Friends of the Bay

Working to keep the oyster in Oyster Bay

2004 Annual Water Quality Report
Open Water Body Water Quality Monitoring Program

Prepared in 2007 For

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Funded In Part By

Arrow Electronics Inc. • Frank M. Flower & Sons, Inc
The M.O. and M. E. Hoffman Foundation

This *2004 Annual Water Quality Report* was produced in 2007. It presents and describes data and observations that were recorded by Friends of the Bay Water Quality Monitoring Program in 2004.

Who We Are

Friends of the Bay (FOB) – a widely respected, not-for-profit organization with thousands of supporters – is dedicated to the protection of the Oyster Bay/Cold Spring Harbor estuary and the surrounding watershed. FOB's advocacy efforts enable the estuary to continue as an unsurpassed scenic, ecological and economically-productive resource.

Our Mission

FOB's mission is to preserve, protect and restore the ecological integrity and productivity of the Oyster Bay/Cold Spring Harbor estuary and the surrounding watershed.

What We Do

- Helping to maintain clean waters that sustain a vital ecosystem, a wide range of recreation and a thriving shellfishing aquaculture business.
- Monitoring water quality within the estuary.
- Creating awareness of the need to preserve water quality and marine life.
- Confronting unsound development proposals.
- Promoting responsible development and land use planning.
- Partnering with residents, organizations, and local businesses.
- Working with government at all levels.

How We Are Perceived

Friends of the Bay has been identified by *The New York Times* as one of the most effective environmental organizations around Long Island Sound. In 1997, we became one of the few East Coast groups ever to receive the prestigious Walter B. Jones Memorial and NOAA (National Oceanic and Atmospheric Administration) Excellence Award in Coastal and Ocean Resource Management presented to the "Non-Governmental Organization of the Year." In 1999, the New York Chapter of the American Planning Association honored FOB with an Award for Meritorious Achievement. Friends of the Bay was selected in the "Best Environmental Organizations" category of the *Long Island Press*' Best of Long Island 2007 issue (issue is dated December 21, 2006 – January 3, 2007). (The prior year, the editors of the *Long Island Press* selected us as their choice in this category.)

More importantly, our cooperative planning efforts are models for local governments and other environmental groups around Long Island Sound that seek to prepare watershed management plans to protect their embayments and reap the benefits of a cleaner Sound. Our Executive Director sits on the Long Island Sound Study Citizens Advisory Committee, the Nassau County Soil & Water Conservation District Board of Directors, Nassau County's 2006 Environmental Program Bond Act Advisory Committee, the Town of Oyster Bay's Environmental Control Commission, and the Town of Oyster Bay's Eastern Waterfront Visioning Plan Steering Committee.

Our History

FOB was formed in 1987 and rallied public support to defeat an environmentally disastrous development plan which would have sited 78 condos, a 225 slip marina with a wave baffle, a restaurant atop a 3-story office building and a boatel – all on a contaminated shipyard site. After defeating the environmentally destructive proposal, FOB led an extraordinary public process that resulted in the "Land Use Plan for the Oyster Bay Western Waterfront."

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ACKNOWLEDGEMENTS

Friends of the Bay would like to thank the individuals and organizations that make our water quality monitoring program possible.

The McAllister Family - Donald Jr., Maureen and Liane McAllister, residents of Centre Island, for their financial donation, which provided the following needed items: "How's the Water? Educational Display boards, Depth Finder, YSI repairs, and Drink holders.

Carolina Skiff - In 2000, Carolina Skiff provided a brand new 19' Carolina Skiff Semi-V Hull boat at a 50% discount. The "semi-v" hull provides a stable work platform for volunteers to conduct water quality monitoring, education programs, harbor clean-ups, and for members of the press to photograph events.

Evinrude - Evinrude, through its government sales office, enabled Friends of the Bay to purchase the 70 horsepower 4-stroke engine for 40% off the regular price. The more environmentally friendly 4-stroke engine, which burns 31% less fuel than a 2-stroke engine, does not discharge oil into the bay and meets the goal, set in the EPA 2006 emissions regulations.

Frank M. Flower and Sons, Inc. - Dwight and Dave Relyea and Joseph Zahtila, owners of Frank M. Flower and Sons, Inc., have provided ice, dock space, boats, and logistical support for Friends of the Bay's monitoring program since 1992.

Oyster Bay Marine Center - Donates the fuel for the Baywatch II each year and fulfills technical needs of the program.

Bridge Marina - Richard Valicenti and his staff continuously and graciously provide support to Friends of the Bay through repairs, parts, service, and advice for our vessel, the "Baywatch II".

Nassau County Department of Health - Nassau County Department of Health (John Jacobs, Director of Environmental Health is our primary contact) donates laboratory testing services for bacteria samples collected by FOB.

Village of Bayville - Helped arrange for Nassau County Department of Health to donate services.

Bill Hastback - New York State Department of Environmental Conservation - Provided advice and information throughout the monitoring season.

South Mall Analytical Labs, Inc. - Graciously donated their laboratory services for the testing of nitrates, nitrites, total nitrogen, ammonia-N, and organic nitrogen once per month as part of our Water Quality Monitoring Program.

Water Quality Monitoring Work Group - As a participant in the Water Quality Monitoring Work Group, Friends of the Bay has benefited from the collective knowledge of numerous

individuals and organizations from around Long Island Sound, especially Carol DiPaolo from the Coalition to Save Hempstead Harbor.

Tow/Boat US and North Shore Diving Services - Mitch Kramer has graciously agreed to support "Baywatch II" in "any way he can."

Nicole Pedersen - As the water quality monitoring program coordinator, Nicole oversaw the collection of coliform and nitrogen samples and the dissolved oxygen, turbidity, water temperature, and salinity sampling. She recruited, trained and scheduled the volunteers who assisted in the water quality monitoring.

Volunteers -
*Joanne Gallo * Bud Kadzan *Hank Kasven *Catherine McConnell *Jim Monk * Nicholas Naphenas * Linda Storackre * Charlotte Schmidlapp*

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EXECUTIVE SUMMARY

Friends of the Bay's Water Quality Monitoring Program is an important component of our efforts to protect the Oyster Bay/Cold Spring Harbor estuary ecosystem while serving to increase public awareness of local threats to water quality. This program was developed in cooperation with the United States Fish and Wildlife Service, United States Environmental Protection Agency, New York State (NYS) Department of Environmental Conservation, local governments, and other volunteer monitoring groups around Long Island Sound.

The year 2004 was marked by continuing and improving upon the work of 2003; continued to collect data to track the health of the ecosystem. Friends of the Bay went out on the bay 22 times between May 5th and October 27th, collected approximately 415 samples that were analyzed for coliform bacteria (378) and nitrogen pollution (37) and recorded 723 measurements each of dissolved oxygen and temperature.

Friends of the Bay monitored nineteen locations within Cold Spring Harbor (CSH) (FOB #1 – FOB #4), Oyster Bay (Locations FOB #5 – FOB #12), and Mill Neck Creek (FOB #13 – FOB #19). Each site was monitored in the morning once per week, weather and tide permitting, for dissolved oxygen, bacteria pollution, salinity, temperature, and clarity. Nitrogen samples were collected twice during the season.

Three major water quality parameters were monitored in 2004: coliform bacteria levels, dissolved oxygen levels and enrichment of the water by nitrogen. Analysis of this season's data provided many useful insights into the quality of water in the estuary.

In 2004, an apparent increase in bacteria levels occurred in both Mill Neck Creek and Cold Spring Harbor. In Mill Neck Creek, total and fecal coliform levels approached levels not observed since 2001 and 2002. In Cold Spring Harbor, the seasonal geometric mean for coliform was the highest ever recorded. In 2004, three sampling stations were rated unacceptable, per the Nassau County water quality standards for bathing, as compared to one station in 2003, and no stations in 2002 received that rating.

Fortunately, these high bacteria levels did not affect the Oyster Bay Harbor shellfishery, where coliform levels were slightly lower than in 2003. These elevated coliform levels should indicate a need for increased monitoring and identification of pollutant sources within the estuary and its watershed.

The third year of nitrogen monitoring also suggested increases in nitrogen levels in several areas of the estuary in 2004 as compared to 2003. Nitrogen levels were elevated in Cold Spring Harbor and parts of Mill Neck Creek this year. Despite this observation, 6 monitoring locations would have met the nitrogen standard for marine waters that New York State applies to the Peconic Bay estuary, if that standard were to be applied to the Oyster Bay/Cold Spring Harbor estuary as well. In 2003, 7 locations would have met the standard, and in 2002, only two sites met the standard. It is possible, then, that nitrogen levels have improved somewhat over the last three years. However, it should be noted that 2002 was the first year in which nitrogen data was collected, and only two monitoring events in 2004 included the collection of nitrogen data, so it is unclear if the observations represent a trend or merely random variability.

Once the Oyster Bay Sewer District completes construction of the nitrogen removal upgrade to its wastewater treatment plant, the Friends of the Bay nitrogen data collected in 2002, 2003, 2004 and subsequent years will provide a valuable baseline in evaluating the effect of reduced nitrogen loading on the Bay. The upgrade represents an important improvement in infrastructure available to the public, which should improve Bay water quality.

Dissolved oxygen (DO) data was collected throughout Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor during the monitoring season. DO trends indicate that the waters of the estuary are enriched with nutrients, since dissolved oxygen levels decrease steadily from spring through late summer, and then begin to increase in late summer. The lowest DO levels were observed in deep water, which is consistent with decay of organic matter when temperatures are warm and the water column cannot mix vertically. Both severely hypoxic conditions (DO levels from 2 to 1 mg/l) and anoxic conditions (DO levels below 1 mg/l) were observed in Cold Spring Harbor. Severely hypoxic conditions were observed in Oyster Bay Harbor as well. A long-term reduction in nitrogen inputs should reduce the occurrence of extremely low DO conditions in the bottom of the harbor.

All waters in the Oyster Bay/Cold Spring Harbor estuary need protection. However, additional management efforts should be focused on areas of concern such as Cold Spring Harbor, Mill Neck Creek/Beaver Lake and the Oak Neck Creek area. 2004 results from Cold Spring Harbor and Mill Neck Creek suggested that pollutant inputs may have increased in 2004 compared to 2003, as indicated by increased bacteria levels.

INTRODUCTION

Friends of the Bay is a widely-respected non-profit environmental organization located on the North Shore of Long Island. Friends of the Bay's mission is to preserve, protect, and restore the ecological integrity and productivity of the Oyster Bay/Cold Spring Harbor estuary and the surrounding watershed[1]. Appendix A presents a fact sheet for the estuary.

The Oyster Bay/Cold Spring Harbor estuary complex consists of a unique ecosystem in close proximity to New York City. Consider:

- The U.S. Fish & Wildlife Service maintains a 3,209 acre National Wildlife Refuge (NWR) within the Oyster Bay/Cold Spring Harbor Estuary Complex.[2]
- Two State-designated Significant Coastal Fish and Wildlife Habitat areas exist within the Oyster Bay/Cold Spring Harbor Estuary Complex.[3]
- More than 80 commercial baymen annually harvest up to 90% of New York State's oyster crop[4] and 33% of hard clams[5] from the Oyster Bay NWR.
- The Harbor Complex is home to the Cold Spring Harbor Fish Hatchery & Aquarium. The Hatchery is proud to have the largest living collection of New York State freshwater reptiles, fish, and amphibians.
- Oyster Bay is a designated New York State "historic maritime area."
- Oyster Bay (Mill Neck) is among the 33 Inaugural Stewardship Areas listed within the Long Island Sound Stewardship Initiative 2006 Atlas.[6]

Friends of the Bay's Water Quality Monitoring Program was initiated to continue data collection efforts that were cancelled by county funding cuts. This program was developed in cooperation with the United States Environmental Protection Agency (EPA), New York State Department of Environmental Conservation (DEC), local governments and other volunteer monitoring groups around the Long Island Sound. Friends of the Bay considers this program a necessary component in the effort to preserve the Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor ecosystem and hopes to increase public awareness of local threats to water quality. The water quality program of Friends of the Bay is being conducted to:

1. Provide high quality data to continue the dissolved oxygen-testing baseline established by the Nassau County Department of Health in 1972
2. Screen for water quality impairments
3. Monitor the estuary in support of the Total Maximum Daily Load (TMDL) for pathogens that has been established for Oyster Bay Harbor and Mill Neck Creek[7]

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[1] Friends of the Bay Mission Statement as of 2005
[2] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[3] http://www.nyswaterfronts.com/waterfront_natural_narratives.asp; For almost two decades, there have been three state designated Significant Coastal Fish and Wildlife Habitats within the Oyster Bay/Cold Spring Harbor Estuary: Cold Spring Harbor, Oyster Bay Harbor, and Mill Neck Creek Wetlands (these habitat designations originated in 1987). On October 15, 2005, The New York State Department of State recommendations to consolidate these designations became effective. The two habitats now include 1) Mill Neck Creek, Beaver Brook, and Frost Creek, and 2) Oyster Bay and Cold Spring Harbor.
[4] http://refuges.fws.gov/profiles/index.cfm?id=52563
[5] 2004 New York Annual Shellfish Landings, New York State Department of Environmental Conservation
[6] The Stewardship Initiative identifies places with significant biological, scientific, or recreational value throughout Long Island Sound and works to develop a strategy to protect and enhance those special places. The Stewardship Initiative has five specific goals: 1) Preserve native plant and animal communities and unique habitat types; 2) Improve recreation and public access opportunities; 3) Protect threatened and endangered species in their natural habitats; 4) Preserve sites that are important for long-term scientific research and education; and 5) Promote efforts to plan for multiple uses. For additional information, visit http://longislandsoundstudy.net/stewardship/stewardship_atlas06.pdf

4. Determine long-term water quality trends
5. Document effects of water quality improvements
6. Educate and involve citizens and public officials about water quality protection
7. Watchdog activity within the watershed and harbor
8. Assist local, State, and Federal agencies in harbor management

This program enables trained volunteers working alongside Friends of the Bay staff to monitor various components of the marine ecosystem. Volunteers track a number of parameters in the bay including water temperature, clarity, salinity, dissolved oxygen, nitrogen and bacteria. Measuring these parameters enables Friends of the Bay to better understand changes within the local marine ecosystem.

A Cooperative Agreement exists between Friends of the Bay and the U.S. Fish and Wildlife Service as well.[8] In this agreement, Friends of the Bay supplies collected data to the Fish and Wildlife Service. The objectives of this cooperative effort are to support long-term water quality monitoring within Oyster Bay Harbor, Mill Neck Creek, and Cold Spring Harbor, waterways contained within the Oyster Bay National Wildlife Refuge in addition to cooperative efforts on environmental education, interpretation, and outreach projects.

This Annual Water Quality Report summarizes the data collected during the 2004 monitoring season. This report was produced in 2007 as part of Friends of the Bay's continuing commitment to study the complex forces that impact water quality within the estuary complex and the surrounding watershed.

[7] *Pathogen Total Maximum Daily Loads for Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek.* NYSDEC (2003)
[8] under the authority of the *U.S. Fish and Wildlife Coordination Act,* as amended, (16 U.S.C. Section 661) and Section 7 of the *Fish and Wildlife Act of 1956* [16 U.S.C. 742F(a)(4)], and the *Interior and Related Agencies Appropriation Act of 1992* (PL 102-154, Title 1, 105 Stat. 995.)

1.0 MONITORING PROGRAM

Every Monday morning from May through October 2004, Friends of the Bay staff and dedicated volunteers collected data on water quality and ambient conditions at 19 sites throughout the estuary complex. The parameters measured by Friends of the Bay included dissolved oxygen, salinity, water temperature, water clarity, coliform bacteria, and nitrogen species.

