

Reconnaissance Mapping of Landfills in New York City

by Daniel C. Walsh

Abstract

A reconnaissance study was performed to map the distribution of historic landfills within the five boroughs of New York City. The study consisted of a comprehensive review of literature pertaining to past solid waste landfilling practices and a comparative analysis of topographic maps of the study area from five discrete time periods: 1844; 1891-1900; 1924; 1954-1957; and 1979-1981. A preliminary map of landfilled area was prepared by an overlay analysis of the period maps. The map was refined by performing additional analysis in areas where solid waste landfills were identified in the literature. Determination of the nature of fill material at landfill sites is beyond the scope of this study.

The methodology employed in this study was useful in identifying over 45,500 acres of landfilled area within the limits of New York City. Prior to 1900, landfill activity was concentrated along the shorelines surrounding heavily populated areas of Manhattan and northwestern Brooklyn. Approximately 6,740 acres of land filled prior to 1891-1900 were identified. Between 1891-1900 and 1924, improved waste transport methods enabled fill activity to spread outward to the southwestern Bronx and southern Brooklyn. Approximately 7,240 acres of land filled during this time interval were identified. Between 1924 and 1954-1957, solid waste landfilling of tidal wetlands was integrated with a policy of infrastructure development. This highly focused initiative led to a period of land reclamation that is unparalleled in the city's history. Approximately 23,400 acres of land filled during this time interval were identified. Recent trends include the progressive closure and consolidation of city landfills and vertical expansion of the remaining sites. In 1991, only one landfill operated within the border of New York City. Approximately 8,270 acres of land filled between 1954-1957 and present were identified. This study was performed as a reconnaissance investigation and is intended to assist in only the preliminary phase of environmental investigations.

Introduction

During the last three centuries, landfilling has been practiced extensively within New York City. Excavation material, construction and demolition debris, dredge spoil and solid waste have typically been applied to low-lying tidal wetlands, shoals and open-water areas that were abundant along the periphery of the city's five boroughs. The objectives of land filling were diverse and include facilitation of marine access and overland transport through creation of raised bulkheads and roadways, eradication of

wetland areas that were perceived as nuisances, creation of new land for construction of parks, municipal facilities, and other development projects. Over the last century, an increase in population and commerce has sharply increased the volume of solid waste generated in the city and has led to the development of a formal strategy of solid waste landfilling to eradicate wetlands and to create new land on which to improve the city's infrastructure. There are, however, limited accounts of the location and extent of historic landfilling activity within New York City.

Study Objectives

The objectives of this study are to perform reconnaissance mapping of landfills within New York City, to prepare an evaluation of the progression of landfilling activity through time, and to provide an historic framework for landfill disposal of one type of fill material, solid waste. A primary goal of this study is to assist in the reconnaissance phase of future environmental studies within the study area. The study area includes the five boroughs of New York City and is shown in figure 1.

Methods of Investigation

To achieve the objectives of this study, an investigation was performed in two parts: (1) a literature review of historical solid waste landfill activity in New York City; and (2) analysis of topographic maps of the study area for selected time periods.

Historical Solid Waste Literature Review

A search was performed to identify literature relevant to solid waste landfilling activities within New York City. The literature search was conducted at the New York City Municipal Archive, The New York Public Library, the New York Historical Society and the Staten Island Historical Society. Research was performed between 1988 and 1991. References reviewed include annual reports prepared by the New York City Department of Sanitation (and the New York City Department of Street Cleaning, NYCDSC, a former waste management agency), mayor's reports, articles and other documents. A comprehensive review of the available literature was performed to develop an understanding of the location and duration of land disposal of solid wastes in the study area. During the literature search, a list of solid waste landfill sites identified in the literature was prepared and cataloged by year(s) of operation. The literature search did not address land application of fill materials other than solid waste.

Topographic Map Analysis

A detailed analysis of historic topographic maps was performed to identify the progression of landfill activity in the study area. In order to determine the progression of landfill activity through time, land maps from five discrete time periods were selected for review. The time intervals used in this study were 1844, 1891-1900, 1924, 1954-1957, and 1979-1981.

