2003 Annual Water Quality Report
Water Quality Monitoring Program

2007

Prepared For

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Funded In Part By

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This *2003 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 2003.

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 Oyster Company - Dwight and Dave Relyea and Joseph Zahtila, owners of Frank M. Flower and Sons Oyster Company, 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.

Rob Crafa - As the past environmental analyst for Friends of the Bay, Rob created the framework from which this report is based.

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

Larry Schmidlapp - Donated a GPS to Friends of the Bay for the Volunteer Water Quality Monitoring Study and stores the Baywatch II during the winter months.

Thomas Zoller - Donated a hand held ship-to-shore radio to the WQM program and built housing for "How's the Water?" educational displays.
Diane and Raymond Knight: Made a financial contribution towards the printing of the "How's the Water?" education displays, which post weekly monitoring results around key water front locations in Oyster Bay and Cold Spring Harbor.

Buckingham Variety: Donated two dry erase boards for the "How's the Water?" displays, the public educational component of the VWQM program.

Huntington Business Products: Donated a dry erase board for the "How's the Water?" educational displays.

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."

Polly Weigand – As the environmental analyst, Polly Weigand 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 -
**O.J.Donovan *Tom Ferraro * Scott Gurney *Alena Hornakova *Hank Kasven *Catherine McConnell *Jim Monk * Audie O Conner * Bud Rappuhn *Jeremiah Relyea *Margaret Rendich *Ailene Rogers *Sandy Walczyk *Seth Watkins **

EXECUTIVE SUMMARY

Friends of the Bay's Volunteer Water Quality Monitoring Program is an important component of our efforts to preserve the Oyster Bay – Cold Spring Harbor 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 2003 was marked by continuing and improving upon the work of 2002; we reorganized and fine-tuned our sampling locations while continuing to collect data to track the health of the ecosystem. Friends of the Bay went out on the bay 22 times between April 16th and October 22nd, and collected almost 500 samples that were analyzed for coliform bacteria (390) and nitrogen pollution (101) and took 632 readings of dissolved oxygen and temperature.

Friends of the Bay monitored nineteen locations, including in Oyster Bay (Locations FOB #5 – FOB #12), Cold Spring Harbor (CSH) (FOB #1 – FOB #4), and Mill Neck Creek (FOB #14 – FOB #19). Each site was monitored in the morning once per week, weather and tide permitting for dissolved oxygen, bacteria pollution, salinity, temperature, clarity, and nitrogen.

This season was the second in which nitrogen parameters were monitored within the estuary. Total nitrogen levels are a potential concern, especially within CSH and Mill Neck Creek (MNC). However, the total nitrogen levels throughout the estuary suggest that more attention should be paid to nitrogen loadings that enter the bay, to determine what sources are dominant.

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, 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 the Town's infrastructure, which should improve Bay water quality.

While coliform bacteria levels still present a challenge in regard to the NYS standard for shell fishing, one positive development was observed. The data indicated that overall decreases observed in total and fecal coliform levels in 2002 continued in 2003. However, water quality as measured by bacteria results declined at two locations, including FB-10 (adjacent to the Beekman Beach and Mill Pond Outfall) which declined in county rating from very good to unacceptable, and FB-18 (Mill Neck Cove) which declined in rating from excellent to passable.

All waters in the Oyster Bay estuary need protection. However, the management efforts should be more focused on the areas of concern such as Mill River/Mill Pond, CSH Inner Harbor, MNC/Beaver Lake and the Oak Neck Creek area. In 2003, the Town of Oyster Bay, with Friends of the Bay as a partner, was awarded a grant by New York State to study land use within the Mill River Watershed, as well as other conditions that could contribute to degradation of water quality within the watershed. Once the study is complete, public outreach and stewardship programs will be developed to mitigate identified problems.

Increasing knowledge of land use within the watershed will help to better understand the source of pollutants that Friends of the Bay and others observed in Mill Neck Creek, Oyster Bay, and Cold Spring Harbor. For example, a 2003 report by the New York State Department of Environmental Conservation stated, "urban storm water is... the major source of pathogens (approx. 88% of total) to the Harbor."[1] Studying the watershed will help identify and eliminate the sources of these pathogens, as well as other pollutants.

Friends of the Bay looks forward to future seasons by continuing to work with volunteers, government agencies, and fellow not-for-profit organizations. Together we will continue to improve and expand our monitoring program while providing a link to show how investment in water quality protection is improving Oyster Bay and Cold Spring Harbor.

[1] *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

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[2]. 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.[3]
- Two State-designated Significant Coastal Fish and Wildlife Habitat areas exist within the Oyster Bay/Cold Spring Harbor Estuary Complex.[4]
- More than 80 commercial baymen annually harvest up to 90% of New York State's oyster crop[5] and 33% of hard clams[6] 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.[7]

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 Oyster Bay/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 and Mill Neck Creek[8]

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[2] Friends of the Bay Mission Statement as of 2005
[3] http://refuges.fws.gov/profiles/WildHabitat.cfm?ID=52563
[4] 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.
[5] http://refuges.fws.gov/profiles/index.cfm?id=52563
[6] 2004 New York Annual Shellfish Landings, New York State Department of Environmental Conservation
[7] 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
[8] *Pathogen Total Maximum Daily Loads for Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek.* NYSDEC (2003)

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.[9] 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, 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 2003 monitoring season. This report was produced in April 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.

[9] 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 Wednesday morning from April through October 2003, Friends of the Bay staff and dedicated volunteers collected water quality and ambient conditions data at 19 sites throughout the bay 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 Yellow Springs Instruments (YSI) Model 85 and 58. The instruments include probes that can be lowered within the water column to analyze the water's attributes in-place, and handheld dataloggers that interpret the probe measurements and present them to the sampler. Water clarity was measured using a Secchi disk, a circular disk with opposing white and black quarters 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 are 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 our 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 nineteen sites throughout the Cold Spring Harbor/Oyster Bay estuary, including Locations FOB #5 – FOB #12 in Oyster Bay, Locations FOB #1 – FOB #4 in Cold Spring Harbor (CSH), and Locations FOB #14 – 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 listed in Appendix B. The station identifiers were revised following the 2002 monitoring season, so the locations listed below cannot be directly compared to the locations 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 nineteen monitoring sites using the YSI 85 or 58 probe and sonde (each meter has these capabilities). At each station, dissolved oxygen readings were taken at one half-meter above the bay bottom, at one-half meter below the water's surface and at one-meter intervals between the top and bottom. DO is measured 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. The effect of dissolved oxygen levels on aquatic life is well established. In general, dissolved oxygen levels above 6.0 mg/L are preferred. Levels between 5 and 6 mg/L are acceptable for most aquatic life. Levels between 3 and 5 mg/L can cause harm to many organisms if exposure is prolonged for greater than 2 to 3 weeks. When dissolved oxygen levels decline below 3 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 YSI 85 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 on the shaded side of the boat. 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 - Further information collected at the sites include: the time the sample was collected; air temperature (°C); wind direction (1 of 8 directions); wind speed (estimated in 5-mph increments); wave height (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 between April and October, 2003. 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 and temporally 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 main hydrographic areas: 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 divisions are characterized by differing physical and land use characteristics of the estuary.

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. Numerous small tributaries flow into the estuary as well, including 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 numerous environmental and ecological conditions within the estuary. Figure 1 shows the sampling season (April through October) averages of parameters monitored in Oyster Bay during 2000 through 2003.

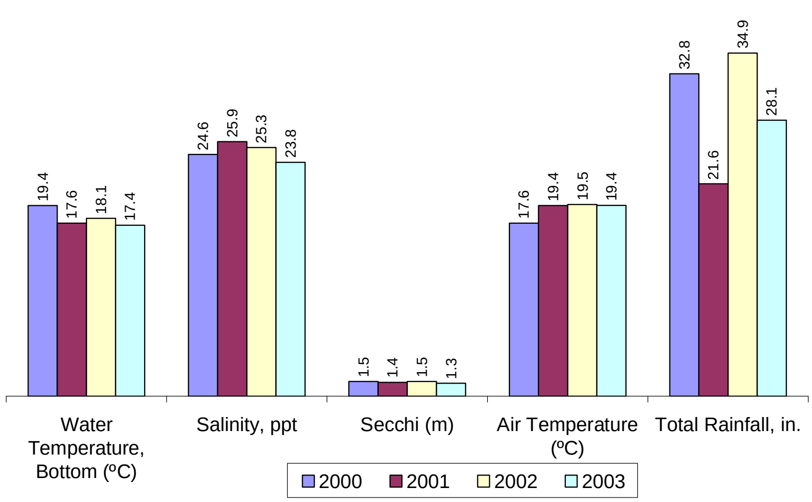

Figure 1. Physical conditions in Oyster Bay for four monitoring seasons

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.

Average bottom water temperatures measured within the estuary were slightly lower than recorded during previous years; 17.4 ºC was recorded in 2003, which is 0.7 ºC lower than in 2002, and 0.2 ºC lower than in 2001. These differences are small, however, and would not have a significant impact on dissolved oxygen solubility. Average air temperature recorded during monitoring in 2003 is the same as in 2001 (19.4 ºC), and only one-tenth of a degree cooler than in 2002.

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 2003, 23.6 ppt were slightly lower than levels recorded during the previous three years (24.6, 25.9, and 25.3 ppt in 2000, 2001, and 2002, respectively). Similarly, 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. A Secchi disk reflects ambient light from the surface back through the water column to the observer. The Secchi disk depth is the depth where enough light is reflected, absorbed, or scattered within the water column that the reflected light can no longer return to the surface (i.e. the transmissivity of the water column to light). Dissolved solids, particulate solids, algae, and other biota can impact clarity in a water column. Secchi disk depths in the Cold Spring Harbor/Oyster Bay complex are generally between 2.5 and 0.5 m. Although the cause of the attenuation has not been studied in detail, it is likely caused by algal growth fueled by nitrogen inputs to the bay.

Figure 2 presents a scatter plot of all Secchi disk data collected during 2003. Although trends in individual sample locations are difficult to discern, there is more variability between stations in measurement in the spring and late summer than in mid-summer. In general, Secchi disk depths increased throughout the season, although measurements at FB-15 and FB-17 in Mill Neck Creek decreased slightly. Recorded values in mid-May range from 0.3 to 2.2 m, a range of 1.9 m and values in early September range from 2.75 to 0.3 m, a range of 2.45 m, while values in mid-July only ranged by 1 m throughout the estuary, from 0.5 to 1.5 m.

Figure 3 presents the 2003 Secchi disk results as averaged by component water body of the complex. Average Secchi disk depths for the Mill Neck Creek locations were 1.02 m, whereas average results for the Cold Spring Harbor and Oyster Bay locations were 1.47 and 1.46, respectively. Results in all three embayments were generally smaller (e.g. the water was less clear) in late spring at the beginning of the monitoring season, and becoming larger as the season progressed.

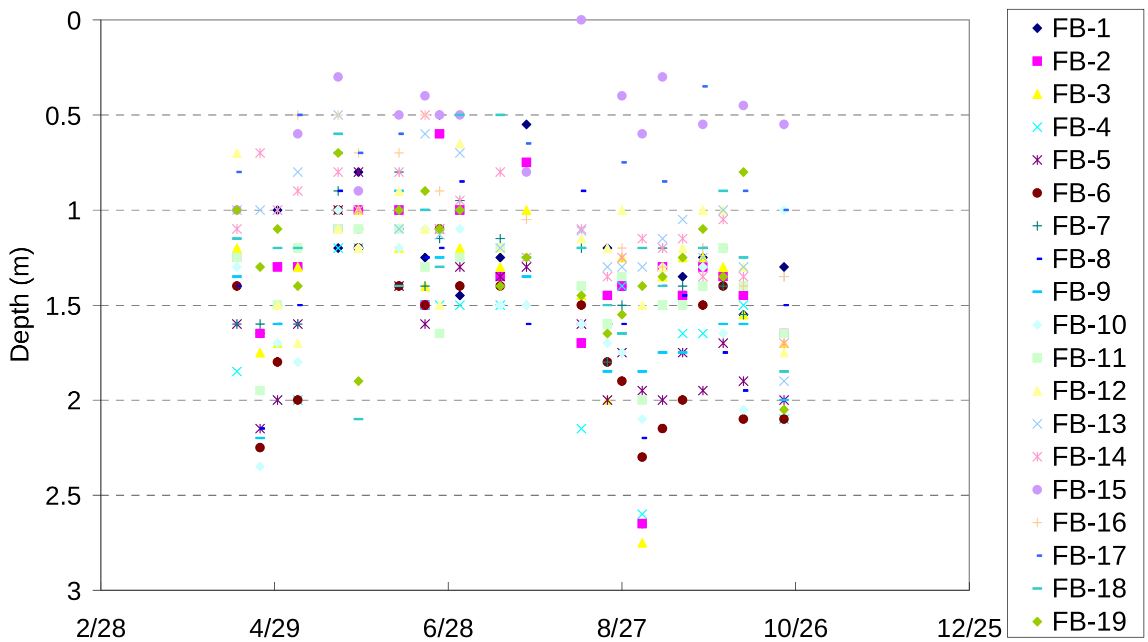

Figure 2. 2003 Secchi disk results (all data).