Dissolved oxygen, salinity, and water temperature were measured using a Hydrolab Quanta. The instrument includes a probe that can be lowered within the water column to analyze the water's attributes in-place and a handheld datalogger that interprets the probe measurements and displays them for the sampler.

Water clarity was measured using a Secchi disk, a circular disk with opposing white and black quadrants that is lowered into the water column to the depth at which it can no longer be distinguished by an observer at the surface.

Water samples for coliform bacteria and nitrogen measurement were also collected by Friends of the Bay and analyzed by the Nassau County Department of Health (NCDH) and South Mall Analytical Labs, Inc., respectively.

Field measurements collected and observations made at the time of sampling were recorded on field water quality monitoring sheets, which are presented in Appendix C. The following is a summary of the water quality testing locations and methods. These methods are equivalent to those that are presented in the Standard Operating Procedures and Quality Assurance Project Plan that were approved by the EPA in May of 2006.

1.1 Monitoring Locations

Friends of the Bay monitored a total of 19 sites throughout the Oyster Bay/Cold Spring Harbor estuary, including Locations FOB #5 – FOB #12 in Oyster Bay Harbor, Locations FOB #1 – FOB #4 in Cold Spring Harbor (CSH), and Locations FOB #13 – FOB #19 in Mill Neck Creek. A map identifying the approximate location of each site, as well as a table of GPS coordinates for each station are included in Appendix B. These station locations and identifiers were revised in 2003, so care should be used when comparing results from 2004 and 2003 to results presented in the 2002 monitoring report.

1.2 Monitoring Methods

Friends of the Bay monitored each site for the following water quality parameters:

- Dissolved Oxygen and Water Temperature - Dissolved oxygen (DO) and water temperature were measured at 19 monitoring sites using the Hydrolab Quanta datalogger and sonde. At each station, depth permitting, dissolved oxygen readings were taken at approximately one half-meter above the bay bottom, one-half meter below the water surface, and at one meter below the surface. The DO data was measured and recorded in milligrams per liter (mg/l), which is equivalent to parts per million (ppm). The measured values are then compared to ranges that describe the effect of dissolved oxygen on aquatic life, which are well established. In general, dissolved oxygen levels above 5.0 mg/l are preferred. Levels between 4 and 5 mg/l can cause harm to some species of organisms, especially the larvae of crustaceans such as lobster and crabs. Levels between 2 and 4 mg/l can cause harm to many organisms if exposure is prolonged. When dissolved oxygen levels decline below 2 mg/l, many organisms can be harmed quickly. Few organisms can survive exposure to levels below 1 mg/l for more than very short periods.

- Salinity - Salinity is the measurement of the concentration of dissolved salts in the water. Friends of the Bay monitored salinity with the Quanta meter, which measures specific conductivity (a direct measurement of the ease with which electricity passes through water) and converts that measurement to salinity. In earlier years, Friends of the Bay monitored salinity with a hydrometer, an instrument used to measure the specific gravity of liquids.

- Water Clarity - Friends of the Bay measured water clarity with a Secchi disk. The 8-inch diameter disk is divided into alternating black and white quadrants. The disk is lowered into the water with the sun at the volunteer's back. The point at which the disk becomes completely obscured is noted. The disk is then raised and the point at which the disk becomes visible again is noted. The average of these two numbers is the Secchi Depth, recorded to the nearest tenth of a meter (decimeter).

- Coliform Bacteria - Water samples are collected by Friends of the Bay in sterile swirl packs approximately one foot below the water surface. The swirl packs are then stored in a cooler with ice and transported immediately to the NCDH laboratory in Hempstead for analysis. The NCDH uses the Multiple-Tube Fermentation Technique - Method No.9221 (Standard Methods for the Examination of Water and Wastewater, 1995), which uses a 5-tube decimal dilution test. The level of total and fecal coliform bacteria in a water sample is expressed as the most probable number per 100ml (MPN/100ml). To ensure that proper temperature standards are met, an additional water sample is collected at the first station and designated as the temperature control (TC). It is placed in the cooler with the ice and, upon arrival at the NCDH laboratory; the TC temperature is immediately recorded. The results may not represent environmental conditions if the TC temperature exceeds 10°C, and the datasheet is marked appropriately.

- Nutrients - Nitrogen species water samples are collected from the water surface in plastic bottles containing sulfuric acid and placed into a cooler with ice packs. They are then transported to South Mall Analytical Labs located in Plainview, NY. The water samples are analyzed for common forms of nitrogen, including nitrate/nitrite, ammonia, and organic nitrogen, collectively called nitrogen species. The techniques used for analysis include the following methods from APHA and AWWA (1995): Nitrate/nitrite-N (mg/l) 4500-NO_3-E & 4500-NO_2-B, Total Kjeldahl Nitrogen (mg/l) 4500-N_{org}-B, Ammonia-N (mg/l) 4500-NH_3-D. Total Kjeldahl Nitrogen (TKN) measures oxidizable nitrogen, including organic and ammonia nitrogen concentrations collectively. Organic nitrogen levels are then calculated as the difference of TKN and ammonia. Total nitrogen can be calculated by adding TKN and nitrate/nitrite results.

- Other Parameters - Other information collected at the sites include: the time the sample was collected; qualitative description of rainfall in the previous 24 hours; tidal stage (scale of 1-4), air temperature (°C); wind direction (1 of 8 directions); wind speed (estimated in 5-mph increments); wave height (subjective scale, estimated in 0.5 ft increments); weather conditions (on a predetermined 1-6 scale); and any unusual conditions (i.e., odors, fish kills, water color, debris).

2.0 RESULTS, ANALYSIS, AND DISCUSSION

With the help of numerous volunteers, Friends of the Bay monitored water quality at a total of 19 locations on 22 monitoring dates from May through October, 2004. Four sites are located in Cold Spring Harbor, eight are located in Oyster Bay Harbor, and seven are located in Mill Neck Creek. Data collected during this season was analyzed both spatially (differences between areas in the estuary) and temporally (changes throughout the season) and compared to results recorded during previous seasons. A more extensive analysis of data collected during several monitoring seasons is planned for the future. The estuary was considered as a whole, and in terms of the three primary water bodies that compose the estuary: Cold Spring Harbor (monitoring locations FB-1 through FB-4), Oyster Bay Harbor (FB-5 through 12), and Mill Neck Creek (FB-13 through FB-19).

These three water bodies are distinguished by hydrographic separations and differ in terms of physical characteristics, use, watershed features, and tidal influence (See Monitoring Locations Map in Appendix B). Relatively narrow constrictions separate each water body. Plum Point separates Oyster Bay Harbor from Cold Spring Harbor, and the narrows at the Bayville Bridge divide Oyster Bay Harbor from Mill Neck Creek. Mill Neck Creek is shallow and likely to be more influenced by tributary inflows than the other hydrographic areas. Oyster Bay Harbor contains a large mooring area and industrial facilities, is more densely developed on its south shore, and is somewhat separated from Long Island Sound by Centre Island and the landmass that includes incorporated and unincorporated parts of Bayville. Cold Spring Harbor is open to Long Island Sound and is likely to be most rapidly impacted by tidal inflows and water quality within the Sound. Tributaries flowing into the estuary include Whites Creek, Mill River, Beaver Brook, Spring Lake, Tiffany Creek, Cold Spring Brook, and others.

2.1 Physical Parameters

Salinity, water temperature, air temperature, and water clarity were measured at each sampling station throughout the season. These physical parameters can impact environmental and ecological conditions within the estuary. Figure 1 shows data averaged by sampling season (April through October) for parameters monitored in the estuary during 2000 through 2004.

Water temperature significantly influences water quality. Dissolved oxygen (DO) solubility decreases while biological activity increases with increasing temperature. In the summer months, the decay of dead algae and other organisms is accelerated, consuming DO while DO is also being driven out of solution by elevated temperatures. These factors often result in hypoxic (low DO) or anoxic (no DO) conditions that can severely inhibit or kill aquatic macroorganisms.

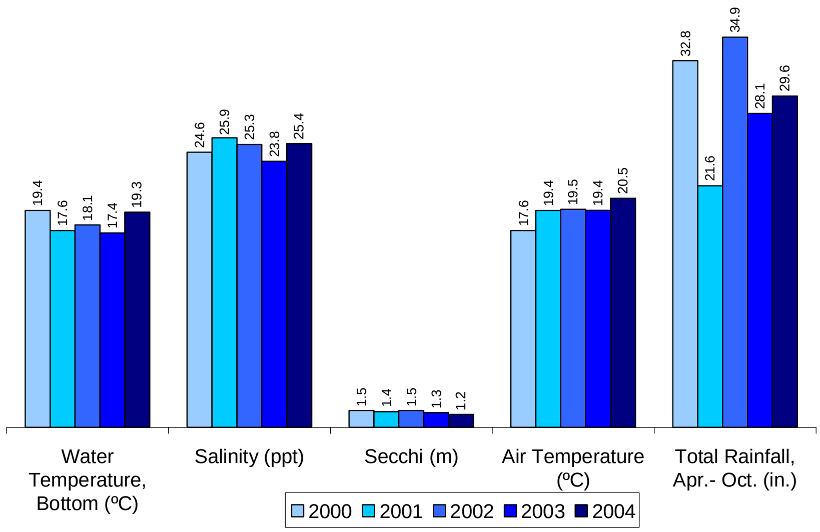

Figure 1. Physical conditions in the Oyster Bay/Cold Spring Harbor estuary for five monitoring seasons

Average bottom water temperatures measured within the estuary were slightly higher than recorded during previous years; 19.3ºC was recorded in 2004, which is almost 2ºC above levels recorded in 2003 and 2001, more than 1ºC above 2002 levels, and 0.1ºC less than 2000 levels. These differences are small, however, and would not have a significant impact on dissolved oxygen solubility. Average air temperature recorded during monitoring in 2004 is higher than in previous years, at approximately 1ºC above 2001 through 2003 levels and 3ºC above 2000 levels.

Water salinity can also affect DO levels; the saturation dissolved oxygen level at 25 parts per thousand (ppt) is approximately 85% the saturation dissolved oxygen level of freshwater (Chapra, 1997). Average salinity levels recorded in 2004 were similar to levels recorded in 2000 through 2002 (measurements range from 25.3 to 25.9 ppt during 2000 through 2002 and 2004), and are higher than the unusually low levels recorded in 2003 (23.8 ppt). These differences in salinity are also unlikely to significantly impact dissolved oxygen levels in the estuary.

Measuring Secchi disk depth is an indication of water clarity. Light that penetrates the surface of the water passes through the water column, reflects off the disk, and passes back through the water column to the eye of the observer. The Secchi disk depth is the depth where enough light is scattered (by objects, such as sediment particles) or absorbed (by being converted to heat or chemical energy, such as by algae) within the water column that the light reflected by the disk can no longer return to the surface. Dissolved solids, particulate solids, algae, and other biota can impact clarity in a water column. Secchi disk depths in the Oyster Bay/Cold Spring Harbor estuary are generally between 2.5 and 0.5 m. Although the cause of the attenuation has not been studied in detail, it is likely to be caused by algal growth fueled by nitrogen inputs to the bay.

Figure 2 presents the 2004 Secchi disk depth results as averaged for Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor for each week in the monitoring season. Average Secchi disk depths for the Mill Neck Creek locations were 0.83 m, whereas average results for the Cold Spring Harbor and Oyster Bay Harbor locations were 1.36 m and 1.33 m, respectively. Secchi disk depths were generally lower (e.g., the water was less clear) in late spring at the beginning of the monitoring season, with a trend of generally increasing clarity as the season progressed. The rate of change in average secchi disk depth varies by location; clarity in Cold Spring Harbor and Oyster Bay Harbor increased at a slightly faster rate throughout the year than clarity in Mill Neck Creek. However, increases in Secchi disk depth are usually consistent at the three locations.

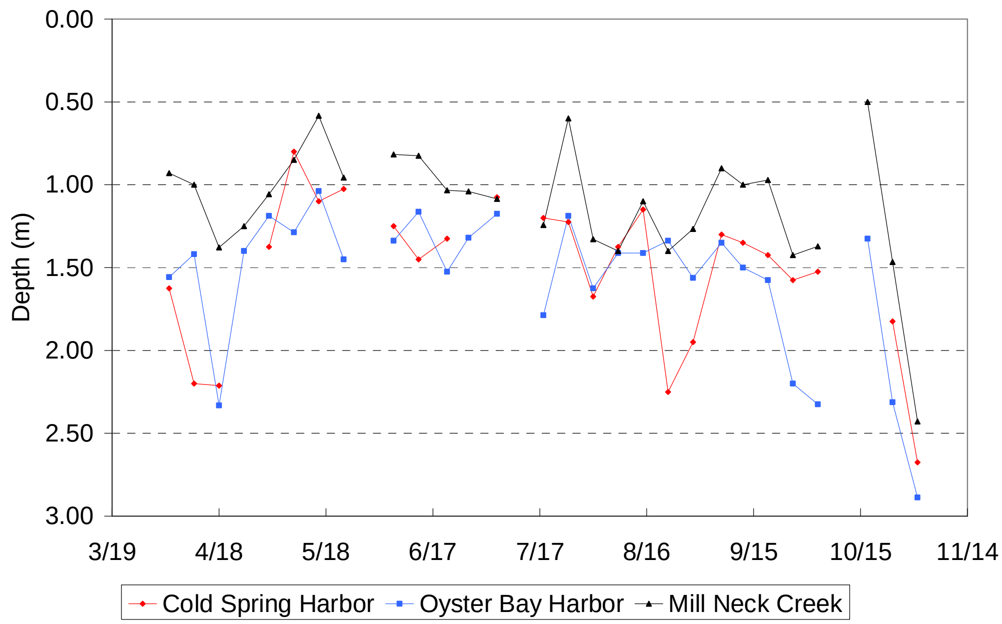

Figure 2. 2004 Secchi disk results, averaged locationally.

This trend of increasing clarity throughout the year (also observed in 2003) may result from rapid biological growth early in the season. As temperatures rise, nutrients that accumulated in the water column during the winter fuel rapid growth once sunlight and temperature conditions become more favorable to algae. As the nutrients are consumed, dying cells settle to the bottom, stripping the water column of these nutrients and reducing the capacity for algal growth later in the season (See Section 2.3 for additional discussion regarding this topic).

2.2 Coliform Bacteria

Coliform bacteria are introduced in the marine environment through various point and non-point sources such as surface water runoff, industrial and agricultural discharges or wastewater sewage discharges. In NYS, they are used as an indicator of the possible presence of human pathogens. The New York Code of Rules and Regulations (NYCRR) specifies levels of total and fecal coliform bacteria that should be met in bodies of water designated for different purposes. Waters used for shellfish cultivation and harvest have to meet the most stringent bacteriological criteria. Table 1 summarizes shellfish and bathing standards for total and fecal coliform bacteria that are enforced by New York State (NYS). 2003 was the last year that these standards were in effect. In 2004, new beach closure standards were implemented that are based on measured levels of enterococci, an alternate indicator bacteria, and fecal coliform (although a total coliform standard is still included). The new standards are summarized in Table 2.

Table 1. NYS Coliform Bacteria Standards.

	Shellfishing Open*	Swimming Open**
Total Coliform	LOG AVG < 70 MPN/100ml and If < 10% of samples do not exceed 230 MPN/100 ml	LOG AVG 30 days < 2,400 MPN/100ml If < 20% of samples do not exceed 5,000 MPN/100 ml
Fecal Coliform	LOG AVG <14 MPN/100 ml and If < 10% of samples do not exceed 43 MPN/100 ml	LOG AVG 30 days < 200 MPN/100ml

* 6NYCRR §47.3
**6NYCRR §703.4 and NYS Sanitary Code, prior to 2004

Table 2. NYS Coliform Bacteria Standards, effective 2004.