The 1844 time-period was selected because it was the earliest date for which a map series was available with accurate landform depiction of the study area. The map was prepared as part of a survey of the coast of the United States (Hassler, 1844, 1:30,000). The map series from the remaining four periods were topographic maps prepared by

1. Yonkers, N.Y.- N.J.
2. Mount Vernon, N.Y.- N.J.
3. Weehawken, N.J.- N.Y.
4. Central Park, N.Y.- N.J.
5. Flushing, N.Y.
6. Sea Cliff, N.Y.
7. Elizabeth, N.J.- N.Y.
8. Jersey City, N.J.- N.Y.
9. Brooklyn, N.Y.
10. Jamaica, N.Y.
11. Lynbrook, N.Y.
12. Arthur Kill, N.Y.- N.J.
13. The Narrows, N.Y.- N.J.
14. Coney Island, N.Y.- N.J.
15. Far Rockaway, N.Y.
16. Lawrence, N.Y.

7.5-Minute U.S.G.S. Quadrangles

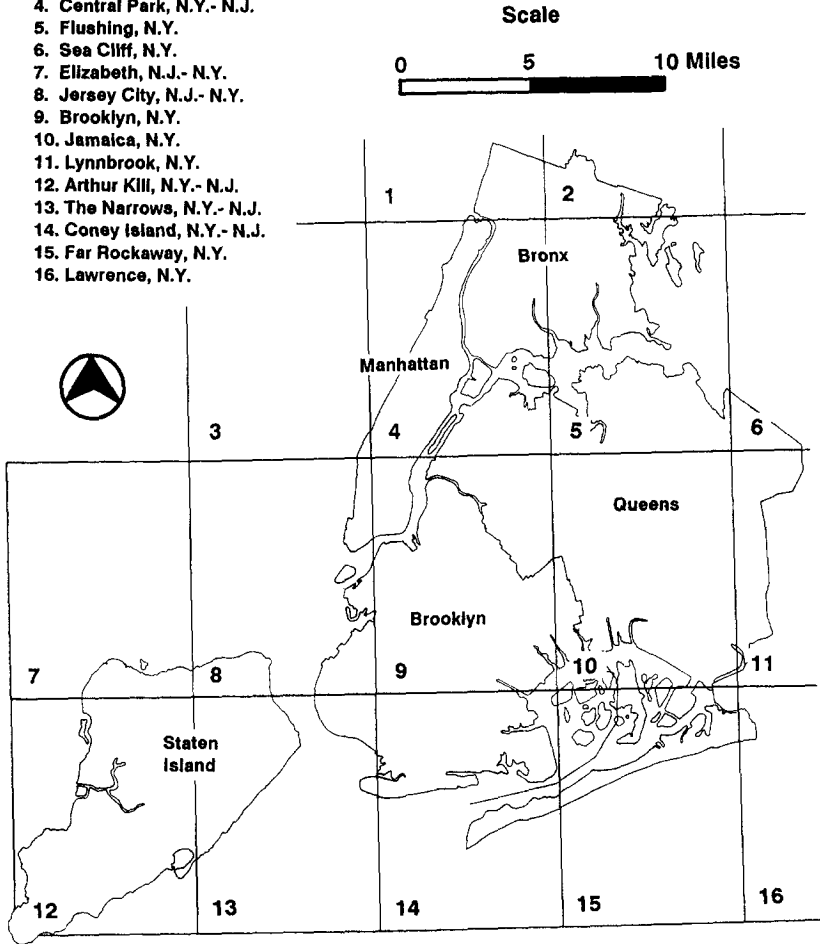


Figure 1. Location of the study area showing 7.5-minute USGS topographic quadrangles.

the United States Geological Survey (USGS). The quadrangle maps from 1891-1900 and 1924 were published at a scale of 1:62,500, while the latter two quadrangle series were published at a scale of 1:24,000. The 1891-1900 map series and the 1954-1957 series were based on original field surveys. The series from 1924 is based on an earlier survey but contains a partial revision of shoreline features. The 1977-1981 series were photorevised from an earlier survey.