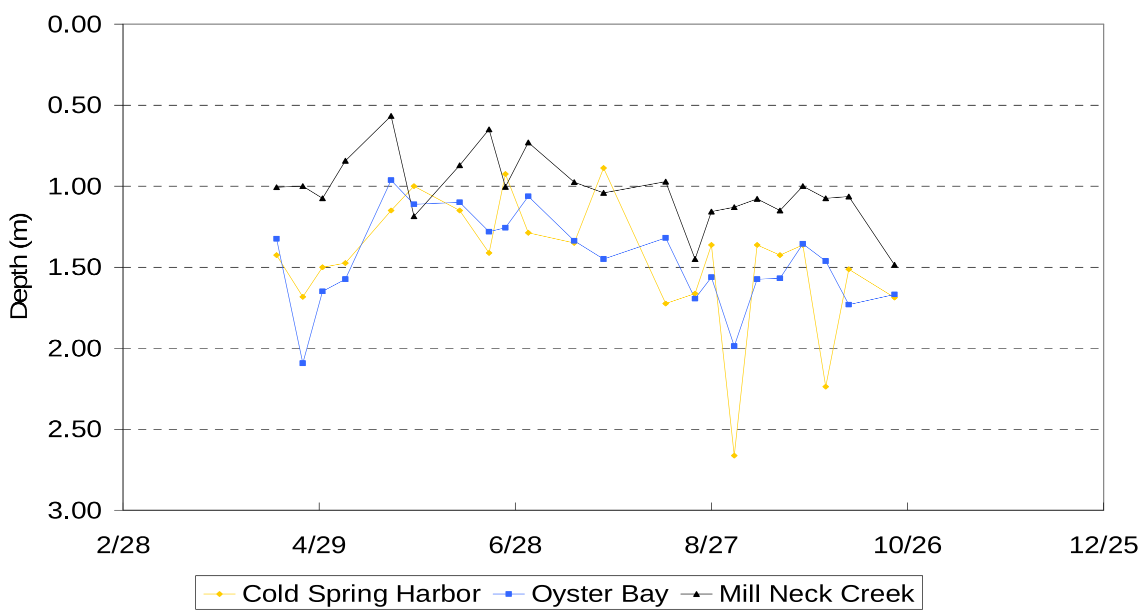

Figure 3. 2003 Secchi disk results, averaged locationally

This trend often results 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. Results also indicate that Secchi disk depths are more variable in Cold Spring Harbor, likely resulting from the greater influence of water there from water in Long Island Sound.

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) specified 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 NYS. 2003 was the last year that these standards were in effect. In 2004, new standards were implemented that are based on measured levels of enterococci, an alternate indicator bacteria, and fecal coliform.

Table 1. NYS Coliform Bacteria Standards

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

* 6NYCRR §47.3
**6NYCRR §703.4 and NYS Sanitary Code

Coliform bacteria levels are reported as monthly logarithmic average (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 at all nineteen locations during the 2003 monitoring season. Table 2 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-6, FB-9, FB-11, FB-13, and FB-16. These results show an improvement in water quality over those observed during the 2002 monitoring season. In that year, none of the monitoring locations in Mill Neck Creek met the state shellfishing 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, a direct result of the sewage overflows from "The Birches" housing development in Locust Valley that have plagued Mill Neck Creek.

Table 2. Comparison of 2003 Monitoring Results to State Shellfishing Standards

	Total Coliform		Fecal Coliform		
Station	Seasonal Geomean	90th Percentile	Seasonal Geomean	90th Percentile	Location
FB-1	61.7	300.0	28.9	130.0	CSH
FB-2	13.8	77.0	6.1	47.3	CSH
FB-3	142.0	500.0	64.5	300.0	CSH
FB-4	132.7	500.0	56.8	300.0	CSH
FB-5	43.4	230.0	14.0	52.0	OBH
FB-6	12.9	80.0	4.6	22.4	OBH
FB-7	67.7	300.0	36.1	166.0	OBH
FB-8	142.1	2150.0	58.5	300.0	OBH
FB-9	8.5	30.0	4.0	17.6	OBH
FB-10	481.9	5000.0	215.7	3600.0	OBH
FB-11	8.0	23.0	2.9	8.0	OBH
FB-12	120.9	1100.0	60.0	600.0	OBH
FB-13	11.1	30.0	3.2	8.0	MNC
FB-14	69.5	230.0	29.0	130.0	MNC
FB-15	36.5	293.0	17.0	79.0	MNC
FB-16	25.0	122.0	8.7	30.0	MNC
FB-17	44.2	473.0	23.4	211.0	MNC
FB-18	434.4	2930.0	220.6	2100.0	MNC
FB-19	63.3	293.0	32.3	125.0	MNC
Shellfish Standard	70	230	14	43	

Table 3 presents an evaluation of the estuary's bathing water quality for 2003 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 occurred at five locations, including FB-1, FB-2, FB-15, FB-16 and FB-17, whereas reduction in rating occurred at six locations, including FB-3, FB-4, FB-8, FB-10, FB-12, and FB-18. In Cold Spring Harbor, two locations improved in rating, while two locations declined, although a net improvement was observed (two 'excellent' ratings resulted from 2003 results, where only one of the locations received this rating in 2002). In Oyster Bay, three locations declined in rating, while none improved. In Mill Neck Creek, three locations improved in rating, while one declined.

Note that the FB-10 location (Beekman Beach and Mill Pond Outfall) declined in rating from 'very good' to 'unacceptable,' the only unacceptable rating to occur for any site in the two-year period. The reason for this extreme decline in water quality is unclear. Measured coliform levels at that site were extremely high in late August and throughout September (four total coliform measurements during a five week period were 5000 MPN/100 ml or above at that location, and no sample was recorded during the fifth week). A significant decline in water quality also occurred at FB-18 (Mill Neck Cove).

Table 3. Station Ratings According to Nassau County Bathing Water Quality Standards

New ID	Site Description	2002 Rating	2003 Rating	*Old ID*
FB-1	CSH South Cove	very good	excellent	*FB-10*
FB-2	CSH Cove North Mooring Field	Good	excellent	*FB-11*
FB-3	CSH South	very good	good	*FB-1*
FB-4	CSH North	excellent	very good	*FB-2*
FB-5	Plum Point	excellent	excellent	*FB-3*
FB-6	Seawanhaka Yacht Club PSTP Outfall	excellent	excellent	*FB-12*
FB-7	Oyster Bay Cove	excellent	excellent	*FB-13*
FB-8	White's Creek and OB-STP Outfall	excellent	very good	*FB-14*
FB-9	Roosevelt Beach	excellent	excellent	*FB-4*
FB-10	Beekman Beach and Mill Pond Outfall	very good	unacceptable	*FB-15*
FB-11	West Harbor	excellent	excellent	*FB-5*
FB-12	Turtle Cove	excellent	very good	*FB-16*
FB-13	Mill Neck Creek-East	excellent	excellent	*FB-6*
FB-14	Mill Neck Creek-West	excellent	excellent	*FB-7*
FB-15	Mill Neck Creek-South	passable	excellent	*FB-8*
FB-16	Mill Neck Creek-North	Good	excellent	*FB-9*
FB-17	The Birches STP	passable	very good	*FB-18*
FB-18	Mill Neck Cove	excellent	passable	*FB-17*
FB-19	Flower's Oyster Hatchery	excellent	excellent	*FB-19*

Figure 4 presents seasonal geometric means for total and fecal coliform, respectively, for each of the estuary's embayments. These results mirror those presented in Table 3. A significant reduction occurred in coliform geometric mean levels (both fecal and total coliform) measured in Mill Neck Creek for the second consecutive year. The total coliform geometric mean decreased by more than two thirds, from 149 to 43 MPN/100 ml, while the fecal coliform geometric mean decreased by more than half, from 40 to 19 MPN/100 ml.

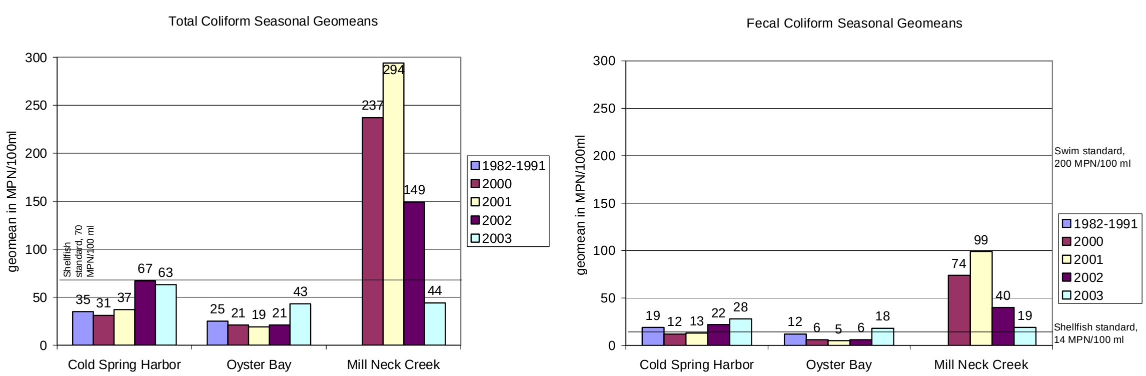

Figure 4. Seasonal geomeans of total and fecal coliform data, by location

Similar reductions in coliform levels were not observed in Cold Spring Harbor nor Oyster Bay. In Cold Spring harbor, total coliform levels decreased by 4 MPN/100 ml, while fecal coliform levels increased by 6 MPN/100 ml. These changes are small and may not be significant, due to the variability in bacteria data. In Oyster Bay, total coliform levels more than doubled, from 21 to 43 MPN/100 ml, while fecal coliform levels tripled from 6 to 18 MPN/100 ml. Prior to

2002, fewer locations were sampled. Thus, the values presented for those years may include less comprehensive data sets and are not comparable to results from 2002 and 2003.

Quality control issues occurred with bacteria samples during eight sampling events in 2003. The issues include exceedance of the 6-hour hold time (two instances), collection time or date unknown (two instances), sample volume less than 100 mL (one instance) and sample temperature too high (three instances). In general, the magnitude of the problems were relatively small (e.g. the hold time for one or several of the earlier samples was exceeded while the time was met on the other samples, and the temperature criteria was never exceeded by more than 2.5ºC). As such, the data was accepted and included in this report since the acceptance criteria are conservative and any error is likely to be small.

2.2.1 Cold Spring Harbor Results

Four stations were monitored for coliform bacteria in Cold Spring Harbor in 2003. Stations 1 and 2 (formerly stations 10 and 11) were added to the monitoring program in 2002. Figure 5 and Figure 6 present the 2003 total and fecal coliform monthly bacteria geometric means for each station.

The monthly geomeans show that only one station in CSH (FB-2) complied with the NYS shellfish standards for the duration of the season. The other three stations failed to comply with the NYS shellfish standards for both total and fecal coliform bacteria for portions of the monitoring season. All stations but FB-3 were below the swim standard for the season, and FB-3 only exceeded the standard during September.