	Swimming Open†
Total Coliform	LOG AVG 30 days < 2,400 MPN/100ml
Fecal Coliform	LOG AVG 30 days < 200 MPN/100ml, and no sample greater than 1,000 MPN/100ml
Enterococci	LOG AVG 30 days <35 MPN/100 ml, and no sample greater than 104 MPN per 100 ml

†10 NYCRR Section 6-2.15 - Water quality monitoring

Coliform bacteria levels are reported as logarithmic average with a 30-day averaging period (also known as the geometric mean, or geomean). Geomeans are often used for regulatory thresholds as they are less prone to influence by outlier values which frequently result during bacterial analysis.

Total and fecal coliform levels were measured and reported at all nineteen locations during the 2004 monitoring season. Samples were collected for enterococci as well, but a different laboratory method was used in 2004 than in 2005 and later. The method used in 2004 resulted in elevated values compared to these later years, so 2004 enterococci it is not included in this report.

Table 3 presents a summary of the season's bacteria results compared to the New York State Shellfishing Standards presented in Table 1. Bacteria levels exceeded these standards at all but FB-4, FB-5, FB-6, FB-11, and FB-12. These results show similar results to those observed in 2003, when five locations also passed the shellfishing standard (in 2003, locations FB-6, FB-9, FB-11, FB-13, and FB-16 passed the standard). However, in 2004, as in 2002, no monitoring locations in Mill Neck Creek met the standard. In 1983, the New York State Department of Environmental Conservation closed Mill Neck Creek to shellfishing due to the elevated coliform bacteria levels found there, which is likely to be a result of the sewage overflows from "The Birches" (aka Continental Villa) housing development in Locust Valley that have plagued Mill Neck Creek.

Table 3. Comparison of 2004 Monitoring Results to State Shellfishing Standards.

Station	Total Coliform Seasonal Geomean	Total Coliform 90th Percentile	Fecal Coliform Seasonal Geomean	Fecal Coliform 90th Percentile	Location
FB-1	522.3	3000.0	219.4	3000.0	CSH
FB-2	209.8	1700.0	77.4	500.0	CSH
FB-3	66.2	300.0	31.1	300.0	CSH
FB-4	12.3	50.0	5.6	23.0	CSH
FB-5	9.4	30.0	3.7	11.0	OBH
FB-6	10.1	30.0	4.4	22.0	OBH
FB-7	104.1	500.0	34.7	230.0	OBH
FB-8	54.6	230.0	14.9	130.0	OBH
FB-9	34.7	80.0	10.9	48.0	OBH
FB-10	185.8	1660.0	47.2	230.0	OBH
FB-11	13.9	80.0	8.2	30.0	OBH
FB-12	16.0	30.0	8.0	29.3	OBH
FB-13	113.9	500.0	79.9	480.0	MNC
FB-14	211.0	770.0	123.9	500.0	MNC
FB-15	969.4	5000.0	469.2	4600.0	MNC
FB-16	296.5	4160.0	127.8	1940.0	MNC
FB-17	710.6	5800.0	217.0	2300.0	MNC
FB-18	89.7	320.0	45.7	300.0	MNC
FB-19	101.2	300.0	41.2	130.0	MNC
Shellfish Standard	70	230	14	43	

Table 4 presents an evaluation of the estuary's bathing water quality for 2004 using bathing water quality standards developed by the Nassau County Department of Health. These standards are older, and less stringent than the current New York State standards (and thus are not the standards used to determine if beaches should be closed) but can be used to compare bacterial pollution at the monitoring locations. Since several of the bathing quality criteria are based on 30-day running geometric means (a.k.a. log averages), the 30-day period with the highest bacteria levels were selected for comparison. A description of these standards is presented in Appendix E.

Improvement in rating between 2003 and 2004 occurred at six locations, including FB-3, FB-4, FB-8, FB-10, FB-12, and FB-18, whereas declines in rating occurred at nine locations, including

FB-1, FB-2, FB-7, FB-13, FB-14, FB-15, FB-16, FB-17, and FB-19. In Cold Spring Harbor, two locations improved in rating, while two locations declined. In Oyster Bay Harbor, three locations improved in rating, while one declined. In Mill Neck Creek, all locations except FB-18 declined in rating.

It is important to note that in 2004, three locations are rated as unacceptable (FB-1, FB-15, and FB-17). Each of these locations are in areas that are strongly influenced by stormwater and overland runoff, so it is likely that discharges to the bay resulted in these high bacteria results. One of these unacceptable locations, FB-17, is near the Birches sewer outfall, which discharges minimally treated sewage into Mill Neck Creek. However, in 2003, only one location was rated unacceptable, and in 2002, no locations received that rating.

A comparison of results from 2004 with results from 2002 is even more troubling. Over the two-year period, only one location (FB-3, in Cold Spring Harbor) improved in rating, whereas ten locations declined in rating, including every sampling location in Mill Neck Creek. This result demonstrates a need to increase the focus of non-point pollutant source monitoring into the Bay, especially Mill Neck Creek, to prevent further increases in bacteria pollution. Fortunately, waters in Oyster Bay Harbor (monitoring stations FB-5 through FB-12) where the majority of shellfishing occurs were rated either, good, very good, or excellent in 2004.

Table 4. Station Ratings According to Nassau County Bathing Water Quality Standards.

New ID	Site Description	2002 Rating	2003 Rating	2004 Rating	Change 03-04	Change 02-04
FB-1	CSH South Cove	very good	excellent	unacceptable	▼	▼
FB-2	CSH Cove North Mooring Field	good	excellent	good	▼	◄►
FB-3	CSH South	very good	good	excellent	▲	▲
FB-4	CSH North	excellent	very good	excellent	▲	◄►
FB-5	Plum Point	excellent	excellent	excellent	◄►	◄►
FB-6	Seawanhaka Yacht Club PSTP Outfall	excellent	excellent	excellent	◄►	◄►
FB-7	Oyster Bay Cove	excellent	excellent	very good	▼	▼
FB-8	White's Creek and OB-STP Outfall	excellent	very good	excellent	▲	◄►
FB-9	Roosevelt Beach	excellent	excellent	excellent	◄►	◄►
FB-10	Beekman Beach and Mill Pond Outfall	very good	unacceptable	good	▲	▼
FB-11	West Harbor	excellent	excellent	excellent	◄►	◄►
FB-12	Turtle Cove	excellent	very good	excellent	▲	◄►
FB-13	Mill Neck Creek-East	excellent	excellent	very good	▼	▼
FB-14	Mill Neck Creek-West	excellent	excellent	very good	▼	▼

New ID	Site Description	2002 Rating	2003 Rating	2004 Rating	Change 03-04	Change 02-04
FB-15	Mill Neck Creek-South	passable	excellent	unacceptable	▼	▼
FB-16	Mill Neck Creek-North	good	excellent	passable	▼	▼
FB-17	The Birches STP	passable	very good	unacceptable	▼	▼
FB-18	Mill Neck Cove	excellent	passable	very good	▲	▼
FB-19	Flower's Oyster Hatchery	excellent	excellent	very good	▼	▼

Figure 3 and Figure 4 present seasonal geometric means (i.e. May through October) for total and fecal coliform, respectively, for each of the estuary's embayments. These results mirror those presented in Table 4. A significant increase occurred in total and fecal coliform geometric mean levels measured in Mill Neck Creek and Cold Spring Harbor.

In Cold Spring Harbor, the 2004 total and fecal coliform seasonal geometric means were 54% and 46% higher than the 2003 seasonal geometric means, respectively, resulting in the highest seasonal geometric means recorded for that area. Similarly total and fecal coliform geometric means in Mill Neck Creek were approximately 351% and 405% higher in 2004 than in 2003, respectively, although 2004 geometric means of each were lower than in 2001 (note that in 2001 and prior, fewer locations were sampled by Friends of the Bay, so locationally averaged data cannot be directly compared). Although the shellfish and swim standards are included on the figures, the locationally-averaged geomeans cannot be used to directly determine compliance with the standards.

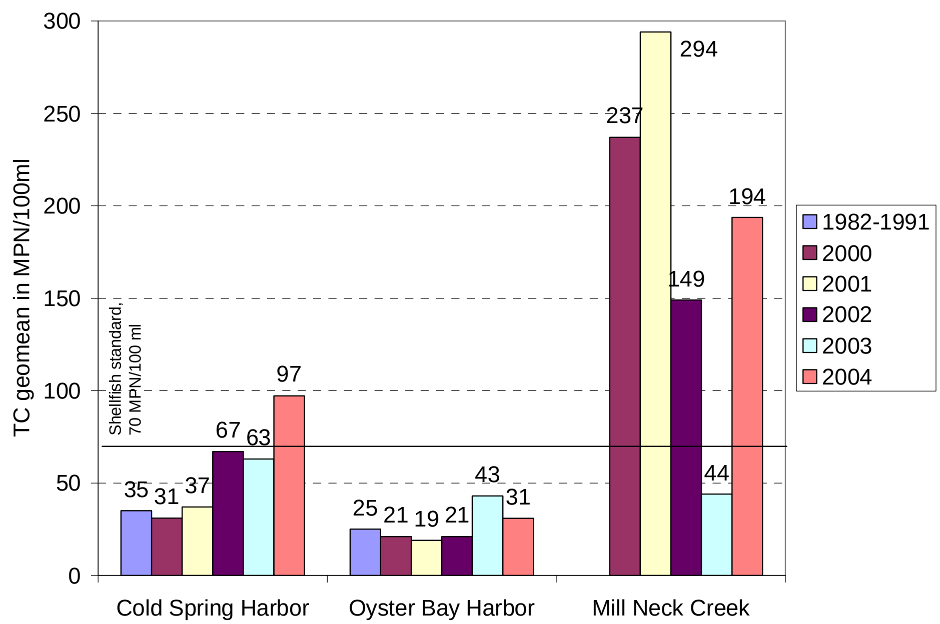

Figure 3. Seasonal geomeans of total coliform data by location.

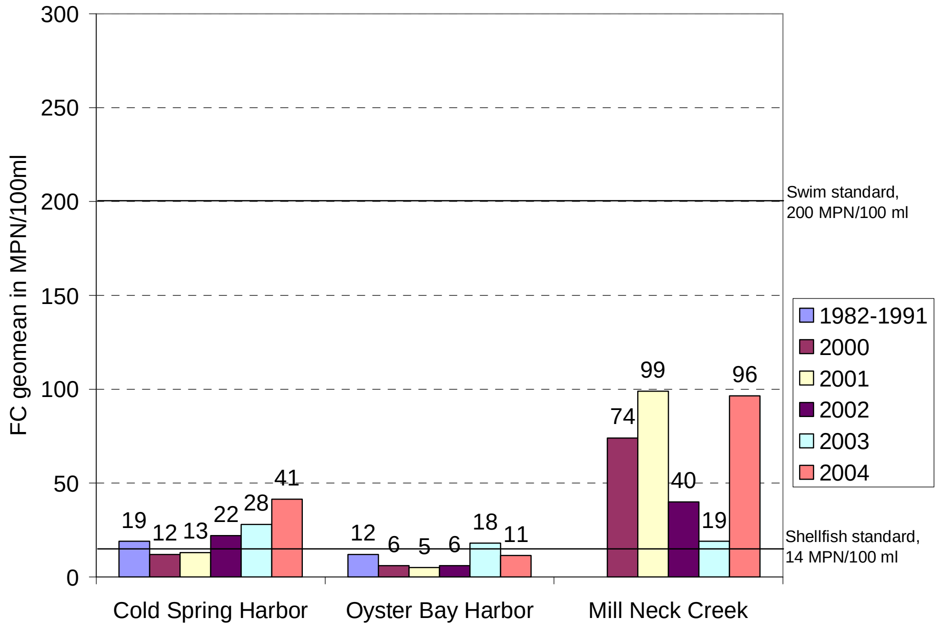

Figure 4. Seasonal geomeans of fecal coliform data, by location.

Figure 5 presents total monthly precipitation as recorded at a precipitation station in Muttontown. July and September of 2004 were the wettest months, with 5.91 and 10.29 inches falling, respectively. More precipitation fell during those two months than during the other five months of the monitoring season combined. In contrast, June and October were significantly drier, with 1.87 and 1.28 inches of precipitation received during those months, respectively. Distribution of precipitation through the monitoring seasons is important since stormwater runoff can transport bacteria pollution to receiving waters.

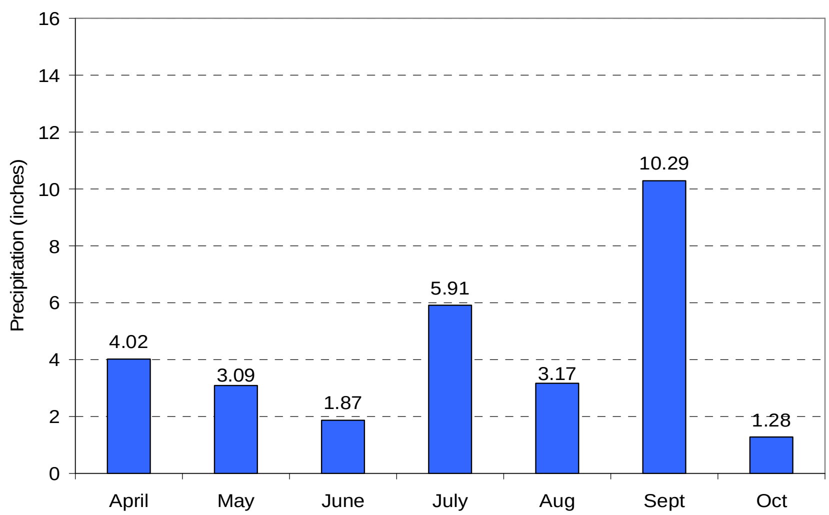

Figure 5. Precipitation recorded at Muttontown, Long Island.

2.2.1 Cold Spring Harbor Results

Four stations were monitored for coliform bacteria in Cold Spring Harbor in 2004. Figure 6 and Figure 7 present the 2004 total and fecal coliform 30-day running bacteria geometric means for each station. Table 5 presents the number of times fecal coliform samples were greater than 1,000 MPN / 100 ml for each monitoring location, resulting in a single sample exceedance of the bathing water quality standard.

The results for shellfishing agree with those presented in Table 3; that only one station in CSH (FB-4) complied with the NYS shellfish geometric mean standard for the duration of the season. The other three stations failed to comply with this standard for both total and fecal coliform bacteria for portions of the monitoring season. FB-3 and FB-4 met the geometric mean component of the swim standard for the season, and FB-2 only exceeded the standard during July. A total of 6 fecal coliform samples at FB-1 and FB-2 exceeded 1,000 MPN / 100 ml, which would have resulted in beach closures.

At FB-1, FB-2, and FB-3, the highest monthly geometric mean results occurred in late July, which contrasts with results from 2003, where the highest geometric mean was observed in September. It is notable that more precipitation occurred in July than in other months (except September), which could have contributed to the elevated bacteria levels.

