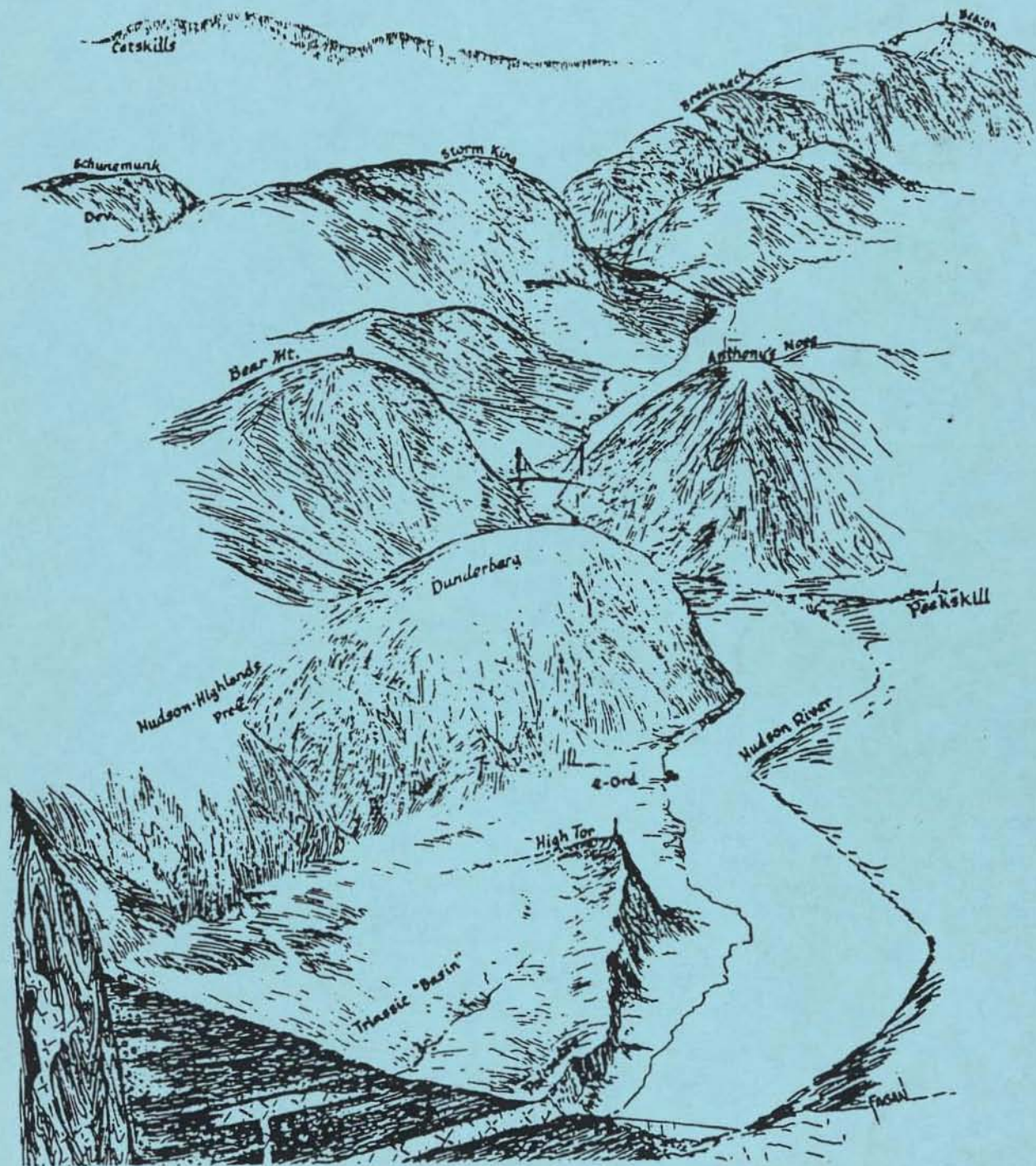


The HUDSON RIVER Guide



A Geological and Historical Guide to the Lower and
Mid-Hudson Valley Region, as Viewed from the River.

Vassar College, Poughkeepsie, New York, 1976



THE HUDSON RIVER GUIDE

A GEOLOGICAL AND HISTORICAL GUIDE TO THE LOWER AND
MID-HUDSON VALLEY REGION, AS VIEWED FROM THE RIVER

by

John H. Johnsen

Professor of Geology

Vassar College

Especially prepared for a Hudson River Trip on the
occasion of the 48th Annual Meeting of the New York
State Geological Association at Vassar College
October 15-17, 1976

"We are slow to realize water, - the beauty and the magic of it. It is interestingly strange to us forever...."

"The river is my own highway, the only wild and unfenced part of the world hereabouts."

"To see the phenomena of the water and see the earth from the water side, to stand beside it on another element, and so to get a pry on it in thought at least, that is no small advantage....I vastly increase my sphere and experience by a boat."

- Henry David Thoreau, Journal

PREFACE

In the spring of 1965 toward the close of his first year as President of Vassar College, Mr. Alan Simpson proposed that Vassar consider a new interdisciplinary course on "The River". He envisioned geologists, chemists, historians, economists, architects and political scientists combining their special knowledge and talents to an in depth study of the Hudson Valley. After reviewing the natural history and uses which man has made of this majestic environment, from the woodland Indians to modern times, the students would plunge into the problems of natural resources, pollution, power, expressways, scenic preservation, urban renewal, the aesthetics of urban design, and the politics of planning. The course was approved by the faculty and offered for the first time in the spring of 1966. It continued for nine years through the spring of 1974 when it was dropped from the curriculum because of waning faculty and student interest.

It became obvious from the outset that no intensive study of the river would be complete without a first-hand view of this great natural resource from the river itself. An appropriate boat and a trial run were needed. During the summer of 1965, Helen Miringoff, Director of Field Work, and myself searched the lower reaches of the Hudson for a boat of sufficient size appropriately equipped for our needs. We found such a vessel - the Palace II - a 110-foot former submarine chaser converted for group and charter fishing in the Atlantic, commanded by Captain Lester Baletti. Our inaugural trip took place on September 29, 1965, a beautiful fall day, and for that occasion the first "Hudson River Guide" was hastily gathered without verification and regard to style. The trip was a huge success, the course was approved, and for the nine years it was offered a river trip was an annual event in May.

This is a new guide especially assembled for the 48th Annual Meeting of the New York State Geological Association at Vassar College, October 15-17, 1976. Material was gathered freely from many sources with permission and appropriate acknowledgement when possible. It is impossible to keep up with day-to-day changes along the route and, in a task of this dimension, there is room for error. The guide seeks to breach the gap between the professional and the amateur; hopefully it is not too technical nor

too simple. It is intended for any Hudson River buff in the lower and middle valley whether he is a Sunday sailor or an estuarine scientist. Most of the guide is not paginated because additions and deletions disrupt the order; hence, there is no Table of Contents nor a List of Illustrations. Thanks are due all colleagues who assisted me on a total of eleven earlier trips and provided me with a wealth of information in their areas of expertise. Special thanks are due Professor John J. Fagan, the City College of New York, for permission to reproduce his drawing of the Hudson Highlands for the cover of this guidebook.

Before the trip commences, permit me to lay some ground rules. I do not intend to speak over the public address system for the entire seven hours of the journey. Most of the pertinent information can be obtained from the notes that accompany the 1:24,000 (2.65 inches to the mile) topographic maps arranged in sequence from New York Harbor to Poughkeepsie, specialized maps and charts inserted at appropriate places, fact sheets, and articles. To make the trip an even more exciting and informative experience, I invite any member of this Bicentennial trip to take the microphone and contribute his special knowledge of the Hudson River corridor at any time he may deem appropriate.

Welcome aboard!

October 15, 1976

John H. Johnsen
Professor of Geology
Vassar College
President, NYSGA, 1976

RUNNING RIVER OF TIME*

Rising of the Half Moon

Through the long, murmuring centuries, the river had known only the light touch of Indian canoes on its broad back. Then came a day when the bowsprit of a small sailing ship peeled its dark surface, the undulating hull encrusted with brine from distant seas.

In river language, this was happening in the warm time before the coming of ice. In the language of modern man, it was September, 1609, and the vessel was the Half Moon, property of the Dutch East India Company. It was commanded by an English sea captain, Henry Hudson, whose mission, among other things, was to find the fabled northwest passage to China. He thought that this might be it, this broad river breaching stony mountains that were now quilted in autumn's colors. Wind voices were in the waves and in the high rock walls that rose from the water's edge. Possibly, around some further bend, there would be the open sea again and eventually the temples and pavilions of Canton...riches for his company and rewards for himself and his crew of Dutch and English mates.

But Henry Hudson found part of a new world instead, a resplendent river valley that was later to bear his name. He and his crew were the first white men to marvel at it, although the native Indians had known of the "great river of the mountains" since primitive times. Its spirit and mystery had long since infused their folklore.

But for Robert Juet, an officer of the Half Moon, seeing the valley for the first time was a challenge to his powers of description. "The land was high and bold... the river full of fish," he wrote in his journal. Passing the site of the future city of Newburgh, he noted it was "a very pleasant place to build a town upon." At other times, when Captain Hudson and members of his crew went ashore to visit and trade with the Indians, Juet reported that it was "as pleasant a land as one could tread upon,"

* Reproduced from HISTORIC PRESERVATION IN ACTION: A Report on the Mid-Hudson Bicentennial Heritage Preservation Program by Mid-Hudson Pattern, Inc., 61 Livingston Street, Poughkeepsie, New York, 12601, May 1976, with the permission of C. David Loeks, President.

covered with sweet-smelling grass and flowers, tall oaks and walnuts, and a "great store of slate for houses and other good stones."

At one Indian camp, in sight of high blue mountains that would later be known as the Catskills, Hudson and his crew feasted on roasted pigeons and a fat dog, newly killed and skinned with shells from the riverbank. In the yard outside of the dome-shaped, tree-bark shelter, where they took their meal, the mariners remembered seeing huge stores of corn and beans drying in the sun, "enough to load three ships besides what was growing in the fields."

During the upriver journey, encounters with the "simple, loving" Indians had been largely friendly. Grapes and corn had been pressed upon them by the buckskinned natives; also, roasted venison, pumpkins and tobacco, beaver and otter skins--all in exchange for beads, knives and hatchets. It was a long way from the markets of Canton, but still a rich land in its own right.

End of the Dream

As the Half Moon sailed further up the river, however, Hudson felt his hopes mire in the shallow reaches toward the headwaters. The crew of the little pilot boat, after taking soundings, reported they had come to the end of navigable waters. The dream had become an illusion.

On the return journey, Hudson's disillusionment was only to deepen. Not only did the weather turn against him, but also the Indians. For a time, the ship rode at anchor in a heavy gale. A few days after that, one of the crewmen shot to death an Indian, who was discovered ransacking Juet's cabin. Other natives on board at the time, who had come to trade, leaped over the sides and struck for shore leaving some of their canoes behind. The crew of the Half Moon fled south in a running battle with the Indians, fending off volleys of arrows from flanking war canoes. When the ship reached the open sea again, Hudson and his crew had left only a few tokens of their civilization behind. What they took with them, the animal pelts, vegetables and memories of greater bounty from the fertile ground, represented an opportunity for the future.

Contenders For a New Land

The Dutch were not long in returning. A year later, they built a fort at Atkarkarton at the mouth of Rondout

Creek in Ulster County, and by 1614, the site became one of the first three trading posts to be established along the Hudson by the Dutch West India Company. This was also some six years before the famous landing of Pilgrims at Plymouth Rock.

But the basic misunderstandings that Henry Hudson and his men experienced with the Indians were to persist through generations of early Dutch and English settlers. Hudson had described the Indians simply as "swarthy." A Dutchman, who apparently might have had harsh dealings with them, characterized the natives as being "of ordinary stature, strong and broad shouldered; olive color, light and nimble of foot, subtle of mind, of few words which they previously well consider, hypocritical, treacherous, vindictive, brave and obstinate in self defense, in time of need right resolute to all." But he could just as well be describing one of his own kind, a hardy Dutch tradesman or trapper.

Mid-Hudson Indians

The Indian tribes of the Mid-Hudson valley were members of the Algonquin nation, simple hunters and tillers of the land, whose fragile culture was slowly beaten back into the earth by the coming of the white man in ever greater numbers. Today, the memory of these tribes survives largely as names on maps and signposts--Wappinger, Esopus, Delaware, and Minisink; in archeological diggings, and in the flint arrowheads and broken pottery unearthed first by farmers' plows, and later, by construction bulldozers and suburbanites digging in their gardens.

The Indian women have been described as wearing knee-length dresses of buckskin; the men, buckskin leggings, a breechcloth and moccasins. In cold weather, they threw fur robes around their shoulders. To the harried settlers, forced to eke out a living in a hostile wilderness, they may have been regarded as merely another force of nature to be overcome. Their friendly dispositions, too, made for easy exploitation, and their land was often bought for small remuneration or acquired by trickery. To the Indian, European concepts of sale, barter and land ownership were no doubt alien; they may have well resented being barred from lands they once used so freely, and were willing to share with the newcomers.

Warfare broke out periodically, but it soon became apparent which side had the superior forces. Indian society gradually disintegrated under the advances of the white

man's culture, with his more complex psychology and modes of living--and also his diseases, which the Indians found to be particularly fatal. By 1800, the entire Indian population on both sides of the Hudson had dwindled to less than 300. Many of them had migrated into Pennsylvania, Ohio, and other areas outside the region.

During this period, probably about 1690, someone planted a tree where two ancient Iroquois and Algonquin Indian trails crossed, in what is now the Town of Newburgh, Orange county. Today, the Balmville Tree is among the oldest trees in North America, its trunk some 90 inches in diameter and deeply furrowed. Its crown soars 83 feet into the air, spreading out a leafy canopy to shade a traffic circle in an affluent suburb. Some historians believe that the Indians had planted it as a symbol of peace and brotherhood.

The European Settlers

Some of the contenders for the new land came for trade and profit; others to homestead and build a new life. Many also were escaping from religious persecution. The river was the great nurture of this new era in human settlement, providing food, a means of transportation, and for conducting trade and commerce. The first towns were assembled along its banks. Then, as roads were gradually developed, settlers moved into the inland wilderness to till the ground, build houses and new communities. In later years, stately mansions were to rise above the Hudson's shores, and noble houses and public buildings in the streets of the river towns: Newburgh, Poughkeepsie, and Kingston, among others.

But in those earlier times, it was the staunch Dutch farmers who settled along the Esopus Creek at the northern edge of present-day Kingston, working their land under the gaze of hostile Indians. After several violent incidents, Peter Stuyvesant, the director-general of New Netherland, ordered the settlers in 1658 to remove their homes to higher, more defensible ground, and to enclose the area within wooden palisades. Within a few years, this stockade was enlarged, a local government established, and the new settlement named Wiltwyck. A few miles to the southwest, a new village called Nieuw Dorp (later Hurley), was laid out and settled.

Then, quite suddenly, the uneasy peace of those years was shattered by the Esopus Indians in a surprise attack on the Wiltwyck stockade and Nieuw Dorp in 1663, which left

the compound partially destroyed by fire, and the village a smoking ruin. Twenty-one inhabitants were killed, seven wounded, and forty-four women and children taken captive by the retreating Indians.

Soldiers and militia went after them, penetrating the surrounding wilderness as no white men had done before them, save for some solitary trappers. In their search for the captives (which they were later to recover), the Dutch forces destroyed Indian crops and villages as they moved into the valleys of the Rondout, Wallkill, and Esopus, but they also discovered flourishing cornfields and rich alluvial lands, particularly along the Wallkill River where New Paltz now stands.

French Huguenots later were to settle in that area, while other settlements followed in the Rondout and Wallkill valleys, moving into Cuddebackville and Montgomery in what is now Orange County, along the Hudson at Marlboro, and later into the hills and mountains of the Catskills. During this period, young Pieter Bronck came down from Berwyck (Albany) and purchased a large tract of fertile land from the Indians at Coxsackie. He built a stone house there, similar to others of rural Dutch design that were taking shape on the green land, constructed of native limestone, with a sloping roof and two-part "Dutch doors" that opened in the middle. That house, though altered over the centuries, is still standing, and is the oldest dwelling in Greene County.

Dutch pioneers also settled along the Hudson in Columbia, Dutchess and Putnam counties. English homesteaders followed, many of them Quakers, and eventually outnumbered the Dutch. Unfamiliar with stone construction, they built most of their homes of wood, usually in a simple style typified by the single-storied "salt-box," with its short roof in front and long, sloping roof to the rear, resembling a container in which salt was stored in those times.

Plight of the Palatines

Among these early immigrants was a large group of refugees from the Palatine-Rhineland region of Germany, who were seeking to reconstruct lives broken by war, famine, disease, and the ravages of a brutal winter. But they were to go from one grueling hardship to another before reaching the Mid-Hudson about 1715 and for several years afterward.

French troops had pillaged their wines and trampled their vegetable fields. Then as the Palatines struggled to rebuild, their valley was struck by the coldest winter

in memory. Fruit trees and vineyards died in the icy blasts; precious wines were turned into solid blocks of ice within their casks. As one historian described it, "farmers said the ground was so cold that they could not coax a flame out of firewood in the open air...flying birds were stopped in mid flight and fell stiff and frozen to the earth."

Queen Anne felt that these defeated and suffering Palatines could be of use to the British Crown in setting up a new industry in the Hudson Valley to manufacture tar and other maritime necessities that would crimp the Swedish monopoly on such products. At the same time, they might also act as a line of defense against the French and their Indian allies.

Offered passage to a new land, food, and the chance of one day owning their own land again, the Palatines struggled toward London by the thousands. Eventually, ten ships took 2,800 of them to America, the largest single emigration in all the colonial period. For six months, they huddled in cramped, dark quarters below deck, surrounded by foul air and vermin. Typhus broke out, killing over 400 men, women and children. The disease devastated so many of them that for years afterward it was known as "Palatine fever."

In the new world, the English had set up camps for the refugees in Ulster and Columbia counties, primarily tents which were later replaced by log cabins. Once the Palatines had made and shipped enough tar to pay their transportation and settlement expenses, Queen Anne had promised she would give each family a plot of 40 acres for each of its members. For two years they labored, barking pine trees, later felling the trees and roasting the barked sections in kilns to sweat out the tar.

To men long used to tending vineyards and raising vegetables, such work must have seemed unnatural, even outlandish. Ill-fed and ill-housed, the Palatines probably caught sight of the river boats from time to time, special Hudson River sloops designed by the Dutch to easily navigate the currents. Plying the river between New York and Albany, the sloops were generally laden with green vegetables, apples and golden grain, hogs, butter, brandy, flour, animal pelts and lumber--all the signs of a land beginning to prosper. The decks, too, were usually alive with passengers, businessmen and merchants on various ventures, farmers, emigrant families looking for a place to settle, where a man might be free to till his own soil and not have to eat bad food or sleep in drafty, crowded quarters.

Bad as conditions were for the Palatines, they were only to get worse. Their tarmaking enterprise was abandoned by the English when Tories succeeded the Whigs to power in Parliament, and viewed the Hudson Valley endeavor as "extravagant and unreasonable." The Palatines became refugees once again, and were forced to seek new homes under the grey sky of an approaching winter. Their minister wrote: "They boil grass and the children eat the leaves of the trees. I have seen old men and women cry that it should almost have moved a stone."

Searching for an end to their misery, the Palatines wandered down both sides of the Hudson, some as far as New York City. One group settled on the Livingston Manor lands in Columbia County, others made their way to Dutchess and Orange counties, where they put down roots in places that later were to be known as Rhinebeck, Red Hook, Pine Plains, Amenia, Clove Valley, Balmville, and the City of Newburgh.

Dutch and British Imperialism

Until 1664, southeastern New York--then called New Netherland--was under the control of the Dutch. In 1664, the province came under English rule, following a bloodless action in which a British fleet of five vessels, under the command of Colonel Richard Nicolls, sailed into the harbor at New Amsterdam and laid claim to the colony. Director-General Peter Stuyvesant was informed that the British move was justified by the earlier explorations of Cabot and Smith. New Amsterdam was soon to become New York, Rondout to become Kingston, and Berwyck, Albany.

For the settlers, the transfer of power produced little change in their lives; if anything, it made the situation better. Under the rule of James, Duke of York, they were allowed to keep their lands and other properties, and were no longer required to pay the heavy taxes and duties imposed upon them by the Dutch West India Company. They had a chance now to prosper.

The monopolistic stock company had been organized by the Dutch government in 1621 to take advantage of the American trade potential, and to encourage colonization in the new land. But profits from fur cargoes soon occupied most of its attention. The company managers found it easier to lure traders in search of quick profits than than farmers and craftsmen, who would populate the colony and help secure Dutch control.

Land Grant System

In 1629, the director of the Dutch West India Company created the Patroon system, which permitted grants of huge river estates to members of the company, who would, within four years of accepting the terms of the contract, establish settlements of at least 50 persons. The patroon had to purchase title to his lands from the Indians, but once having obtained it, he might hold the land as a perpetual fief of inheritance.

When the British took over, they honored these grants and extended the system through the granting of patents under the authority of Queen Anne. Thousands of acres were often conferred in this way in exchange for the patentees' expressed allegiance in the form of political favors and annual rents of money or produce. In this way were the manor lords of the Hudson established as a major political and economic power, against which tenant farmers would be struggling for generations. Vast domains went to Robert Livingston, Frederick Philipse, Stephen Van Cortlandt, and Captain John Evans.

But the source of all property rights still resided in the Crown, and the great burden for paying these annual tributes, including frequently excessive rents, rested on the actual cultivator of the land, the tenant-settlers. These people could clear the land, build a home, and till the crops, but never could become independent. Nor could they vote, for the suffrage was extended only to the freeholders, who were absentee landlords for the most part. It was the feudal system in a form modified to meet American conditions.

Revolt of the Tenant Farmers

Numerous small rebellions broke out, culminating in the "Anti-Rent War" of 1766, where tenant farmers took up arms first in Columbia County in defiance of crushing tax levies. Armed resistance spread rapidly to Dutchess, where the insurgents were led by William Prendergast, a tenant farmer, who had assembled a formidable band on Quaker Hill in the Town of Pawling. British grenadiers in Poughkeepsie were ordered to advance against the rioters, but refused until reinforced by some 200 troops and cannon from New York. Once these reinforcements arrived, Prendergast and his men found effective resistance impossible and were forced to surrender.

He was tried in Poughkeepsie and sentenced to be hanged, but through the extraordinary efforts and appeals of his wife before the British authorities, he was granted a royal pardon. The act came almost at the very moment when 50 armed farmers arrived at the jail determined to set him free,

The brief rebellion may have been a failure, but it marked the first time that American farmers had taken up arms against British redcoats in the cause of political and economic freedom. Ground was broken for the Revolution. And it happened here in the Hudson Valley, nearly a decade before Lexington and Concord....

MID-HUDSON HISTORY AT A GLANCE

I. Colonial Period, 1609-1775

Henry Hudson's voyage of discovery...Early European settlers contend with native Indians for possession of the new land...New Netherland becomes a British province in 1664...Patroon system of land ownership is transmuted into a series of patents conferred by British Crown...Mid-Hudson continues to develop agriculturally under modified feudal system involving manor lords who employ tenant farmers to work their vast holdings...Numerous small farmer rebellions break out, culminating in the celebrated "Anti-Rent War" of 1766, in which first shots were fired by American farmers against British redcoats--nearly a decade before Lexington and Concord.

II. Revolutionary War Period, 1776-1783

British fail in their move to control Hudson Valley and divide the states...General Burgoyne is defeated at Saratoga, after attempting to march on Albany from Montreal... British General Sir Henry Clinton is forced to retreat back to New York City after burning Kingston and Clermont... Victory proves crucial to outcome of war, which thereafter largely moves out of the Mid-Hudson...General Benedict Arnold, commander of West Point, attempts to betray American cause by selling fortification plans of the Point to British...After

victory at Yorktown, General Washington returns to the Mid-Hudson to await outcome of negotiations to end the war.

III. Early Nineteenth Century Economic Expansion, 1783-1850

Specially designed Hudson River sloops continue to carry people and products to Albany and New York City markets... The Mid-Hudson during this period is noted as a producer of lumber, grain and hay, green vegetables and apples, Rosendale cement, bricks, bluestone, hogs, cattle and butter...Hudson is established as an important whaling port by a group of New England merchants...Other such ports are developed at Poughkeepsie and Newburgh before whaling industry dies out in the late 1830's...In 1807, Robert Fulton's steamboat, Clermont, inaugurates a new era in river travel...With the opening of the Erie Canal in 1825, western New York farmers compete in Albany and New York City markets, and Mid-Hudson farmers begin concentrating on dairy farming...Major industries of the time include textile production, iron mining and smelting, machine and tool manufacturing, tanning and ice cutting...In 1828, the Delaware and Hudson Canal is completed, linking the Pennsylvania coal fields with the river port of Rondout... The period also produces notable changes in the area's cultural life with the Dutch colonial stone farmhouses and wooden "salt box" structures of the early settlers being outnumbered by more imposing residences and public buildings, representing a variety of architectural styles...Artists and writers are drawn to the area, including Thomas Cole, who helps establish the Hudson River school of painting; Washington Irving, James Fenimore Cooper, and Newburgh's own Andrew Jackson Downing, who attracted national attention with his ideas on landscape gardening and architecture.

IV. Industrial Growth Through the Victorian Age, 1850-1900

Railroads built after the Civil War promote the expansion of local industry, including tourism and vacationing with huge hotels being built on mountaintops in the Catskills and Shawangunks...To prevent further commercial exploitation of Catskill forests, the State Legislature of 1885 creates the State Forest Preserve...As the turn of the century approaches, economic conditions begin to change, with the automobile and truck replacing the horse, railroads replacing the Delaware and Hudson Canal, mechanical refrigeration replacing great ice houses stocked with Hudson River ice, and Portland Cement replacing

Rosendale cement...Manufacturing declines in inland areas and is generally centered in the river cities...Victorian architecture of the time is sometimes embellished with a projecting roof and supporting brackets, which came to be known as "Hudson River bracketed".

V. Modern Period, 1900-1976

With the slowdown in the economy, population begins to decline, the trend reaching back into the previous century... Large reservoirs are constructed in the early 1900's to provide New York City with water...Conditions generally improve as increasing automobile travel generates new highway construction in the area...World War II ushers in a new era of economic growth, with IBM developing into one of the nation's major industries...Plants are located at Poughkeepsie, Kingston and Fishkill...Further improvements in highway and rail travel reinforce the Mid-Hudson's position in the competitive economic market, placing it in close proximity to major corporate headquarters in New York City, and important consumer markets throughout the northeast.

And as in Henry Hudson's time, the river always flows on, its motion without beginning and without end; but still changed by the works of man, time-tarnished and impermanent as they are.

Dear John -

I thought you might like to have a copy of this for your files.

It's a fairly readable account; how accurate is it?

all best wishes

Pete



The following article, entitled THE HUDSON RIVER, was written by Rudolph Ruedemann, an earlier Hudson Valley geologist and former State Paleontologist of New York. It was published in Vol. II, No. 1 of THE HUDSON RIVER MAGAZINE, April, 1939. It was brought to my attention by Pete Seegar. With the author and the magazine long gone from the scene, I reproduce it freely for you Hudson River buffs. I believe its inclusion in this guide is most appropriate.

John H. Johnsen

THE HUDSON RIVER

by RUDOLF RUEDEMANN

The Hudson River, though not one of the largest streams of America, is nevertheless for the historic and literary interest attached to its name and for its scenic beauty one of the most beloved and best known of our rivers. Because of its location and direction, of its long navigable channel, of its passage through forbidding mountain ridges, and because it has the finest harbor in America at its mouth, the Hudson is, under all circumstances, destined to become one of the leading highways of American commerce. There is no question about this great future; The question is only how soon it will materialize. These qualities of the river, which make it peculiarly fitted for a great waterway, are the result of, and directly explainable by, its geologic history. I shall therefore attempt to tell you the history of this river, giving you as fairly a continuous story as the geologist has so far been able to unravel, often in small pieces and after much labor.

The history of the Hudson River is very long. The river's connection with civilized human history is a drop in the bucket if compared to its prehistoric geologic history; for the latter is not counted in centuries or thousands of years, but undoubtedly in millions, perhaps hundreds of millions of years, judging from present geologic time scales.

We know now that the North American continent has always had essentially the present form as far as we can go back in geologic history, that is, to the very formation of the earth crust. North America is one of the primary continental blocks of this crust. Of course it has changed its outline repeatedly and materially. There was a time when it extended in the north over Greenland to Scotland, another when the region of the middle

Atlantic states ran much farther east and out into the Atlantic ocean and there were periods when the Pacific coast was located farther west. Scores of times the sea has invaded this continent, from one or all of its four sides and sometimes it ran fairly across. But these invading seas were all shallow, destined to run off again. The North Atlantic opposite our shores is considered the oldest part of the whole Atlantic ocean. We must, therefore, infer that rivers flowed toward it from the very beginning, often in the direction of the present Hudson. Yet no river flowing in the site of the Hudson can be recognized until Mesozoic time, the age of the Reptiles. (about 100 million years ago). It Devonian time, or the age of the Fishes (325 million years ago), of which period we have such a splendid representation in the rocks of New York, the sea still invaded the southern and middle part of the area of New York State. The Catskill Mountains were built up by deposits in the estuary of a mighty river of that time which came from the northeast, right across the course of the present Hudson and emptied into a sea that came up from the south.

After the sea had finally withdrawn from New York, there came a whole series of geologic periods, as the one in which the coal fields of Pennsylvania were formed (200 m. yrs.), and the one in which the sandstones of Connecticut and the red sandstones and shales of New Jersey (150-75 m. yrs.) were laid down in embayments and the trap rocks of the Palisades and of the New Jersey Hills were forced into the sediments. Large mountain ranges, the ancestors of the Appalachians arose parallel to the sea coast and diverted the drainage toward the west; but they were leveled again and fi-

nally, after eons of weathering and erosion of the surface of the eastern continent, the whole was worn down to a low plain, and the rocks were deeply decayed and weathered, so that the ancestral Hudson, like his brothers the Delaware and Susquehanna, did not find any serious obstacles and flowed leisurely and in fairly direct course to the ocean. On account of the deeply weathered condition of the earth crust the river paid no attention to the deeply buried old ranges. In fact, it flowed right across these fundamental structures of the continent, such as the gneisses and granites of the Adirondacks and of the Highlands which are all directed towards the northeast, while the river flows north-south. Such rivers are called antecedent, they antedate the later geologic structures coming to the surface.

Finally, in the Cretaceous period (75 million yrs. ago) this low plain was elevated over the New York and Pennsylvania areas, the elevation continuing into the following Tertiary time (50 m. yrs. ago). As a result the old Hudson River was rejuvenated, as geologists call it; to be sure, without insertion of monkey glands or other stimulants of our latter day civilization. Its waters again ran faster and they began to deepen its bed in the accumulated soft debris of the preceding ages. Its tributaries to the right and left helped bravely, keeping step with it, and it undertook now to carry off to the ocean most of the continental waste. When we look from the Hudson River day boat at the 4,000-foot pile of the Catskill Mountains on the west and at the Taconic Mountains on the east, on the New York-Massachusetts line, and consider that the river in those ages eroded and carried off the enormous amount of rock between the tops and bases of these ranges, we get a fair picture of the Hudson River as an excavating engineer on a scale that makes the Panama canal engineers as insignificant as ants. And that is not all. The rocks that rise up to the skies in the Catskill Mountains, with the Helderberg limestones below them, once extended north far into the Adirondacks. The

Hudson and his efficient assistant, the Mohawk, carried all these rocks off and produced the fertile low-lying plains of Albany and Saratoga counties, a truly gigantic performance beyond the measure of mere man!

But gnawing so industriously down into the earth, the Hudson River was finally bound to reach the fundamental structures, the buried old mountain ridges, of the Highlands and of the Adirondacks. The southern Adirondacks were largely brought out by the industrious Mohawk and its tributaries, that river along its whole course gradually sliding southward so to speak on the hard Adirondack rocks, by working into the soft black, so-called Utica shale beds. Now when the Hudson River had reached the roof of the buried Highland ridges, it became a question whether or not it would be able to gnaw down faster through these ridges than they were being uncovered. If it did it would form a gorge through the ridges, if it did not erode fast enough, it might be dammed up into a lake and finally get through by the recession of a fall or be directed altogether in another direction. As a matter of fact, the Hudson succeeded as well as the Delaware and Susquehanna did in breaking through the rising Appalachian Mountains. In forcing their northern continuation, the Highlands, thus proving that it managed to keep step with the gradual rising of these ranges. These rivers are, then, superimposed on the old structures, as the geologists say, and are independent of them. This explains the passage of the Hudson through the Highlands though not the great depth of its gorge, as we shall presently see.

At the end of the Tertiary period, about the time when man is supposed to have appeared on earth, (1 million yrs. ago) the Hudson and its tributaries had formed the broad valley extending from the foot of the Catskills to the Taconic range. North of Fort Edward it had a different course, or courses, from the present one. It came either from Corinth directly south around the Mount McGregor range, or,

with another branch, through the valley extending north from Glens Falls to Fort Ann and beyond. The Mohawk River rose at Little Falls and another river flowed westward from that old divide. Toward the end (c. 60 m. yrs.) of the Cretaceous period, the Hudson had again reached grade and formed its broad valley. A new uplift late (c. 10 m. yrs.) in Tertiary time then produced the inner gorge.

After the Tertiary period came the Glacial period. For as yet unknown reasons an enormous cake of ice was formed that covered northern North America reaching clear over the Adirondacks and Catskills and extending south as far as Long Island, Staten Island, New Jersey and Pennsylvania. The accumulation of drift in front, mainly composed of clay and boulders, formed the terminal moraine, the so-called back bone of Long Island. No doubt the northern part of the continent stood at that time many hundreds of feet higher than now giving the ice a steeper gradient towards the south and also contributing to the colder climate. This glacial period lasted millions of years, the ice advanced five times with warmer periods between, disappeared and reappeared again. It picked up and plowed up all the loose rock waste and soil, plucked out all rocks that were jointed or otherwise accessible to the action of freezing water and thus loaded with debris, under its own tremendous pressure it changed the entire surface of the country beneath it. It filled out the smaller valleys so completely that the tributaries with the exception of the Mohawk, have not to this day found their old courses, and are coming to the Hudson in new valleys at much higher levels than the main stream, thus forming so-called "hanging valleys" with waterfalls at their mouths. These hanging valleys and waterfalls of the tributaries of the Hudson are one of the great sources of power along the Hudson valley. Before the glacial period these tributaries had all reached grade, to use that geological expression, and joined the Hudson river at its level. Even the Mohawk river has lost

its lower course and its former mouth at the site of Albany, and comes now in a round-about way into the Hudson, thereby forming the splendid Cohoes Falls. The Hudson River itself has found its old valley from Fort Edward southward but not everywhere its old bed or channel and grade as is manifest from the rapids at Mechanicville and Troy. Its new course above Fort Edward furnishes the fine falls and waterpower at Glens Falls, Hudson Falls and Fort Edward. You see, what means trouble to a river in its search to attain grade, means a blessing to man in his search for power.

Where ice is forced into narrow, steep sided valleys it develops, just like rivers, greater velocity and enormous eroding power, as is shown by the fjords of Norway, a thousand and more feet in places, the firths of Scotland, and the deep rock gorge of the Highlands, which was found to be more than 700 feet deep. As the ice could not erode below sea level, there is no doubt that the country stood much higher when this gorge was eroded. When the great ice cake finally disappeared for the last time (about 30,000 yrs. ago), long tongues of ice or glaciers, still lingered and flowed in the Hudson Valley. They continued the work of erosion in the river bed and the immediate neighborhood, while farther back great masses of gravel and sand were piled up against the ice by the tributaries; these are the great gravel and sand banks we find east and west of the old valleys, as for example back of East Green Bush and Troy, and north of Albany.

The melting ice produced enormous floods which finished the work of erosion started by the ice. Mighty rivers flowed in front of the ice, and for a long time when the ice stood still north of the Adirondacks the waters of the Great Lakes, now discharging through the St. Lawrence, came down the Mohawk valley. This produced the broad level stretches, now occupied by Lake Oneida and used to good advantage by the barge canal. These waters also broke through the divide at Little Falls and,

filling up the deep valley to the west, created the present longer course of the Mohawk river beyond Little Falls.

When the ice had receded north of Albany, a large fresh water lake (or series of lakes) was formed, the Lake Albany of the geologists, extending from the Kingston region northward to the edge of the ice, probably with much of the ice stagnant by that time; for a long time its northern shores were near the location of modern Schenectady and Saratoga and finally it reached clear up to the Lake Champlain basin. The lake had no open or sea level connection with the sea, the region of the lower course of the Hudson having been elevated as a reaction to the relief from the tremendous weight of the ice or in connection with the general elevation near the edge of the ice, in the way that a ridge is produced around your boot when you step in soft mud. However, there is no doubt that the lake existed and that the Mohawk carried the drainage of the St. Lawrence basin into it. The Mohawk, together with the upper reaches of the Hudson, dumped enormous quantities of clay and sand into Lake Albany, which served as a settling basin thereby producing the valuable clay deposits of the Hudson Valley and furthering our brick industry.

The combined result of the greater elevation of the land, the gouging action of the ice and the powerful erosion of the glacial water was the deep gorge of the Hudson river extending from the site of Albany to the mouth of the river. It was hundreds of feet, perhaps a thousand feet deep down at New York City and below. Even near Albany where once the Mohawk emptied into the Hudson at grade level the rock surface is more than one hundred feet below sea level in the old bed, as was found in searching for a rock foundation for the Education Building and other structures. The canyon of the Hudson River, 700 ft. deep at the Highlands, extends 100 or more miles beyond New York at the bottom of the ocean. It goes down at least 4,800 feet, according to Spencer even to 9,000 feet, and at one place 50

miles from Sandy Hook, it plunges down in one sheer drop of 1,600 feet. There is no doubt of the existence of this stupendous canyon in the otherwise perfectly flat sea bottom for it has been fully established by soundings and can now be seen as a dark stripe from an airplane. Writers naturally seized upon this picturesque feature of a submarine canyon, and not only popular authors but also serious geologists have delighted in pen pictures and artistic restorations of this gigantic canyon below New York harbor that rivalled or even exceeded the Grand Canyon. Within the last decade the New York Times in its Sunday Magazine section had a wonderfully elaborate and vivid description of this canyon and properly so, for it is a function of the press to arouse the interest of the readers in their natural surroundings by means of popular and entertaining articles. But even our dry geologists considered this mammoth cleft in the bottom of the ocean as an old river gorge and have fixed the first inter-glacial period as the time of its formation. Now allow me a few remarks to warn you against these naive conclusions. Geologists would have to assume a rise of the land of at least 4,800 feet to account for this gorge by river erosion. Spencer even blithely infers a rise of 9,000 feet. It is against reason to assume that this whole eastern part of the continent had been raised to such a stupendous height and let down again in the short time of 400,000 years, for that is the time now considered to have passed since that inter-glacial interval. As a matter of fact, at least one American publication, viz. Chamberlin-Salisbury's Text book of Geology, has suggested that tidal erosion may have produced the lower end of the submarine gorge and European authors quite generally doubt the origin of the submarine canyons through river erosion. Similar submarine gorges have been found at the mouths of other rivers, as the Connecticut, Delaware and Susquehanna Rivers and on a much larger scale beyond the Congo, Ganges and other rivers. After Swiss geologists had discovered similar gorges beyond the mouths of the Rhone

River in Lake Geneva and the Rhine in the Lake of Constance, in the former case even under and beyond a delta, European scientists began to doubt and finally positively rejected the origin by river erosion of these gorges. They do not know as yet the true cause; counter-currents to the river currents at the bottom, prevention of deposition on the sea-bottom by the river current, tidal currents, and the erosive action of ground water-streams flowing below the rivers and beyond them, have all been adduced as explanations, the last one lately in Germany. All have so far proved ineffective as possible agents in one or the other of the cases, save the last one and that seems hardly competent. To be sure I am sorry to throw doubt upon this wonderfully picturesque idea of the Grand Canyon of New York, but scientists are critical by nature or by sad experiences and the progress of science means continuous doubting and the falling by the wayside of many beautiful theories.

