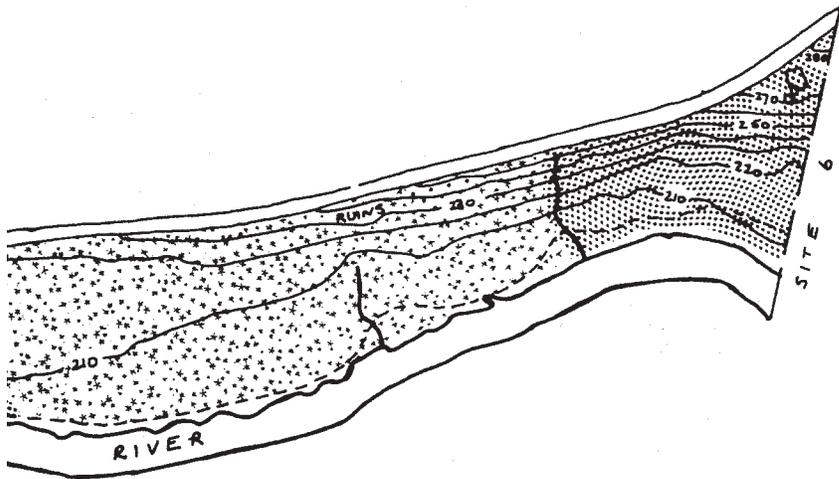
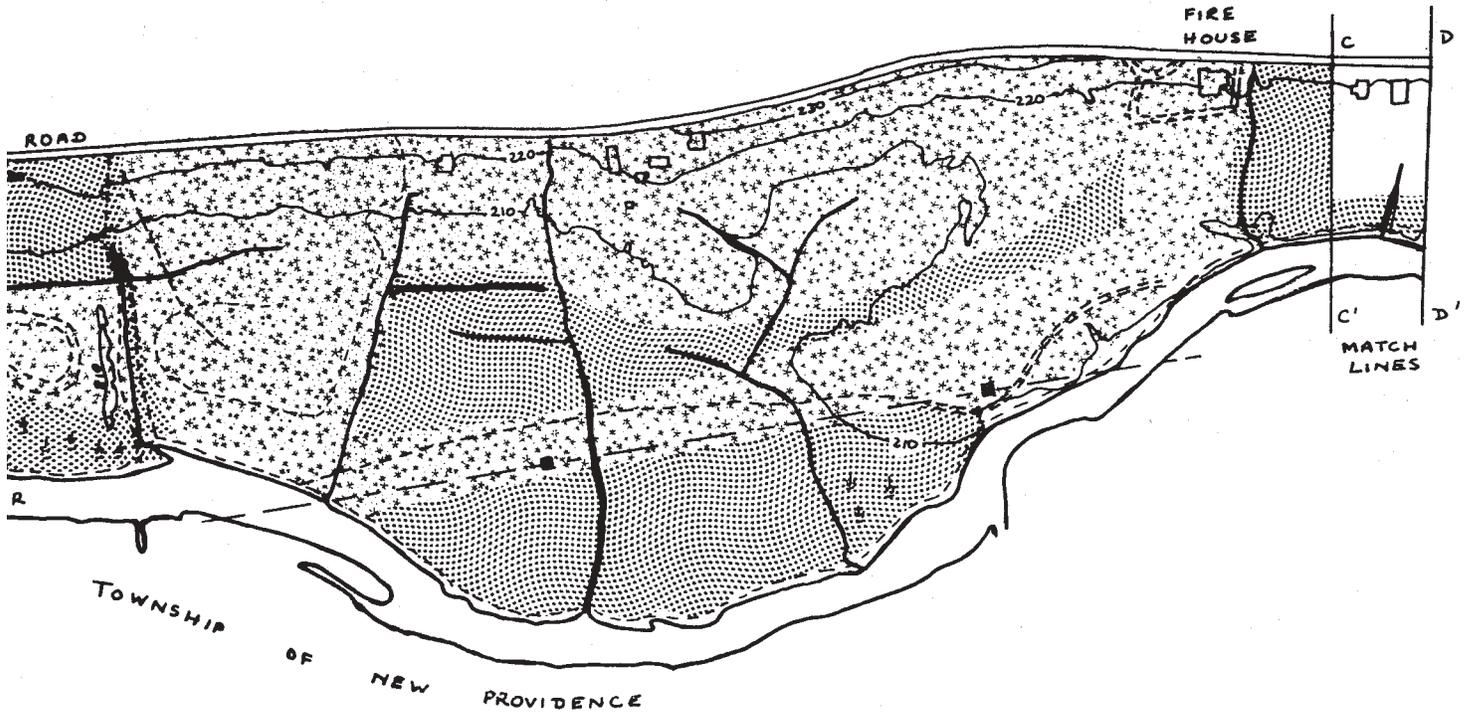
Except where explicitly noted, the land described here is private property.

THE PASSAIC RIVER



PASSAIC RIVER (cont'd)



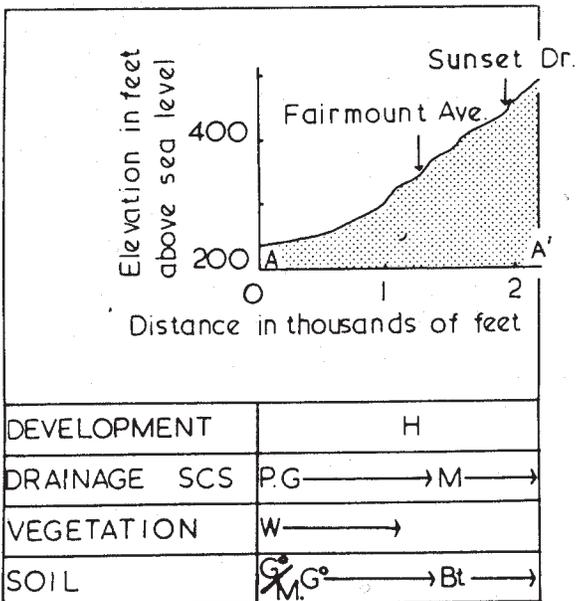
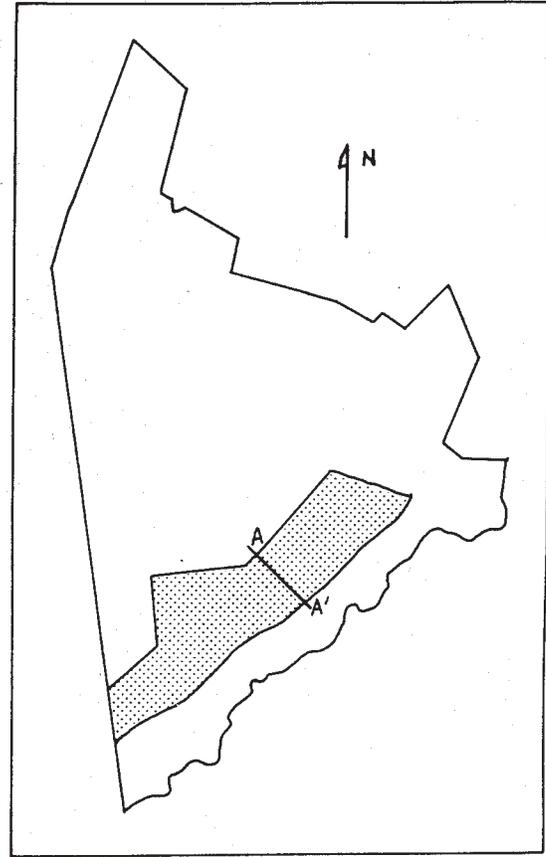


1" = 400'

-  Stream
-  Pond
-  Elevation
-  Open
-  Growing back
-  Woodland

Figure 18
PRINCIPAL REGION: NORTH OF RIDGE

ACREAGE	1974	1999	% CHANGE
HOUSE	398	485	+22%
APT/COMMERCIAL	2	2	0%
PUBLIC/SEMI-PUB.	103	103	0%
RECREATION			0%
G.S.N.W.R.	26	26	0%
UNDEVELOPED	<u>352</u>	<u>265</u>	- 25%
TOTAL	881	881	



