Jamaica Bay: A Case Study of Geo-environmental Stress

by

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INTRODUCTION

Jamaica Bay is the westernmost of the estuarine marshes which lie behind a system of barrier beaches along the south shore of Long Island (Figure 1). Horseshoe shaped, the bay is encircled by a gently sloping glacial outwash plain along its northern perimeter and by the elongate Rockaway barrier beach to the south. Human activities have fundamentally changed the surface character of the region and disrupted the natural geologic processes. The purpose of this paper is to examine the historic relationship between the natural geological environment and human activities.

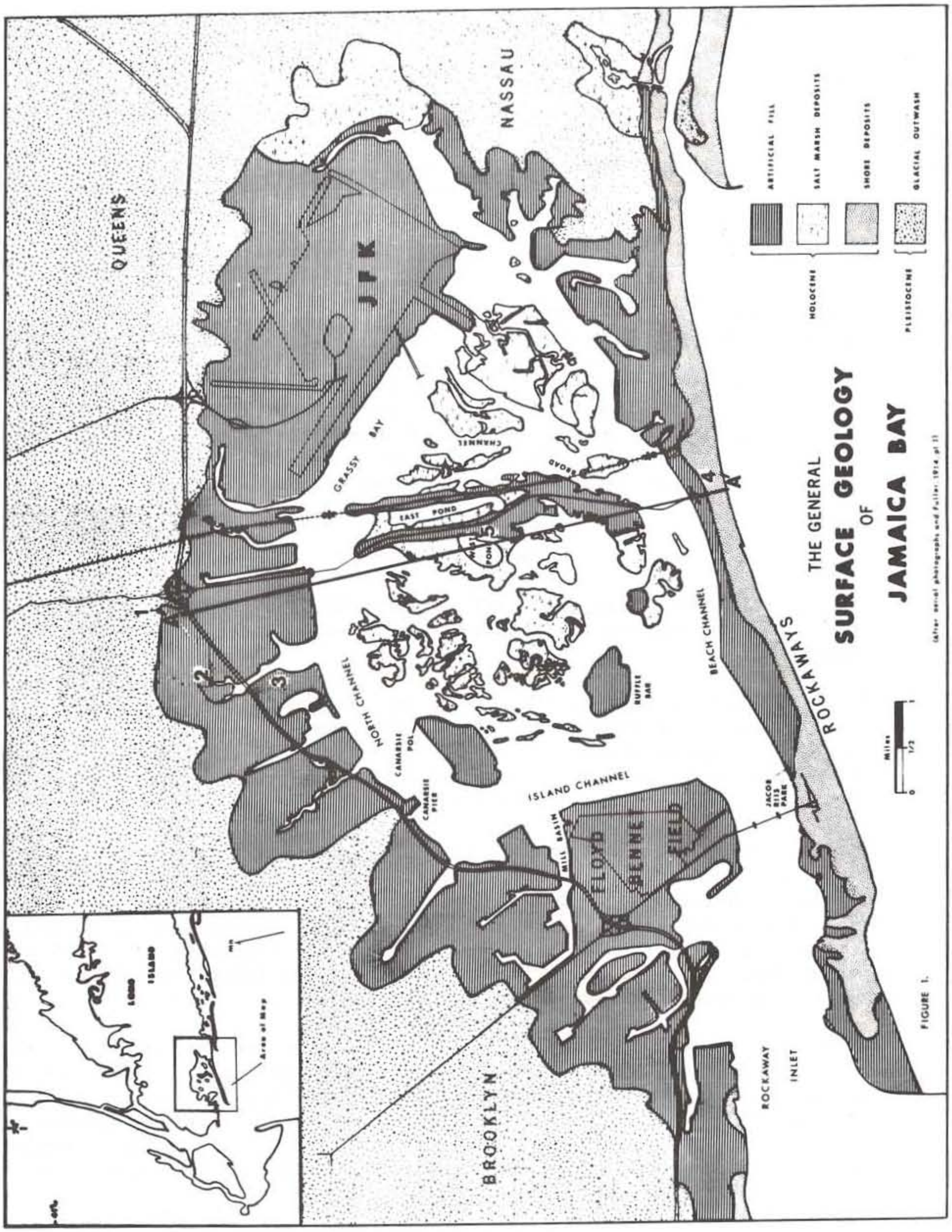
SUBSURFACE GEOLOGY

Although the field trip can visit only the surface of the Jamaica Bay area, the subsurface geology plays a significant role in the recent geo-environment.

The subsurface geology of the Jamaica Bay region is known almost entirely from well logs. A blanket of Late Wisconsinan glacial outwash, itself obscured by modern shore and urban deposits, conceals an unconsolidated sedimentary wedge overlying the erosionally sculpted, southeastward dipping crystalline basement complex of the New York City series.