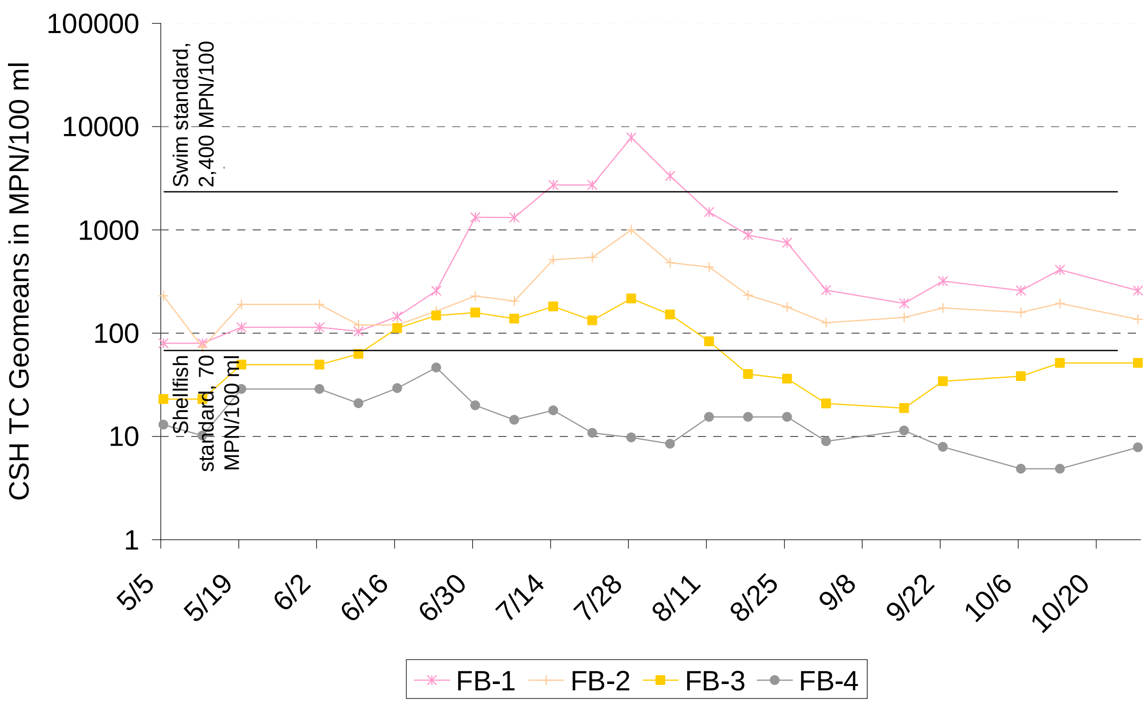

Figure 6. 30-day running geometric mean of 2004 Cold Spring Harbor total coliform samples.

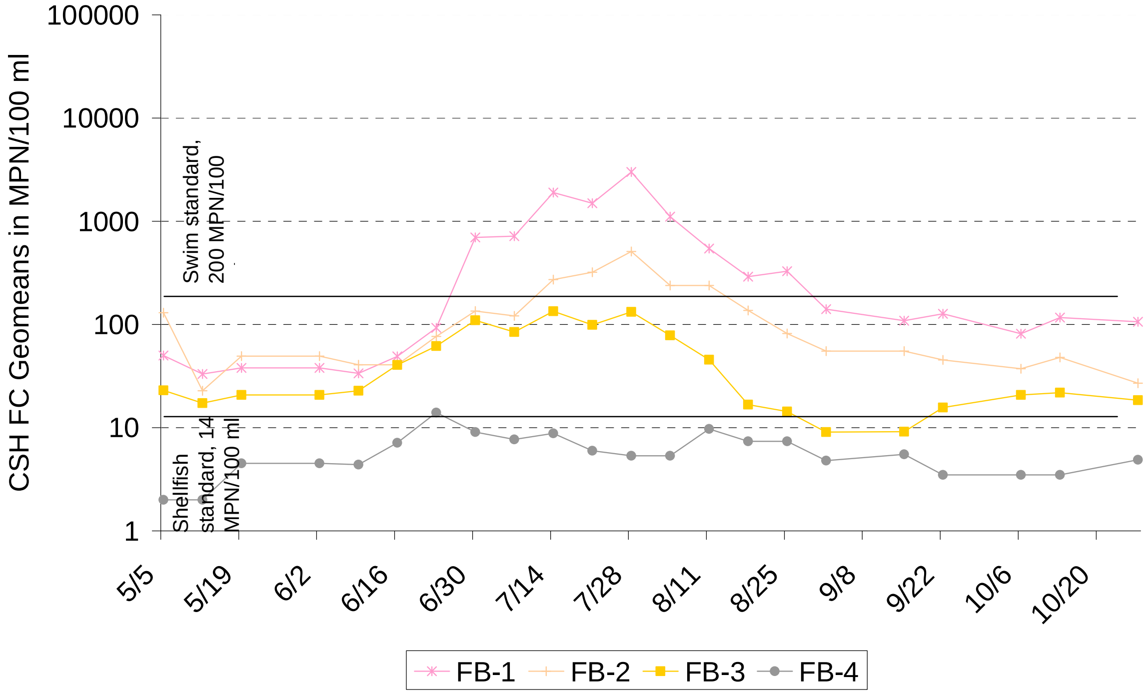

Figure 7. 30-day running geometric mean of 2004 Cold Spring Harbor fecal coliform samples.

Table 5. Single-Sample Bathing Water Quality Standard Exceedances for Fecal Coliform in Cold Spring Harbor.

Location	Number
FB-1	4
FB-2	2
FB-3	0
FB-4	0

2.2.2 Oyster Bay Harbor Results

A total of eight stations were monitored for coliform bacteria in Oyster Bay Harbor in 2004. In 2004, the geometric mean of fecal and total coliform results at four stations (FB-5, FB-6, FB-11, and FB-12) met the geometric mean component of the NYS water quality criteria for shell fishing for the season. Based on running 30-day geometric mean results, FB-9, FB-11, and FB-12 only exceeded the standard for small portions of the year (this is not the basis for compliance with the standard). However, as shown in Figure 8 and Figure 9, the total and fecal coliform bacteria 30-day geomeans at stations FB-7, FB-8, and FB-10 significantly exceeded the standard, with the highest levels occurring in July.

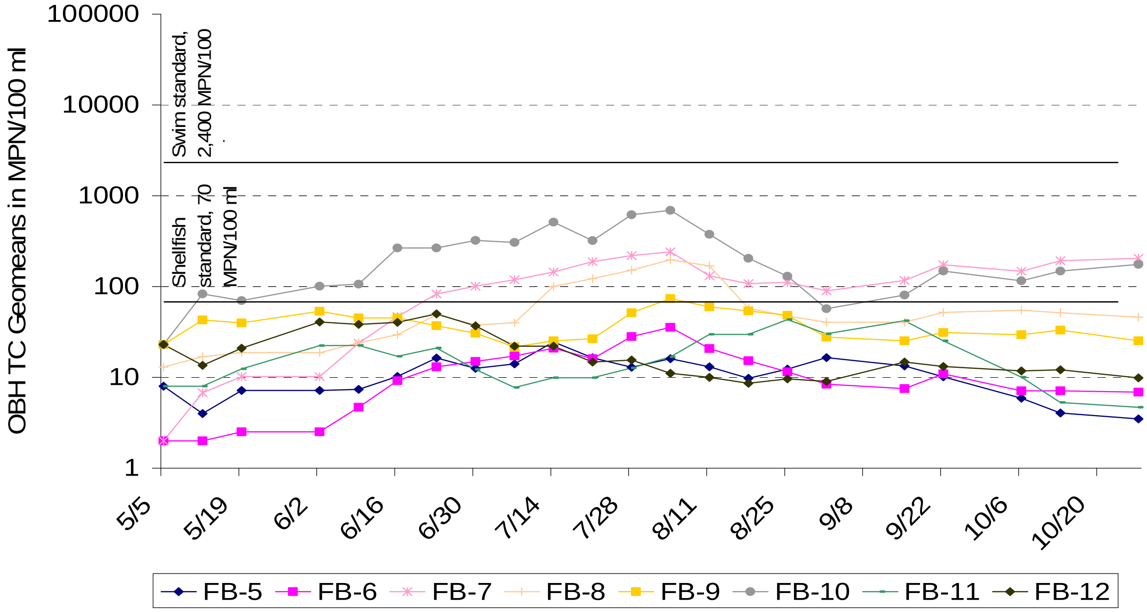

Figure 8. 30-day running geometric mean of 2004 Oyster Bay Harbor total coliform samples.

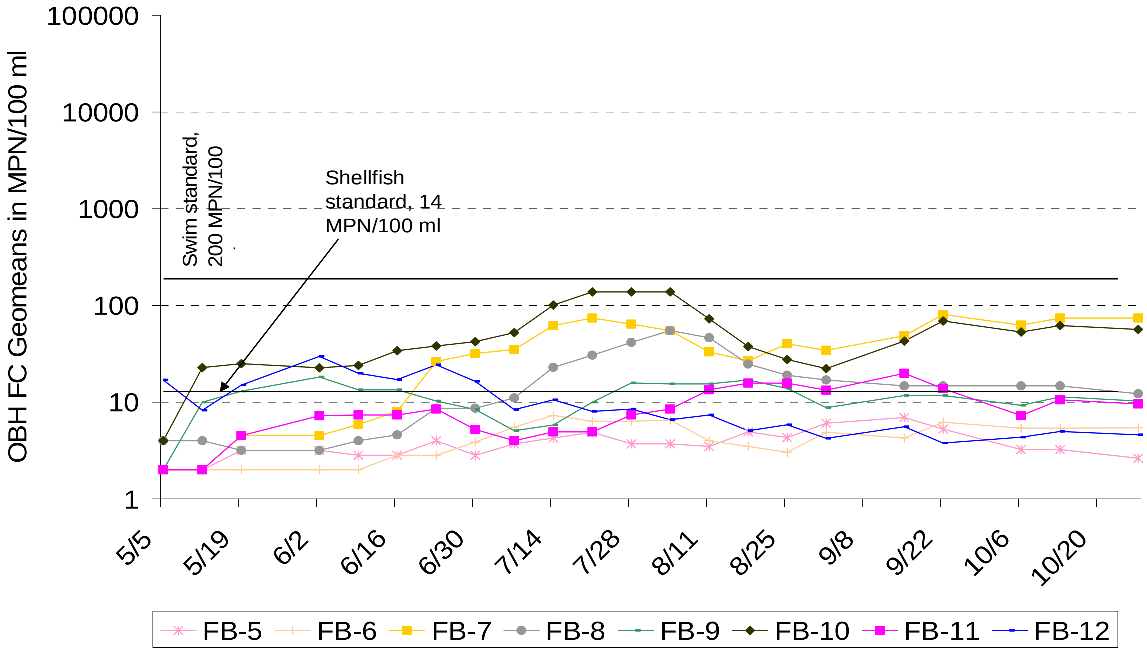

Figure 9. 30-day running geometric means of 2004 Oyster Bay Harbor fecal coliform samples.

Each location met the geometric mean component of the swim standard for the entire season, however, FB-10 exceeded the fecal coliform single sample standard of 1,000 MPN / 100 ml once (September 15).

2.2.3 Mill Neck Creek Results

In 2004, seven stations were monitored in MNC for coliform bacteria pollution, and monthly geometric means were calculated for the data. Figure 10 and Figure 11 present the results of this analysis.

FB-15, FB-16, and FB-17 are difficult to monitor since low tidal conditions often prevent access; FB-15, FB-16, and FB-17 were only successfully sampled on 59%, 59%, and 45% of the monitoring events during 2004, respectively. Therefore, the analysis is based on a much smaller pool of data, which may affect the analysis of the resulting data. In general, sample collection at these sites was consistent; samples were collected at each location at least twice a month (with the exceptions of all of these stations in September, and FB-7 in May).

None of the Mill Neck Creek locations met the geometric mean component of the State shellfishing standards. Locations FB-14, FB-15, FB-16, and FB-17 did not meet the geometric mean component of the State swimming standards for the majority of the season. Only FB-13, FB-18, and FB-19 in Mill Neck Creek exceeded the fecal coliform single sample standard of 1,000 MPN / 100 ml less than twice during the season (see Table 6). As observed in Cold Spring Harbor and Oyster Bay Harbor, bacteria levels in Mill Neck Creek were elevated in July and August as compared to other months.

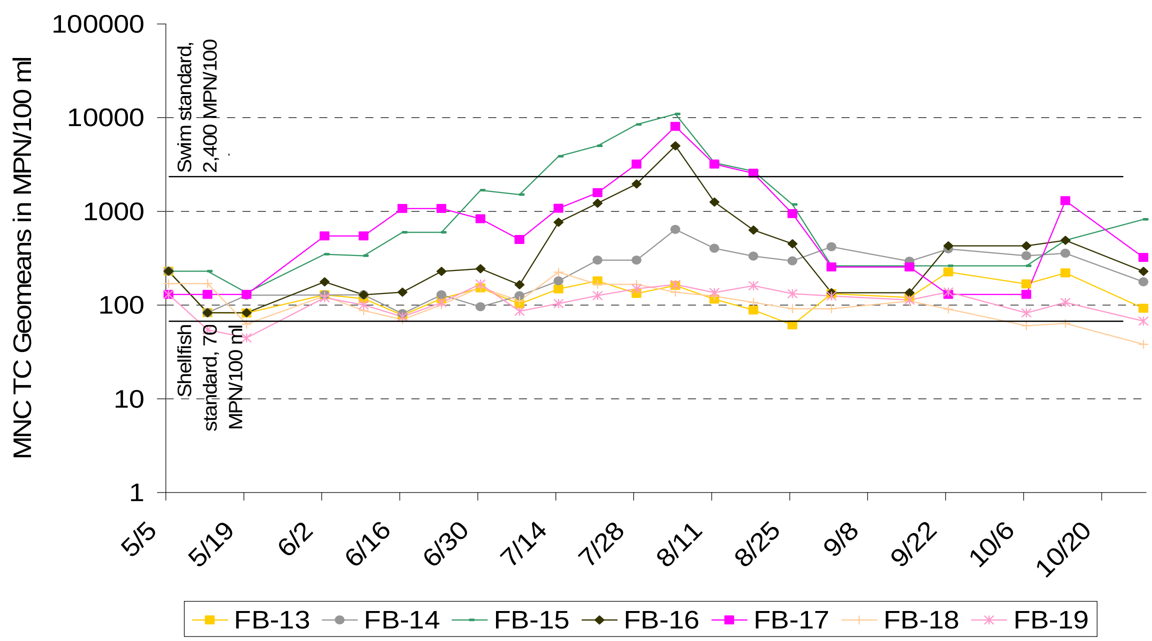

Figure 10. 30-day running geometric mean of 2004 Mill Neck Creek total coliform samples.

Table 6. Single-Sample Bathing Water Quality Standard Exceedances for Fecal Coliform in Mill Neck Creek.

Location	Number
FB-13	1
FB-14	2
FB-15	4
FB-16	2
FB-17	2
FB-18	0
FB-19	1

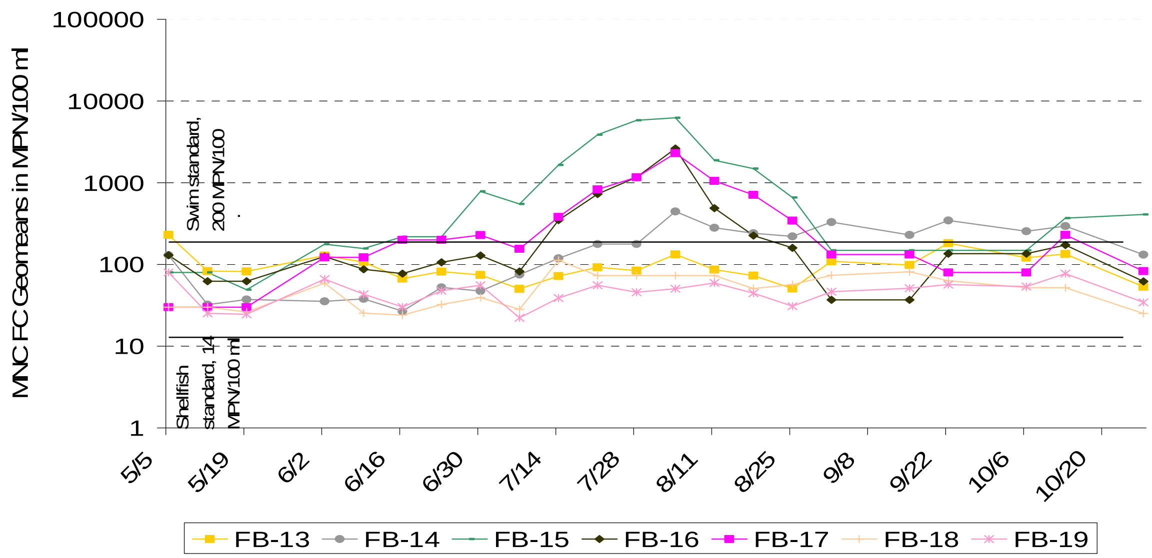

Figure 11. 30-day running geometric mean of 2004 Mill Neck Creek fecal coliform samples.