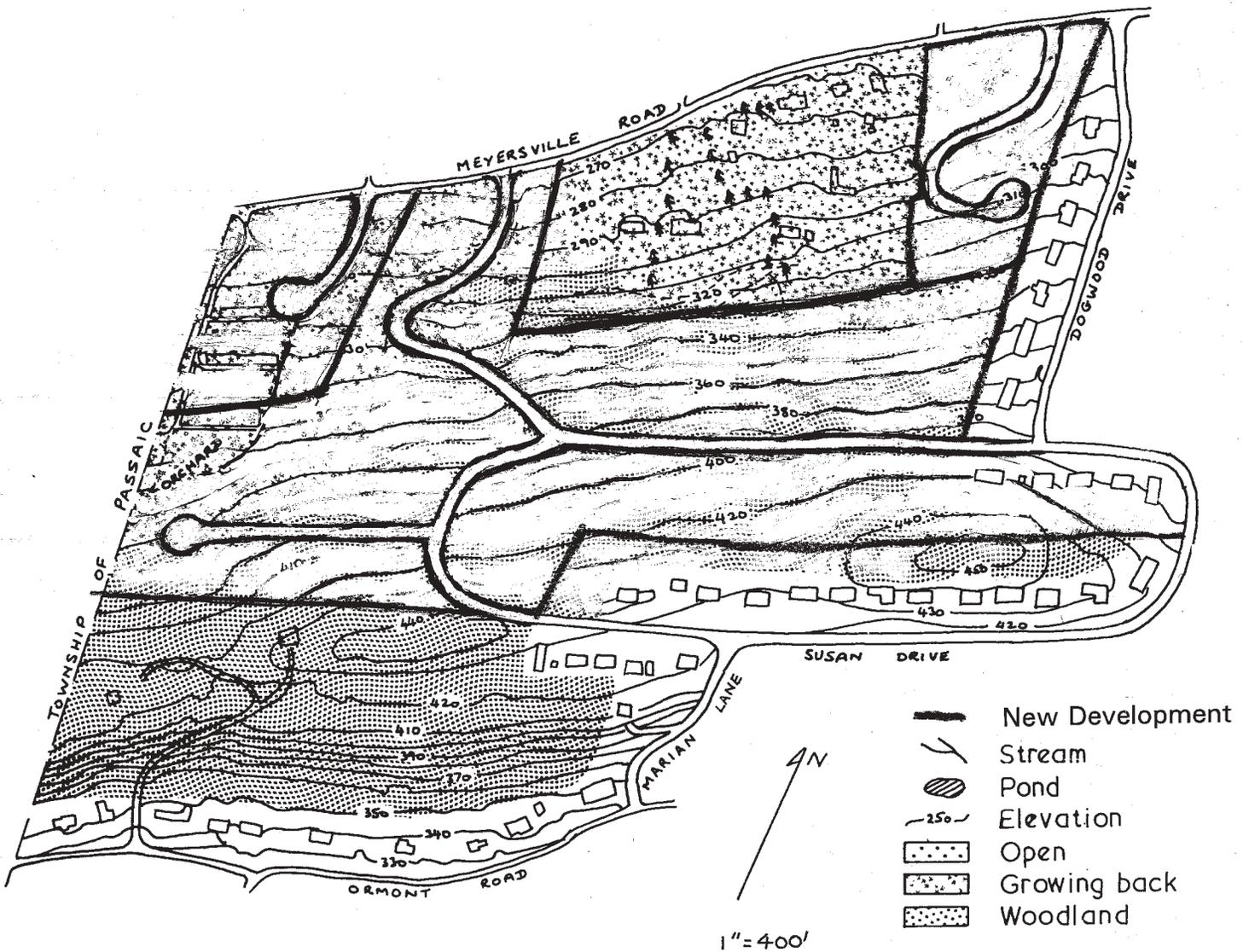
LEGEND: P. 30

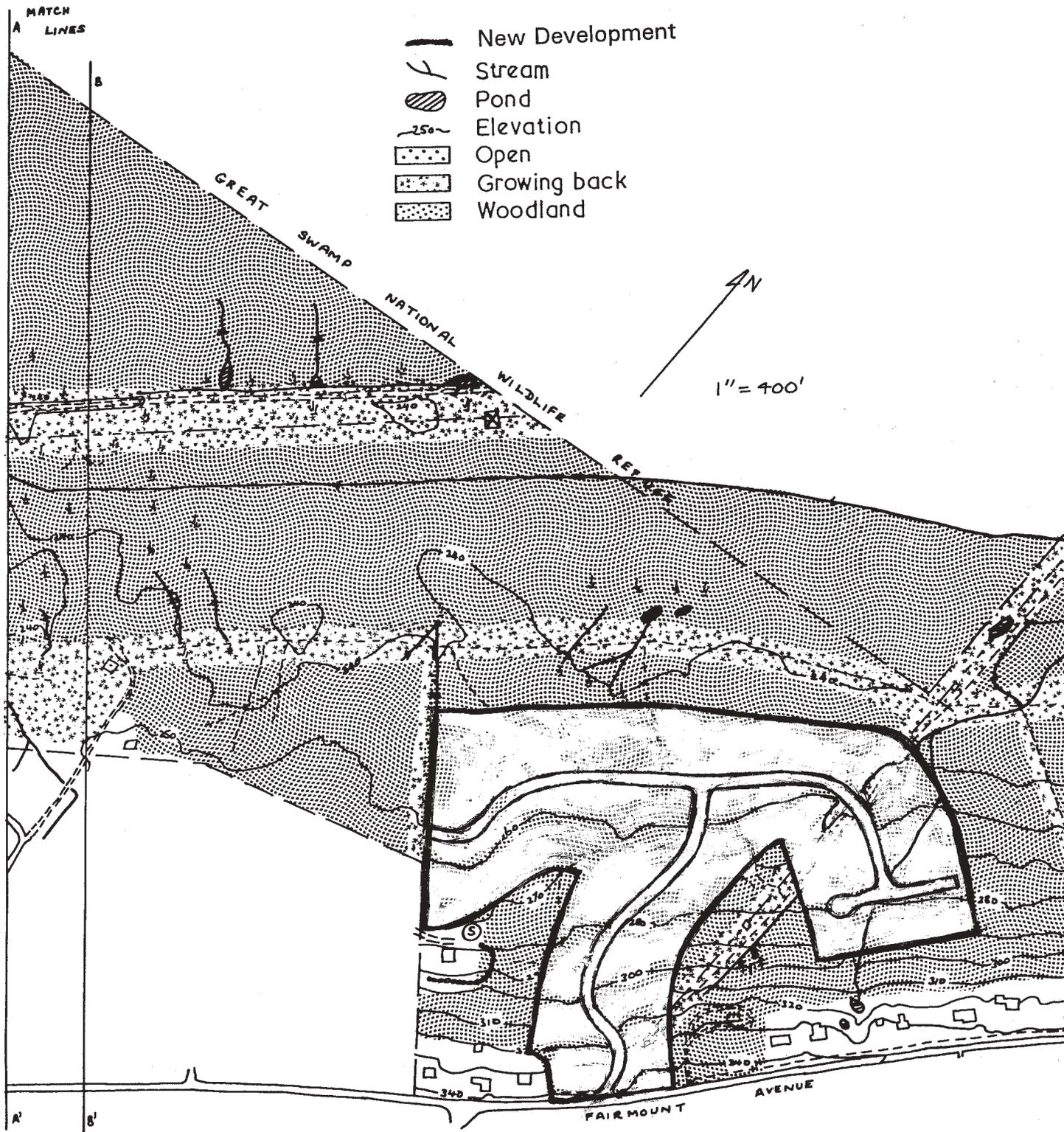
SITE 3. THE ORCHARD

Most of this site was uniform dry woodland sloping west from the crest of Long Hill which rises 190 feet above Meyersville Road. The trees were mainly tulip, oak, beech, ironwood, maple, birch and dogwood. The westerly hillside is now occupied by subdivisions along three new streets: Tree Top Lane, Jodi Lane and Molino Drive.

A small portion of this site is on the steeper slope of Long Hill facing east towards the Passaic River. The change in natural conditions is marked and interesting. The southern exposure is much more wild and varied. There are some huge old trees, a few young ones, many vines and brambles, small bushes and grasses. There are good views to the south from the area along Susan Drive.

Except where explicitly noted, the land described here is private property.





SITE 4. MOUNTAINVIEW

This is a low largely wetlands area lying between Long Hill and the Great Swamp Refuge. In addition to natural drainage and storm sewer piping, all of the water discharged from the Chatham Township Sewage Treatment Plant is channelized through here. A variety of uses of the land over the years had produced some interesting conditions on this site. In one place there is a large stand of mature pine trees on a knoll. The floor of this little forest is a bed of pine needles, dark and cool. There is a small pond among the trees. Behind the municipal building the swampy terrain has small mossy hummocks rising out of water supporting trees, water plants and animals.

Long Hill Lane and Evergreen Road are built on a ridge of land slightly higher than the surrounding areas. To the northwest of the power lines, several homes are built on the high spots. They are surrounded by lush laurel bushes, huge beech trees and large evergreens.

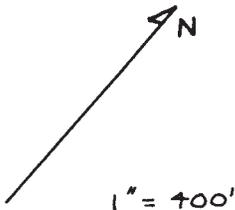
The area in the eastern section is on higher ground and is dryer. The Stonewyck and Pembroke Road development was constructed here in the late 1970's. Karlin Drive development was constructed in the 1980's. This area when inventoried in 1973 contained several springs and streams. Trails and campsites showed that people used to take advantage of the area's recreational possibilities.

The power lines have a raised dirt road along them, but are otherwise very wet. Water-loving plants such as cattails and phragmites exist in great abundance. Wildflowers also abound, and the waterways are hosts to wild ducks and geese. The lands under the power lines are used for hiking and cycling.

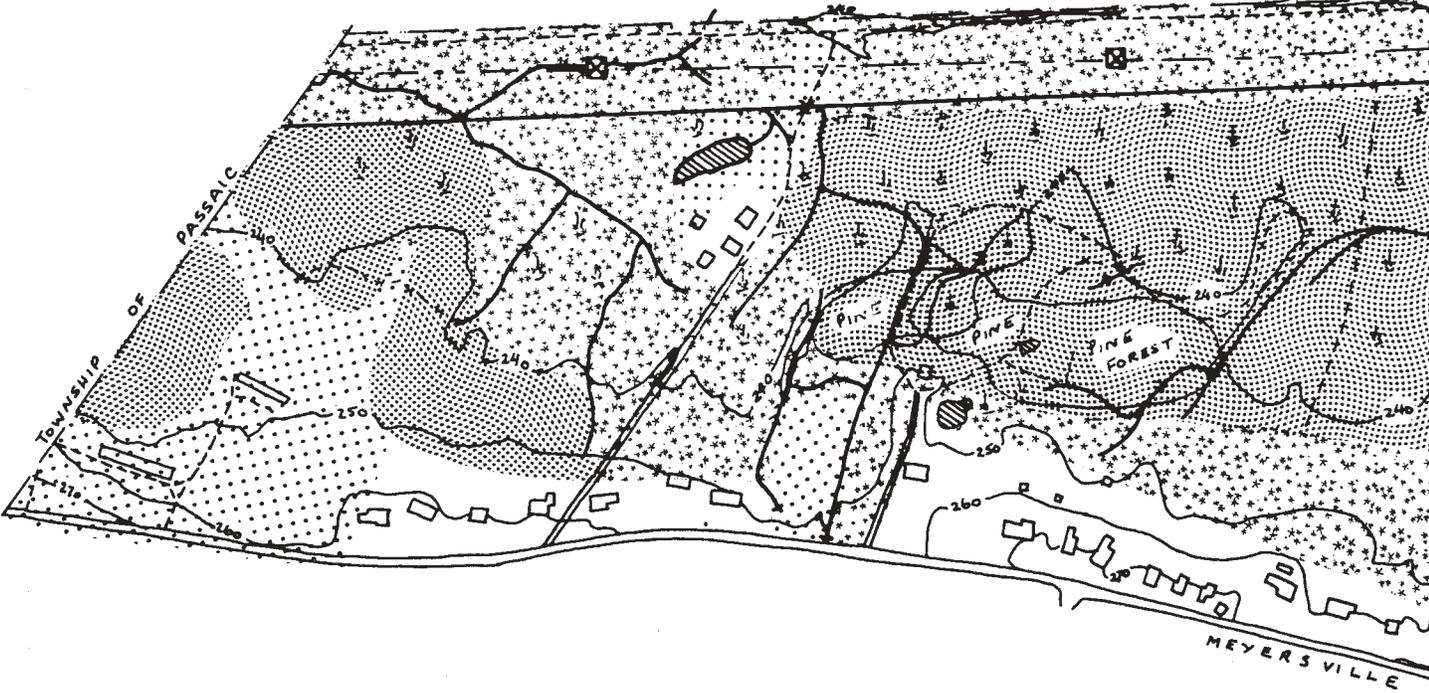
Except where explicitly noted, the land described here is private property.



SITE 4 MOUNTAINVIEW



-  Stream
-  Pond
-  Elevation
-  Open
-  Growing back
-  Woodland



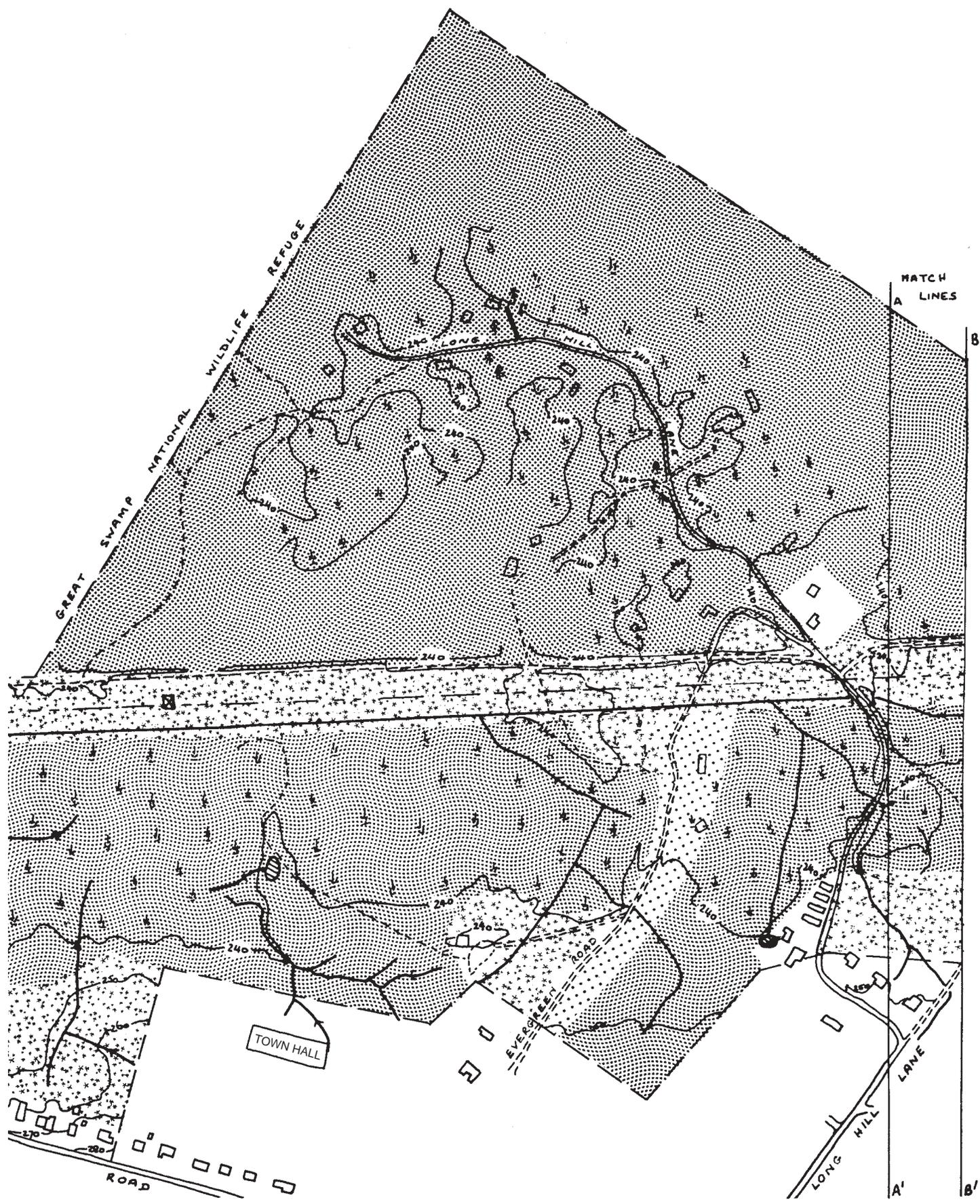
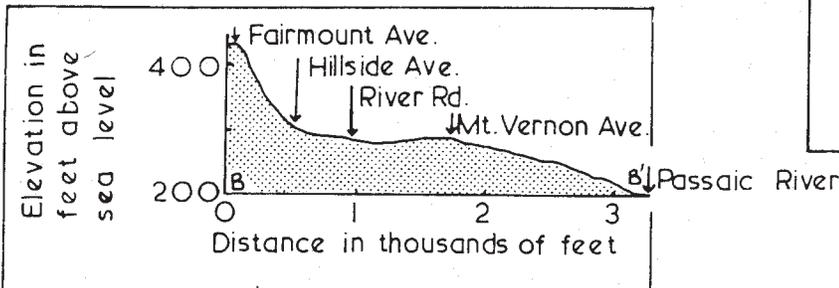
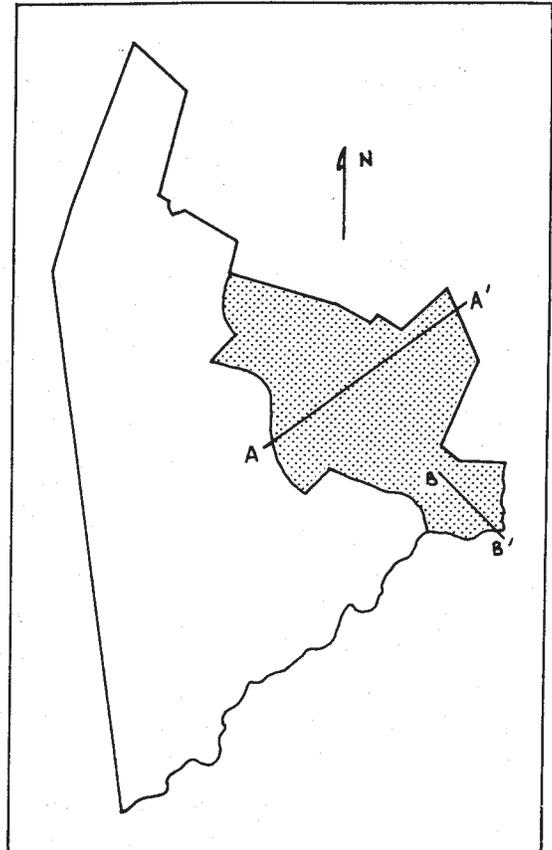