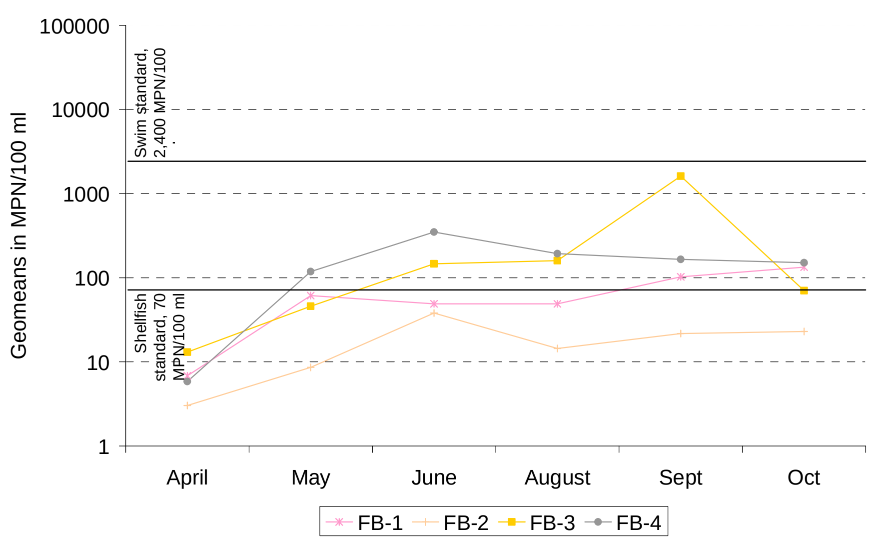

Figure 5. Monthly Cold Spring Harbor total coliform geomeans for 2003

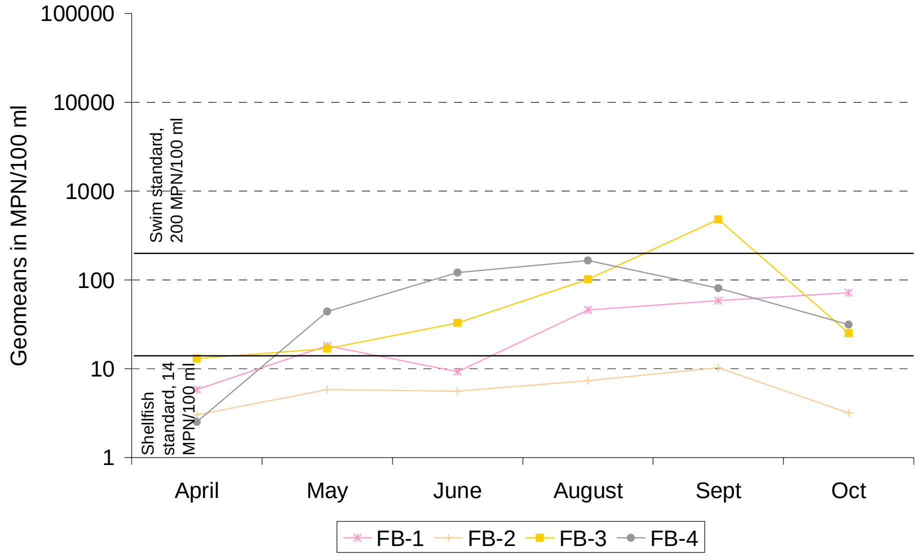

Figure 6. Monthly Cold Spring Harbor fecal coliform geomeans for 2003

2.2.2 Oyster Bay Harbor Results

A total of eight stations were monitored for coliform bacteria in Oyster Bay Harbor in 2003. Each of the stations were monitored in 2002, although all but three were added in 2002. In 2003, five stations (5,6,7,9, and 11) met the NYS water quality criteria for shell fishing. However, as shown in Figure 7 and Figure 8, the total and fecal coliform bacteria monthly geomeans at stations FB-8, 10, and 12 failed to meet the standards on several occasions.

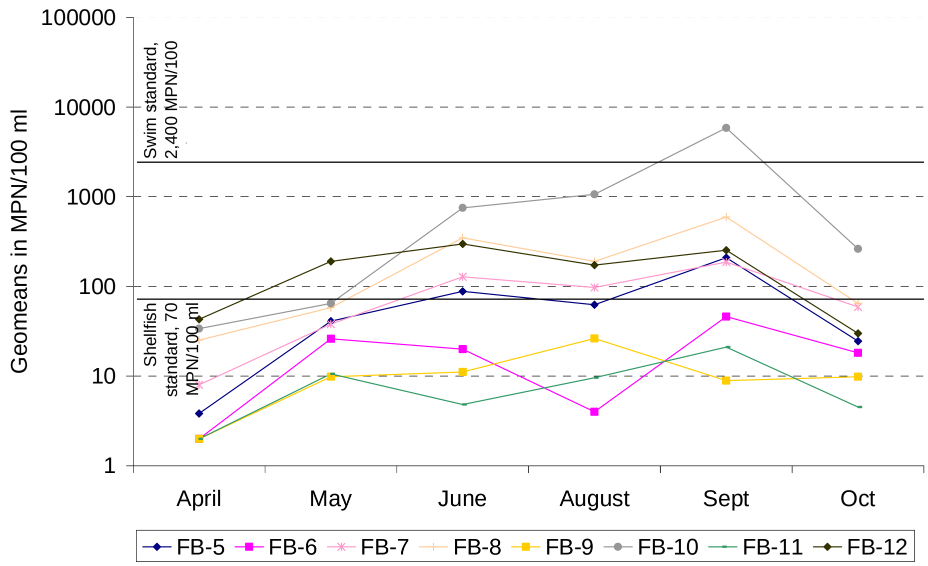

Figure 7. Monthly Oyster Bay Harbor total coliform geomeans for 2003

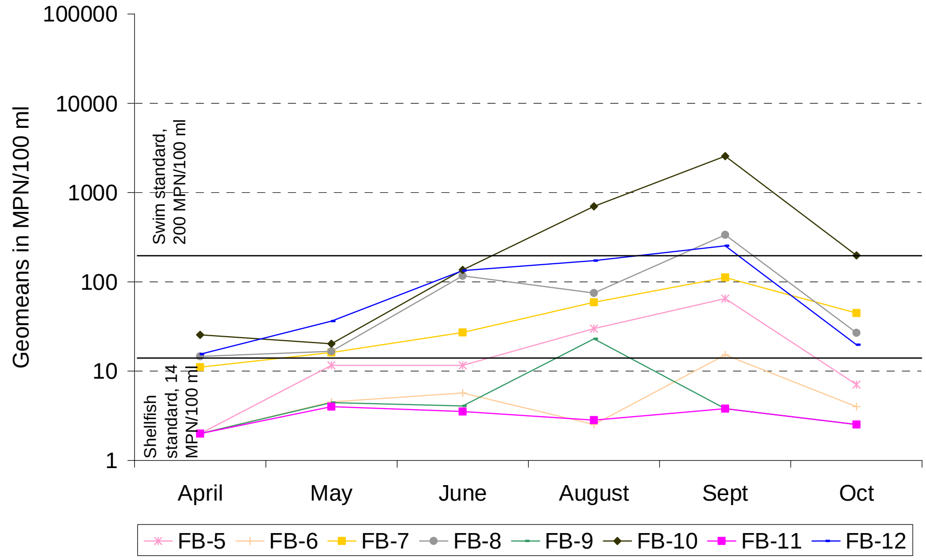

Figure 8. Monthly Oyster Bay Harbor fecal coliform geomeans for 2003

2.2.3 Mill Neck Creek Results

In 2003, seven stations were monitored in MNC for coliform bacteria pollution. Figure 9 and Figure 10 present the results of this analysis. Due to the low tide, the station FB-18 was inaccessible 10 times out of 22 monitoring days. Therefore, the analysis is based on a much smaller pool of data, which might have affected the station's statistical analysis results. The fecal and total coliform standard for swimming was exceeded in August at FB-14.

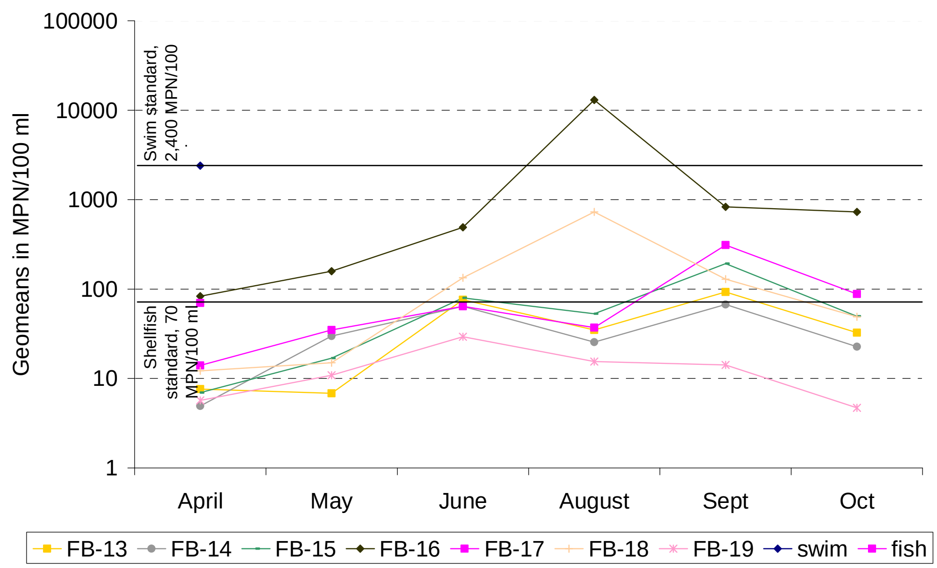

Figure 9. Monthly Mill Neck Creek total coliform geomeans for 2003

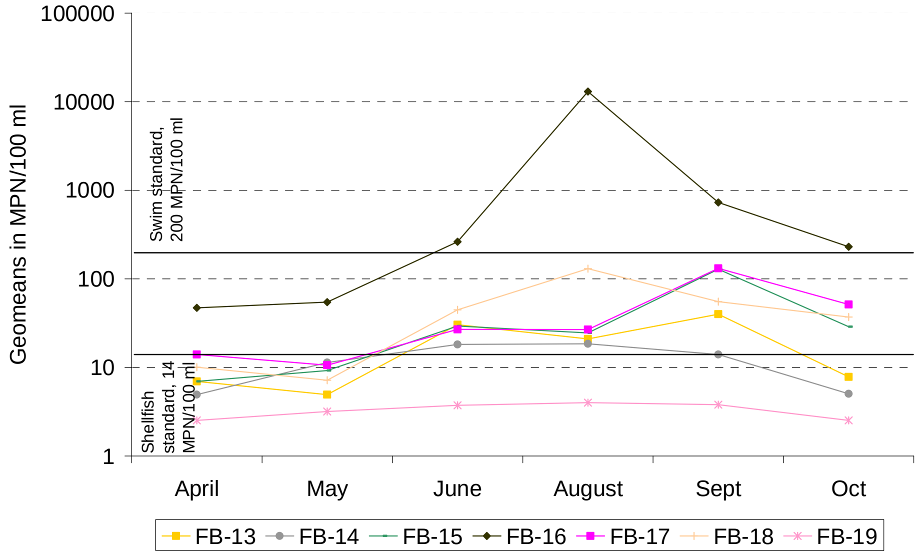

Figure 10. Monthly Mill Neck Creek fecal coliform geomeans for 2003

In general, 2003 coliform levels were slightly improved over levels observed in 2002. The largest improvements occurred in Mill Neck Creek, with small improvements occurring in Cold Spring Harbor. However, elevated levels measured in Oyster Bay Harbor near the Mill Pond outfall are a potential concern and should be investigated if they reoccur.

2.3 Nutrient Enrichment by Nitrogen

Nutrients such as nitrogen and phosphorus, as well as other minerals are essential elements that support life in marine environments. However, nutrients 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. Thus, when a water body becomes enriched with nutrients, microorganism populations increase rapidly. These rapid increases in the quantity of planktonic (algal) cells are algae blooms. During a 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 (LISS, 1994). 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 3mg/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 in marine systems. 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 11 presents a schematic of the interrelationships between these species, showing the processes that impact nitrogen in the marine environment. *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 storm water runoff. Dissolved forms of organic nitrogen are available to bacteria and phytoplankton populations and promote their growth.

