2000 New York Harbor Water Quality

Regional Summary

Inner Harbor Area

The Hudson River from the city line to the Verrazano Narrows; the lower East River to the Battery; and the Kills. Represented by 21 monitoring stations.

Upper East River–Western Long Island Sound

Northeastern portion of the Harbor from Hell Gate to Steppingstones, Western Long Island Sound, and the Harlem River. Represented by 17 monitoring stations.

Lower New York Bay–Raritan Bay

Most oceanic portion of the Harbor, composed of open shallow waters, bordering the NY Bight. Represented by 5 monitoring stations.

Jamaica Bay

An urban estuarine embayment, covering approximately 25 sq. miles and represented by 10 monitoring stations.

NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DEP
www.nyc.gov/dep

Rudolph W. Giuliani, Mayor

Joel A. Miele Sr., P.E., Commissioner

June, 2001

The following **2000 New York Harbor Water Quality Regional Summary** represents the 91st year of comprehensive monitoring of water quality in New York Harbor, and demonstrates the continued improvement of the City's waterways and the regeneration of their aquatic ecosystems. In fact, the Harbor is in better shape today than it has been in more than thirty years.

Under the management of the Department of Environmental Protection (DEP), the City's advanced wastewater treatment and pollution prevention programs are clearly producing positive results. Largely because of these efforts, our bathing waters are cleaner and our aquatic environment is flourishing. What's more, we are committed to doing even better next year. With further enhancements to our treatment plants and other infrastructure upgrades already underway, the quality of the Harbor, and of City life, will surely continue to improve.

I encourage all New Yorkers to review this report to gain an appreciation for the extensive efforts the City has undertaken to reduce pollution in the Harbor and to protect our wonderful natural resources.

Sincerely,

Rudolph W. Giuliani
Mayor

June, 2001

The New York City Department of Environmental Protection (DEP) performs an intensive, annual survey of water quality in New York Harbor. The purpose of the Harbor Survey Program is to assess the effectiveness of the City's various water pollution control programs, and their combined impact on water quality.

The following **2000 Regional Summary** includes discussion of our monitoring results in this the 91st year of the program and trend data, in some cases dating back to 1970. A more comprehensive presentation of this material is available in the full NYC Regional Harbor Survey.

We are continually striving to improve our programs and to enhance the usefulness of these reports. To that end, this regional summary provides data summaries for four significant regions of the Harbor. Your comments on these regional summaries, and on other information in the report, are encouraged. Questions or suggestions may be directed to Robert Ranheim or Naji Yao of DEP's Marine Sciences Section at (212) 860-9378.

We are proud of the results of our efforts to improve the quality of New York City's waterways. Your interest in the success of our programs is greatly appreciated.

Sincerely,

Joel A. Miele Sr., P.E.
Commissioner

INTRODUCTION

The New York City Department of Environmental Protection's (NYCDEP) Harbor Survey has been collecting water quality data for over 90 years. These data delineate both impacts and improvements in New York Harbor water quality and provide a valuable reference for scientists, educators, and citizens.

The Harbor Survey program has evolved from an initial effort by the Metropolitan Sewerage Commission that covered twelve stations around Manhattan into a Harbor-wide program with 43 stations, measuring 20 water quality parameters and human health indicators. The initial surveys were made in response to a public outcry about pollution in the waterways of the Harbor. Since that time the Harbor waters have shown a marked improvement and in most cases are available for recreation and commerce.

These improvements in water quality have focused attention on other areas in New York harbor that still need attention. The NYCDEP has begun two new efforts to address these conditions.

The Use and Standards Attainment Project will focus on the Harbor tributaries and other bodies of water that currently may not attain water quality standards. The project will study 23 waterbodies and their drainage basins, and present a comprehensive plan that will allow each waterbody to attain its best use. The Program began in 2000 looking at the Bronx River and Paerdegat Basin in Jamaica Bay. A draft plan for one or both of these waterbodies will be released in 2001.

The NYCDEP also has begun stewardship of a volunteer beach monitoring effort. In 2000, sixteen volunteers reported on floatables and other litter at 13 beaches within the City. These volunteers collected 4,500 items during 60 surveys at these beaches in 2000. The intention is to expand the program in 2001 and further integrate it into the City's monitoring efforts.

This regional report of the Harbor Survey's 91st year of monitoring provides an overview of the water quality based on a breakdown of the Harbor into four regions. Each region is discussed separately but common points are made within each discussion. This report will focus on four parameters that have been shown to be major indicators of water quality in New York Harbor.

This synopsis explains the four major indicators of environmental change in the Harbor Estuary[1]. A more expanded discussion on each of these parameters is included in the full Harbor Survey Report. These four indicators are:

Fecal Coliform (FC) Bacteria – Fecal coliform are a group of bacteria primarily found in human and animal intestines and associated with sewage waste. These bacteria are widely used as indicator organisms to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing) bacteria. Fecal coliform concentrations are measured in NY Harbor as human-health related indicators of sewage-related pollution.

Chlorophyll 'a' – Chlorophyll 'a' is a pigment found in most phytoplankton that can be used as an estimate of phytoplankton abundance.

Phytoplankton are small free-floating aquatic plants that form the basis of the food web in aquatic systems. These organisms respond quickly to environmental changes, therefore, their abundance may serve as a measure of water quality and an indicator of greater ecosystem change.

There is no current standard for chlorophyll a, but the Harbor Survey measures chlorophyll 'a' to provide an assessment of ecosystem health. Levels above 20 µg/L are considered indicative of enriched or eutrophic[2] conditions, indicating a decline in water quality.

Dissolved Oxygen (DO) – Dissolved Oxygen in the water column is critical for respiration of most aquatic life forms, including fish and invertebrates, such as crabs, clams, zooplankton, etc. Dissolved oxygen concentration is therefore one of the most universal indicators of overall water quality and a means of determining habitat and ecosystem conditions.

Secchi Transparency – A Secchi disk is used to estimate the clarity of surface waters. High Secchi transparency (greater than 5 feet) is indicative of clear water, with declines in transparency typically due to high suspended solid concentrations or plankton blooms. Low Secchi readings (less than 3 feet) are typically associated with degraded waters. These conditions are indicative of light limiting conditions, which in turn affect primary productivity and nutrient cycling.

Coliform and dissolved oxygen indicators are used by the New York State Department of Environmental Conservation (NYSDEC) to quantify ecosystem health. NYS DEC standards reflect a range of acceptable water quality conditions corresponding to the State-designated "best usage" of the water body. Common uses and NYS DEC standards for fecal coliform and dissolved oxygen are noted in the adjacent chart.