For each map series, the location of waterfront features and boundaries, tidal-wetlands (salt-marshes) and freshwater wetlands (swamps) were outlined. Topographic contours along waterfront areas were also highlighted. To allow the employment of an overlay system of evaluation, the outlined maps with 1:30,000 and 1:24,000 scale were photographically reduced to conform to a common scale of 1:62,500. The maps were then overlain in sequence by time. Locations exhibiting landform changes were identified. A preliminary base map denoting areas with landform changes, approximating the progression of landfill activity, was prepared for each time interval. Where filling continued at a site across a time interval, it was identified only on the earlier map. Each map, therefore, represents an estimate of fill activity at new locations.

In addition to the analysis of topographic maps, reconnaissance mapping of historic landfill area in New York County (Manhattan, Wards Island, Roosevelt Island and Randalls Island) was supplemented by a map prepared by Viele (1874). This map showed the landforms of that time period and included an estimate of the original shoreline prior to any filling activity. In addition, to include some fill activity performed between 1981 and present, the last map series was supplemented by review of selected recent aerial photos.

The preliminary fill-progression base maps for each time-interval were then compared to the chronological list of solid waste landfills that was prepared during the literature review. If the listed landfill was not represented on the map, a second detailed review of the topographic maps that bracketed the time period of landfill operation was performed. Estimates of the total area of land that was filled during each time interval was prepared by measurement with a planimeter. The landfill area was also subdivided by borough.

The results of this investigation are presented in the following section. A discussion of the solid waste landfill history during each time interval, derived from the literature review, is integrated into the discussion of the results of the reconnaissance landfill mapping to provide an explanation for the observed trends.

Although the literature review was directed toward one type of fill material, solid wastes, no attempt was made to determine the type of fill material deposited at any landfill site identified in this study.

Results

The results of this study are presented as a sequence of reconnaissance maps that define estimates of landfill progression during four time intervals: (1) prior to 1891-1900; (2) 1891-1900 to 1924; (3) 1924 to 1954-1957; and (4) 1954-1957 to present (based on 1979-1981 topographic maps as modified by review of recent aerial photographs). For the purpose of this study, the five boroughs of New York City are referenced in all

reconnaissance maps. Prior to 1900, however, New York City consisted only of Manhattan and the western Bronx.

Landfill Activity Prior to 1891-1900

An estimate of the distribution of filled land in New York City prior to 1891-1900 is shown in figure 2. Definition of the extent of landfilling in Kings County (Brooklyn), Queens County (Queens), Richmond County (Staten Island) and Bronx County (Bronx) is

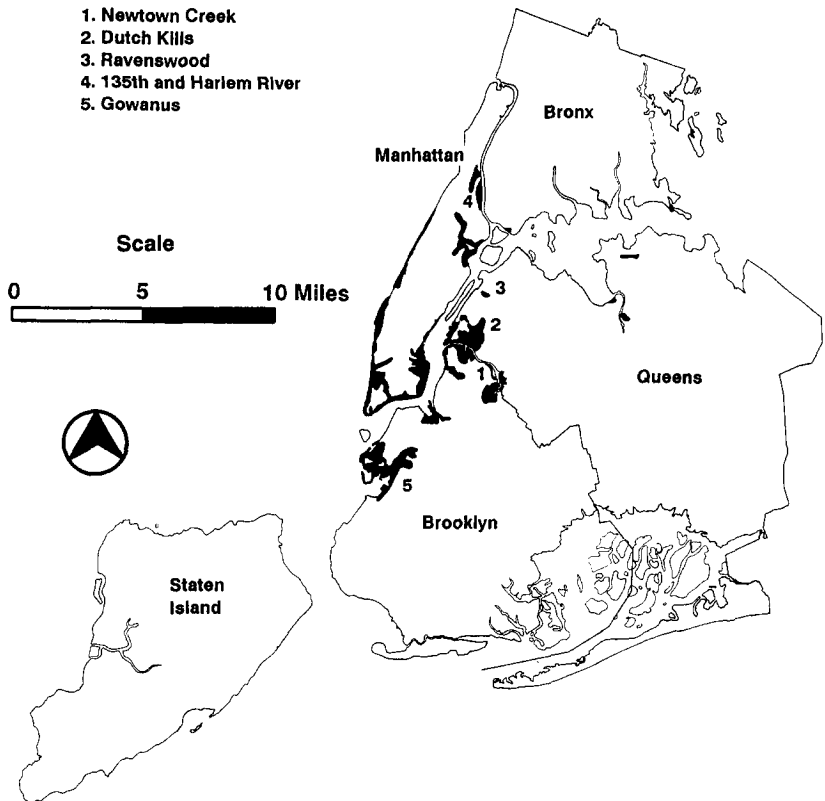


Figure 2. Map of the study area with shaded areas showing the location of land filled prior to 1891-1900. Numbers show the location of selected barge-fed landfills.