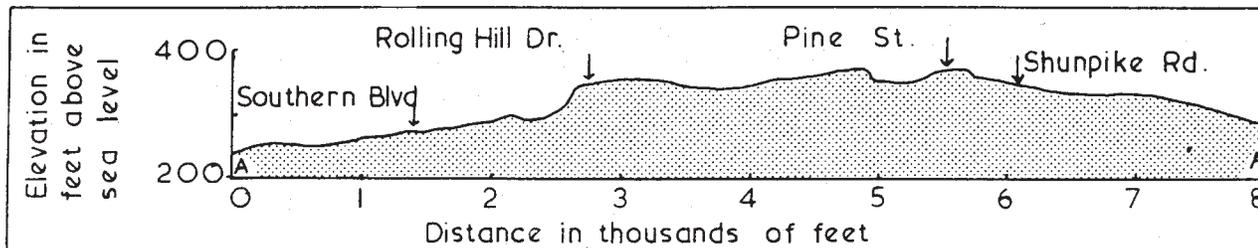
Figure 19
PRINCIPAL REGION: MORaine

ACREAGE	1974	1999	% CHANGE
HOUSE	704	838	+ 19%
APT/COMMERCIAL	2	2	0%
PUBLIC/SEMI-PUB.	129	129	0%
RECREATION	222	222	0%
G.S.N.W.R.	24	24	0%
UNDEVELOPED	371	237	- 25%
TOTAL	1452	1452	



DEVELOPMENT	H →
DRAINAGE SCS	G → P →
VEGETATION	O → W →
SOIL	Bh → S → M _o →

LEGEND: P. 30

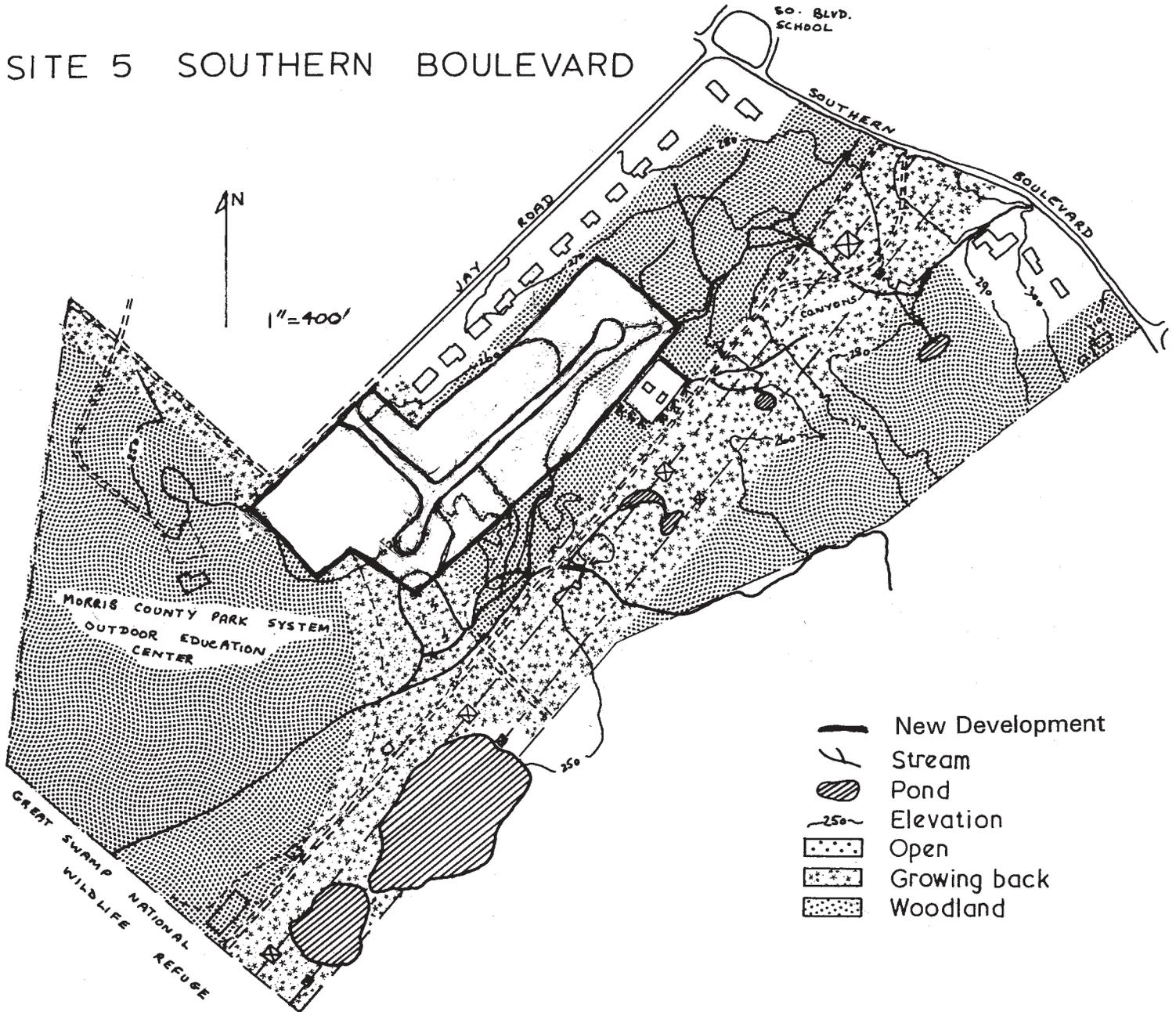


DEVELOPMENT	R → H → PsP →
DRAINAGE SCS	P → G → P →
VEGETATION	
SOIL	G ^o → U →

SITE 5. SOUTHERN BOULEVARD

This site is dominated by a power line and gas right-of-way. It is traversed by a small stream and woods. In the 1980's, housing and a new street, Geoffrey Court, were constructed on one side of the power lines. On the other side of the power lines, housing and a street were added to the Wickham Woods area, formerly known as the Schwartz farm.

SITE 5 SOUTHERN BOULEVARD



SITE 6. AVERETT

This site at the eastern end of Chatham Township is very different in character from the rest of the undeveloped land. These differences arise primarily from the glacial moraine and from the beach soils and clay deposits of the Glacial Lake Passaic which are found here.

Descending from Fairmount Avenue is a steep wooded slope. From its top, one has a good view of the land below. From here, you can see a large brick house in the center of carefully landscaped lawns and gardens. The mature ornamental vegetation is beautiful. Along Hillside Avenue there are many horse chestnut trees and a high hemlock hedge that has been pruned and nurtured for over seventy years. A large section to the east of the house is devoted to the growing of evergreen trees, mostly spruce.

A 900-unit townhouse development now occupies the areas south of River Road. There are four separate sections: Briarwood and Coachlight Square (north of Mt. Vernon Avenue), Sutton Woods, Heritage Greene and Vernon Grove (south of Mt. Vernon Avenue).

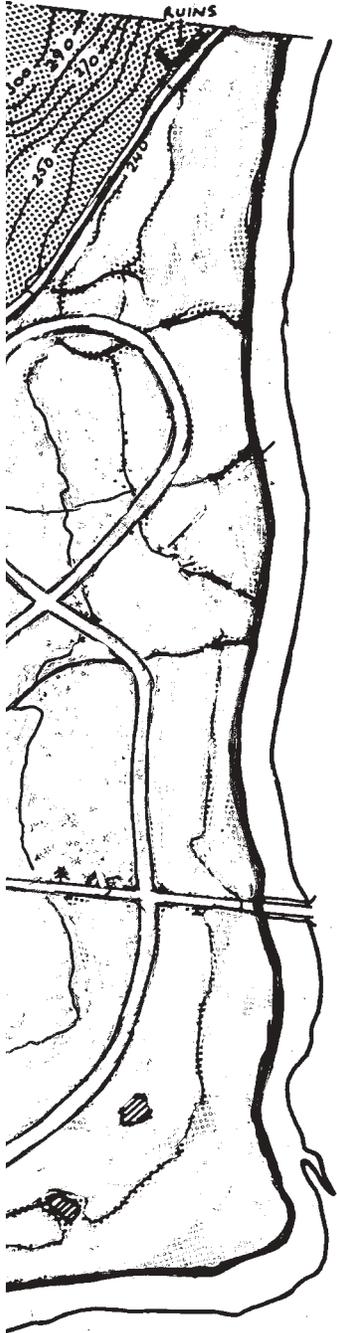
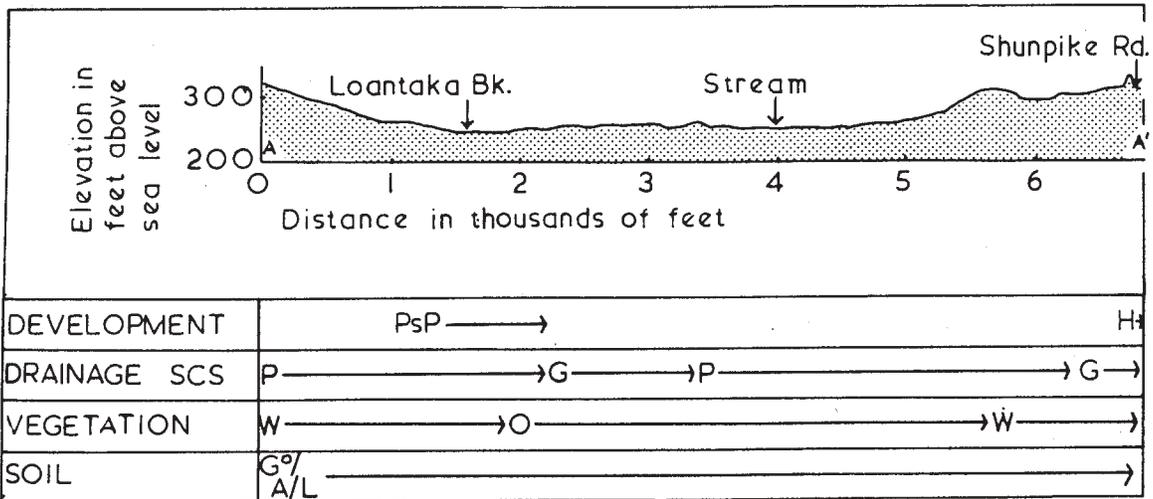
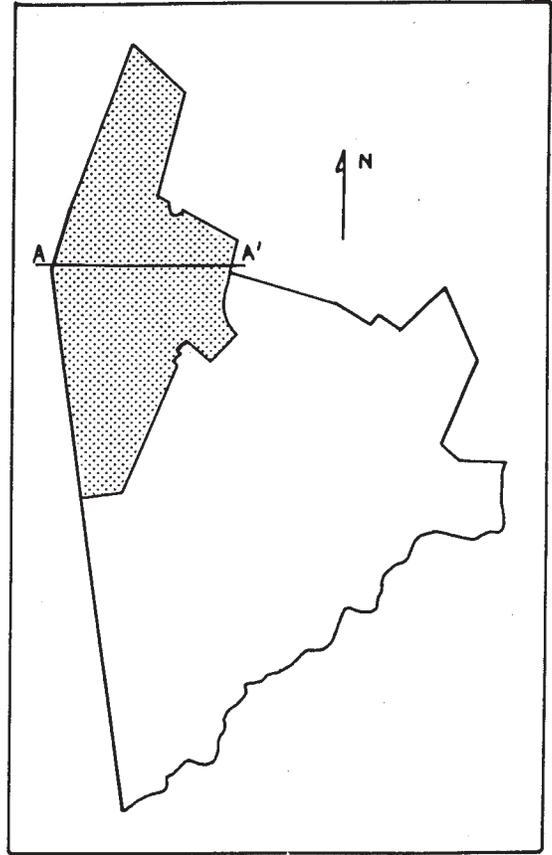