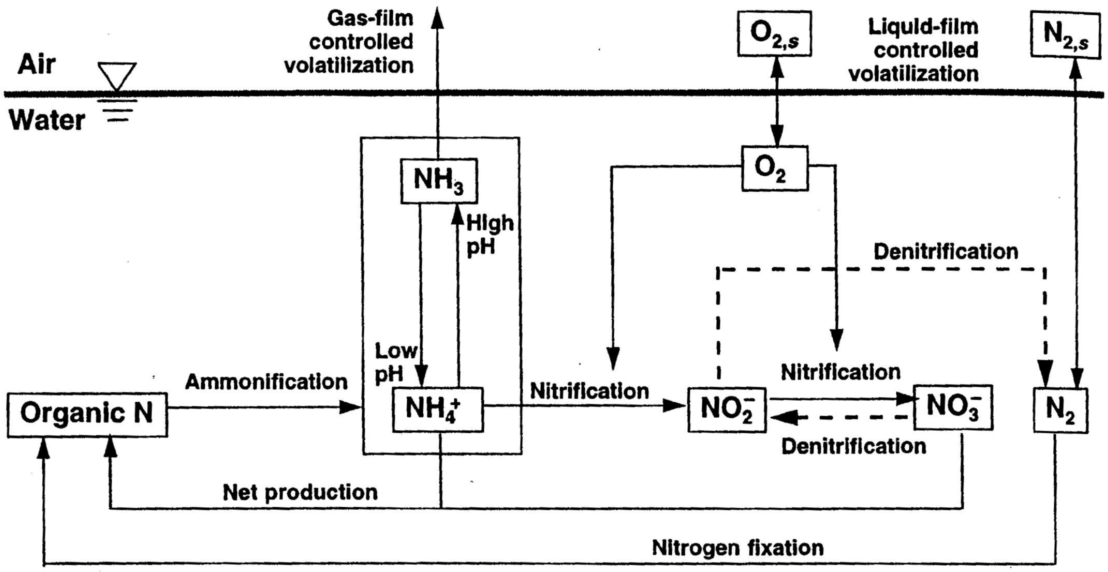

Figure 11. Nitrogen species and processes in marine environments (Source: Chapra, 1997)

Phytoplankton also utilize inorganic forms of nitrogen –ammonia-N, nitrate and nitrite. Organic nitrogen decays through ammonification to ammonia. *Nitrates and nitrites* are carried into the marine waters by storm water runoff or result from nitrification of ammonia-N. 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-N* may pose a danger to aquatic life. With rising temperatures and pH, ammonia ions (NH_4^+) change at increased rates into a unionized form of ammonia (NH_3). This form of ammonia is toxic to fish and aquatic plants.

In 1989, the U.S. EPA proposed ambient water quality criteria for ammonia in salt water. The EPA recommends that continuous total ammonia levels should not exceed 0.72 mg/L for waters of these conditions: salinity 20 ppt, temperature 25 °C, pH 8. However, for slightly more alkaline conditions (pH 8.4) the criterion decreases to 0.30 mg/L. The nitrogen cycle in estuarine environments is very complex. Different nitrogen species are assimilated by algae and bacteria and are transformed from one form to another. They are then trapped in the sediments and deposited from and released into the atmosphere.

The 1994 Long Island Sound Study (LISS) identified several major sources of nitrogen. These sources include atmospheric depositions, 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 them, sewage treatment plant upgrades for nitrogen removal and reduction of nitrogen from non-point sources, could potentially gain a 55% reduction of nitrogen load.

Nitrogen water quality standards vary across the U.S. Some states follow total maximum daily loads (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). Even 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. The first 40% of the 58.5% reduction should be accomplished by August 2004.

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

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 2003, 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 analysis, Total Kjeldahl Nitrogen (TKN) levels (i.e., the concentration of total oxidizible nitrogen, or organic nitrogen plus ammonia) and total nitrogen (i.e, TKN plus nitrate and nitrite) can be calculated. Samples were collected and analyzed once a month from April to October. Figure 12 shows seasonal averages of nitrogen species for the monitored stations.

Following the NYS DEC guideline for the Peconic Bay estuary, 11 of the monitoring stations including FB-1, FB-2, FB-5, FB-7, FB-8, FB-10, FB-13, FB-14, FB-15, FB-16, and FB-17 would have exceeded the total nitrogen seasonal mean of 0.5 mg/L in 2003. In 2002, all but two monitoring locations would have exceeded the guideline, suggesting that water quality relative to nutrients may have been improved in 2003.

Organic-N is generally present in larger quantities in the Oyster Bay estuary waters than ammonia and nitrate plus nitrite, generally accounting for 50 to 75% of total nitrogen at OB sites. The highest levels of organic nitrogen were measured in inner Cold Spring Harbor (FB-1, south of the bar beach), and at sites in Mill Neck Creek (FB-13, 15, 16). Organic nitrogen levels in Oyster Bay and in Cold Spring Harbor north of the bar beach were generally lower in concentration (only one location in Oyster Bay had organic nitrogen levels above 0.3 mg/L).

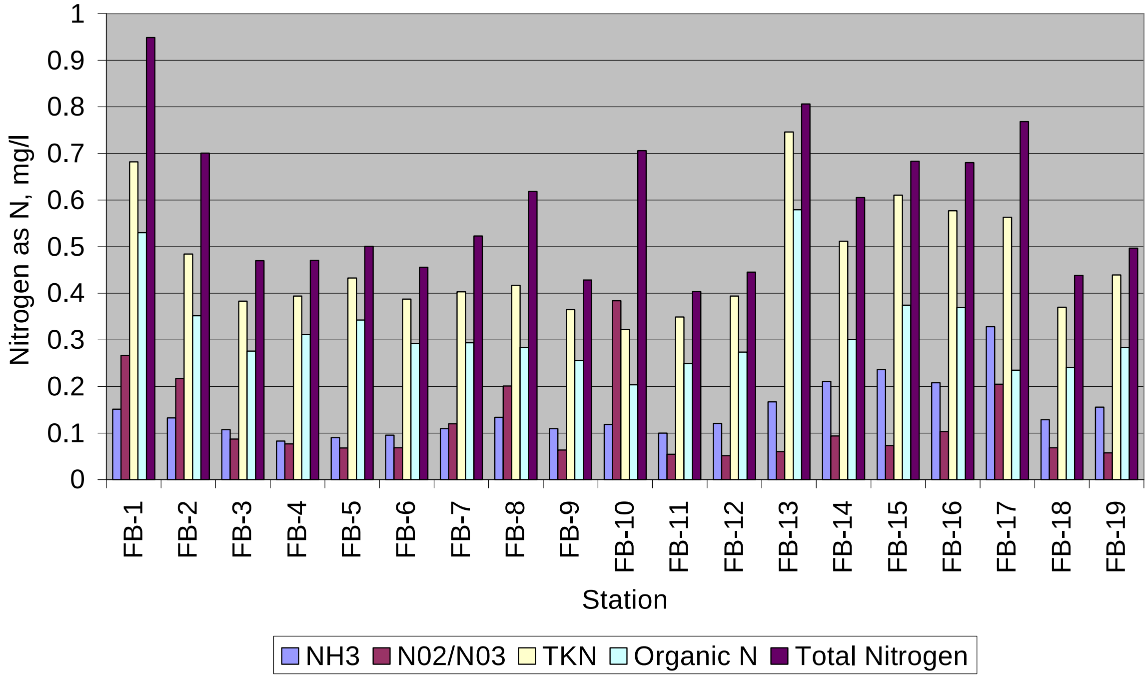

Figure 12. Seasonal average nitrogen species results for 19 stations in Oyster Bay Estuary

Figure 13, Figure 14, Figure 15, and Figure 16 present time-series scatter plots of nitrogen species results for each location in 2003, along with a regression line for the average daily concentration (the results of each monitoring event averaged together). The data indicate that an increase in average total nitrogen concentrations occurs throughout the 2003 monitoring season. The increase in total nitrogen is minor, from 0.51 to 0.59 mg/L. Additional statistical analysis is necessary to determine whether the increase is significant.

The highest concentrations were measured at FB-1 (Cold Spring Harbor Lower Harbor) and FB-13 in Mill Neck Creek, both on July 25. These outlying values were driven by high organic nitrogen levels at those locations (1.49 and 2.19 mg/L, respectively). On that date, total nitrogen levels were generally higher through the estuary than on other monitoring dates.

Average organic nitrogen levels throughout the year suggest a slight downward trend, although, again, the magnitude of the trend may not be statistically significant. Declining organic nitrogen levels could result from declining algal densities throughout the season, a trend that can be observed in the Secchi disk data as well (see Section 5.1). Average organic nitrogen levels declined from 0.37 at the start of the 2003 season to 0.30 mg/L at the end of the season.