based on a comparison of map series from 1844 and 1891-1900. This study does not address areas filled prior to 1844 for these boroughs. For Manhattan, the 1891-1900 time-interval topographic maps were compared to a map prepared by Viele (1874) that showed the original landforms of the island prior to development. For this borough, therefore, the estimate of lowland fill activity is complete.

Approximately 6,740 acres of land filled prior to 1891-1900 were identified within the study area. Figure 2 shows that by the start of the 20th century, much filling had already taken place adjacent to the most heavily populated areas: Manhattan (3,250 acres), western Queens (1,030 acres), and northwest Brooklyn (2,320 acres). Most of the landfills were situated on shoreline marshes and enabled creation of a straight, square and deep bulkhead line capable of supporting access for marine commerce. In some inland areas, streams and swamps were filled to remove barriers to overland travel and to facilitate access to marsh-locked islands.

Although New York City relied heavily on ocean dumping to dispose of solid waste, a substantial volume of this material was barged to 'sunken' shoreline areas for disposal. The solid waste of this era consisted mainly of coal and wood ash, with minor amounts of rubbish and putrescible garbage. In 1888, 6,000,000 tons of coal fuel were consumed in the city, leaving approximately 1,020,000 tons of ash for disposal (NYCDSC, 1888). Barge-fed landfills are identified in the literature in Queens (Newtown Creek, Dutch Kills, Ravenswood, and Hunters Point), Manhattan (135th and Harlem River), Brooklyn (Newtown Creek and Gowanus). Minor amounts of barged waste were disposed at numerous other areas throughout the city. Barge landfills were also located in New Jersey at Morris Canal Basin, Caven Point, Fort Lee, Elizabeth-Port New Jersey, Port Liberty, Edgewater and the Jersey Flats.

Almost all of the lowland fill activity that took place in Manhattan took place prior to 1900, and is depicted on figure 2. In northwestern Brooklyn and southwestern Bronx, it is expected that substantial fill activity occurred prior to 1844 in preparation of an extensive network of piers that were already in place. These fill areas are not depicted on figure 2 and are not included in this study.

Landfill Activity from 1891-1900 to 1924

The progression of landfill activity during this time-interval is estimated in figure 3. Approximately 7,240 acres of land filled during this time interval were identified. This does not include fill activity on land identified during the prior time period. The distribution of filled land by borough is as follows: Brooklyn (3,240 acres); Bronx (1,750 acres); Queens (1,740 acres); Staten Island (390 acres); and Manhattan (125 acres)

In 1895, a waste management plan was instituted in New York City that curtailed ocean dumping and shifted the waste stream to land disposal sites. The volume of waste directed to land dumps was further increased as a result of increased commerce, rapid population growth and a commensurate rise in the quantity of waste generated. Almost all of the landfills constructed during this time interval were situated in tidal wetland areas. Filling of wetlands had a perceived benefit of elimination of insect and rodent nuisances as well as creation of new land and generation of new revenue for the city from taxation. Typically, these shoreline areas were filled to an elevation just 5-10 feet above sea level.