In general, 2004 coliform levels were higher than levels observed in 2002 and 2003. On a seasonally averaged basis, bacteria levels in Mill Neck Creek were generally higher than levels in Oyster Bay Harbor and Cold Spring Harbor (see Figure 3 and Figure 4). Based on the older Nassau County bathing beach standards for bacteria, one Cold Spring Harbor site received the first unacceptable rating recorded there. Oyster Bay Harbor coliform levels were generally good during 2004, although the shellfishing standard was exceeded at the four monitoring locations along the south shore. It would be beneficial to identify and eliminate potential bacteria sources to reduce the occurrence of elevated levels in this area.

2.3 Nutrient Enrichment by Nitrogen

2.3.1 The Nitrogen Cycle

The nutrients nitrogen and phosphorus, as well as other minerals, are essential components for organisms in the estuary. Nitrogen and phosphorus are typically the limiting factor in the quantity of biomass (organisms, such as algae, bacteria, fish, and plants) that can grow in a water body. When nutrient inputs to a water body increase, microorganism populations also increase. These increases are generally first seen in the density of algae, resulting in an algal bloom.

A common rule of thumb is that the ratio of nitrogen to phosphorus in biomass is approximately 7.2. This means that, if the quantity of available nitrogen divided by the quantity of available phosphorus is greater than 7.2, the phosphorus inputs will establish how much algae can grow. If the ratio is less than 7.2, biological growth will be limited by nitrogen (Chapra 1997).

During the course of a year, several blooms may occur. When the nutrients are depleted, phytoplankton populations die off and sink to the bottom, contributing to large amounts of organic matter in the water column. This organic matter decays while sinking and is further decomposed by bacteria in the estuarine sediments.

While decomposing dead phytoplankton, bacteria consume oxygen. This depletion of oxygen may result in hypoxia (DO less than 3 mg/l) at the harbor bottom. Typically, hypoxia occurs in summer, when the water column stratification hinders the oxygen replenishment. There is a general consensus among scientists that nitrogen is a limiting nutrient in saline waters (National Research Council, 2000), since phosphorus and silica are typically abundant. By contrast, in freshwater, nitrogen is typically abundant, and phosphorus limits growth. Therefore, in order to limit the propagation of phytoplankton in marine environments, nitrogen loadings into the waters have to be controlled.

There are four nitrogen species present in marine waters: ammonia-N, nitrate, nitrite and organic nitrogen. Figure 12 presents a schematic of the interrelationships between these species, showing the processes that impact nitrogen in the marine environment.

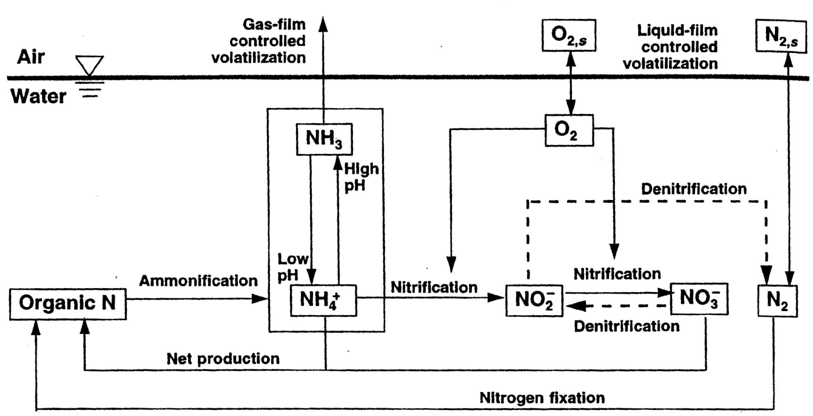

Figure 12. Nitrogen species and processes in marine environments (Source: Chapra 1997).

Organic nitrogen is present in the form of urea, amino acids, proteins and other compounds (LISS, 1994). It can be bound to organic matter such as plants or algae. Dissolved forms of organic nitrogen come from sewage plants effluent, sewer overflow, failing septic systems and stormwater runoff. Dissolved forms of organic nitrogen are available to bacteria and phytoplankton populations and promote their growth.

Phytoplankton also utilize inorganic forms of nitrogen, including ammonia, nitrate and nitrite. Organic nitrogen decays through ammonification to ammonia. Nitrates and nitrites are carried into the marine waters by stormwater runoff or result from nitrification of ammonia within the water body. Nitrates and nitrites can be converted to nitrogen gas by bacteria under anoxic conditions, and thus removed from the aqueous environment. High levels of ammonia may pose a danger to aquatic life. With rising temperatures and pH, ammonia ions (NH_4^+) change at increased rates into an un-ionized form of ammonia (NH_3). This form of ammonia is toxic to fish and aquatic plants.

2.3.2 Nitrogen Criteria and Standards

In 1989, the U.S. EPA proposed ambient water quality criteria for ammonia (NH_3) in salt water. The EPA recommends that continuous total ammonia levels should not exceed 0.72 mg/l for waters having the following conditions: salinity 20 ppt, temperature 2 °C, and pH 8. However, for slightly more alkaline conditions (pH 8.4), the criterion decreases to 0.30 mg/l.

The 1994 Long Island Sound Study (LISS) identified several major sources of nitrogen. These sources include deposition from air pollution, delivery from large tributaries, sewage treatment plants, failing septic systems, and storm water runoff. LISS presented several management options for controlling the nitrogen load into the Sound. Two of these options, including sewage treatment plant upgrades for nitrogen removal and reduction of nitrogen from non-point sources, could potentially result in a 55% reduction of nitrogen load to Long Island Sound.

Nitrogen water quality standards vary across the U.S. Some states follow total maximum daily load (TMDL) criteria. Others use site-specific or waterbody-based ambient nutrient levels (National Research Council, 2000). New York State has not yet adopted water quality standards for nitrogen for the Long Island Sound. However, the NYS DEC has adopted a total nitrogen (TN) guideline of 0.5 mg/l for the Peconic Bay estuary surface water (Suffolk County Department of Health Services, 1999). This guideline is based on the 1988-1990 summer data correlation of the mean TN levels with an occurrence of dissolved oxygen standard violations. The 1999 Comprehensive Conservation and Management Plan for the Peconic Bay Estuary proposed a change of this guideline to 0.45 mg/l based on more recent data (1994-1996). A more stringent criterion of 0.4 m/L TN is being considered for shallow waters in order to protect eelgrass habitat areas.

LISS established a target of 58.5% nitrogen reduction from the 1990 baseline for cumulative point and non-point in-basin sources (NYS DEC, 2000). This target is to be achieved through maintaining maximum annual loads of nitrogen at 11 management zones. As of 2002, sewage treatment plant upgrades decreased nitrogen loads to the Sound by 28% (EPA 2006). An additional 12% reduction was targeted for completion by August 2004 (it is unknown if this goal was accomplished).

With the intent of reducing nitrogen discharges into the Oyster Bay/Cold Spring Harbor estuary and Long Island Sound, the Oyster Bay Sewer District planned to begin construction of a nitrogen removal process for its wastewater treatment plant in 2004. This addition to the plant was anticipated to be completed in 2006.

2.3.3 Monitoring Results

FOB began monitoring nitrogen in 2002 with the goal of establishing a baseline of data and identifying possible areas of concern in the estuary. In 2004 FOB monitored three species of nitrogen at nineteen sites in the Oyster Bay estuary, including ammonia-N, nitrate/nitrite-N and organic-N. From these analyses, Total Kjeldahl Nitrogen (TKN) levels (i.e., the concentration of total oxidizable nitrogen, or organic nitrogen plus ammonia) and total nitrogen (i.e., TKN plus nitrate and nitrite) can be calculated.

Figure 13 shows averages of nitrogen species for the monitored stations. It is important to note that nitrogen samples were collected during only two monitoring events in 2004 (July 7 and July 28), as compared to the monthly sampling interval used in other years. As such, the 2004 data is less representative than data collected in other years, and care should be exercised when comparing this data to other datasets or standards.

Following the NYS DEC guideline for the Peconic Bay estuary, 12 of the monitoring stations including FB-1, FB-2, FB-3, FB-4, FB-7, FB-10, FB-12, FB-14, FB-15, FB-16, FB-17, and FB-18 would have exceeded the total nitrogen seasonal mean of 0.5 mg/l in 2004. In 2003, 11 locations would have exceeded the guideline, and in 2002, all but two would have exceeded the guideline, suggesting that water quality relative to nutrients may have been improved in 2003 and 2004.

Organic-N is typically present in larger quantities in the Oyster Bay estuary waters than ammonia and nitrate plus nitrite, generally accounting for more than 50% of total nitrogen at the sites that FOB monitors. The highest organic nitrogen seasonal averages were in Cold Spring Harbor (FB-1, south of the bar beach; FB-2 and FB-3), and at sites in Mill Neck Creek (FB-14, and FB-15). Organic nitrogen levels in Oyster Bay Harbor were generally lower in concentration (only one location in Oyster Bay Harbor had organic nitrogen levels above 0.5 mg/l).

In general, ammonia and nitrate/nitrite levels were low compared to organic nitrogen levels. At FB-17, however, ammonia levels were elevated, likely due to the proximity of the sampling location to the Birches sewage discharge. It is notable that total nitrogen levels in Cold Spring Harbor were generally elevated over nitrogen levels in Oyster Bay Harbor in 2004. In contrast, in 2003, nitrogen results were more similar in Oyster Bay Harbor and Cold Spring Harbor, except for at FB-1, where total nitrogen levels approached 1 mg/l (note that, in 2002, both FB-1 and FB-2 results exceeded 0.5 mg/l). However, these 2004 results may be influenced by the limited number and timing of nitrogen samples compared to 2003.

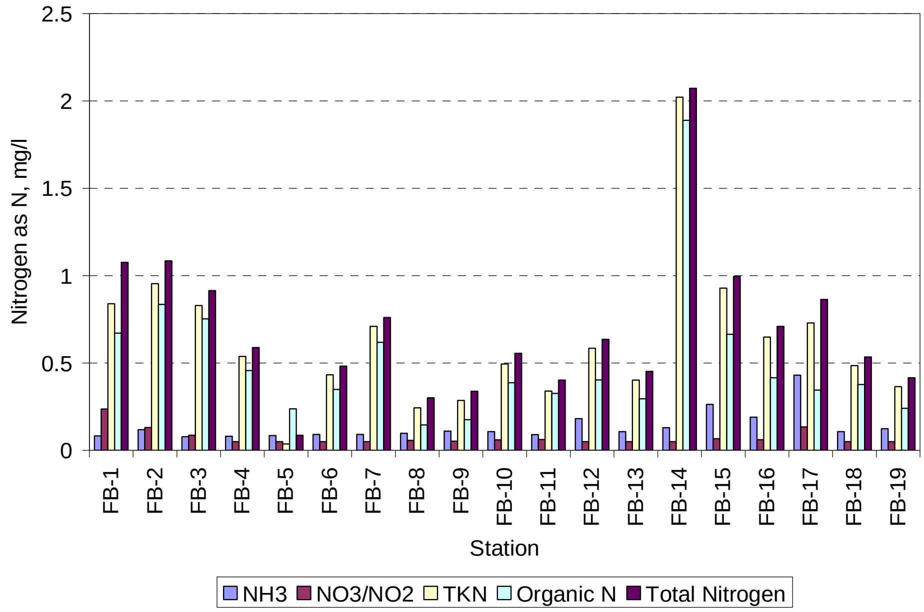

Figure 13. Seasonal average nitrogen species results for 19 stations in the Oyster Bay Estuary.

Nitrogen data collected during the 2005 sampling season should be examined to determine if elevated nitrogen levels were measured during both the 2004 and 2005 sampling seasons. If so, future additions for Friends of the Bay monitoring seasons should focus on Mill Neck Creek and Cold Spring Harbor, to identify the sources of these potentially elevated nitrogen levels and to track the possible effects within the estuary.

2.4 Dissolved Oxygen

LISS (1994) concluded that low dissolved oxygen (hypoxia) poses the most serious threat to the health of the Sound ecosystem. The waters of the western and central portions of the Sound generally exhibit hypoxia through the months of July, August and September. During these months, dissolved oxygen concentrations in the top level of the water column are typically 5-9 mg/l, while on the bottom levels of as 3-4 mg/l can be observed.

All aquatic life depends on oxygen availability in the water column. Low levels of oxygen have multiple affects on the marine ecosystems such as a change of species behavior, sensitive species growth impairment and in severe conditions, death of large populations of fish and other species. LISS summarized the effects of different oxygen impairment levels on some organisms of the Long Island Sound. An excerpt of these findings is presented in Table 7.

Table 7. Effect of Dissolved Oxygen Concentrations on Selected Organisms. (LISS, 1994).

Dissolved oxygen concentrations above the pycnoline (top of the water column)	
4-5 mg/l	Suitable for many species and life stages, may result in limited biological consequences
3-4 mg/l	25-50% mortality of larval lobsters (based on 4-day long experiments)
2-3 mg/l	50-95% mortality of larval lobsters (based on 4-day long experiments)

Dissolved oxygen concentrations below the pycnoline (bottom of the water column)	
4-5 mg/l	Protective for most biological consequences
3-4 mg/l	Protective for many biological consequences, reduced growth of juvenile Am. Lobster, grass shrimp, summer flounder (12-day experiments)
2-3 mg/l	Impaired finfish habitat (reduced abundance), mortality of larval grass shrimp and mud crabs (12-day experiments)
1-2 mg/l	Impaired lobster and finfish habitat, 10-90% mortality of some non-larval species (4-day experiments)
0-1 mg/l	Many severe consequences, even at short exposures

In bodies of water, oxygen is replenished from the atmosphere and by plant and algal photosyn-thesis. While aquatic plants and algae produce oxygen during the day, throughout the night photosynthesis does not occur, and consumption of oxygen by bacteria through decay of dead biomass consumes residual oxygen. Thus, the lowest levels of the daily cycle occur in the early morning hours. Several other factors influence the amount of dissolved oxygen found in a particular body of water:

- Water temperature - cooler water holds more oxygen; therefore, warm summer waters can be particularly stressful for marine organisms.
- Salinity - with increasing salinity the capacity of water to hold oxygen diminishes.
- Water turbidity - poor water clarity prevents sunlight from reaching oxygen-producing aquatic plants lower in the water column.
- Nutrients - excess nutrients can cause an algal bloom which blocks sunlight from aquatic vegetation lower in the water column. When algae dies and sinks to the bottom, the bacteria involved in decay of the plant material consume a significant amount of dissolved oxygen.
- Mixing of the waters - stagnant waters and waters that are stratified hinder transport of oxygen into lower levels of the water column.

NYS established saline water quality standards for dissolved oxygen as follows (6NYCRR §703.4):

- The waters designated for shell fishing (class SA), primary and secondary contact recreation (SB, SC) should not have less than 5 mg/l of dissolved oxygen at any time.
- The waters suitable for secondary recreation, fishing and fish propagation (I) should not have less than 4 mg/l of dissolved oxygen at any time.
- The waters suitable for fishing and fish survival (SD) should not have less than 3 mg/l of dissolved oxygen at any time.