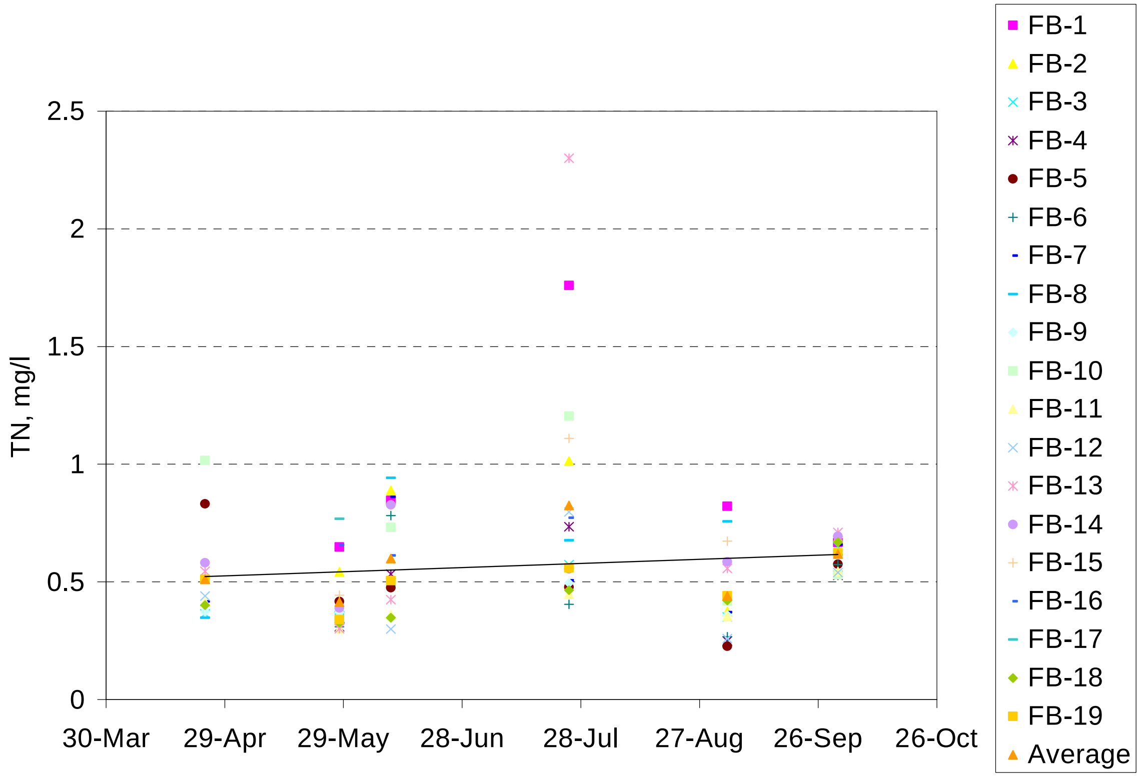

Figure 13. Time series plot of total nitrogen in Oyster Bay

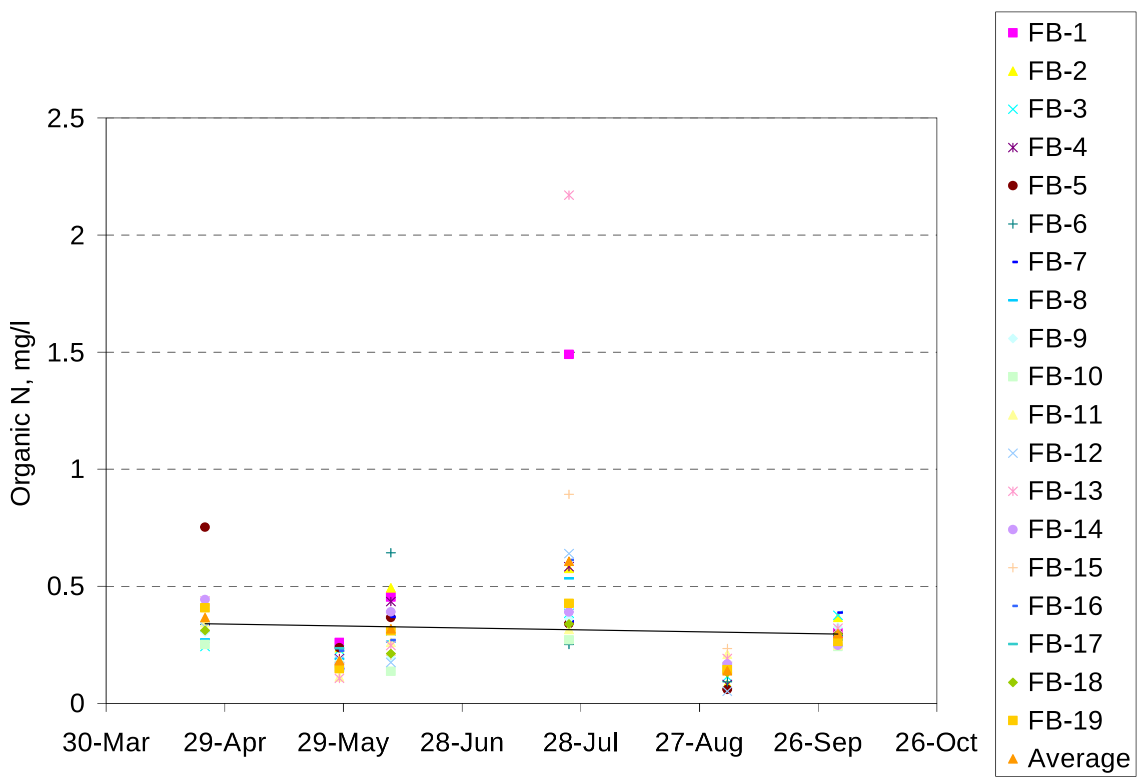

Figure 14. Time series plot of organic nitrogen in Oyster Bay

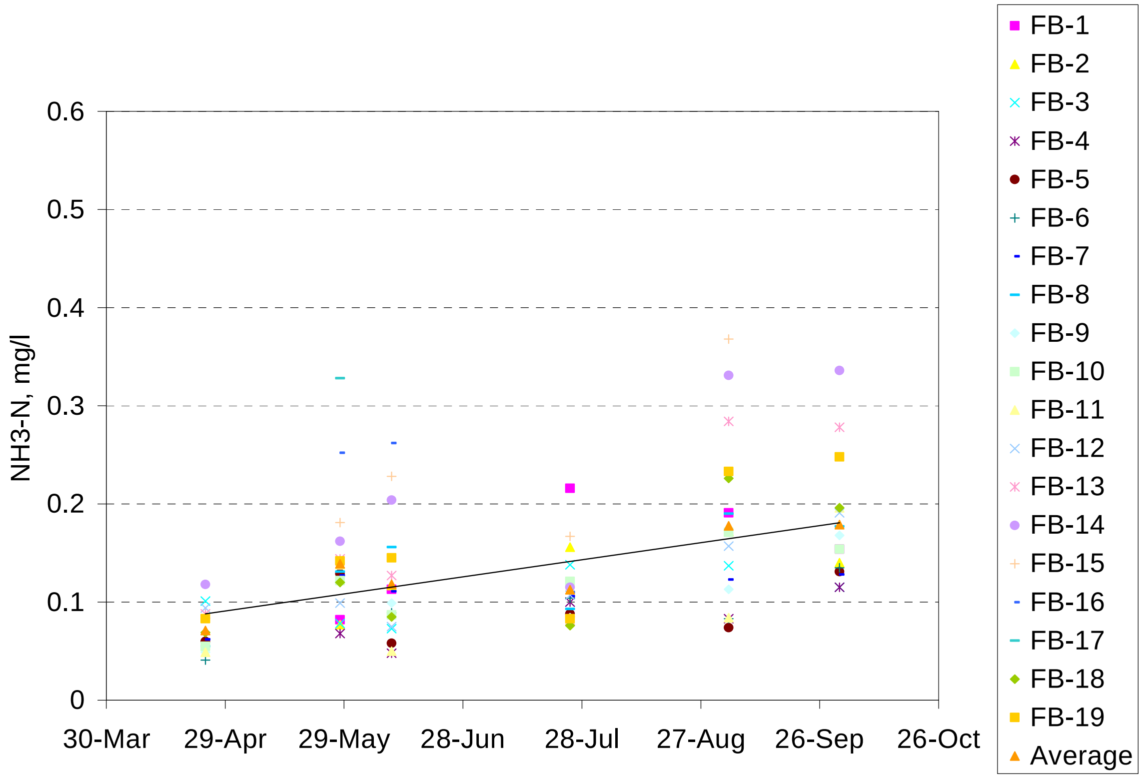

Figure 15. Time series plot of ammonia nitrogen in Oyster Bay

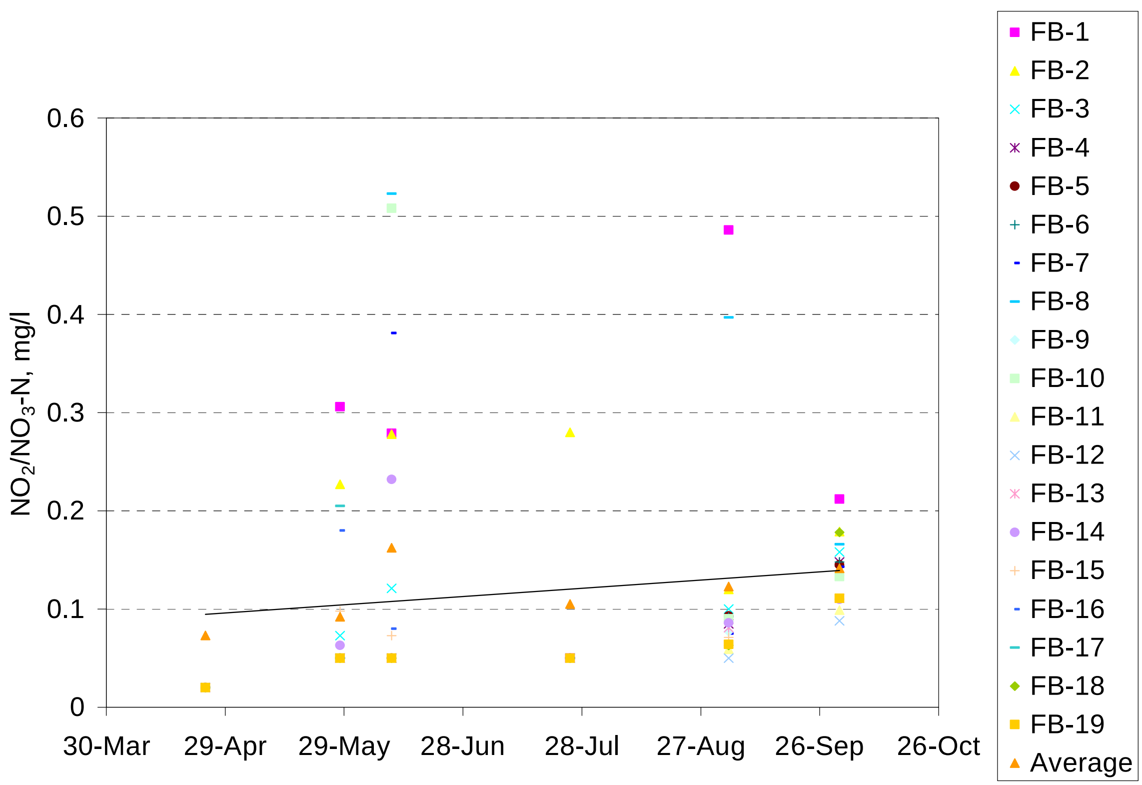

Figure 16. Time series plot of nitrate and nitrite nitrogen in Oyster Bay

Aquatic systems have two mechanisms through which pollutants can be removed; through advection, or the transport of compounds out of the system (e.g. "flushing," or transport), and through decay. In a tidal system, estimating advection can be difficult since the tides make it difficult to estimate the rate at which water is exiting the system. Since the tributaries entering the bay complex are relatively small, tidal action would tend to move water in and out of the bay in a periodic fashion. A tide table for the embayment complex is presented in Appendix D.

As such, if an observer marked a segment of water and tracked the movement of that water, it could tend to move back and forth between two similar locations during a tidal cycle, while over long periods (on the order of months) inflows to the estuary would push these two end locations further toward Long Island Sound.

Although this assumption oversimplifies the impact of tides on water quality within the bay, it provides a framework that lets us focus on the impact of decay on water quality, since decay is likely to be an important process driving pollutant removal. Thus, we may expect the decline in organic nitrogen levels to be accompanied by an increase in levels of other organic species.

Ammonia and nitrate/nitrite data from the estuary does suggest an overall increase in ammonia and nitrate levels throughout the estuary. Average ammonia levels more than doubled throughout the season, from 0.07 mg/ L to 0.18 mg/L, and nitrate and nitrite levels increase from 0.07 to 0.14 mg/L. Recall that elevated organic nitrogen levels were measured throughout the estuary on July 25.

Additionally, note that ammonia and nitrate/nitrite levels were elevated over previous weeks during the September 3 monitoring event (the highest nitrate/nitrite level recorded on September 3 occurred at FB-1, the same location where one of the highest organic nitrogen levels was recorded the month before).

It is likely that these elevated ammonia and nitrate/nitrite levels are a result of decay from organic nitrogen. This result suggests that in-harbor processes dominate advective processes, and that the Oyster Bay Harbor complex could be acting as a natural treatment 'system for waters entering Long Island Sound via the complex.

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 4.

Table 4. 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 photosynthesis. 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. This reduces the amount available for fish and other benthic (bottom dwelling) organisms.
- 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 in the whole water column at 19 sites in the Oyster Bay estuary.

Difficulties with the electrometric dissolved oxygen meter prevented collection of data between late May and mid-August, 2003. Thus, it is difficult to evaluate dissolved oxygen trends within the estuary and compare results to previous years. Very low dissolved oxygen levels (generally less than 1.0 mg/L) were recorded on June 20 at every location where the instrument was deployed. This result is not consistent with data from other years, such as in 2002, when D.O. levels were above 1 mg/L at most locations throughout the season, and is thus likely the result of an instrument difficulty, rather than chronic low D.O. measurements. DO monitoring results are presented in Appendix F.

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 D.O. at 1-meter intervals throughout the water column (an example is shown as Figure 17). This practice ceased in 2003 due to the extremely large number of measurements being recorded each week. However, stratification data can be useful in tracking conditions within the estuary. FOB should consider measuring D.O. 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). The figure below shows how dissolved oxygen levels in deep [illegible] water column is stratified.

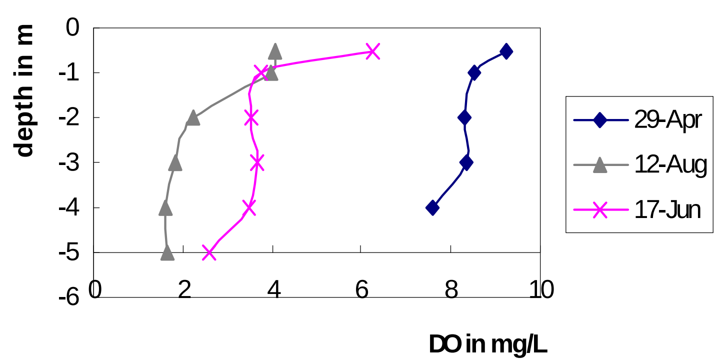

Figure 17. Vertical Dissolved Oxygen profiles for several monitoring events (year and location unknown)

2) Alternate the sequence in which the stations are monitored. Last monitoring season the stations were consistently monitored in the same sequence: from CSH (early morning) to MNC (noon). The data gathered was confined to that sequence: lowest levels of DO were measured in CSH, highest at MNC. However, while we have a basic understanding of how low the levels of DO go in CSH, we do not have the same information about MNC. Monitoring these stations at noon does not tell us what the

levels are in the early morning hours before DO levels are replenished from photosynthizing plants. Therefore, it is suggested that the monitoring sequence be changed at least once in the season; preferably in months when hypoxia occurs (June-September).