Figure 20
PRINCIPAL REGION: LOANTAKA

ACREAGE	1974	1999	% CHANGE
HOUSE	110	117.5	+ .07%
APT/COMMERCIAL	42	42	0%
PUBLIC/SEMI-PUB.	4	4	0%
RECREATION	315	315	0%
G.S.N.W.R.	51	51	0%
UNDEVELOPED	1069	1961.5	- .007%
TOTAL	1591	1591	



LEGEND: P. 30

SITE 7. GIRALDA FARMS (formerly known as Dodge)

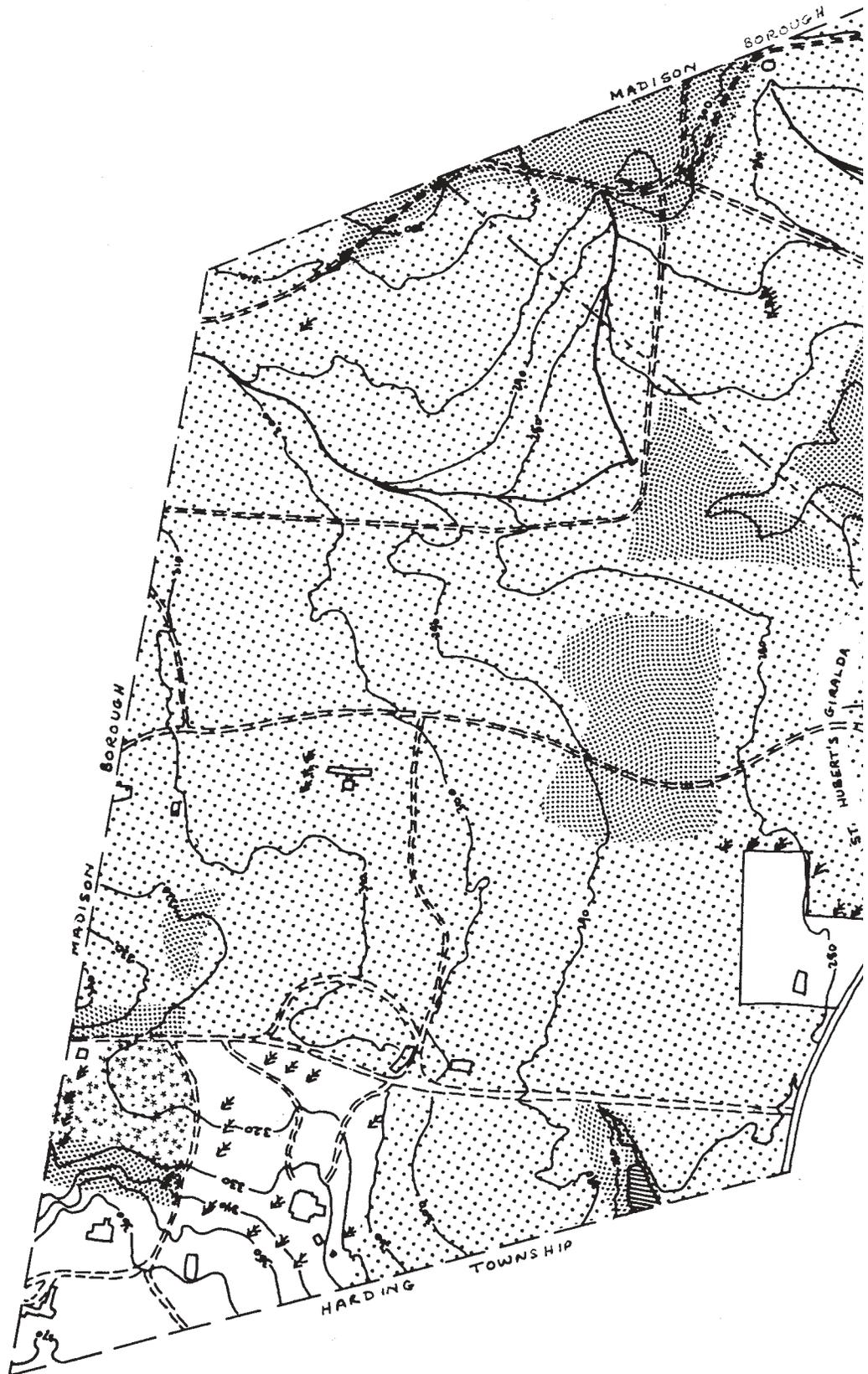
This site lies at the northern tip of Chatham Township. With the exception of Long Hill, it is the highest land in town. Several springs rise on the property and drain to the southwest through a wooded area, eventually to Loantaka Brook.

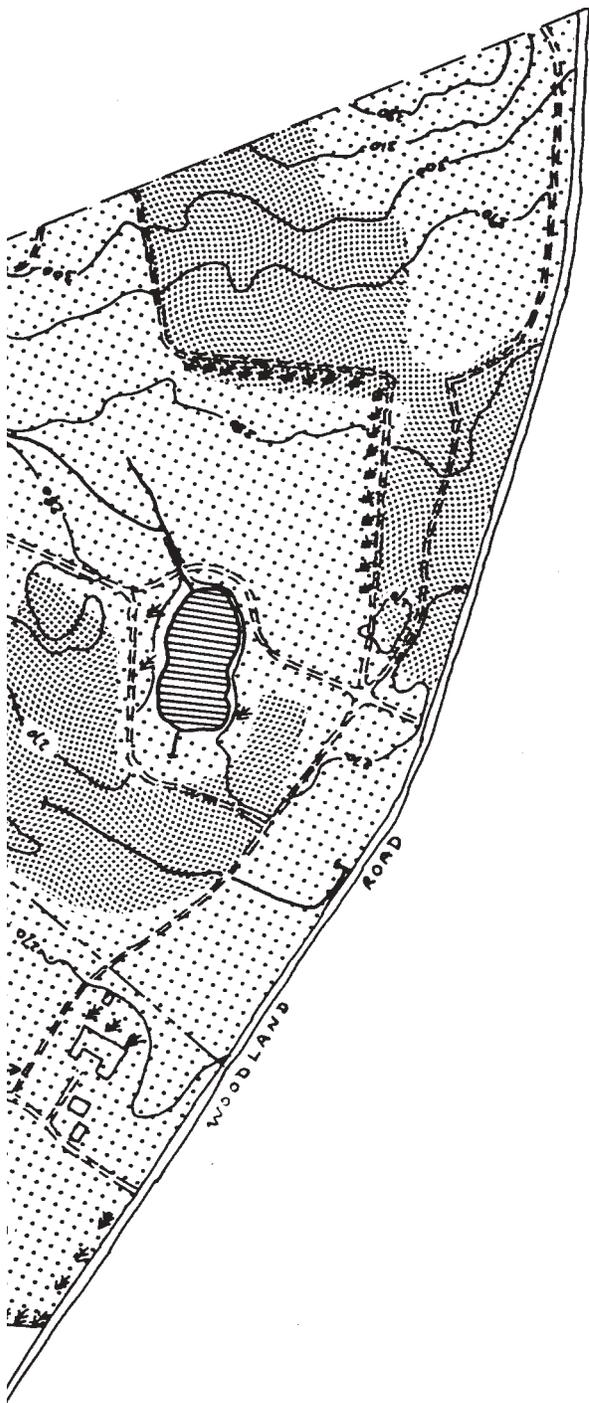
The section of this site bordered by Harding Township and Treadwell Avenue has five houses set among tall trees, many of which are mature evergreens. Prominently positioned, the Boisaubin House was built around 1790. It was a stop on the Underground Railroad and is on the National Register of Historic Houses. The property boasts the first historic conservation easement in the state to protect the seven acres surrounding the house. The property on the corner of Treadwell and Woodland Avenues has been subdivided and two new homes will be built.

The rest of this site is Giralda Farms, part of the former Dodge Estate. It is zoned for office development and most of the access drive is located in Chatham Township. Here a gently rolling terrain has been developed into broad lawns and small woods. It is planted with well-spaced trees which, through years of care, have developed into beautiful specimens of many indigenous and imported species. Access is by appointment only.

Except where explicitly noted, the land described here is private property.

SITE 7 DODGE
(GIRALDA FARMS)





1" = 400'

-  Stream
-  Pond
-  Elevation
-  Open
-  Growing back
-  Woodland

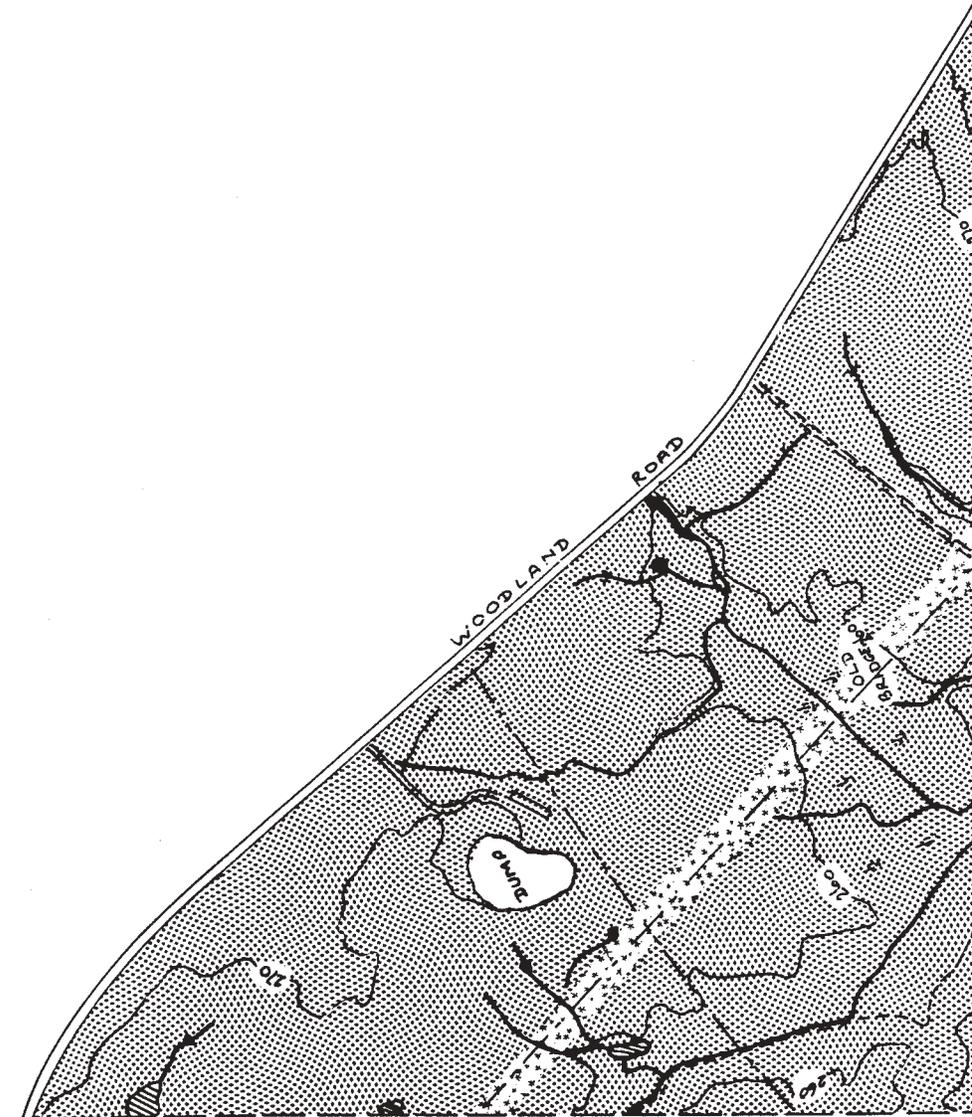
SITE 8. LOANTAKA

With the exception of the properties along Loantaka Lane North, this site is a secluded wooded valley owned for the most part by the Morris County Park System. It is easily entered and traversed along a county bike path. The setting is one of small streams, woods, swampy places, occasional clearings and Loantaka Brook, which is the major local watercourse. The only intrusion on the tranquillity of this site is the periodic passage of low-flying airplanes, on their way to Morristown Airport.