The basement surface beneath western Long Island is deeply weathered and exhibits relief locally up to 300 feet (Newman, 1966). It strikes approximately northeast-southwest with a dip of about 80 feet per mile and is about 1,100 feet below sea level at Far Rockaway (Sutter, deLaguna and Perlmutter, 1949). Flint (1963) considered this bedrock floor to be a continuous, southward subsurface extension of the facetlike surface in coastal Connecticut known as the "Fall Zone."

Lying unconformably on bedrock in ascending order are: two terrestrially derived formations of Late Cretaceous age, the Raritan Formation, and the Magothy Formation-Matawan Group undifferentiated (Perlmutter and Todd, 1965, p. 9); the Pleistocene pre-Wisconsinan Jameco Gravel and Gardiners Clay; a series of Wisconsinan glacial and interglacial deposits (Rampino, 1973); Holocene shore, bay and salt marsh sediments; and artifical fill deposits.


QUEENS
NASSAU
JFK
BROOKLYN
ROCKAWAYS
GRASSY BAY
EAST POND
NORTH CHANNEL
BEACH CHANNEL
ISLAND CHANNEL
CANARSIE POL
CANARSIE PIER
RUFFLE BAR
MILL BASIN
FLOYD BENNET FIELD
JACOB RIIS PARK
ROCKAWAY INLET
ARTIFICIAL FILL
SALT MARSH DEPOSITS
SHORE DEPOSITS
GLACIAL OUTWASH
HOLOCENE
PLEISTOCENE
Miles
THE GENERAL
SURFACE GEOLOGY
OF
JAMAICA BAY
FIGURE 1.

These stratigraphic units contain the four distinct aquifers described by Cohen, Franke, and Foxworthy (1968, p. 18). These include in ascending order, the Lloyd aquifer (the Lloyd aquifer is equivalent to the Lloyd sand, the lower member of the Raritan Formation), the Magothy aquifer, the Jameco aquifer, and the upper glacial aquifer. Although these predominately sand or gravel or gravel aquifers are generally hydrologically separated from one another by clay or clay-rich sand, they are locally contiguous due to non-deposition, removal by erosion, or facies changes (Sutter, deLaguna and Perlmutter, 1949).

SURFICIAL GEOLOGY

The natural surface geology of Jamaica Bay includes all of the land surface exposed above low tide. Three major sediments: 1) glacial outwash, 2) salt marsh deposits, and 3) beach and dune deposits characterize the area's major depositional environments.

Sloping gently upward away from the northern bay perimeters, the outwash plain is composed of stratified sands and gravels which Fuller (1914, p. 127; pl. 1) variously placed within his Manhasset Formation, described as "outwash from ice along Harbor Hill moraine with outcrops of the Manhasset Formation", or left undifferentiated. More recently Mills and Wells (1974), and Sirkin (1971) have described this outwash as being a glacial meltwater deposit of upper Wisconsinan (Woodfordian) age.

To the south, the narrow eleven mile long Rockaway Peninsula is one of the barrier beaches which separate most of the south shore of Long Island from the Atlantic Ocean. Sand derived from the prevailing westerly drift of the littoral current (Fuller, 1914; Taney, 1961) has added successive recurved beach ridges at the distal tip of the barrier (Johnson, 1919). These have probably doubled the length of the Rockaways within historic time (Bassett, 1967, p. 3). In an 1878 report to the U. S. Army Corps of Engineers, Lt. Col. John Newton calculated westward inlet migration at the rate of 220 feet per year; a figure which is close to Johnson's (1919, p. 416) figure of 200 feet per year for the period 1889-1912. Taney (1961, p. 46) estimated the annual littoral transport rate at Rockaway Inlet to be 450,000 cubic yards.

The upland marshes of Jamaica Bay are presumed to have begun developing in the intertidal zone along the western margins of the outwash plain some 3-4,000 years ago in a pattern analogous to that described by Redfield (1972) in his study of the Great Marshes of Barnstable Harbor, Massachusetts. Two grasses dominate the flora of the marsh: *Spartina alterniflora*, a coarse tough plant, lives within those portions of the marsh flooded twice daily by the tides, while *Spartina patens*, once prized by settlers as salt hay, thrives in the less frequently flooded margins of the marsh. By trapping and binding sediment they cause salt peat to accrete upward and maintain the living marsh in a position in equilibrium with rising sea level (Bloom and Stuiver, 1963; Redfield, 1972, p. 209).

Ground Water Utilization

Exploitation of the four aquifers which underlie Jamaica Bay largely enabled the urban development that has so severely altered the nature of the area.