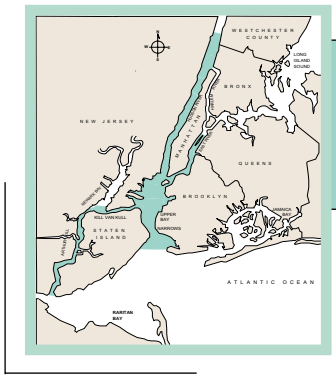
COMMON WATER USE AND NYS DEC STANDARDS FOR FRESH AND SALINE WATERS

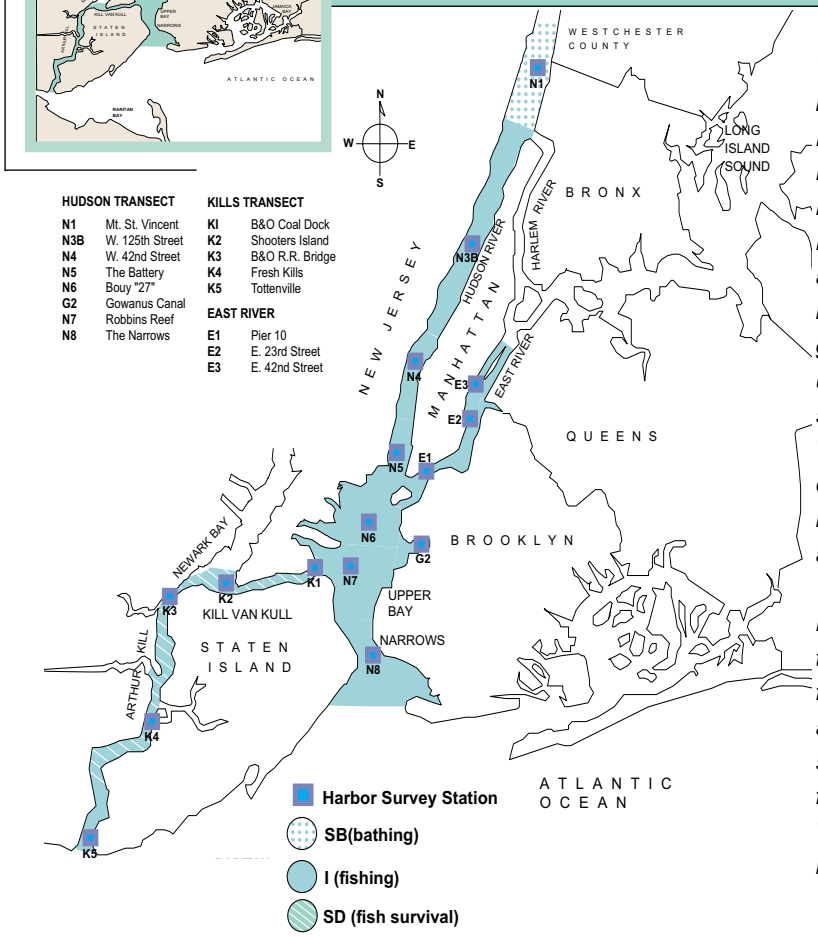
Class	Best Usage of Waters	Fecal Coliform	Dissolved Oxygen (never-less-than)
SA	Shellfishing and all other recreational use.	No standard	5.0 mg/L
SB	Bathing and other recreational use	Monthly geometric mean less than or equal to 200 cells/100mL from 5 or more samples	5.0 mg/L
I	Fishing or boating	Monthly geometric mean less than or equal to 2,000 cells/100mL from 5 or more samples	4.0 mg/L
SD	Fish survival	No standard	3.0 mg/L

[1] ***Estuary*** – *a semi-enclosed coastal body of water where fresh water and salt water mix.*

[2] ***Eutrophic conditions*** – *a condition in which nutrient-rich waters allow for excessive growth of algae, often leading to reduced water clarity and DO levels.*

INNER HARBOR AREA





HUDSON TRANSECT

N1	Mt. St. Vincent
N3B	W. 125th Street
N4	W. 42nd Street
N5	The Battery
N6	Bouy "27"
G2	Gowanus Canal
N7	Robbins Reef
N8	The Narrows

KILLS TRANSECT

KI	B&O Coal Dock
K2	Shooters Island
K3	B&O R.R. Bridge
K4	Fresh Kills
K5	Tottenville

EAST RIVER

E1	Pier 10
E2	E. 23rd Street
E3	E. 42nd Street

The Inner Harbor is defined as the area including: the Hudson River from the NYC- Westchester line, through the Battery to the Verrazano Narrows; the Lower East River to the Battery; and the Kill Van Kull-Arthur Kill system. This area contains 16 Harbor Survey monitoring stations that have been grouped together due to common water uses and functions, as well as similarities in point source loadings. Waters of the Inner Harbor are often continuous, through connecting branches or straits, and cover a large and diverse geographic expanse.

Most of the Inner Harbor Area, excluding the Kills, is classified by NYS DEC as I, for uses such as fishing or boating. The area in the Kills is classified for fish survival only (SD). The Hudson River, from North of the Harlem River to Westchester County is designated for bathing (SB).

FECAL COLIFORM

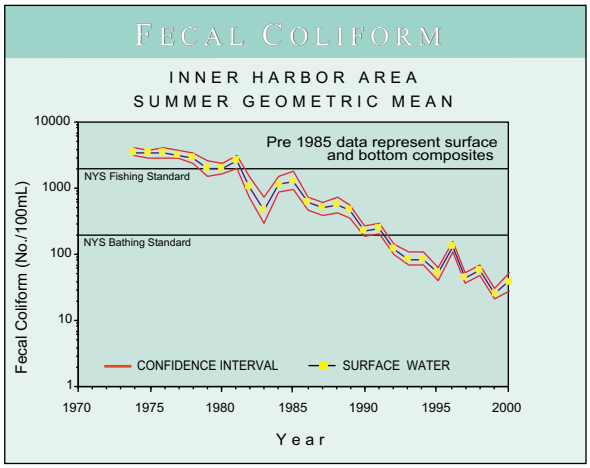
Sanitary water quality as estimated by fecal coliform (FC) concentrations was excellent for the Inner Harbor Area in summer 2000. All Inner Harbor Area monitoring sites complied with monthly FC standards of 200 cells/ 100 mL. Only six of sixteen sites had geometric means greater than 50 cells/100 mL.

The average (or more specifically, the geometric mean[3] of) FC concentrations may mask short-term fluctuations in water quality. Wet weather data shows that the Inner Harbor Areas are prone to short-lived degradation due to an increase in FC loadings following rain storms. Under these conditions, FC in the Upper Hudson River (from its junction with the Harlem River to W. 125th Street) and portions of the Lower East River and Upper NY Bay increase from below 100 to 100–200 cells/ 100 mL. Most of the remaining Inner Harbor Area reaches FC levels of 201–2,000 cells/100 mL. This degraded water quality after a rain storm still meets designated standards for fishing.

[3]***Geometric mean*** *- a calculation of central tendency for a set of data often employed when a high degree of variation is present.*

TRENDS

Fecal coliform concentrations for the Inner Harbor Area show a dramatic decline (over two orders of magnitude) from the early 1970s to the present time. During this period, FC concentrations went from levels well above 2,000 cell/ 100 mL to levels well below 200 cells/ 100 mL, and for most of the 1990s below 100 cells/ 100 mL. As a result, today's water quality has improved to the degree that it surpasses conditions deemed appropriate for most recreational activities, whereas 1970s water quality did not meet fishing standards. This improvement is noteworthy in view of the multitude of point sources that discharge into these waters and the magnitude of increased loading known to occur in these waters during rain events. This improvement is largely attributable to abatement of raw sewage discharges through construction, expansion, and upgrading of Water Pollution Control Plants (WPCPs), elimination of illegal discharges, and the reduction of combined sewer overflows (CSO).[4]

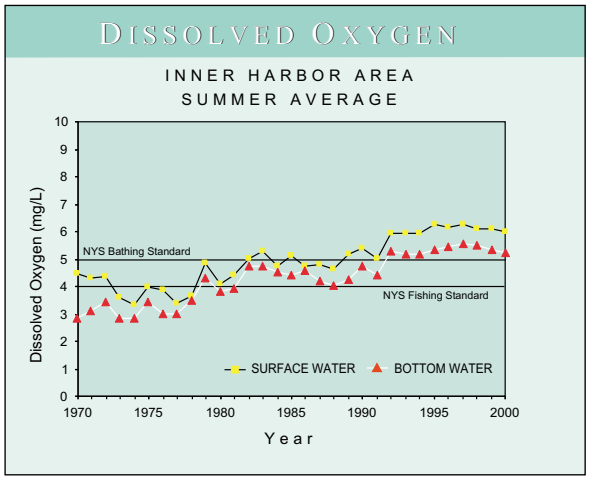


DISSOLVED OXYGEN

Dissolved oxygen (DO) values observed in the Inner Harbor Area for the summer of 2000 were quite favorable. Average DO values were above the DEC standard of 4 mg/L deemed appropriate for fishing for both surface and bottom waters. Discrete DO measurements failed to comply with applicable DO standards for the Inner Harbor Area 5.6% of the time in bottom waters and less than 1% in surface waters. Only one location (N3B) in the Inner Harbor had an average minimum DO value below 3 mg/L (the NYS-DEC standard for fish survival and the threshold regionally defined as hypoxia[5]).