Now to return to our Hudson River history. After that great elevation of the land during the Glacial period a profound sinking took place in the so-called Champlain period. The sinking was probably a slow reaction of the continent to the overloading with ice and a continuation of that reaction for some time after the ice was gone. In this period the sea entered the Champlain valley and the St. Lawrence basin as far as Lake Ontario. It rose high on the hills of Vermont and now in Middleburg, Vermont, there is to be seen in the Museum the skeleton of a whale that once sported in the waters of the Champlain Sea which deposited the fertile clays of the Champlain region.

At the same time the sea reached from the south into the Hudson valley extending an unknown distance northward. A geologist of our survey, a few years ago, showed by a study of the fossils that the Champlain salt sea became fresh southward and the Hudson river embayment northward, the Hudson river and Mohawk river debouching in the middle of the

channel and their waters flowing off in both directions, north and south. The floods of that time of depression of the country and after have silted up the great gorge of the Hudson river to such an extent that when the question of the navigation of the river by ocean steamers came up, dredging became necessary over that deep gorge. Finally when the country rose again and Albany lake and its successors were drained, the Mohawk had built a fine delta in that lake, extending from Schenectady to Albany and could not get over it any more and had to lift its course to the north around it. Hence the new course and the waterfall at Cohoes. Eastern New York has either not yet risen sufficiently since that time to give the lower Hudson a normal grade, or more probably the coast has been sinking again. At any rate the Hudson is still in the condition of a "drowned river," as geologists call it, that is of a river, the lower valley of which has been entered by the sea and the water backed up a great distance. The Delaware and Susquehanna and other rivers of the east coast are in the same condition. As a result the tide reaches as far up as Albany and the Hudson river appears from here downward as a broad and mighty stream, cut of proportion to the quantity of water it actually carries as the engineers who try to prevent silting and ice-dams in the spring know to their sorrow. Still this drowning has made it suitable for a great waterway at sea level.

The most important part of the river is its mouth, the harbor of New York, that has made the city the metropolis of the State and of the country. Another paper could be written on the origin of this wonderful spacious harbor but that matter has been discussed fully in print by geologists of the city of New York. Let me only mention that the harbor also is the result of the drowning of a number of rivers that come together at the mouth of the Hudson, from northeast and northwest, as the Passaic and Hackensack rivers and Harlem creek, and of the erosion in the East River of limestone beds and the probable action of

faults, that weakened the underlying rock structure, the tide having done the final engineering work of excavation.

In fine, looking back at the history of the river, as presented here, we may say truthfully that the Hudson is not only lovable for its scenic beauty and broad expanse of water and immensely valuable for its commercial influence, but also venerable for its enormous age and long history. It was flowing long before man was thought of and who knows but that it will flow yet when man is forgotten.

The Hudson River should be loved as much by every New Yorker as the Father Rhine is by the Germans, the Mississippi was by the Indians, and the Ganges is by the Hindus. It deserves reverence, for with proper development, it will become the very artery of our life.

Facts about the

HUDSON RIVER BASIN

EARLY EXPLORATION: River first discovered in 1524 by Giovanni da Verrazano, an Italian sailor. In 1609, Henry Hudson, an English sea captain, working for the Dutch East India Company, was first to explore the river upstream. Indians living on shores of the river called it "Shatemuc"; Hudson called it "Great River of the Mountains"; his Dutch employers named it officially "River of Prince Mauritius"; later it bore the name "North River"; eventually it was named Hudson after Henry Hudson.

HEADWATERS: River begins as a small stream flowing out of Lake Tear of the Clouds in the Adirondack Mountains, in Essex County, New York.

MOUTH: Upper New York Bay at 40°42' N latitude, and 74°02' W longitude.

MAJOR TRIBUTARIES: Mohawk, Schroon, Sacandaga, Hoosic, and Wallkill Rivers; Schoharie, Kinderhook, and Rondout Creeks.

COURSE: From its source, 4,322 feet above sea level, in the wildest part of the Adirondacks, the river winds for more than 100 miles in an irregular south-southeasterly direction to Corinth, then east to Glens Falls and neighboring Hudson Falls. From here it flows for 45 miles almost directly south to the head of the tide at the Federal Dam at Troy, 150 miles above its mouth. Below Troy the river passes through a farming and industrial area and enters the colorful Highlands region about 60 miles south of Albany. For 16 miles it winds through a narrow valley with high and rocky shores of great beauty. The river is sometimes called the "Rhine of America," because the rocks of the Highlands resemble the huge castles on the banks of the Rhine. Continuing south, the river is bordered by majestic cliffs, called the Palisades, before it widens into upper New York Bay at the southern tip of Manhattan Island.

LENGTH: The river travels 306 miles, entirely within New York State. Ranks 71st in length of 135 U.S. rivers that are more than 100 miles long.

WIDTH: About 3½ miles at Haverstraw Bay; seldom more than 1,000 feet near midpoint at Troy; approximately 1 mile at its mouth.

DEPTH: Deepest point—200 feet near West Point; navigable channel depth of 32 feet is maintained in the 143-mile tidal section between Albany and New York City.

RATE OF FLOW: Near Troy—6 million gallons a minute; near Glens Falls—2 million gallons a minute; at mouth—9 million gallons a minute.

HIGHEST AND LOWEST FLOW: In 1913, greatest flood since 1846 at Albany; lowest annual flow in at least 44 years occurred in 1965.

QUALITY: Water is fresh in estuary south of Troy, becoming brackish below Poughkeepsie and saline below Peekskill. Water is generally soft and slightly alkaline. In upper Basin, water requires minimum treatment, but requires full treatment in many areas because of industrial and municipal pollution.

DAMS, RESERVOIRS, AND CANALS: Croton, Rondout, Ashokan, Schoharie, Sacandaga; Hinckley, Delta, and Indian Lake Reservoirs; Federal Dam at Troy. Erie Canal still used between Rome and Albany and the Champlain Canal between Albany and Fort Edward near Glens Falls (both are part of the New York Barge Canal).

GEOLOGIC SETTING: Basin lies in six physiographic provinces: Piedmont, New England, Valley and Ridge, St. Lawrence, Adirondack, and Appalachian Plateau. The entire Basin has been covered one or more times by continental glaciers and the valleys are floored with deposits of glacial sand, gravel, and clay. The northern part of the Basin is densely forested and contains many lakes and streams. Several of the Adirondack Mountain peaks are more than 5,000 feet high. Below Albany, the land becomes open country except where the rugged hills of the Catskills and the Hudson Highlands cut through the Hudson Valley. South of the Highlands the Basin is again open country, except along the igneous outcrops which form the high cliffs of the Palisades.

DRAINAGE AREA: Basin area is 13,370 square miles, most of which lies within New York State, although small parts extend into Vermont, Massachusetts, Connecticut, and New Jersey.

AVERAGE RAINFALL: From 35 to 40 inches annually in the northeast to about 50 inches annually in the west and south.

FIRST SETTLEMENT: Iroquois, Mahican, Delaware, and Wappinger Indians were the first-known inhabitants of the Basin. In 1614, Dutch traders built Fort Nassau (near Albany). When it was destroyed in 1617 they constructed a trading center at Fort Orange (now Albany). Colonists were settled in 1624 and about this time the Dutch established New Amsterdam on Manhattan Island.

MAJOR CITIES: Part of the New York City metropolitan area, Newburgh, Poughkeepsie, Kingston, Albany, Schenectady, Troy, Glens Falls, Amsterdam, Utica, and Rome.

MUNICIPAL AND INDUSTRIAL WATER USE: About 3 million people use approximately ½ billion gallons of surface water each day, and about 1 million people on farms, in small towns and suburbs use 100 million gallons of ground water each day.

COMMERCIAL WATER USE: Shipping in estuary, barge traffic on upper Hudson, hydroelectric power generation.

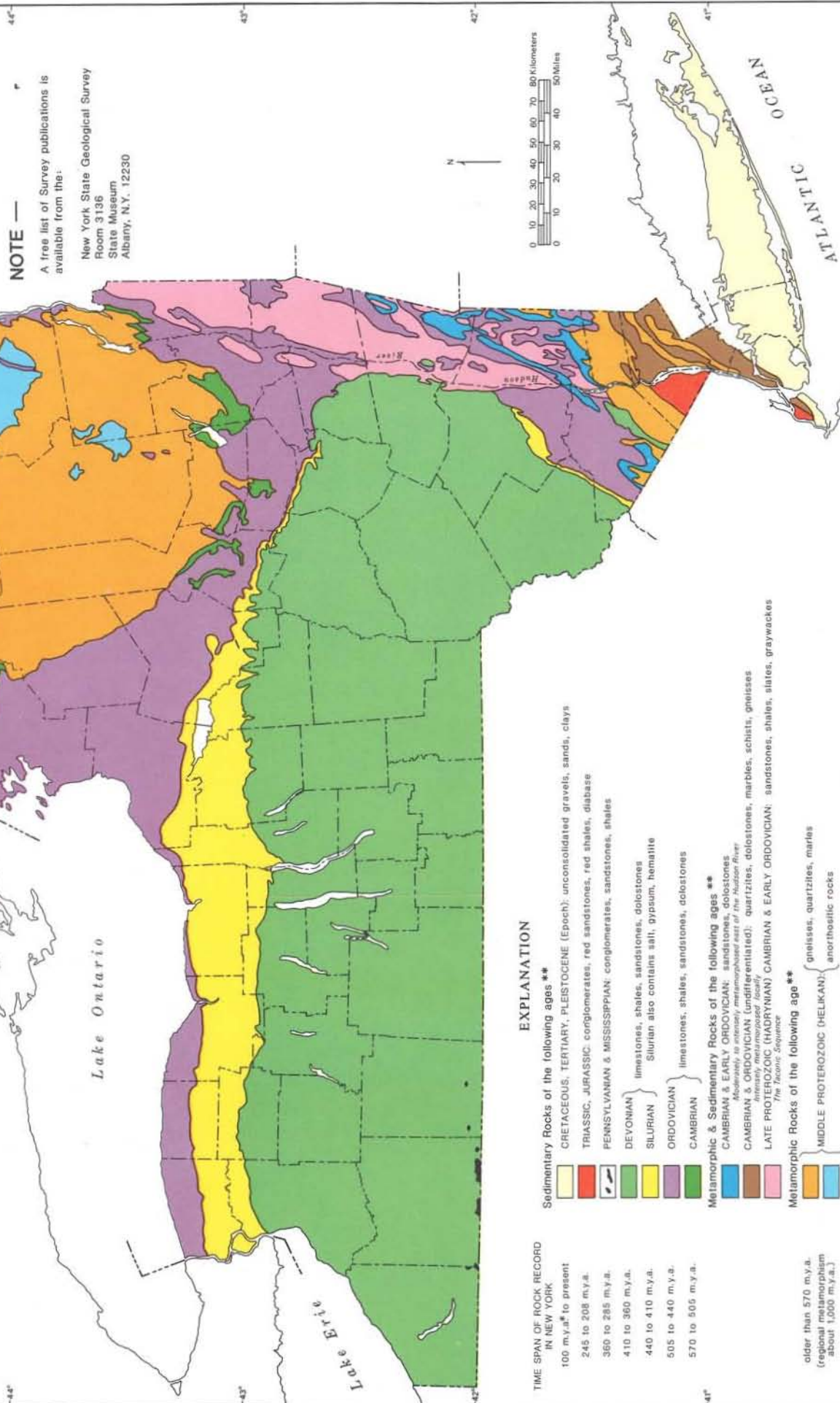
AGRICULTURE: Dairy products, poultry and livestock production, general and truck farming, specialty fruits and vegetables, and maple sugar and syrup.

INDUSTRY: Textiles and wearing apparel, food and food products, machinery and metal products, transportation equipment, primary metals, and pulp and paper.

MINERALS: Clays, limestone, sand and gravel, zinc, iron, garnet, and titanium.

GENERALIZED BEDROCK GEOLOGY of NEW YORK

Compiled by the
Geological Survey, New York State Museum
1986



NOTE —
A free list of Survey publications is available from the:
New York State Geological Survey
Room 3136
State Museum
Albany, N.Y. 12230

EXPLANATION

- Sedimentary Rocks of the following ages ****
- CRETACEOUS, TERTIARY, PLEISTOCENE (Epoch): unconsolidated gravels, sands, clays
 - TRIASSIC, JURASSIC: conglomerates, red sandstones, red shales, diabase
 - PENNSYLVANIAN & MISSISSIPPIAN: conglomerates, sandstones, shales
 - DEVONIAN: limestones, shales, sandstones, dolostones
Silurian also contains salt, gypsum, hematite
 - SILURIAN
 - ORDOVICIAN: limestones, shales, sandstones, dolostones
 - CAMBRIAN
- Metamorphic & Sedimentary Rocks of the following ages ****
- CAMBRIAN & EARLY ORDOVICIAN: sandstones, dolostones
 - CAMBRIAN & ORDOVICIAN (undifferentiated): quartzites, dolostones, marbles, schists, gneisses
(primarily metamorphosed locally)
 - LATE PROTEROZOIC (HADRYNIAN) CAMBRIAN & EARLY ORDOVICIAN: sandstones, shales, slates, graywackes
The Taconic Sequence
- Metamorphic Rocks of the following age ****
- MIDDLE PROTEROZOIC (HELIKAN): gneisses, quartzites, marls
(orthothetic rocks)
- ** locally includes some igneous rocks**

**TIME SPAN OF ROCK RECORD
IN NEW YORK**

- 100 m.y.a.† to present
- 245 to 208 m.y.a.
- 360 to 285 m.y.a.
- 410 to 360 m.y.a.
- 440 to 410 m.y.a.
- 505 to 440 m.y.a.
- 570 to 505 m.y.a.

older than 570 m.y.a.
(regional metamorphism
about 1,000 m.y.a.)
*millions of years ago

ERA	PERIODS & EPOCHS	MT. BUILDING EPISODES	DURATION AND DATE B.C. IN MILLIONS OF YEARS	
CENOZOIC ERA	QUATERNARY Pleistocene Epoch	Cascadian	1	
	Pliocene Epoch		10	
	TERTIARY	Miocene Epoch		14
		Oligocene Epoch		15
		Eocene Epoch		20
		Paleocene Epoch	Laramide	10
				70+-2
MESOZOIC ERA	CRETACEOUS PERIOD		65	
		Nevedien		135+-5
	JURASSIC PERIOD		45	
	TRIASSIC PERIOD	Peliaside		180+-5
PALEOZOIC ERA	PERMIAN PERIOD	Appalachian	45	
	PENNSYLVANIAN PERIOD	Merathon		270+-10
	MISSISSIPPIAN PERIOD		80	
	DEVONIAN PERIOD	Acedian		350+-10
			50	
	SILURIAN PERIOD	Taconic	40	
	ORDOVICIAN PERIOD		60	
			500+-15	
	CAMBRIAN PERIOD		100	
PROTEROZOIC ERA	KWEENAWAN PERIOD	Killarney		600+-20
	MURONIAN PERIOD		1,900	
ARCHEOZOIC ERA	TIMISKAMING PERIOD	Algonan		Geochronologists are not in full agreement as to the duration of Pre-Cambrian time. A popular figure for the age of the earth is four and one-half billion years. to 5 billion years.
	KEEWATIN PERIOD	Laurentian	2,100	

GEOLOGIC TIME SCALE

THE GEOLOGY AND MINERAL RESOURCES OF THE LOWER AND MIDDLE
HUDSON VALLEY

by

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The Hudson River, from its birth in the high peaks of the Adirondack Mountains to its marriage with the Atlantic Ocean, is one of the most interesting rivers in the United States considering the beauty and magnificence of its scenery, its natural, political and social history, the agriculture and mineral treasures of its vicinage, the commercial wealth along its shores, and the relations of its geology, geography and topography to some of the most important events in the history of the Western Hemisphere.

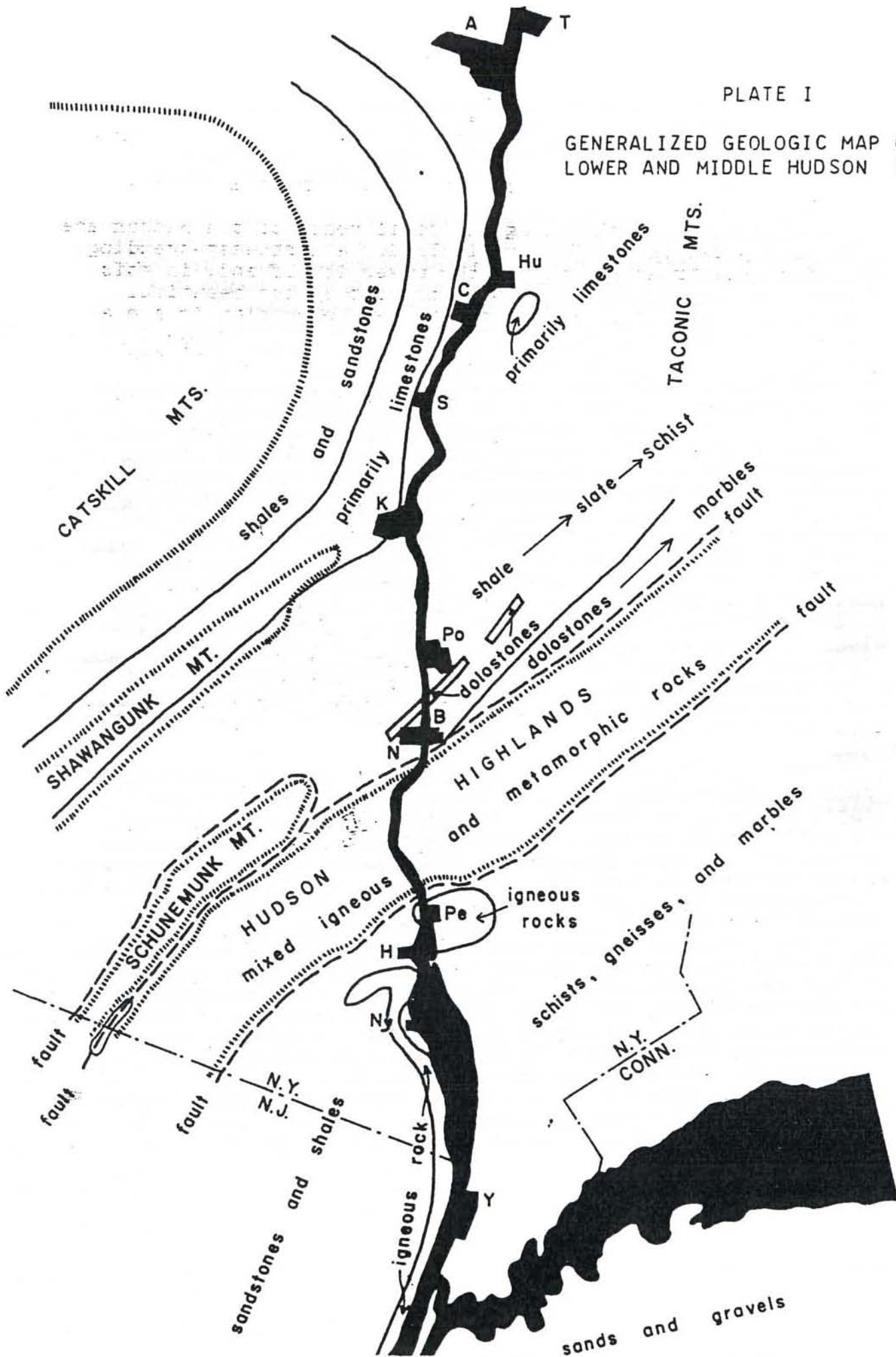
The Hudson lies entirely within the state of New York. From its source in Lake Tear of the Clouds, 4,322 feet above sea level on the flank of Mount Marcy, the river winds through some of the wildest parts of the Adirondacks for 109 miles in an irregular south-southeasterly direction before it flows for 195 miles almost directly south to its mouth. South of the Adirondacks, the river passes through the Capital District and a farming and industrial area bounded by the Catskill and Taconic mountains before entering the colorful and majestic Hudson Highlands, often called the Rhineland of America, about 60 miles north of New York City. Continuing south the river opens into the broad Tappan Zee, 3.2 miles wide, and is then bordered on the west by the stately cliffs of the Palisades before entering upper New York Bay at the southern tip of Manhattan Island.

Over half its distance to the open Atlantic the Hudson River is an arm of the sea, for it experiences the daily rise and fall of the oceanic tides in the more than 150 miles between Green Island Dam at Troy (T)^{1/} and New York Harbor. Traces of salt are detectable in the Hudson's waters north nearly to Poughkeepsie (Po) during periods of extraordinarily low discharge or unusually high tides, but the water is always somewhat saline to the North Gate of the Hudson Highlands just south of Newburgh (N) and Beacon (B).^{1/} Throughout its estuarine and tidal river segments, the valley of the Hudson is characterized by diverse terrain richly endowed with a wide variety of mineral resources which account for nearly one-third of the

^{1/} Abbreviations for cities depicted on Plate I are denoted in parentheses.

PLATE I

GENERALIZED GEOLOGIC MAP OF THE LOWER AND MIDDLE HUDSON VALLEY



dollar value of New York State's mineral industry. The principal products are industrial minerals necessary to building and highway construction such as crushed stone, sand and gravel, lightweight aggregate, portland cement and brick.

The oldest rocks along the tidal reach of the Hudson are those exposed in the Hudson Highlands, a northeast-trending upland area breached only by the river itself and, in this stretch, the river flows past some of the most beautiful scenery in its course. The rocks are Precambrian in age and date back to more than 1,100 million years. Nearly all of the rocks in the Highlands are metamorphic; i.e., changed into granular aggregates of interlocking grains from some earlier-formed rocks that were subjected to intense pressures and temperatures in the roots of a long since-eroded mountain system. The most pronounced metamorphic types are gneisses of complex and often uncertain origin that share one common characteristic - a coarsely-foliated texture which produces a streaked or banded appearance. The most durable of these is a granitic gneiss, formerly quarried in a few places for crushed stone and building stone, which forms the conspicuous summits of North Beacon Mountain, Breakneck Mountain, Storm King Mountain, Bear Mountain and Dunderberg. The weaker gneisses form lower hills, and valleys tributary to the Hudson follow relatively soft marble belts or zones of crushed rocks along ruptures or faults. In the past, several mining operations produced iron from localized concentrations of the iron oxide mineral, magnetite. An occurrence of iron sulfide opposite Bear Mountain yielded ore for the production of sulfuric acid but it too has ceased to operate.

The rocks south of the Highlands and east of the Hudson are also structurally complex, often intimately mixed and almost entirely metamorphic. In general, the sequence consists of a basal gneiss and granitic gneiss, and intermediate marble, and an upper schist with some gneiss which collectively are termed the New York City Group. Because of their complex relationships there had been considerable controversy regarding their position in the scale of geologic time though it is now generally agreed that the basal gneisses are probably Late Precambrian in age whereas the middle and upper units are of Cambrian-Ordovician age. The ridges and rolling hills of Westchester County, therefore, are in part composed of the second oldest rocks along the Hudson Estuary for the more durable gneisses and schists form the hills and the marbles occupy the valleys. The gneisses and marbles were quarried for building stone adjacent to the Hudson years ago; today only a few active quarries operate inland where granitic gneiss is excavated for building purposes and marble is quarried for aggregate in concrete.

Adjacent to the Highlands at Peekskill (Pe), an unusual group of igneous rocks, known as the Cortlandt Complex, intrude the New York City Group in funnel fashion to produce a roughly circular area of outcrop. Though obviously younger than the intruded rocks, these rocks have been dated at 435 ± 10 million years; i.e., latest Ordovician age. Natural chemical reactions between the intrusive rocks and those intruded resulted in the formation of commercial emery deposits, a mixture of very hard minerals having abrasive properties such as corundum, magnetite and spinel. These deposits support the only emery mines in the Western Hemisphere. Although these intrusive igneous rocks are largely of a variety that is nearly black (norite), the final phase of the igneous activity resulted in the formation of the attractive white Peekskill Granite (356 m.y.) which was quarried for building stone at one time. It was used in the construction of the Cathedral of St. John the Divine in New York City and the New Croton Dam.

On the north flank of the Hudson Highlands, the rocks are nearly of the same age as those in Westchester County but their geology is less complicated. The major rock type is an intensely deformed Middle Ordovician shale which locally contains interlayers of tough sandstone and quartzite. The sandstone and quartzite resist erosion to form hills such as Illinois Mountain opposite Poughkeepsie. Less extensive are the older Late Cambrian and Early Ordovician dolostones (carbonate rocks such as limestone but containing appreciable magnesium carbonate in addition to calcium carbonate) which underlie the shales. In several places rectangular blocks of dolostone appear within the shale as a result of possible submarine slides and subsequent faulting. Eastward the dolostones have been metamorphosed to marbles and the shales changed to slates and schists, the last frequently injected with quartz along foliation surfaces. The more durable schists form the Taconic Mountains. The dolostones are quarried principally for crushed stone. One of the largest quarries along the Hudson, operated by the New York Trap Rock Corporation, is located in the dolostone a few miles south of Poughkeepsie at Clinton Point. The shale is not widely used although it had been quarried for the manufacture of brick near Beacon.

North of Kingston (K), the shales continue to floor the river lowland to the Albany-Troy area and beyond, but on the west side ridges appear (see Plate 1) which are formed of still younger rocks lying above the shales. These are primarily folded limestones of Upper Silurian and Lower Devonian age. Higher and forming pediment-like foothills to the Catskill Mountains are terraces of shale and sandstone on which rests Ashokan Reservoir, part of the New York City water supply system. Still higher are the nearly flat-lying sandstones, red shales and occasional pebble conglomerates of the Catskills which preserve a large composite delta and alluvial plain built by streams flowing westward into an interior arm of the sea during the Late Devonian about 350 million years ago. The Silurian and Devonian limestones are extensively quarried for crushed stone and as raw material for the manufacture of a

variety of cements. Five of the Mid-Hudson Valley's six cement manufacturing companies operate in this belt of rock from Kingston north nearly to Albany. The remaining cement producer is located in an erosional remnant containing these limestones immediately southeast of Hudson (Hu) on the east side of the river. Within the limestone sequence there is a formation of shale that has the ability to bloat and expand at elevated temperature to produce a porous cinder-like material called lightweight aggregate. Three concerns in the Kingston-Saugerties (S) area are engaged in the manufacture of expanded shale. Certain of the shales above the limestones are used in the manufacture of brick and the sandstones provide crushed stone. One of the sandstone formations was extensively quarried for flagstone in former years because the rock had a pronounced tendency to split along parallel surfaces so as to yield smooth thin slabs.

The youngest and perhaps the most distinctive consolidated rocks in the valley occur west of the river, downstream from the Highlands in southern New York and northern New Jersey. Here a succession of brick red Triassic shales and sandstones more than 10,000 feet thick occupy a structural basin bounded by the much older rocks of the Highlands Upland on the west and the Westchester County hills on the east. Curiously enough, the prominent rock in this area is a comparatively thin (400-900 feet) sheet of igneous rock intruded as a molten mass through and between the red sedimentary layers of the Stockton Formation during the latest Triassic or earliest Jurassic, 185-190 million years ago, which is today conspicuously exposed in the sheer wall of the Palisades. The cliff extends for nearly 40 miles from its northern hook at Haverstraw (H) south opposite Manhattan Island and across Staten Island and, except for a structural sag which causes it to swing away from the river at Nyack (Ny), it lines the west shore throughout its length. The rock composing the Palisades is diabase, a tough, finely crystalline dark rock often called "trap" that is characterized by intersecting vertical cracks produced by contraction on cooling to form polygonal columns that resemble massive stone logs. The entire region of Triassic outcrop is one of gentle topography except for the relief afforded by the Palisades which rises highest above the river in the north where its serrated crest forms the prominences of Tallman Mountain, Hook Mountain and High Tor. Diabase is quarried at several localities for crushed stone, most of it used as concrete and bituminous aggregate in building and highway construction. The more massive of the Triassic sandstones formerly furnished the brownstone once used extensively as exterior facing on buildings.

Most recently, the entire Hudson Valley region was covered at least once by a thick sheet of glacial ice that reached south to New York City. In its advance, the ice picked up

soil and weathered rock, planed down weak bedrock, and abraded and polished hard bedrock. When the ice flow paralleled a pre-existing valley such as the Hudson, it widened and deepened that valley. The maximum advance of the ice is marked by an east-west line of low hills across northern Long Island and Staten Island composed of material carried by the leading edge of the ice sheet and deposited when the ice front melted back. This terminal moraine is breached by the Hudson at the Narrows that separates Upper New York Bay from the Lower Bay. As melting accelerated and the ice sheet broke up to expose the higher land areas, beginning about 15,000 years ago, a heterogeneous mixture of clay, sand, pebbles and boulders was left as a blanket of till termed ground moraine, obscuring much of the bedrock. Local meltwater lakes developed in the lowland areas south of the receding glacier and considerable clay was deposited in these bodies of fresh water. The glacially-formed lake that once occupied the Lower Hudson Valley is referred to as Glacial Lake Hudson. Concurrent with the retreat of the ice, the land rose, relieved of the weight of the great mass of ice, at the rate of 2.25 feet per mile northward. This uplift renewed the activity of meltwater streams which deposited their loads of sand and gravel as deltas into the lakes or as marginal deposits between the valley walls and the dwindling ice. Much of Croton Point, for example, is a delta of the Croton River draining into former Lake Hudson. North of the Highlands, Glacial Lake Albany was formed later during the ice recession and it also received similar deposits of clay, sand and gravel. The total picture of sand and gravel distribution is closely related to the patterns of stream flow which attended the melting of the ice. The clays provide raw material for the manufacture of brick and the sands and gravels provide fine and coarse aggregate used in construction.

In summary, for its length from the Albany-Troy area south to the Newburgh-Beacon region, the Hudson flows through the Hudson Lowland developed by erosion of a belt of weak shale between the Catskills and the Taconics. Throughout this portion of its course, elevations marginal to the river are generally low and relief is small. From a point just below Newburgh south to New York City, the river cuts its way through the New England Uplands; first the Hudson Highlands and then the western border of that province as it flows past the Palisades which mark the eastern margin of the Triassic Lowland. The rocks of the New England Uplands are either metamorphic or igneous and the land configuration bears a close relationship to the relative durability of the various rocks. The Hudson Highlands have considerable relief with elevations to more than 1,600 feet, whereas the topography in Westchester County south of the Highlands, though rugged, is more subdued. Long Island and a portion of Staten Island lie within the Coastal Plain Province but have been covered by glacial drift which has been breached by the Hudson.

PLATE II

MINERAL RESOURCE MAP — HUDSON VALLEY

EXPLANATION

- be Iron-magnesian rocks with local emery
emery used as abrasive and non-skid aggregate
N.Y.S. Geologic Map, 1961: Xcc, Xban, Xhn, Xpd, Xopx, Xd, Xpx;
- fm Iron-magnesian rocks not used for aggregate
N.Y.S. Geologic Map, 1961: amg, am, Xs
- d Unmetamorphosed diabase (trap)
Concrete aggregate
N.Y.S. Geologic Map, 1961: Tr d
- g Granites and granitic gneisses which have been or are being quarried
curbing stone
concrete aggregate
building stone
N.Y.S. Geologic Map, 1961: bg, hg, Xbd, Xpk, Xy, gtlg;
- pg Gneisses which have not been extensively quarried
dimension stone? concrete aggregate?
N.Y.S. Geologic Map, 1961: gpg, rg, bgpc, Xf, Xsg
- qt Quartzite and high silica sandstone and conglomerate
concrete aggregate, high silica sources?
N.Y.S. Geologic Map, 1961: Cpg, Ssk, DS (DS includes shale and limestone)
- mb Marbles of Pre-Silurian but otherwise unknown age and Precambrian Marble
building stone, concrete aggregate, lime
N.Y.S. Geologic Map, 1961: mb, Xi
- COmb Cambrian-Ordovician Carbonate Rocks
building stone, lime
N.Y.S. Geologic Map, 1961: COmb
- cb Silurian-Devonian Carbonate Rocks
cement, concrete aggregate, lime,
rough dimension stone,
N.Y.S. Geologic Map, 1961: Dhg, Dgl, Don
- sh Shale with siltstone and with or without accessory sandstone
flagstone (Dnm, Dh); locally light weight aggregate, locally shale for cement, locally shale for brick and tile; locally crushed for fill?
N.Y.S. Geologic Map: Cc, UC, On, Osh, Dh, Dha, Dhm, TRs, R b
- sp Micaceous Metamorphic Rocks
lightweight aggregate? crushed locally for fill?
N.Y.S. Geologic Map: bb, Xe, Xm
- uc Unconsolidated Pleistocene and Cretaceous clay, silt, sand and gravel
clay for brick manufacture, fire and coarse concrete aggregate
N.Y.S. Geologic Map: Kr, Km, Q

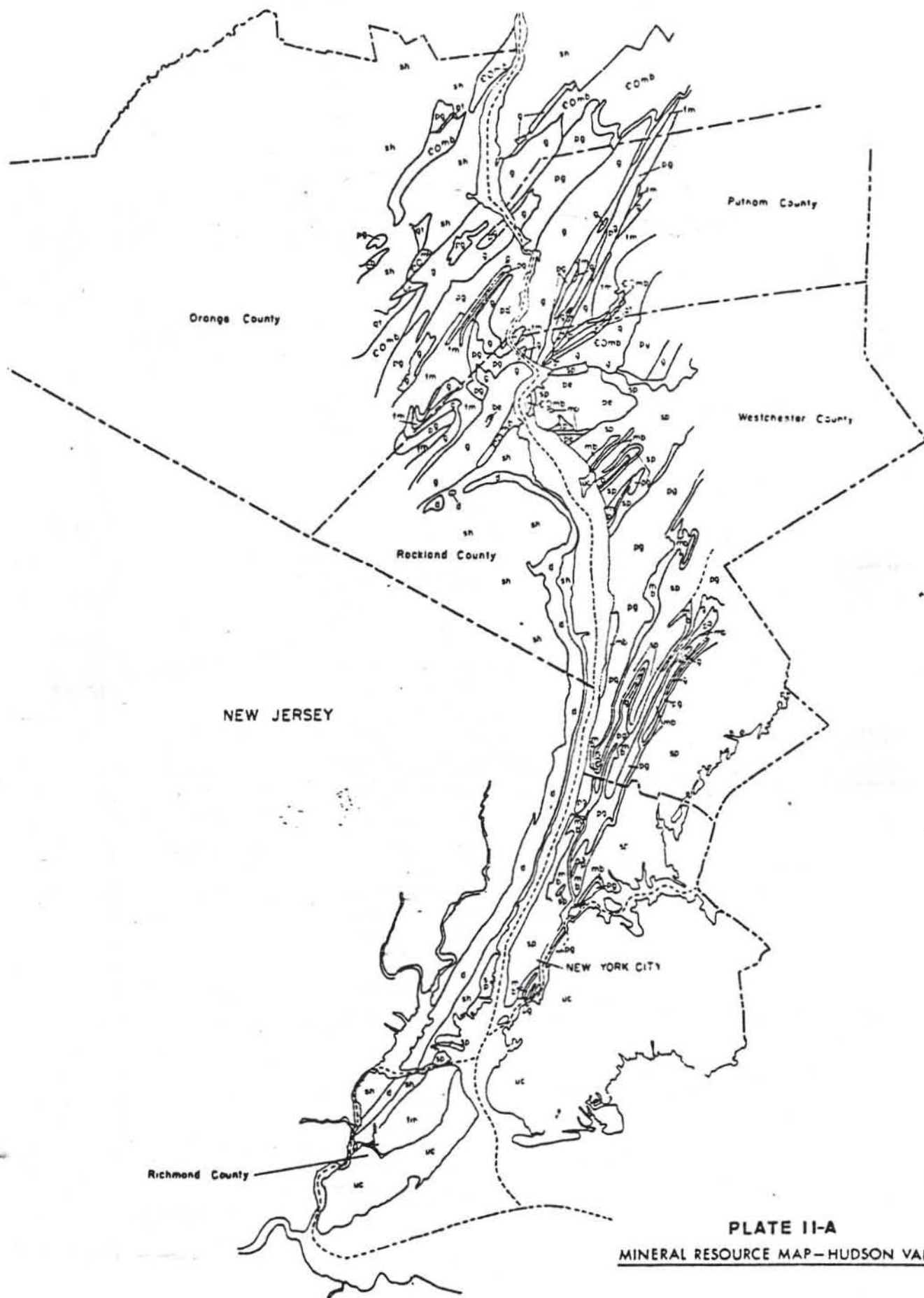


PLATE II-A
MINERAL RESOURCE MAP—HUDSON VALLEY

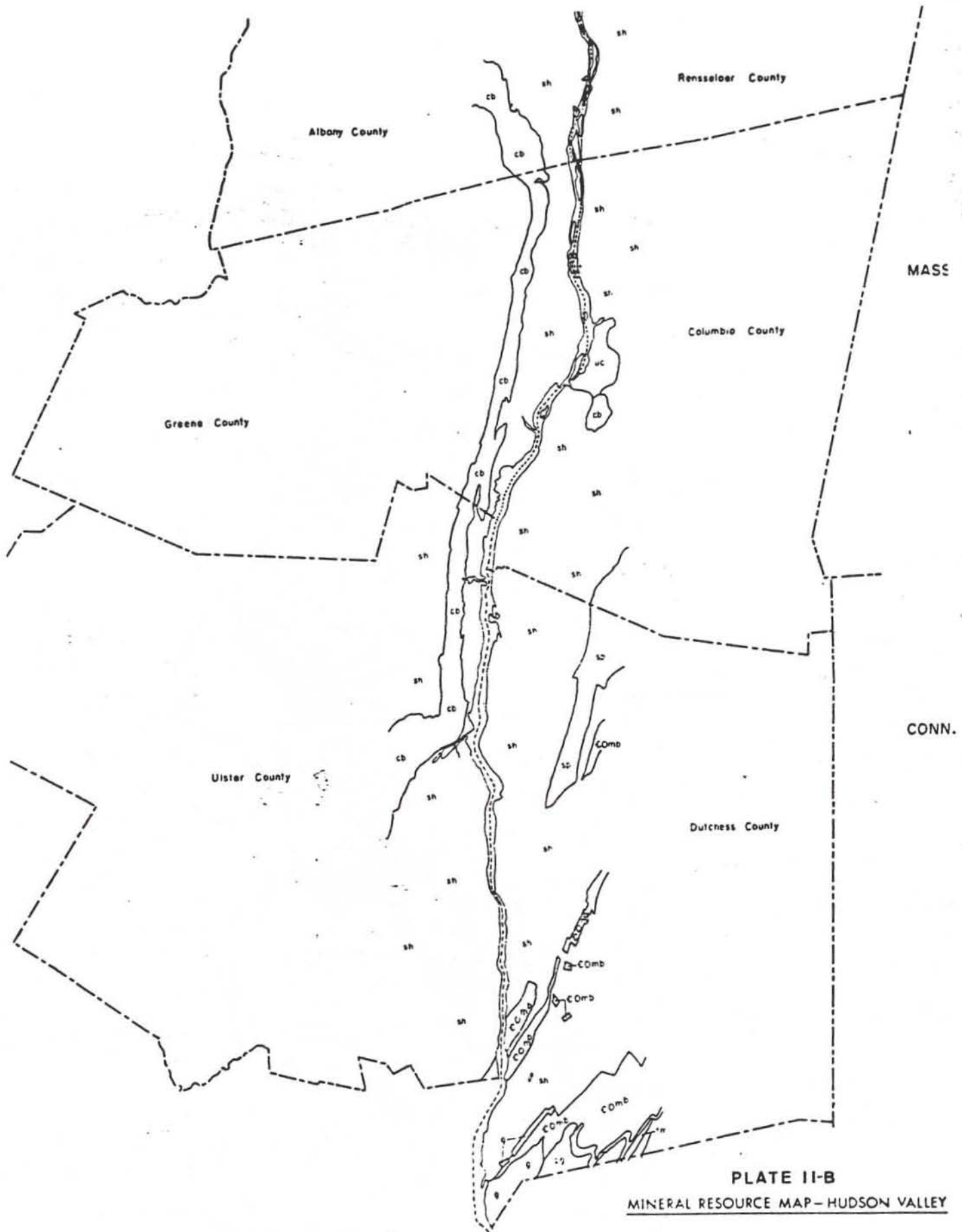


PLATE II-B

MINERAL RESOURCE MAP - HUDSON VALLEY

GENERALIZED GEOLOGIC SECTION FOR THE MID-HUDSON VALLEY *
 FORMATIONS (Thickness in feet)

PRINCIPAL LITHOLOGY

DEVONIAN PERIOD

Middle Devonian

Plattekill Fm. (800)

Reddish-purple mudstones and siltstones, dark-gray shales and impure sandstone

Ashokan Fm. (300)

Bluish-gray sandstone (flagstone), olive-gray shale

Mt. Marion Fm. (800)

Gray sandstone and shale

Bakoven Fm. (200)

Black shale

Onondaga Fm. (170-180)

Moorehouse Member (100+)

Gray limestone with dark-gray chert

Nedrow Member (35)

Gray limestone

Edgecliff Member (35-40)

Gray coralline limestone with light-gray chert

Lower Devonian

Schoharie Fm. (74-222)

Saugerties Member (18-77)

Medium-gray argillaceous limestone and calcareous mudstone

Aquetuck Member (30-45)

Calcareous mudstone and siltstone with some gray argillaceous limestone; occ. chert

Carlisle Center

Member (26-124)

Calcareous dark-gray siltstone and mudstone

Esopus Fm. (150-200)

Dark-gray shale and siltstone

Glenerie Fm. (20-55)

Dark-gray siliceous limestone with chert

Connelly Fm. (0-20)

Gray conglomerate and sandstone

Port Ewen Fm. (10-100+)

Gray argillaceous limestone with interbedded shale

Alsen Fm. (20-25)

Dark-gray limestone with some chert

Becraft Fm. (35-50)

Gray to pinkish-gray crinoidal limestone

New Scotland Fm. (95-150)

Dark-gray calcareous mudstone and argillaceous limestone

Kalkberg Fm. (75)

Broncks Lake Member (43)

Gray argillaceous limestone and limestone with some dark-gray calcareous shale

Hannacroix Member (32)

Dark-gray to gray limestone, gray shale partings, chert at base

Coeymans Fm.