Utilization of ground water in the Jamaica Bay region began in 1636 when Dutch settlers found the area reminiscent of their native Holland and established Long Island's first settlement in the Flatlands section of "Brookland" (Brooklyn). Shallow dug wells and the numerous natural springs, streams, and ponds were ample sources of freshwater for their domestic and agrarian needs.

Large scale public water use began in the mid 1800's paralleling the increase in population associated with eastward urban growth. By 1880 over-development of the shallow aquifers in western Kings County initiated large scale removal of water from the larger and untapped ground water reservoir in Queens County for public supply uses in Brooklyn (Soren, 1971). Continually increasing water usage finally outstripped natural recharge capabilities. This resulted from two major causes: 1) decreased recharge due to extensive impervious paved surfaces, and 2) the increased development of sewers. Pavements reduced the effective recharge surface area while sewers prevented recycling by piping fresh water into the bay. By 1908 there were about 800 miles of common sewer lines. In Kings County alone this figure grew to 1,700 miles by 1972 (Kimmel, 1972).

By 1947 all public supply pumping had to be stopped. The depressed water table had caused most fresh water streams entering the bay to shrink or disappear and induced massive salt water intrusion of aquifers near the shore. Perlmutter, Geraghty, and Upson (1959) calculated that in southeastern Queens County, the water table had declined by as much as 20 feet between 1903 and 1959. They speculated that increased withdrawals in central Queens were the cause of as much as two miles of landward encroachment.

Significant changes occurred following the cessation of pumping. In 1972 Kimmel observed that water levels in Kings County were nearly the same as they were before intensive urban development. This, despite the fact that impermeable surfaces had been placed on over 90% of the recharge area. Citing abnormally high nitrate concentrations observed in the upper glacial and Jameco aquifers, he suggested that leakage of contaminated fresh water from the dense area-wide network of sanitary and storm sewers was responsible for the unexpected recovery.

Due to easy access to the upper aquifers, the Lloyd was rarely tapped and, the few private wells that currently draw from the Lloyd aquifer generally produce uncontaminated water (Julian Soren, personal communication).

CULTURAL SURFACE GEOLOGY

Man's influence on the surficial geological environment has been profound. The consequences of his actions on each habitat are described below.

The Beach and Dune Environment

The presence of man upon the Rockaway barrier island is apparent even from a distance. Multi-story buildings form a crowded silhouette that suggests how completely the island has been modified. The bay side has been bulkheaded and backfilled to create valuable real-estate, while the ocean shore has been stabilized by the emplacement of over 100 groins. In addition, the once extensive dune fields (Fuller, 1914, p. 181) have been leveled to create a platform for residential housing.

The effects these alterations may have on the barrier as it reacts to the continuing rise of sea level and periodic intense storms are not known. Certainly the processes of oceanic overwash (Dolan, 1972) and landward migration (Sanders and Kumar, 1975) have been halted. The island that was once a flexible wave form in equilibrium with oceanic energies (McCormick, 1972) is now rigid and unyielding.

Storms are an important part of the inventory of geologic process which act on the Rockaway barrier beach. In their natural condition, the low resistance that barrier beaches present to storm surges enables them to survive the severe perturbations of tropical and extratropical storms (Dolan, 1972, p. 277). The Long Island area experiences a storm which causes moderate damage, on the average, about once every two years. Severe storms occur about three times every century. Fortunately, the track of a major hurricane has not crossed Jamaica Bay since 1893 (Davies, Axelrod, and O'Conner, 1973).

In 1960 and 1962, two severe storms accompanied by high winds and tides, struck the New York area. Flooding was extensive in Jamaica Bay and the Rockaways were severely eroded. In 1965 the U. S. Army Corps of Engineers revealed plans for a dike and sea wall 18 feet above the mean high water (eight feet above the 10 foot elevation of the beach) to run along the Rockaway Peninsula for six miles before crossing over in the vicinity of Riis Park to join up with a 4,530 foot long hurricane barrier. This was to have straddled Rockaway Inlet to connect with a dike 1.2 miles long on the Brooklyn shore. A six hundred foot opening in the center of the barrier was designed to close at the time of high water. Legislative delays, rising high costs (53 million dollars in 1965), and public concern for shore access and water quality (construction by the gates would increase residence time of water in Jamaica Bay) defeated the plan.

The Bay-Salt Marsh Environment

A salt marsh is a natural storm buffer. By intercepting wave shock and absorbing water, marshland is capable of mitigating the effects of storm surge. Johnson (1969) calculated that one acre of marsh is capable of holding 300,000 gallons of water through its sponge-like peat and grass composition.