An especially noteworthy aspect of this site is the view that is seen by motoring along Loantaka Way. The scene is a very large clearing edged by young maple woods whose colors change not only with the season, but also with the atmospheric conditions of the day. The low-lying land often has pockets of mist or ground fog. Deer graze in this area, undisturbed by passing cars.

On the higher elevations in the northerly part of this site is an area of about 24 acres known locally as the Loantaka Moraine. Accessed from Woodland Road, it has beautiful views looking out over the Loantaka Valley. The undulating topographic lines show where waves of Glacial Lake Passaic once broke. Efforts to preserve this section of the site are ongoing.

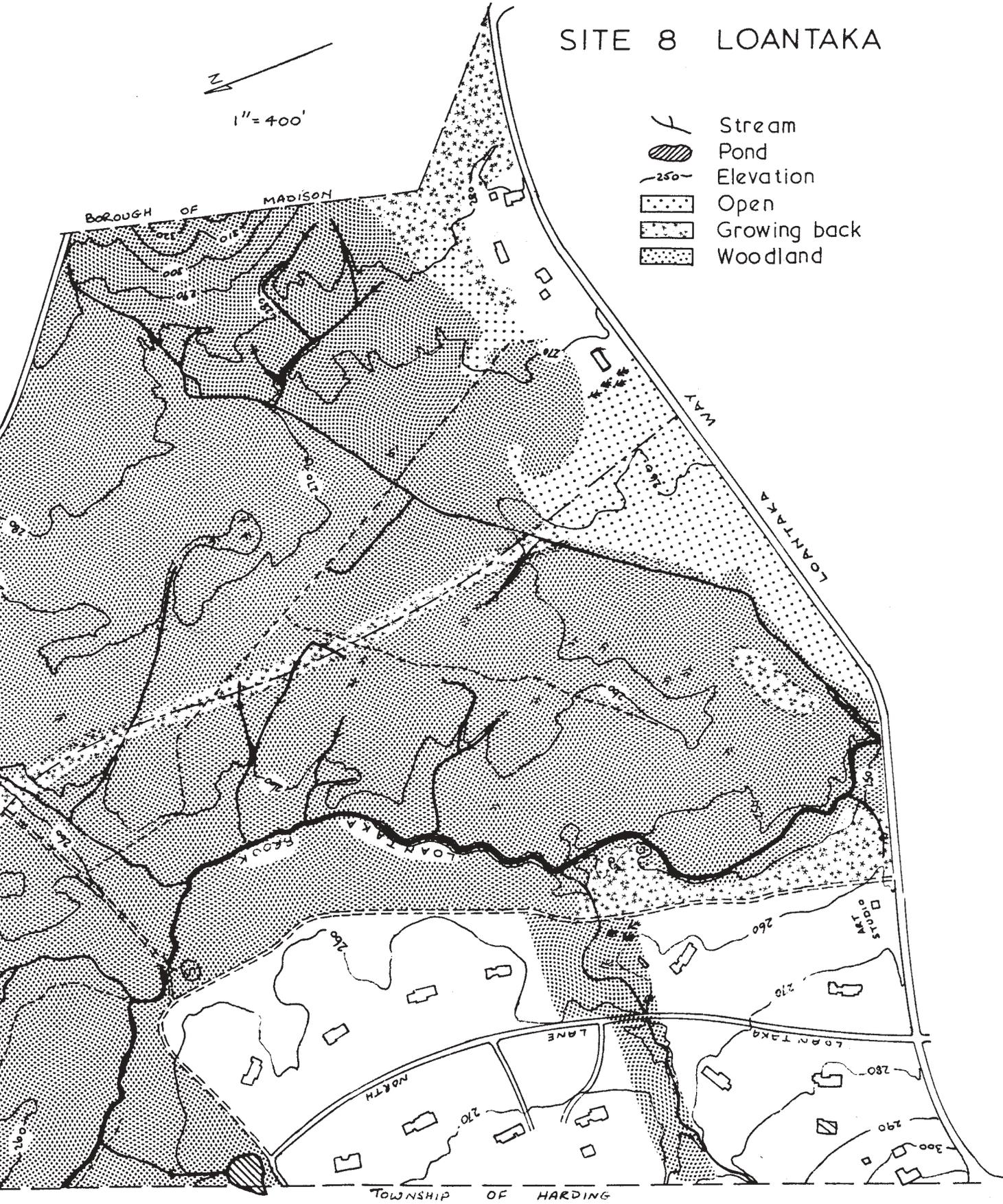
Except where explicitly noted the land described here is private property.



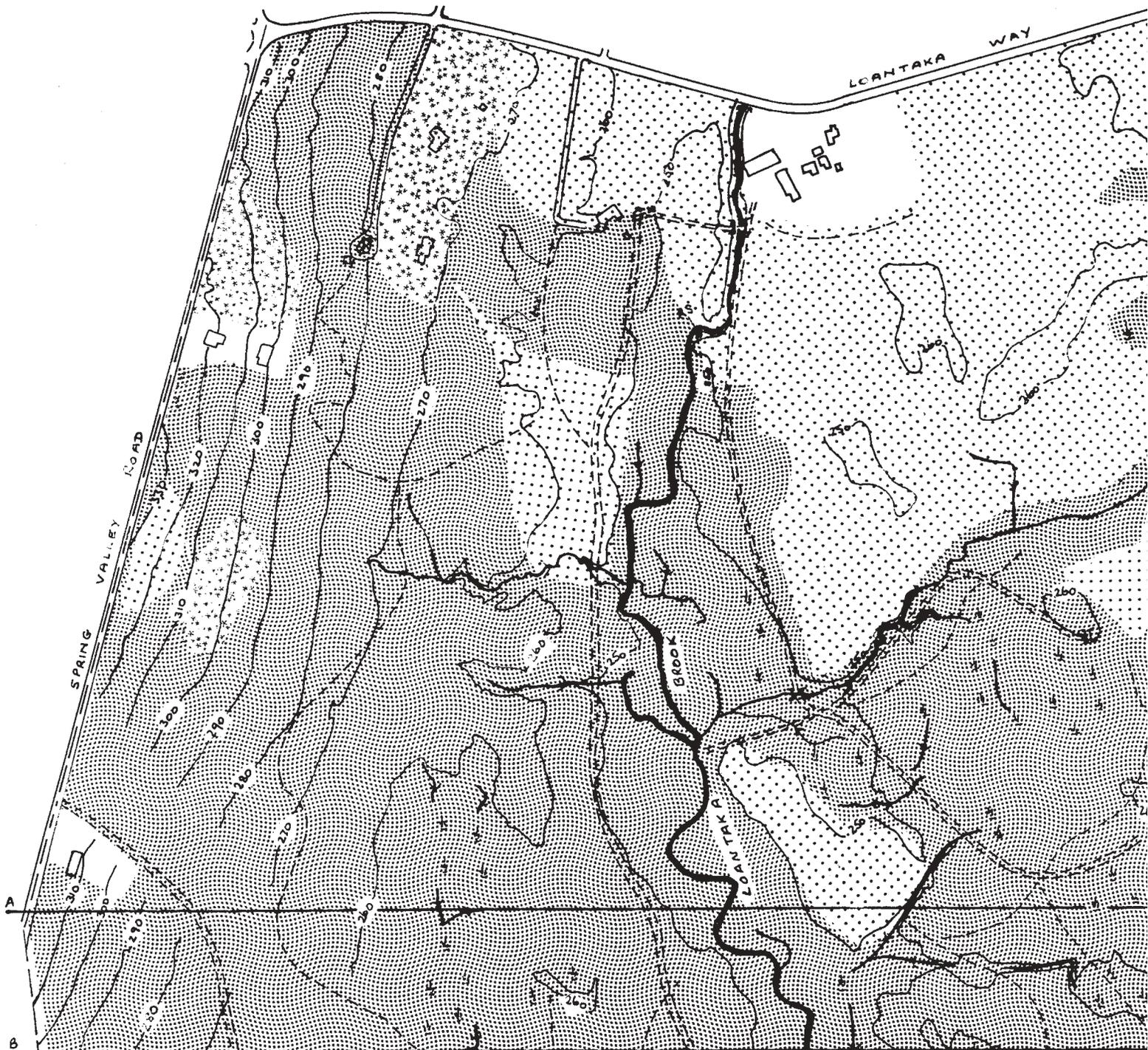
SITE 8 LOANTAKA


 1" = 400'

-  Stream
-  Pond
-  Elevation
-  Open
-  Growing back
-  Woodland



SITE 9 HICKORY



SITE 9. HICKORY

This site is comprised of a broad basin rather like a pie plate with a flattened southern edge. It has three more or less distinct natural divisions:

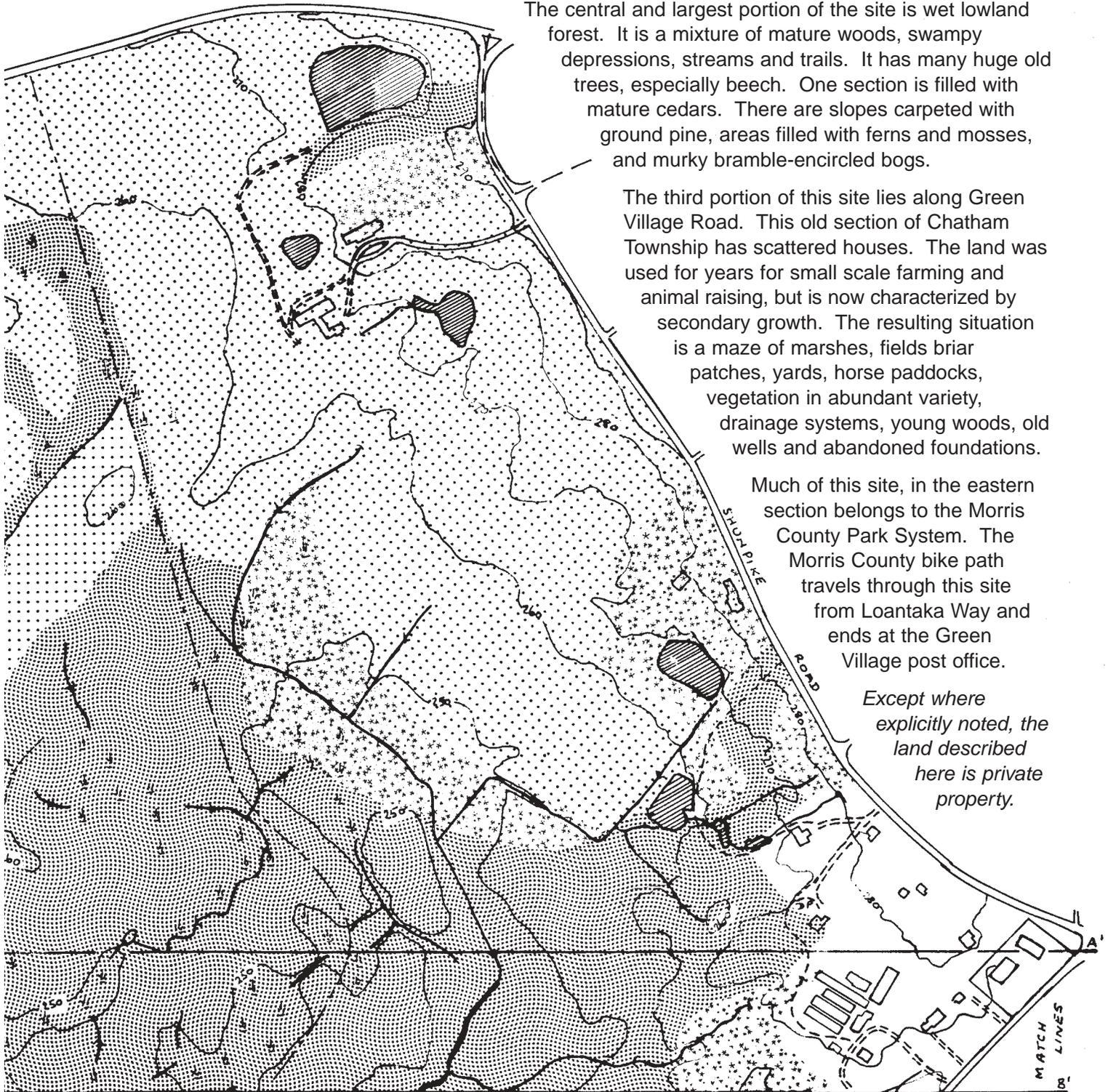
The northern portion of the site is cleared land, mostly grass with large, well-maintained rural homes. It is scenic. A site on the National Register of Historic Places, the Gibbons Barn, sits near the stone bridge over Loantaka Brook. Much of the grassland is pasture for horses.