Ravena Member (20-28)

Medium-gray to gray limestone

Manlius Fm.

Thacher Member (48-50)

Dark-gray to medium-gray limestone, occ. laminated; magnesian at base

SILURIAN PERIOD

Upper Silurian

Rondout Fm. (30-55)

Whiteport Member (4-16)

Glasco Member (10-13)

Rosendale Member (6-27)

Wilbur Member (4-12)

Binnewater Fm. (0-35)

High Falls Fm. (0-85)

Gray argillaceous magnesian limestone

Gray coralline limestone

Gray argillaceous magnesian limestone

Medium-to light-gray limestone

Blue-gray to greenish-gray cross-bedded,
occ. ripple-marked quartz sandstone

Red and green shale

Middle Silurian

Shawangunk Fm. (0-600+)

Milky white to gray quartzite and quartz
pebble conglomerate

MAJOR UNCONFORMITY

ORDOVICIAN PERIOD

Middle Ordovician

Normanskill Fm. (2000)

Austin Glen Member (1200+)

Mount Merino Member (250+)

Graywackes, black and gray shale and
siltstones

Black shale and chert with local red
and green shales

Lower Ordovician

Stockbridge Group (Wappinger carbonate sequence)

Balmville Fm. (70)

Copake Fm. (400)

Rochdale Fm. (750)

Halcyon Lake Fm. (350)

Gray limestone

Dark-gray dolomite with some limestone

Light-blue-gray limestone, some dolostone

Light-gray dolimitic limestone

CAMBRIAN PERIOD

Upper Cambrian

Stockbridge Group (con'd.)

Briarcliff Fm. (700)

Pine Plains Fm. (1475)

Light-gray dolostones

Light-gray, slightly sandy dolostone,
some sandstone and shale

Middle and Lower Cambrian

Stissing Fm. (500)

Gray dolostone, some with chert

Lower Cambrian

Poughquag Fm. (300)

Gray quartzite

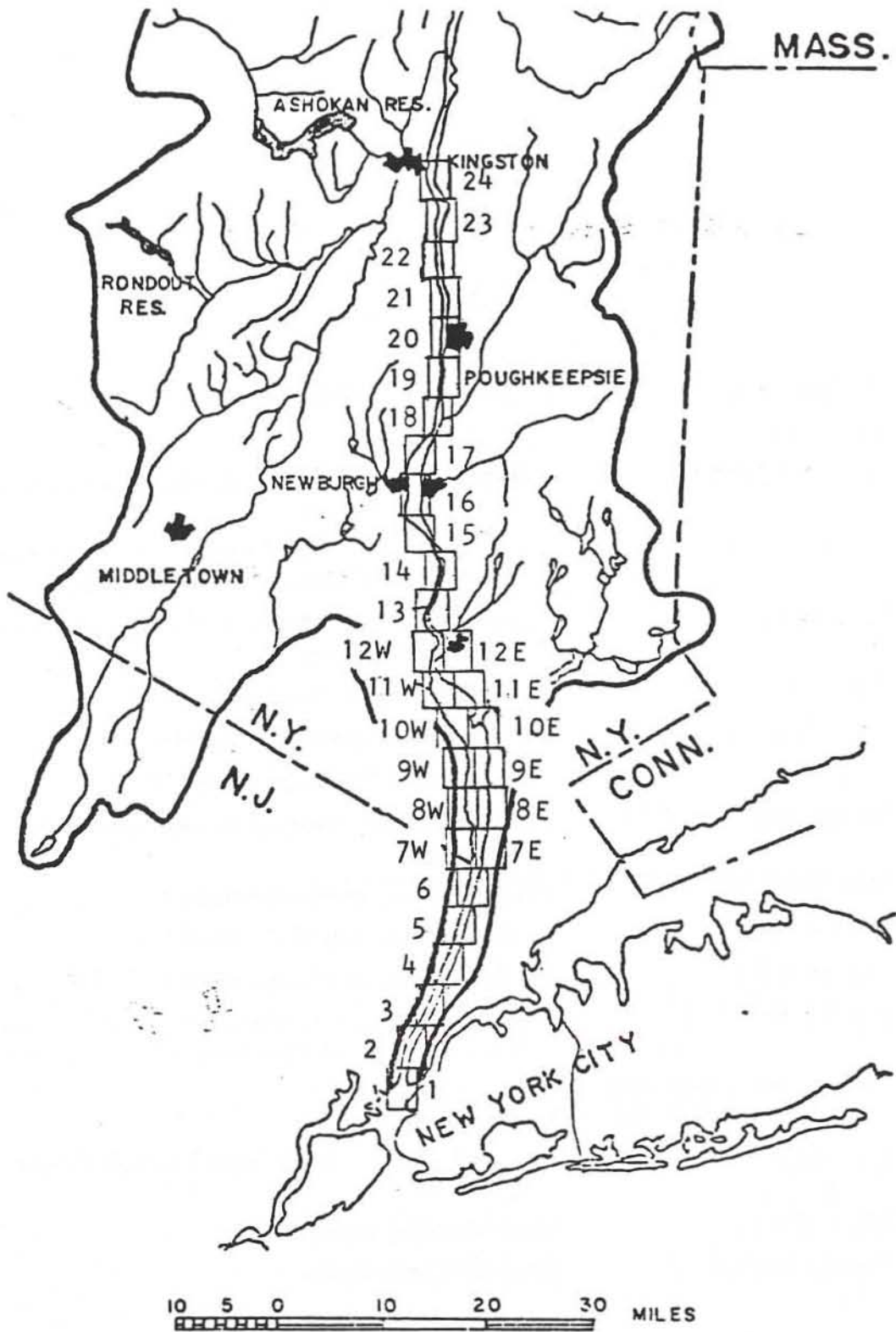
MAJOR UNCONFORMITY

PRECAMBRIAN (exposed in the Hudson Highlands)

USES OF THE ROCK FORMATIONS IN THE MID-HUDSON VALLEY

Plattekill Fm.	Extruded wire cut brick
Ashokan Fm.	Flagstone
Mt. Marion Fm.	Extruded wire cut brick, argillaceous component in portland cement
Onondaga Fm.	Crushed stone, portland cement, locally blast furnace flux and agricultural limestone
Esopus Fm.	Lightweight aggregate, argillaceous component in portland cement
Glenerie Fm.	Crushed stone, portland cement*
Port Ewen Fm.	Crushed stone, portland cement*
Alsen Fm.	Crushed stone, portland cement*
Becraft Fm.	Portland cement, crushed stone, agricultural limestone
New Scotland Fm.	Crushed stone, portland cement*
Kalkberg Fm.	Crushed stone, portland cement*
Coeymans Fm.	Crushed stone, portland cement*
Manlius Fm.	Crushed stone, portland cement, blast furnace flux, agricultural limestone
Rondout Fm. (Rosendale & Whiteport Members)	Natural cement
Normanskill Fm.	Extruded wire cut brick, possibly lightweight aggregate
Briarcliff Fm.	Crushed stone, riprap
Pine Plains Fm.	Crushed stone, riprap

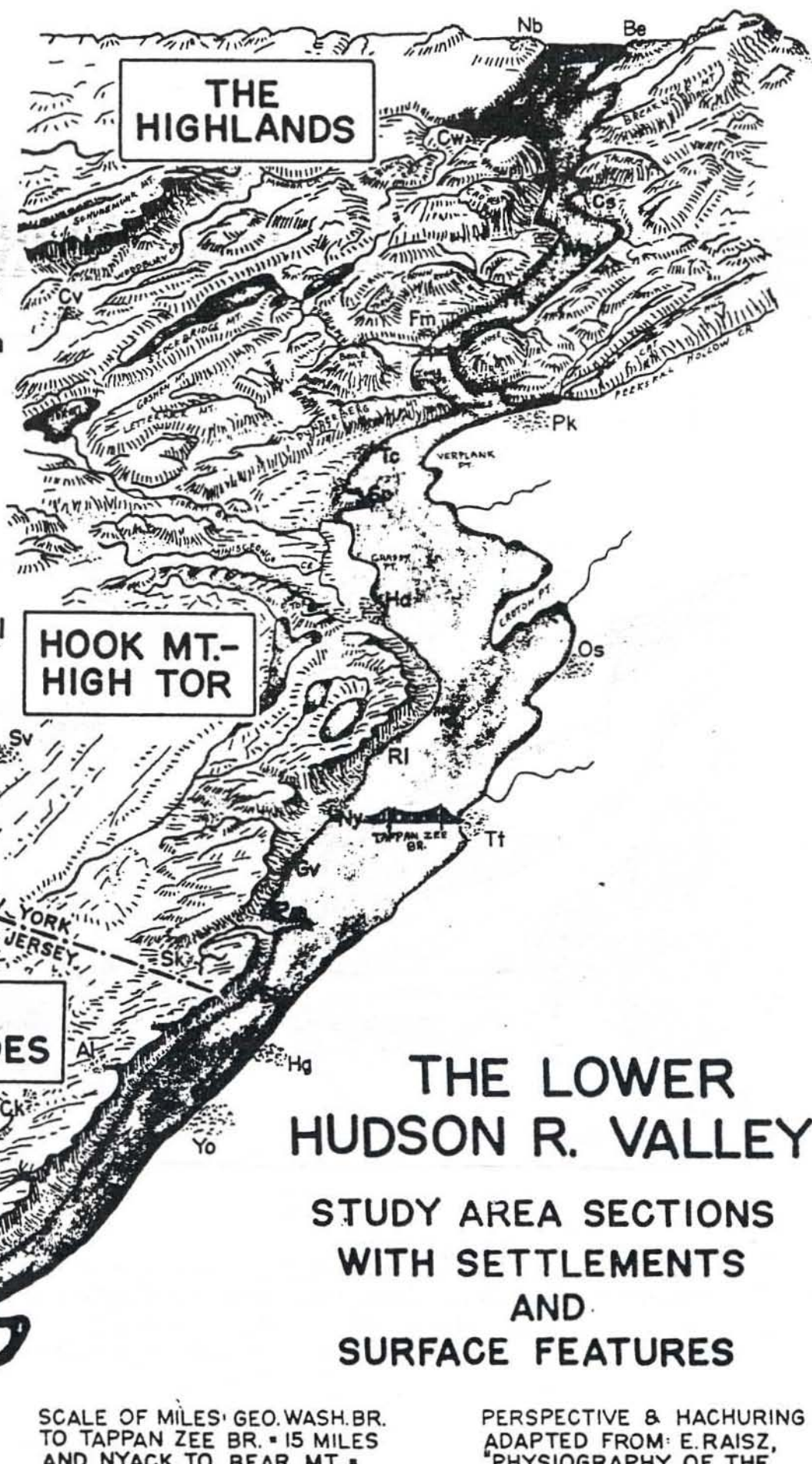
*When mixed with purer limestones such as Becraft, Coeymans or Manlius

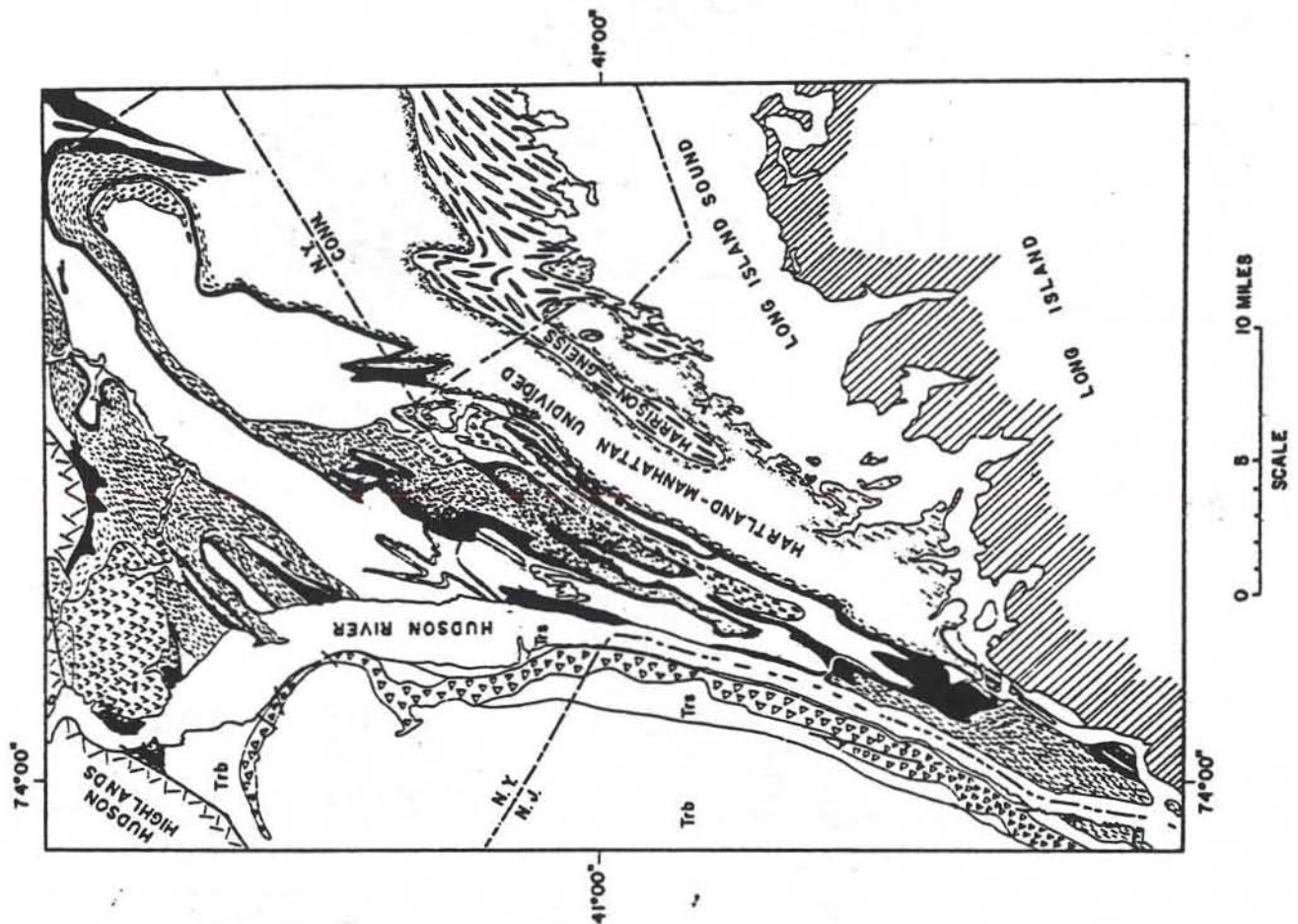
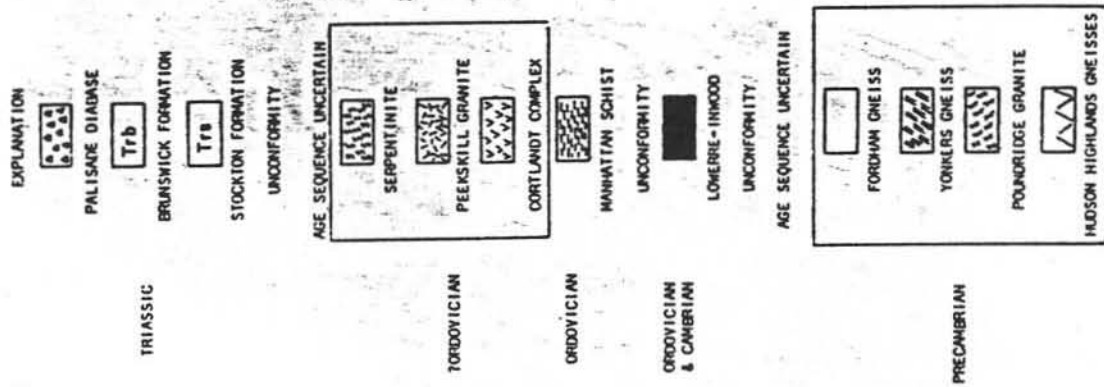


LOWER AND MIDDLE HUDSON RIVER DRAINAGE BASIN SHOWING AREA OF EACH INDIVIDUAL MAP IN THIS GUIDEBOOK

**KEY TO CITIES
AND TOWNS**

- Alpine — Al
- Beacon — Be
- Central Valley — Cv
- Cold Spring — Cs
- Cornwall — Cw
- Creskill — Ck
- Englewood Cliffs — Ec
- Fort Lee — Fl
- Fort Montgomery — Fm
- Grandview — Gv
- Hastings — Hg
- Haverstraw — Ha
- Highland Falls — Hf
- Newburgh — Nb
- Nyack — Ny
- Ossening — Os
- Peekskill — Pk
- Piermont — Pm
- Rockland L.Landing — Rl
- Snedens Landing — Sl
- Sparkill — Sk
- Spring Valley — Sv
- Stony Point — Sp
- Tarrytown — Tt
- Tenafly — Tf
- Tomkins Cove — Tc
- West Point — Wp
- Yonkers — Yo





Geologic Map of the Lower Hudson Valley - New York City to the Hudson Highlands - after Leo Hall, New York State Geological Association Guidebook, 40th Annual Meeting, Queens College, CUNY, 1968, p. 10. For use with Maps 1 through Maps 12E & 12W.

MAPS 1 AND 2

The point of embarkation is the home berth of the Palace II, a pier situated at the foot of 14th Street in Hoboken, New Jersey, near Weehawken Cove (see asterisk, Map 2). A magnificent view of the mid-town Manhattan skyline, including the Empire State Building directly opposite, is afforded from this location.

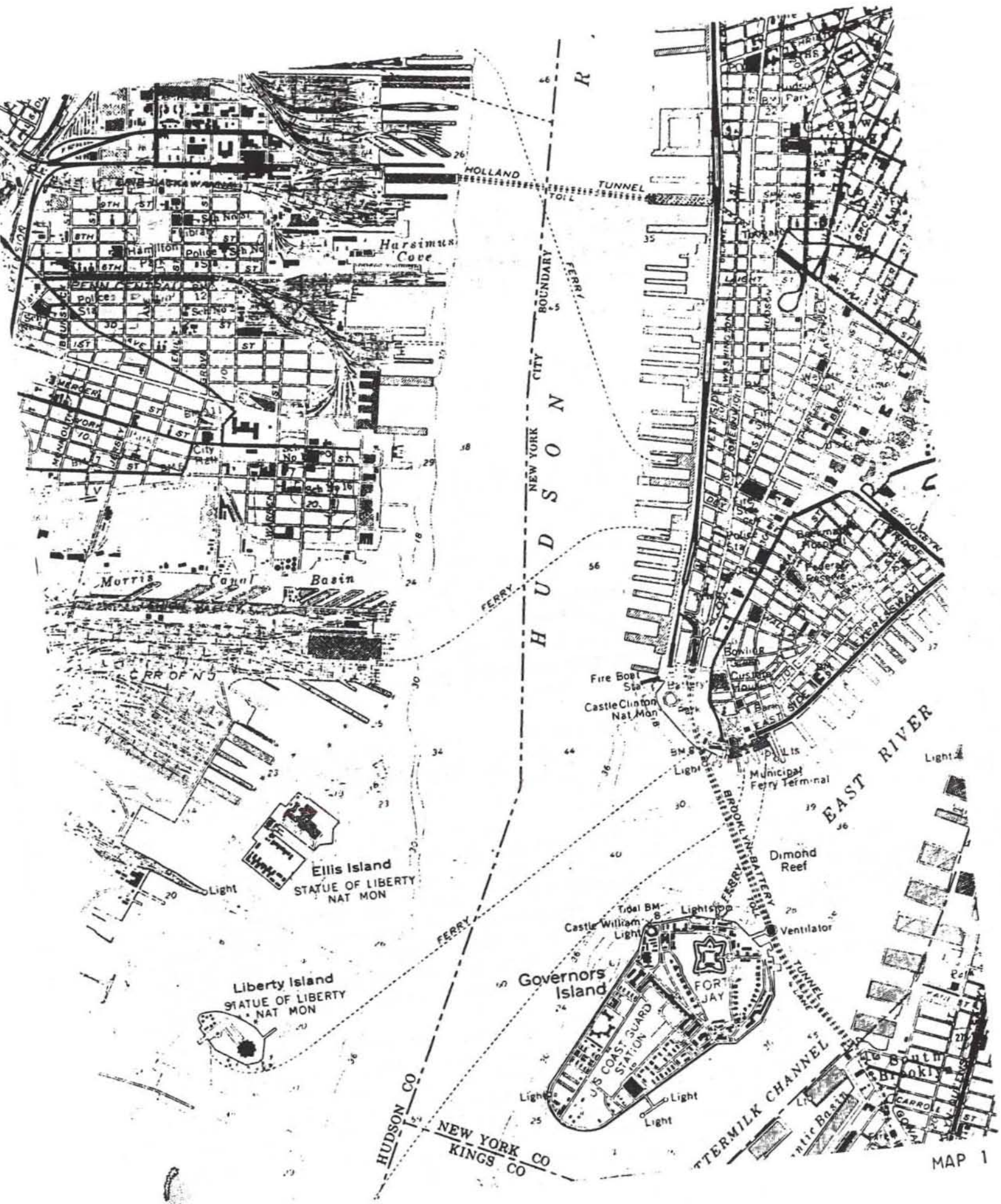
We proceed south along the New Jersey shore to Upper New York Bay (Map 1) passing Stevens Castle, a variety of old piers, the Holland Tunnel ventilation tower, Harsimus Cove, the Morris Canal Basin, and the New Jersey Central Railroad yards.

Stevens Castle on Hoboken's skyline is now part of the campus of the Stevens Institute of Technology (1870). It was once the home of John Stevens (1749-1838), one of the early developers of the steamboat. Fulton and Livingston's steamboat, the Clermont, made its first Hudson River run from near this point in 1807, beginning a period of fast, cheap freight and passenger transportation, and linking with the Erie Canal in 1823 to connect New York City and other Hudson River ports with the Great Lakes. The Fulton-Livingston monopoly under New York law was invalidated by the Supreme Court in 1823 under the Commerce Clause but not before Stevens had yielded to the monopoly by ceasing to operate a steam ferry between Hoboken and New York City.

Bedrock adjacent to the river along this reach is obscured by river front development. It is, however, the Manhattan Formation undivided of questionable Ordovician age (Geological Map of New York, 1970).

In Upper New York Bay we make a gradual turn toward Lower Manhattan passing Ellis Island, once a part of the U.S. Immigration Service, and Liberty Island, both now composing the Statue of Liberty National Monument, and Governors Island, the site of Fort Jay and a U.S. Coast Guard Station. The New York-New Jersey boundary is crossed midway between Ellis and Governors islands and from that point on we cruise in New York waters.

Starting our journey north at the southern tip of Manhattan Island we can view the mouth of the East River, the municipal ferry terminal serving Staten Island and Governors Island, the Liberty Island ferry dock, Battery Park and the classic lower Manhattan skyline. New to the scene in the last decade are the imposing twin towers of the World Trade Center built on new land once occupied by the piers shown on the map.





* Home berth of Palace II. Point of embarkation.

Battery Park is the site of the Castle Clinton National Monument. Castle Clinton postdated the Revolutionary War, having been built in 1811 as one of four forts to protect New York City. Of the four forts of that period, only Castle Clinton and Castle Williams are still in existence although none of the forts saw any action during the War of 1812. Known as West Battery during the War of 1812, it was generally circular in shape, had eight-foot thick walls of red Triassic sandstone and was designed for 28 guns in one tier of casemates. In 1824, no longer needed for military purposes, Castle Clinton was leased by the City of New York for entertainment purposes. Castle Garden became the New York City Aquarium in 1896 and the aquarium was closed in 1941 to make way for the Battery to Brooklyn tunnel approach. However, on August 12, 1946, Castle Clinton was declared a national monument by congressional action and the destruction of the aquarium stopped short of the original fort walls and in October 1950 the work of restoration began. The New York City Aquarium is now located at Coney Island on Brooklyn's south shore.

Continuing north we pass a constantly changing Manhattan waterfront arriving directly opposite Stevens Castle at approximately W. 14th Street in Manhattan. Bedrock (still obscured) on the New York side of the river continues to be the Manhattan Formation (undivided) throughout Maps 1 and 2 but a change becomes apparent on the New Jersey side. The hill on which Stevens Castle and the Stevens Institute of Technology are located is composed of serpentinite similar (or identical) to that in a large mass of serpentinite in north-central Staten Island - one of the five boroughs of New York City adjoining New Jersey seven miles to the southwest. The serpentinite is an ultrabasic igneous rock presumed intruded in Lower Ordovician time. The lower areas about Hoboken, Weehawken Cove and the New Jersey waterfront to the northern limit of Map 2 at West New York and beyond is underlain by the Stockton Formation, a sequence of generally reddish arkoses, conglomerates and mudstones, that makes up the basal portion of the Newark Group (Upper Triassic age). Conspicuous above the Stockton Formation is our first good glimpse of the Palisades believed by the Mahican Indians to be ramparts raised by the Great Spirit to protect his favorite spot from man. The Palisades create a conspicuous feature of the western Hudson River landscape for 40 miles north to the hook at Haverstraw. The origin of this magnificent feature is described on page four of the short article on the "Geology and Mineral Resources of the Lower and Middle Hudson Valley" included earlier in this guide. On top of the Palisades in the metropolitan area are many high-rise residential buildings that have been the subject of widespread

controversy raising questions about the long-range policy for preserving its natural features.

At West 33rd Street we pass over the Penn-Central Railroad tunnel connecting with New Jersey and at West 39th Street, the Lincoln Tunnel serving automobile and truck traffic. Immediately north of the Lincoln Tunnel on the New Jersey side is the site of the famous duel between Alexander Hamilton and Aaron Burr in 1804 at the foot of the Palisades where Hamilton, first Secretary of the Treasury, lost his life. At Day's Point, half a mile north of the site of the duel, is the west shore terminus of the former West Shore Division of the New York Central Railroad, then the Penn Central Railroad and now probably Conrail.

Almost directly opposite the West Shore Terminal at the Haaren High School and 57th Street area in Manhattan is a small serpentinite exposure of questionable Lower Ordovician age.

MAP 3

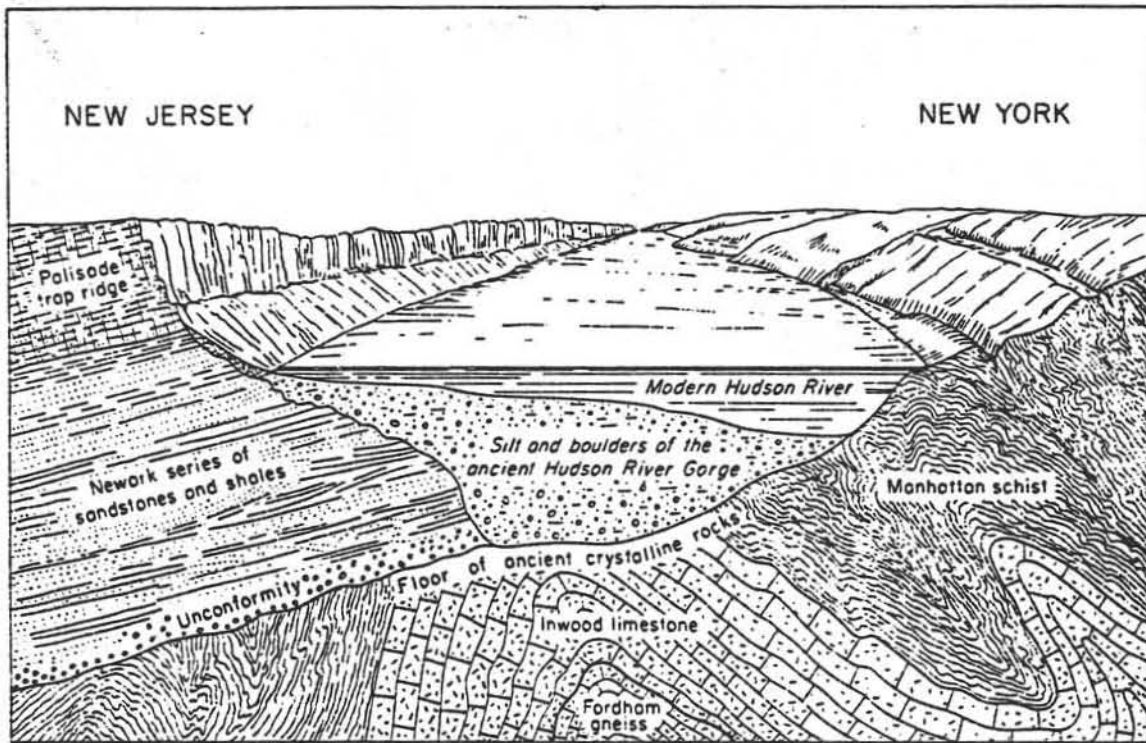
As we proceed onto Map 3, Riverside Park and the Henry Hudson Parkway are conspicuous features on the Manhattan waterfront, the southern section of Riverside Park extending north nearly 2.75 miles to the site of the former 125th Street Ferry connecting with Edgewater, New Jersey, and the former Palisades Amusement Park. Near the northern end of this section of the park may be seen Riverside Church, a portion of the Columbia University campus on the heights and the General Grant National Memorial or "Grant's Tomb". The upper part of this imposing tomb is reminiscent of that of King Mausolos' at Halicarnassos although the basic proportions and shape have been modified. The interior recalls Napoleon's tomb in the chapel of the Palace des Invalides in Paris carried out on a smaller scale. A portico supported by ten fluted Doric columns projects from the southern face and above the square lower section is a rotunda surrounded by Ionic columns. This in turn is surmounted by a conical dome with a five-ton capstone. The interior is lined with white marble. In the center is an open crypt containing the sarcophagi of President General Grant and his wife and, to the rear of the crypt, are two trophy rooms with Union Army battle flags and wall maps depicting Civil War campaigns.

The northern section of Riverside Park begins at 135th Street, continuing north nearly to the George Washington Bridge where it becomes Fort Washington Park below the heights of former Fort Washington (see Map 4). Projecting into the Hudson River at 135th Street is the new North River Treatment Plant (still under construction) which treats wastewater from 44 combined sewer outlets in western Manhattan. The North River interceptor is 12 miles long, including nine miles of tunnel and will cost in excess of 127 million dollars. Since nearly all of New York City's sewers are combined storm and sanitary sewers, the design and construction of intercepting sewers is a vital part of the city's water pollution control program. An intercepting sewer system collects dry-weather flow from combined sewer outlets and conveys it to a treatment plant. It also automatically limits wet-weather flow which exceeds treatment plant capacity.

At Edgewater, New Jersey, opposite Riverside Park at 145th Street, may be seen a cut in the face of the Palisades which at one time served as the road bed for an inclined railway to carry passengers from the riverfront to the Palisades Amusement Park. At the switchback midway to the top is exposed an olivine-rich zone in the Palisade Diabase. The rock on the New York side continues to be the Manhattan Formation.



MAP 3



Geology and structure under the Hudson River, at the Palisades. (After Fig. 7, Guidebook, 61st meeting, Geol. Soc. Am.)

Generalized geologic structure section across the Hudson River between Manhattan Island, New York, and the New Jersey shore opposite.

MAP 4

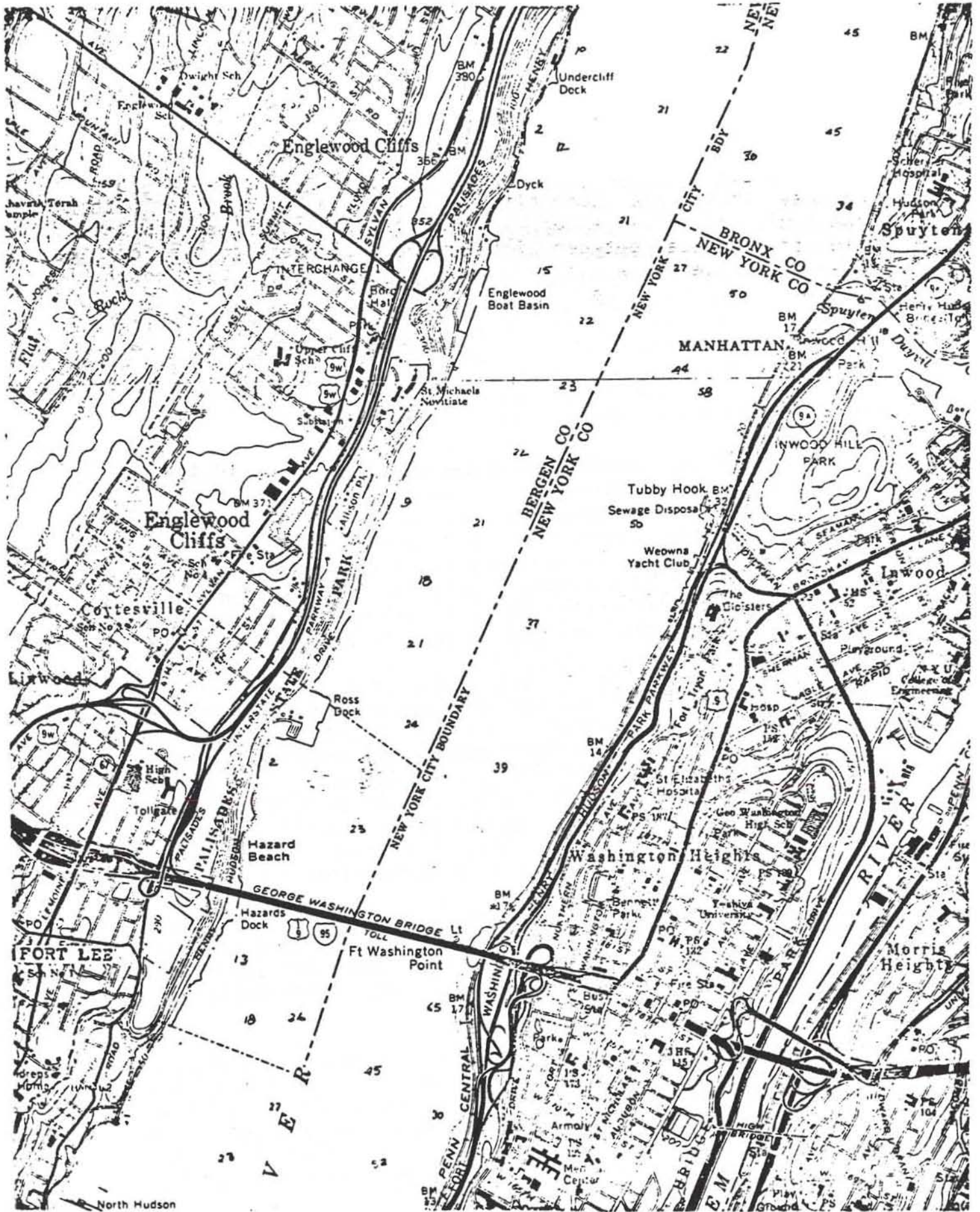
Although the George Washington Bridge, completed in 1932, has been in view for some time, it spans the Hudson River within the limits of Map 4, extending from the Washington Heights section of Manhattan between 178th and 179th streets to the Fort Lee area in New Jersey as Interstate 95. It has been reported that the mass of the Palisade Diabase deflected the plumb lines sufficiently to the west so that correction had to be made by an astronomer before the West Tower could be constructed. The bridge originally had a single level but, to accommodate increased vehicular traffic, a lower level was added later and it is affectionately known as Martha Washington.

Control of the Hudson became the strategic key to the continent early in the Revolutionary War or War for American Independence. Construction was begun on Fort Washington in June 1776, atop the highest point on Manhattan Island (approximately 250 feet asl) overlooking the Hudson, an area now known as Washington Heights. Work was also begun on a complementary fortification on top of the Palisades (approximately 300 feet asl) opposite Fort Washington at what is now Fort Lee, New Jersey, in July 1776.

Following the Battle of Long Island on August 27, 1776 and the successful withdrawal of the American troops to Manhattan Island, Washington determined to strengthen the fortifications on the Palisades opposite Fort Washington, both to protect the river and to protect the important source of supplies through the Jerseys. General Nathaniel Greene was assigned command in the Jerseys with headquarters at the Burdett Ferry fortification. In September 1776, there were 3,531 men at or near the fort and the work of building barracks and other accommodations actively began.