TRENDS

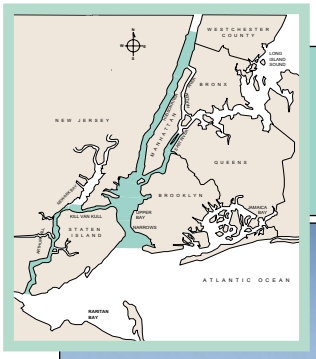
Dissolved oxygen (DO) has shown a consistent increase in the Inner Harbor Area over the past 30 years. The average DO values for bottom waters have increased from below 3 mg/L in 1970 to above 5 mg/L in 2000.



This change is substantial in that values rose from levels that were not adequate for fish survival to levels fully supportive of ecological productivity. This improvement is evident in the heavy re-infestation of Harbor wood pilings by marine organisms, and partially responsible for recovery of the shortnose sturgeon to record numbers in the Hudson River.

[4] ***Combined sewer overflows (CSO)*** *- a discharge of stormwater runoff and untreated domestic sewage through designated outfalls. Overflow to the Harbor occurs when WPCP hydraulic capacity is exceeded.*

[5] ***Hypoxia*** *- a condition of low dissolved oxygen, considered stressful to many aquatic organisms.*



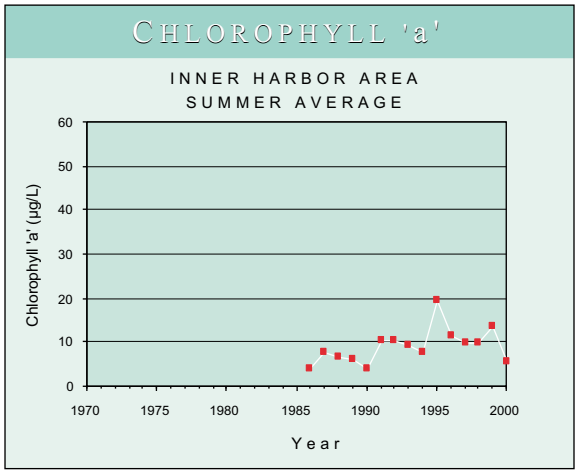
INNER HARBOR AREA

CHLOROPHYLL 'a'

Inner Harbor Area had only one location (K5) with an average chlorophyll 'a' concentration above 20 µg/L. Concentrations at the remaining stations were much lower, with all remaining locations well below 10µg/l.

TRENDS

Of the four geographical Harbor Survey regions, the Inner Harbor Area shows the least year to year chlorophyll 'a' variation and the lowest summertime averages. In this vicinity, high flushing rates are likely responsible for limiting the development of standing phytoplankton communities. Trends show a slight increase in chlorophyll 'a' concentrations in the 1990s relative to values of the 1980s. The average summer concentration for the area since 1991 remains at about 10 µg/L, despite a short-lived peak in 1995 to 19 µg/L. and a 2000 average of 5 µg/L.



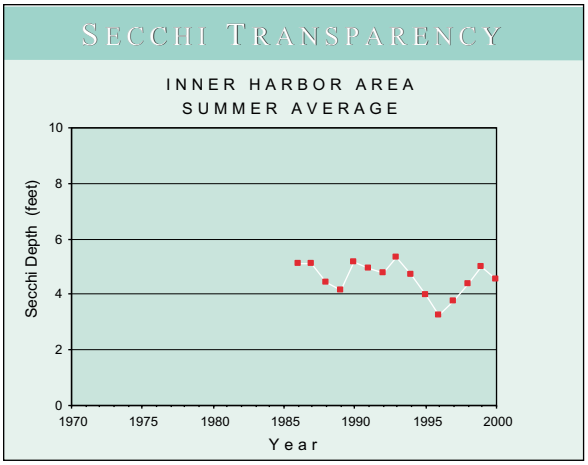
The current drop of chlorophyll 'a' concentrations may be due more to methodology changes than actual biological processes.

SECCHI TRANSPARENCY

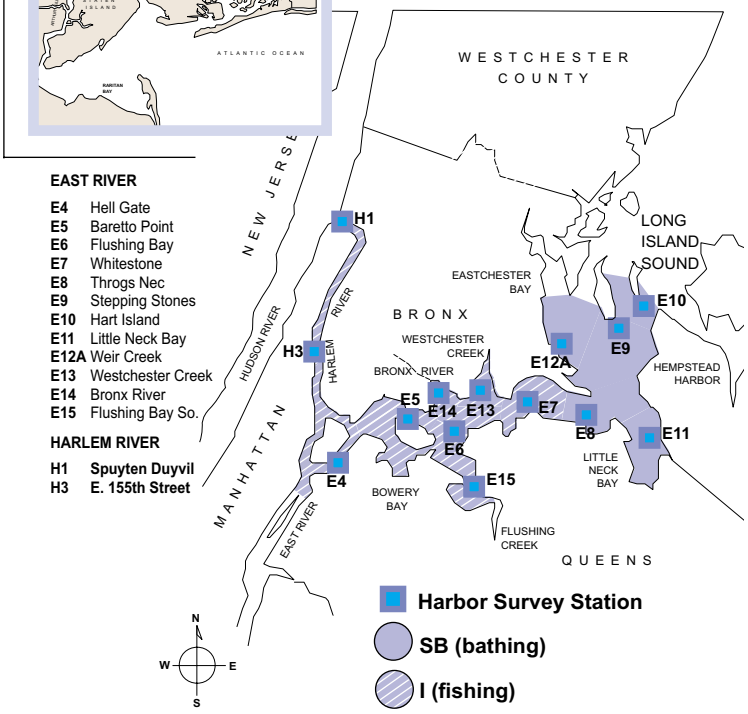
No water quality standards exist for Secchi transparency. In general, high Secchi numbers (depths 5 feet or better) are associated with clearer water, while low Secchi transparencies (depths 3 feet or less) are indicative of turbid (or light limiting) conditions. Of the 16 Inner Harbor Area stations, 10 sites had average Secchi transparency values of 5 feet or better, including the lower East River sites and the Upper New York Bay area through the Narrows. Highest transparency values (averages greater than 8 feet) were observed in the mouth of the Gowanus Canal. Only a single site, at the junction of the Kills (K3), had an average Secchi value below 3 feet.

TRENDS

Annual averages show Secchi transparency depths for the Inner Harbor Area to have remained at about 5 feet (from 1986 -1994) with some temporal downward trending. Following 1994, transparency dropped notably to a low of 3.3 feet in 1996. A gradual increase and return of Secchi transparencies to a 1999 average of 5 feet is evident over the past three years.



UPPER EAST RIVER–WESTERN LONG ISLAND SOUND



EAST RIVER

E4 Hell Gate
E5 Baretto Point
E6 Flushing Bay
E7 Whitestone
E8 Throgs Nec
E9 Stepping Stones
E10 Hart Island
E11 Little Neck Bay
E12A Weir Creek
E13 Westchester Creek
E14 Bronx River
E15 Flushing Bay So.

HARLEM RIVER

H1 **Spuyten Duyvil**
H3 **E. 155th Street**

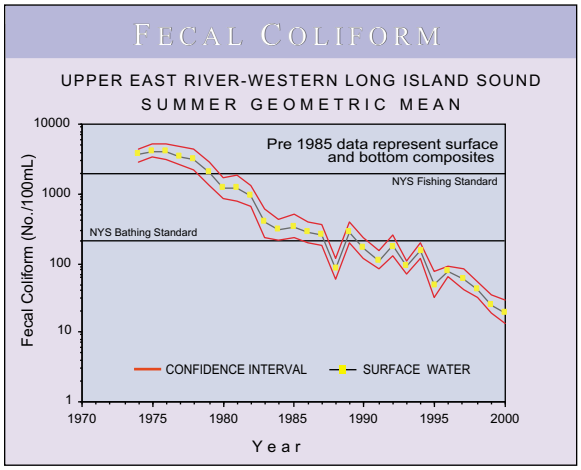
The Upper East River-Western Long Island Sound (UER-WLIS) represents the north-eastern portion of NY Harbor, from Hell Gate in the East River, up into the Western Long Island Sound (WLIS). ***The Harbor Survey Program*** *provides coverage of this area, including the Harlem River and the East River, from Roosevelt Island to Hart Island at the NYC- Westchester County boundary. This area contains 14 Harbor Survey monitoring stations. Waters of this vicinity, though divergent in salinity and depth, share similarities in pollutant loadings and are targeted for intensive management efforts as part of the* ***Long Island Sound National Estuary Program****.*

The majority of the Upper East River-Western Long Island Sound complex is classified as I, for uses such as fishing or boating, with the area east of the Bronx-Whitestone Bridge designated for bathing (SB).