Friends of the Bay monitored dissolved oxygen levels at the top and bottom of the water column at 19 sites in the Oyster Bay estuary. Table 8 presents a summary of DO monitoring results for 2004, including the total number of samples, and the number of samples occurring in each defined DO range.

Table 8. 2004 Dissolved Oxygen Monitoring Results.

		Number of Samples within Range						
Station ID	Depth	# of Samples	>5 mg/l	5->4 mg/l	4->3 mg/l	3->2 mg/l	2->1 mg/l	1->0 mg/l
FB-1	Top DO	21	9	2	3	6	1	0
	Btm DO	21	4	7	1	6	2	1
FB-2	Top DO	22	10	5	1	6	0	0
	Btm DO	22	6	4	3	7	2	0
FB-3	Top DO	22	13	1	5	3	0	0
	Btm DO	21	8	2	2	6	3	0
FB-4	Top DO	22	13	5	4	0	0	0
	Btm DO	21	9	1	7	3	1	0
FB-5	Top DO	22	13	3	5	1	0	0
	Btm DO	21	12	1	5	3	0	0
FB-6	Top DO	22	11	4	6	1	0	0
	Btm DO	21	10	5	4	2	0	0
FB-7	Top DO	22	12	3	4	2	1	0
	Btm DO	19	9	3	5	2	0	0
FB-8	Top DO	22	10	5	5	2	0	0
	Btm DO	21	9	5	7	0	0	0
FB-9	Top DO	22	12	5	4	1	0	0
	Btm DO	19	10	4	5	0	0	0
FB-10	Top DO	22	12	4	6	0	0	0
	Btm DO	22	12	3	7	0	0	0
FB-11	Top DO	22	12	4	6	0	0	0
	Btm DO	22	12	5	5	0	0	0
FB-12	Top DO	22	9	3	5	5	0	0
	Btm DO	21	9	4	4	4	0	0
FB-13	Top DO	22	10	5	4	3	0	0
	Btm DO	22	11	5	4	2	0	0
FB-14	Top DO	22	9	5	4	4	0	0
	Btm DO	17	8	5	4	0	0	0
FB-15	Top DO	22	13	3	4	2	0	0
	Btm DO	7	2	2	3	0	0	0
FB-16	Top DO	22	15	3	2	2	0	0
	Btm DO	8	4	2	2	0	0	0
FB-17	Top DO	22	15	2	3	2	0	0
	Btm DO	5	1	2	2	0	0	0
FB-18	Top DO	22	9	7	5	1	0	0
	Btm DO	14	7	4	3	0	0	0
FB-19	Top DO	22	8	8	5	1	0	0
	Btm DO	22	9	7	6	0	0	0

At each monitoring location, DO levels were below 4 mg/l (the standard for secondary contact recreation, fishing, and fish propagation) at least once during the monitoring season. At 17 of the 19 locations, DO levels were below 3 mg/l (hypoxic) at least once. At five locations, levels of 1 to 2 mg/l (severely hypoxic) were recorded, and at one location (FB-1) one anoxic result was recorded.

In most cases, DO levels recorded at the bottom of the water column were lower than levels recorded at the surface. Similarly, the majority of the severely hypoxic measurements were recorded in Cold Spring Harbor, where the sampling locations are in deeper water than in Oyster Bay Harbor and Mill Neck Creek. Figure 14 presents DO data collected at the bottom of the water column throughout the season.

The DO data follows a similar trend to those observed in prior years; DO levels are relatively high early in the season, when the water temperature is cold and bacterial decay of organic matter is a relatively small component of the dissolved oxygen budget. DO levels then declined from late April through early September. The lowest DO levels were measured between August 1 and August 25 at FB-1, FB-2, and FB-3, all at the bottom of Cold Spring harbor. These results are similar to results observed in 2002, when the lowest DO levels were observed in Cold Spring Harbor as well. In Mill Neck Creek, no DO levels below 2 mg/l were recorded. This result is likely due to the relatively shallow nature of the creek, although Mill Neck Creek nitrogen levels were slightly lower than Cold Spring Harbor nitrogen levels.

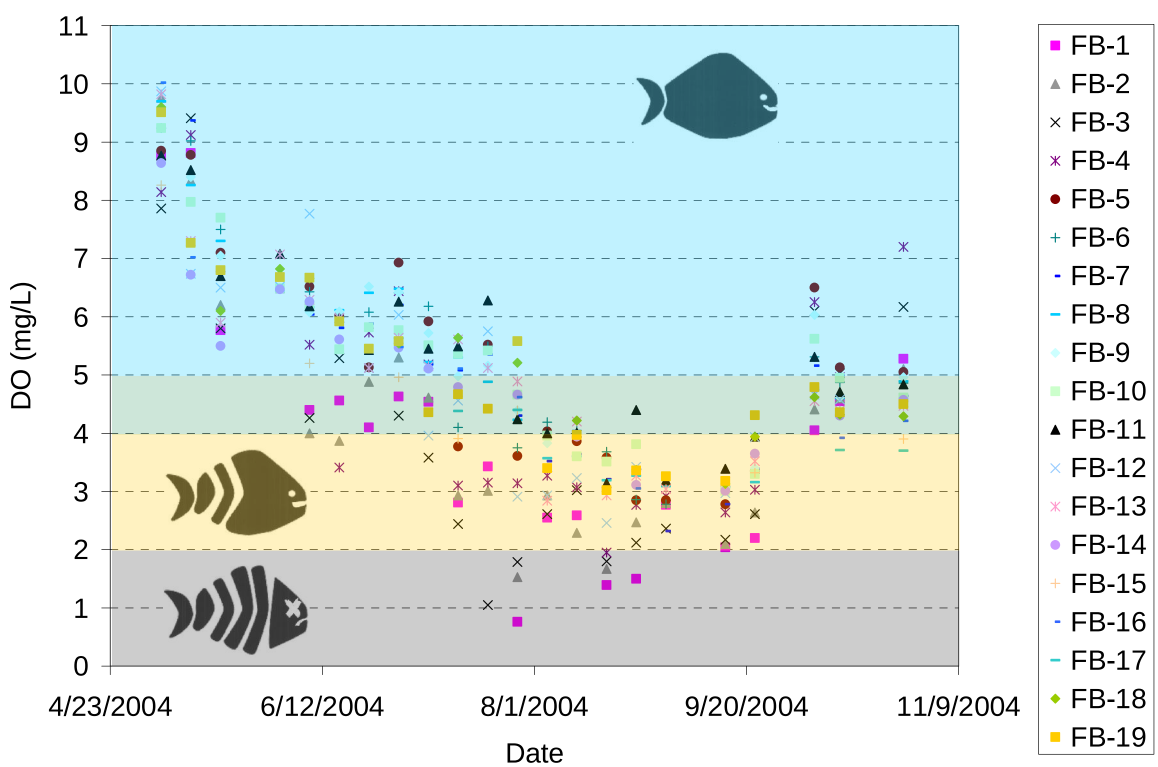

Figure 14. Dissolved oxygen time series plot for all monitoring locations.

While hypoxic and anoxic conditions were recorded in the Oyster Bay/Cold Spring Harbor estuary, it is important to remember that no fish kills were reported. As such, it is likely that the existing ecologic community has adapted to low DO levels, and that no unusual excursions occurred. Low dissolved oxygen levels are a symptom of over enrichment by nutrients and not a problem that can be solved directly. To improve DO levels in the estuary, nutrient inputs need to be reduced and the influence of Long Island Sound water quality on water quality in the estuary needs to be examined.

3.0 PROGRAM RECOMMENDATIONS

A. Proposed Changes to Monitoring Procedures

1) Add one location for monitoring stratification within the water column. Prior to 2003, FOB recorded DO at 1-meter intervals throughout the water column. This practice ceased in 2003 due to the excessive number of measurements being recorded each week. However, stratification data can be useful in tracking conditions within the estuary. FOB should consider measuring DO profiles at one of the deep monitoring locations to track the development of stratification throughout the season. If temperature and salinity profiles were also recorded at that location, then the pycnoline (depth interval of steep density gradients) could be tracked via the halocline (depth interval of steep salinity gradients) and thermocline (depth interval of steep temperature gradients).

2) Focused study of pollution problems in CSH and MNC. A focused study of the Cold Spring Harbor inner harbor area and Beaver Lake and Oak Neck Creek in Mill Neck Creek area could provide more insight into pollution sources in these areas of concern. Perhaps a partnership with a research or educational organization would provide necessary insight into the design of such a study.

B. Take Action

Friends of the Bay should continue initiating water quality improvement programs by participating in studies and applying for grants to reduce pollution threats in Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor. Participation in the Bayville Cesspool Study in 2001 and Bilge Sock Education program in 2002 have continued to facilitate such efforts. In 2003, the Town of Oyster Bay (with Friends of the Bay as a sub-contractor) was awarded funding through the Local Waterfront Revitalization Program of the Department of State to undertake a study of the Mill River subwatershed. The study includes an inventory of land use activities and other conditions that contribute to water quality degradation within the Mill River. Once the study is completed, a public education and stewardship program will be developed to mitigate identified problems.

C. Continue Partnerships

In 2004, Friends of the Bay's Water Quality Monitoring Program was made possible by supporting members, businesses and volunteers. For example, partnerships with the Nassau County Department of Health, Frank M. Flower & Sons, Inc., on boat-volunteers and Friends of the Bay's interns were invaluable this monitoring season. Additionally, the new partnership with South Mall Analytical Labs in 2002 enabled Friends of the Bay to test for nitrogen species, thereby establishing a nitrogen baseline to help identify trends and high nitrogen areas in the estuary.

It is our volunteers who fulfill a multitude of roles by participating in sample collection, data recording and boat operations. Individually they bring fun, humor, intellectual curiosity, personal skills and compassion for the environment to the program. All the individuals listed in the acknowledgements use their volunteering opportunity to get involved in protecting the estuary.

We had a great volunteer base in 2004, all but three of our on-boat volunteers resided in Oyster Bay, suggesting that Friends of the Bay could do more to extend its outreach into Cold Spring Harbor.

D. Look to the Future

To further refine the understanding of Cold Spring Harbor, Oyster Bay Harbor, and Mill Neck Creek, Friends of the Bay considered the following additions to the program:

- Stationary Probe - Installing a stationary probe will allow FOB to continuously monitor fluctuations of dissolved oxygen, salinity, and water temperature at FB-1. Such an instrument would also allow FOB to identify how long FB-1 remains hypoxic and to compare dissolved oxygen readings with that of other stations.

- Apparent color - Apparent color is an easy way to get general information about what material is dissolved or suspended in the water, and would thus be a beneficial parameter for FOB to monitor. Water with very little dissolved or suspended material appears blue in color. The presence of dissolved organic matter such as decaying plant matter can result in water color of yellow or brown. The presence of dinoflagellates can produce a reddish or deep yellow color. Water that is rich in phytoplankton and algae appears green. Runoff can result in a variety of colors including yellow, red, brown or gray.

- Chlorophyll a and/or algal enumeration - In addition to measuring apparent color, it would benefit the monitoring program to measure chlorophyll levels within Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor. A chlorophyll test would measure the concentration of algae in the water column, helping to identify if algal blooms are influencing water clarity. Alternatively, algal enumeration by an experienced limnologist can identify the quantity of specific algal species that are present. Varying algal species can be an indicator of changes in a water body from year to year.

- Wildlife Populations - Being on the water starting at sunrise for about five hours (length of typical monitoring run) affords many opportunities to observe and identify wildlife undisturbed by human activities. Osprey; hawks; terns; egrets; herons; ducks; swans; geese; Diamondback Terrapin turtles; Moon, Comb and Lion's Mane jellies; and Horseshoe Crabs are some of the wildlife observed. Turtles, fish, jellies, and birds as indicator species, are the first to exhibit the effects of environmental change.

Acknowledging this, Friends of the Bay will add wildlife monitoring to the weekly monitoring study. This will allow volunteers to become more familiar with wildlife in the estuary, and to create an additional baseline of information, providing further indications of environmental stress in the Oyster Bay/Cold Spring Harbor Estuary.

- Quality Assurance Project Plan - A Quality Assurance Project Plan (QAPP) for the monitoring program will be implemented in 2006 to formalize quality control procedures to be performed by Friends of the Bay.

4.0 CONCLUSION

Since 2000, Friends of the Bay's Water Quality Monitoring Program has developed into a well-conceived periodic monitoring program of several important water quality parameters throughout the Oyster Bay/Cold Spring Harbor estuary complex. In 2004, four stations were monitored in Cold Spring Harbor, eight in Oyster Bay Harbor and seven in Mill Neck Creek.

Three major water quality parameters were monitored in 2004: coliform bacteria levels, dissolved oxygen levels and enrichment of the water by nitrogen. Analysis of this season's data provided many useful insights into the quality of the estuary.

In 2004, an apparent increase in bacteria levels occurred in both Mill Neck Creek and Cold Spring Harbor. In Mill Neck Creek, total and fecal coliform levels approached levels not observed since 2001 and 2002. In Cold Spring Harbor, the seasonal geometric mean for coliform was the highest ever recorded. In 2004, three sampling stations were rated unacceptable, per the Nassau County water quality standards for bathing, as compared to one station in 2003, and no stations in 2002 received that rating.

Fortunately, these high bacteria levels did not affect the Oyster Bay shellfishery, where coliform levels were slightly lower than in 2003. These elevated coliform levels indicate a need for increased monitoring and identification of pollutant sources within the estuary and its watershed.

The third year of nitrogen monitoring also suggested increases in nitrogen levels in several areas of the estuary in 2004 as compared to 2003. Nitrogen levels were elevated in Cold Spring Harbor and parts of Mill Neck Creek this year. Despite this observation, 6 monitoring locations would have met the nitrogen standard for salt water that New York State applies to the Peconic Bay estuary, if that standard were to be applied to the Oyster Bay/Cold Spring Harbor estuary as well. In 2003, 7 locations would have met the standard, and in 2002, only two sites met the standard. It is possible, then, that nitrogen levels have improved somewhat over the last three years. However, it should be noted that 2002 was the first year in which data was collected, and only two monitoring events in 2004 included the collection of nitrogen data, so it is unclear if the observations represent a trend or merely random variability.

Once the Oyster Bay Sewer District completes construction of the nitrogen removal upgrade to its wastewater treatment plant, the Friends of the Bay nitrogen data collected in 2002, 2003, 2004 and subsequent years will provide a valuable baseline in evaluating the effect of reduced nitrogen loading on the Bay. The upgrade represents an important improvement in infrastructure available to the public, which should improve estuary water quality.

Dissolved oxygen data was collected throughout the estuary during the monitoring season. DO trends indicate that the waters of the estuary are enriched with nutrients, since dissolved oxygen levels decrease steadily from spring through late summer, and then begin to increase in late summer. Nutrient enrichment can result from inadequately treated sewage discharges, polluted stormwater runoff, over-fertilization of lawns and gardens, agricultural runoff, and atmospheric deposition of air pollutants.

The lowest DO levels were observed in deep water, which is consistent with decay of organic matter when temperatures are warm and the water column cannot mix vertically. Both severely hypoxic conditions (DO levels from 2 to 1 mg/l) and anoxic conditions (DO levels below 1 mg/l) were observed in Cold Spring Harbor. Severely hypoxic conditions were observed in Oyster Bay Harbor as well. A long-term reduction in nitrogen inputs should reduce the occurrence of low DO conditions in the bottom of the harbor.

All waters in the Oyster Bay estuary need protection. However, additional management efforts should be focused on areas of concern such as Cold Spring Harbor, Mill Neck Creek/Beaver Lake and the Oak Neck Creek area.