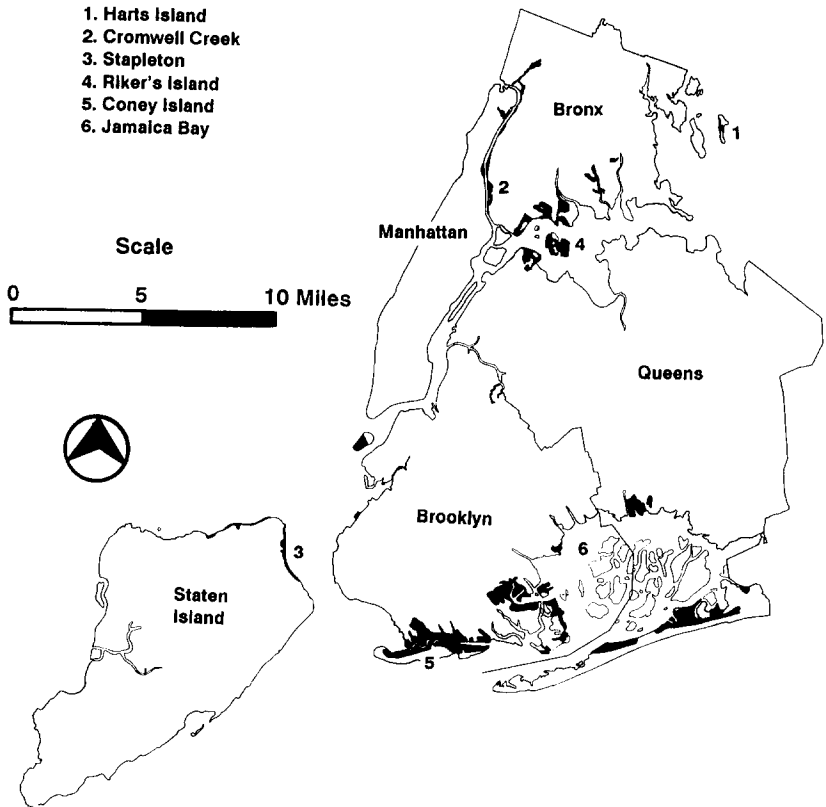


Figure 3. Map of the study area with shaded areas showing the location of land filled between 1891-1900 and 1924. Numbers 1-4 denote barge-fed landfills; 5 is a railway-fed landfill.

For the first fifteen years of the 20th century, numerous landfills fed by barge-loads of waste from Manhattan and the western Bronx are identified in the literature. Barge-fill sites are identified in figure 3 in the Bronx (Rikers Island, Harts Island and Cromwell Creek) and Staten Island (Stapleton). Barge-fed landfills were also operated in New Jersey at Bayonne, Jersey City, the Newark Meadows, Maurer and Weehawken. By 1924, all barge-fed landfill operations were consolidated at Rikers Island.

By 1900, Brooklyn was feeling the pressure of diminished landfill space near the population center along the northwest shoreline of the borough. Landfills were scarce, remote and expensive. Haul distances were long and very time consuming for the

horse-drawn carts that transported waste. In 1902, Brooklyn entered into a new contract to have its waste hauled by rail along existing trolley lines. With the transport problem solved, filling began at a 1,700-acre tidal marsh north of Coney Island. By 1913, most of this fill was complete and the island was linked with the mainland.

In Queens, Staten Island and eastern Bronx, a smaller and more dispersed population prevented the unification of solid waste management strategies practiced in other areas of the city. Disposal of waste in these areas was limited to local cart-fed landfills (many of which are not addressed in this study). In 1915, automotive waste collection trucks first appeared in New York City and by 1924, the end of this time interval, overland transport to more distant truck-fed landfills was feasible.

At the close of the 1900-1924 time-interval, the enormous tidal wetland systems in the eastern Bronx, Staten Island and Jamaica Bay were largely intact. They were not unnoticed, however. These expansive ecosystems were considered fodder for future filling as the following passage demonstrates "The [city's] lowland's ... afford an almost unlimited supply of dumping ground ... the possibilities of land reclamation are almost boundless. (NYCDSC, 1905)"

Landfill Activity from 1924 to 1954-1957

The progression of fill activity in the city during the time period from 1924 to 1954-1957 is estimated in figure 4. The figure shows clearly an enormous increase in the area and distribution of filled land in comparison to the previous time interval. The combined effect of sharply increasing volumes of waste, more widely distributed population, improved means for overland transport of waste, and the emergence of a highly focused municipal policy to eradicate all wetlands led to a period of land reclamation that is unparalleled in New York City history. Approximately 23,400 acres of new land filled between 1924 and 1954-1957 were identified during this study. The landfill acreage for this time interval is distributed by borough as follows: Queens (11,040 acres); Brooklyn (5,640 acres); Bronx (3,610 acres); Staten Island (2,700 acres) and Manhattan (420 acres).