FECAL COLIFORM

In 2000, sanitary water quality continued to be superior for this area. Fecal coliform (FC) concentrations for all monitoring sites were in compliance with their specified best use classifications for bathing and fishing. The summer geometric mean for all sites was below 100 cells/100 mL.

During wet weather conditions a decline in this area's water quality was discernible, with increased FC levels throughout the Harlem River and in the Upper East River, from Hell Gate to Throgs Neck. Even under these conditions, FC levels deemed appropriate for fishing are maintained in the western portion and for bathing in the eastern portion of the study area.



TRENDS

Fecal coliform concentrations continue to show a downward trend as they have for more than twenty years in the Upper East River-Western Long Island Sound (UER-WLIS) region. This improvement, measuring about two orders of magnitude, indicates FC concentrations met standards suitable for bathing 90% of the time over the past decade. The ongoing upgrade of wastewater treatment facilities and improved control of flow regulators and combined sewer overflow events have had, and will continue to have, a major impact on the reduction of fecal coliform loads. Flushing Bay, which in the past has been problematic, improved dramatically in 2000 but remains targeted for additional CSO abatement (including construction of wet-weather storage facilities) and is the focus of a joint NYCDEP- Army Corps of Engineers Ecosystem Restoration Project.

DISSOLVED OXYGEN

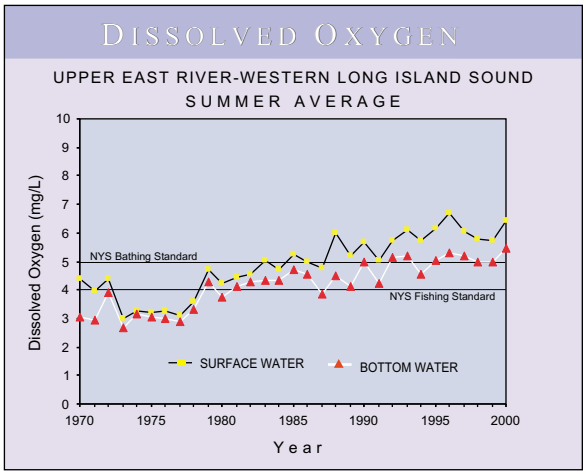
Average summer DO values for the UER-WLIS vicinity met and exceeded 4 mg/L (conditions suitable for fishing). However, average bottom water values at three of the five stations designated as SB, were below the applicable 5 mg/L standard for bathing waters. These three locations (E8,9, and 10) had discrete values lower than the standard an average of 60% of the time for bottom waters and 2% for surface waters. Dissolved oxygen values of less than 3 mg/L (defined as hypoxic) were observed at least once at three of the UER-WLIS monitoring sites.

These observations highlight the need for continued ecological concern for the vicinity of the WLIS, which is the major focus of the *Long Island Sound Study* initiated in 1985. Together with the states of New York and Connecticut, and Westchester County, DEP is committed to efforts to reduce nitrogen loadings to the Long Island Sound. Since 1994, NYC decreased average dry weather nitrogen loads by over 30,000 lbs/day at its four UER facilities.

TRENDS

Trend analysis for the UER-WLIS area shows an increase in DO of about 1.5 mg/L for top waters and almost 2 mg/L for bottom waters since 1970. Most notable, are improvements in bottom waters that have risen from well below fishable (4 mg/L) to close to bathing standards (5 mg/L). Trends however also demonstrate high DO variability, with an increasing gap between surface and bottom water improvements since the mid-1980s (This suggests the formation of two separate water masses or pronounced stratification[6]).

In the WLIS in particular, conditions symptomatic of eutrophic waters have been observed since the late 1980s. These conditions include extremely high surface water DO (often associated with algae blooms) and sporadic, but extremely low, bottom DO. This decline in water quality is being addressed by the *Long Island Sound Study*.



[6] ***Pronounced stratification***- *the development of separate water masses within the water column, most often due to distinct differences in salinity and/or temperature.*

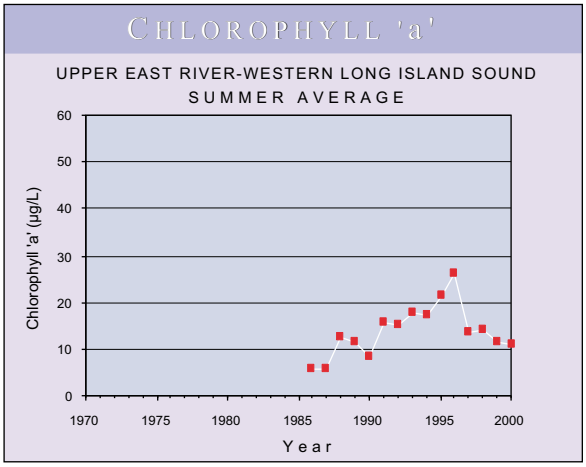
UPPER EAST RIVER– WESTERN LONG ISLAND SOUND

CHLOROPHYLL 'a'

Chlorophyll 'a' concentrations for the Upper East River-Western Long Island Sound (UER-WLIS) remained close to (or only slightly below) that of the previous two years, with the average summer concentration measuring 11.1 µg/L for 2000. Only two HS stations in this vicinity had average concentrations above 20 µg/L, considered indicative of eutrophic conditions. Highest concentrations, were observed in Little neck (E11), and Flushing Bay South (E15). Steps now being implemented, as part of the *Long Island Sound Study,* to reduce nitrogen discharges into the East River, are expected to reduce enrichment of these waters and limit algal growth.

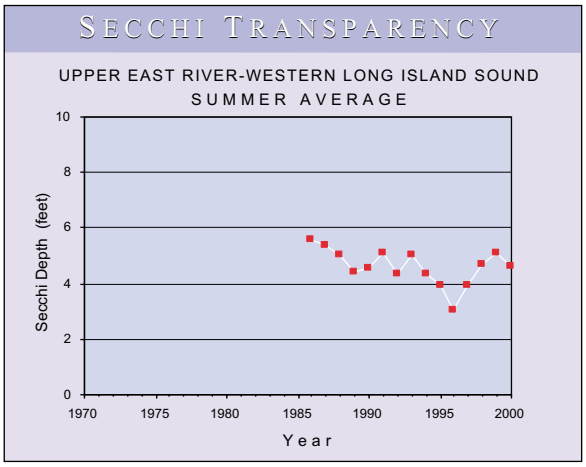
TRENDS

Until experiencing a sharp decrease of almost 13 µg/L in 1997, chlorophyll 'a' in the UER-WLIS showed a fairly consistent rate of increase, close to 5 µg/L every three years. Since 1997, values have been fairly stable. More importantly, current chlorophyll 'a' levels demonstrate group values to be well below 20 µg/L and close to pre-1990 levels.



SECCHI TRANSPARENCY

Average Secchi transparencies for half the UER-WLIS HS sites were greater than 5 feet. The remaining stations had average values ranging from 2.2 – 4.8 feet. Average values below 3 feet (considered light-limited) were observed at only one location (H1).