Friends of the Bay looks forward to working with volunteers, government agencies, and fellow not-for-profit organizations in future monitoring seasons. Together, FOB and its partners will continue to improve and expand their monitoring efforts. These efforts will provide a link to show how investment in water quality protection is improving the quality of water in Mill Neck Creek, Oyster Bay Harbor and Cold Spring Harbor.

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APPENDIX A

OYSTER BAY/COLD SPRING HARBOR ESTUARY COMPLEX FACT SHEET

Friends of the Bay
Working to keep the oyster in Oyster Bay
Post Office Box 564 ● Oyster Bay, NY 11771

Oyster Bay/Cold Spring Harbor Estuary Complex

Background Information

Located on the north shore of Long Island, the Oyster Bay/Cold Spring Harbor Estuary Complex – approximately 6,000 acres in size – is recognized as a vital natural, economic, cultural, historical and recreational resource.

And there is so much more to know about the Oyster Bay/Cold Spring Harbor Estuary Complex:

- The Oyster Bay/Cold Spring Harbor Estuary Complex is an embayment of Long Island Sound. (In 1987, the Sound was officially designated an Estuary of National Significance under the National Estuary Program.)

- The U.S. Fish & Wildlife Service maintains a National Wildlife Refuge (NWR) within the Oyster Bay/Cold Spring Harbor Estuary Complex. In fact, the Oyster Bay NWR – which encompasses part of Cold Spring Harbor – is the largest of the Long Island Complex's eight refuges. The NWR consists of 3,209 acres of bay bottom, saltmarsh, and a small freshwater wetland. Nationally, Oyster Bay NWR is one of the few bay bottom Refuges owned and managed by the U.S. Fish and Wildlife Service.[1]

  The Oyster Bay NWR – which was established in 1968 via land donation from the Town of Oyster Bay and several local villages under the Migratory Bird Conservation Act – consists of high quality marine habitats that support a variety of aquatic-dependent wildlife. The refuge's waters and marshes surround Sagamore Hill National Historic Site, home of Theodore Roosevelt - father of the National Wildlife Refuge System.[2]

  Subtidal (underwater up to mean high tide line) habitats are abundant with marine invertebrates, shellfish and finfish.[3] The Refuge is located off of the Long Island Sound and the sheltered nature of the bay makes it extremely attractive as winter habitat for a variety of waterfowl species, especially diving ducks.[4]

  In 2005, Defenders of Wildlife included the Oyster Bay NWR on their list of the ten most endangered Refuges in the country. The *Refuges at Risk: America's Ten Most Endangered National Wildlife Refuges 2005* report explains that the Oyster Bay NWR has become threatened by polluted stormwater runoff; non-sustainable development; habitat destruction; and human sewage associated with failing sewer infrastructure, inadequate on-site septic systems, and boat discharge.

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[1] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[2] http://refuges.fws.gov/profiles/index.cfm?id=52563
[3] http://refuges.fws.gov/profiles/index.cfm?id=52563
[4] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563

- For almost two decades there have been three State-designated Significant Coastal Fish and Wildlife Habitats within the Oyster Bay/Cold Spring Harbor Estuary: Cold Spring Harbor, Oyster Bay Harbor, and Mill Neck Creek Wetlands (these habitat designations date back to 1987).[5] The New York State Department of State recently concluded a review involving proposed revisions to 25 designated Significant Coastal Fish and Wildlife Habitats (SCFWH) on the North Shore in Nassau and Suffolk counties. The habitat designations went into effect on October 15, 2005. Among the 25 habitats that have been revised are areas that fall within the OB/CSH Estuary. The three Habitats will now be consolidated into two: 1) Mill Neck Creek, Beaver Brook, and Frost Creek and 2) Oyster Bay and Cold Spring Harbor. [See end of document for more info regarding SCF&W Habitat areas.]

- OB/CSH Fish and Wildlife Facts:
  - More than 126 bird species have been documented at the Oyster Bay National Wildlife Refuge, including 23 species of waterfowl.[6]
  - Oyster Bay National Wildlife Refuge has the heaviest winter waterfowl use of any of the Long Island National Wildlife Refuges.[7]
  - According to the U.S. Fish and Wildlife Service (USFWS), species that rely on this ecosystem include Federal and State designated endangered and threatened species such as the bald eagle, peregrine falcon, osprey, northern harrier, and least tern.[8]
  - The northern diamondback terrapin is common at the Oyster Bay National Wildlife Refuge, particularly in the Frost Creek and Mill Neck Creek sections. The Refuge is considered to have one of the largest populations of diamondback terrapins on Long Island.[9]
  - The Harbor Complex hosts a productive marine finfishery. Oyster Bay has been designated by the National Marine Fisheries Service (NMFS) as Essential Fish Habitat (EFH) for 15 species of finfish across multiple life stages. The harbor serves as a nursery and feeding ground from early spring to late fall for these species and, as a result, contributes to the abundance of fisheries resources that are of regional significance.[10]

- New York State's 1999 Long Island Sound Coastal Management Program, prepared by the NYS Department of State, identifies the Oyster Bay-Cold Spring Harbor area as a Regionally Important Natural Area.[11] [See end of document for more info regarding RINA.]

- The Oyster Bay/Cold Spring Harbor Estuary Complex is also considered one of the most important shellfish producing areas in New York State. The majority of Oyster Bay is certified for commercial shellfish harvest, with economically important shellfisheries including oyster (*Crassotrea virginica*) and hard clam (*Mercinaria mercinaria*). The waters of Oyster Bay are classified SA - the highest and best water quality determination for shellfishing. This is an unusual distinction given the harbor complex's proximity to New York City and the fact that harbors to the west have been closed for more than 30 years.

- The F.M. Flower & Sons, Inc., along with more than 90 licensed independent commercial baymen (45 of which are full-time baymen), annually harvests up to 90% of New York State's oyster crop[12] and 33% of hard clams[13] from the heart of the Oyster Bay National Wildlife Refuge.

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[5] http://www.nyswaterfronts.com/waterfront_natural_narratives.asp
[6] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[7] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[8] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[9] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[10] National Marine Fisheries Service and Mid-Atlantic Fishery Management Council. 2000. *Guide to Essential Fish Habitat Designations in the Northeastern United States.* http://www.nero.noaa.gov/hcd/webintro.html
[11] http://www.nyswaterfronts.com/downloads/pdfs/lis_cmp/Chap6.pdf
[12] http://refuges.fws.gov/profiles/index.cfm?id=52563
[13] 2004 New York Annual Shellfish Landings, New York State Department of Environmental Conservation

- A section of the surrounding watershed is located within the Oyster Bay Special Groundwater Protection Area – a Critical Environmental Area[14] – on the spine of the deep flow water recharge area. Virtually all of Long Island's drinking water is drawn from a system of underground reservoirs or aquifers. The Island's drinking water system was designated as the nation's first Sole Source Aquifer, requiring special protection. The Oyster Bay Special Groundwater Protection Area is one of two such state-designated areas in Nassau County designed for the purpose of maintaining open space to recharge the aquifer.

- The Harbor Complex is home to the Cold Spring Harbor Fish Hatchery & Aquarium. The Hatchery is proud to have the largest living collection of New York State freshwater reptiles, fish and amphibians which are housed in the Julia F. Fairchild Building, the Walter L. Ross II Aquarium Building and in eight outdoor ponds. Brook, Brown and Rainbow trout are raised to stock private ponds.

- Renowned for its maritime legacy, Oyster Bay has been designated a "historic maritime area" by New York State.

What is a Significant Coastal Fish & Wildlife Habitat?

The New York State Department of Environmental Conservation evaluates the significance of coastal fish and wildlife habitats, and following a recommendation from the DEC, the Department of State designates and maps specific areas.

A habitat is designated "significant" if it serves one or more of the following functions: (a) the habitat is essential to the survival of a large portion of a particular fish or wildlife population; (b) the habitat supports populations of species which are endangered, threatened or of special concern; (c) the habitat supports populations having significant commercial, recreational, or educational value; and (d) the habitat exemplifies a habitat type which is not commonly found in the state or in a coastal region.

In addition, the significance of certain habitats increases to the extent they could not be replaced if destroyed.

What is a Regionally Important Natural Area?

Regionally important natural areas are defined geographic areas within the Long Island Sound coastal boundary and generally are composed of a variety of smaller, natural ecological communities that together form a landscape of environmental, social, and economic value to the people of New York. A regionally important natural area would meet the following three conditions:

1) The area contains significant natural resources.
2) The resources are at risk.
3) Additional management measures are needed to preserve or improve the significant resources, or sustain their use.

[14] http://www.dec.state.ny.us/website/dcs/seqr/cea/ To be designated as a CEA, an area must have an exceptional or unique character with respect to one or more of the following: a benefit or threat to human health; a natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space and areas of important aesthetic or scenic quality); agricultural, social, cultural, historic, archaeological, recreational, or educational values; or an inherent ecological, geological or hydrological sensitivity to change that may be adversely affected by any change. Following designation, the potential impact of any Type I or Unlisted Action on the environmental characteristics of the CEA is a relevant area of environmental concern and must be evaluated in the determination of significance prepared pursuant to Section 617.7 of SEQR.

Additional information:

- Use impairments in Oyster Bay Harbor, Mill Neck Creek, Cold Spring Harbor and its tributaries are identified in the 2000 Atlantic Ocean/Long Island Sound Basin Waterbody Inventory and Priority Waterbodies List (PWL).[15] The use impairments include shellfishing, public bathing, fish consumption, habitat/hydrology, aquatic life, and recreation. (The use impairment of shellfishing is reinforced by the following facts: 1) Oyster Bay Harbor, Mill Neck Creek and its tidal tributaries are among the 69 water bodies, in the New York State 2002 303(d) list, impaired for shellfish harvesting[16] (SEE BELOW) and 2) The NYS DEC has decertified all shellfish harvesting areas in Mill Neck Creek and some shellfish harvesting areas in Oyster Bay.)

- According to *Pathogen Total Maximum Daily Loads for Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek*, a September 2003 report[17] by the New York State Department of Environmental Conservation, "urban storm water is…the major source of pathogens (approx. 88% of total) to the Harbor." The report also points out that "the waters support a large recreational environment for boating which represents the second largest source of pathogens (approx. 11% of total) to these bodies."

- Oyster Bay Harbor, Mill Neck Creek, and its tidal tributaries are among the 69 water bodies listed in the New York State's 2002 303(d) as impaired for shellfish harvesting. The New York State Department of Environmental Conservation, with the cooperation and technical assistance of the U.S. Environmental Protection Agency (USEPA), along with their contractors Battelle and HydroQual, has completed the total maximum daily loads (TMDL) for pathogens in the shellfish waters for Oyster Bay Harbor and Mill Neck Creek. In accordance with USEPA's Water Quality Planning and Management Regulations (40 CFR, Part 30), TMDLs need to be developed to achieve the applicable water quality standards. Oyster Bay Harbor needed to be broken down into several distinct areas where individual TMDLs have been developed. Once implemented, these TMDLs are expected to achieve the targeted reductions in pathogen loads from point and non-point sources with the ultimate goal of achieving the water quality standards for shellfish harvesting. In management zone OBH-2 a 10% pathogen load reduction is mandated and in management zone OBH-3 an 89% pathogen load reduction is mandated. In the other management zones, it is necessary to ensure no increase in pathogen discharges.[18]

  Further, the TMDL indicates that pollution from marinas and boat mooring areas should be reduced using appropriate mitigation techniques such as:
  - Public awareness campaigns on illicit dumping of wastewater,
  - Enhancement of public toilet facilities near the shore and,
  - Expansion of current pump-out programs including the mobile and on-shore pump out facilities.

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[15] 2000 Atlantic Ocean/Long Island Sound Basin Waterbody Inventory and Priority Waterbodies List (PWL), New York State Department of Environmental Conservation.

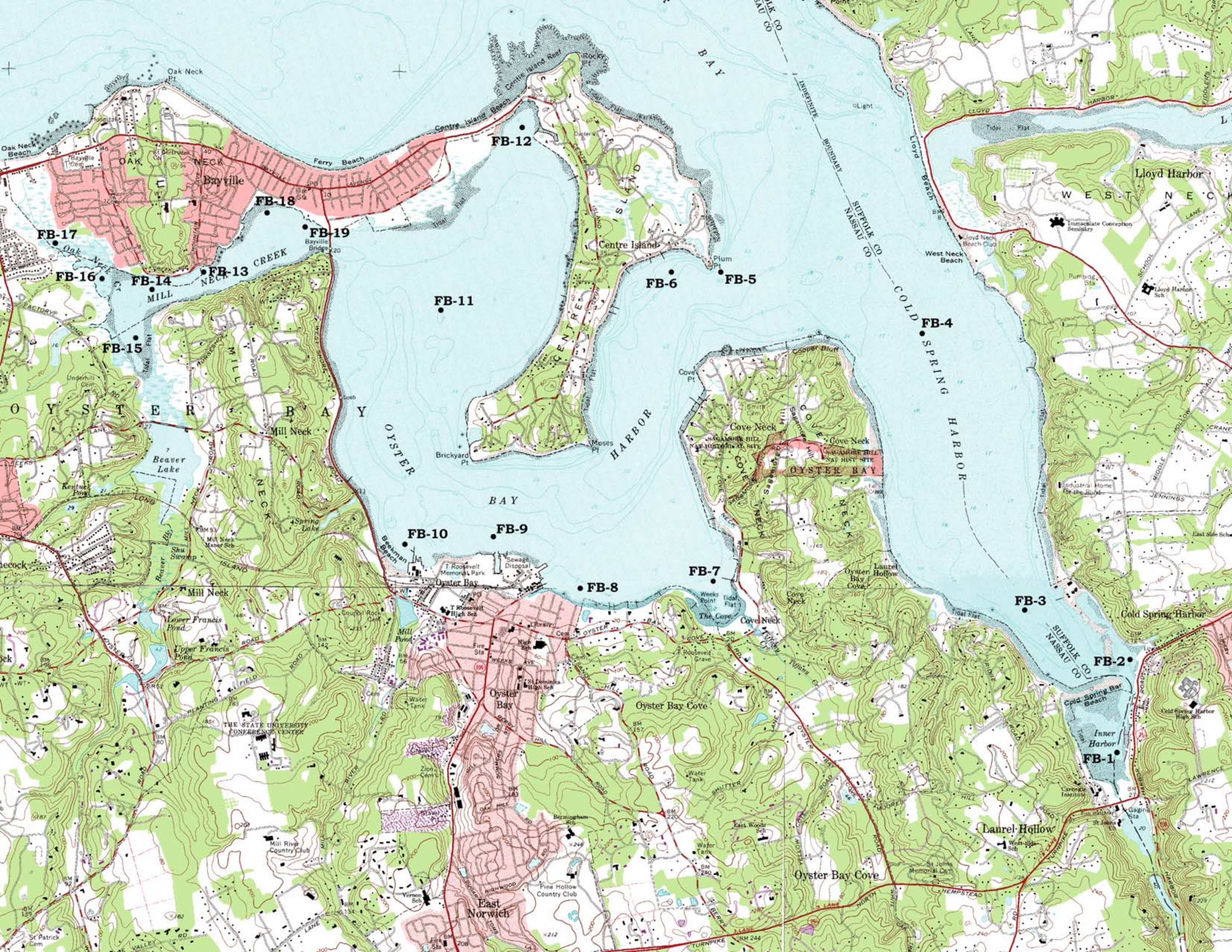
[16] *Pathogen Total Maximum Daily Loads For Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek*, New York State Department of Environmental Conservation (September 2003) http://www.dec.state.ny.us/website/dow/oystbay.pdf

[17] *Pathogen Total Maximum Daily Loads For Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek*, New York State Department of Environmental Conservation (September 2003) http://www.dec.state.ny.us/website/dow/oystbay.pdf