In 1907 Jamaica Bay was 24,640 acres in extent. Of this, 16,170 acres was marsh. However during the first seventy years of this century at least 125 million cubic yards of marsh and bay bottom was dredged from Jamaica Bay. By 1970 dredging and filling had reduced the bay to only 13,000 acres of which only 4,000 were marshland. Dredging also increased the original average water depth from 3 to 16 feet. Dredging and filling are in part responsible for the contaminated condition of bay waters. By decreasing tidal flushing action, these operations have impounded the water pollution caused by storm overflow, street runoff, and the outfall from sewage treatment plants. Dredging accounts for 70% of the present volume of the bay. Coupled with decreased tidal flow caused by the filling of marshes, this equates to a higher residence time for pollutants entering the estuary. Contemporary turnover rates of about 35 days are more than triple Jamaica Bay's original retention time of 10 or 11 days.

Although a concert of other causes have contributed over the years to high water-pollution levels in Jamaica Bay, many of these effects are short lived (e.g., oil spills) or technically correctable (e.g., sewage disposal). However, the destruction of bay bottom and salt marsh environments are almost totally irreversable actions. It is difficult to imagine how the amount of material necessary to restore Jamaica Bay's bottom could be obtained (Grassy Bay is now over 50 feet deep in places). The high marsh is essentially a non-renewable resource (Redfield, 1972) and even under controlled conditions Spartina alterniflora is difficult to regenerate (Terry, Udell, and Zarudsky, 1974). Taken in the complete context of the ecologic, economic, educational, and esthetic benefits provided by marshes (Teal, 1969), the destruction of 75% of Jamaica Bay's marshes amounts to a questionable final choice in land use and resource utilization.

HISTORY OF LAND USE

Interpretation of a modern surface geology map of Jamaica Bay (Figure 1) is best made in the context of a historical as well as geological narrative. In addition to geological processes which have shaped the modern sediments of beach, bay, and marsh; patterns of population growth, evolving technology, geographic proximity to the urban hub, and planning influenced by political and economic considerations must be examined.

Such patterns are apparent in the below listed chronology*:

Land Use in Jamaica Bay: An Historical Outline

1636 Flatlands, the first settlement on Long Island is established by Dutch colonists; the Hudde and Gerritsen Grant is obtained from the Canarsie Indians securing ownership of most of the western bay.

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* Compiled from many sources. Those not listed in the bibliography include newspaper clippings and other sources from the reference section of the Queensboro Central Library in Jamaica and the vertical files of the Environmental Information Service Library, S.U.N.Y. Stony Brook.

1650 English obtain the area from Peter Stuyvesant and name it "Jamaica" after the Jameco Indians.

1651 Flatbush is settled.

1655 Governor Nicholl confirms a patent for marshes bordering Jamaica Town "to extend southeast to the Rockaway Swampe."

1656 A patent is issued granting ownership of valuable salt hay meadows to "indwellers and inhabitants of the Canarsie meadows lying east of The Indian Planting Ground."

1850 Development of large tourist industries along the ocean beaches, and fishing industries within the bay.

1877 The Long Island Rail Road testle to the Rockaways is built.

1880 Queens County begins the large scale pumping and export of ground water to Kings County.

1898 To protect the ocean beachfront a pneumatic lift system, serving a summer colony of 29,000, goes into operation at Far Rockaway. The ejectors lift sewage over the barrier island and discharge it into Jamaica Bay.

1903 New York City takes title to the Jamaica Town colonial patents. The area includes some 7,000 acres and 12 miles of waterfront in and around Grassy Bay.

1906 Harry Chase Bearly publishes an influential pamphlet urging large scale commercial development and conversion of Jamaica Bay into a major deep water port.

The Jamaica Bay Improvement Commission is appointed.

1910 An act is passed by the State Legislature ceding all land under water in Jamaica Bay to the City of New York.

New York City and the Federal Government enter into a cooperative agreement to develop Jamaica Bay via deep-channel dredging.

1913 Purchase of Brooklyn's Marine Park is authorized by Mayor Mit hel.

The main channel from Barren Island to Mill Basin is dredged to a width of 500 feet and a depth of 18 feet.

1921 Completion of the Mill Basin Pier, the first commercial pier in Jamaica Bay. It is 1,200 feet long and made of concrete.

All shellfish beds are closed.

1922 Deputy Dock Commissioner Henry A. Meyer proposes extensive further development in Jamaica Bay.

1923 The Jacob Riis State Park shore is fitted with groins and a bulkhead.

Cross Bay Boulevard is completed.

1925 Jacob Riis Park is opened.

1927 Groins and a bulkhead are constructed between Fort Tilden and Rockaway Point.

Groins and beach fill are emplaced east of Jacob Riis State Park.

1930 An act passed by the State Legislature permits the City of New York to lease lands fronting Jamaica Bay for commercial purposes.

Robert Moses proposes that the world's largest waterfront park be created in Jamaica Bay.