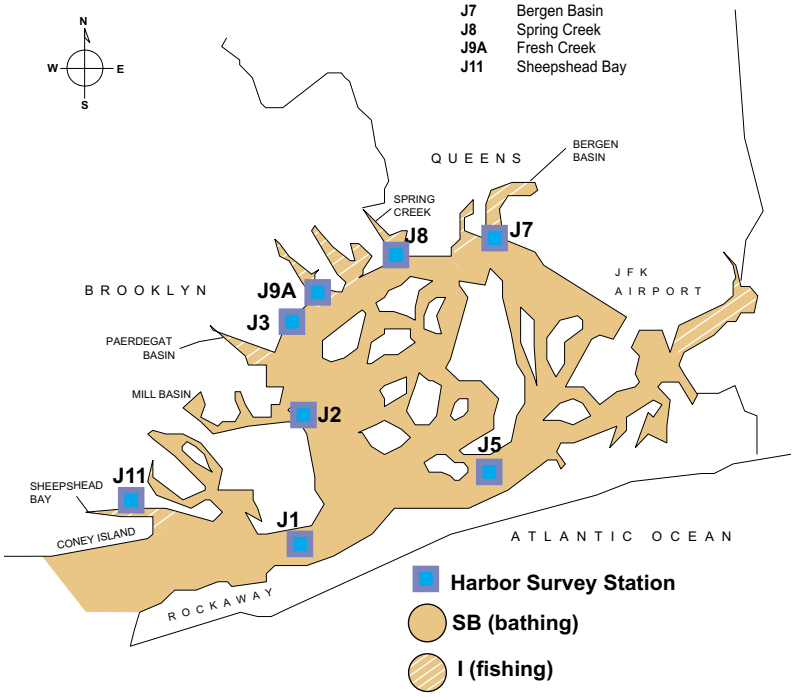
TRENDS

For UER-WLIS stations as a group secchi transparency has varied between about 4 and 5 feet since 1985. During the late 1980s, the transparency dropped from 5.6 feet to almost 4 feet. Declines in transparencies were interrupted by several short-lived trend reversals in the early 1990s, before again dropping to a low of 3 feet in 1996. Improved transparencies over the past three years (to a recent high of 5 feet) have arrested further declines and may coincide with a significant decrease in Chlorophyll 'a' (since 1996) for the same waters.

JAMAICA BAY

JAMAICA BAY

J1	Rockaway Inlet
J2	Mill Basin
J3	Canarsie Pier
J5	Railroad Trestle
J7	Bergen Basin
J8	Spring Creek
J9A	Fresh Creek
J11	Sheepshead Bay



Jamaica Bay is located at the southwestern end of Long Island. This urban, estuarine embayment and national park consists primarily of tidal wetlands, upland areas, and open waters. The Bay and its drainage area are almost entirely within the boroughs of Brooklyn and Queens, except for a small area at the eastern end that is in Nassau County. Jamaica Bay joins the New York Harbor to the west, via the Rockaway Inlet at the tip of Breezy Point and includes the Rockaway Peninsula, which forms the southern limit of the Bay and separates it from the Atlantic Ocean. This estuarine water body, consisting of approximately 20 square miles of open water, is covered by 8 Harbor Survey monitoring stations.

Open waters of Jamaica Bay are classified for bathing or other recreational use (SB). Areas within the Bay's tributaries and dead-end canals are prone to reduced water quality due to direct surface runoff and poor flushing. These areas are designated for secondary contact use (I), such as fishing or boating.

FECAL COLIFORM

In 2000, sanitary water quality was superior for Jamaica Bay, with summer fecal coliform (FC) concentrations well below standards for most stations.

Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the SB standard of 200 cells/100 mL for the entire northern portion of the Bay (from Mill Basin to Bergen Basin). This decrease in water quality is limited to the Bay proper, as Lower NY Bay waters (immediately outside of the mouth of Jamaica Bay) are not typically affected by wet weather events.

TRENDS

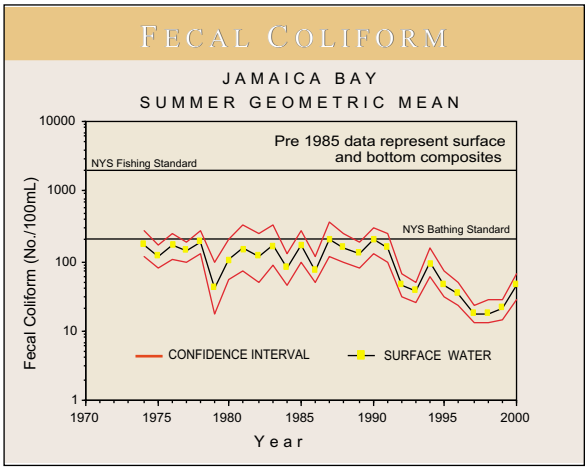
Trends for Jamaica Bay FC, from the early 1970s until 1990, show considerable variability above and below the standard. Counts during this period ranged from well below 100 cells/100 mL to highs near 300 cells/100 mL. However, beginning in the 1990s, a significant improvement is apparent. From this point, and continuing through 1999, the geometric mean FC concentration decreased by an order of magnitude (from 200 to 20 cells/100 mL). 2000 saw a slight increase in FC concentration (Currently unexplained, but we are looking into weather as a cause). The DEP is presently in the process of constructing CSO storage tanks and other treatment facilities in several Jamaica Bay Tributaries, which should further help lower FC level in Jamaica Bay. In addition, a joint DEP-Army Corps of Engineers Jamaica Bay Restoration Project is being designed to improve habitat and recreational value of the Bay.

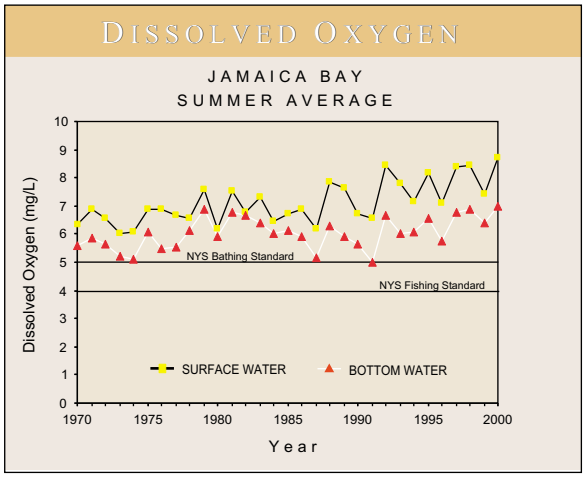
DISSOLVED OXYGEN

The 2000 summer averages for dissolved oxygen (DO) for surface and bottom waters surpassed the New York State standard of 5 mg/L for bathing (SB) at all 8 Jamaica Bay sites. Discrete measurements failed to comply with the applicable standard only 11% of the time in bottom waters and less than 1% in surface waters. Only one sample at station J7 had a measured concentration of less than 3mg/l.

TRENDS

Average DO concentrations in Jamaica Bay have shown improvement over the past 30 years, with top waters often reaching DO levels over 8 mg/L since the 1990s. This is notable in that average DO levels were well above bathing standards as early as 1970. Of note are high DO variability within and between years and an increasing gap between surface and bottom waters since the mid-1980s. High surface DOs are often due to super-saturated conditions, attributable to algae blooms or eutrophic waters.

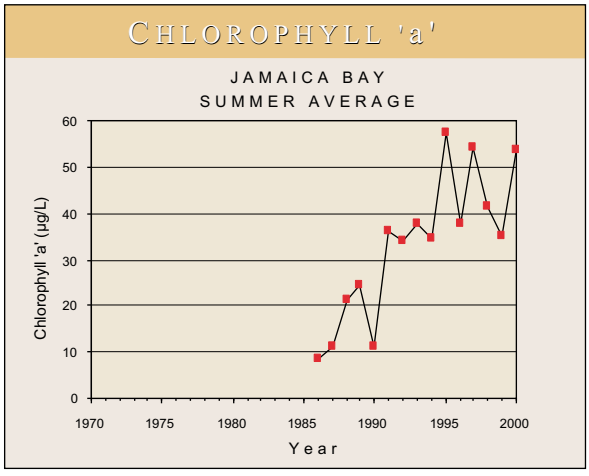




JAMAICA BAY

CHLOROPHYLL 'a'

High chlorophyll 'a' concentrations in Jamaica Bay are indicative of eutrophic conditions. The slow turnover of water within the Bay[7] allows for development of large standing phytoplankton populations. Of the four geographic Harbor Survey regions, Jamaica Bay continues to display the widest range of individual chlorophyll 'a' measurements. Summer averages at all Harbor Survey stations have values above 20 µg/L, On average, chlorophyll 'a' concentrations for the Bay measured 53.58 µg/L. This follows the pattern of large inter-annual swings seen in the past 5 years.