3) MNC station FB-18. Due to the low tide, the station FB-18 was inaccessible 17 times out of 29 monitoring days. This posed a problem to the data analysis. For example, there were insufficient data points to calculate monthly geomeans. Therefore, it is suggested that an adjustment be made to secure continuous monitoring of this station. This could be achieved by moving this station to a closer location that would allow for consistent monitoring from April to October.

4) MNC stations FB-9 and FB-8. These two stations were moving stations – they did not have a fixed location. FB-8 moved down towards the Beaver Lake and FB-9 up the Oak Neck Creek with the tide. It is suggested that these stations should assume a location that can be monitored consistently despite tidal stage or alternatively they should have set boundaries within which they move. Ideally this would be in a 10-20m radius. If movable stations are still preferred for some reason, then it would be good to record the GPS coordinates from where the samples were taken.

5) Focused study of pollution problems in CSH and MNC. A focused study of CSH inner harbor and MNC Beaver Lake and Oak 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 needs to continue initiating water quality improvement programs by participating in studies and applying for grants to reduce pollution threats in Oyster Bay and Cold Spring Harbor. Our participation in the Bayville Cesspool Study in 2001 and our 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 2003, Friends of the Bay's Water Quality Monitoring Program was made possible by our 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 intern Colin Lindsay were invaluable this monitoring season. Additionally, the new partnership with South Mall Analytical Labs enabled Friends of the Bay to test for nitrogen species, thereby establishing a nitrogen baseline to help identify trends and high nitrogen areas in Oyster Bay and Cold Spring Harbor.

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, 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.

Although we had a great volunteer base in 2003, 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 our understanding of our local waters, Friends of the Bay was considering for the next monitoring season the need for additional sites and parameters for testing. Friends of the Bay was also considering the following additions to the program:

- Stationary Probe - Installing a stationary probe will allow us to constantly monitor fluctuations of dissolved oxygen, salinity, and water temperature at FB-1. Such an instrument would also allow us 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. 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 is ideal to measure chlorophyll levels within Oyster Bay 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 at sunrise, for six hours a week, affords us 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 we observe. 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 our weekly monitoring study. Not only will this allow our volunteers to become more familiar with the environment around them, but it will also 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 would formalize quality control procedures to be performed by Friends of the Bay. Formalized procedures will lead to greater acceptance of the data by EPA, and LISS, as well as ensure the quality of the data that is being provided to the Fish and Wildlife Service and used in Friends of the Bay's annual reports.

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 2003, the existing monitoring locations were reorganized, the monitoring process was streamlined, and the program revised to ensure the long term usability of the collected data. Four stations were monitored in Cold Spring Harbor, eight in Oyster Bay Harbor and seven at Mill Neck Creek.

Three major water quality parameters were monitored in 2003: 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.

While coliform bacteria levels still present a challenge in regard to the NYS standard for shell fishing, one positive development was observed. In 2003, the data indicated that MNC waters continued to experience a decrease of both total and fecal coliform levels for three consecutive years (although the county bathing rating declined at several of the locations). In 2003, these decreases continued, with Mill Neck Creek bacteria levels improving again. Additionally, marginal improvements were noted in Cold Spring Harbor bacteria levels. On the other hand, an increase in bacteria levels was noted in Oyster Bay Harbor, including FB-10, which declined in county rating from very good to unacceptable, and FB-18 which declined in rating from excellent to passable. This increase is a concern, especially in the vicinity of the Mill Pond Outflow and the Beekman Creek discharge, which saw the largest increases. This result should be considered in analysis of the data of future years, to attempt to identify the cause of this decline in quality.

The second year of nitrogen monitoring suggested that nitrogen cycle processes within the Oyster Bay/Cold Spring Harbor complex could be an important factor in the fate of nitrogen, thus indicating that Oyster Bay may be providing treatment for water entering Long Island Sound through the estuary. The source of the nitrogen that is being transformed is a concern, especially in the lower Cold Spring Harbor and Mill Neck Creek, where elevated nitrogen species levels were noted during both the 2002 and 2003 monitoring seasons.

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, 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.

Unfortunately, difficulties with the dissolved oxygen portion of the YSI datalogger and sonde prevented complete collection of dissolved oxygen during the most critical time of the season. FOB will continue to monitor D.O. within the estuary since low D.O. levels can so severely impact organisms.

All waters in the Oyster Bay estuary need protection. However, additional management efforts should be more focused on areas of concern such as CSH Inner Harbor, MNC/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, we will continue to improve and expand our monitoring efforts. These efforts will provide a link to show how investment in water quality protection is improving the quality of water in Oyster Bay and Cold Spring Harbor.

5.0 REFERENCES

APHA; AWWA; WEF (1995) *Standard Methods for the Examination of Water and Wastewater, 19th Edition.* Washington, D.C.

Chapra, Steven C. (1997) *Surface Water Quality Modeling.* McGraw-Hill, Inc. New York, NY

Dexter, Barbara L. and Richard B. Harris. 1992. *Water Quality Monitoring: A Guide For Concerned Citizens*. 99 pp.

DiPaolo, Carol. 2000. *Water-Monitoring Program for Hempstead Harbor 1999 Report*.

Fisher, Nina A. 1993. *Volunteer Estuary Monitoring: A Methods Manual*. United States Environmental Protection Agency. Washington, D.C. 176 pp.

New York Sea Grant Extension. 1990. *Pathogens: Long Island Sound Study Fact Sheet #12*, Stony Brook, NY. 4 pp.

Ohrel, Jr., Ronald L. & Register, Kathleen M.: *Volunteer Estuary Monitoring: A Methods Manual*: Second Edition p.2-8

Save the Sound, Inc. 1998. *Volunteer Procedures Manual: for Save the Sound, Inc.'s Water Quality Monitoring Program*. Save the Sound, Inc. Stamford, CT 31 pp.

Yergeau, S. and J. Thalhauser. 1999. *1999 Long Island Sound Water Quality Report*. Save the Sound, Inc. Stamford, CT 74 pp.

Zimmer, Kimberly. 1996. *How Low Dissolved Oxygen Conditions Affect Marine Life in Long Island Sound*. Stony Brook, NY. 2 pp.

Cook Inlet Keeper. 1998. *Volunteer Training Manual: Citizens Environmental Monitoring Program*. Cook Inlet Keeper. Homer, AK 188pp.

The National Research Council. 2000.Clean Coastal Waters: Understanding and reducing the Effects of Nutrient Pollution, National Academy Press Washington D.C. pp. 67-83, 242-246

LISS – Long Island Sound Study. The Comprehensive Conservation and Management Plan. 1994. published by NYS Department of Environmental Conservation, The Connecticut Department of Environmental Conservation, The EPA Long Island Sound Office. pp.11-40

Comprehensive Conservation and Management Plan: Peconic Estuary Program, September 1999 Suffolk County Department of Health Services. Office of ecology. Peconic Estuary Program Office. Walter Davydiak. Chapter 3, pp. 8-12, 64-65

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.

- 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

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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
[5] http://www.nyswaterfronts.com/waterfront_natural_narratives.asp

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 Company, along with more than 80 independent commercial 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.

- 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.

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[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

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.

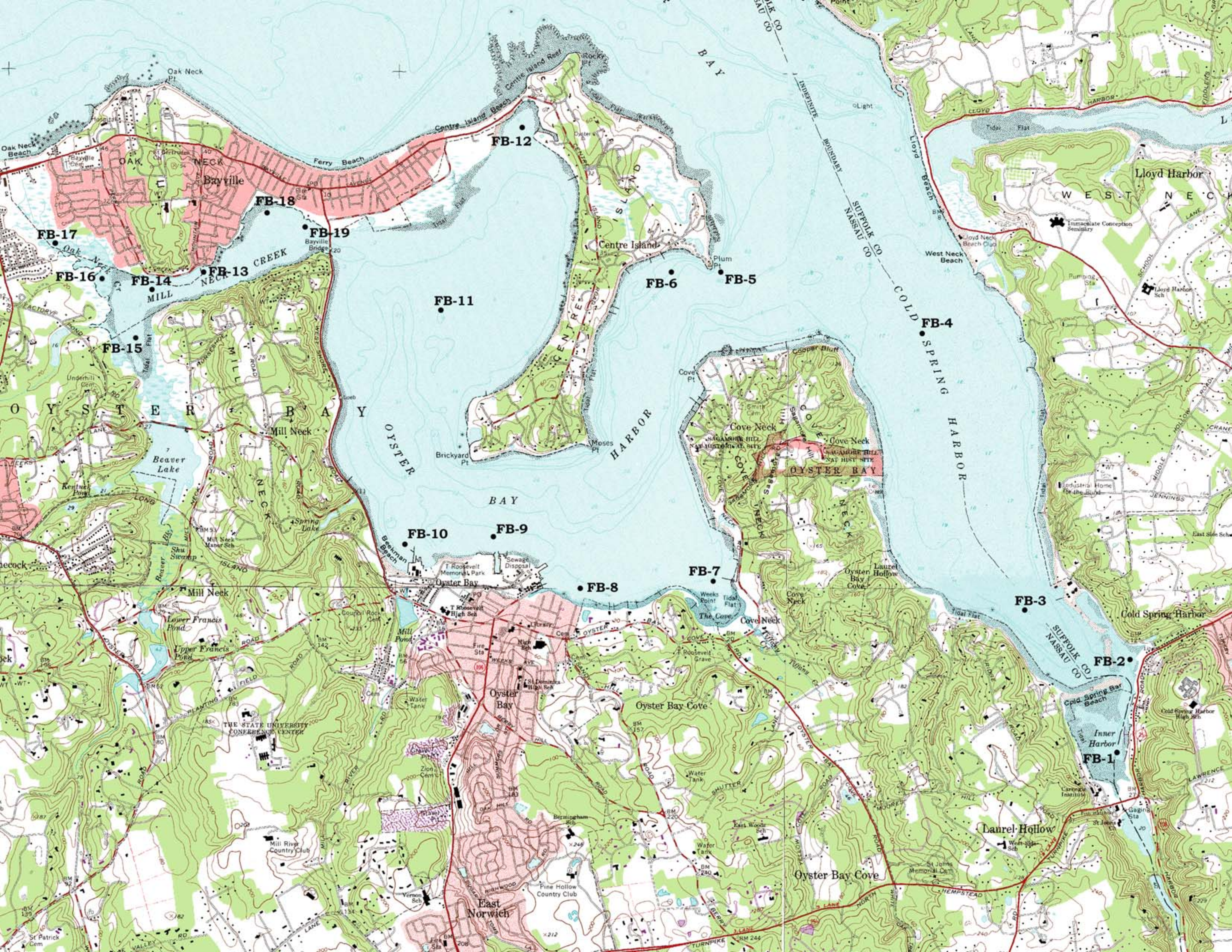
What is a Regionally Important Natural Area?

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.