1931 Floyd Bennett Field, New York City's first municipal airport, is created by filling 1,320 acres on Barren Island.

1933 A jetty is constructed at Rockaway Point.

1936 Sanitation Commissioner William F. Carey proposes that the marsh islands in the center of the bay be converted into a garbage dump. City Park Commissioner Robert Moses fights the plan and wins.

Copies of a resolution sponsored by 90 Jamaica Bay civic associations urging completion of a circumferential highway along the eastern and northern shores of Jamaica Bay is forwarded to Commissioner Moses.

1937 A court ruling against private claims based on the Hudde and Gerritsen Grant gives New York City clear title to 1,774 acres, including Floyd Bennett Field.

1938 Expanded facilities, including parking for 9,000 cars, are completed at Jacob Riis Park.

The Marine Parkway Bridge is opened.

Robert Moses' recommendations for large scale park and recreational use of City-owned bay property are accepted; Jamaica Bay becomes a New York City park. The plans include six beaches, ball fields, a golf course, a marina, and a wildlife refuge.

The Belt Parkway is completed.

Cross Bay Boulevard is widened to 8 lanes.

A dredging permit is authorized for 60 million cubic yards of fill for creation of Idlewild (John F. Kennedy) Airport.

1941 Canarsie Pier is completed.

1942 Floyd Bennett Field is converted to a Naval Air Station.

1946 Grassy Bay is dredged to a depth of 50 feet and 4,900 acres of tidal marsh are filled as part of the construction of Idlewild Airport.

1947 All public supply pumping of ground water is stopped in Kings and Queens Counties.

1948 Idlewild Airport is opened.

1950 Part of the Long Island Rail Road's wooden trestle burns and the railroad elects to abandon the spur.

The New York City Transit Authority decides to run a subway to Far Rockaway and replace the trestle along Broad Channel with a viaduct built from bay-bottom sand.

Robert Moses grants permission to dredge to the Transit Authority in return for construction of dikes for two fresh water ponds for a wildlife refuge. The dikes require six million cubic yards of fill.

1953 Diking of the ponds is completed and the Jamaica Bay Wildlife Refuge is established.

Herbert Johnson is placed in charge of the refuge and initiates a planting program which stabilizes the sand dikes and attracts wildlife.

1956 Digested sludge from the Hendrix Creek Sewage Treatment Plant is mixed with sand and applied to Carnarsie Pol to create, after planting, a "wildlife cafeteria." Canarsie Pol becomes the largest island in the bay.

1958 4.3 million cubic yards of sand is dredged to form the Easterly Runway extension at John F. Kennedy Airport ("JFK").

1962 11.5 million cubic yards of sand is dredged to form the Westerly Runway extension at JFK.

For seven months while repairs are made on the South Ozone Park Sewage Treatment Plant, raw sewage is dumped into Bergen Basin. Gases generated by the sewage blackens paint on homes nearby.

1964 Bergen Basin is dredged to remove decomposing sewage.

1969 The Port of New York Authority commissions a study of the environmental effects of the construction of two large runways at JFK.

1971 The two volume multi-disciplinary study "Jamaica Bay and Kennedy Airport" is released. It recommends against airport expansion.

1974 The National Park Service takes over large areas in the bay to create the Jamaica Bay Unit of the Gateway National Park.

DISCUSSION

Several generalizations regarding land use and resource utilization emerge from an examination of this historical sequence of events. The period of 1636-1850 was characterized by a non-disruptive or "passive" relationship with the geo-environment in which human activity was, for the most part, in harmony with natural geological processes. During this time man lacked either the technology, economic incentive, or need to overtly alter the bay area. The period from 1850-1900 was "transitional" in the sense that previous land uses were being abandoned as an ever increasing population placed new demands upon the resources of the bay. During the period of 1900 to the present man has interacted in an "intensive" fashion with the bay area geo-environment.

As used here, "intensive" refers to interaction with the environment such that man himself becomes a geologic agent, i.e., a force effecting or facilitating geological-scale changes. By moving, removing, adding to or otherwise changing earth materials, man has altered the character of the sedimentary record. More importantly perhaps, in a time frame measured on the scale of human life and values, by modifying Jamaica Bay's interdependent biologic and geologic processes without a full awareness of or regard for the long term environmental implications, man has brought about changes which have eliminated important land use alternatives.

The intensive-use years were especially destructive primarily because of the manner in which human impact was involved. Conflicting political jurisdictions, interests, and sources of funding led to a haphazard development pattern during the first part of this century. When several powerful regional authorities were unified in 1934 under the aegis of New York City Park Commissioner Robert Moses (Caro, 1974, p. 362), they were totally without environmental accountability. In one stroke Moses' Circumferential (Belt) Parkway simultaneously blocked recreational access to most of the shoreline, made the automobile the most important form of area transportation, initiated large scale landfilling along the flanks of the parkway, and cut off much of the natural flow of fresh water into the bay.