[7] ***The slow turnover of water within Jamaica Bay*** *- is partially due to JFK Airport construction in the 1960s. Removal of over 70 million cubic meters of bottom material changed the Bay's mean depth from 3 to 16 ft and increased water residence time from 11 to 35 days.*

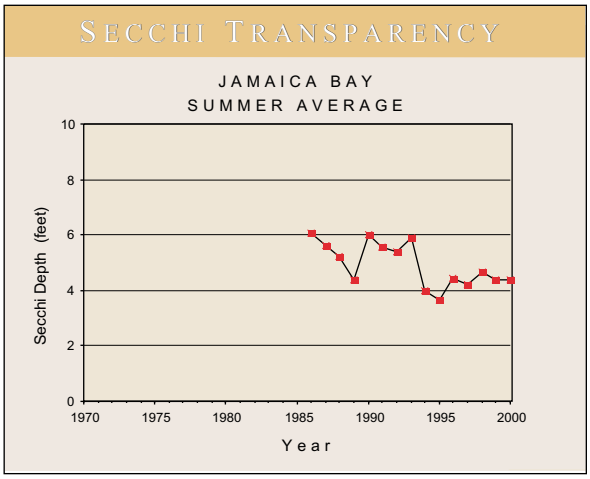
TRENDS

Chlorophyll 'a' concentrations in Jamaica Bay have shown tremendous increases over the past 14 years, with a yearly average rate increase, of 4.3 µg/L since 1986. Yearly summer averages peaked in 1995 at 57.6 µg/L, but concentrations over the past 5 years have shown sharp fluctuations, both up and down, extending below 40 µg/L in 1996 and1999. These conditions have coincided with prolonged algae blooms in Jamaica Bay and reports of nuisance algae at the head of bay tributaries and canals, as well as, dynamic DO fluctuations.

Nutrient loadings to Jamaica Bay are now being carefully monitored to control eutrophication of these waters. Average dry weather nitrogen has been reduced by over 5,000 lbs/day since 1997 to limit algal growth. A recently initiated DEP Use and Standards Attainment Project will focus on needed improvements of Jamaica Bay tributaries and canals.

SECCHI TRANSPARENCY

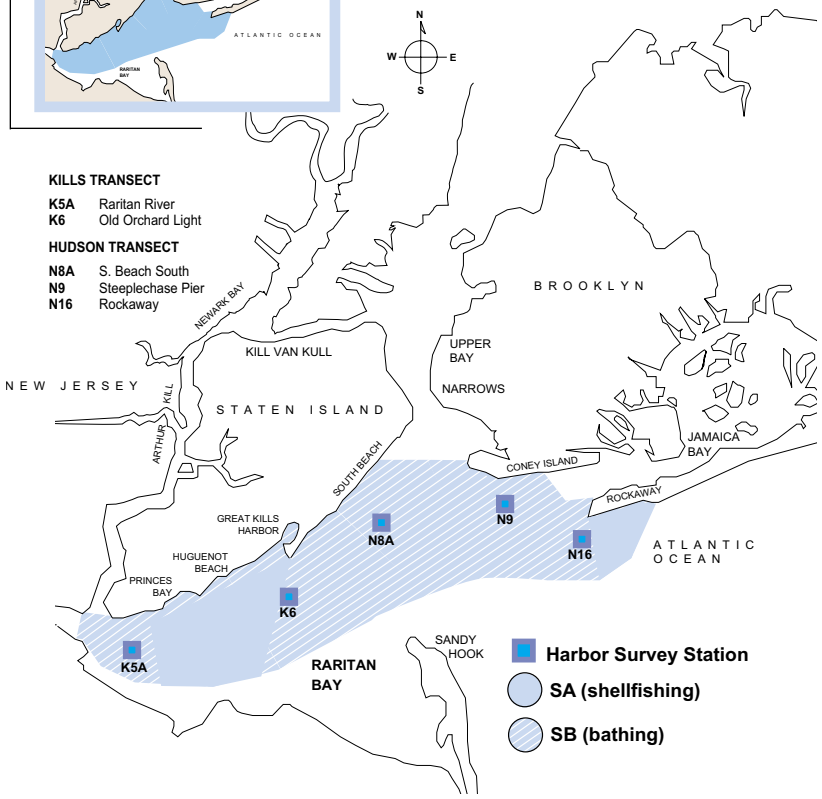
Average Secchi transparencies were never less than 3 feet at any of the Jamaica Bay sites. Two stations, (J1 and J11) had average readings above 5 feet, depths associated with cleaner waters. Both of these locations are outside the Bay proper and experience greater water exchange than sites within the Bay. Average Secchi values for interior Bay tributaries and canals were fairly consistent with values ranging from 3.0 - 4.0 feet.



TRENDS

Annual averages for Secchi transparency indicate a gradual decline from 1986 to 1995, but with large inter-annual variability at times. Recently the levels have been fairly stable at about 4 feet for the past five years.

LOWER NEW YORK BAY–RARITAN BAY



*The Lower NY Bay-Raritan Bay (LNYB-RB) vicinity represents the most oceanic portion of the **Harbor Survey Program**. This area of 100 square miles is represented by 5 Harbor Survey monitoring stations and is composed mostly of open shallow waters, partially confined by Brooklyn's Coney Island to the north, Staten Island to the northwest, and New Jersey's Middlesex and Monmouth Counties and Sandy Hook to the south. The remainder of its eastern boundary is open to Rockaway Inlet and the greater Atlantic Ocean.*

This area of the Harbor is classified for bathing and other recreational use (SB). Portions of those waters are also designated for the permitted use of shellfishing (for relay to cleaner waters, but not direct consumption), having a stricter use classification of SA.

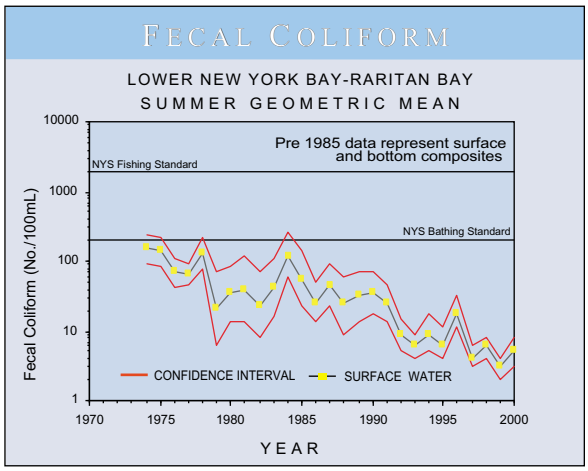
FECAL COLIFORM

Sanitary water quality as estimated by fecal coliform (FC) was superior for the Lower New York Bay–Raritan Bay (LNYB-RB) in summer 2000. Examination of seasonal FC numbers shows waters of the LNYB-RB to meet and surpass NYS standards for this area, with all locations having geometric mean values of less than 20 cells/100 mL.

Examination of wet weather data shows only the waters in the vicinity of Steeplechase Pier (N9) to experience temporal degradation or increased FC loadings following rain events. Under these conditions, FC increased from less than 100 to 100-200 cells/ 100 mL. While a similar effect is apparent for waters bordering the Lower Bay, such as the Upper NY Bay, the Narrows, and the Arthur Kill, the remainder of the LNYB-RB area remains unchanged, due to the dynamics of flushing and dilution.

TRENDS

Coliform concentrations for LNYB-RB show significant declines (more than an order of magnitude) from the early 1970s to the present time. While FC concentrations for surface waters were below 200 cells/100 mL (and therefore in compliance with bathing standards) as early as 1974, recent average FC levels in 2000 were no more than 5 cells/100 mL (potentially satisfying shellfishing standards). Though FC counts declined in 1979, strong variation is evident through 1984, after which FC have shown more consistent decreases. Subsequent to these improvements, 30,000 acres of shellfishing beds have been approved for clamming off the Rockaways and in Raritan Bay. Even greater FC decreases (improvements to sanitary water quality) occurred after 1991, coinciding with improved NYC sewage system operations and implementation of USEPA's recommended CSO controls.[8] These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet-weather swimming advisories for all but three beaches in LNYB-RB.