In the midst of the haste to establish these fortifications and the concern of a new British attack, General Charles Lee returned to the New York area and Washington gave him command of the troops north of King's Bridge. The fort on the Palisades was named Fort Lee in his honor.

The Battle of White Plains (inland east of Dobbs Ferry, Map 7E) took place on October 28th, but it was an inconclusive engagement. It resulted, however, in shifting the theater of war to Manhattan Island and then to the Jerseys. On the morning of November 16, 1776, the British attacked Fort Washington. The defending garrison of 3,000 men were attacked from the north,



MAP 4

east and south and were bombarded on the west from a British man-of-war in the river. Fort Washington surrendered at four in the afternoon of that day. Immediately following the fall of Fort Washington, the futility of maintaining Fort Lee was realized. The British landed a force of 6,000 to 8,000 men about seven miles north of Fort Lee on November 20th under the command of General Cornwallis who then moved immediately against the fort. General Washington ordered a retreat across the Hackensack River and, although nearly all of the garrison escaped, the loss of materiel was substantial.

Thomas Paine's account of the evacuation of Fort Lee includes the following famous passage:

"These are times that try men's souls. The summer soldier and the sunshine patriot will, at this crisis, shrink from the service of their country; but he that stands it now deserves the love and thanks of man and woman. Tyranny, like Hell, is not easily conquered; yet we have this consolation with us - that the harder the conflict the more glorious the triumph. What we obtain too cheap we esteem too lightly; it is dearness only that gives everything its value. Heaven knows how to put a proper price upon its goods, and it would be strange indeed if so celestial an article as Freedom should not be highly rated."

Very little of Fort Lee remains. The site of the batteries on the bluff close to the river is included within the southern portion of Palisades Interstate Park. The fortification area on the heights of the Palisades in the community of Fort Lee has been engulfed by urban development. To my knowledge, nothing remains of Fort Washington.

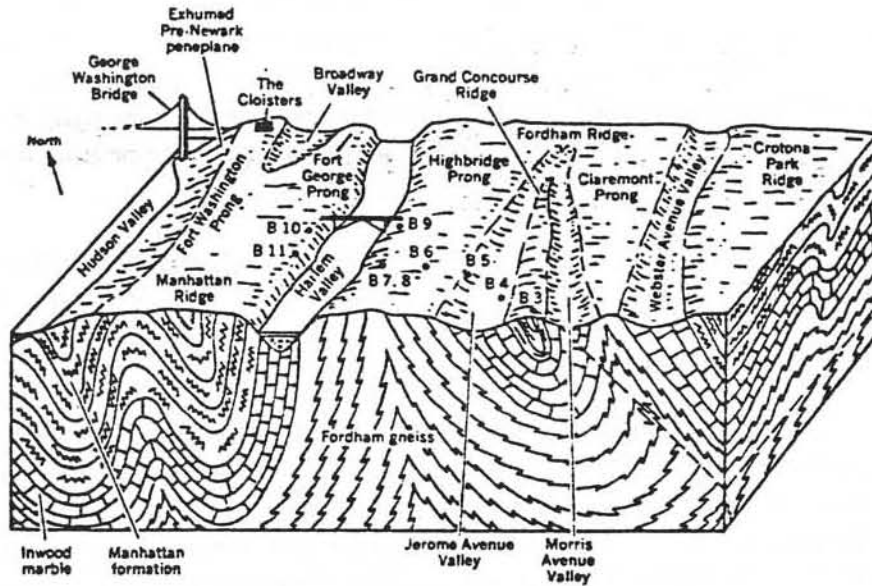
The threatened destruction of the Palisades' cliffs for commercial purposes stimulated the creation of the Palisades Interstate Park. The wildness and beauty of those cliffs remained largely unchanged into the early decades of the nineteenth century, when some lumbering and rock quarrying began to take place. After the Civil War, however, stone quarries multiplied rapidly, especially at the end of the century when the demand for aggregate stone for use in concrete for construction purposes became heavy.

During the 1890's, concerned citizens along its nearly 40-mile extent in New York and New Jersey realized that only action by the two states could save the Palisades. In New Jersey, the State Federation of Woman Clubs secured the passage of a bill in 1899, which the governor signed, authorizing the creation of a commission to study how the Palisades could be saved. New York created a similar commission which Governor Theodore Roosevelt gladly backed. For about a year the two commissions met and discussed the situation, finally deciding that an Interstate Park Commission should be created with the power to purchase land in each state for a park from Fort Lee, New Jersey, to Piermont, New York. Thus the Interstate Park Commission was born - a unique cooperative movement by two states to preserve a scenic and natural resource. Today, the Palisades Parks Commission, a single commission formed by a compact between New York and New Jersey in 1937, administers a park that serves the nation's largest metropolitan area. Despite its size, stretching north intermittently for nearly 50 miles along the west bank of the Hudson to Storm King Mountain, and variety of attractions, the nucleus of the park is the original 14-mile stretch of the Palisades between Fort Lee and Piermont.

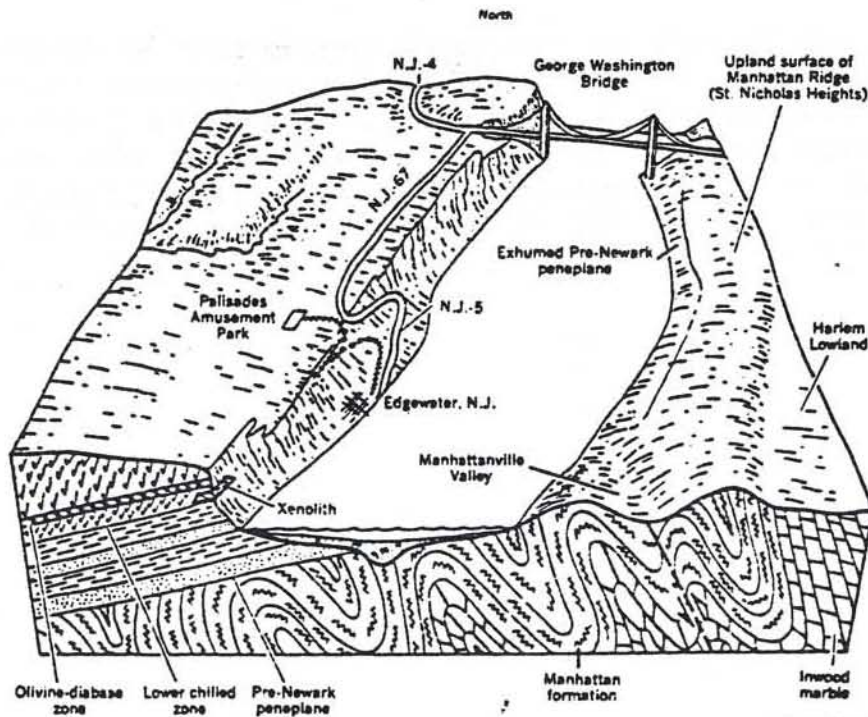
Near the northern tip of Manhattan Island is the second most extensive green belt in New York County composed of Fort Tryon and Inwood Hill parks; actually, it is the northern terminus of the discontinuous Riverside Park - Fort Washington Park system, providing green areas along nearly half of Manhattan's Hudson River shore. The Cloisters, at the northern end of Fort Tryon Park, is a monastery-like museum containing medieval art from Romanesque to late Gothic periods which includes parts of five medieval Cloisters and a 12th Century Chapter House. The Tapestries and manuscripts rank with world's greatest treasures.

The Manhattan Formation, composed primarily of a variety of schists but containing some gneiss, schistose gneiss, amphibolite and calcsilicates, is the dominant rock unit on Manhattan Island, its type locality. It lies unconformably on the Cambrian-Ordovician Inwood Marble which is composed of a number of rock types including calcite marble, dolomite marble, calc-schist, granulite and quartzite. The Inwood, in turn, may grade downward into patchy Early Cambrian Lowerre Quartzite which is not present everywhere below the marble. Differential erosion of the more soluble portions of the Inwood, which crops out on the back side of Inwood Hill Park (Type Locality), has resulted in the low area east of the park and, in part, the valley along

Block diagram showing the general topography and subsurface geology between the Hudson Valley, Crotona Park Ridge, and 165th Street to the south and The Cloisters of the Metropolitan Museum of Art and Burnside Avenue to the north.



Block diagram of the Lower Hudson Valley near Edgewater, New Jersey. (Adapted from a diagram produced by the Geology Department of The City College of The City University of New York)



Block diagrams of the Lower Hudson Valley showing topography and general geology in the vicinity of the George Washington Bridge. After Christopher J. Schuberth, *The Geology of New York and Environs*, Natural History Press, 1968.

which Dyckman Street runs. In Bronx County, north of Spuyten Duyvil, the Inwood and Lowerre formations crop out along the waterfront north to Yonkers in a belt only a few hundred feet wide. The higher elevations expose the Fordham Gneiss, a mixed sequence of metamorphic rocks with gneissic types predominating, of Precambrian age. The Inwood and Lowerre formations rest unconformably on the Fordham.

The Palisades Diabase continues to dominate the New Jersey waterfront with impressive vertical cliffs towering 350 feet above river level. The underlying Stockton Formation is largely obscured by talus and vegetation.

Half a mile south of the George Washington Bridge at the former Burdett ferry crossing (site of General Nathaniel Greene's headquarters) there is an obvious dislocation of the Palisades. On the north, the rock was nearly at the river's edge while southward it is some 1,500 to 2,000 feet inland. This is the result of displacement along an essentially north-trending strike-slip fault that occurs at this locality. Similar offsets occur along other faults at the West Shore Railroad Terminal near Donnelly Memorial Park and Lincoln Tunnel near King's Bluff (Map 2).

Spuyten Duyvil, at the northern end of the Harlem River, is known for its treacherous currents and eddies set up by frequent reversal of water flow because of the tides and narrow channel with rapid descent into the depths of the Hudson. The name stuck after a Dutch colonial swam across to warn inhabitants to the south of an impending Indian attack "in spite of the Devil".

MAPS 5 AND 6

Beginning at the Lincoln Tunnel crossing (Map 2) and continuing to the Tappan Zee (Maps 7E and 7W), the Hudson River flows in a straight course slightly to the west of south and maintains an average width of approximately one mile.

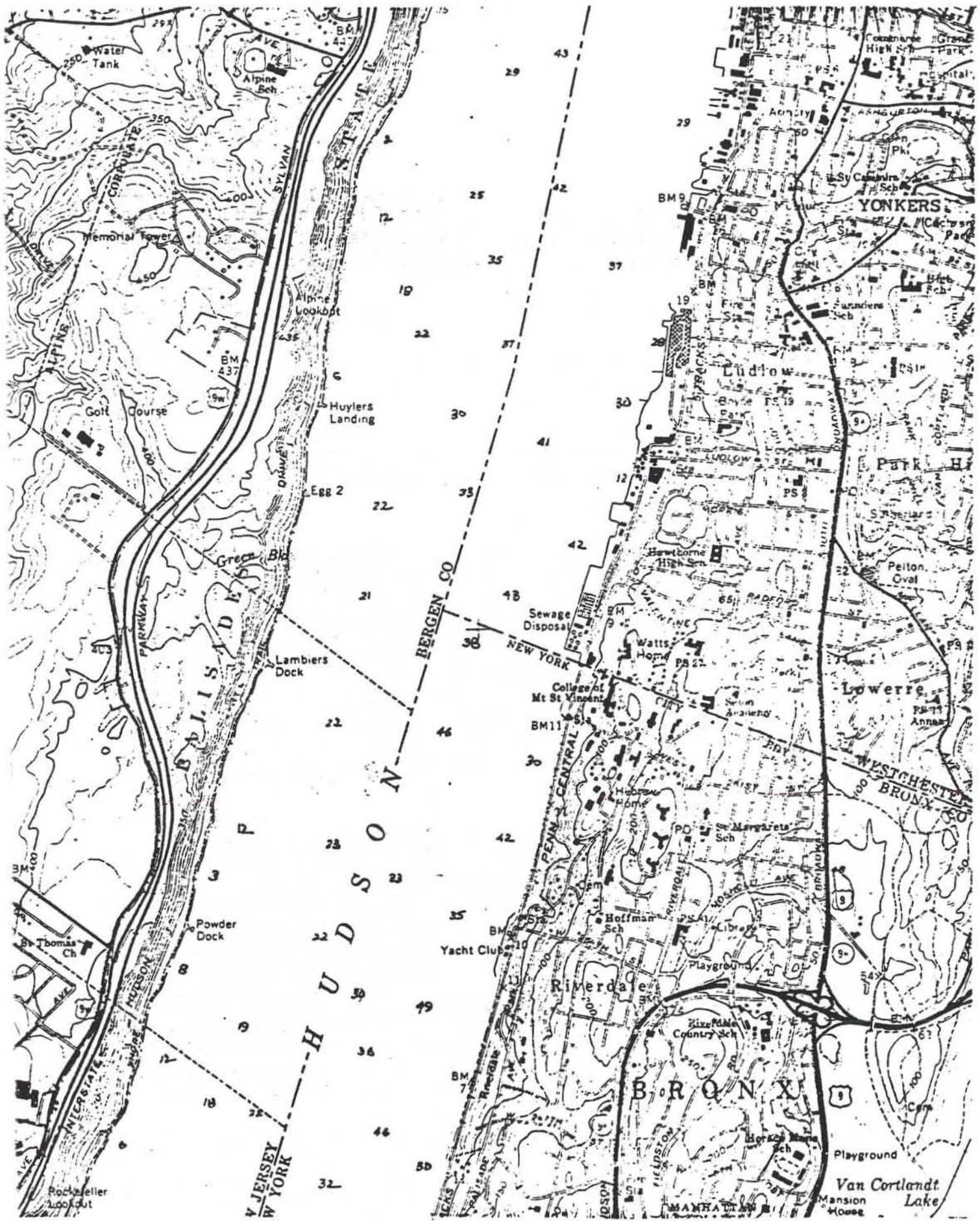
Visible on the New York side as we leave the area of Map 4 is the Riverdale section of Bronx County. Riverdale was formerly a low-density, high-income suburb but it has now changed to high-density residential use with high-rise, high-rent apartments capturing river views. Near the Bronx-Westchester border is the College of Mt. St. Vincent. As we proceed north, there are many large estates on which present taxes are prohibitive that have been converted to institutional use by religious and educational non-taxable organizations.

From the Westchester County line for nearly 3.5 miles lies the city of Yonkers (204,370)*, the fourth largest city in New York State. Yonkers was once the site of an Indian village called Nappeckamack meaning "town of swift water" from the now-called Nepperhan River which joins the Hudson at this locality. The Dutch West India Company bought it from the Indians in 1638. It was, in turn, sold to Adriaen Van der Donck (1) who built a mill where the Nepperhan River joined the Hudson. Van der Donck was known as "Dejonkheer" or young gentleman and, in time, the name of his estate changed from "The Yonkeheers Land" to "Yonkers", and, finally, to Yonkers.

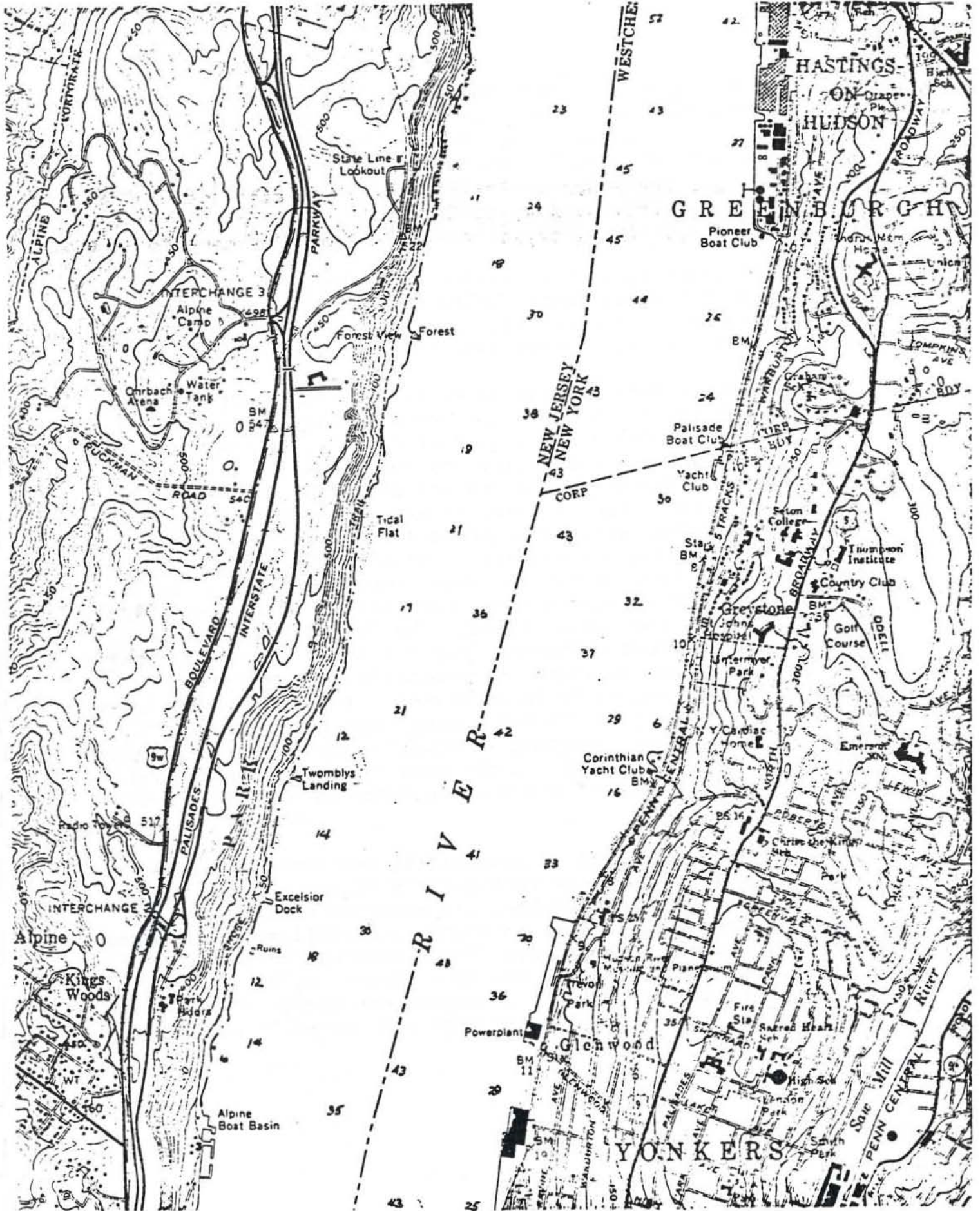
In 1672, the land around and including Yonkers became the property of the Philipsburgh family. The Philipse manor house is located in Yonkers and is designated a New York State Historic Site. The mansion served as the social and administrative center of the great manor of Philipsburg, created under English rule in 1693. The manor extended more than 20 miles along the east side of the Hudson, from Spuyten Duyvil northward to the Croton River (Map 10E), embracing some 156,000 acres, with Frederick Philipse as its First Lord. The Philipse domain became an important unit in the political and social development of provincial New York and, at the time of his death, the First Lord was recognized as one of the colonies' most influential citizens. His grandson,

(1) Van der Donck was the first lawyer in New Netherlands.

* Figures in parentheses after cities or towns throughout the guidebook indicate population according to the 1970 census.



MAP 5



MAP 6

Frederick Philipse II, inherited the manor and maintained the family's role of leadership in the colony. Frederick III remained loyal to the Crown when the colonies declared their independence and, in 1776, he was arrested on orders of General Washington and the Manor of Philipsburg was confiscated. When Philipse and his family fled to England, a colorful and significant chapter in the story of colonial America came to an end.

In the years after the Revolutionary War, the mansion passed through several hands coming into possession of the Village of Yonkers in 1868 for use as the Village Hall and later the City Hall. It was turned over to the state in 1908.

Yonkers was incorporated on April 12, 1855. It took in an area of two miles north-south and one mile east-west. In 1872, it became a city with a population of 20,000. It now covers an area of 21 square miles of hilly and rolling land. From its earliest times, Yonkers was a trading and shipping post. A hat factory was established in 1840, an elevator manufacturing plant (Otis) in 1854 and, later, a sugar refinery which is located on the river to receive raw materials and distribute the finished products. There are, of course, many other industries. Land use is characteristic of Hudson River communities, with the railroad running close to the Hudson shore. The tendency has been for the entire waterfront to become industrial and commercial, taking advantage of access to water transportation in the first half of the 19th century and to railroad sidings in the second half. The building of a marina in the last decade and other waterfront development suggest increasing interest in converting the shoreline to non-industrial use. It has been suggested that Trevor Park at the north edge of the city be extended into the river with sanitary fill.

Among Yonkers points of interest is the Hudson River Museum which includes paintings of such artists of the Hudson River School as Bierstadt and Coleman. It also has many documents associated with famous names in history, as well as old costumes, firearms and other antiquities. The museum was originally built in 1876 by John B. Trevor, a New York financier, for a summer home, but it later became his permanent residence. It was purchased by the city of Yonkers in 1924 and turned into a museum and park.

Hastings-on-Hudson (9,479), supposedly named for Hastings, England, is a characteristic Hudson River town which was settled in 1650 and incorporated in 1879. At one time it was a part of Philipse Manor. The general growth of the community coincided with the opening of the Hudson River Railroad. Today the town is an intensely developed commuter suburb with manufacturing and low-income residences along the waterfront. Hastings-on-Hudson has one of the very few deep water facilities along this stretch of the river.

Between Yonkers and Hastings-on-Hudson along U.S. Route 9 is the Boyce Thompson Institute where biologists are engaged in a wide variety of plant research, including projects on plants in the river and adjoining marshlands.

The land adjoining the Hudson River on the west side in New Jersey lies within Palisades Interstate Park; hence, there is no development save for an occasional old dock or landing and one or two boat basins.

The rock along the west shore continues to be the Palisades Diabase underlain by the Stockton Formation as depicted on the Geologic Map of the Lower Hudson by Leo M. Hall that precedes Map 1. On the east shore, The Inwood Marble and Lowerre Quartzite, first encountered in the Inwood Hill Park and Spuyten Duyvil areas, continue to underlie the area immediately adjacent to the river to approximately the northern limits of Yonkers. The belt of outcrop is perhaps no more than a few hundred feet wide. East of and lying unconformably below the Inwood-Lowerre sequence is an extensive belt of Precambrian Fordham Gneiss, a mixed series of metamorphic rocks with gneissic types predominating. From Yonkers north nearly to Hastings-on Hudson, only the Fordham Gneiss is exposed along the shore but beginning just south of Hastings, the Inwood Marble-Lowerre Quartzite sequence again makes an appearance along the waterfront. The marble was quarried in the Hastings-on-Hudson area many years ago. Today the abandoned quarries, none very large, are residential sites or are overgrown and generally obscured from view.

MAPS 7E AND 7W

The New Jersey-New York boundary, delineated by agreement in 1650, lies just inside the northern margin of these maps and, from this point on, the trip takes place entirely in New York State waters.

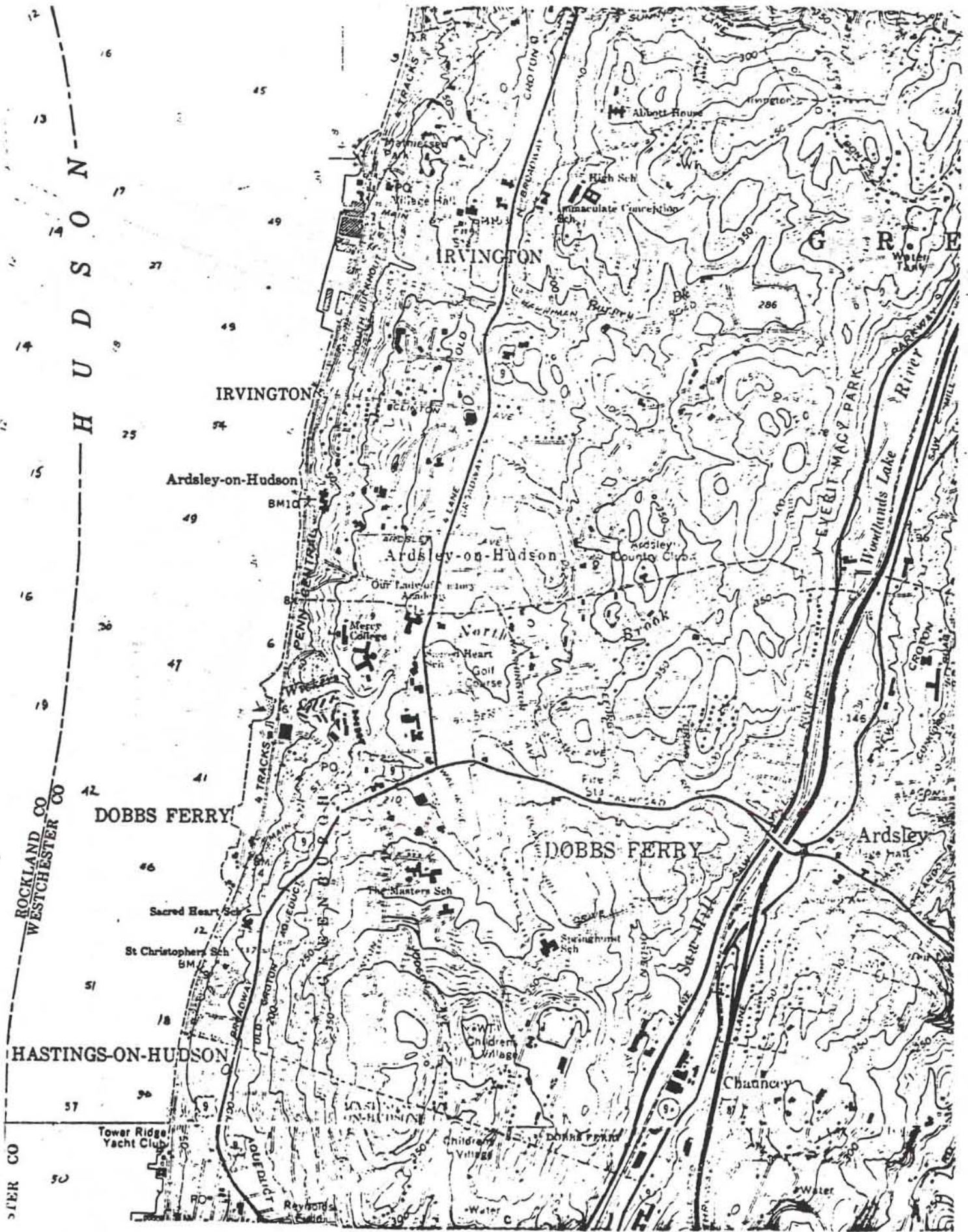
North of Hastings-on-Hudson on the eastern shore is the village of Dobbs Ferry (10,353), a residential suburb named after Jeremiah Dobbs, an old Swedish ferryman who carried passengers across the Hudson to the foot of the Palisades at what is now known as Sneden's Landing. He made his first ferry in 1698 by hollowing out a log. In the years that followed, his family developed more sophisticated ferries and operated the business for more than 100 years.

The British were stationed at Dobbs Ferry in 1776 and withdrew shortly thereafter. In 1777, a division of the American Revolutionary Army under the command of General Lincoln was encamped there for several months. In 1870, Dobbs Ferry was one of those places where General Benedict Arnold, recently appointed commander of West Point, supposedly met with Major John Andre, Adjutant General of the British Army, to plan the British take over of West Point. After a later meeting in Haverstraw (Map 10W), Andre was captured near Tarrytown attempting to reach the sloop H.M.S. Venture anchored off Teller's Point at the south end of Croton Point (Map 10E) and all the incriminating documents seized. He was imprisoned in a tavern in Tappan and tried and sentenced in the Dutch Reformed Church. He was hanged there on October 2, 1780, at the age of 29.

One and a half miles north of Dobbs Ferry is the village of Irvington (5,878) which was settled in 1650 but known as Dearman until the middle of the 19th century. It was renamed for Washington Irving who bought ten acres of "Wolferts Roost" in the extreme northern portion of present-day Irvington (top-most portion Map 7E) which he named "Sunnyside". His home has been restored to the era he lived there and is open to the public. Irving wrote with the flavor of the Dutch Hudson - of Brom Bones clattering up and down the back roads of the valley. His imagination was responsible for such classics as "Rip Van Winkle", "The Legend of Sleepy Hollow", "The Devil and Tom Walker" and many others. He often wrote under a pseudonym such as Diedrich Knickerbocker.



MAP 7W



MAP 7E

Beginning in the 1850's, Irvington became a showplace of costly and magnificent estates. Among the more famous residents of the village were Charles Tiffany, founder of the famous jewelry firm; George D. Morgan, founder of the House of Morgan and uncle to J.P. Morgan, also an Irvington resident; and James Hamilton, son of Alexander Hamilton. In the latter part of the 19th Century, Irvington ranked first in the country in per capita wealth.

There are several industries in Irvington, including manufacturers of heating equipment, greenhouses and fabrics. Despite these industries, about seventy-five percent of the residents commute to New York City.

Less than half a mile north of the New Jersey-New York boundary in Rockland County, New York, is the Lamont-Doherty Geological Observatory. Located on top of the cliffs of the Palisades sill overlooking the west bank of the Hudson some fifteen miles north of New York City, it has a commanding view of the river. The 150-acre estate on which it is located was originally the home of the famous botanist, John Torrey, and, in 1928, the property was acquired by financier Thomas W. Lamont. After Thomas Lamont's death, the estate was given to Columbia University which designated it for use as a research center in the earth sciences in 1949. Mrs. Lamont resided there after her husband's death and, at the time of her death in 1953, all but 23 acres of adjoining cliff and woodland to the south were turned over to the university. The 23 acres were willed to her two sons with the wish that the tract of land be preserved in its natural beauty and, to this end, Corliss Lamont, eldest of her sons, arranged for the American Humanist Association to become the official custodian of the Lamont Nature Sanctuary in 1963.

The countryside and the Hudson River in the neighborhood of the Observatory and this sanctuary are rich in Revolutionary history and lore, for this part of the Hudson Valley played a strategic role in the maneuvering of both the American and British forces. Three miles to the northwest is the village of Tappan (7,424) where General Washington briefly made his headquarters and where Major John Andre, the British spy, was executed. Seven miles to the south at Alpine, New Jersey, is the place where Cornwallis' 6,000 troops scaled the Palisades in November, 1776, to capture Fort Lee.

As mentioned earlier, in 1698 a ferry began to operate from Dobbs Ferry to the west side where the hamlet of Palisades is now situated. From the high points on the cliff, one can clearly trace the route of the old ferry, discontinued in 1938 after a career of 240 years. Its western terminal eventually became known as Sneden's Landing because the Sneden family lived there for more than 100 years, owned ferry boats and operated them. The most celebrated ferry captain (or ferry mistress as she was known) was Mollie Sneden, a robust and colorful character reputed to be a dead shot. She died in 1810 at the age of 101. It is said that Mollie Sneden ferried Martha Washington across the Hudson in the fall of 1775 on her way from Mount Vernon to join George Washington at Cambridge, Massachusetts.

On July 18, 1781, General Washington crossed to the western shore from Dobbs Ferry with Count de Rochambeau, who was in command of the French army in America, enroute to Fort Lee for the purpose of reconnoitering the British positions in New York City. At that time, he was still considering a plan to attack and capture the city. At a later date, Washington also met with Rochambeau at the Livingston Manor house in Dobbs Ferry to plan the Yorktown campaign which resulted in the surrender of Cornwallis and the end of the war.

American troops were stationed at a fortified military post called the Citadel on the high ground above Sneden's Landing. A sturdy stone blockhouse was added in 1870 by order of General Washington after General Anthony Wayne sent him a favorable report concerning the terrain. In September, 1870, General Nathaniel Greene reported to Washington about the completion of the blockhouse and described it as "a very strong place. On two occasions some 150 Revolutionary soldiers repulsed savage attacks by the British. The American garrison obtained water from a nearby spring which came to be called "Washington's Spring" and the official name of the winding road to Sneden's Landing to this day is Washington Spring Road.

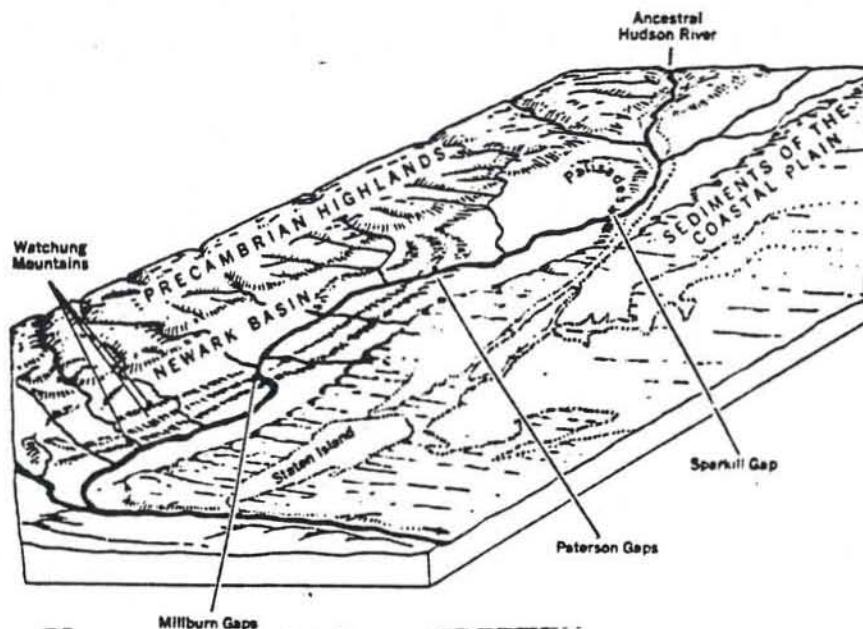
In 1821, the two sisters of Major John Andre came ashore from an English Man-of-War anchored off Sneden's Landing. They went to Tappan where they recovered the remains of their brother and took them back to England where they were placed in Westminster Abbey with an elaborate mural plaque. Andre is one of the most lamented spies in military annals.

North of Sneden's Landing is a section of the Palisades Interstate Park known as Tallman Mountain State Park, a scenic portion of the Palisades bounded by an arm of the Hudson in the valley of Sparkill Creek on the north, the decaying Piermont Pier

on the northeast and marshlands along the Hudson River shore on the east.

Only a brief glimpse of the drowned portion of the lower reach of Sparkill Creek between Tallman Mountain and Piermont Pier on the west side of the river is afforded but with a quick glance one can see the Sparkill Gap presumed to have been cut by the ancestral Hudson River on its way to the sea in Tertiary time. The evolution of the Hudson from the beginning of the Tertiary Period is poorly known but it was postulated by Douglas W. Johnson (Stream Sculpture on the Atlantic Slope, Columbia University Press, 1931) that the course of the Hudson during this time took it over a cover of Coastal Plain sediments and that it veered southwestward near the northern end of the Palisades through what is now Sparkill Gap eventually to join the Raritan River and enter the Atlantic Ocean of that time through what is now Raritan Bay south of Staten Island. With only slow and gradual uplift to contend with, the river managed to cut through the Cretaceous cover down into the Devonian and Silurian rocks north of the Hudson Highlands and the resistant rocks of the Highlands, the intrusive diabase of the Palisades and the basaltic ridges in the New Jersey lowlands. It seems possible that a smaller consequent stream slowly lengthened its course northward from present day New York City along the soft shales of the Stockton Formation and when this stream intercepted the ancestral Hudson at Sparkill, it captured the Hudson and diverted its waters to the present course (see diagram below).

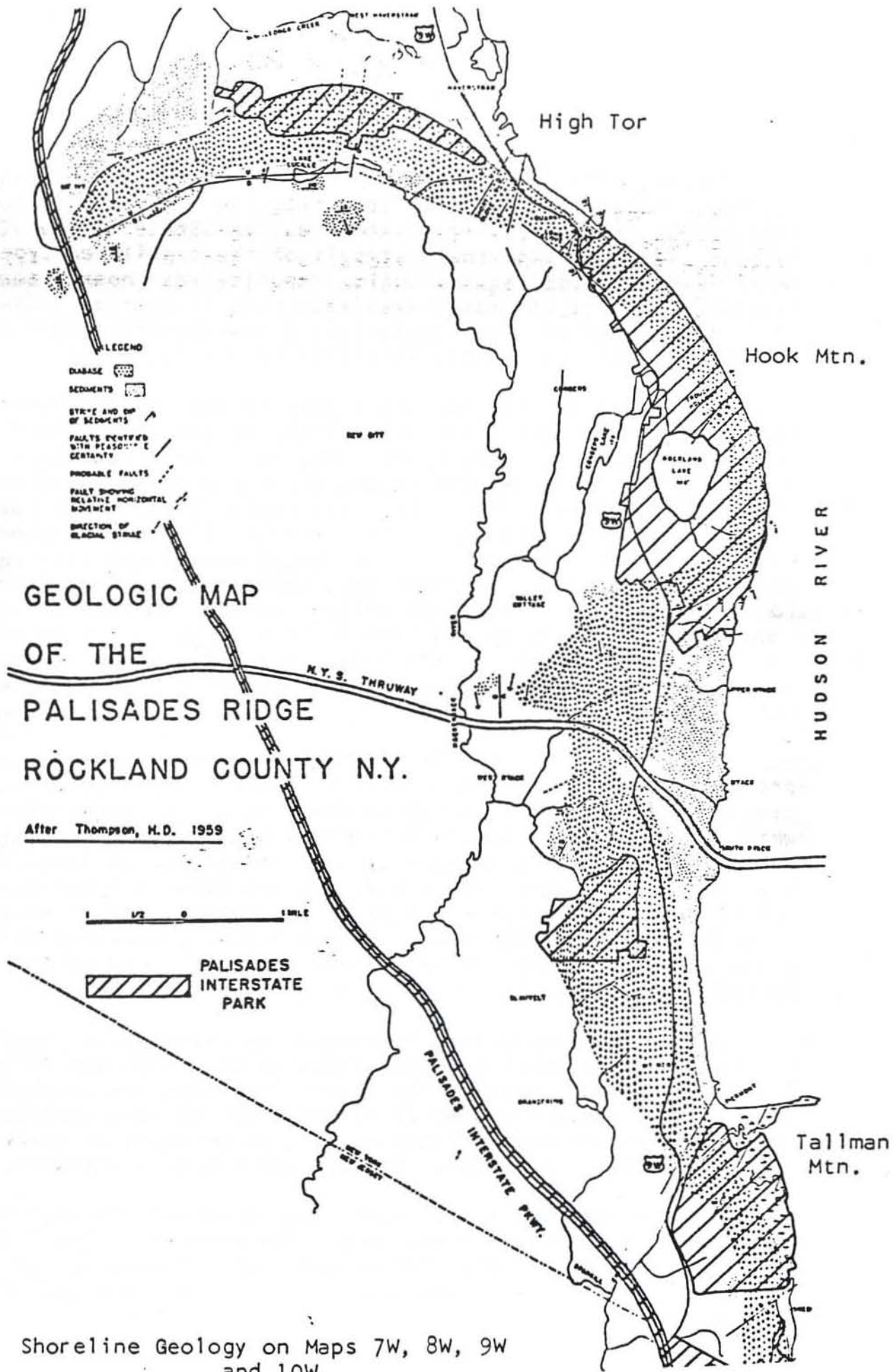
Block diagram showing the possible course of the ancestral Hudson River over the unconsolidated sediments of the Coastal Plain and across the newly emerging Watchung and Palisades ridges. By continually eroding downward, the streams removed the Coastal Plain sediments and encountered the ridges of tougher rock. The passes through the resistant rock are called water gaps. Most of the Coastal Plain sediments that covered Staten Island, Manhattan, and so on at that time, perhaps about thirty or so million years ago, have since been removed by continual erosion. (Adapted from D. W. Johnson, op. cit.)