The great Jamaica Bay Park which Moses proposed to compliment the boulevard and parkway skeleton, was never built because polluted bay water made construction of a multi-million dollar bathing-beach park unfeasible. As a result, the major part of the central bay remained relatively undisturbed.

In effect, the preservation of the last natural part of the bay was made possible by the fouling of surrounding areas; an irony that should be appreciated by those who scorn Jamaica Bay's polluted waters while enjoying her relatively unspoiled marshes.

CONCLUSIONS

The geologic character of Jamaica Bay is the result of both natural events and human activities. The historical development of the Jamaica Bay geo-environment provides a model useful in predicting effects of, and (where appropriate), seeking alternatives for man-induced changes in similar settings.

Intentions to modify any analogous coastal region should be carried out within the context of modern planning methods that include periodic reassessment and a comprehensive understanding of regional geologic processes.

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ROAD LOG

Assembly Point: Hofstra University

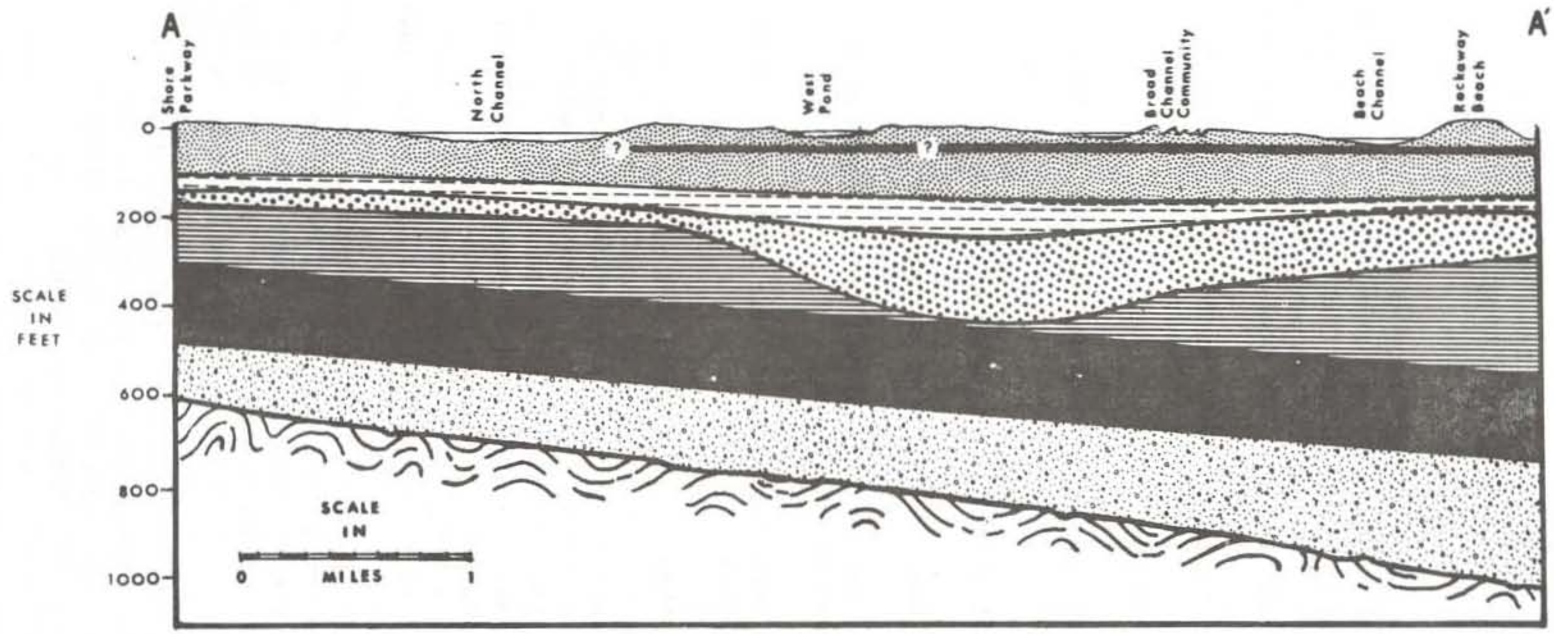
Departure Time: 8:30 A.M.