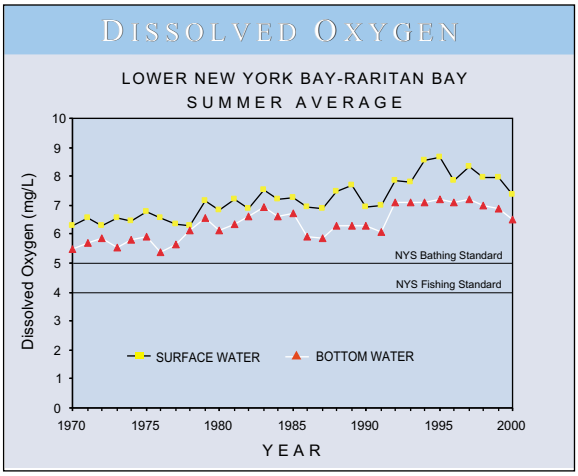


DISSOLVED OXYGEN

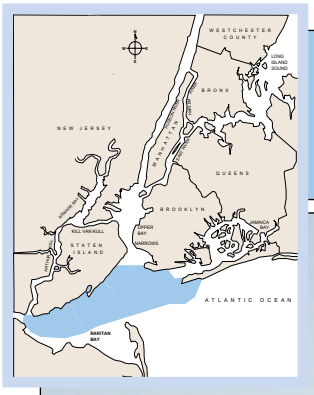
Dissolved oxygen (DO) values for top and bottom waters show excellent compliance with the NYS DO standard of 5 mg/L. Actual DO values were found to be below 5 mg/L only 4 times out of 388 measurements and minimum DO values were never below 3.0 mg/L. This is true despite the Lower NY Bay's proximity to more degraded waters in the Arthur Kill, Narrows, and mouth of Jamaica Bay.

TRENDS

Since 1970, average DO concentration have increased over 1.5 mg/L, from just over 6 mg/L to nearly 8 mg/L for surface waters, and from about 5.5 mg/L to nearly 7 mg/L for bottom waters. Most of the general improvement in this vicinity is attributable to improved water quality of K5A (located due east of the Raritan River and south of the Arthur Kill). This improvement reflects loading decreases in sanitary waste in the vicinity of the Arthur Kill and the Raritan River.



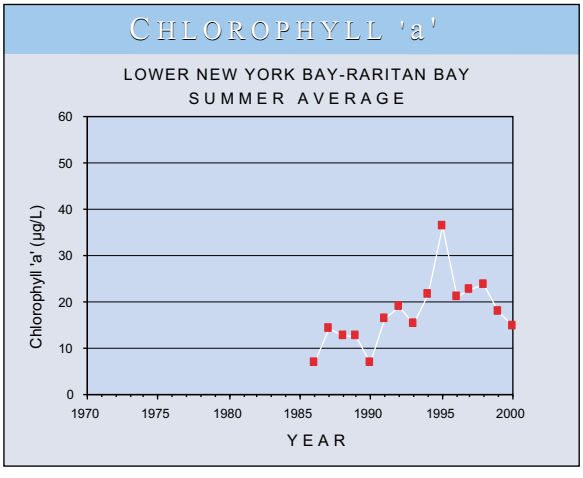
[8] ***USEPA recommended CSO controls*** *- a set of management actions issued in 1996 by the US Environmental Protection Agency for the purpose of mitigating CSO impacts. These actions are collectively referred to as 'The Nine Minimum Controls' (see full Harbor Survey Report).*



LOWER NEW YORK BAY–RARITAN BAY

CHLOROPHYLL 'a'

Of the five Lower New York Bay–Raritan Bay (LNYB-RB) sites, the 3 stations paralleling the Staten Island beaches into Raritan Bay, had average chlorophyll 'a' concentrations above 15 µg/L, levels indicative of eutrophic conditions. Based on an increase of citizen complaints, phytoplankton blooms[9] (algae slicks) appear to have become more common in these waters in the past few years. This vicinity of relatively shallow, slower moving water appears ideal for phytoplankton bloom formation, as nutrient rich Harbor waters empty into the LNYB-RB area. Slower moving waters allow for the condensing of organic material and the growth of algae into tangible slicks, often visible from shore bathing areas. Contact with nutrient-rich oceanic waters only further serves to fuel additional phytoplankton growth, until slicks are dispersed again or washed out of the Bay area. The two most eastern LNYB-RB stations had average concentrations closer to 10 µg/L. This is likely due to better tidal flux (active exchange of Harbor and oceanic waters).



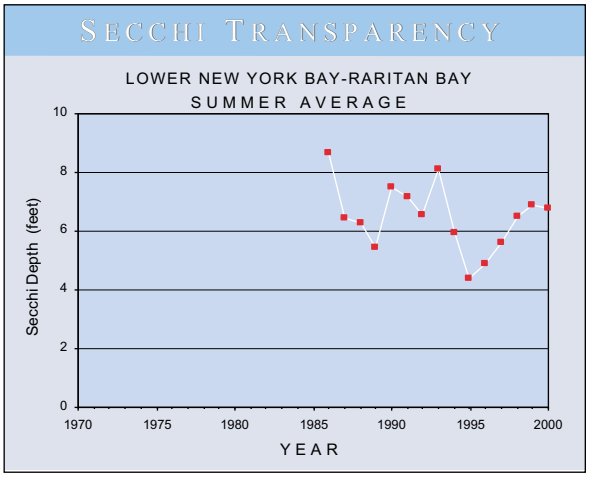
[9] ***Phytoplankton blooms-*** *recognized as a concern by the NY/NJ Harbor Estuary Program (HEP), algae blooms are the focus of increased monitoring in LNYB-RB waters.*

TRENDS

Average chlorophyll 'a' concentrations for the LNYB-RB area remained at or below 15 µg/L until 1991. From this time on, concentrations began to raise slightly, first exceeding 20 µg/L in 1994. Following a 1995 spike in chlorophyll 'a', group values have returned to levels close to 20 µg/L over the past 4 years, the average dropping to 15 µg/L in 2000.

SECCHI TRANSPARENCY

Average Secchi values for LNYB-RB stations were all close to or well above 5 feet. Secchi depths can be seen to increase, moving from the most western Raritan Bay site (K5A), eastward, across the Lower New York Bay. A high average value of over 10 feet was recorded at Rockaway Point (N16). This site, the most oceanic of the Harbor Survey's 53 monitoring stations, commonly experiences the widest range in Secchi values. In 1999, measurements at N16 ranged from 7-17 ft, indicative of extremely clean conditions and superior water clarity.



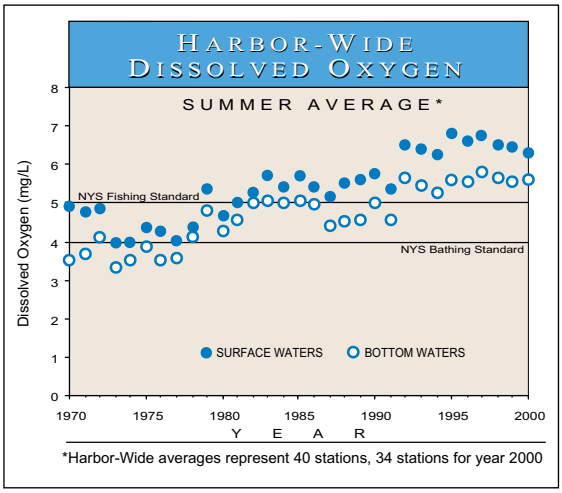
TRENDS

While group average values for the LNYB-RB sites are typically 1-2 feet higher than those of Jamaica Bay, Secchi trends show similar patterns for both vicinities. Transparency in LNYB-RB is seen to decrease from 1986-1989, with a nearly full trend reversal occurring in the early 1990s. Secchi transparency dropped off again from a high of over 8 feet in 1993, to a low of 4.4 feet in 1995. Water clarity has shown strong, if gradual improvement over the past 4 years, with the average group value close to 7 feet in 2000.

HARBOR-WIDE IMPROVEMENTS

The regional trends noted above for fecal coliform (FC) and dissolved oxygen are no less impressive when discussed on a Harbor-wide basis. Harbor-wide, fecal coliform concentrations have decreased nearly two orders-of-magnitude from 1974 through 2000, with the most marked changes occurring from 1974 through 1988. These declines are primarily due to the abatement of raw sewage discharges through construction and upgrading of water pollution control plants (WPCPs). Further improvements since 1989 are attributed to the increased surveillance and improved maintenance and operation of the entire sewage collection system.