Rockland County historians say that Henry Hudson made his first landing in the Hudson River at the site of Piermont Pier on September 15, 1609. Piermont (2,386) takes its name from the one-mile long pier constructed in 1835 by the Erie Railroad as the eastern terminus of its line from Lake Erie to New York City. It was developed because the railroad, cut off from access to the Hudson River shore to the south by the steep cliffs of the Palisades, used the Sparkill Gap to get to the waterfront and from here passengers and freight were shipped to New York City by boat. Use of the pier was discontinued when the Erie Railroad tunneled through the Palisades near the western end of the Holland Tunnel (Map 1). It was later acquired by the Continental Can Company but not developed and today it lies in a state of decay. It is a potential addition to the Tallman Mountain State Park.

On May 7, 1783, General Washington was rowed out from Piermont to a British warship lying off Sneden's Landing to confer with Sir Guy Carleton on the British evacuation of New York City. The English gave a 17-gun salute to the American flag flown by Washington's boat. This was the first British salute to the flag of the United States.

The geology is identical to that discussed with Map 6. The Inwood Marble-Lowerre Quartzite crop along the shore from the river bank half a mile inland to U.S. Route 9; east of Route 9, the Fordham Gneiss is exposed. The Palisades Diabase forms the conspicuous cliffs on the west underlain by the Triassic Stockton Formation. Though not visible from the river, on the backslope of the Palisades north of Piermont are many abandoned "brown-stone" quarries in the lower portion of the Brunswick Formation which provided building stone more than 60 years ago.



Shoreline Geology on Maps 7W, 8W, 9W and 10W.

MAPS 8E AND 8W

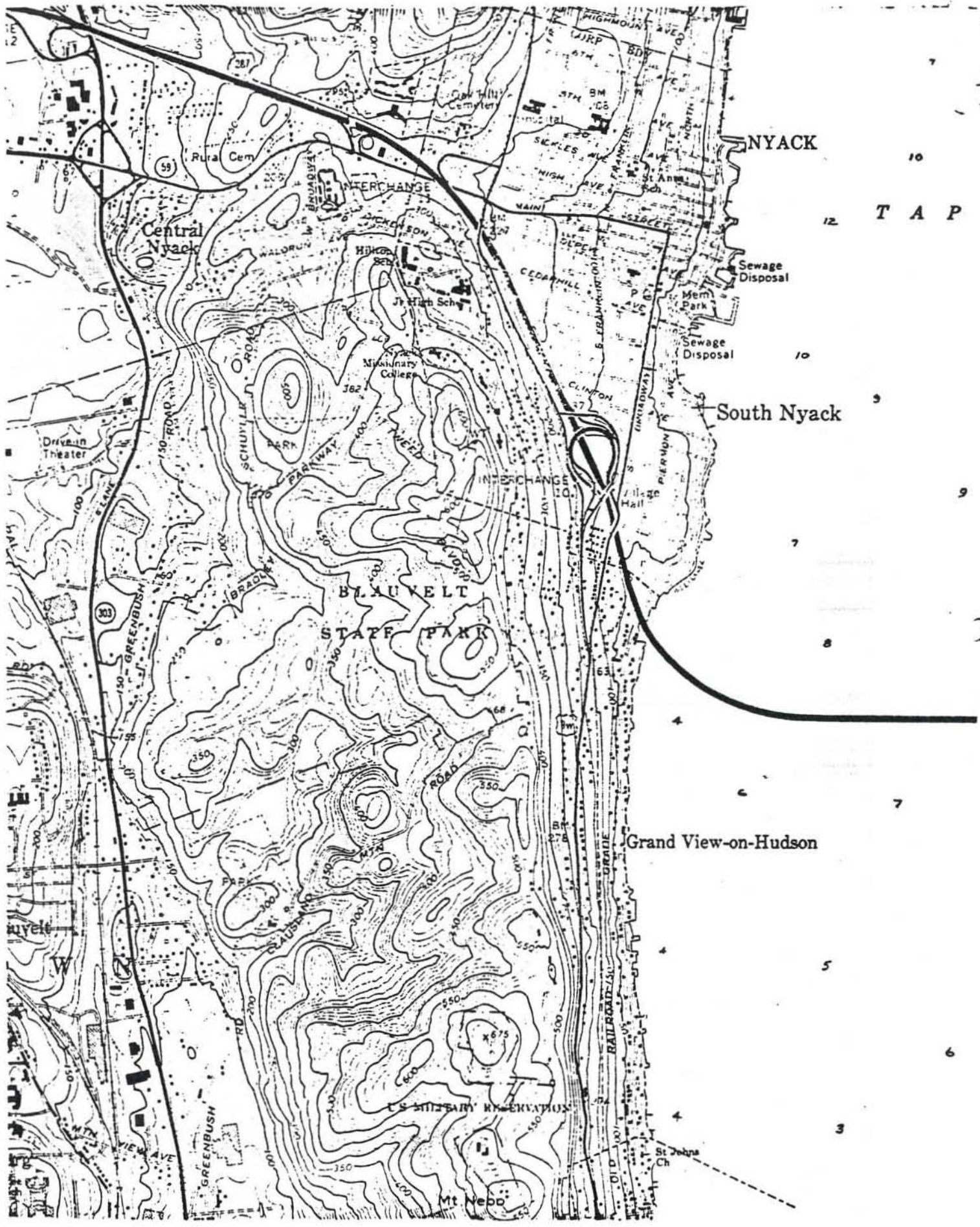
Although in view for some time, the most obvious features on these maps are the Tappan Zee Bridge and the Tappan Zee itself. The bridge, the river link of the New York State Thruway (I-287) between Tarrytown and the Nyacks, is of the cantilever type and cost 60 million dollars to build. The site was chosen because of the shallow water in this area (less than 25 feet over 85% of the crossing) which undoubtedly was an overwhelming consideration in construction costs considering its four-mile length.

The Tappan Zee is the widest part of the Hudson River, extending north nearly nine miles from the Irvington-Piermont Pier area almost to Stony Point (Map 11W), the widest part measuring 3.2 miles between Croton-on Hudson and Haverstraw (Maps 10E and 10W). The Tappan Zee, named by the Dutch for Tappan (Indian name meaning "cold springs"), was the legendary abode of ghosts and goblins. The legend best known is of Rombout Van Dam who rowed up the river from Spuyten Duyvil one Saturday to attend a party in Rockland Hills. He started back on Sunday though he was warned by his friends that it was a sin to row on the Sabbath. He never arrived home and the story has it that he was doomed to row forever. If you listen carefully, you can hear the swish of his oars.

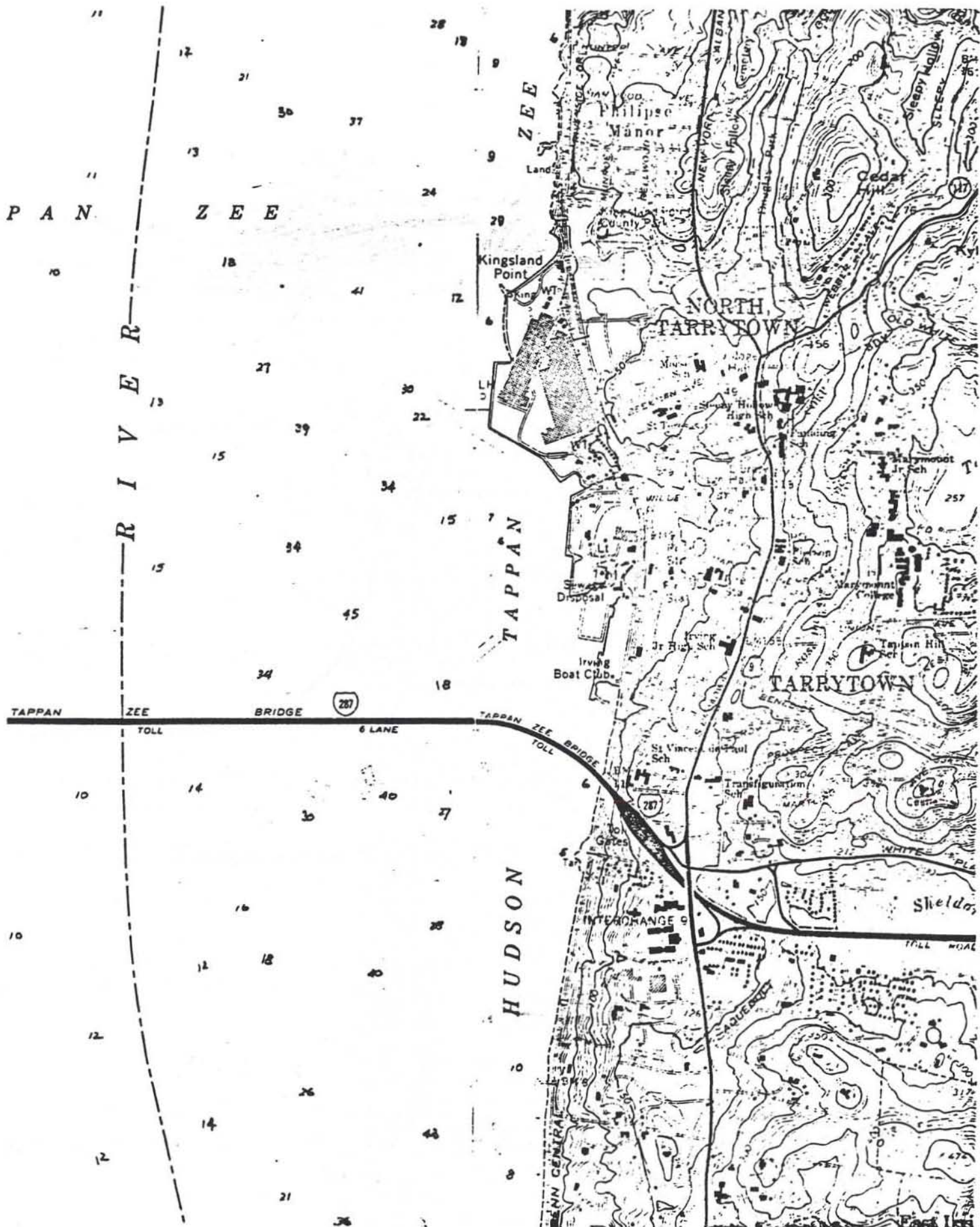
Tarrytown and North Tarrytown (9,449 combined) are the principal urban centers on the eastern shore. Tarrytown was the site of an Indian village called Alipconk or "place of the elms" which was burned out by the Dutch in 1644. Later a trading post was established there because of its convenience in landing a boat between New York City and Albany and after the Revolutionary War it became an active river port. The opening of the Hudson River Railroad in 1849 marked its decline as a port for farm produce from the interior of eastern New York could be transported to New York City much faster by rail.

During the Revolution, Tarrytown was essentially "neutral ground", lying between American lines to the north and British lines to the south most of the time. The residents of this area were without the protection of either army and were subject to theft, vandalism and sometimes killing as a result of guerilla warfare between the Colonial Cowboys and the Tory Skinners.

On September 23, 1870, Major John Andre was captured in Tarrytown. A monument to his memory was erected in 1853 with an inscription that reads: "Andre was captured here by John Paulding, David Williams and Isaac Van Wert, all natives of this county".



MAP 8W



MAP 8E

Tarrytown gained recognition as a distinguished residential community in the early 1800's. One of the earliest mansions to overlook the Hudson from this locality was built by General William Paulding in 1838. Now known as Lyndhurst, it was designed in 19th Century Gothic Revival style by Alexander Jackson Davis, one of America's most influential architects of the time. The mansion was enlarged by its second owner, George Merritt, in the same style and later acquired by Jay Gould. It was the home of the Gould family from 1880 to 1964. The mansion is now open to the public.

The Philipsburgh Manor House, also known as Upper Mills to distinguish it from Philipse Manor in Yonkers, is also located in Tarrytown and open to the public. The manor appears as it did in the early 1700's when it was an important grist mill-trading center complex. Its principal structures are its two-story manor house dating to the 1680's and outfitted with period furnishings; operational water-powered grist mill; 200-foot long wooden dam and huge Hudson Valley barn with farm implements. It was built by Frederick Philipse, one of the richest men in the Province of New York. He started as a carpenter for Governor Peter Stuyvesant and accumulated through hard work and a good marriage sufficient wealth so that within 20 years he owned one-third of what is now Westchester County. In 1693, his landholdings were elevated to "Mannour of Philipseborough" by the English Crown. The house itself was unchanged until 1720 for it never was a major residence of the Philipse family but, rather, served as a fort if the need for defense should arise. Frederick I left the house to his son, Adolph, who duplicated the plans and doubled its size. In 1750, upon Adolph's death, his nephew, Frederick II, inherited the estate. Frederick II was appointed supreme court justice of the colony and was one of the three judges officiating at the Peter Zender trial, a landmark in the American concept of freedom of the press. When Frederick II died only a year later, the lands were passed on to Frederick III, the eldest son and, as with the land in Yonkers, he lost the manor following the Revolutionary War because of his Tory sympathies on orders from General Washington.

In North Tarrytown is the old Dutch Church of Sleepy Hollow, built in the closing years of the 17th Century by Frederick Philipse. The building is still in good condition and is occasionally used for special services. According to one source, the church was built for Catherine Van Cortlandt, second wife of Philipse.

By the latter part of the 19th Century, there were several manufacturers in the Tarrytown area. There was a brickyard utilizing Pleistocene clay from along the river, a small iron foundry, a boot and shoe factory, and the Tarrytown Pottery Works.

In the 20th Century, social and economic changes gradually altered the character of the community. The large estates were split up into single family residences and some of the old mansions were converted to business use. Zoning laws were changed to permit apartment houses and the building of the Tappan Zee Bridge sped up the growth rate, including the construction of several large hotels and conference sites at the Routes 9 and I-287 Interchange.

Principal industries in Tarrytown today include the General Motors Chevrolet assembly plant plainly visible on the waterfront, Continental Can, the General Foods Research Center, the Union Carbide Technical Center and the Olivetti Education Center.

Approximately two miles northeast of North Tarrytown are the Pocantico Hills, location of Vice President Nelson A. Rockefeller's estate.

On the west shore are the Nyacks with a combined population of 12,190. South Nyack and most of Nyack are shown on Map 8W whereas Upper Nyack is included on Map 9W. Nyack is less industrial than the towns on the east bank. It is a community of dense settlement where individual homes are slowly giving way to apartment-type dwellings. Nyack, the Indian word for "fishing place", was occupied by the Tappan Indians, an Algonkian tribe, as a summer settlement while they lived on fish and oysters. It is the site of the first European settlement in Rockland County. The first settler was Harmon Taelman (later anglicized to Tallman) whose family retained possession of the site until after the Revolutionary War. Taelman sold his property in 1799 for \$25 an acre. Nyack village was incorporated in 1872 but dissolved shortly thereafter over dissention regarding public improvements, and incorporated again with narrower limits in 1883.

There is little change in the geology from the earlier maps. The Inwood Marble-Lowerre Quartzite sequence ceases to crop out along the eastern shore at approximately the lower margin of the map giving way to the Fordham Gneiss. On the western side, the Palisades Diabase is still the most conspicuous rock type. However, beginning at the western end of the Tappan Zee Bridge, there

is a sag in the Palisades, because the sill intruded a higher part of the west-dipping Newark Series, causing the cliffs to be as much as a mile west of the Hudson River. It swings back to the River on Map 9W cutting across somewhat lower Newark strata. The lower area on which the Nyacks are located is underlain by the lower part of the Triassic Brunswick Formation composed of reddish-brown shales, mudstones and arkoses. The contact between the red shales and diabase is visible in many places.

MAPS 9E AND 9W

Exclusive housing on wooded rolling land characterizes the view between North Tarrytown and Ossining along the Hudson's eastern shore. On the north is the southern portion of the city of Ossining which continues on Map 10E. Ossining (21,659), originally a part of the Philipse tract, was first settled in 1750 and incorporated as a village in 1813 - the first village in Westchester County to be incorporated. The city's original name, Sing Sing, was derived from the Indians meaning "stone upon stone".

During the 19th Century, farm products were shipped to New York City from the village dock at Hunter's Landing. Boat building and river trade thrived until the railroad was opened in 1849. Printing and publishing was an important industry in the early part of that century. Today, manufacturers in Ossining produce machine tools, surgical equipment, specialty wires for aerospace and computer industries, office and school furniture, textiles, dresses and pleasure boats.

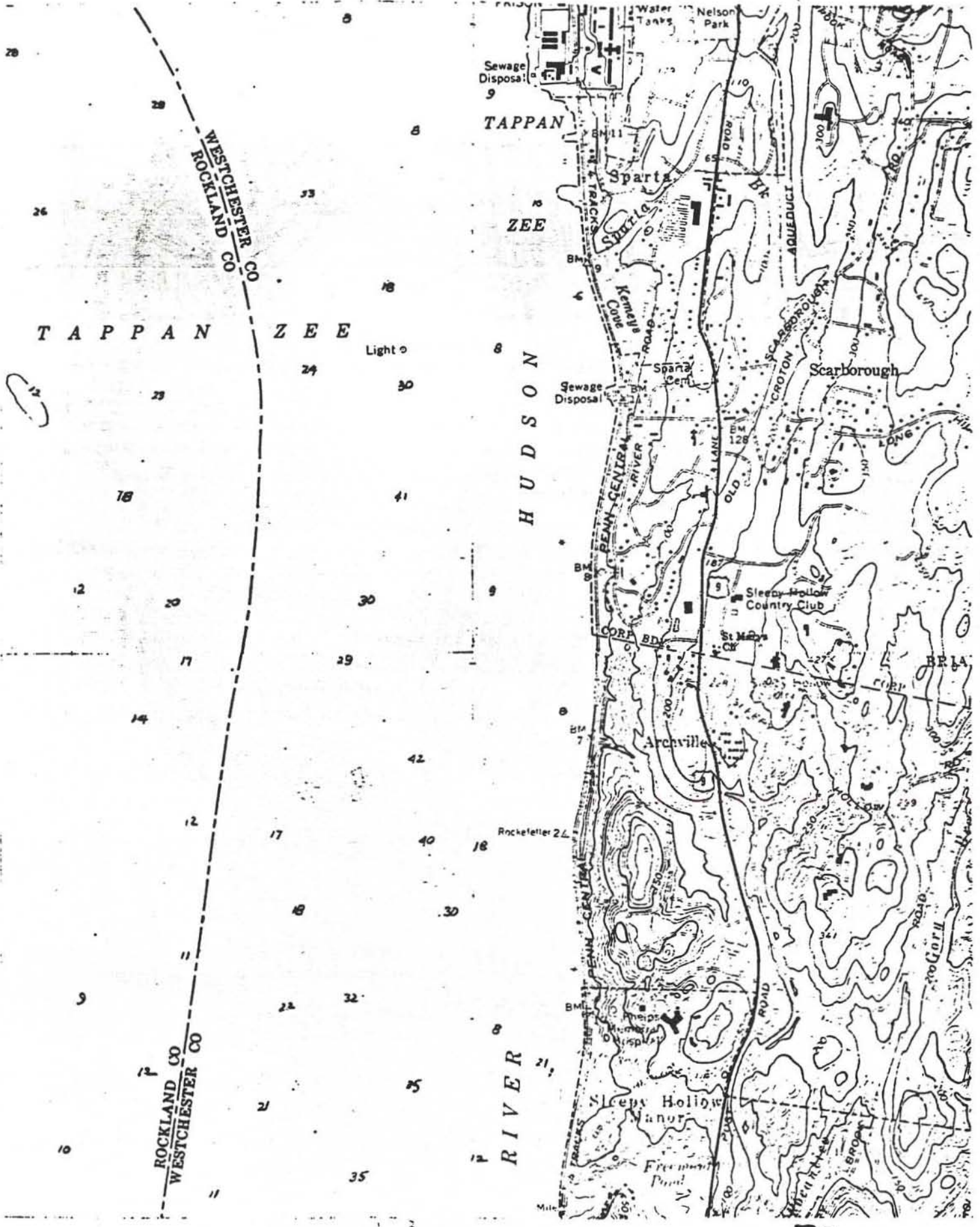
Shad fishing is an important industry in the Hudson River from this point north but the recent discovery of high levels of Pcb's (polychlorinated biphenyls) in the river and the fish has produced adverse consumer reaction. The situation should improve as the General Electric Corporation at Troy, New York, has agreed not to discharge this substance in the river as of this year.

The most distinguishing feature of the Ossining waterfront is the state penal institution commonly known as Sing Sing Prison. The institution was constructed by prison labor from the Inwood (Mt. Pleasant) Marble quarried locally in the 1820's. Sing Sing was the site of the State's electric chair but it has since been moved to Green Haven Prison in eastern Dutchess County. The prison was the place of detention for many of the notorious New York City mobsters of earlier days which led to the expression "sent up the river".

Otherwise, the community has many of the same characteristics as other urban areas along the river.



MAP 9W



MAP 9E

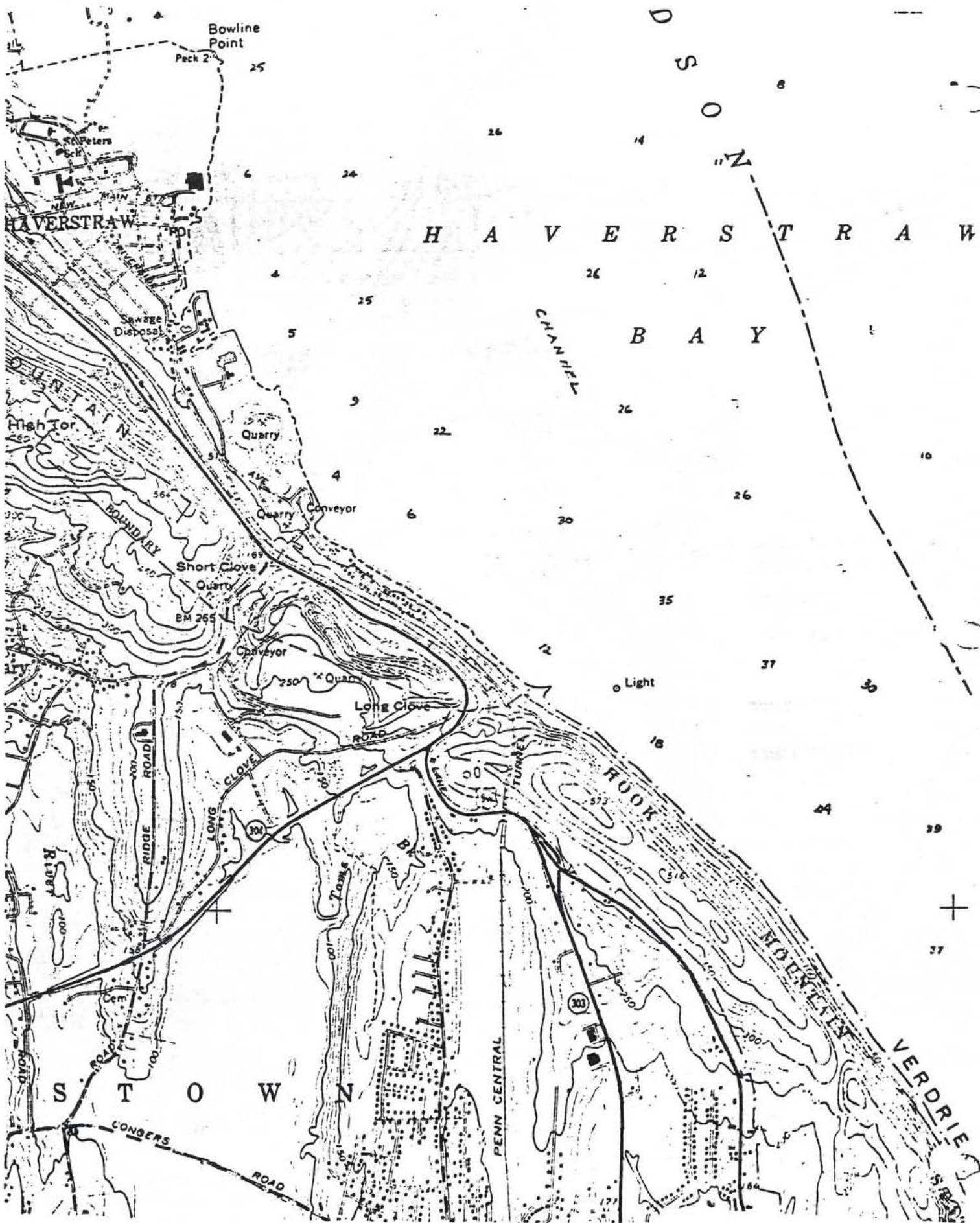
On the west shore, the Palisades Diabase swings back towards the river cutting across somewhat lower Newark strata to form Hook Mountain. Along the river front may be seen scars on Hook Mountain formed by quarrying at the turn of the century which threatened to destroy this fine crag. The efforts of various individuals and groups roused public opinion to the point where the operator agreed not to quarry the river face of the mass away, thus preserving the line of the Palisades. On the back slope of Hook Mountain is Rockland Lake, not visible from the river. In the mid-1800's, the Knickerbocker Ice Company cut more than 200,000 tons of ice each winter from this lake, primarily for the New York City market, and employed 1,000 men. Nyack Beach State Park, developed on a shelf at the base of a quarry scar below Rockland Lake, is a step in a series of public measures to save, preserve and develop the Palisades for public recreation.

The rock units cropping out along the waterfront on both sides of the river remain the same as on earlier maps. However, on the eastern shore the rocks composing the New York City Series, i.e., the Fordham Gneiss, Lowerre Quartzite, Inwood Marble and Manhattan Schist, strike approximately N. 45° E. rather than parallel to the river, causing repeated exposures of these units along the shore (see Geologic Map of New York, 1970). The Inwood Marble, as mentioned earlier, underlies most of the Ossining area. On the west, the Palisades reach a height of more than 620 feet.

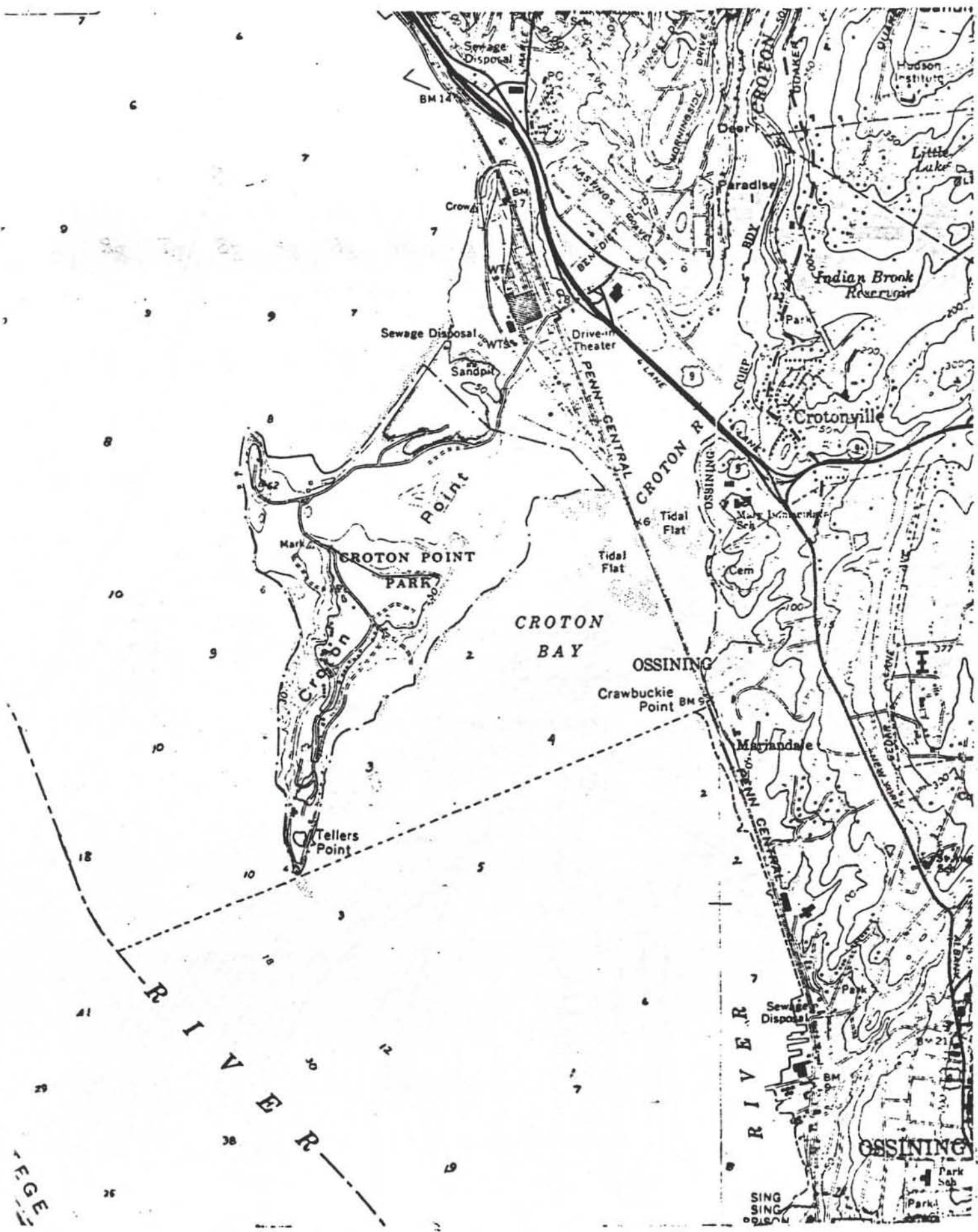
MAPS 10E AND 10W

The most obvious feature on the eastern shore is Croton Point, in part glacial moraine (higher elevations at its west-terminus) and part a delta built by the Croton River into glacial Lake Hudson, a higher stand of the Hudson River during Pleistocene deglaciation. From a scenic point of view, Croton Point is one of the choice sites along the river. Formerly the location of brickyards utilizing clay from the swampy area north of Croton Bay and of extensive vineyards for Hudson Valley wine, the mile-long promontory is now a Westchester County Park. A booklet prepared by the Croton Chamber of Commerce states that the Croton River was called the Kitchawan River by the Indians and that it emptied into the Shattemuc (Hudson or "river which flows two way") at Point Senasqua (Croton Point). Chief Croton, sachem of the Indians along th Kitchawan, lost his life defending the point from white enemies and, in 1671, the point was sold by the Indians to the whites for a barrel of rum and 12 blankets. The point was renamed Croton Point in honor of Chief Croton. The northern portion of the point, known as Potato Rock, was an Indian campsite as evidenced by the presence of oyster middens. Some of the best fishing in the Hudson is around Croton Point. The British sloop, H.M.S. Vulture, was anchored off Teller's Point to pick up Major John Andre with plans for the surrender of West Point.

The extensive tracks and repair yards of the former Penn-Central Railroad and now under various direction of Conrail, Amtrak and the MTA, lie between Croton Point and the residential sections of this area. On the bank of the Croton River east of the tracks and Route 9, lies the Van Cortlandt Manor House. The house, which is open to the public, was originally built as a fortress and refuge from Indians in 1655 and later converted into a residence and hunting lodge by Thomas Dongan, British governor of New York. In 1697, the Manor of Cortlandt was established, following the purchase of 21 miles of land east of the Hudson from the Croton River north to Anthony's Nose (Map 13). The house was occupied by descendents of Stephen Van Cortlandt until the death of Ann Stevenson Cortlandt in 1940; it reflects the way of life of a famous Hudson Valley family prominent in the 18th and 19th centuries. The Blackhorse Tavern, still standing on the south bank of the Croton River at the old ferry landing in Crotonville, was a popular resting place enroute from New York City to Albany.



MAP 10W



MAP 10E

Beyond the Van Cortlandt Manor House is the picturesque Croton River Gorge which was rescued a few years ago from real estate developers by concerned citizen action. In the distance to the northeast may be seen a portion of the New Croton Dam that retains the upper reaches of the Croton River to form the New Croton Reservoir. The dam, completed in 1905, is said to have been one of the greatest handhewn masonry construction projects of modern times, second only to the Pyramids.

On the west side of the river, the Palisades, until now a conspicuous and spectacular feature of the Lower Hudson scene, turns abruptly westward at Haverstraw. Hidden from view on the back side of the Palisades is a large quarry in the diabase located there in response to citizen's efforts to preserve the view from the river (see text Map 9W),

Haverstraw (8,198) is located at the foot of High Tor (827'), supposedly shaped like a Dutchman's hat and the locale of Maxwell Anderson's 1937 play entitled "High Tor" in which a man who loves the mountain as it is finds himself in conflict with big business that threatens to destroy it. Haverstraw, founded in 1666, is the site of the Treason House where General Arnold concluded his negotiations with Major Andre. Along the riverfront, just south of town, are a variety of storage areas and loading facilities associated with rock industries. There is an old sand and gravel quarry at the bank of the river and a conveyor belt carries crushed stone through Short Clove from the stone quarry on the back side of the Palisades for shipment downriver by barge.

The Fordham Gneiss, Lowerre Quartzite, Inwood Marble and Manhattan Schist continue to crop out here and there along the eastern bank. On the west, as mentioned earlier, the northern end of the Palisades hooks westward at Haverstraw not to be seen again as we journey northward. From Haverstraw north to Stony Point (Map 11W), sandstones, siltstones and mudstones of the Triassic Brunswick Formation form the bedrock.

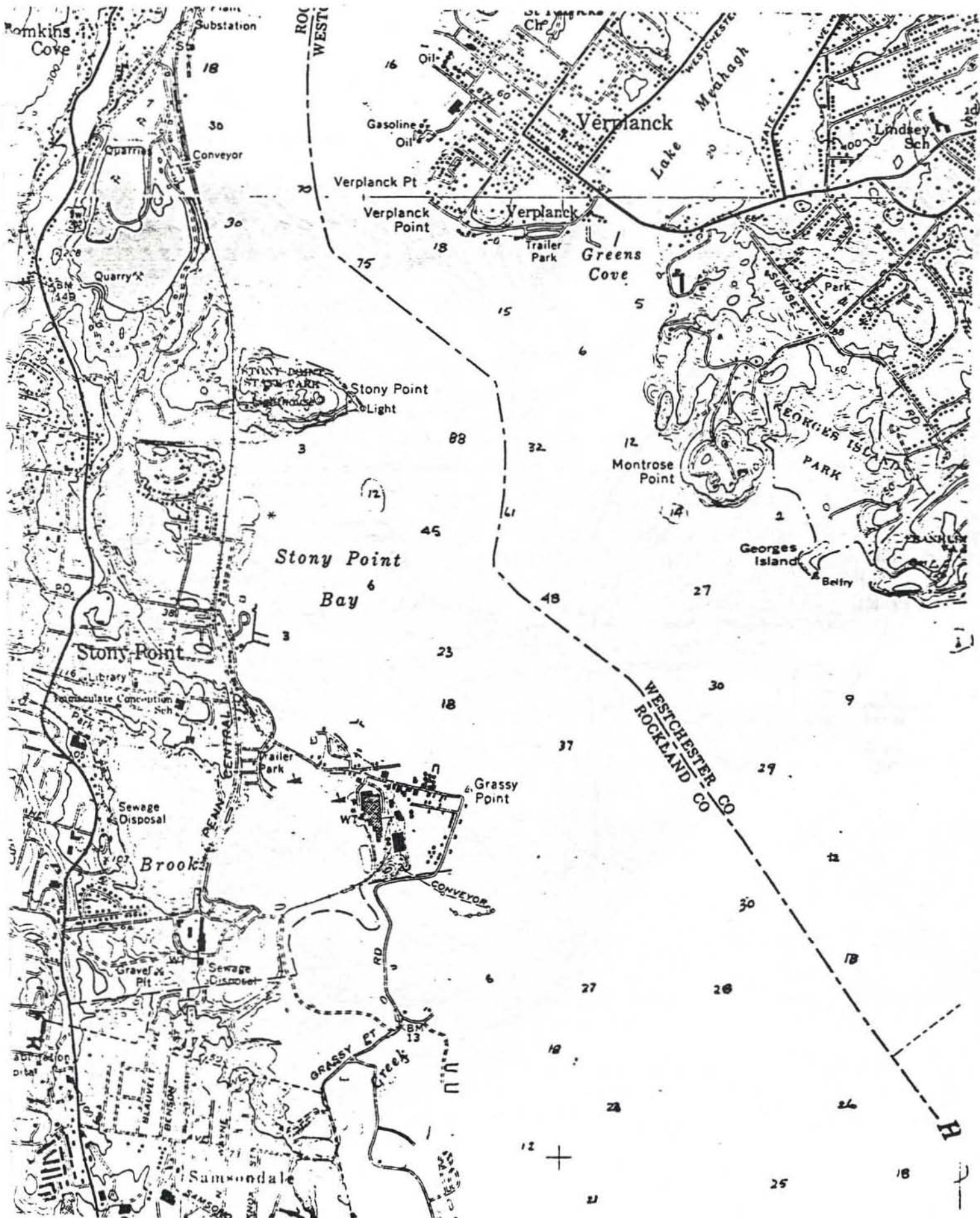
MAPS 11E AND 11W

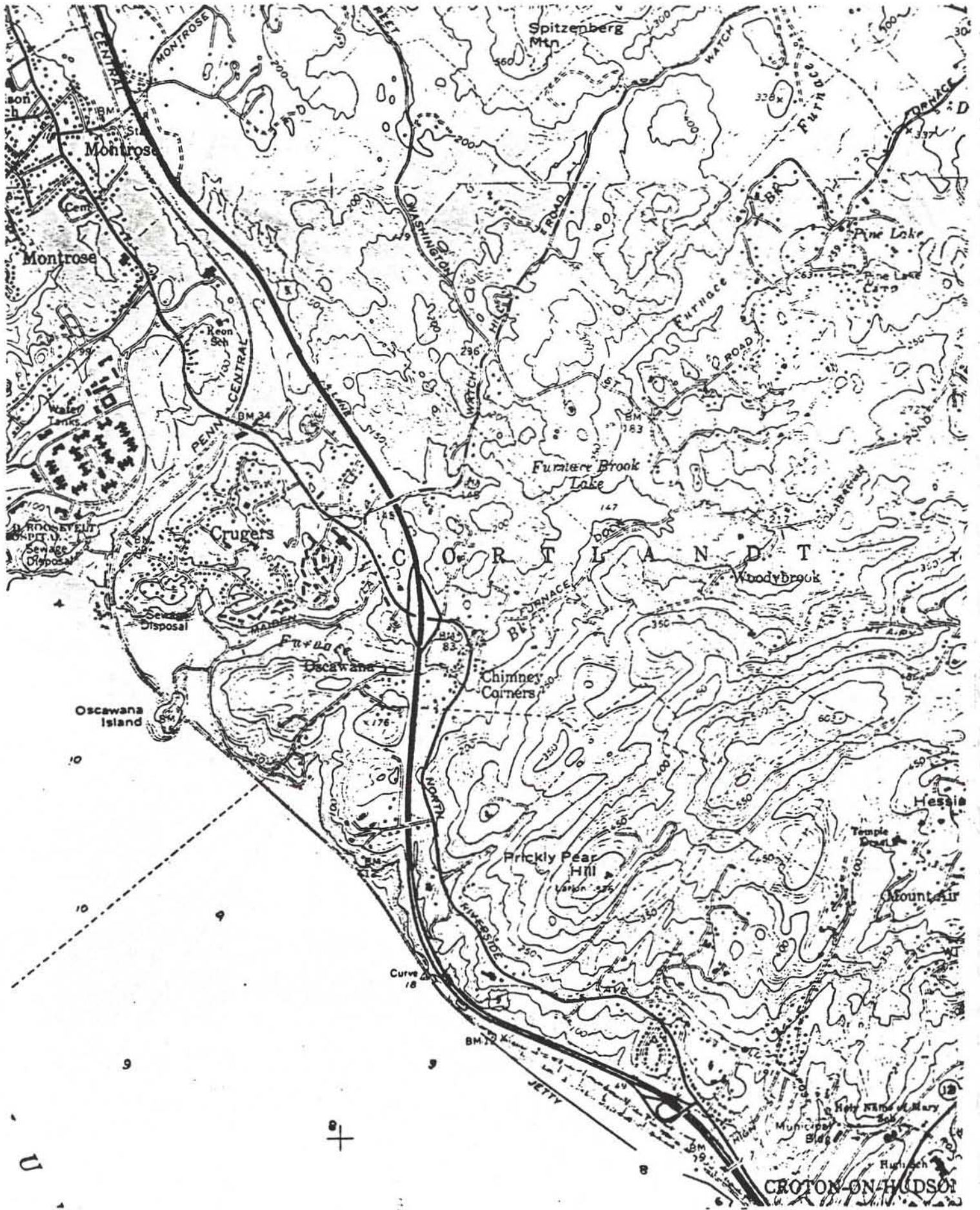
Croton-on-Hudson (7,523) essentially came into existence as the home of Irish and Italian laborers who were building the dam that created Croton Reservoir. The village of Croton was incorporated in 1898 and enlarged in 1930 to include the Harmon subdivision, Mt. Airy and Oscawana. About the time of World War I, Max Eastman and several others who wanted to live economically and escape from Greenwich Village tenements, acquired land on the wooded hills above Croton and built small houses. Among these were Edna St. Vincent Millay, poet; Dudley Field Malone, lawyer; Doris Stevens, militant feminist; Floyd Dell, novelist; John Reed, radical journalist; Boardman Robinson, cartoonist and painter; and Stuart Chase, economist. On Prickly Pear Hill, north of the village, a former estate with superb views of the river is now the Institute for Motivational Research.