Trip Leaders: Steven Englebright, S.U.N.Y. at Stony Brook.
Julian Kane, Hofstra University

Cumulative Miles	Miles from last point	Description
0.0	0.0	Leave Hofstra University (Begin mileage under foot bridge) proceeding west on Rt. 24.
0.9	0.9	Turn left (south) onto Peninsula Boulevard.
6.1	5.2	Turn right (west) onto Merrick Road.
9.5	3.4	Turn left (south) onto Brookville Boulevard.
10.0	0.5	Turn right (west) onto North Conduit Avenue and continue on it until intersecting the Cross Bay Boulevard.
15.7	5.7	Make a right turn (north) onto the Cross Bay Boulevard and get into the left turn lane (quickly!).
15.9	0.2	Turn left onto 149th Avenue. Go one block to the corner of 149th Avenue and Redding Street.

STOP 1. This street corner is approximately on the boundary of what was, at the turn of the century, the shore of Jamaica Bay. Stretching out before you to the south was one of the great salt marshes of the northeast. Its 16,000 acres were penetrated by shallow meandering channels bordered by smooth chord grass, *Spartina alterniflora*. A broad belt of high marsh, the outer edge of which was approximately where we stand, was covered by *Spartina patens.* Notice that today you cannot even see the bay from here. The urban development that is apparent everywhere in this vicinity is typical of almost all of the former upland margins of Jamaica Bay.

Notice also figures 1 and 2 of the field guide.



A Generalized Geologic Cross Section of

Jamaica Bay

along Cross Bay Boulevard

Geological section information from SOREN, United States Geological Survey (oral communication, September 1975) and from well data on file at Mineola, New York. Data is provisional and subject to revision.

Explanation:

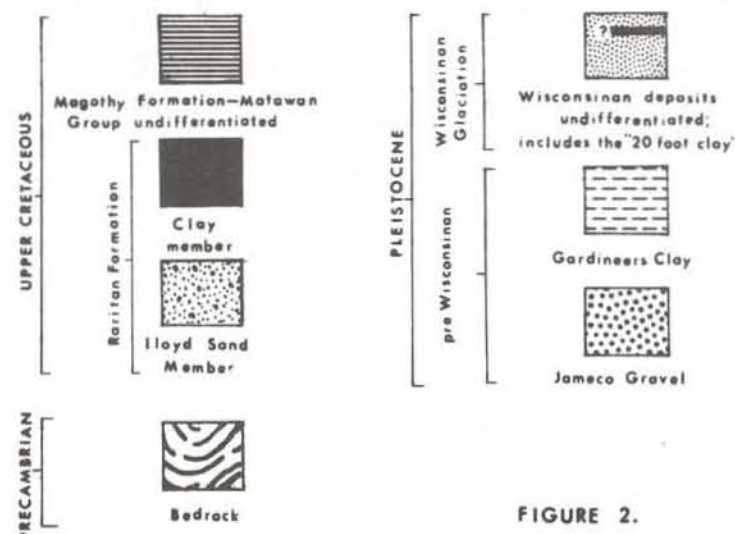


FIGURE 2.

Figure 1 shows where our field stops are located. The trip will take us across the Cross Bay Boulevard in a roughly north-south transect of the bay.

The geologic cross-section (figure 2) was drawn to closely parallel our path today. During the trip you may find it interesting to periodically consult the cross-section and compare changes in surface and sub-surface features along our route.

16.0	0.1	Proceed straight (west) on 149th Avenue to the stop sign. Turn right (west) onto North Conduit Avenue.
16.3	0.3	Bear left (careful changing lanes!) and turn onto Linden Boulevard.
16.9	0.6	Turn left (south) onto Drew Street.
17.0	0.1	A right turn onto Loring Avenue.
17.1	0.1	Go left onto Forbell Street and proceed south to the end of the street.
17.3	0.2	STOP 2. The building on your left is the South Shore Incinerator.

In 1960 there were 2.5 million people living in New York within 5 miles of Jamaica Bay. The solid waste this large population produces is a serious disposal problem. By burning solid refuse, its volume can be reduced by as much as 90% and make its ultimate disposal considerably more efficient. As urban growth took place around the bay, solid refuse was used as landfill. This plant is built on filled marshland.

The South Shore Incinerator receives solid wastes from western Queens and most of Brooklyn. Collection trucks dump material into a waiting bin until it can be placed directly into one of four furnaces. The refuse is its own fuel unless it has rained, in which case oil is sometimes added to keep the furnace hot. The standard temperature is 1500-1600^{o}F and the plant is kept operative 24 hours per day, Monday through Saturday. (On Sunday the furnaces are cleaned which explains the quiet, inactive atmosphere here today.) After incineration the residue is carted to a landfill. Before boarding the bus again, examine some of the ash (refuse) where it is piled outside the south end of the plant. After burial in a sanitary landfill these ashes will cause groundwater percolating through the fill to become highly acidic. Because of leaching, sanitary landfill sites, especially those immediately adjacent to the bay can be expected to be a continuous pollution source.