The central and largest portion of the site is wet lowland forest. It is a mixture of mature woods, swampy depressions, streams and trails. It has many huge old trees, especially beech. One section is filled with mature cedars. There are slopes carpeted with ground pine, areas filled with ferns and mosses, and murky bramble-encircled bogs.

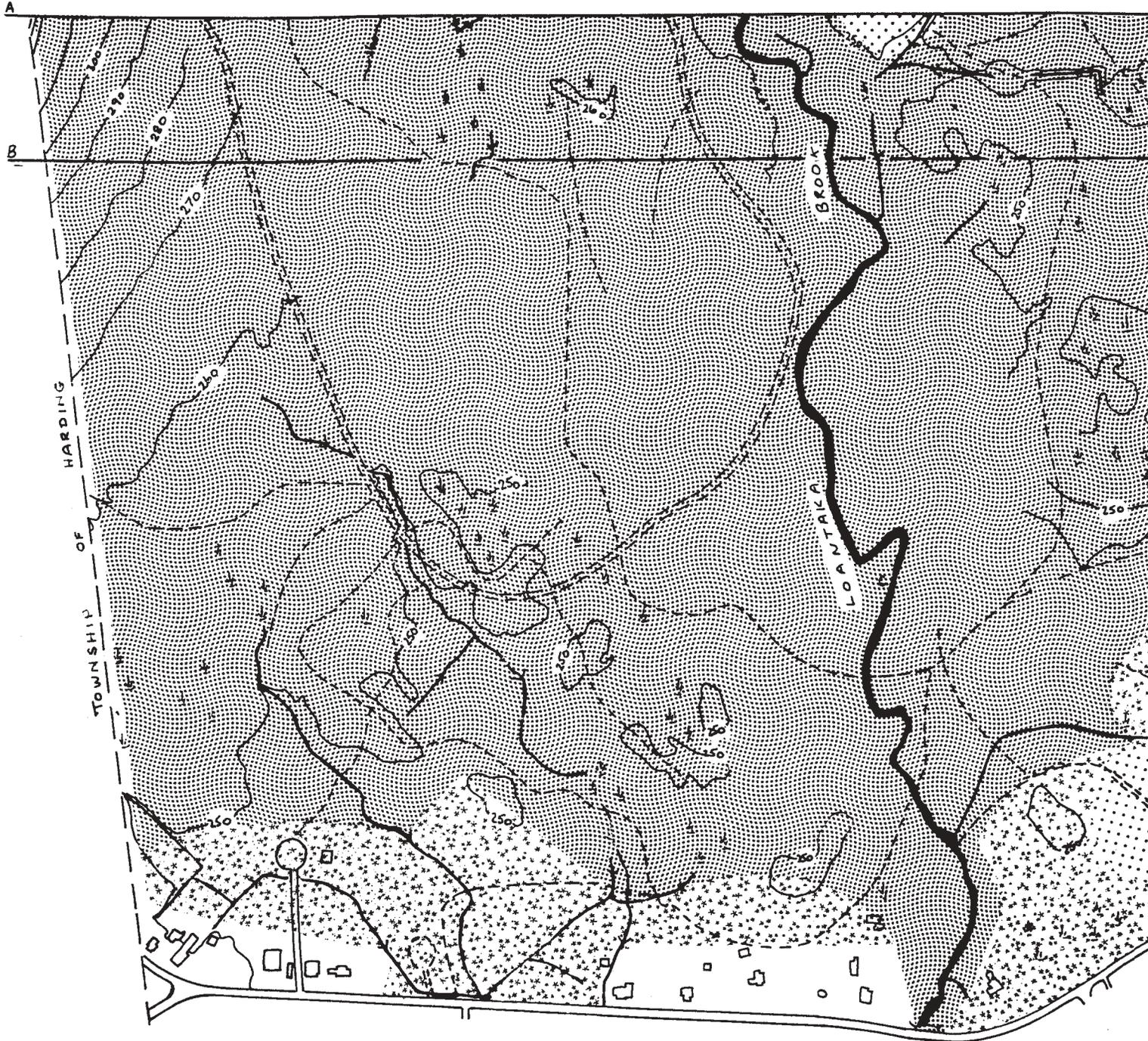
The third portion of this site lies along Green Village Road. This old section of Chatham Township has scattered houses. The land was used for years for small scale farming and animal raising, but is now characterized by secondary growth. The resulting situation is a maze of marshes, fields briar patches, yards, horse paddocks, vegetation in abundant variety, drainage systems, young woods, old wells and abandoned foundations.

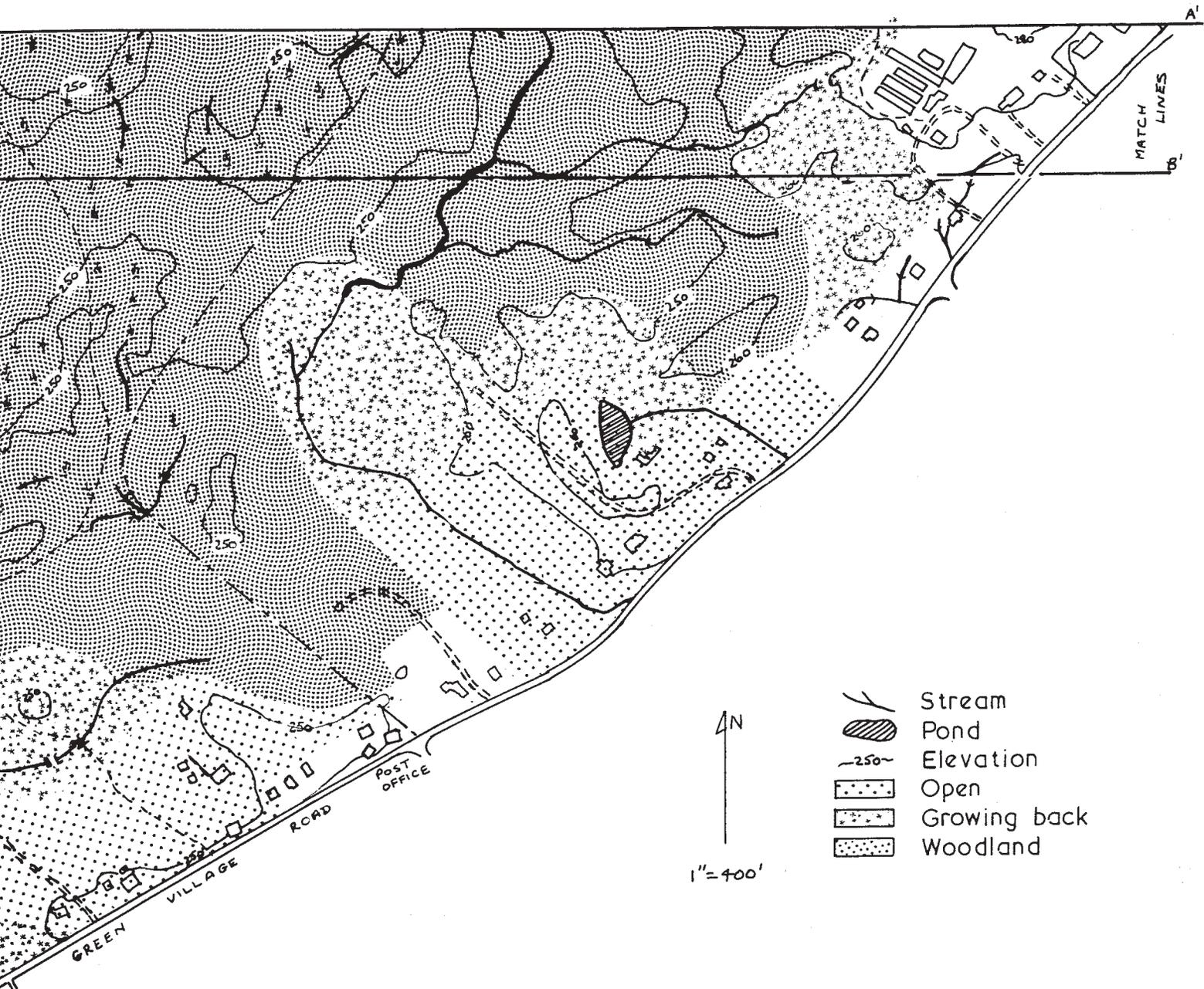
Much of this site, in the eastern section belongs to the Morris County Park System. The Morris County bike path travels through this site from Loantaka Way and ends at the Green Village post office.

Except where explicitly noted, the land described here is private property.



HICKORY (cont'd)





SITE 10. DELTA

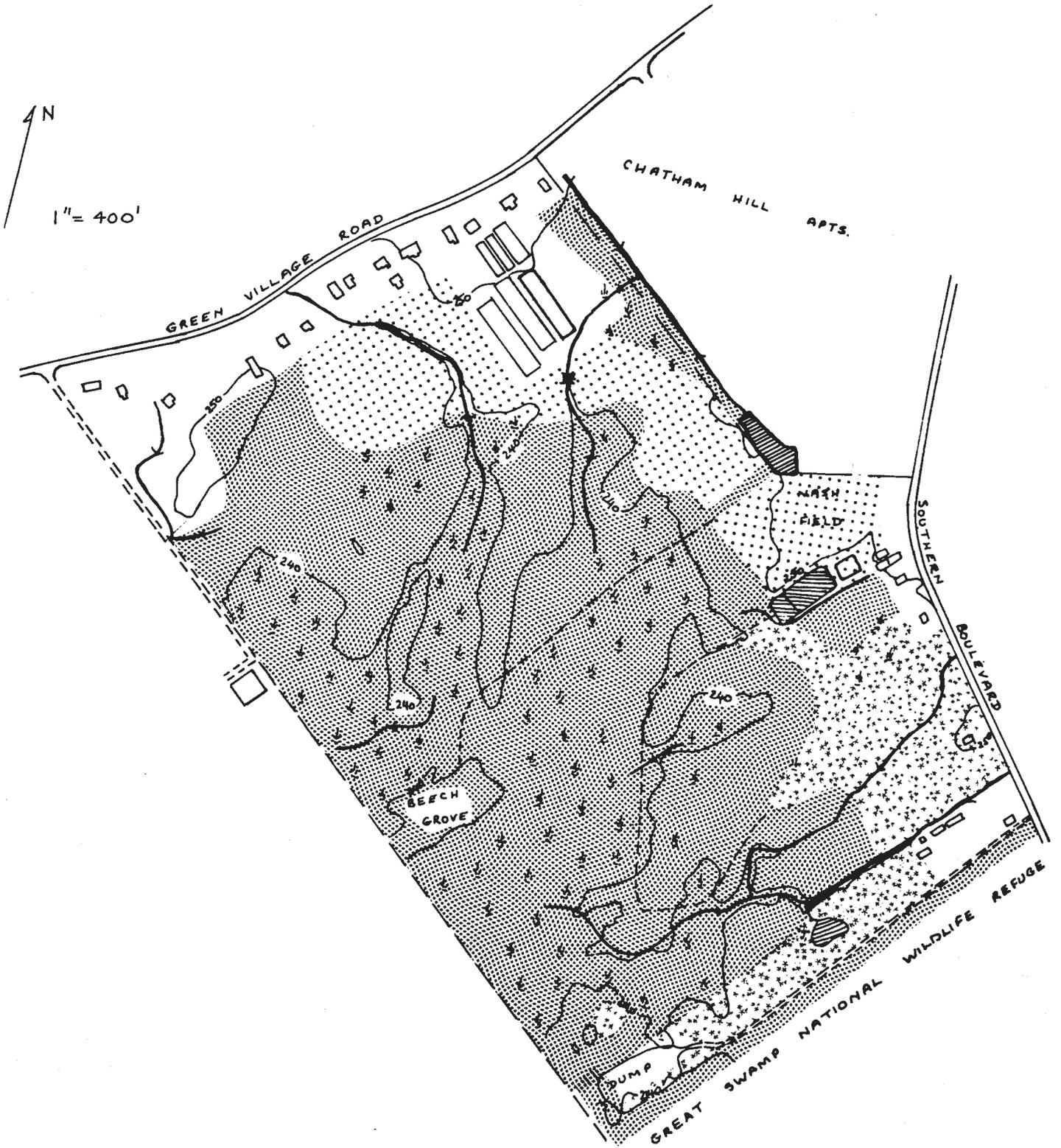
The most prominent feature of this site is water. The land receives runoff from a large area to the north and east and eventually discharges it into the Great Swamp. There is extensive use of drainage ditches and pipes to route water away from the buildings, cultivated fields, pastures and recreational areas. There are many low wet woods, swamps and marshes. Sandy ridges and knolls (principally along Britten Road and to the east) provide well-drained places for houses and small gardens. Practically all of the uncleared land is laced with dirt roads, trails and paths which skirt the wet areas.