Progressive improvement (decreases in FC) for four time periods (each reflective of enhanced sewage treatment and operational controls) is portrayed in the figure on page 23. In **1974**, prior to secondary upgrades, waters did not meet levels appropriate for fishing in the Inner Harbor Area, nor bathing in outlying waters. Significant improvement can be seen following plant expansion and upgrades (**1985**) and start-up of the City's last two WPCPs (**1988**). Together, operation of the North River and Red Hook plants ended the discharge of 210 million gallons per day (mgd) of untreated sewage to the Manhattan and Brooklyn shorelines. Further water quality improvements (**2000**) are attributable to the increased surveillance and improved maintenance and operation of the entire sewage collection system. This has abated 3.2 mgd of illegal discharges, practically eliminated raw sewage bypassing, and increased the capture of rainfall that enters the combined sewer system to an average of 55% in fiscal year 2000.

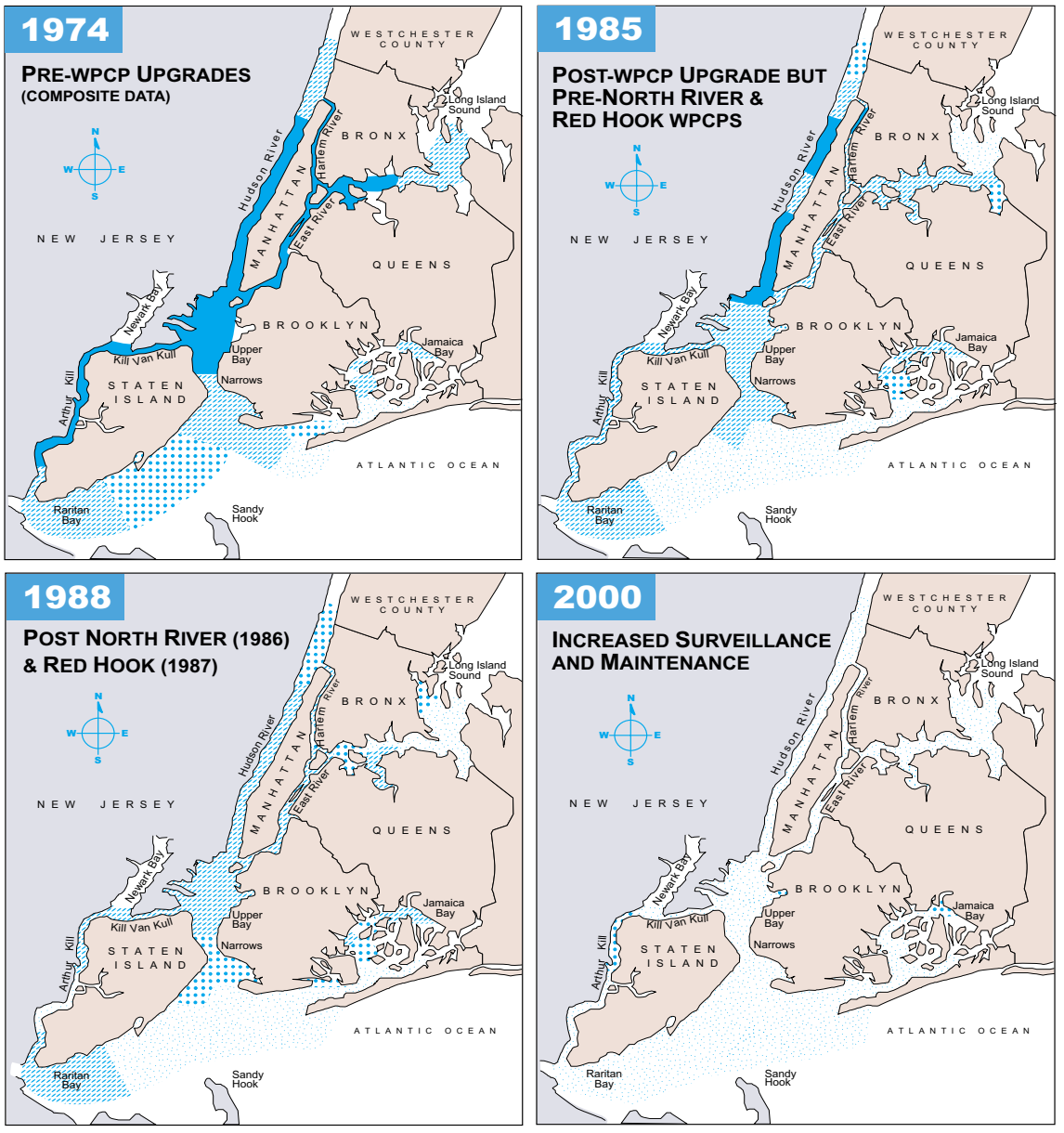


Although, as a result of these actions, average FC in 2000 met New York State bathing standards in all Harbor waters, NYC DOH requirements preclude bathing at locations near sewer outfalls and where coliform exceeds bathing criteria after significant rainfall. Therefore, bathing activities are permitted only at designated areas.

Area-wide decreases in sewage loading have resulted in greater environmental improvement in the Harbor. Indicative of this improvement are dissolved oxygen (DO) levels. Harbor Survey monitoring has documented significant Harbor-wide increases in DO concentrations (~2 mg/L) over the past 30 years (see below). Today, Harbor waters have DO concentrations above levels first recorded at the beginning of the 20th century.

HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

SUMMER GEOMETRIC MEAN FOR FECAL COLIFORM IN SURFACE WATERS



KEY: UNIT= Fecal Coliform Cells/100mL

NYC DOH requirements preclude bathing near sewer outfalls and where rainfall may substantially increase coliform levels.

NOT MEASURED	POOR (>2000)	FISHING (201-2000)	BATHING (100-200)	SUPERIOR (<100)

NYS Best-Use Classifications: ≤ 200 FC/100mL=SB (Bathing); ≤ 2000 FC/100mL=I (Fishing)
Poor does not meet fishing standards; Superior does not imply shellfishing quality

Conclusion

Based on the previously mentioned water quality indicators and trends, as well as other performance measures, there is overwhelming evidence that New York Harbor's environment is cleaner and the water quality better than at any time since the early 1900s. Improvements range from the re-establishment of breeding populations of water fowl in several areas of the Harbor, to improved benthic (bottom-dwelling) communities in the lower New York Bay, and include:

- the opening of all NYC public beaches since 1992 and the lifting of wet-weather swimming advisories for all but three of these beaches;
- the upgrading of 68,000 acres of shellfish beds since 1985, including the removal of shellfishing restrictions for 30,000 acres off of the Rockaways and in Raritan Bay;
- recovery of Hudson River shortnose sturgeon to record breaking numbers;
- the heavy re-infestation of woodpilings by marine wood-borers and other aquatic organisms;
- decreases in chemical concentrations in fish tissues and a subsequent relaxing of state advisories on human consumption of striped bass in parts of the Hudson River; and
- a 50-90% reduction from peak levels of priority pollutants in fine-grained sediment in the Hudson River.

These improvements can be attributed in large part to the continued development and upgrading of the City's sewage treatment system, and the implementation of a suite of aggressive pollution control programs. These actions, together with operational improvements implemented over the past 12 years, have:

- virtually eliminated raw sewage discharges;
- reduced identified illegal discharges by 96%;
- increased capture of wet-weather related floatables to 71%;
- increased capture of rainfall that enters the combined sewer system to an average of 55%; and
- reduced toxic metals loading to the waste stream from industrial sources by over 90%.

Despite the milestones noted above, a number of environmental problems remain unresolved for New York Harbor and the region's estuarine environment. Some of these concerns include: sediment contamination and limitations on dredge spoil disposal; remaining fish advisories; episodically low dissolved oxygen; and nuisance algae and algal slick formation. These challenges defy political boundaries and require continued regional adherence to, and support of, strong environmental control programs. Only through broad stakeholder involvement throughout the Harbor's watershed can we anticipate further enhancement of New York Harbor and its environs.

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