During the 1930's, the city's waste disposal policy was clearly focused on wetland reclamation as a means to create new land and improve a city infrastructure that was lagging behind its rapid population growth. Through combined planning between the New York City Department of Sanitation (NYCDOS) and the New York City Department of Parks, land reclamation by filling with solid waste led to the construction of numerous highways, parks, municipal facilities, and airports. During the 1930's, 17 million cubic yards of waste fill was transferred from Rikers Island to northern Queens to build LaGuardia Airport (NYCDOS, 1940). The 1934 World's Fair site was built on 1,200 acres of filled wetland in Flushing, Queens. The JFK Airport was built on a land reclamation project encompassing over 3,500 acres in southwestern Queens. Extensive marsh areas surrounding Eastchester Bay in the Bronx were similarly filled and developed during this time period. In 1940, over 200 acres of marshland were reclaimed with solid waste. The acreage reclaimed by filling with solid waste increased to 414 acres in 1947 and 690 acres in 1949 (NYCDOS, 1940-1949).

The type of waste disposed at landfills in New York City also changed during this time interval. By the end of the 1920's, oil became the common fuel and the ash output from

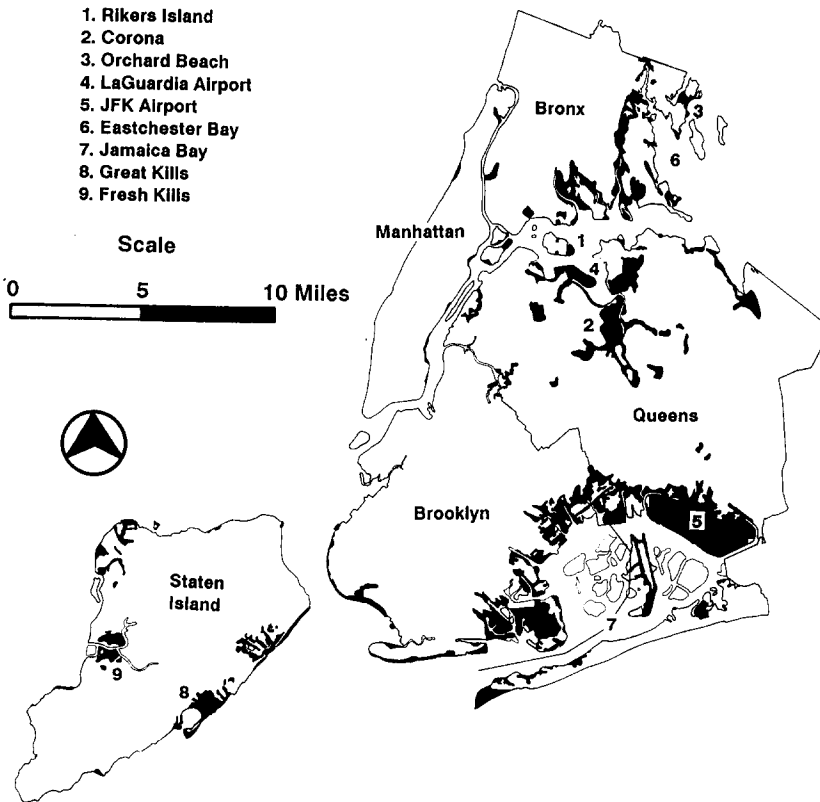


Figure 4. Map of the study area with shaded areas showing the location of land filled between 1924 and 1954-1957. Numbers 1-4 and 8-9 denote barge-fed landfills.

coal burning was greatly diminished. Barge landfilling operations continued at Rikers Island through the early 1930's. Unlike other city landfills, which were filled to a height that usually did not exceed 10 feet above sea level, Rikers Island Landfill was mounded as high as 125 feet in the eastern fill area. In 1934, barge-fed landfills were opened and operated for a short time at Corona, Queens and Orchard Beach, Bronx. In 1943, the bargefill operations were moved from Rikers Island to the Great Kills Marsh on the southern shore of Staten Island. The 467-acre landfill was closed in 1948 after 5 years of operation and the site was converted into a park. The bargefill operations were

moved in that year to the last major expanse of wetlands remaining in New York City, the 2,500-acre Fresh Kills Marsh in Staten Island.