North of Croton-on-Hudson, U.S. Route 9 was reconstructed in the last decade to facilitate through truck and automobile traffic and in so doing the expressway was relocated closer to the river. The cut is clearly visible but, in my estimation, blends in with the surroundings.

At Crugers, the railroad turns inland to Peekskill (Map 12E), one of the few stretches where the tracks do not parallel the Hudson River shore. From this point north we leave the rocks of the New York City Series and enter the Cortlandt Complex, a mafic intrusive mass of Ordovician age (see the three geologic maps in the pages that follow), roughly circular in outline. Much norite is exposed on Montrose Point, a good portion of which has been developed into Georges Island County Park.

Verplanck (no census notation), settled in the mid-17th Century, was at one time part of the Van Cortlandt estate. It served as the eastern terminal of Kings Ferry in colonial days and during the Revolution, the ferry was used to transport Washington's troops across the Hudson. After the surrender of Cornwallis, Verplanck became the scene of one of the grandest international military reviews in the history of the nation. French troops marched north from Virginia and crossed to Verplanck where 8,000 Continentals hailed them with cheers and cannon salutes. Tents were decked with laurel and evergreen





CROTON-ON-HUDSON

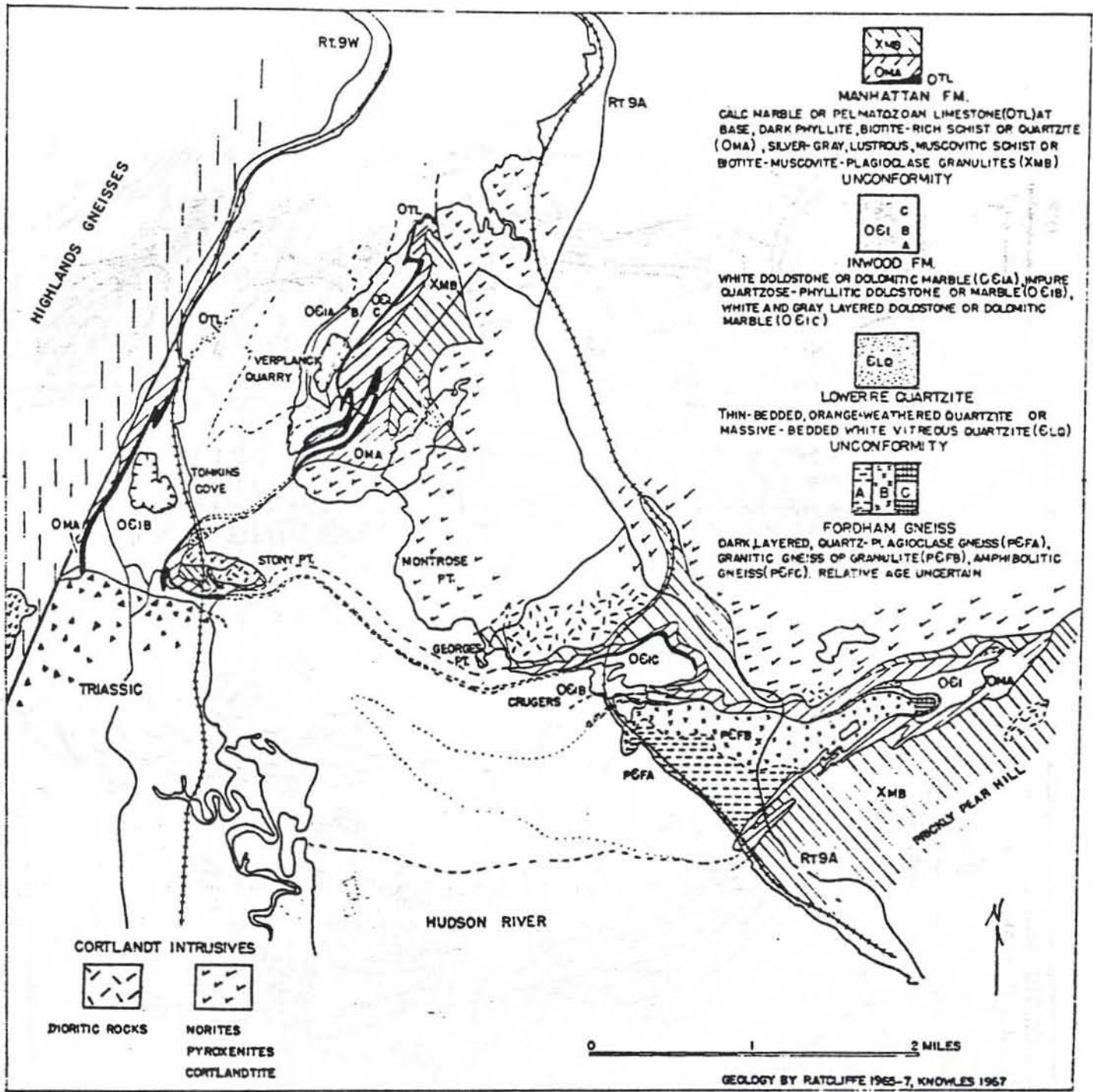
MAP 11E

and on October 1, 1782, Washington reviewed the French troops and, on the next day, French officers reviewed the Americans. According to Robert H. Boyle, author of "The Hudson River - A Natural and Unnatural History", "it would be an understatement to term Verplanck picturesque. It is today a weird settlement, by turns beautiful and scarred, but almost always fascinating. It is a cross between Cannery Row and an undiscovered Williamsburg". Most of the houses are of sturdy red brick from the local clay pits worked during the 19th Century and many Hudson River fisherman reside there.

On the western shore is Grassy Point, a legendary cache of Captain William Kidd's treasure. In the late 1600's, piracy off the New York coast became so great a scandal that New Yorkers formed a company to buy a ship with 36 guns to drive these pirates "off the seas". The man the company picked to captain their ship was William Kidd, a resident of New York City and his crew was composed in the main of Hudson River men. Unfortunately for the company, Kidd also turned pirate and a number of places in the Hudson are reputed caches of his treasure. Another one of these is off Jones Point (Map 12W) where the crew, returning home, scuttled a prize ship during a severe storm. Today the large U.S. Gypsum plant occupies Grassy Point.

Opposite Montrose Point is Stony Point and the village of Stony Point (8,270). Stony Point peninsula contains the only section of mafic rock typical of the Cortlandt Complex west of the river. The peninsula is now a state park and features a historical museum. This narrow section of the river was one of the places where a heavy section of chain was stretched across to prevent the British fleet from advancing further upstream and its western end was anchored at Stony Point. The fort at Stony Point changed hands many times during the Revolution. On July 16, 1779, General Anthony Wayne stormed the British fortifications at Stony Point with 1,350 handpicked American troops to recapture the fort that had been lost to the British only one month before. Wayne's feat, with a loss of about 15 killed and 83 wounded versus 63 British killed, 70 wounded and 543 captured, was a severe setback to the British and earned Wayne the nickname "Mad Anthony". Since the fort was undefendable, it was dismantled and evacuated on July 18, 1779. The British, however, came back for a second occupation but abandoned it again in late October, 1779, and from that time on the middle and upper Hudson was safe for the Americans.

Along the west shore, the reddish-brown sandstones, siltstones and mudstones of the Triassic Brunswick Formation compose the bedrock north to Stony Point; Stony Point, itself, is composed of mafic igneous rock unique to the Cortlandt Complex and largely confined to the eastern shore; and between Stony Point and the Hudson Highlands is a wedge-shaped area underlain by dolostone assigned to the Inwood Formation. This last-named rock has been extensively quarried adjacent to the river at Tomkins Cove by the New York Trap Rock Corporation, a subsidiary of Lone Star Industries.



Geologic map of the western edge of the Cortlandt intrusives after Ratcliffe, New York State Geological Association Guidebook, 40th Annual Meeting, Queens College, CUNY, 1968. Map includes portions of Haverstraw and Peekskill, N.Y., 7.5-minute quadrangles. See Maps 10E, 10W, 11E, 11W, 12E and 12W this guidebook.

74°00'00"

73°57'30"

73°55'00"

73°52'30"

73°50'00"

CORTLANDT COMPLEX MAGNETIC MAP

● VERTICAL INTENSITY STATION
 CONTOUR INTERVAL IS 200 GAMMAS

N. C. STEENLAND & G. P. WOOLLARD, JUNE 1948

% Magnetite Content:
 Granite, mica schist: .4%
 Rocks of Complex: 2.6%
 Border emery schists: 11.8%
 Border emery: 14.85%

41°17'00"

41°15'00"

41°13'00"

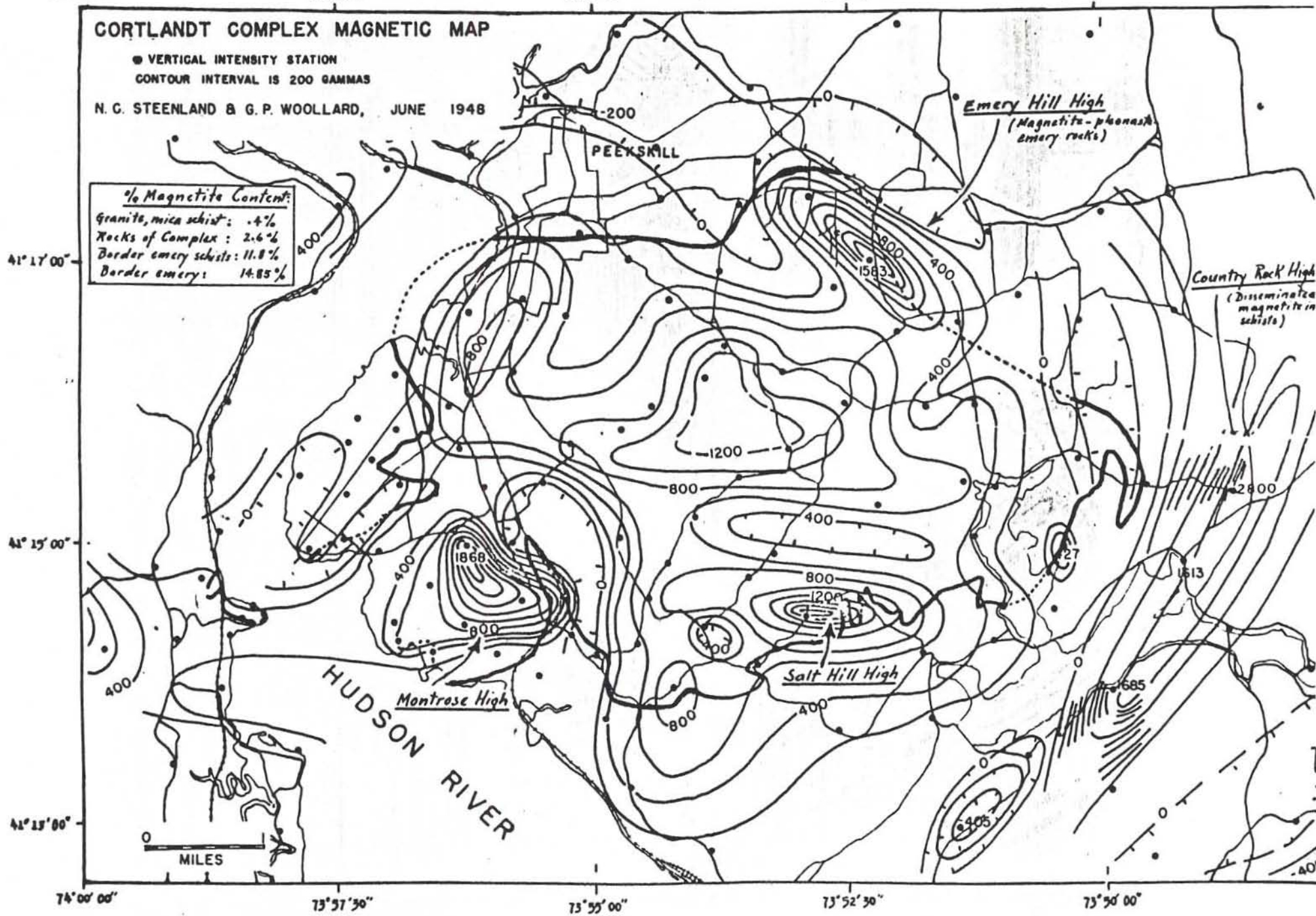
74°00'00"

73°57'30"

73°55'00"

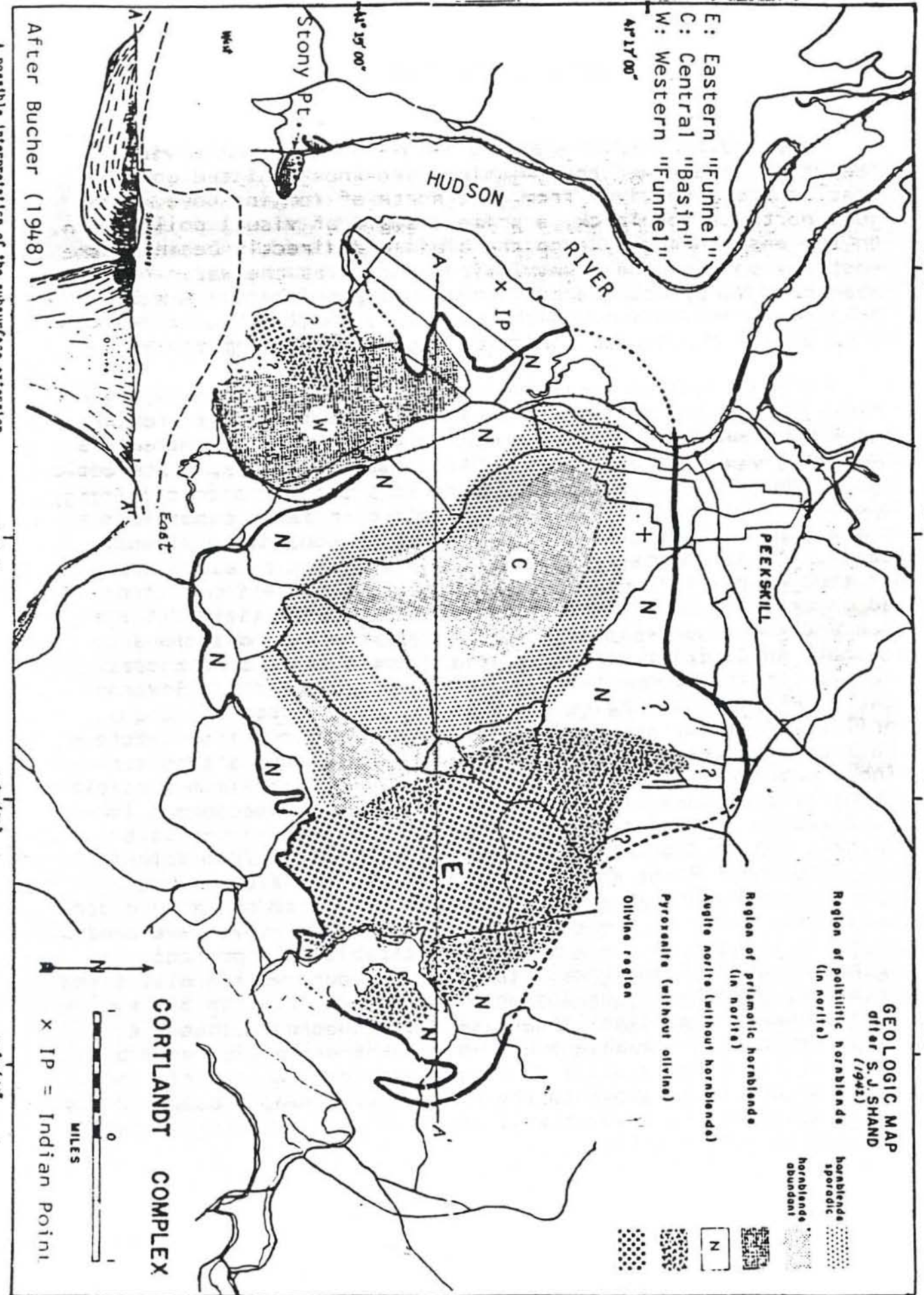
73°52'30"

73°50'00"



74°00'00" 73°57'30" 73°55'00" 73°52'30" 73°50'00"

E: Eastern "Funnel"
 C: Central "Basin"
 W: Western "Funnel"



GEOLOGIC MAP
 after S. J. SHAND
 (1942)

- Region of polytictic hornblende (in norite)
- Region of abundant sporadic hornblende (in norite)
- Region of prismatic hornblende (in norite)
- Angite norite (without hornblende)
- Pyroxenite (without olivine)
- Olivine region

CORTLANDT COMPLEX



x IP = Indian Point

After Bucher (1948)

Usable interpretation of the subsurface extension of the Cortlandt complex.

73°55'00"

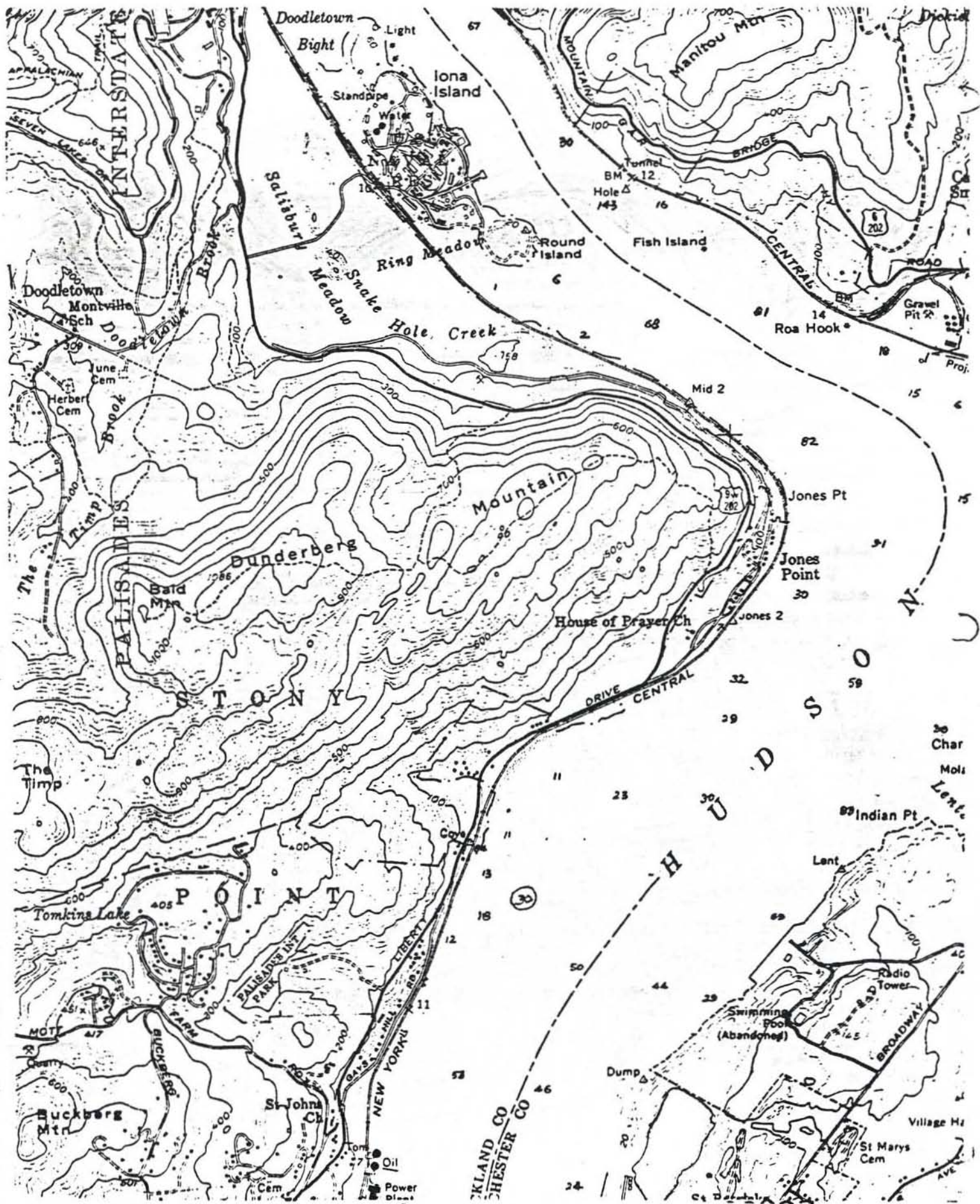
73°52'30"

73°50'00"

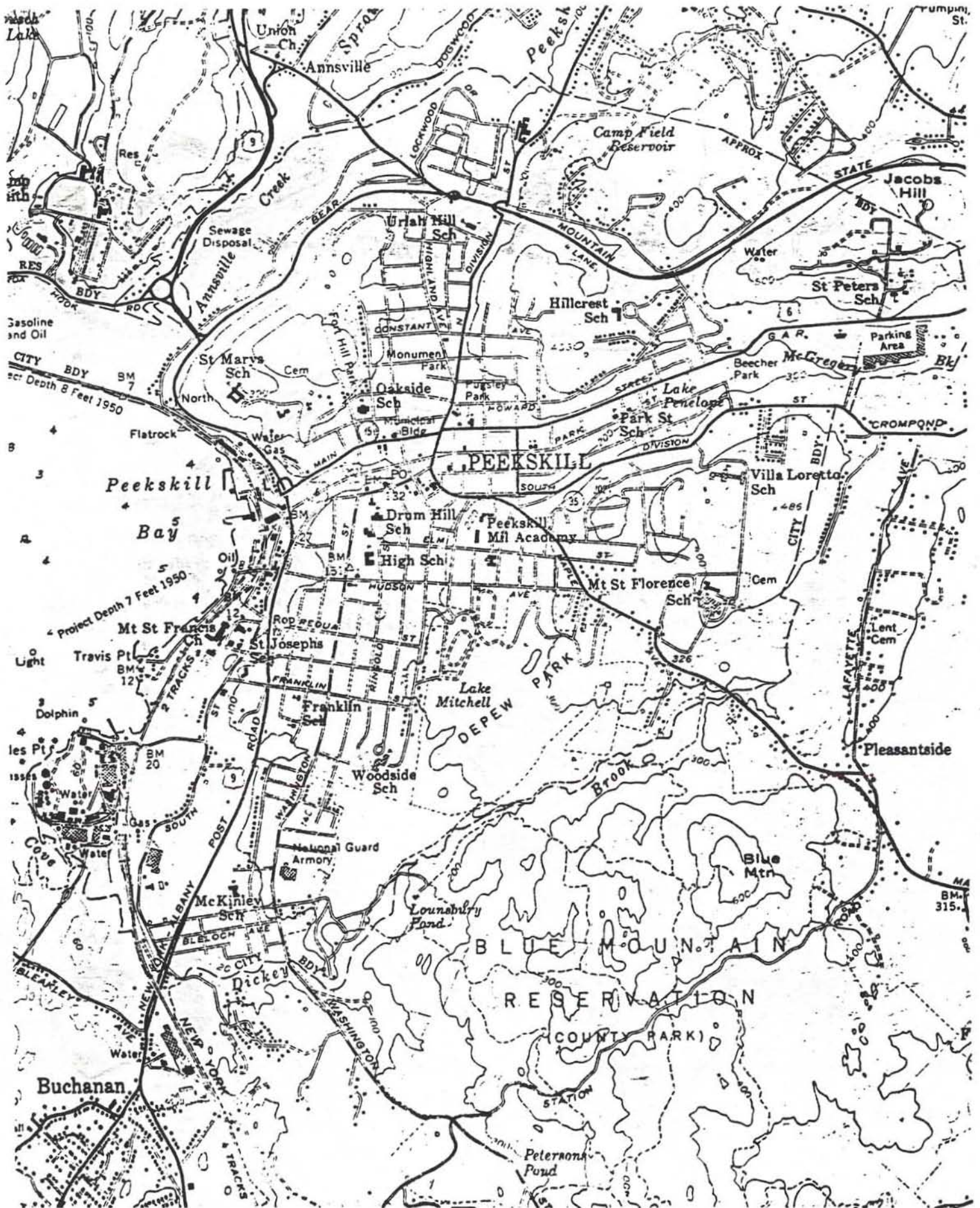
MAPS 12E AND 12W

Proceeding into the area of Map 12W, the most obvious feature is the power transmission line (not depicted on map) that crosses the river from just north of Tomkins Cove to just north of Verplanck, a prime example of visual pollution. On the eastern shore, atop the bluff and directly behind the easterly pole of the transmission line, lies the water-filled abandoned Verplanck Quarry formerly operated by the New York Trap Rock Corporation. As the quarry at Tomkins Cove, this too lies within the Inwood Formation (see geologic map provided).

A short distance north of the Verplanck Quarry, on Indian Point, are the Con Edison Indian Point nuclear power plants that have been the source of much heated controversy over the past few years. On April 19, 1974, James F. Davis, State Geologist of New York, submitted a report to the State Atomic Energy Council in which he termed the analysis of seismic conditions in the Indian Point area as carried out by Con Edison "inadequate". Davis maintained that the Indian Point reactors could not shut down safely during an earthquake because Con Edison had underestimated the earthquake intensity potential of the area and had underdesigned them for east coast conditions in general. An Ossining-based citizens group opposed to nuclear energy, Citizens Committee for the Protection of the Environment (CCPE) is challenging the safety of the reactors and on April 21-23, 1976, arranged the first phase of hearings before the Nuclear Regulatory Commission's Board of Appeals to determine whether the reactors are underdesigned for maximum possible intensity earthquakes in the area. All three reactors are located within 3,000 feet of the Ramapo Fault which bounds the southern Hudson Highlands, trending northeasterly from Tomkins Cove past Jones Point into the mouth of Annsville Creek and separating metamorphic and sedimentary rocks from the much older Precambrian rocks of the Highlands. The hearings revolve around two basic issues: is the Ramapo Fault capable of producing an earthquake and, if so, what intensity of ground motion will that earthquake produce in the Indian Point area? Dr. Lynn Sykes of Lamont-Doherty Geological Observatory has concluded that the Ramapo Fault is a "capable fault" under the definition used by the NRC. Controversy still continues regarding the effects of heated water discharged into the river after being used for cooling purposes on the fish as well as the problem of water intake and resulting fish kills.



MAP 12W



MAP 12E

Beyond Indian Point, is Peekskill Bay and Peekskill (18,881), named for Jan Peek, a Dutch trader who settled here in the mid-17th Century after running his ship aground nearby. The village occupies the site of the former Indian village of Sachoes. In 1665, the settlement was confirmed by a royal charter and the territory was known as "Ryck's Patent".

During the Revolution, Fort Independence, just above the village was occupied by Colonial troops. Continental Village, another fortified camp a few miles to the northeast, was the headquarters of Generals Parsons and Putnam. The Tory spy, Edward Palmer, was captured in Peekskill and General Israel Putnam, responding to a British officer's plea that clemency be shown Palmer, replied: "He was taken as a spy, tried as a spy and shall be executed as a spy". A few hours later he was hanged.

The Fleischman distillery and yeast plant dominates the east bank immediately below Peekskill proper on Charles Point. The Peekskill area has numerous other industries including clothing manufacturers, furniture and woodworking establishments, food processing plants, printers, machinery manufacturing plants, firms making specialty iron and steel products and many other small industrial establishments.

Peekskill is fortunate in being surrounded by numerous natural parks. Within the city limits is the 75-acre Depew Park, named for the late Senator Chauncy Depew.

As we cross the Ramapo Fault and enter the South Gate of the Hudson Highlands, framed by Manitou Mountain and Anthony's Nose on the east and Dunderberg on the west, we cruise into what is perhaps the most spectacular and picturesque section of the Hudson Valley. A brief description of the geology is given on page 2 of the article entitled "The Geology and Mineral Resources of the Lower and Middle Hudson Valley" included in the early portion of this guide. The area of Manitou and Anthony's Nose to the Westchester-Putnam County line at the Bear Mountain Bridge is Camp Smith, a training camp for the New York State National Guard, established in 1882. It contains 1,900 acres and is named for former Governor Alfred E. Smith.

On the west bank, the area from Tomkins Cove to Jones Point served as the anchorage for the "Mothball Fleet", up to 189 surplus World War II mass-produced Liberty and Victory ships, following the cessation of hostilities. There were originally

anchored there for standby purposes in case of an emergency but used later as storage space for surplus wheat which accumulated under the price support policy for farm products. The spot was chosen because of its naturally-protected location and because the water is sufficiently fresh to discourage growth of marine-fouling organisms. The ships were gradually sold off for scrap in this country and later to bidders for scrap or service in the non-Communist world. The last two ships sailed out of Tomkins Cove on July 8, 1971 bound for Spain.

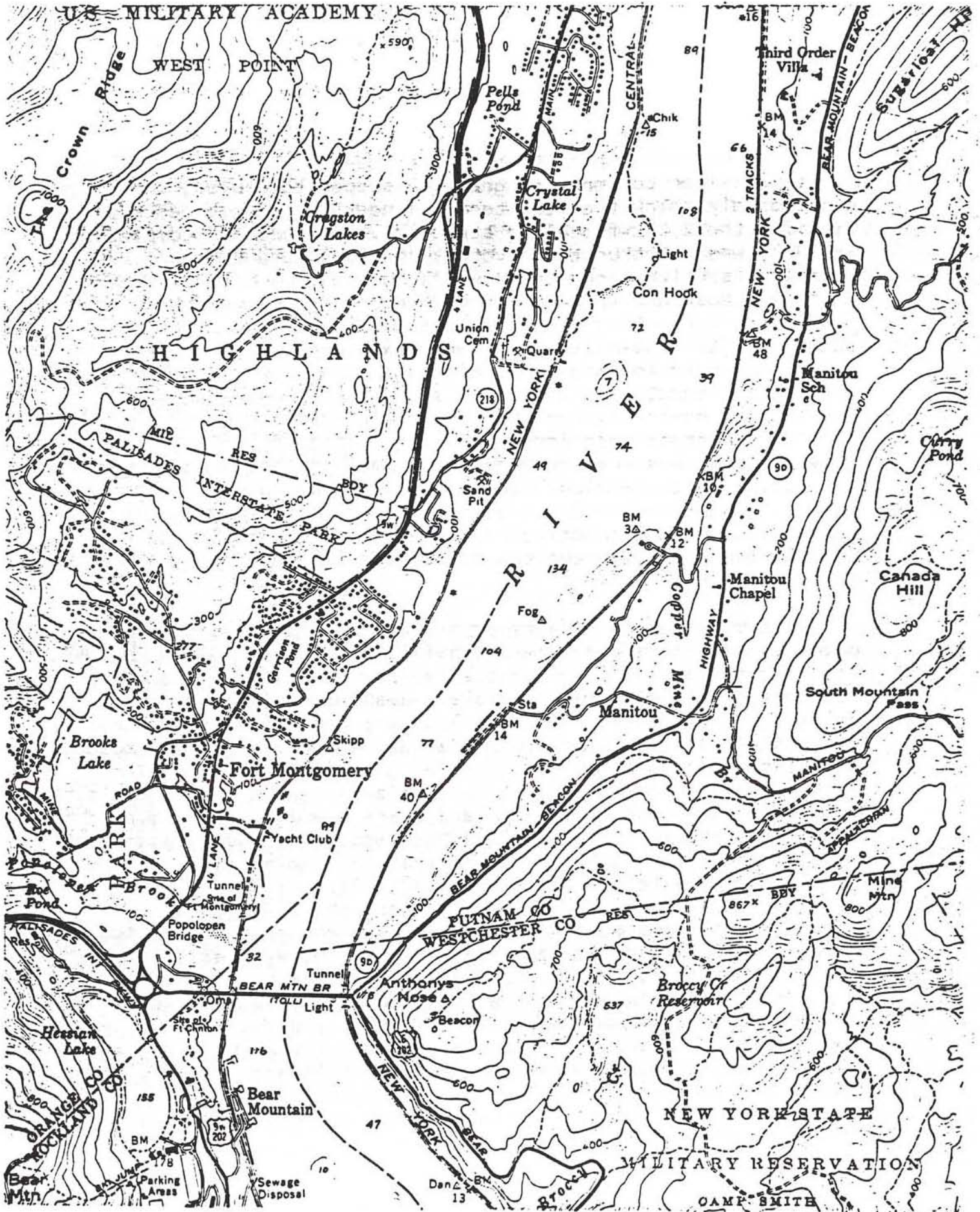
Iona Island, formerly a U.S. Naval Reservation and munitions storage depot, was the first headquarters of the Hudson Valley Commission established in 1964 by Governor Nelson A. Rockefeller. It has been acquired by the state for use as a state park and landscape engineers were retained in the early 1970's by the Palisades Interstate Park Commission to develop the island as a recreation area. The former channel of the Hudson in back of the island is being filled in naturally with sediment brought in by Doodletown Brook subsequent to the isolation of the channel by the West Shore Railroad, so that the "island" is now connected to the mainland. Salisbury Meadow marshland is a significant wildlife refuge.

Dunderberg is composed of hornblende granite and granitic gneiss, the Storm King Granite and Canada Hill Gneiss, respectively, often referred to as the Highlands Complex.

MAP 13

To look at the picturesque Bear Mountain Bridge, with its tall silver columns and graceful suspended cables, one would hardly think that the term "pioneer" is an apt description for the 2,252-foot-long structure. The bridge, completed in 1924, was constructed privately and took advantage of the narrowest section along the river's course (0.3 mile) between Anthony's Nose and the foot of Bear Mountain. It was the first automobile connection between the east and west banks of the Hudson for the 150-mile stretch from New York City to Albany. The bridge used for the first time a special type of galvanized steel cable containing 7,252 wires and other engineering measures which paved the way for modern suspension bridge construction. But perhaps most importantly, its span of 1,632 feet between columns was the longest in the world at the time and it showed that a suspension bridge could be used to span great distances. The success of the Bear Mountain Bridge led to the conception and construction of the 3,500-foot span George Washington Bridge in 1931 and the 4,200-foot span Golden Gate Bridge in 1937.

Throughout its 16 years of private ownership, the bridge operated at a loss and it was acquired by New York State in 1940. It presently serves as one entrance from New York, Westchester, Putnam and Dutchess counties to the Bear Mountain Section of Palisades Interstate Park which has many publicly-operated recreational facilities, including a nature museum, geology museum, ice skating, skiing, swimming, camping and Bear Mountain Inn. Park authorities have developed many lakes in the hills beyond, installed permanent campsites, and operate a daily cooked food service from the Inn for children's camps. Palisades Interstate Park was extended this far north by the Harriman family gift of 10,000 acres of land and one million dollars in 1910. The Appalachian Trail, running from Maine to Georgia, crosses the Hudson River via the Bear Mountain Bridge and joins the network of trails in the park. On the eastern shore, virtually at the end of the bridge, is the Westchester County-Putnam County border and the western end of the bridge essentially marks the Rockland County-Orange County line. Anthony's Nose, facing the eastern end of the Bridge, composed largely of amphibolite and hornblende gneiss, was named, according to legend, for the nose of Peter Stuyvesant's trumpeter, Anthony Corlaer, who had a nose "of vast lusty size strutting boldly from his countenance like a mountain of Golconda".



From this point northward through Dutchess County, the east bank has many old mansions erected, for the most part, in the 19th Century by New York's wealthiest families. Although a few are still privately owned, most have passed on to religious or educational institutions or have been designated historic monuments under state or federal control with consequent diminution of the tax base.

Manitou is a small residential settlement barely above tide level between the railroad and the river but, in recent years, there have been a fair number of new residences built on the slope up to N.Y. Route 9D.

On the western flank of Canada Hill, a little over a mile north of the Bear Mountain Bridge, is "Manitoga", a newly-opened "nature conservancy" featuring nature trails and occasional artistic events. It is owned by Russell Wright, the industrial designer, who maintains a home on the property.

On the west side of the river, opposite Manitou, is the hamlet of Fort Montgomery (900), a small residential community hemmed in by Palisades Interstate Park, the U.S. Military Reservation and the Hudson River.

South of the hamlet of Fort Montgomery, flanking Popolopen Brook, are the sites of the twin forts Montgomery and Clinton constructed in 1776-77 to stand guard in the Highlands. The location of most of the Fort Montgomery fortifications can be identified and the outer redoubt of Fort Clinton is in good condition. The four pages that follow, obtained from Historic Sites of the Hudson Valley published by the Hudson River Valley Commission in 1965, describe the role of these forts in the American Revolution.

FORT MONTGOMERY AND FORT CLINTON

LOCATION: Bear Mountain

CLASSIFICATION: War for American Independence.

SIGNIFICANCE: Forts Montgomery and Clinton were erected to stand guard in the Hudson River Highlands 45 miles north of New York City, five miles south of West Point. These two forts, called the Twin Forts of the Popolopen, were constructed during 1776 and 1777.

The strategic importance of the Hudson River was recognized early in the conflict between the American colonies and Great Britain. Every road connecting New England with the other colonies crossed the Hudson River at some point. The Hudson River was also important as a means of transportation from the St. Lawrence through Lake Champlain and southward to the Atlantic Ocean at New York City. The colonists realized the necessity of keeping control of the river and preventing the separation of the colonies by the British.