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
Cove Neck
Oyster Bay
Oyster Bay Cove
Cold Spring Harbor
Laurel Hollow
East Norwich
Mill Neck
OYSTER BAY
OYSTER BAY HARBOR
COLD SPRING HARBOR
Inner Harbor
Beaver Lake
MILL NECK CREEK
SUFFOLK CO
NASSAU CO

2003 Sampling Locations in Oyster Bay Estuary

	2003 Site ID	Site Name	Site Description	Latitude	Longitude	0ld Site ID (2002)
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-10*
Cold Spring Harbor	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-11*
Cold Spring Harbor	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-1*
Cold Spring Harbor	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"	*FB-2*
Oyster Bay Harbor	FB-5	Plum Point	Off Plum Point, 110 yards south of Red Nun "4"	40°54'04"	73°30'23"	*FB-3*
Oyster Bay Harbor	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-12*
Oyster Bay Harbor	FB-7	Oyster Bay Cove	Center of cove 100 yards south-west of Mr. Yampole's pier	40°52'31"	073°30'25"	*FB-13*
Oyster Bay Harbor	FB-8	Whites Creek and OB-STP outfall	100 yards east of Commander Oil dock	40°52'31"	073°31'17"	*FB-14*
Oyster Bay Harbor	FB-9	Roosevelt Beach	Approx. 200 yards offshore and in line with flagpole at Roosevelt Park.	40°52'45"	073°31'53"	*FB-4*
Oyster Bay Harbor	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-15*
Oyster Bay Harbor	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-5*
Oyster Bay Harbor	FB-12	Turtle Cove	110 yards west of canal	40°54'44"	073°31'41	*FB-16*
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-6*
Mill Neck Creek	FB-14	Mill Neck Creek -West*	Confluence of Oak Neck Creek and Mill Neck Creek	40°53'56"	73°34'03"	*FB-7*
Mill Neck Creek	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-8*
Mill Neck Creek	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-9*
Mill Neck Creek	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 Creek	FB-18	Mill Neck Cove	North most point which tide will allow	40°54'20"	073°33'20"	*FB-17*
Mill Neck Creek	FB-19	Flowers Oyster Hatchery	10 feet south of warning buoy marking shellfish racks.	40°54'15'	073°33'04"	*FB-19*

*Coliform Bacteria sampling only
Field Blank obtained from NDCH Lab

File: 2003site_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

TOWN OF OYSTER BAY

2003

Date of NEW MOON

Date of FULL MOON

John Venditto

Town Supervisor

NORTH SHORE HIGH TIDE TABLE

HELP US KEEP OUR WATERWAYS CLEAN
USE MARINE PUMPOUT FACILITIES

JUNCTION OF OYSTER BAY AND COLD SPRING HARBOR

	JAN.		FEB.		MARCH		APRIL		MAY		JUNE	
	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.	9:22	10:18	11:13	11:40	10:14	10:38	11:13	11:26	11:21	11:29		12:08
2.	10:34	11:09	11:57		10:57	11:18	11:48		11:56		12:13	12:47
3.	11:24	11:58	12:22	12:39	11:37	11:55	12:00	12:23	12:03	12:32	12:52	1:27
4.	12:13		1:02	1:20		12:15	12:34	12:58	12:38	1:09	1:34	2:11
5.	12:45	1:00	1:42	2:00	12:31	12:51	1:08	1:35	1:16	1:49	2:20	2:58
6.	1:31	1:47	2:23	2:42	1:07	1:28	1:46	2:15	1:57	2:33	3:11	3:49
7.	2:17	2:34	3:05	3:27	1:44	2:06	2:26	2:59	2:43	3:22	4:07	4:43
8.	3:04	3:23	3:51	4:16	2:22	2:47	3:13	3:50	3:35	4:16	5:06	5:40
9.	3:53	4:13	4:41	5:09	3:05	3:33	4:06	4:46	4:33	5:13	6:07	6:37
10.	4:43	5:06	5:34	6:06	3:52	4:25	5:05	5:46	5:34	6:10	7:08	7:33
11.	5:34	6.01	6:29	7:04	4:46	5:23	6.07	6:44	6:35	7:06	8:07	8:29
12.	6:26	6:55	7:24	7:59	5:44	6:23	7:07	7:40	7:34	8:00	9:04	9:23
13.	7:17	7:47	8:17	8:50	6.44	7:21	8:04	8:32	8:30	8:53	10.00	10:17
14.	8:05	8:37	9:06	9:37	7:41	8:15	8:57	9:21	9.24	9:44	10:04	11:10
15.	8.52	9:23	9:53	10:22	8:35	9:05	9:49	10.09	10:17	10:34	11:48	
16.	9:36	10:07	10:30	11:08	9:26	9:52	10:39	10:57	11:10	11:26	12:03	12:41
17.	10.19	10:50	11:24	11:50	10:14	10:38	11:28	11:46		12:02	12:58	1:34
18.	11:02	11:32	12:10		11:02	11:23		12:19	12.18	12:56	1:50	2:28
19.	11:45		12:34	12:57	11:49		12:36	1.12	1:12	1:52	2:46	3:23
20.	12:15	12:29	1:21	1:46	12:10	12:38	1:29	2:08	2:09	2:51	3.42	4:17
21.	12:59	1:15	2:11	2:39	12:58	1:29	2:26	3:08	3:09	3:52	4.40	5:12
22.	1:45	2:04	3:05	3:57	1:49	2:23	3:28	4:13	4:12	4:53	5:37	6:05
23.	2:34	2:57	4:04	4:41	2:44	3:22	4.35	5:20	5:17	5:54	6:33	6:56
24.	3:27	3:55	5:09	5:51	3:45	4:28	5:45	6:26	6:19	6:49	7.25	7:44
25.	4:25	4.58	6.18	7:01	4:53	5:38	6:52	7:26	7:16	7:40	8:14	8:29
26.	5:27	6:04	7:26	8:07	8:04	6:48	7:51	8:17	8:07	8:25	9:00	9:12
27.	6:32	7:11	8:29	9:04	7:13	7:52	8.43	9:02	8.53	9:07	9:43	9:52
28.	7:36	8:16	9:25	9:54	8:15	8:46	9:28	9:42	9:35	9:46	10:24	10:32
29.	8:37	9.15			9:09	9:33	10:08	10:19	10:15	10:23	11:04	11:11
30.	9:34	10:08			9:55	10:13	10:45	10:54	10:53	11:00	11:44	11:51
31	10:25	10:56			10:36	10:51			11:30	11:36		

	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.
1.		12:23	12:53	1:22	2:09	2:33	2:49	3:11	4:48	5:12	5:26	5:51
2.	12:31	1:04	1:39	2:07	3:05	3:29	3:54	4:17	5:56	6:21	6:26	6:53
3.	1:14	1:47	2:29	2:57	4:06	4:32	5:03	5:28	6:58	7:24	7:20	7:48
4.	2:00	2:33	3:23	3:51	5:14	5:40	6:14	6:39	7:54	8:19	8:09	8:37
5.	2:49	3:23	4:22	4:50	6:24	6:49	7:20	7:44	8:42	9:07	8:53	9:21
6.	3:43	4:16	5:26	5:53	7:32	7:54	8.18	8:40	9:24	9:50	9:34	10:02
7.	4:42	5:13	6:33	6:58	8:33	8:53	9:08	9:30	10:03	10:28	10:12	10:40
8.	5:43	6:12	7:39	8:01	9:26	9:46	9:51	10:14	10:40	11:06	10:49	11:17
9.	6:47	7:12	8:41	9:01	10:13	10:33	10:31	10:53	11:15	11:41	11:25	11:54
10.	7:50	8:11	9:38	9:56	10:56	11:16	11:08	11:31	11:50			12:02
11.	8:50	9:09	10:29	10:47	11:35	11:56	11:43		12:17	12:25	12:32	12:39
12.	9:47	10:04	11:17	11:34		12:14	12:07	12:19	12:54	1:02	1:11	1:18
13.	10:42	10:58		12:01	12:34	12:51	12:43	12:54	1:34	1:42	1:52	2:01
14.	11:33	11:49	12:19	12:44	1:13	1:29	1:20	1:32	2:17	2:27	2:36	2:48
15.		12:23	1:02	1:26	1:52	2:09	2:01	2:13	3:04	3:16	3:24	3:40
16.	12:39	1:11	1:45	2:08	2:34	2:52	2:46	2:59	3:56	4:11	4:15	4:36
17.	1:28	1:59	2:29	2:51	3:21	3.40	3:36	3:51	4:51	5:10	5:10	5:35
18.	2:17	2:47	3:14	3:37	4.13	4:33	4:32	4:49	5:47	6:10	6:07	6:36
19.	3.06	3:35	4:03	4:27	5:11	5:31	5:30	5:48	6:42	7:07	7:04	7:36
20.	3:57	4:25	4:57	5:20	6.10	6:29	6:27	6.47	7.35	8:03	8:00	8:34
21.	4:50	5:17	5:54	6:15	7:07	7:25	7:20	7:42	8:27	8:56	8:55	9:30
22.	5:45	6:09	6:51	7:10	7:59	8:17	8:10	8:33	9:17	9:49	9:49	10:25
23.	6.40	7:00	7:46	8:02	8:46	9.05	8:58	9:23	10:07	10:41	10:43	11:19
24.	7:33	7:50	8:36	8:50	9:31	9:52	9:44	10:12	10:58	11:33	11:36	
25.	8:23	8:37	9:22	9:36	10.15	10:37	10:31	11:00	11:49		12:12	12:29
26.	9:10	9:22	10:05	10:20	10:59	11:23	11:18	11:50	12:26	12:43	1:05	1:23
27.	9:54	10:05	10:47	11:03	11:43			12:07	1:21	1:39	1:59	2:18
28.	10:36	10:46	11:28	11:47	12:10	12:29	12:41	12:59	2:19	2:38	2:54	3:15
29.	11:17	11.28		12:11	12:59	1:19	1:36	1.54	3:20	3:41	3:50	4:13
30.	11:57		12:32	12:55	1.52	2.12	2:35	2:55	4.23	4:47	4:47	5:13
31	12:10	12:39	1:19	1:42			3.40	4:02			5:43	6:12

EASTERN STANDARD TIME
January 1 through April 5
October 27 through December 31

EASTERN DAYLIGHT SAVINGS TIME
April 6 through October 26

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.

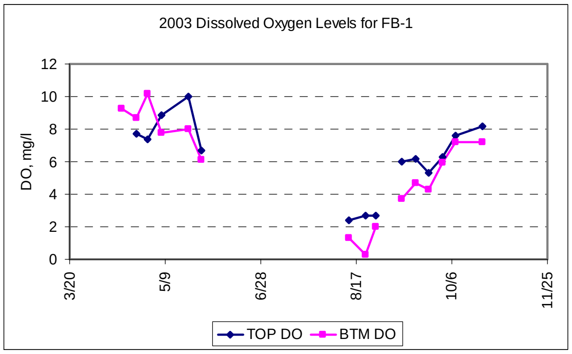
*EXCEEDS NEW YORK STATE HEALTH DEPARTMENT STANDARDS FOR BATHING WATER QUALITY - A beach receives this rating when the 30 day log average for total coliform goes over 2,400 at any time during the bathing season, or when more than 20 percent of the samples taken in the- season contain total coliform counts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

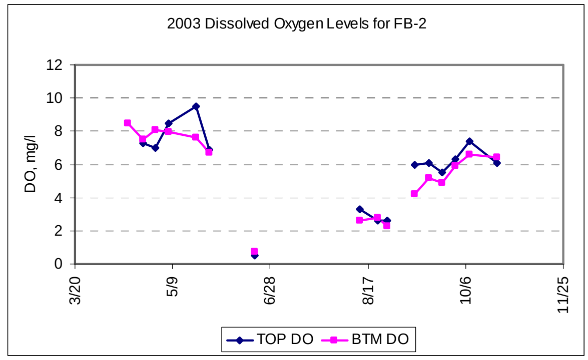
*Fecal coliform test used in evaluation of beaches not attaining at least "Good" water quality.