By the end of the 1940's, the scarcity of suitable landfill sites was evident. To preserve waste disposal capacity, the final grade of existing landfills was increased in 1949 to 15-20 feet above sea level.

Landfill Activity from 1954-1957 to Present

The location of new landfills operated between 1954-1957 to the present is estimated in figure 5. Approximately 8,270 acres of land filled during this time interval were

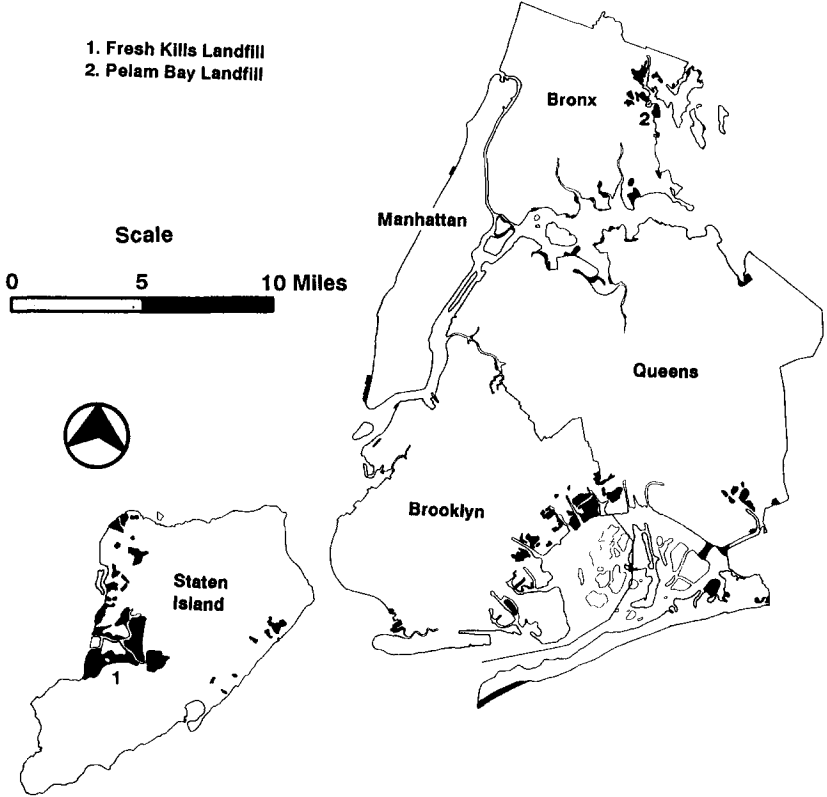


Figure 5. Map of the study area with shaded areas showing the location of land filled between 1954-1957 and present.

identified. The distribution of new fill area by borough is as follows: Staten Island (3,050 acres), Queens (2,300 acres), Brooklyn (1,480 acres), Bronx (1,200 acres), and Manhattan (250 acres). Comparison of figure 5 with figure 4 illustrates a sharp reduction in the total area and distribution of new landfills. Rapid filling during the prior time-interval exhausted most of the sites available for solid waste disposal and many of the remaining wetland areas were filled by the early 1960's. Many of the new solid waste landfill sites were pushed out into the open water. Unable to expand laterally, these landfills expanded vertically.

Much of the waste from Manhattan, western and southern Bronx, western Queens and Brooklyn was transported by barge to the Fresh Kills Landfill. Filling at the site expanded to new areas surrounding the network of tidal creeks. By the early 1960's, landfill sites in the eastern Bronx and northeastern Queens were very scarce.

A similar phenomena was evident at Jamaica Bay in southern Brooklyn and Queens. Most of the available tidal wetlands were filled by the early 1960's and new solid waste landfills were extended out into open water. In Staten Island, continued filling of tidal wetlands in the northwest and the southeast was observed.