On May 25, 1775 the Continental Congress in Philadelphia ordered the erection of fortifications in the Hudson River Highlands and directed Colonel James Clinton and Christopher Tappan to report to the Congress upon such fortifications. Clinton and Tappan recommended the erection of fortifications on the east and west sides of the river in the vicinity of West Point and Constitution Island. Fortifications were begun on Constitution Island; but later the commissioners recommended placing a strong battery five miles to the south at Popolopen Creek. Thus, in March 1776, construction of Fort Montgomery was begun because of its strategic location where it "would command the reach of the river downward to the point of the Dunderbarragh, being the distance of nearly three miles, and from the same point the reach upwards may be commanded as far." As work on Fort Montgomery progressed it became obvious that the higher land on the south side of Popolopen Creek had an even greater strategic location and work was begun on a fort in that location.

On August 27, 1776, the Americans lost the Battle of Long Island and withdrew to Manhattan Island. On September 16, the Battle of Harlem was fought and thereafter the British slowly but surely crowded the Americans northward, and New York City became the headquarters of His Majesty's forces under Sir William Howe.

The summer of 1777 was a time of crisis in New York because of a 3-pronged plan of invasion:

SIGNIFICANCE:
(continued)

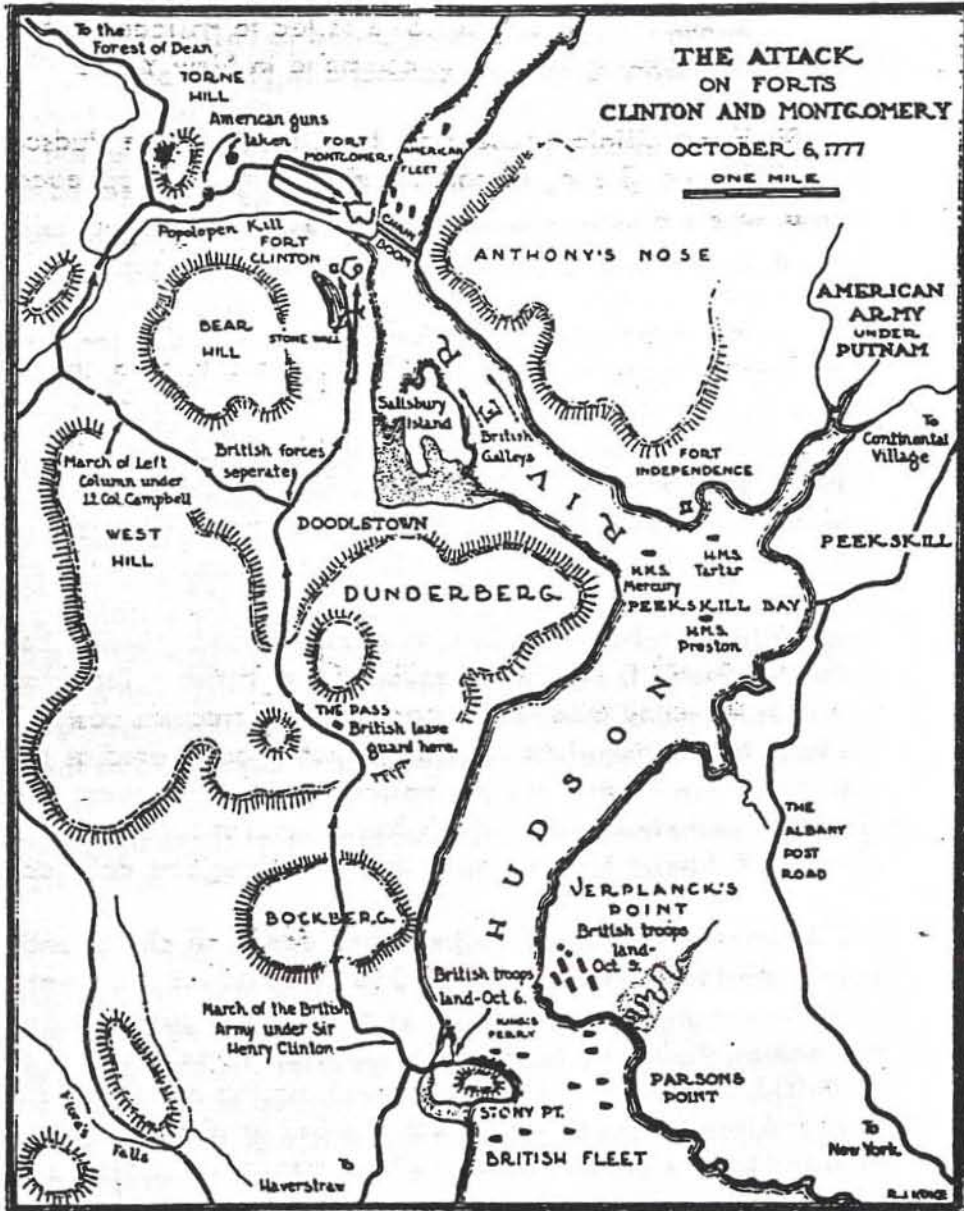
- St. Leger moved eastward through the Mohawk Valley toward Albany;
- Burgoyne moved southward through the Hudson Valley toward Albany;
- and Howe was to move northward through the Hudson Valley toward Albany. General Howe sailed to Philadelphia, however, leaving Sir Henry Clinton in command in New York.

Sir Henry Clinton made plans for a thrust up the Hudson. On the night of October 3 and the morning of the 4th, he proceeded as far as Tarrytown where a landing was made. On October 5, he landed at Verplanck Point as a menacing gesture toward Putnam at Peekskill.

Early on the morning of October 6, Sir Henry Clinton landed a large number of troops at Stony Point for a march through the mountains to attack Forts Montgomery and Clinton from the rear. Early in the afternoon, the British forces under Generals Campbell and Vaughn and Sir Henry Clinton himself "invested Forts Montgomery and Clinton on all sides". For three hours the 500 to 600 defenders remained at their posts behind the protecting works of Forts Montgomery and Clinton. At five o'clock, the British called a truce and asked for surrender. The Americans replied that Forts Clinton and Montgomery would be defended and called, instead, for the surrender of the British. Ten minutes later the British launched a powerful attack. The attackers pushed their men up the fortifications where they were shot or bayoneted as the garrison beat them back. In spite of their valiant efforts, however, the defenders were finally overwhelmed by British forces several times their number. Under cover of darkness, less than half of the American defenders escaped.

The Americans had placed great confidence on chains and booms which were placed across the river. One of these was the great iron chain which was strung across the river at Fort Montgomery. The device proved ineffectual, however, and a few days after the battle of the Twin Forts the British fleet sailed northward to Kingston and set fire to the whole Town. Although the British won the battle of the Hudson Highlands, they were too late to aid Burgoyne who surrendered his entire army on October 16, the same day as the burning of Kingston. Sir Henry Clinton was ordered back down the river to New York City.

"Sir Henry Clinton's raid up the Hudson had been brilliantly executed; nevertheless, it had failed in its primary objective of relieving Burgoyne. It had resulted in the destruction of Forts Clinton, Montgomery, Constitution, and Independence. The great chain across the Hudson had been severed, and considerable amounts of American stores in the Continental Village, north of Peekskill, had been destroyed. The American fleet had been totally destroyed. Sixty-seven pieces of ordinance had been seized with immense quantities of cannon shot, ammunition and powder in the two Popolopen forts. North of the Highlands the country along the river banks lay in shambles. Vessels on stocks had been burnt or



THE ATTACK ON FORTS CLINTON AND MONTGOMERY
HUDSON HIGHLAND CAMPAIGN October 6, 1777

SIGNIFICANCE:
(continued)

captured. Kingston was in ruins; of over three hundred houses in the Town only one was left standing. The cheveaux-de-frise had proved a failure; the enemy fleet had sailed straight through it. In twenty days Sir Henry Clinton had undone everything the Americans had been laboring upon for more than two years. Destruction marked the location of every patriot post upon which the powerful blow fell. The dramatic history of the first set of fortifications in the Hudson Highlands drew to a close with the departure of the last British vessel in 1777." 1/

In December 1777, on General Washington's initiative, work was resumed by the officers of the Continental Army and the State Legislature to plan new defenses in the Hudson River Highlands. West Point was selected as the most strategic location and fortifications were developed rapidly. By 1780, West Point had become a citadel of such importance that Benedict Arnold who was in command of the post, tried unsuccessfully to betray it to the British.

CONDITION:

The outer redoubt of Fort Clinton is in good condition and only traces remain of the other fortifications.

The location of most of the Fort Montgomery fortifications can be identified.

OWNERSHIP:

Palisades Interstate Park Commission.

PUBLIC USE:

The Park Museum is located on the site of Fort Clinton. There is no public use at Fort Montgomery at this time.

**RECOMMEN-
DATION:**

Continue research and excavation program, and interpretation of the fortifications and their significance.

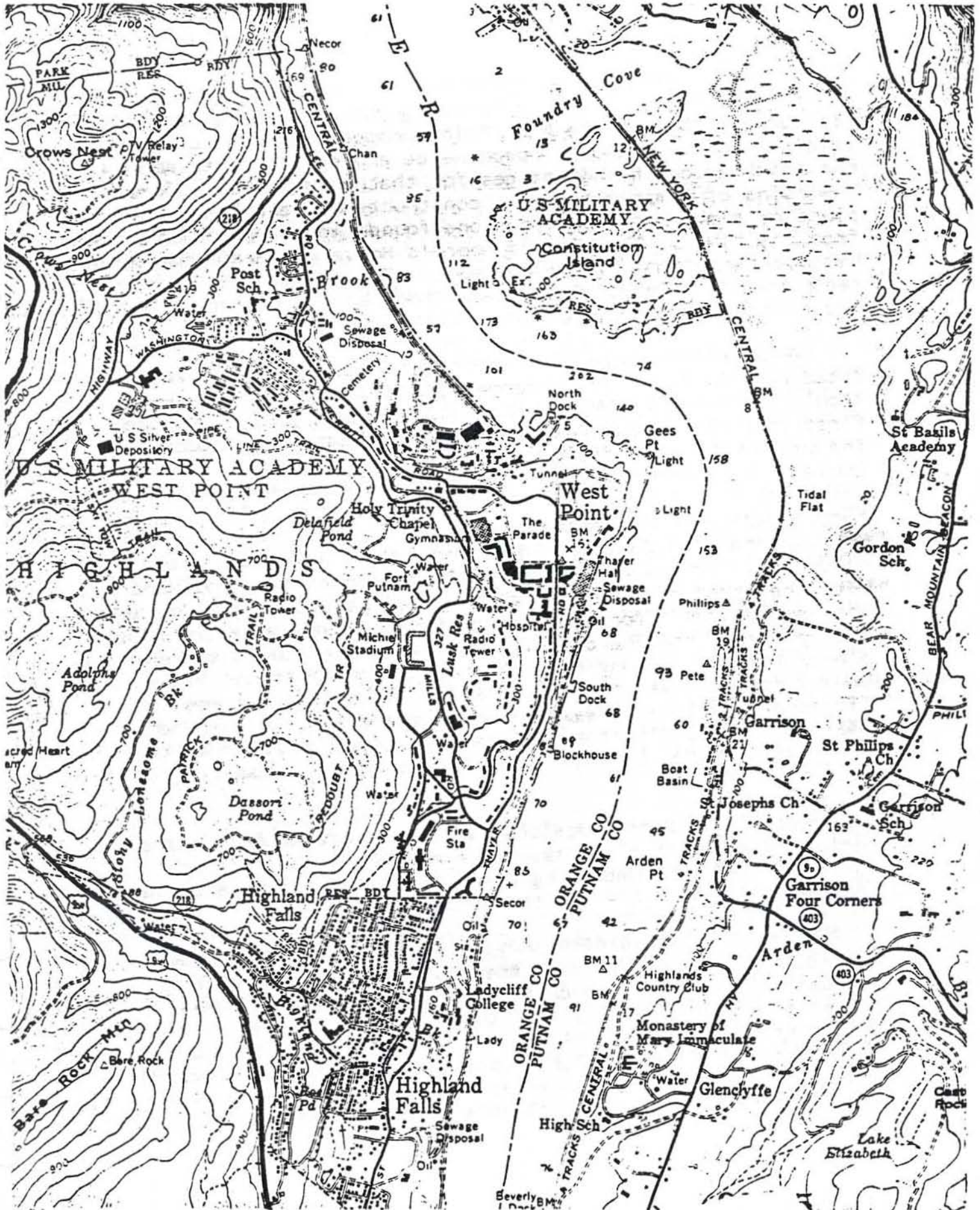
Source: 1/ Twin Forts of the Popolopen, Forts Montgomery and Clinton, 1775-1777.
William H. Carr and Richard J. Koke.

MAP 14

Although the deepest portion of the present day Hudson River channel lies between the West Point dock and Constitution Island at 202 feet (according to the USGS 7.5-minute Series Topographic Map), the channel is deepest throughout the Highlands area; viz., 91 Ft. at Jones Point, 165 Ft. northern end of Iona Island (Map 12W), 116 ft. at Bear Mt. Bridge, 130 ft. above Fort Montgomery, 125 ft. at Con Hook (Map 13), 93 ft. at Garrison, 158 ft. at Gees Point and 112 ft. due west of Constitution Island. These figures, however, are not always in accord with those marked on the pilot sheets prepared by the National Oceanic and Atmospheric Administration. Depths for these same localities on the NOAA soundings chart are as follows: Jones Point (91), Iona Island (165), Bear Mt. Bridge (116), Fort Montgomery (124 and 130), Con Hook (125), Garrison (93), Gees Point (175), West Point dock (150) and due west of Constitution Island (127). The northeasterly course of the Hudson in this section from Fort Montgomery to Constitution Island follows a major fault which may in part be responsible for the deeper channel. The eastern side of the river is underlain by garnet-bearing gneiss and interlayered quartzite, whereas rocks on the west shore are largely rusty and gray biotite-quartz-feldspar gneisses with minor marble and calcsilicate rock.

No large communities are found on the eastern shore but Garrison or Garrison-on-Hudson, as it is commonly known, is a quaint residential area on the river. A few years ago, the railroad station, no longer used, was converted into a theater and a number of buildings were either constructed or modified to give the appearance of the Yonkers waterfront in the late 1800's for the filming of "Hello Dolly".

North of Garrison, the river bends sharply to the northwest, the course again structurally controlled, and Constitution Island, the only portion of the U.S. Military Academy on the eastern shore of the Hudson River comes into view. Constitution island was the site of Fort Constitution built under the direction of Colonel Bernard Romans, a Netherland's civil engineer, commencing on August 29, 1775. In the fall of 1777, General Sir Henry Clinton organized the British expedition for the capture of the forts in the Highlands as described with Map 13. Following the capture of Verplanck Point, Stony Point, Forts Montgomery and Clinton, on October 8 1775, 2,000 men under General William Tryon proceeded to Constitution Island to complete the demolition of the Highland's fortifications. Although



MAP 14

Clinton was forced to return to New York City after reaching and burning Kingston because of Burgoyne's defeat at Saratoga, his success thrust "the West Point" opposite Constitution Island into a position of prominence and crystallized American thinking on the advantages for that location of a fort. The ruins of Roman's battery, constructed of earth and held in place by timber on top of a stone foundation can still be seen from the river. The site of Moore's House, General Washington's headquarters from July to November, 1779, was in the narrow sequestered valley of Crows Nest Brook on the western side of the river opposite Constitution Island.

George Washington, in a letter to General Israel Putnam dated December 2, 1777, recommended that a strong fortress should be erected at West Point, and on January 27, 1778 the first group of soldiers crossed the ice to begin construction. The walled fortification was first supervised by a Lt. Colonel Louis de la Radiere and he, in turn, was succeeded by Thaddeus Kosciuszko in the spring of 1778. By the summer of 1778, the fortification was sufficiently advanced toward completion to receive the name Fort Arnold to honor Benedict Arnold, the hero of Quebec. It was renamed Fort Clinton (not to be confused with the other at Bear Mountain) upon Arnold's defection. The last successful effort by the British to invade the Highlands took place at the end of May, 1779, when they again seized Verplanck Point and Stony Point after which "Mad Anthony" Wayne, in his daring move, recaptured Stony Point with the enemy garrison and stores. Washington lauded Wayne's success and looked upon West Point as the most important post in America and transferred his headquarters there (Moore's House) to conduct the defense.

Washington's presence at Moore's House transformed the region into a center of state, for next to the Congress in Philadelphia, the commanding general and his staff were the objects of continental and international attention.

Shortly after Washington moved his headquarters from West Point in November, 1779, he directed Generals McDougall and Steuben to reinforce the garrison there and cover the southern entrance to the Highlands. On August 3, 1780, General Benedict Arnold proceeded to West Point to assume command from General Robert Howe and it was from this position that he conducted his negotiations with Andre to sell West Point to the enemy which, as we learned earlier, was thwarted. While in command of West

Point, Arnold lived in the Robinson House on the east side of the river near Garrison. The house was built in 1758 by Beverly Robinson on a 60,000-acre estate which was Mrs. Robinson's share of the Philipse property (Mrs. Robinson was Susannah Philipse, eldest sister of Frederick III). Colonel Beverly Robinson supported the British and the property was confiscated in 1777. After that, several American generals made "Beverly" their home, the best known Benedict Arnold. The house was destroyed by fire in 1892.

The United States Military Academy was established in 1802 as part of the Corps of Engineers with five officers and ten cadets. The reasons given for its creation are: the Revolutionary War experience when the Americans were forced to rely on foreign military technicians; military technology required a great deal of study and could not be acquired by practice alone; and some education reformers felt that the established colleges of the time were not furnishing the type of practical education required for American development. Until 1812, West Point was basically an apprentice school for military engineers; it was reorganized in 1812 when 250 cadets began a four-year curriculum that continues today.

Constitution Island was not always a part of the military. It reverted to private ownership in the years following the Revolution and was donated to the Academy by Mrs. Russell Sage and Miss Anna B. Warner. Miss Warner and her sister Susan were spinsters who wrote popular romantic novels. The island is connected to the mainland in the same fashion as Iona Island to the south. The swamp and isolated bay are part of an Audubon Nature Preserve.

On the heights above the sanctuary stands Boscobel, a beautiful restored mansion of the early 1800's. It was built by States Morris Dyckman at Cruger Park but was not completed until after his death in 1806. Boscobel was designed by Robert Adams, the noted Scottish architect. The interior workmanship reflects the elegance of the Federal Period. The house, threatened with demolition at its original site, was saved by Boscobel Restoration and moved to its present locale 15 miles to the north. It is open to the public.

The building at the head of Foundry Cove represents the former location of the Marathon Battery Company which has since moved elsewhere. The company, in the process of manufacturing

batteries, permitted cadmium to be dumped into the tidal marsh below. Analysis of the marsh showed that it contained 16 per cent cadmium - a real mine. Cadmium is considered more dangerous than mercury as it replaces bone marrow. The company was stopped by legal means from dumping more of the element into the marsh and, in the process of reclaiming it, they realized a savings of \$60,000 per year. The original cadmium, dumped into the marsh before the cease and desist order, still remains. Foundry Cove takes its name from an old iron foundry that existed there in Revolutionary times.

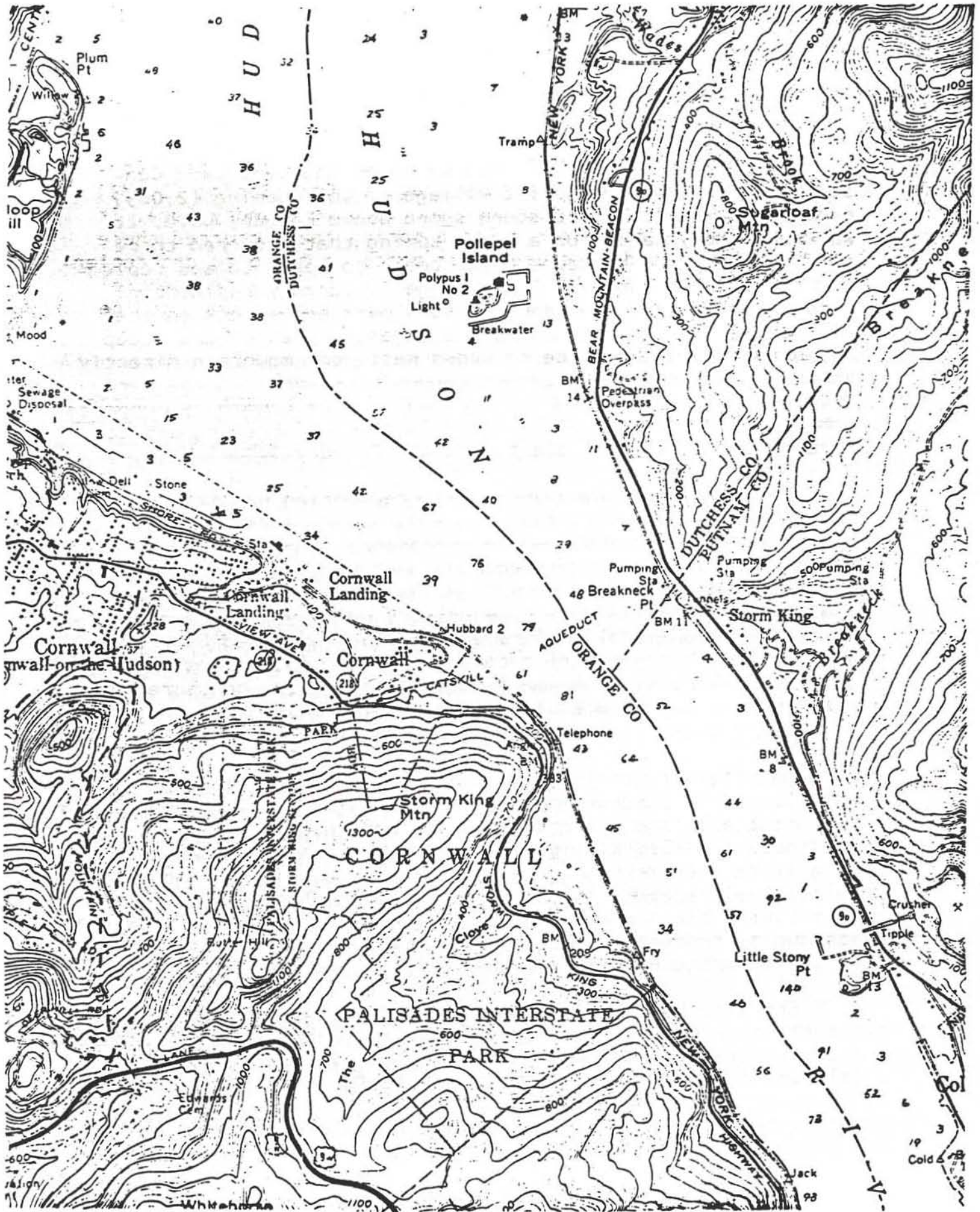
MAP 15

Swinging more northerly as we round the bend past Constitution Island, the quaint village of Cold Spring (2,083) comes into view on the eastern shore above Foundry Cove. It was supposedly named for a large spring that occurred there sufficiently good to cause river boats to heave to and replenish their water supply. The village is largely residential with a couple of picturesque inns, a park and a dock on the waterfront. The residents have a majestic view of the steep 1,350-foot high east face of Crows Nest, the mountain directly across the river, which causes deepening shadows in the early afternoon as the sun sinks in the west. The community supports some light industry, mainly a manufacturer of hearing aid components and a chemical plant, and the Foundry School Museum.

The bedrock at Cold Spring is Precambrian biotite-quartzfeldspar gneiss but it changes rapidly northward to quartz-plagioclase gneiss and then to hornblende granite and granitic gneiss with subordinate leucogranite at Little Stony Point and Mt. Taurus or Bull Hill (1,420' asl) immediately to the east. The last-named variety is of excellent quality for a variety of crushed stone applications and was last quarried by the O'Brien Brothers just prior to World War II (note massive scar). Operations were never resumed because of citizen pressure to preserve the river face of the Hudson Highlands. The crusher, tipple and conveyer belt housing are still visible.

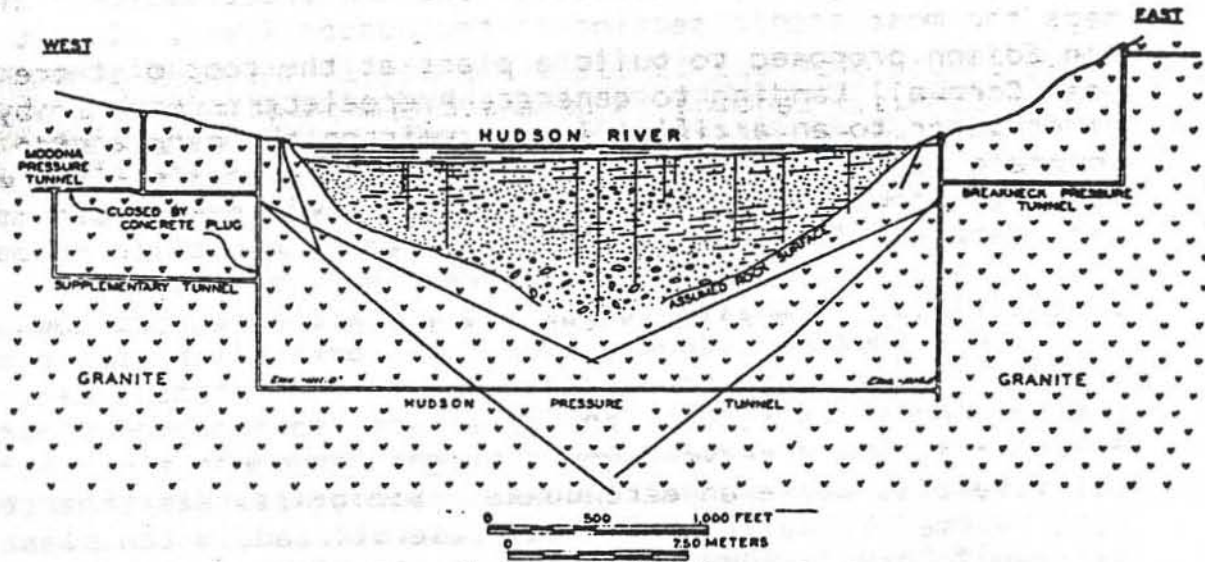
Immediately north is the imposing North Gate of the Highlands bounded by Breakneck Ridge (1,280') at the Dutchess-Putnam line on the east and Storm King Mountain (1,410' asl) on the west. South of Storm King Mountain there is a gap shown on the map as "The Clove" through which northwest winds commonly roar to peril small boats. In 1824, the sloop Neptune capsized and thirty-five persons were drowned there. To the Dutch, this gap was known as "Mother Cronk's Cove" and the perilous stretch of river through the Highlands as "Martyr's Reach"

Storm King Mountain and Breakneck Ridge-Sugarloaf Mountain owe their majestic splendor to the resistance of the hornblende granite or Storm King Granite of which they are composed. At this point is the river crossing of the Catskill Aqueduct carrying water to New York City. Two cross sections of the channel based on test borings, one looking north and the other south, are pictured on the following page.

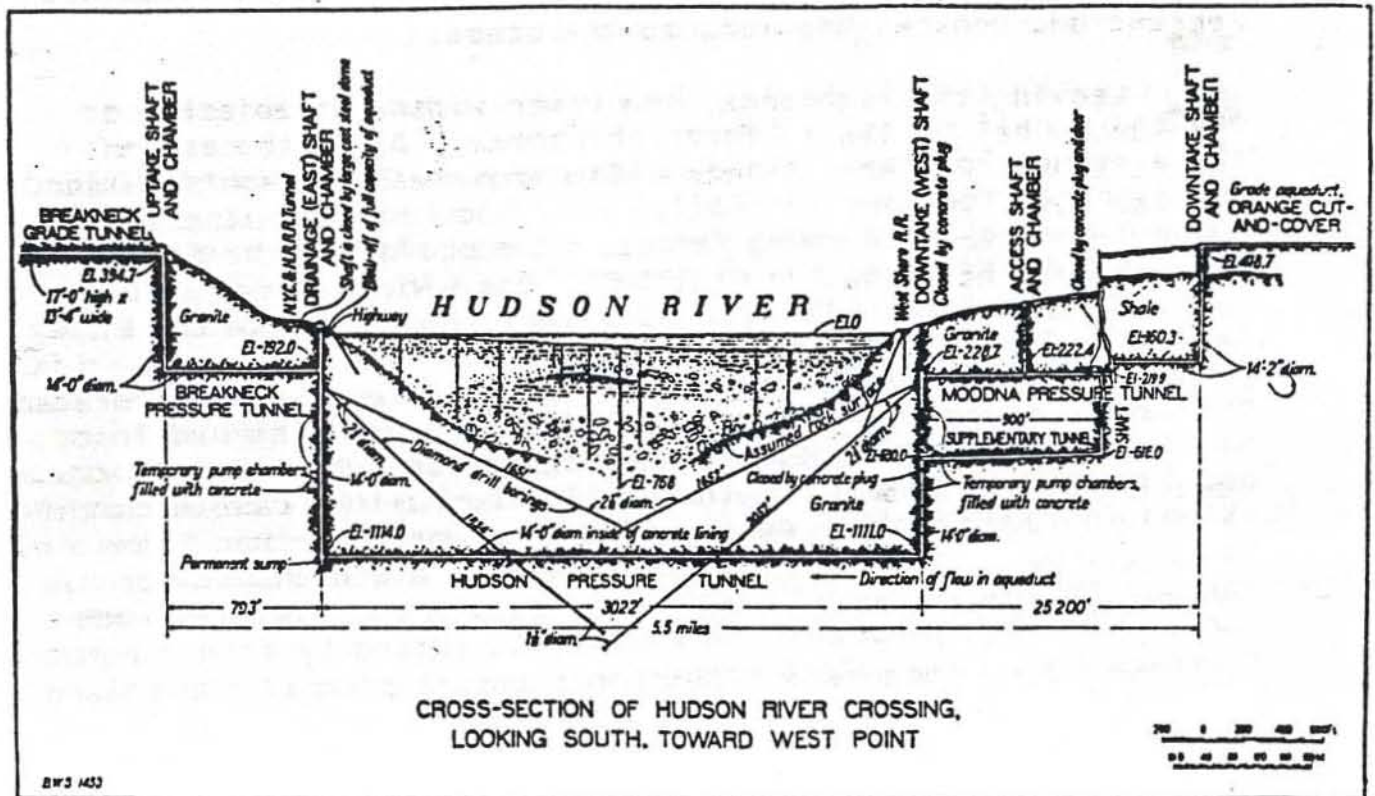


Storm King Mt.

Breakneck Mt.



Geologic section across the Hudson River at Storm King, based on exploratory borings for the Catskill Aqueduct. See Guidebook cover.



CROSS-SECTION OF HUDSON RIVER CROSSING, LOOKING SOUTH, TOWARD WEST POINT

Storm King Mountain has had its share of publicity in recent years because of a controversial pumped power project with its threat to geologic stability and the preservation of perhaps the most scenic section of the Hudson River. In the 1960's, Con Edison proposed to build a plant at the foot of the mountain near Cornwall Landing to generate hydroelectric power by pumping river water to an artificial reservoir on the back side of the mountain during periods of low demand and releasing it via conduits through the plant to generate power during periods of peak demand. The idea is simple and thorough but it brought a great deal of opposition from a great many scientists and environmentalists. A massive thrust fault, extending from New Jersey to northern Dutchess County, bounds the north flank of Storm King, more or less passing through the area of the proposed plant. Some geologists felt that the day-to-day loading and unloading of water in the reservoir would trigger movement along the fault sufficient to cause an earthquake. Biologists felt that the water warmed by radiation in the reservoir, and in the plant itself, would have an adverse effect on the fish population (the spawning ground of striped bass), and environmentalists felt that the plant and power lines crossing the river would mar the beauty of the site. The pros and cons have been argued back and forth in court for years and, to my knowledge, is still unresolved. Central Hudson Gas and Electric Corporation planned a similar project along Breakneck Brook immediately across the river, but they abandoned the project when opposition to Con Ed became apparent and donated the land to the state.

Leaving the Highlands, the river widens immediately to one and a half miles, a factor of three. Along the eastern shore stands Pollepel Island, also known as Bannerman's Island. It was named for Mary (or Polly) Pell who had two suitors, a young minister and a young farmer. She preferred the farmer but her parents liked the minister. One wintry day the clergyman took her sleighriding on the river; the ice broke and they fell in. The farmer, seeing their plight, raced across the ice, jumped in, and brought them safely to the island. Polly embraced the farmer so lovingly that the minister, sensing he had lost, married them on the spot. Frances Bannerman, who made a fortune dealing in munitions after the Civil War, built a castle on the island in 1900 which he decorated with armor and other items he had acquired. It may be that it served as a storehouse for his wares. After his death in 1918, the castle and business were turned over to his sons. The castle was gutted by fire a number of years ago. Long before Bannerman's acquisition of the island,

Matthew Vassar, the Poughkeepsie brewer, planned to purchase Pollepel and erect a statue honoring Henry Hudson. When his project failed to receive much state or public support, he abandoned the idea and decided instead to begin a college for the education of women.

On the shore immediately behind the island was located the eastern docking point for a pre-Revolutionary ferry that connected with Cornwall Landing. At this same location, an Indian campsite was discovered which contained, at a depth of two or three feet, many oyster shells although oysters have not flourished in the Hudson above Haverstraw in modern times.

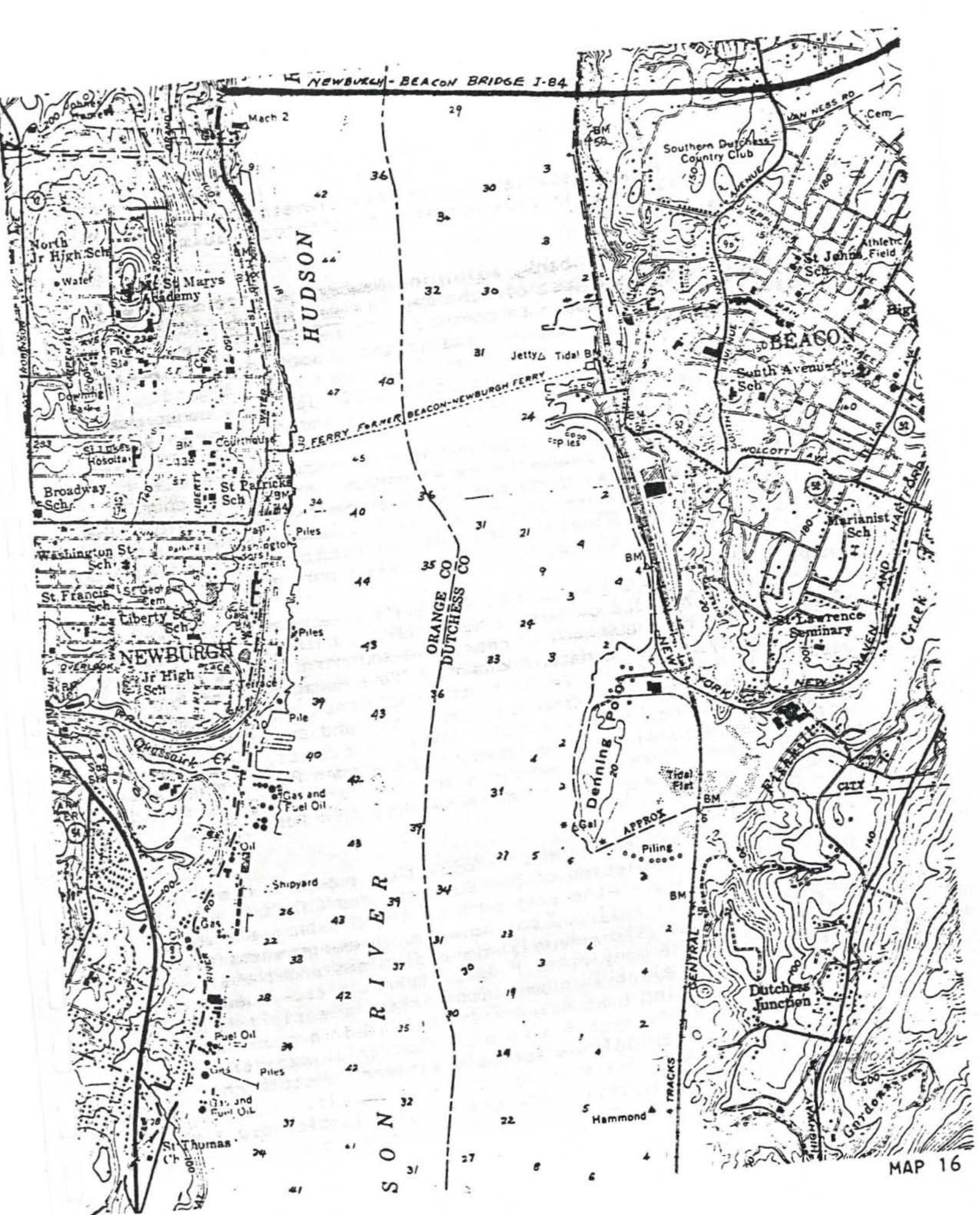
Beyond the northern gateway to the Hudson Highlands, the lower areas on either side of the river at the foot of Sugarloaf and Storm King Mountains, though veneered here and there by varying amounts of glacial deposits as elsewhere north of New York City, are underlain by the Austin Glen Formation, consisting of graywackes (lithic sandstones) and shale deposited in Late Middle Ordovician (Trenton) time.

MAP 16

Denning Point, the southwestern extremity of the City of Beacon at the mouth of Fishkill Creek, was once the site of a flourishing brickyard utilizing good quality Pleistocene clay deposited in a higher stand of the Hudson during deglaciation. Fishkill Creek is the second largest stream in Dutchess County, flowing 26 miles from the vicinity of North Clove with a total fall of about 600 feet or about 23 feet per mile. In bygone years, the stream was used to power cotton mills and foundries located nearby to produce cotton machinery.

What is now Beacon (13,255) was first settled by Francis Rombout and his partner, Gulian Verplanck, who bought 85,000 acres of land from the Indians before the 18th Century. Rombout climbed the "mountain" (North Beacon Mountain?) and claimed "all the lands he could see". His share of 28,000 acres was inherited by the Brett family (Cathryna Rombout Brett) in 1708. Roger and Cathryna built a home in 1709 near the location of the present Beacon High School (see word "High" just visible on the right hand margin of Map 16) which is today the oldest standing structure in Dutchess County. Washington, Lafayette, Von Steuben and other patriots were guests of Madam Brett's granddaughter, Hannah Brett Schenk, in this home. The Madam Brett Homestead is open to the public.

Beacon was formed by the merger of Matteawan and Fishkill Landing, the last-named one of the oldest landings on the Hudson having had a ferry operating from 1743 to the completion of the Newburgh-Beacon Bridge (I-84 crossing) in 1963 visible about 2.5 miles to the north. The City of Beacon was incorporated in 1913 - a newcomer as Hudson River cities are concerned - but it was a pioneer in local government. Beacon was the first city in the United States to adopt the commission form of government; i.e., it is governed by an elected city council, consisting of a mayor and four commissioners in charge of accounts, finance, public safety and public works. The city took its name from the signal fires lit on top of North Beacon Mountain to warn Washington's troops, camped on the western shore, of Sir Henry Clinton's raid up the Hudson in the fall of 1777 (see text Map 13). Today, Beacon is essentially a manufacturing community ideally situated with respect to the railroad and the interstate highway system. The largest single employer is the Texaco Research Laboratory situated in the northeasterly suburb of Glenham.