[18] *Pathogen Total Maximum Daily Loads For Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek*, New York State Department of Environmental Conservation (September 2003) http://www.dec.state.ny.us/website/dow/oystbay.pdf

APPENDIX B

SAMPLING LOCATIONS MAP AND DESCRIPTION



FB-1
FB-2
FB-3
FB-4
FB-5
FB-6
FB-7
FB-8
FB-9
FB-10
FB-11
FB-12
FB-13
FB-14
FB-15
FB-16
FB-17
FB-18
FB-19
Bayville
Centre Island
Lloyd Harbor
Cold Spring Harbor
Oyster Bay
Oyster Bay Cove
Cove Neck
Mill Neck
Laurel Hollow
East Norwich
OYSTER BAY
OYSTER BAY HARBOR
COLD SPRING HARBOR
MILL NECK CREEK
Beaver Lake
Inner Harbor
SUFFOLK CO
NASSAU CO

Sampling Locations in Mill Neck Creek, Oyster Bay, and Cold Spring Harbor

	Site ID	Site Name	Site Description	Latitude	Longitude
Cold Spring Harbor	FB-1	South Cold Spring Harbor Cove	50 yards off last dock in Cold Spring Harbor, just south of Whalers Yacht Club Slips.	40°51'45"	073°27'51"
	FB-2	CSH Cove North Mooring Field	Cove just north-east of Powell's Marina, east of large sand bar and small mooring field	40°52'09"	073°27'48"
	FB-3	CSH South	200 yards west of Cold Spring Harbor mooring field; mid channel between Mobil Oil Terminal and orange brick house	40°52'22"	73°28'25"
	FB-4	CSH North	Center of CSH, south-east of Plum Point; just north of Charles Wang's dock	40°53'47"	73°29'08"
Oyster Bay Harbor	FB-5	Plum Point	Off Plum Point, 110 yards south of Red Nun "4"	40°54'04"	73°30'23"
	FB-6	Seawanhaka Yacht Club PSTP outfall	Out fall is located at pink buoy. Station 200 years off boat yard dock.	40°54'05"	073°30'42"
	FB-7	Oyster Bay Cove	Center of cove 100 yards south-west of Mr. Yampole's pier	40°52'31"	073°30'25"
	FB-8	Whites Creek and OB-STP outfall	100 yards east of Commander Oil dock	40°52'31"	073°31'17"
	FB-9	Roosevelt Beach	Approx. 200 yards offshore and in line with flagpole at Roosevelt Park.	40°52'45"	073°31'53"
	FB-10	Beekman Beach and Mill Pond outfall	Mid Channel between mooring field and finger piers, 100 yards off shore.	40°52'40"	073°32'24"
	FB-11	West Harbor	Midway between east and west shores, off large white house on North western shore	40°53'52"	73°32'11"
	FB-12	Turtle Cove	110 yards west of canal	40°54'44"	073°31'41
Mill Neck Creek	FB-13	Mill Neck Creek-East	Mill Neck Creek, south of yellow house and wall	40°54'00"	73°33'43"
	FB-14	Mill Neck Creek -West	Confluence of Oak Neck Creek and Mill Neck Creek	40°53'56"	73°34'03"
	FB-15	Mill Neck Creek- South	As far south towards Beaver Dam in Oak Neck Creek as tidal stage allows.	40°53'32"	73°34'04"
	FB-16	Mill Neck Creek-North	As far North in Mill Neck Creek as tidal stage allows to steel pillared dock.	40°53'57"	073°34'18"
	FB-17	The Birches STP	North-west most channel past steel pillared dock in Mill Neck Creek.	40°54'10"	073°34'50"
	FB-18	Mill Neck Cove	North most point which tide will allow	40°54'20"	073°33'20"
	FB-19	Flowers Oyster Hatchery	10 feet south of warning buoy marking shellfish racks.	40°54'15'	073°33'04"

File: Post2003site_numbers.xls

APPENDIX C

WATER QUALITY MONITORING DATA SHEETS

Friends of the Bay

Volunteer Water Quality Monitoring - Data Sheet

DATE: ____________________________

Pilot: ____________________________________ Skipper____

Samplers:____

STATION: __________ Time (2400): ________________ Air Temp (C°)__________

Coliform Sample GPS reading: ______________________

____

Water & Weather Conditions

	Tidal Stage	1=high slack 2 = ebbing/falling 3= low slack 4 = flooding/rising
	Water Color	1 = brown 2 = red brown 3 = green 4 = yellow brown 5 = green brown
	Surface conditions	1= algal bloom 2 = oil slick 3 = foam 4 =dead fish 5 = debris 6=Other:____
	Wave Height	0 = no waves 1= slight movement 2=light chop small waves on shore 3=moderate chop 4 = white caps 5 = swells
	Rainfall –24 hours	0 = none 1=light 2=moderate 3= heavy
	Cloud Cover	0= no clouds 1= <25% 2= 25-50% 3= 50-75% 4= 75-100%
	Wind Speed	0= no wind 1= <5mph 2= 5-10mph 3= 10-15mph 4= 15-20mph 5= 20-25mph 6= >25mph
	Wind Direction	1 = fair 2 = partly cloudy 3 = cloudy 4 = rain 5 = snow 6 = fog

Secchi Depth

	Initials:	Initials:
Descending-Disappearance	(m)	(m)
Ascending - Reappearance	(m)	(m)
Average	(m)	(m)
Hit bottom before disappearing?	Yes No	Yes No
Angle		

Friends OF THE Bay
Working to keep the oyster in Oyster Bay

Water Quality Monitoring

DATE: ___________________________

Pilot: __________________________________ Skipper____

Samplers:____

STATION: _________ Time (2400): _______________ Air Temp (C°)_________

Comments:

FIELD MEASUREMENTS

Depth (m)	Temperature °C	Dissolved Oxygen (mg/l)	Salinity (ppt)
0.5			
1.0			
Bottom =			

EQUIPMENT MAINTENANCE

Conductivity Calibration: ______________________(date)

DO membrane replaced: _______________________(date)

DO Calibration:_______________________________(date)

WILDLIFE SIGHTINGS

____(date)

____(date)

____(date)

APPENDIX D

TIDE TABLE FOR OYSTER BAY

John Venditto
Town Supervisor

TOWN OF OYSTER BAY
2004
NORTH SHORE HIGH TIDE TABLE

JUNCTION OF OYSTER BAY AND COLD SPRING HARBOR

Date of NEW MOON ______
Date of FULL MOON ______

KEEP OUR WATERWAYS CLEAN

* **Free Dockside Pumpout at Tobay Marina**
* **Free Pumpout Vessel Service - Call on Marine Channel 9**

	JAN.		FEB.		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPT.		OCT.		NOV.		DEC.	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
1.	6:38	7:08	7:37	8:10	6:54	7:28	7:57	8:25	9:07	9:30	10:19	10:36	10:56	11:13		12:32	1:22	1:44	1:42	1:56	1:37	1:48	1:51	2:00
2.	7:29	7:59	8:25	8:57	7:47	8:19	8:46	9:09	9:57	10:16	11:13	11:28	11:52		12:51	1:22	2:08	2:29	2:24	2:38	2:21	2:33	2:34	2:44
3.	8:16	8:47	9:11	9:41	8:36	9:05	9:31	9:52	10:46	11:03		12:06	12:09	12:47	1:43	2:12	2:54	3:14	3:08	3:23	3:08	3:21	3:19	3:32
4.	9:00	9:30	9:53	10:21	9:22	9:47	11:16	11:34	11:34	11:50	12:21	1:01	1:04	1:42	2:34	3:01	3:42	4:02	3:54	4:11	4:00	4:14	4:08	4:23
5.	9:42	10:11	10:33	11:00	10:04	10:27		12:00		12:24	1:16	1:56	1:59	2:36	3:25	3:52	4:32	4:53	4:46	5:03	4:53	5:10	4:58	5:17
6.	10:21	10:50	11:12	11:37	10:45	11:06	12:16	12:45	12:38	1:15	2:12	2:54	2:55	3:31	4:17	4:43	5:27	5:48	5:42	6:00	5:47	6:05	5:49	6:12
7.	10:59	11:27	11:51		11:26	11:45	1:00	1:31	1:29	2:09	3:12	3:54	3:52	4:26	5:12	5:37	6:25	6:45	6:39	6:58	6:38	6:58	6:41	7:07
8.	11:36		12:15	12:30	12:07		1:47	2:21	2:24	3:06	4:14	4:55	4:50	5:22	6:09	6:33	7:23	7:42	7:35	7:53	7:26	7:49	7:32	8:01
9.	12:04	12:14	12:53	1:12	12:26	12:51	2:38	3:16	3:24	4:08	5:18	5:56	5:50	6:19	7:07	7:28	8:19	8:35	8:26	8:43	8:12	8:37	8:22	8:54
10.	12:42	12:53	1:35	1:56	1:09	1:37	3:34	4:17	4:28	5:14	6:22	6:55	6:49	7:14	8:04	8:22	9:09	9:24	9:12	9:30	8:57	9:24	9:13	9:46
11.	1:21	1:33	2:20	2:45	1:56	2:28	4:38	5:25	5:37	6:21	7:25	7:52	7:47	8:08	8:58	9:13	9:53	10:08	9:54	10:14	9:41	10:10	10:03	10:38
12.	2:02	2:18	3:10	3:39	2:49	3:25	5:49	6:36	6:47	7:25	8:23	8:44	8:42	8:58	9:46	9:59	10:34	10:49	10:34	10:56	10:26	10:57	10:55	11:31
13.	2:47	3:06	4:06	4:42	3:49	4:31	7:02	7:45	7:53	8:23	9:16	9:31	9:32	9:45	10:30	10:41	11:12	11:28	11:14	11:38	11:12	11:46	11:47	
14.	3:37	4:01	5:10	5:51	4:57	5:43	8:12	8:47	8:53	9:15	10 :04	10:15	10:18	10:29	11:10	11:21		11:49	11:54			12:01	12:25	12:42
15.	4:32	5:01	6:19	7:02	6:11	6:56	9:14	9:41	9:45	10:02	10:47	10:56	11:01	11:09	11:47	11:59	12:07	12:26	12:20	12:36	12:37	12:53	1:20	1:39
16.	5:32	6:06	7:28	8:10	7:22	8:02	10:08	10:28	10:32	10:44	11:28	11:35	11:40	11:48		12:23	12:46	1:04	1:05	1:20	1:32	1:50	2:18	2:39
17.	6:35	7:13	8:33	9:11	8:27	9:00	10:56	11:11	11:14	11:24		12:06		12:18	12:36	12:59	1:27	1:45	1:52	2:08	2:32	2:52	3:18	3:42
18.	7:39	8:18	9:33	10:05	9:24	9:50	11:38	11:51	11:53		12:13	12:44	12:25	12:54	1:13	1:36	2:10	2:29	2:44	3:01	3:36	3:59	4:20	4:47
19.	8:40	9:19	10:26	10:55	10:14	10:35		12:18	12:01	12:31	12:50	1:21	1:02	1:30	1:52	2:14	2:58	3:18	3:42	4:01	4:44	5:09	5:23	5:52
20.	9:39	10:16	11:16	11:40	10:59	11:17	12:29	12:56	12:38	1:08	1:27	1:58	1:39	2:07	2:33	2:55	3:52	4:14	4:47	5:10	5:50	6:18	6:23	6:55
21.	10:35	11:09	12:02		11:41	11:57	1:05	1:33	1:14	1:45	2:05	2:37	2:18	2:46	3:18	3:42	4:55	5:19	5:58	6:22	6:52	7:21	7:20	7:53
22.	11:28		12:24	12:46		12:21	1:42	2:11	1:51	2:24	2:45	3:17	2:59	3:27	4:09	4:34	6:05	6:30	7:08	7:34	7:48	8:18	8:13	8:46
23.	12:00	12:19	1:07	1:29	12:35	1:01	2:20	2:51	2:31	3:05	3:27	4:00	3:44	4:12	5:07	5:34	7:17	7:42	8:13	8:39	8:38	9:09	9:00	9:33
24.	12:49	1:08	1:49	2:13	1:14	1:40	3:00	3:33	3:12	3:48	4:14	4:47	4:34	5:02	6:13	6:40	8:25	8:49	9:10	9:37	9:24	9:54	9:44	10:15
25.	1:36	1:57	2:32	2:58	1:54	2:21	3:44	4:20	3:58	4:35	5:05	5:37	5:29	5:58	7:23	7:49	9:25	9:49	10:01	10:28	10:07	10:36	10:25	10:55
26.	2:24	2:47	3:18	3:46	2:36	3:06	4:33	5:11	4:48	5:25	6:00	6:30	6:31	6:58	8:32	8:56	10:19	10:43	10:46	11:14	10:46	11:16	11:03	11:32
27.	3:13	3:37	4:07	4:38	3:22	3:56	5:26	6:05	5:41	6:16	6:58	7:26	7:36	8:01	9:36	9:57	11:07	11:31	11:29	11:57	11:25	11:54	11:40	
28.	4:04	4:30	5:01	5:35	4:14	4:51	6:23	7:00	6:37	7:09	7:59	8:23	8:41	9:04	10:33	10:54	11:52			12:09		12:02	12:09	12:17
29.	4:56	5:25	5:57	6:33	5:10	5:48	7:20	7:52	7:34	8:01	8:59	9:20	9:45	10:05	11:25	11:46	12:17	12:34	12:37	12:48	12:32	12:40	12:45	12:54
30.	5:50	6:22			6:08	6:44	8:15	8:42	8:30	8:53	9:58	10:17	10:44	11:03		12:13	1:00	1:15	1:17	1:27	1:11	1:19	1:22	1:31
31	6:45	7:17			7:05	7:37			9:25	9:45			11:39	11:58	12:35	12:59			12:56	1:07			2:00	2:11

EASTERN STANDARD TIME
January 1 through April 3
November 1 through December 31

EASTERN DAYLIGHT SAVINGS TIME
April 4 through October 31

For Bayville Bridge Add 5 Minutes
For Northport Bay Subtract 5 Min.

For Bridgeport Subtract 10 Min.
For Orient Point Subtract 1 Hour, 15 Min.

APPENDIX E

BATHING WATER QUALITY STANDARDS

The following rating criteria are being applied to the bathing waters of Nassau County:

EXCELLENT - To obtain this rating a bathing beach must have a cumulative (seasonal) log average of total coliform not greater than 70, and individual total coliform counts of greater than 330 shall not have appeared in more than 10 percent of the total number of samples.

VERY GOOD - To obtain this rating a bathing beach must meet the following: (a) its cumulative (seasonal) log average of total coliform must not be greater than 240 - (b) no 30 day running log average result of total coliform shall be greater than 500 - (c) individual total coliform counts shall not be greater than 5,000 for more than 20 percent of the total number of samples.

GOOD - To obtain this rating a beach shall: (a) have a cumulative log average of total coliform not greater than 240 - (b) individual total coliform counts shall not be greater than 5,000 for more than 20 percent of the total number of samples.

*FAIR - To obtain this rating a beach must have the following: (a) no 30 day fecal coliform log average shall be greater than 200 (b) no 30 day total coliform log average shall be greater than 2,400 - (c) individual total coliform counts shall not be greater than 5,000 for more than 20 percent of the total number of samples.

*PASSABLE - Meets "Fair" rating, but has a 30 day fecal coliform log average exceeding 200.

*EXCEEDS NEW YORK STATE HEALTH DEPARTMENT STANDARDS FOR BATHING WATER QUALITY - A beach receives this rating when the 30 day log average for total coliform goes over 2,400 at any time during the bathing season, or when more than 20 percent of the samples taken in the- season contain total coliform counts in excess of 5,000.

*Fecal coliform test used in evaluation of beaches not attaining at least "Good" water quality.

Source: Nassau County Department of Health: *1974 Surface Water Quality Assessment Report*