To the west of Loantaka Brook is a large area, formerly used by a construction business and for raising horses. It is a picturesque setting.

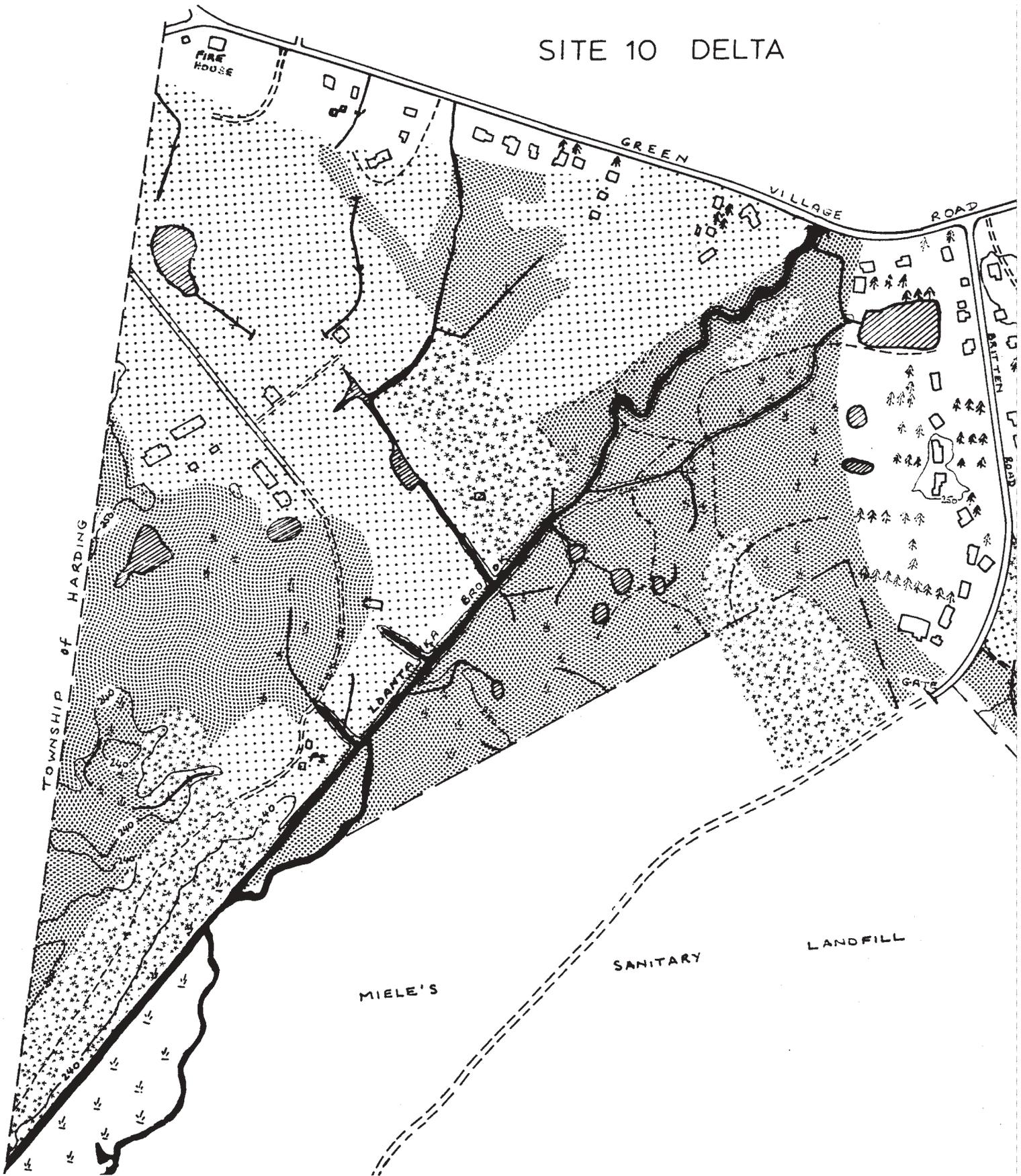
Township residents make use of the recreational facilities at Nash Field where there are ball fields, a skating rink, playground equipment, picnic tables and grills. Trails at the back of Nash Field were formerly used for nature walks. The site is a natural habitat for water oriented wild animals and birds. The dominant tree species here and on the rest of the Delta site are beech, oak and red maple.

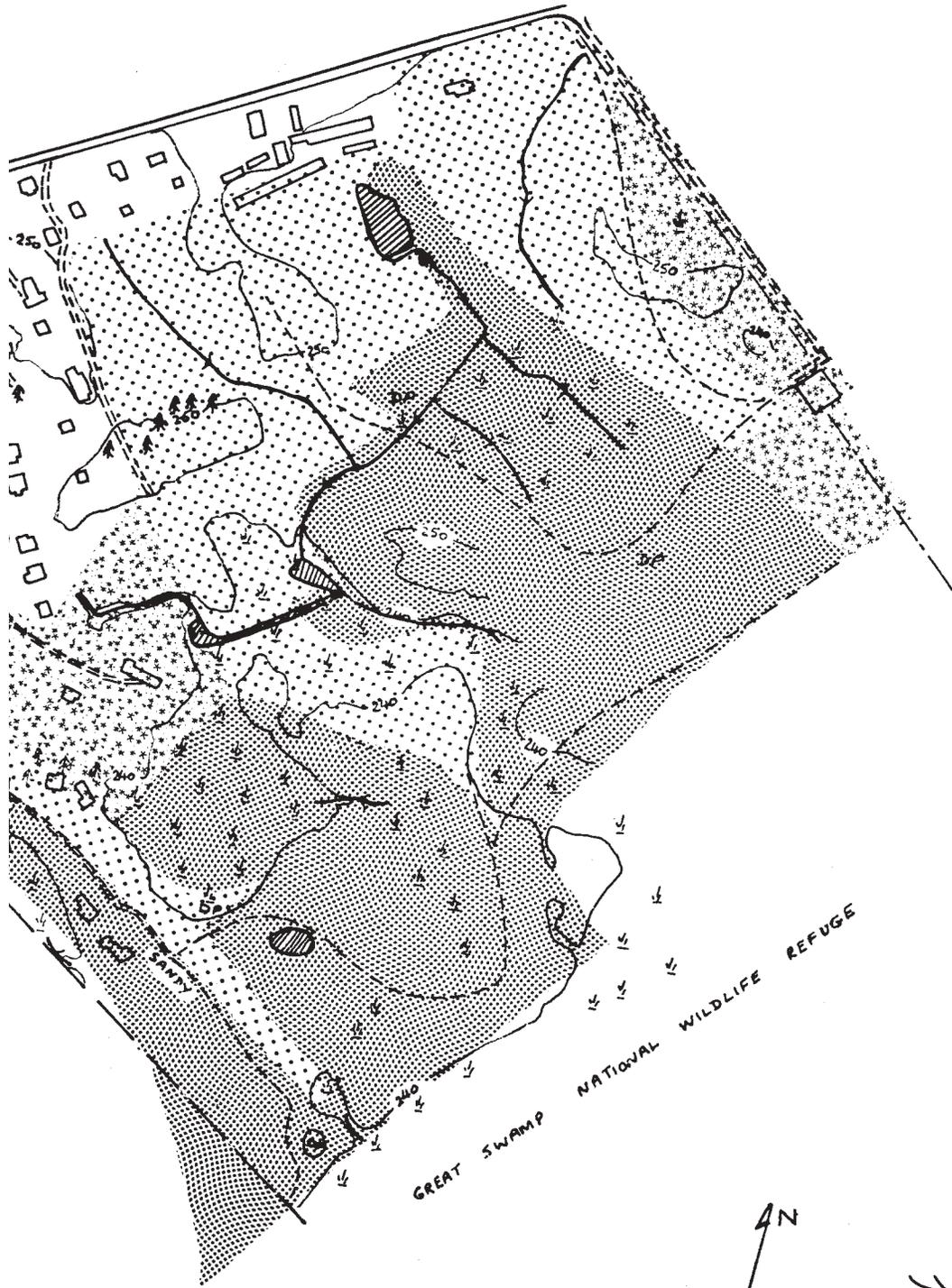
At the end of Britten Road is the Rolling Knolls landfill which was used as a sanitary landfill until it was closed in 1968. The fill has raised the land well above its original level, at the swamp elevation. Records of the Board of Health show that the westerly tributary of Black Brook is blocked by the landfill.

Except where explicitly noted, the land described here is private property



SITE 10 DELTA





GREAT SWAMP NATIONAL WILDLIFE REFUGE



1" = 400'

-  Stream
-  Pond
-  Elevation
-  Open
-  Growing back
-  Woodland

Appendix A

TREES, SHRUBS, AND PLANTS

Trees (Piedmont Lowland Forest)

Acer negundo	Box Elder
Acer rubrum	Red Maple
Acer saccharinum	Silver Maple
Carya ovata	Shagbark Hickory
Comus florida	Flowering Dogwood
Fagus amencana	American Beech
Fraxinus americana	White Ash
Populus tremuloides	Quaking Aspen
Prunus seragina	Wild Black Cherry
Robinia pseudoacacia	Black Locust
Quercus alba	White Oak
Quercus bicolor	Swamp Oak
Quercus palustris	Pin Oak

Shrubs

Ciomus amomurn	Shrub Dogwood
Comus racemosa	Gray Cornel
Lindera Benzoin	Spicebush
Lonicera tatarica	Tatarian Bush-honeysuckle
Viburnum casinoides	Withe-rod
Viburnum dentatum	Northern Arrowwood
Viburnum prunifolium	Black Haw
Rhus typhina	Staghorn Sumac

Vines And Bramble

Rosa multiflora	Wild Hedge Rose
Rubuss pp.	Blackberry, raspberry
Rhus toxicodendron	Poison ivy
Smilax rotundifolia	Cat Brier

Herbaceous Wildflowers

Arisaema triphyllum	Jack-in-the-pulpit
Aster	Aster
Claytonia virginia	Spring Beauty
Erythronium americanum	Trout-lily, Dog-tooth Violet
Geramum. maculatum	Wild Geranium, Crane's-bill
Iris versicolor	Wild Blue Flag
Lobelia siphilitica	Blue Lobeha
Symplocarpus foetidus	Skunk Cabbage
Ranunculus ficaria	Lesser Celandine
Viola conspers	American dog-violet

Appendix B

MAMMALS

The following list of mammals are seen in Chatham Township:

Opossum
Masked Shrew
Smoky Shrew
Short-tailed Shrew
Starnose Mole
Little Brown Myotis (Bat)
Red Bat
Black Bear
Raccoon
Longtail Weasel
Mink
River Otter
Striped Skunk
Red Fox
Gray Fox
Woodchuck
Eastern Chipmunk
Eastern Gray Squirrel
Red Squirrel
Southern Flying Squirrel
Beaver
White-footed Mouse
Gapper's Redback Vole
Meadow Vole
Pine Vole
Muskrat
Norway Rat
House Mouse
Meadow Jumping Mouse
Woodland Jumping Mouse
Eastern Cottontail
Whitetail Deer
Coyote

Appendix C

REPTILES, AMPHIBIANS AND FISHES

The following list of Reptiles, Amphibians, and Fishes are seen in Chatham Township:

Reptiles

Snapping Turtle	Eastern Garter Snake
Common Musk Turtle	Eastern Ribbon Snake
Eastern Mud Turtle	Smooth Earth Snake
Spotted Turtle	Eastern Hognose Snake
Bog Turtle	Northern Ringneck Snake
Wood Turtle	Eastern Worm Snake
Eastern Box Turtle	Northern Black Racer
Eastern Painted Turtle	Smooth Green Snake
Five-lined Skink	Black Rat Snake
Northern Water Snake	Eastern Milk Snake
Northern Brown Snake	

Amphibians

Blue-spotted Salamander	Gray Treefrog
Red-spotted Newt	Northern Spring Peeper
Northern Dusky Salamander	New Jersey Chorus Frog
Redback Salamander	Upland Chorus Frog
Northern Slimy Salamander	Bullfrog
Four-toed Salamander	Green Frog
American Toad	Wood Frog
Fowler's Toad	Northern Leopard Frog
Northern Cricket Frog	Pickerel Frog

Fishes

White Sucker	Tessalated Darter
Creek Chubsucker	Redbreast Sunfish
Carp	Fallfish
Golden Shiner	Common Shiner
Brown Bullhead	Spottail Shiner
Chain Pickerel	Yellow Bullhead
Eastern Mudminnow	Bluespotted Sunfish
Redfiri Pickerel	Satinfin Shiner
American Eel	Mud Sunfish
Smallmouth Bass	Spotfin Shiner
Largemouth Bass	Green Sunfish
Banded Sunfish	Blacknose Dace
Pumpkinseed	Creek Chub
Bluegill	Brook Trout
Black Crappie	