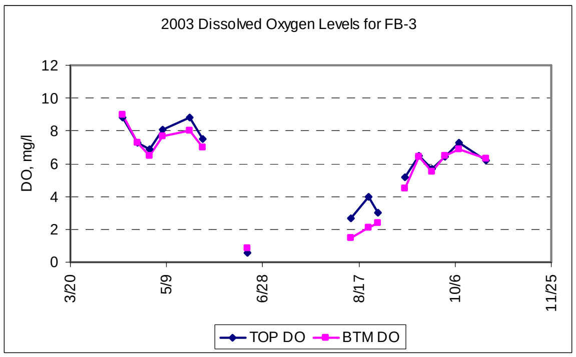
Source: Nassau County Department of Health: *1974 Surface Water Quality Assessment Report*

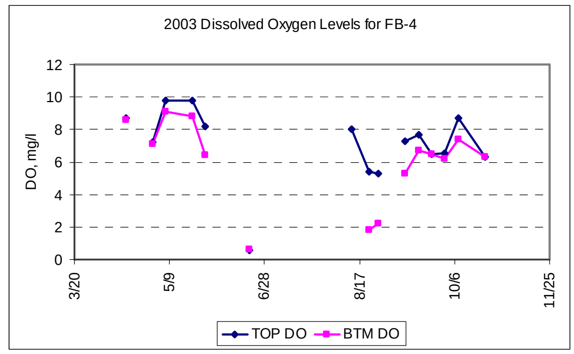
APPENDIX F

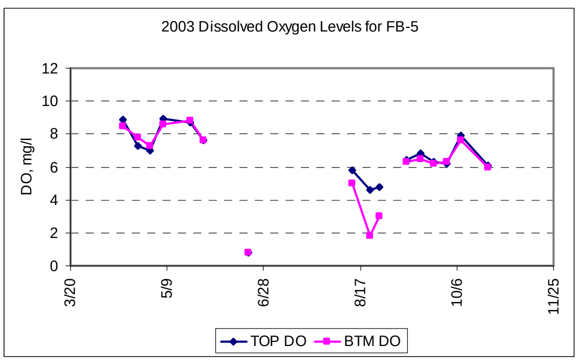
DISSOLVED OXYGEN MONITORING RESULTS

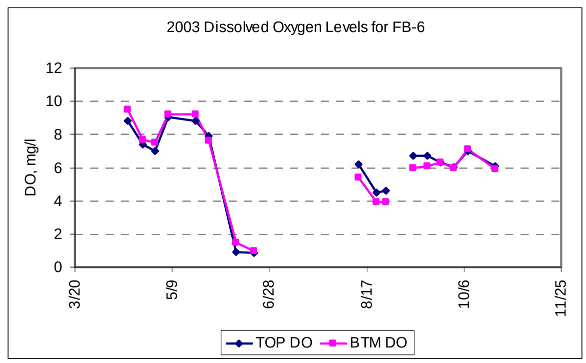

2003 Dissolved Oxygen Levels for FB-1
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO

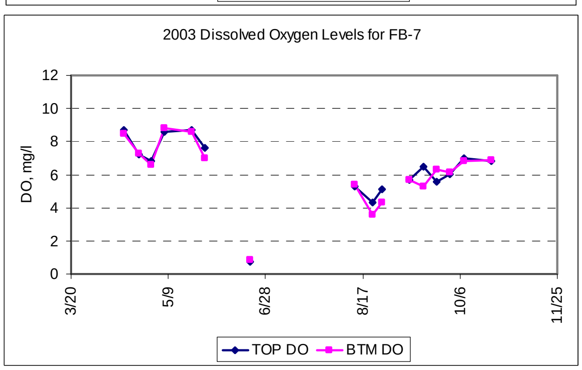

2003 Dissolved Oxygen Levels for FB-2
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO

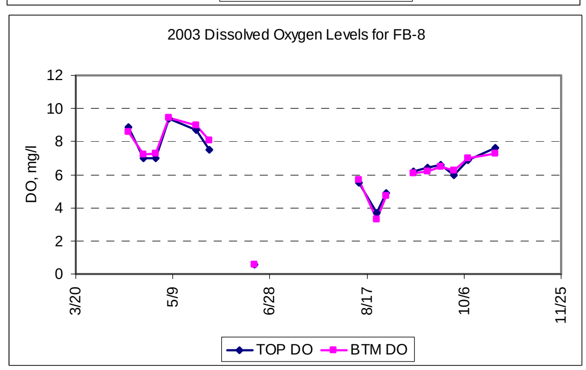

2003 Dissolved Oxygen Levels for FB-3
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO

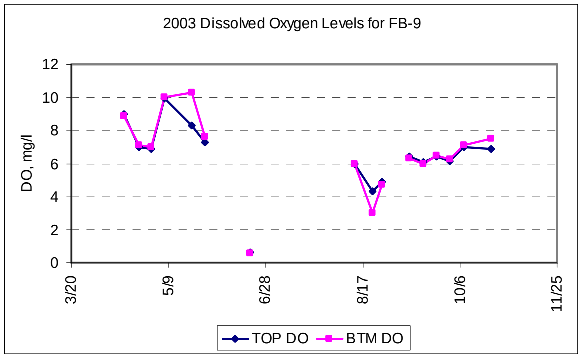

2003 Dissolved Oxygen Levels for FB-4
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO


2003 Dissolved Oxygen Levels for FB-5
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO

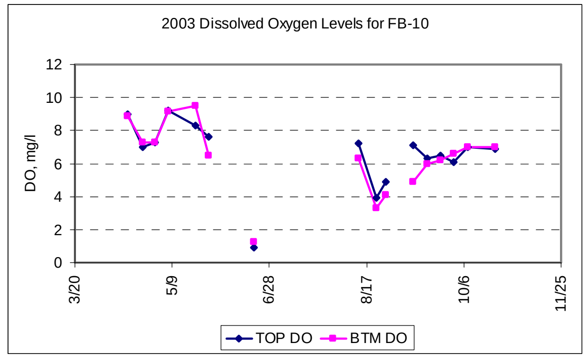

2003 Dissolved Oxygen Levels for FB-6
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO


2003 Dissolved Oxygen Levels for FB-7
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO

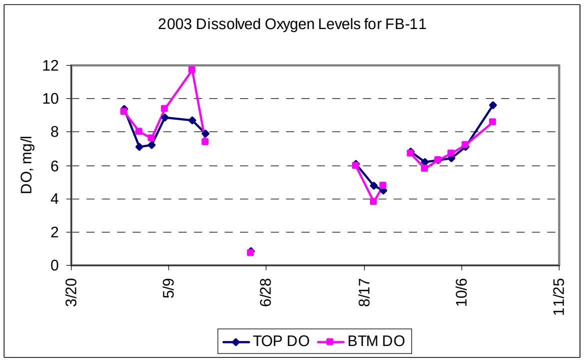

2003 Dissolved Oxygen Levels for FB-8
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO



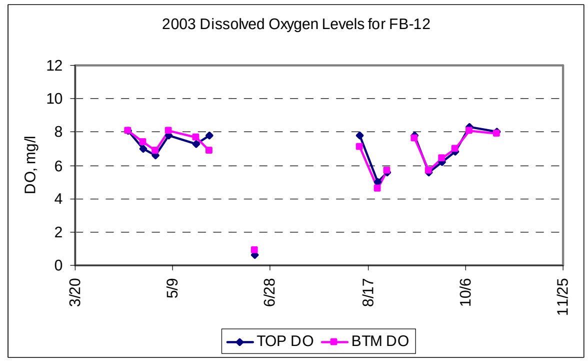
2003 Dissolved Oxygen Levels for FB-9



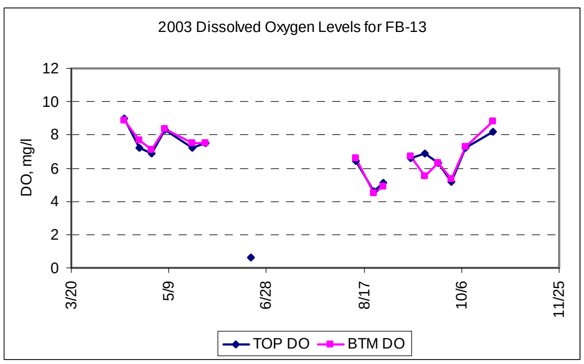
2003 Dissolved Oxygen Levels for FB-10



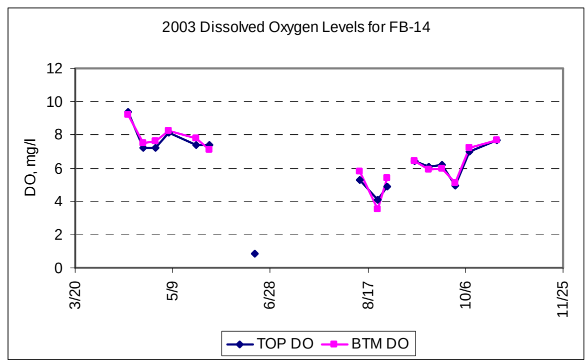
2003 Dissolved Oxygen Levels for FB-11



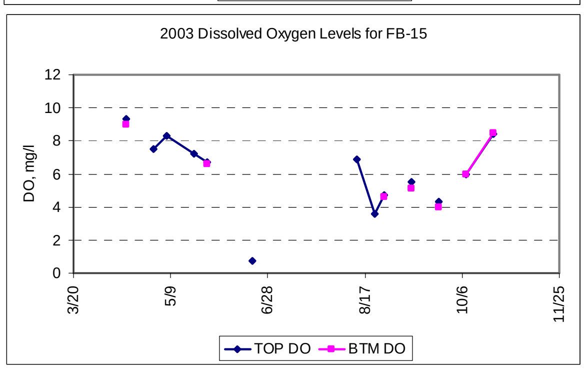
2003 Dissolved Oxygen Levels for FB-12



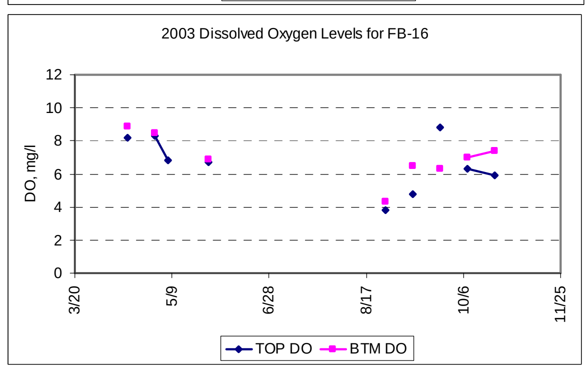
2003 Dissolved Oxygen Levels for FB-13



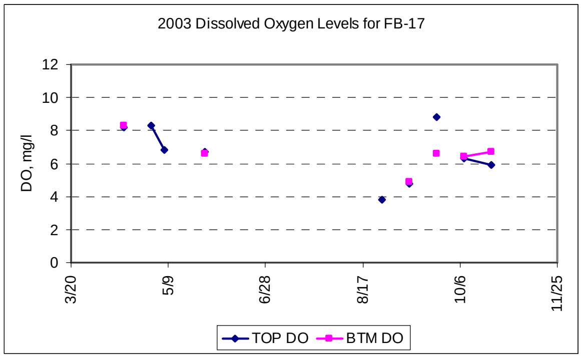
2003 Dissolved Oxygen Levels for FB-14

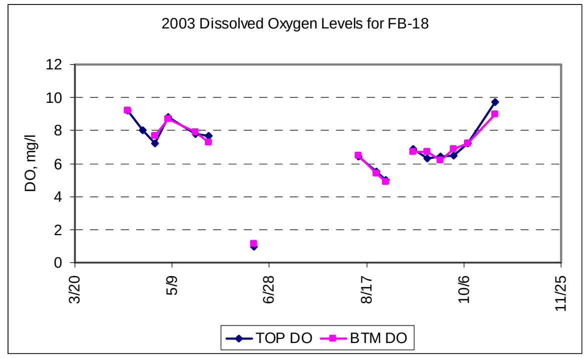


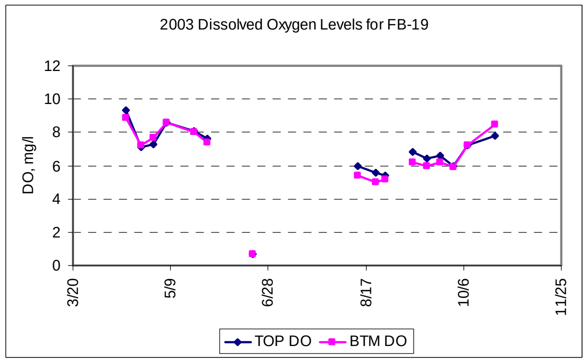
2003 Dissolved Oxygen Levels for FB-15



2003 Dissolved Oxygen Levels for FB-16


2003 Dissolved Oxygen Levels for FB-17
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO


2003 Dissolved Oxygen Levels for FB-18
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO


2003 Dissolved Oxygen Levels for FB-19
DO, mg/l
0
2
4
6
8
10
12
3/20
5/9
6/28
8/17
10/6
11/25
TOP DO
BTM DO