MAP 16

Not shown on the map, but visible to the southeast of Beacon one and a half miles from the river, is the Mt. Beacon Incline Railway, installed by the Otis Elevator Company, that ascends 1,540 feet in five minutes and affords a 60-mile view on a clear day.

On the western bank, adjoining Newburgh on the south and extending westward just off the map, is New Windsor (8,803), the site of the New Windsor Cantonment. It represents the last winter encampment of General Washington's Northern Continental Army in 1782-83 while waiting for the peace to be signed between England and America. One of the 700 log huts constructed by the soldiers as winter quarters still stands. Between New Windsor and Newburgh is the John Ellison House, a colonial field-stone house built in 1754, better known as Knox Headquarters. It was the military headquarters at various times for Generals Knox, Green and Gates during the closing years of the Revolutionary War. George Clinton, the first elected Governor of New York State, lived in New Windsor and DeWitt Clinton, nephew of George and also a governor of New York State, was born there.

Newburgh (26,219) was first settled by a group of fifty German Palatines led by Joshua Kœcherthal, a Lutheran preacher. They settled near Quassaick Creek, the southern boundary of the present city, under a patent known as "The Palatine Parish of Quassaick" in 1708-09. In 1711, the settlement was subsidized by the British Crown to produce pitch, tar and turpentine, but the operation proved unsuccessful. When the Scots, Dutch and English began to settle there later, the German Palatines gradually spread away from the Newburgh area to join other Palatines further up the Hudson, in the Mohawk Valley, in Pennsylvania and in Delaware.

Newburgh was incorporated in 1865 with a population of 16,000. With the completion of the Dutchess and Columbia Railroad from New England to the east bank of the Hudson and the Newburgh and Wallkill Railroad on the west, Newburgh was situated directly between the Pennsylvania coal mines and the New England markets. Like many other Hudson River cities, Newburgh has experienced a decline in population since the early 1950's whereas the surrounding town has nearly doubled in population. However, it has not shared the kind of industrial expansion characteristic of communities across the river in southern Dutchess County so that its economy is not as stable. In 1972, the Metropolitan Transportation Authority (MTA) initiated a vigorous public relations campaign aimed at selling the virtues of

Stewart Airport west of the city as an ideal place for a fourth Jetport to serve the Metropolitan New York area. The U.S. Air Force had occupied the site, then known as Stewart Field, before the Defense Department abandoned the airport, another blow to Newburgh's economy. The proposal was received by Mid-Hudson residents with mixed emotions. Buildings such as a charter passenger terminal and administration center have been built, but the airport is still largely unused save for occasional charter flights, touch and go landings for airline pilots checking out in jets, air freight traffic and as a diversionary landing site for traffic into New York airports during bad weather there.

General George Washington headquartered in the Hasbrouck House, visible near the waterfront, from April 1, 1782 to August 18, 1783. The Dutch Colonial home was built in 1750 by Jonathon Hasbrouck. During Washington's period of residence here he wrote three famous papers. The first was his rejection of the idea that he be made king of the new nation, refusing also the concept of a monarchy. The second was his address to the New Windsor cantonment putting down a movement by his officers and men to force the Congress to settle their claims against the government before the troops were disbanded thereby affirming the American principle of civilian control over the military. The third was a letter sent to all governors of the states outlining four principles for the future of the nation. He also introduced the "Order of the Purple Heart" here in 1782.

The Newburgh-Beacon Bridge was constructed with only two traffic lanes, one eastbound and one westbound. With the completion of Interstate 84, a four-lane divided highway, it was destined to become a "bottleneck" for the expressway. A parallel twin span has been approved for construction north of the present structure.

The Austin Glen graywackes and shales crop out along the eastern bank nearly to the Newburgh-Beacon Bridge where they give way to the underlying Mount Merino and Indian River Formations consisting of shale, argillite and some chert. Most of the bedrock is obscured by glacial and alluvial deposits on the western side of the river, but the Mount Merino-Indian River Formations are present just south of the bridge.

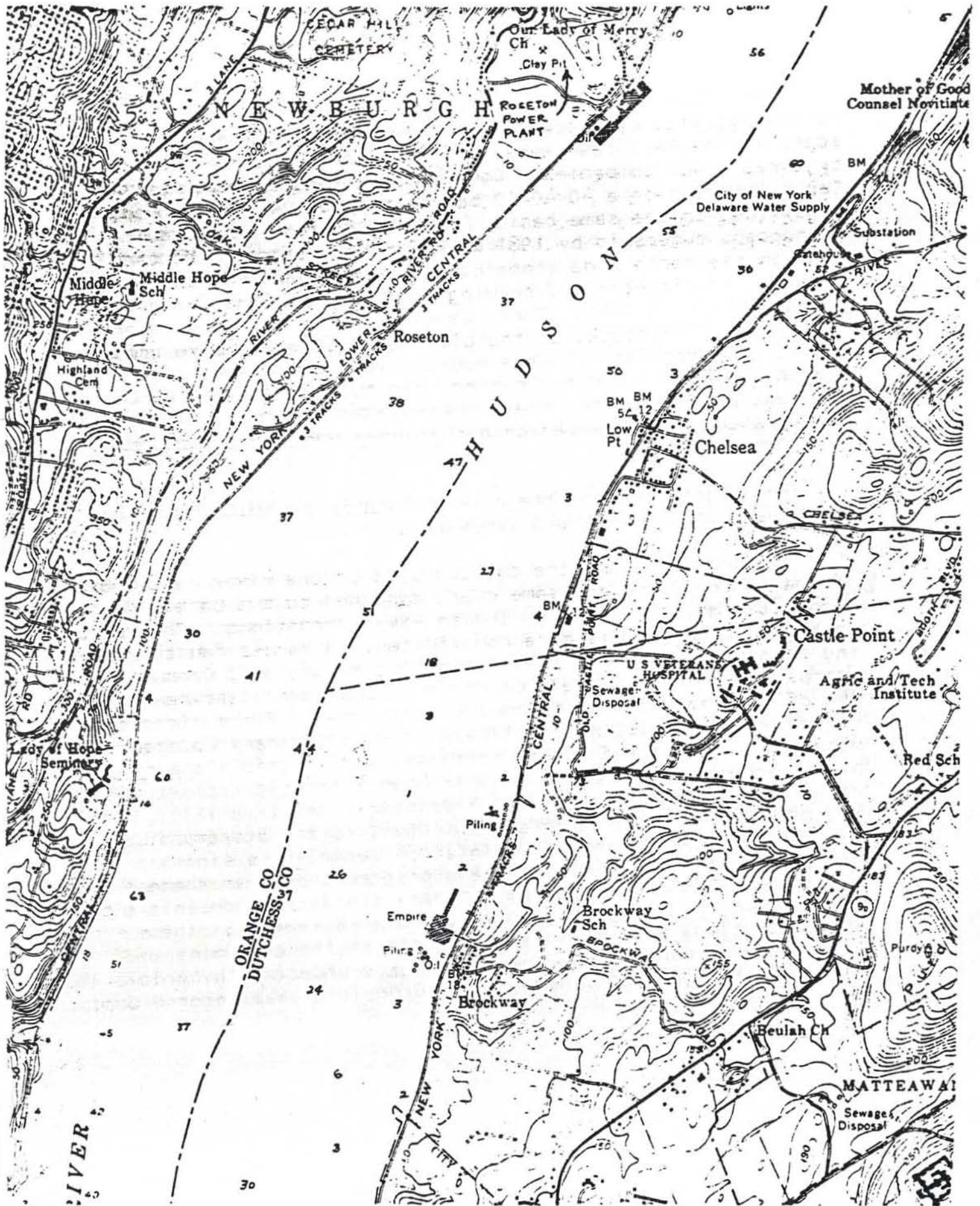
MAP 17

Brockway and Roseton, the latter 2.5 miles north of Brockway on the opposite side of the river, are sites of former extensive brickyards. The Denning Point Brick Works and later the Beacon Brick Corporation operated a clay pit and shale quarry at Brockway and the Jova Brick Works a clay pit at Roseton but they were forced to shut down because the clays became exhausted. The clays in both localities are beautifully laminated or varved and can still be examined at Brockway; the Roseton pit now contains a power plant with oil storage tanks in its deepest portion.

Hudson Valley brick was produced by either the "soft mud" or "stiff mud" processes. "Soft mud" brick was made from clay to which an excess of water has been added to secure plasticity, placed in wooden molds dusted with sand, and allowed to dry before firing. The "stiff mud" or wire-cut method cannot utilize highly plastic clay so ground shale is added to the mix. The clay-shale mix is extruded through a rectangular die and cut off at the appropriate length by a taut wire. Being stiffer, these unfired bricks can be handled with less danger of deformation. In the late 1960's, the Beacon Brick Corporation was making 100,000 wire-cut bricks a day.

The light-colored buildings on the bluff overlooking the Hudson northeast of Brockway are part of the Castle Point Veterans Hospital and immediately north of Castle Point is the small riverfront residential community of Chelsea.

Half a mile north of Chelsea is the river crossing of the Delaware Aqueduct, a part of the New York City water supply system. During the severe drought of the early 1960's, the city's water supply became dangerously low and a plan to introduce Hudson River water into the Delaware water supply system was devised. An intake was installed here, even though the salt front may occasionally move this far north, to mix as much as 100 million gallons daily of Hudson River water with Delaware water in the ratio of 1:10. It was estimated that after screening to remove solids and several chlorinations, with waiting periods in the West Branch, Kensico and Hillview reservoirs, the water would be ready for consumption by New York City residents in three months time. The drought broke and the Chelsea Intake was never used.



MAP 17

The clay pit formerly worked by the Jova Brick Works is now occupied by a power plant new to the Hudson River scene in the last few years. This oil-fired complex is owned by three power companies - Con Edison, Niagara Mohawk and Central Hudson on a 40-40-20 basis, respectively, and output is divided on the same basis. Central Hudson is to acquire 50 percent ownership by 1981 with future options. The tank farm on the north side contains six tanks, each 48 feet high, 185 feet in diameter and holding 8 million gallons for a total of 48 millions gallons. Three tankers supply this fuel every two weeks. The stacks on the plant are 260 feet above ground level. A comparison of the Hudson River power plants, including numbers of units, rating, and fuel used is given on the next page. All but the Danskammer Point plant, seen directly ahead, were passed on our journey northward from New York City.

The region west of the river is largely agricultural with many small fruit farms and vineyards.

The bedrock along the eastern side of the river is composed of shale, argillite and some chert assigned to the Late Middle Ordovician Mount Merino and Indian River formations. The geology on the western side is more complicated. A thrust fault, branching from that at the foot of Storm King Mountain at Cornwall, trends northeasterly one inch north of the lower left-hand margin of the map. It then follows the west bank of the river and swings westward just north of Lady of Hope Seminary to approximately River Road and curves northeastward to rejoin the river by the Roseton power plant and Danskammer Point. It crosses the river diagonally to the mouth of Wappinger Creek (Map 18). The Mount Merino and Indian River formations form the bedrock in that lower inch and in the indentation between the seminary and the Roseton power plant; the higher ground between these two areas on which Lady of Hope Seminary stands is underlain by the graywackes and shales of the Austin Glen Formation. The higher elevations west of the fault north of the community of Roseton and surrounding the power plant are underlain by dolostones and limestones of the Cambrian-Ordovician Wappinger Group.

HUDSON RIVER POWER PLANTS

<u>Name</u>	<u>Owners</u>	<u>Unit #</u>	<u>Rating</u>	<u>Operating Date</u>	<u>Fuel</u>	<u>Comments</u>
Lovett Plant (Tompkins Cove)	Orange & Rockland	1	23 Mw	1949	Oil	Can switch to use of coal in an emergency.
		2	23 Mw	1951	Oil	
		3	70 Mw	1955	Oil	
		4	198 Mw	1966	Oil	
		5	202 Mw	1969	Oil	
Bowline Point	(Orange & Rockland) (and Con Edison)	1	600 Mw	1972	Oil	Output divided one-third and two-thirds, respectively.
		2	600 Mw	1974	Oil	
Indian Point #1	Con Edison	1	257 Mw	1962	Nuclear	
Indian Point #2	Con Edison	1	370 Mw	1973	Nuclear	Full Rating, 503 Mw
Indian Point #3	Con Edison	1	873 Mw	1975	Nuclear	
Roseton	(Central Hudson) (Con Edison) (Niagara Mohawk)	1	600 Mw	1973	Oil	Output divided 20-40-40 respectively.
		2	600 Mw	1973	Oil	
Danskammer Point	Central Hudson	1	66 Mw	1951	Oil	
		2	66 Mw	1954	Oil	
		3	125 Mw	1959	Oil	
		4	225 Mw	1967	Oil	

MAP 18

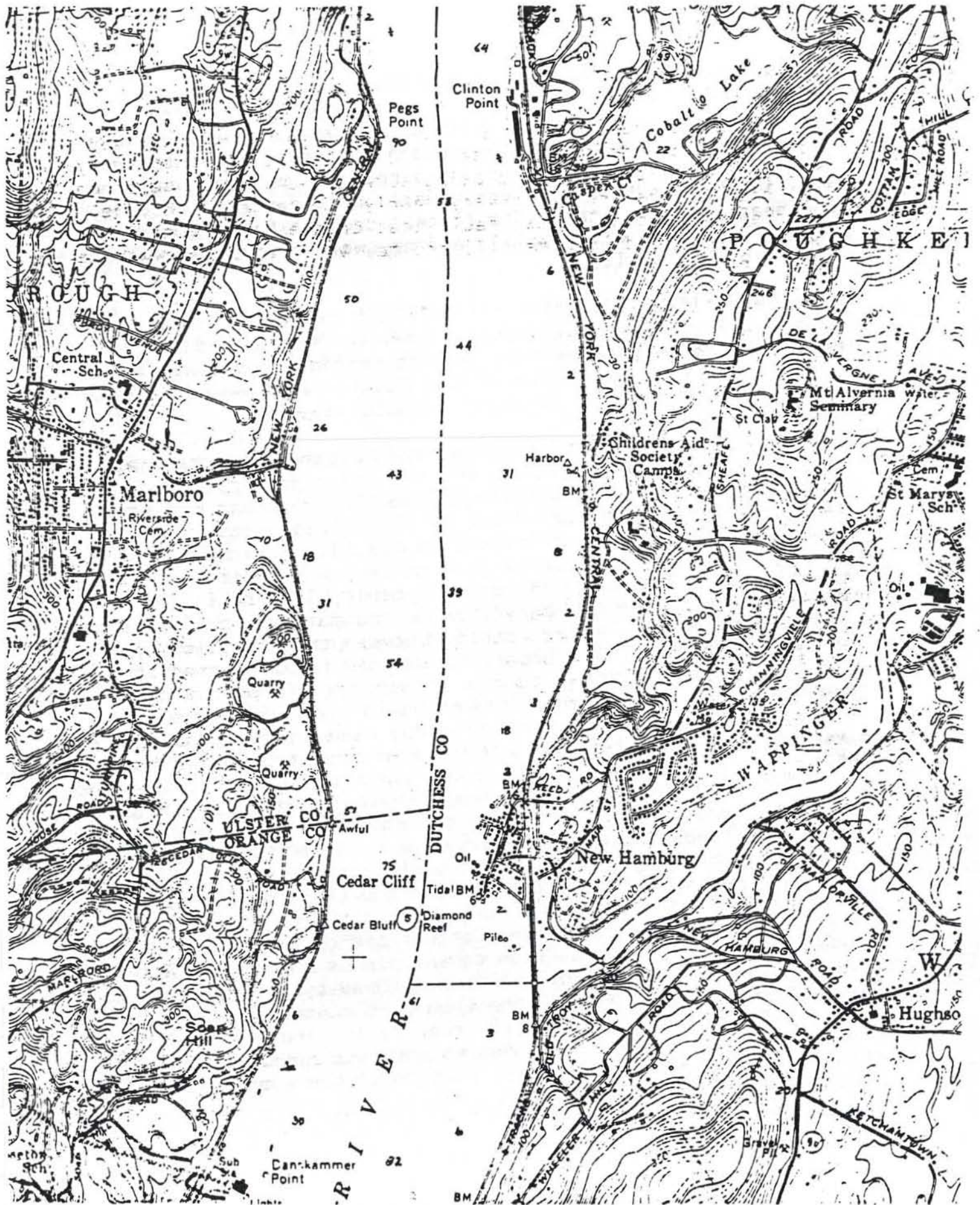
Danskammer Point, jutting conspicuously into the river from the west shore, is the site of the second and older of the two power plants in this area. Ground was broken for this electrical energy-generating plant in 1949 and the first unit, capable of producing 70,000 kilowatts, was placed into service in 1951. A second unit the same size as the first was installed in 1954, a third doubling the capacity in 1959, and a fourth nearly doubling the capacity again in 1967 (see Table with text for Map 17) for a total investment in the plant of \$83 million.

Legend has it that Henry Hudson, on his voyage of discovery up the river on a fall evening in 1609, espied ghostly figures (presumably Indians) dancing by flickering firelight on the point and he referred to it as "de Duyvil's Dans Kammer" or "the Devil's Dance Chamber". Danskammer marks the beginning of "de Lange Rak" or "the Long Reach" of early Dutch sailors, a straight section of the Hudson River extending nearly 12 miles past Poughkeepsie to Crum Elbow south of Hyde Park.

On the opposite shore, one mile to the northeast, is the mouth of Wappinger Creek, the largest stream draining Dutchess County. It flows 32 miles from Pine Plains in the northeastern part of the county to the Hudson River at this location with a total fall of 460 feet and an average fall of about 14 feet per mile. It is tidal in its lowest 1.5 miles.

New Hamburg is a small residential community adjoining the Hudson on the north side of Wappinger Creek. The oldest section of the village between the railroad tracks and the river is quaint but shabby and densely settled for its size. A large marina dominates the waterfront. On both sides of the river, from New Hamburg to Poughkeepsie, are several areas selected by the Hudson River Valley Commission a few years ago for study as possible recreation sites.

On the opposite side of the river from New Hamburg may be seen the loading dock for New York Trap Rock Corporation's Cedar Cliff quarry. However, the company's main source of stone in this area is the Clinton Point quarry operation a part of which is visible on the eastern shore 2.5 miles to the north. From this point on, Ulster County marks the area west of the river's centerline.



MAP 18

As we cruise into the waters between New Hamburg and Cedar Cliff, there is a shoal five feet below the surface of the water at mean tide level known as Diamond Reef. Unlike other shallow areas along the Hudson's course, it is totally isolated from the mainland being surrounded by deep water on all sides. The "reef" is very nearly on the strike of the northeast-trending thrust fault that crosses the river at this point (described with Map 17) and may well be in some way related to that fault.

The village of Marlboro (1,850), situated astride U.S. Route 9W, is a small residential community that serves as the center of the extensive fruit growing region on the western side of the river that makes Ulster County rank second among New York State counties in fruit production.

The Clinton Point Quarry operated by the New York Trap Rock Corporation, a subsidiary of Lone Star Industries, Inc., is the largest quarry along the Hudson River and one of the largest in New York State if not in the United States. The quarry opening is in part located on Map 18 and in part on Map 19, though the plant area is entirely within the limits of Map 18. Very little of the quarry opening is visible from the river because of the company's policy to maintain a 500-foot wide buffer zone or "mercy strip" between the operation and the Hudson River. The company is engaged in stone production of all sizes from riprap to stone screenings (stone sand). It involves a purely mechanical reduction in size from the large fragments produced by blasting (riprap) used in breakwaters to a variety of aggregate sizes utilized in construction (primarily roads) to stone sand for fill or certain masonry work. The rock is dolostone containing an average magnesium carbonate content of 38.16 percent and it meets all the specifications of the New York State Department of Transportation. Visible along the waterfront are the long screen house atop the storage silos, a variety of buildings housing shops and offices and the loading dock for transferring crushed stone to barges for shipment downriver to the metropolitan New York area. Barge traffic from this and other stone quarries, as well as from cement plants up river above Kingston, is a common sight. They are towed by a tug in pairs usually four barges long. Stone from this quarry has been shipped as far as Bermuda to pave the runways at Kindley Field because the soft Bermuda limestones do not have necessary skid resistance when wet. The deepest portion of the quarry is 175 feet below river level.

MAP 19

The area of greatest development in the Clinton Point quarry (Map 18) lies just inside the southern margin of Map 19 on the eastern bank of the Hudson River. The quarry opening at the present time extends northward from that shown on the map more than 2,000 feet (slightly more than one inch) across what was once Camelot Road to the deep re-entrant at the 50-foot contour line. Unfortunately, the Poughkeepsie Quadrangle has not been updated since 1957. Clearly visible on the map and from the boat is the buffer zone purposely left by the company to preserve the river view. As the operation progresses northward, it will eventually become visible from the river through that re-entrant at the south end of the cove isolated by the railroad. This, however, will not take place for years as the northern half of the quarry has been developed only to the +50 or +20-foot levels and deepening is planned to at least -175 feet before further expansion to the north.

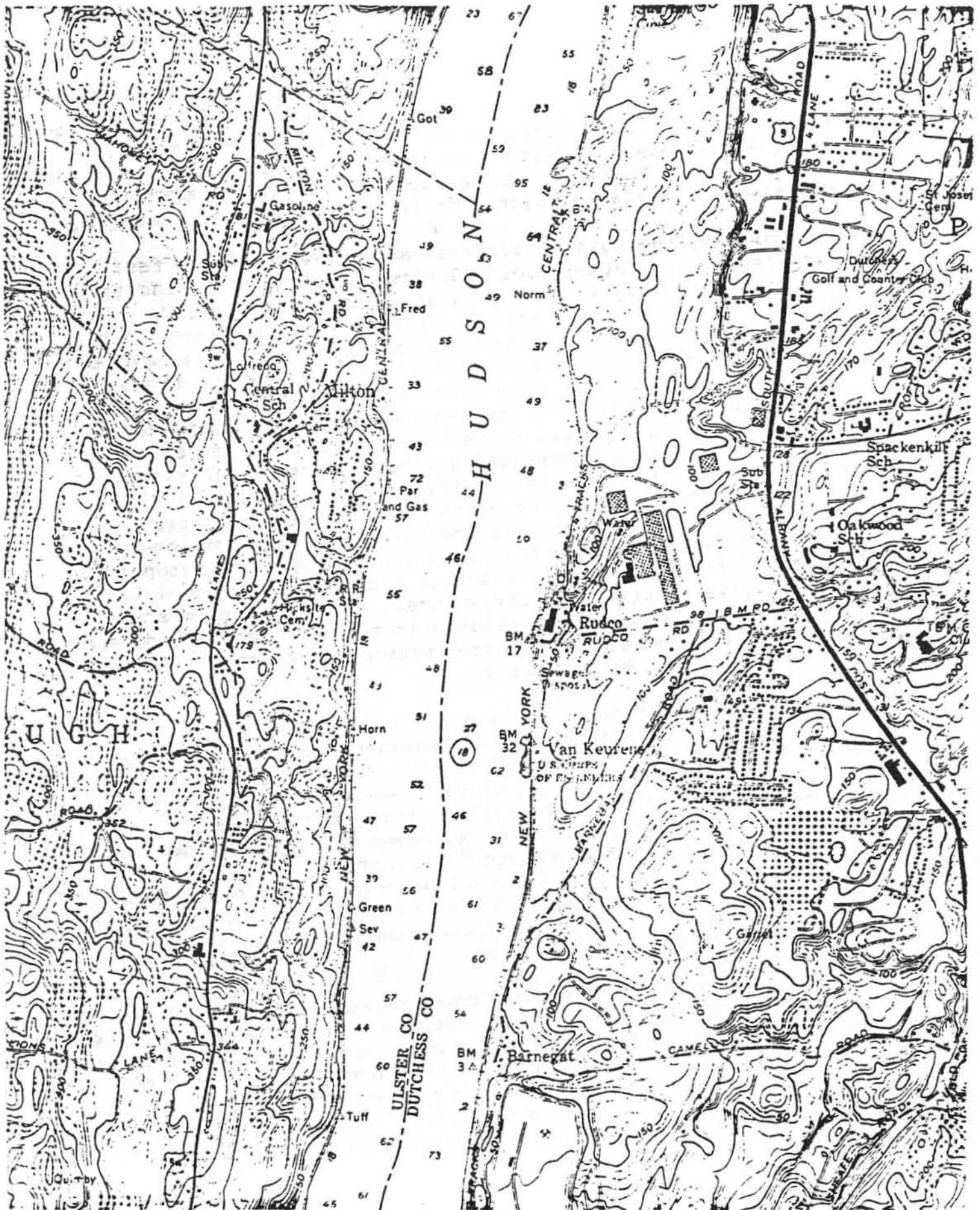
Throughout the length of this map, more or less the middle section of "de Lange Rak", the river is bounded mostly by natural areas, including steep cliffs and wooded zones. The bluffs on the eastern shore rise 80 to 100 feet above river level whereas the bluffs on the western side rise to elevations of 200 or more feet above the river.

The only unnatural aspects of this generally culturally-uncontaminated shoreline are the railroads at river level on both banks and the Town of Poughkeepsie sewage disposal and treatment plant at Rudco midway along the eastern shore. At present, this plant only gives secondary treatment to sewage before discharging it into the Hudson; i.e., it chlorinates, digests and aerates the material before discharge into the river. It will be upgraded to a tertiary treatment plant in the future.

On the bluff above Rudco but hidden from river view is one of three International Business Machines complexes in the Mid-Hudson Valley. The other two are at East Fishkill and Kingston. Frederick E. Hart, inventor of the wire wheel in England which made the modern bicycle possible, came to the United States in 1884 and settled in Poughkeepsie. Ten years later, the Hart Company obtained contracts with several other companies interested in tabulating machines and, in 1911, this company was one of three that united their work which amalgamated into IBM in 1924. It is reported that IBM owns one mile of waterfront from Rudco to the north.

Carbonate rocks of the Cambrian-Ordovician Wappinger Group occur along the west side of the river to a point on the bank due east of Marlboro. Here still another thrust fault trends diagonally northeast across the Hudson River to a point slightly north of Barnegat (Map 19) and, north of this fault, shales, argillites and siltstones of the Late Middle Ordovician Normanskill Formation make their appearance to the northern limit of the map.

On the eastern side of the river, the Mount Merino Formation crops out along the shore north to Wappinger Creek where it makes fault contact with the carbonates of the Wappinger Group. The Wappinger carbonates, in turn, form the bedrock in the higher areas about New Hamburg and to the northeast. The low area along the railroad tracks north to Clinton Point and then extending northeast through Cobalt Lake is underlain by the Normanskill Formation and the Clinton Point quarry area is underlain by another faulted slice of Wappinger carbonates. Detailed mapping of the rock units exposed in the quarrying process last year by the author demonstrated that the specific Wappinger units in the quarry area are Briarcliff Dolostone (latest Cambrian) underlain by the Pine Plains Formation (Late Cambrian). The full thickness of these units was not determined but 585 feet of Briarcliff and 578 feet of Pine Plains were mapped. These rocks continue along the east bank to the northern margin of the map.



Opposite IBM, is the small residential community of Milton in the heart of the Ulster County orchards and vineyards. It lies midway between Marlboro on the south (Map 18) and Highland on the north (Map 20). Throughout this 8.5-mile stretch are a number of cold storage plants for fruit and several wineries.

High on the eastern bluff at an elevation of 180 feet, set back from U.S. Route 9, about 800 feet one inch below the top margin of the map, is a "plus-shaped" home once owned by Samuel F(inley) B(reese) Morse, the inventor of the telegraph. Unfortunately (or fortunately as the case may be) the home is hidden from river view by a dense growth of trees. Morse purchased "Locust Grove" in 1847, three years after his famous message had been flashed over the wire between Washington and Baltimore. He became very fond of Locust Grove and returned to the beautiful estate summer after summer during the 24 years until his death in 1871. The original part of the house was erected in 1830, but Morse added rooms on the north and south sides. Later he added a drawing room on the west and carried this addition up four stories to make a tower which finally gave the home its present outline. Although Locust Grove is a Registered National Historic Landmark, it is still privately owned. The present owner, Miss Annette Young, has made provisions in her will for an endowment to create the Samuel F. B. Morse Museum on her death. The house will then be open to the public.

On the east side of the river, the Cambrian-Ordovician dolostones of the Wappinger Group continue to crop out adjacent to the Hudson from Map 18 north to the small unnamed isolated cove nearly half a mile north of Barneget. Immediately north of this locality, the Normanskill shales, argillites and siltstones form the bedrock. These two major units are separated by the northeast-trending thrust fault that crosses the river diagonally from a point on the latitude of Marlboro (described with Map 18). The Normanskill Formation gives way to the Poughkeepsie Mélange (to be described with Map 20) at Sunfish Cove at the northern border of the map.

The Normanskill Formation also crops out on the west bank to a point approximately opposite Rudco and then the Austin Glen Formation, consisting of graywackes and shales, forms the bedrock to the northern margin of the map. Though not visible on this Map or Map 20, the higher hills on the western skyline, known as the Marlboro Mountains, expose upper Middle Ordovician Quassaic Quartzite which lies conformably on the Austin Glen Formation.

MAP 20

At the foot of Blue Point Road (Oakes), on the western side of the river, is located the Hudson Valley Wine Company, one of many small wineries in the region. The vineyards, covering 100 acres, were begun in the second half of the 19th Century by the Bolognesi (Bole-un-yay-zee) family who run the entire operation today. Guided tours are offered.

A commanding view of Poughkeepsie and its environs is afforded from the 250-foot bluff in front of the winery. This point of land, now known as Blue Point, was called "de Juffrouw's Hoeck" or "the Madam's Point" by the early Dutch and it makes the only kink in the otherwise straight "Lange Rak" or "Long Reach" of the Hudson River.

The southern city limit of Poughkeepsie (32,029) at the waterfront is marked by the northern end of the Poughkeepsie Rural Cemetery. The city has slightly more than two miles of river front land which extends to a point 1,600 feet north of the railroad bridge at the Dutton Lumber Company.

The land in and around Poughkeepsie, sometimes referred to as the "Queen City" of the Hudson, was purchased from the Indians by Mydert Van Den Bogaerdt, a Dutchman, and Robert Sanders, an Englishman, who in turn leased it to two Dutchmen, Baltus Van Kleeck and Hendrick Ostrom. Most people seem to think that the name Poughkeepsie was derived from its original Mahican inhabitants, "Apo-keep-sinck", meaning safe and pleasant harbor. That story was invented by historians. Henry Noble McCracken, former President of Vassar College from 1915 to 1946, while engaged in research for his book "Old Dutchess Forever!" (1956) brought the true origin of the name to light from old deeds and patents. Indian trails followed the Hudson as our highways do today. The north-south trail along the bluff on the eastern side of the river intercepted a "kill" that rippled through a glade in what is now the Poughkeepsie Rural Cemetery (it still does) and it was called "Pakakcincg" and "Pooghkepesingh" in the earliest settlers' records. In 1700, a local deed refers to the stream as a "creek called by the name of Rust Plaets (by the Dutch) or by the Indians Apopeesing". A map of this area by Henry Livingston, Jr., a surveyor, marked the spring along the creek as "Rust plaets spring" Here then lay a station along the Indian runners' path from the Hudson Ford at Albany to Manhattan,



* Point of debarkation - Dutton Lumber Company

in New York and Albany. The situation affected grain producers throughout the Mid-Hudson region and before long there was a shift to dairy farming and manufacturing, which continue today as the major industries of the area.

During the 1830's, Poughkeepsie rivaled Hudson and Newburgh as a whaling port, the docks of the Poughkeepsie Whaling Company and the Dutchess Whaling Company crammed with barrels of spermacetti and oil to fuel lamps and manufacture candles. In all some 30 ships from the three ports roamed the oceans of the world. Ship's logs tell of Hudson River vessels being sighted off Patagonia, of shipwreck's off Valparaiso, and running aground on the Barbary Coast. However, the whaling industry was short lived, falling victim to hard economic times and new sources for illumination such as coal oil in the 1850's and the discovery of crude oil in 1859.

In the decade 1840-1850, industrial expansion in Poughkeepsie saw the likes of carpet manufacturing, foundries, shipbuilding, cooperages, farm machinery manufacturing and the forging of horse-shoes, most located along the waterfront. Perhaps the most renowned was the Smith Brothers Cough Drop Company formed in 1847 by James Smith, a local restaurateur who had been given the formula for an effective "cough candy". He marketed it through the restaurant and the drops became an instant success. Smith's sons inherited the business in 1866 and the name was changed to Smith Brothers. The two brothers, affectionately known as "Trade" and "Mark", had their likenesses engraved on the cough drop box. The manufacture of the cough drops in Poughkeepsie ceased a number of years ago.

Poughkeepsie was incorporated as a city in 1854. Following the Civil War, the city entered into a period of greater manufacturing, with more and more factories and warehouses spreading along the waterfront. Wealthy, socially prominent families who had built palatial homes along the scenic Hudson gradually moved away from the river. Now, over a century later, urban renewal bulldozers have levelled most of these structures which over the years had become empty and dilapidated. Housing in the area suffered the same fate, have deteriorated to slums. The waterfront is now going through a period of rehabilitation with the construction of clusters of middle-income housing (note mansard roofs), high-rise low-income apartments (Rip Van Winkle apartment complex just north of Mid-Hudson Bridge) and riverfront parks.

dividing the trip into two days of seventy miles apiece, an average trot. It was a "resting place" where mats woven from reeds, or "upuhki" of the Indians, were hung on a bent sapling to form a lodge covering or placed on the damp ground as a mattress adjacent to the water place, or "ipis-ing".

There was no military action in the Poughkeepsie area during the American Revolution but several of the first frigates for use in that war were built here. They were burned by the Patriots, however, after General Sir Henry Clinton broke through the chains in the Hudson Highlands (see text Map 13) to keep them out of British hands. Following Sir Henry's burning of Kingston, then the state capital, Poughkeepsie functioned as the capital of New York State. General George Clinton (American), elected Governor of New York in 1777, moved his residence to the Clear Everitt home (built in 1765) in Poughkeepsie to be near the branches of State government convening there and the structure, still standing at 549 Main Street and open to the public, has since been known as the Clinton House. In June, 1778, the convention to ratify the U.S. Constitution met in Poughkeepsie and the State of New York ratified it on July 26, 1788 by a vote of 30-27.

Poughkeepsie was incorporated as a village on March 23, 1799, but, because of technical oversights, it had to be reincorporated on April 18, 1801. In the early 19th Century, Poughkeepsie gained considerable prominence as a river port, with a fleet of eight 100-ton capacity sloops sailing weekly to New York City loaded with grain and flour and bringing back supplies and settlers for "the provinces". One-third of all New York City's flour needs came from Dutchess County and her mills ground more than any other. At about this same time, Matthew Vassar built his brewery that together with stock in other adventures, permitted him to retire a wealthy man at the age of 50. He took ten years after retirement deciding how to spend his money (including the idea to purchase Pollepel Island for a statue honoring Henry Hudson described under Map 15) and ten years more in launching his great idea - Vassar Female College. By 1814, the village had become the first steamboat terminal between New York and Albany, which proved an asset to local economy, as passengers began deserting the Hudson River sloops for the more comfortable and exotic paddle wheel boats. Cargo carrying was still largely left to the sloops. With the opening of the Erie Canal in 1825, Poughkeepsie's and Dutchess County's hold on the grain market began to slip as western New York farmers began competing

The greater Poughkeepsie area can still boast of nearly 100 manufacturing plants but most are no longer on the river. The economy is about equally divided between industry and commerce.

The Mid-Hudson Bridge spanning 0.7 mile from bluff to bluff was completed in 1931 and until the completion of the Kingston-Rhinecliff Bridge to the north and the Newburgh-Beacon Bridge to the south more than two decades later, was the only vehicular link between the eastern and western counties of the Mid-Hudson region. The bridge was originally to be constructed north of its present site but the business community, anxious to funnel traffic into the city center, it is said spent a million dollars to pressure the state into locating the crossing at its present site. The tremendous increase in automobile and truck traffic in the years that followed made it the biggest bottle-neck of all times. It is now costing several million dollars to cure these ills. A new north-south arterial highway (not shown on Map 20), follows the bluff west of the city center with direct access to the bridge and an east-west arterial connecting with the bridge is presently under construction.

At the foot of the eastern end of the Mid-Hudson Bridge and extending south for more than 1,000 feet is Kaal Rock Park, completed a few years ago as part of the riverfront redevelopment. It is the type section for the Poughkeepsie Mélange (more later). Kaal Rock, from the Dutch Kaale Rugh meaning "Bare Rock", is the name given to the promontory jutting into the river immediately north of the bridge.

Just beyond Kaal Rock, at the foot of Main Street, was the site of the former Hudson River Day Line pier and the ferry terminal dock connecting with Highland Landing across the river. Riverside Park, stretching north from Main Street at this locality, was the site of Vassar's brewery and other manufacturers of the time. A little further north, Fallkill Creek enters the Hudson, so named for the falls created as it drops from the higher terrace to the Hudson. Grist mills, flour mills and saw mills formerly used its power but it was abandoned as a power source when coal and steam became generally available.

The railroad bridge, ugly to some and attractive to others, was once a part of the New Haven system. It was completed in 1889, nearly half a century before the Mid-Hudson Bridge. Its construction was authorized after decades of promotion by Poughkeepsie business interests, to provide a direct connection with

the coal fields of Pennsylvania. The bridge, a mile long, was an engineering feat in metal construction at the time. Freight trains, often longer than the bridge, resembled toys from the river as they slowly crossed in either direction. The bridge is no longer used. A disastrous fire in the road bed at its eastern end destroyed a large section of track and warped some of the structure's metal in 1974. As we pass under the bridge, look back and up at the span to see the numbers painted there. These mark the lanes for the sculls when the intercollegiate rowing races, or Poughkeepsie Regatta, were held here. At several places on the west shore to the north of the bridge, college names painted on the rock are still faintly visible. These are the only reminders of the famous yearly spectacle held here on the Hudson River.

Throughout the area of the map on the eastern side of the river is the Poughkeepsie Mélange, so named by Donald W. Fisher, State Paleontologist of New York (Field Guidebook for the 48th Annual Meeting of the New York State Geological Association at Vassar College, October 15-17, 1976, Trip B-6, pages B-6-5 and B-6-26). The type locality is Kaal Rock Park beneath the Mid-Hudson Bridge. Here is found an exquisite exposure of this tectono-sedimentary unit consisting of various sized, angular to rounded clasts of rock with varying attitudes in an unbedded or poorly-bedded argillaceous matrix. Here the blocks are almost exclusively Austin Glen Graywacke; elsewhere, there are varying amounts of quartzite, sandstone, shale and carbonate. This type of sedimentary-tectonic unit (called wildflysch by some) is believed to have resulted when westwardly moving rock masses broke up at their leading edge, spalled off, and tumbled downslope into a deepening basin which was receiving mud. This deposit accumulated during the Vermontian phase of the Taconic Orogeny (mid-Ordovician time). The mélange is distributed irregularly in the lower and middle Snake Hill Shale. West of the river, the rocks are exclusively a part of the Austin Glen Formation.

As we prepare to disembark at the Dutton Lumber Company pier after 75 miles on the lower and middle Hudson, have you noticed that the river is getting cleaner? Tugboat pilots, oil tanker captains, pleasure boat operators, and the Coast Guard have. Based on more than 1,300 samples taken from 1964 to 1973, the state has achieved 95 per cent of its desired goal for the level of dissolved oxygen and 96 per cent for the level of coliform bacteria. No more PCB's are being discharged by General Electric up river and Monsanto is going to stop producing the substance by the end of the year.