In 1959, in response to a pressing need to conserve waste disposal capacity, the final grade of existing landfills was increased to 20-40 feet above sea level. Offset by continued closure of city landfills, the new heights did not provide the needed waste disposal capacity. By the late 1970's the city had less than ten remaining landfills. One of these sites, the Bronx's last active landfill, the 80-acre Pelam Bay Landfill, was closed after reaching a height exceeding 150 feet. By 1985, the number of active landfills dropped to two and by 1991, only one landfill, the Fresh Kills Landfill, was operating in New York City.

Limitations

Due to the broad scope and the historical nature of this study, a series of limitations are inherent in this investigation. Foremost, assessment of the nature of the fill material at each fill site is beyond the scope of this study. The discussion of solid waste landfill activity presented in this paper is based on general accounts contained in the literature. In addition to solid waste, fill can consist of excavation material from subways, tunnels, foundations and grading; hydraulic fill (dredge material); construction and demolition debris; as well as a variety of other material. Determination of the type of fill material contained beneath each site would require a detailed, site-specific investigation. This study is also limited by the 20-foot contour interval utilized on the 1891-1900 and 1924 series USGS topographic maps. Most of the earlier solid waste landfills (prior to 1949) were less than 20 feet thick and would not appear on a topographic map without an additional change such as a modification of the shoreline trace or removal of a wetland denotation. Shallow and small inland landfills are especially vulnerable in this study as are areas of landfilling in peripheral areas surrounding wetlands. In this respect, the maps of landfill progression are likely to be conservative in their estimates (i.e. show less landfill area than exists). Another factor that could affect this study is natural filling and/or erosion that is common along coastal waterfront areas. Natural filling appeared to be minimal, however, with the exception of a major land reformation that occurred between 1844 and 1891 and extended the Rockaway Peninsula with material eroded

from the former Pelican Beach in Brooklyn. Finally, it is expected that a substantial amount of filling occurred prior to 1844 along the highly-populated northwestern waterfront of Brooklyn, adjacent to Manhattan, and in southwestern Bronx. This fill activity is not addressed in this reconnaissance mapping study.

Summary

Approximately 45,660 acres of landfilled area were identified during this study within the five boroughs of New York City. Filling identified for the period prior to 1891-1900 encompassed roughly 6,740 acres. Most of this landfill activity was concentrated along shorelines surrounding heavily populated areas of Manhattan and northwestern Brooklyn. Between 1891-1900 and 1924, the introduction of rail transport of waste and an increase in the volume of waste transported to landfills by barge pushed the limit of landfill activity further from the heavily populated areas. Approximately 7,240 acres of new landfill were identified during this interval as fill activity expanded to southwestern Bronx, and southern Brooklyn and Queens.

Between 1924 and 1954-1957, a municipal policy that strongly integrated waste management, wetland reclamation and infrastructure development led to an remarkable expansion of landfill activity and the eradication of most of the city's remaining tidal wetlands. Automotive waste transport vehicles led to further outward expansion of landfilling activity to the full limit of the municipal boundary. An estimated 23,400 acres of new landfill built during this time interval were identified.

Between 1954-1957 and the present, the city was forced to drastically alter waste landfilling practices. Tidal wetland areas in the city were almost completely eliminated by the early 1960's. New environmental regulations restricted former practices of wetland and open water filling. As landfill facilities closed, they were not replaced by new sites. Landfill final grades were systematically increased to counterbalance the loss of waste disposal capacity. By the end of the study period, only one landfill is in operation. Approximately 8,270 acres of landfill were identified during this time interval.

Conclusions

The methodology employed in this study was useful in identifying extensive areas where landfilling has been performed in New York City. The general approach employed in this study, consisting of overlay of historical topographic maps, is useful for reconnaissance mapping purposes and is especially well suited for study of large areas and urban areas because historic topographic maps are readily available through the USGS and other sources. The effectiveness of the approach is greater if mapped features in addition to topographic contours can be used because the broader contour intervals used in early maps may not be useful for delineating smaller landfills. In this regard, the use of shoreline traces and marsh and swamp denotations were particularly useful in this study. The literature search was invaluable for identifying smaller sites, defining the cause of trends in fill progression, and making preliminary assessment of the source of the material contained within fill sites. However, the historic nature of this literature necessitates a broad and time-consuming search at repositories such as local archives and historical societies.

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Biographical Sketch

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