Appendix D

BIRDS

The following list of Birds are seen in Chatham Township:

Bitterns, Herons, And Ibises

American Bittern	Great Blue Heron
Least Bittern	Green-backed Heron

Swans, Geese, And Ducks

Canada Goose	Mallard
Wood Duck	Blue-winged Teal
Green-winged Teal	Hooded Merganser
American Black Duck	
Vultures, Hawks, and Falcons	
Red-shouldered Hawk	Red-tailed Hawk
Broad-winged Hawk	American Kestrel

Grouse, Quail, And Turkey

Ring-necked Pheasant	Wild Turkey
Ruffed Grouse	
Rails and Cranes	
King Rail	Sora
Virginia Rail	Common Moorhen

Plovers And Sandpiper

Killdeer	American Woodcock
Spotted Sandpiper	

Doves, Cuckoos, Owls, Swifts, And Hummingbirds

Mourning Dove	Great Homed Owl
Black-billed Cuckoo	Barred Owl
Yellow-billed Cuckoo	Ruby-throated Hummingbird
Eastern Screech-Owl	

Woodpeckers And Flycatchers

Red-headed Woodpecker	Acadian Flycatcher
Red-bellied Woodpecker	Alder Flycatcher
Downy Woodpecker	Willow Flycatcher
Hairy Woodpecker	Least Flycatcher
Northern Flicker	Eastern Phoebe
Pileated Woodpecker	Great Crested Flycatcher
Eastern Wood-Pewee	Eastern Kingbird

Larks, Swallows. Lays, And Crows

Purple Martin	Blue Jay
Tree Swallow	American Crow
Barn Swallow	

Titmice, Nuthatches, And Wrens

Black-capped Chickadee	Carolina Wren
Tufted Titmouse	House Wren
White-breasted Nuthatch	Marsh Wren
Brown Creeper	

Kinglets, Thrushes, and Thrashers

Blue-gray Gnatcatcher	American Robin
Eastern Bluebird	Grey Catbird
Veery	Northern Mockingbird
Wood Thrush	Brown Thrasher

Waxwings, Shrikes, and Starling

European Starling

Vireos and Wood Warblers

White-eyed Vireo	Black-and-white Warbler
Yellow-throated Vireo	American Redstart
Warbling Vireo	Prothonotary Warbler
Red-eyed Vireo	Ovenbird
Blue-winged Warbler	Louisiana Waterthrush
Yellow Warbler	Common Yellowthroat
Chestnut-sided Warbler	Yellow-breasted Chat

Tanagers and Sparrow

Scarlet Tanager	Chipping Sparrow
Northern Cardinal	Field Sparrow
Rose-breasted Grosbeak	Song Sparrow
Indigo Bunting	Swamp Sparrow
Rufous-sided Towhee	

Blackbirds and Finches

Bobolink	Northern Oriole
Red-winged Blackbird	House Finch
Eastern Meadowlark	American Goldfinch
Common Grackle	House Sparrow
Brown-headed Cowbird	

Appendix E

OPEN SPACE LISTING - CLASS 1 PROPERTIES (Lots with No Dwelling)

<i>Block</i>	<i>Lot</i>	<i>Owner</i>	<i>Tax Map Number</i>
2	5		25
6	3	Private	1
7	13	Private	1
8	4		1
14	47	Private	21
14	48.01	Private	21
15	1		24
15	7	Private	24
16	70		21
17	78	Utility	32
17	81.08		32
17	81.09		32
18	93	Utility	35
18	94	Utility	35
20	14		24
20	15		24
20	16		24
20	17		24
20	18		24
20	19		24
20	20		24
20	21	Private	24
23	15	Private	24
31	15	Private	24
31	33		24
32	2		24
32	6	Private	24
32	8	Private	24
33	1		24
33	14		24
33	17		24
33	20		24
34	22		24
34	22.01	Private	24
34	22.09		24
34	22.10		24
34	22.11		24
34	22.13		24
34	22.14		24
34	22.15		24
35	5.07		24

<i>Block</i>	<i>Lot</i>	<i>Owner</i>	<i>Tax Map Number</i>
35	8		23
36	9	Private	23
36	16		23
37	5.01	Private	23
37	12	Private	23
38	42	Private	27
38	45	Private	27
39	30	Private	23
39	63	Private	27
39	65	Private	27
40	17	Private	26
48	2	Private	2
48	3	Utility	2
48	12	Utility	2
48	12.1	Utility	3
48	52	Utility	21
48	54	Utility	21
48	55	Utility	21
48	56	Utility	21
48	65.05	Private	21
48	65.07	Private	21
48	67	Private	21
48	68	Private	21
48	69	Private	21
48	73	Utility	32
48	76	Utility	32
48	95	Utility	35
48.1	14	Private	47
48.4	38	Private	47
48.10	104	Utility	47
48.14	107	Utility	46
48.14	110	Utility	6
48.14	113.23	Utility	36
48.15	117.5		37
48.16	121	Private	38
48.16	123		38
48.17	137.1		39
48.17	139		39
48.18	140.1	Utility	17
48.19	157	Private	18
48.20	185	Private	4
48.20	186	Private	4
48.20	187	Private	4
48.20	187.1	Private	4
48.20	188	Private	4
48.21	158.1	Private	5
48.21	165.1	Private	5

<i>Block</i>	<i>Lot</i>	<i>Owner</i>	<i>Tax Map Number</i>
48.21	165.4	Private	5
48.21	181	Private	5
48.21	181.1	Private	5
48.21	182	Private	5
49	1	Private	29
49	3	Private	29
49	3.1	Private	21
50	6	Private	29
53	6.1	Private	29
54	7	Private	29
55	12.1	Private	29
57	9	Private	29
61	16	Private	28
62	54	Private	31
62	71	Private	34
62	88		49
62	101.1	Private	49
62	105	Utility	49
62.1	46.2	Private	49
62.9	2	Utility	28
63	1.3		28
63	2.1	Private	28
63	3	Utility	28
63	4	Private	28
63	5		30
63	5.1	Private	28
63	7	Private	30
63	9	Private	30
63	9.1	Utility	30
63	9.02	Private	30
63	11.1	Utility	30
63	11.02	Private	30
63	12	Private	30
63	12.1	Utility	30
63	12.02	Private	30
63	13	Private	30
63	15	Private	33
64	1		50
67	16	Private	52
69	15.01	Private	53
69	15.02	Private	33
77	2.3	Private	62
77	5	Private	62
77	6	Private	62
78	19.3	Private	62
78	19.4	Private	62
78	20	Private	62
78	20.1	Private	62

Block	Lot	Owner	Tax Map Number
80	6	Private	61
82	1	Private	61
83	3	Utility	61
83	21.01	Private	61
83	31	Utility	61
94	3	Utility	61
84	9	Private	61
90	27	Private	61
92	13	Private	60
93	4	Private	60
93	7	Private	60
95	12	Private	60
95	14	Private	60
95	15	Private	60
95	16		60
95	16.1		60
95	17	Utility	60
95	20	Private	59
95	21	Private	59
95	30		59
95	31	Private	59
95.1	13	Private	59
95.1	14	Private	59
95.1	15	Private	59
95.1	16		59
95.1	30		59
102.8	37	Utility	56
102.11	3	Utility	55
105	5	Utility	55
111	11	Private	36
111	40	Private	36
113	1	Utility	36
114	1	Utility	36
115	1	Utility	36
115	29	Utility	36
124	11		44
128	4		43
128	8		43
128	13.1	Private	58
128	25		58
129	1	Private	43
129	7		43
130	4	Private	43
130	5	Private	43
130	17.1		43
130	18		43
130	28		43
135	1		42

<i>Block</i>	<i>Lot</i>	<i>Owner</i>	<i>Tax Map Number</i>
135	13		42
135	19	Private	42
135	19.1	Private	42
136	1		42
136	5		42
136	7		42
136	9		42
136	10		42
137	1		42
137	10		42
137	13		42
138	4	Private	42
139	1	Private	7
139	1.1		7
139	2	Private	7
139	3.01	Private	7
139	3.02	Private	7
139	3.03	Private	7
139	3.04	Private	7
139	8	Private	9
139	14	Private	9
139	15	Private	9
139	18.2	Private	9
139	18.3	Private	9
139	18.4	Private	9
139	56.4	Private	6
139.1	2	Private	7
140	1.1	Private	10
140	1.2		10
140	3.1		10
140	4.3		10
141	7		11
141	8		14
141	9.4		14
142	2		12
143	1.02	Private	12
143	5	Private	12
143	6	Private	12
144	23		40
144	25	Private	40
144	38	Private	40
144	40	Private	16
144	41.1	Private	16

Appendix F

OPEN SPACE LISTING (Subdividable Lots with Dwelling)

<i>Block</i>	<i>Lot</i>	<i>Acreage</i>	<i>Tax Map Number</i>	<i>Owner</i>
6	5	1.1	1	Private
144	50	5.47	6	Private
139	54	8.04	6	Private
139	61	7.21	6	Private
139	4	4.12	7	Private
139	5	1.9	7	Private
139	18	8.9	9	Private
139	10	6.094	9	Private
139	9	10.84	9	Private
140	3	118	10	Private
140	2.02	1.149	10	Private
141	2	3.762	10	Private
144	48	9.53	16	Private
144	49	6.924	6	Private
144	49.01	5.569	6	Private
144	40	1.8	16	Private
48.18	140	34.8	17	Private
48.18	144	8.8	17	Private
48.19	155	15.35	18	Private
16	65	11.86		
14	62	6.94	21	Private
13	28	26.04	22	Private
39	21	1.158	23	Private
36	12	1.9	23	Private
34	22	4.76	24	Private
32	10	1.75	24	Private
32	14	1.198	24	Private
15	18	1,478	24	Private
38	42	9.412	27	Private
61	10	1.2626	28	Private
62.08		18	14.428	Township
62.08		15	1.276828	Private
62.08		16	1.628	Private
62.08		17	1.2828	Private
17	81.02		3.3832	Private
17	82	3.27	32	Private
17	83	2.13	32	Private
17	84	3.68	32	Private
17	85	3-55	32	Private
17	86	9.71	32	Township
17	90-01	1.24	32	Private
17	90	1.64	32	Private
17	90.02	1.019	32	Private
17	91	2.75	32	Private

<i>Block</i>	<i>Lot</i>	<i>Acreage</i>	<i>Tax Map Number</i>	<i>Owner</i>
63	21	22.39	33	Private
62.02	20	1.047	34	Private
62	74	4.12	34	Private
62	75	4.36	34	Private
62	70	4	34	Private
48.17	138	3.39	39	Private
48.17	137-01	2.428	39	
48.17	130.01	10.18	39	Private
48.17	129	8.27	39	
144	34.01	6.474	40	Private
144	33	5.2	40	Private
144	21	22.96	40	Private
144	22	5.81	40	Private
138	1	3.21	42	Private
135	9	14.28	42	
128	4	1.65	43	
128	3	4.64	43	
62	85	7.1	49	Private
62	87	4.49	49	Private
62	89	6.65	49	Private
62	93	5.1	49	Private
62	100	1.49	49	Private
67	12	17.38	52	Private
66	1	30.24	51	Private
72	5	1.057	53	Private
102.11	5.01	3.02	55	Church
95	11	1.1792	60	Private

Appendix G

GLOSSARY OF TERMS

Aquifer	rocks and sediment that hold large quantities of water. Groundwater moves in and out of aquifers, they are not self contained.
Drift	a mantle of clay, sand, gravel, and boulders
Evapotranspiration	the total water loss from the soil including that by direct evaporation and that by transpiration from the surfaces of plants.
Floodplain	the floodplain is that relatively flat area adjoining the channel of a natural stream which has been or may be covered by floodwater.
Glacier	glaciers are thick masses of slow moving ice.
Horizon, Soil	a layer of soil, approximately parallel to the soil surface, with distinct characteristics, produced by soil-forming processes.
Hydrology	the science of the behavior of water in the atmosphere, on the surface of the earth, and underground.
Leachate	material which has been leached or dissolved from soluble material. It usually refers to chemicals and compounds from sanitary landfills that have gone into solution and entered the ground
Moraine	a heterogeneous mixture of clay, sand, and stone dumped at the front of a glacier.
Recharge Areas	places where precipitation or surface water filters down into an aquifer.
Terminal Moraine	a ridge-like accumulation of drift formed where a glacier stagnates. The ridge-like deposit is broken by gaps where meltwater streams existed.
Till	unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders.
Triassic Period	the period of geologic history which began about 225 million years ago.
Water Table	the highest part of the underlying soil or rock that is totally saturated with water.
Watershed	the land area from which water drains to a single stream, river, or other body of water.
Wetland	an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as a hydrophytic vegetation.

FOLD-OUT MAPS

(see following pages)