17.5	0.3	Return via Forbell Street to the intersection with Loring Avenue.
17.6	0.1	Turn left onto Loring Avenue; go one block west, then turn right and proceed north to Linden Boulevard.
17.7	0.1	Turn left (west) and proceed along Linden Boulevard.
18.3	0.6	Turn left (south) onto Fountain Avenue. Go straight to the end of the road.
19.4	1.1	STOP 3. As New York City grew around Jamaica Bay, it used the bay waters for disposal of liquid waste and the fringing marshlands for the disposal of solid waste. We are at the Fountain Avenue landfill. Some six thousand tons of solid refuse are brought here each day. There are two kinds of solid waste disposal sites: 1) a sanitary landfill consists of refuse which is sprayed with a germ-ocide and periodically covered with a sand or earth cover; and 2) a garbage dump, which is simply an open disposal site. Before 1933 the City dumped most of its solid waste into the ocean, but it was forced to stop this practice after a Supreme Court ruling specifically prohibited it. Partly as a result of this, the deposit of solid wastes around the periphery of the bay increased in the 1930's just as sewage treatment programs were getting under way. Between 1938 and 1971, 10 million cubic yards of sand was dredged from the bay for sanitary land-fills along the north shore of Jamaica Bay. In 1965, Brooklyn and Queens each produced 1.7 million tons of solid waste of which 947,000 tons were deposited in Queens, much of it on the Jamaica Bay marshes. This 300 acre landfill was begun in November of 1961. It is scheduled to operate until 1985 at which time it will become a park.

Return to Linden Boulevard.

20.5	1.1	Turn right (east) on Linden Boulevard.
21.7	1.2	Get onto South Conduit Avenue.
22.2	0.5	Turn right (south) onto the Cross Bay Boulevard.
27.3	5.1	Pay 50¢ toll. Follow signs for "Shore Front Parkway."
30.0	2.7	Turn left (east) along the Shore Front Parkway. Stay in the right lane.
30.4	0.4	Pull over behind the traffic island. Park bus.

STOP 4. Walk up the stairs and go to the ocean side of the boardwalk. Sand trapped in artificially maintained inlets further west has been denied to the Rockaway barrier beach and portions of it have become so severely sand starved as to require artificial beach nourishment. By 1974 the berm in this area was completely gone, erosion of the boardwalk was occurring, and in places the shore parkway was threatened. The wide beach we see today is the result of a current ten million dollar beach restoration project begun in April and administered by the Army Corps of Engineers. By the time this project, the first of three between Jones and Rockaway inlets, is completed in November, 4,950,000 cubic yards of sand will have been placed along the shore between 110th and 45th Streets. The sand is obtained by dredging from a huge accumulation known as the "East Bank" some two miles off of Breezy Point. There it is loaded onto barges which transport it to a "booster" dredge-pump on the bay side of Rockaway Beach. Mixed with water it is then pumped under pressure through steel pipes across the barrier to the ocean side. Sand placement is progressing, steplike fashion in an updrift, i.e., easterly direction. By early September, under the influence of the prevailing westerly drift the area was acting as a feeder for the beaches further west.

Proceed out from behind the traffic island, cross over to the right westbound lane of the Shore Front Parkway. Drive west to B94th Street.

30.9	0.5	Turn right onto B94th Street.
31.1	0.2	Enter the approach ramp for the Cross Bay Boulevard.

31.9	0.8	Pay the 50¢ toll.
		Proceed through Broad Channel community. Look for a Texaco station on the right at the north end of town; your next turn will be the first break in the traffic islands beyond the gas stations. Get in the left lane.
33.6	1.7	Make a U-turn into the right, southbound lane.
33.7	0.1	STOP 5. We are in a National Park. Please read and obey the posted rules and regulations.

Despite its natural look, this too is a man-made environment. Dikes around the two fresh ponds have been landscaped with abundant varied vegetation to attract wildfowl. Besides being a major nesting area, the Jamaica Bay Wildlife Preserve lies on the Atlantic Flyway. Over 300 species of birds have been seen here.

However, our main purpose in stopping here is to collect, not objects, but rather ideas, concepts, and impressions. This is a place of contrasts. Evidences of both positive and negative human interactions with nature are apparent everywhere; on the horizon and under your feet.

The guide for this part of the trip is yourself. Be sure to "synchronize watches" with everyone else before leaving the bus. Your challenge is to discover, observe, and reflect upon what you have seen today, as well as what you are about to explore. Stay on the trails and be sure to return by the appointed time.

Return to Hofstra University basically retracing our earlier route via: Cross Bay Boulevard, South Conduit Avenue, Brookville Boulevard, Merrick Road, Peninsula Boulevard and Rt. 24. Total Mileage: 53.8 miles.

NOTES