Friends OF THE Bay

Working to keep the oyster in Oyster Bay

2006 Annual Water Quality Report

Open Water Body
Water Quality Monitoring Program

Prepared in 2007 For

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Working to keep the oyster in Oyster Bay

This *2006 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 2006.

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.

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

Oyster Bay Marine Center - Donates fuel for the Baywatch II each year.

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.

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.

Boat Captains:
Hank Kasven (Syosset)
Scott Sayer (Centerport)

Volunteers:
Brian Dillman (Oyster Bay)
Burt Goldfeld (Wantagh)
Lorna Mann (Bayville)
Catherine McConnell (Oyster Bay)
Carla Panetta (Bayville)
Jack Panetta (Bayville)
Nick Panetta (Bayville)
Barbel Polansky (Oyster Bay)
Abraham Polauf (Jericho)
Seth Watkins (Bayville)
Denise Wurtz (Laurel Hollow)

Locust Valley High School Students and Teachers:
Chris Schmid (teacher)
Kelly Carusi (student)
Erica Goldberger (student)
Nick Panetta (he volunteers on his own, but is now LVHS student as well)

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EXECUTIVE SUMMARY

Friends of the Bay's Water Quality Monitoring Program is an important component of our efforts to protect the Oyster Bay/Cold Spring Harbor estuary (and the surrounding watershed) 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 Department of Environmental Conservation, local governments, and other volunteer monitoring groups around Long Island Sound.

During 2006, Friends of the Bay (FOB) continued data collection in support of the long-term open water body monitoring program. Once a week since 2000, from spring through fall, Friends of the Bay has collected water quality data in Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor. Friends of the Bay went out on the bay 24 times between April 3rd and October 31st (19 Mondays, 3 Tuesdays, and once each on a Wednesday and a Friday), collected numerous samples that were analyzed for bacteria (385 samples) and nitrogen pollution (approximately 120 samples), recorded 937 measurements each of dissolved oxygen, temperature, and salinity, and measured water clarity 394 times.

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

Additionally, in 2006 Friends of the Bay received Environmental Protection Agency (EPA) approval for a Quality Assurance Project Plan (QAPP), which we prepared with assistance from Fuss & O'Neill. The QAPP formalizes the quality assurance procedures for the data collection portions of our program, and will ensure that our data can be used by EPA and other government agencies. The QAPP includes many procedures that were already implemented by Friends of the Bay, and introduces a few new quality assurance steps as well.

Three major water quality parameters were monitored in 2006: coliform bacteria levels, dissolved oxygen levels and nitrogen concentrations. Analysis of this season's data provided many useful insights into estuary's water quailty.

In 2006, bacterial levels were generally lower than 2004, when coliform bacteria concentrations were unusually high, and similar to 2005 levels. As observed in previous years, bacteria levels in Mill Neck Creek and Cold Spring Harbor were generally higher than in Oyster Bay Harbor. Locations FB-18 and FB-19 in Mill Neck Creek met the state shellfishing standard for fecal coliform on a geometric mean basis for the entire season, although the standard level was exceeded for a portion of August and September based on the 30-day running geometric mean (the regulation is based on the seasonal geometric mean, also called 'geomean,' not the running geomean).

The fifth year of nitrogen monitoring also suggested dramatic increases in nitrogen levels in the estuary in 2006, a trend that was first observed in 2004 (although the dataset was somewhat limited in that year) and continued in 2005. None of the monitoring locations would have met the nitrogen standard for salt water that New York State applies to the Peconic Bay estuary, if that standard were to be applied to Oyster Bay as well. The cause of these increased levels is unclear and warrants additional study.

Construction and start-up is complete of the new $10.6 million advanced wastewater treatment facility serving the Oyster Bay Sewer District (OBSD). The plant went online in December 2005. Microorganisms used to seed the plant were delivered in mid-January 2006, and the plant was fully operational in March 2006. The facility, a Sequencing Batch Reactor, is already achieving the 2014 nitrogen limits imposed by the New York State Department of Environmental Conservation. The upgrade has reduced the daily nitrogen by as much as 75%.

With the completion of this plant, the Friends of the Bay nitrogen data collected in 2002 through 2006 and subsequent years will provide a valuable baseline in evaluating the effect of reduced nitrogen loading on the estuary. The upgrade represents an important improvement in infrastructure available to the public, which should improve water quality of the estuary.

Dissolved oxygen (DO) data was collected throughout the estuary during the monitoring season. In past years, DO trends indicate that the waters of the estuary are enriched with nutrients consistent with the nitrogen monitoring observations, since dissolved oxygen levels decrease steadily from spring through late summer, and then begin to increase in late summer. Nutrient enrichment can result from inadequately treated sewage discharges, polluted stormwater runoff, over-fertilization of lawns and gardens, agricultural runoff, and atmospheric deposition of air pollutants. Long-term reductions in nitrogen inputs should reduce the occurrence of extremely low DO conditions in the bottom of the harbor.

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

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INTRODUCTION

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

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

- Oyster Bay (Mill Neck) is among the 33 Inaugural Stewardship Areas listed within the Long Island Sound Stewardship Initiative 2006 Atlas.[2]
- 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."

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

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[1] Friends of the Bay Mission Statement as of 2005

[2] 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

[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

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[7]
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 estuary including water temperature, clarity, salinity, dissolved oxygen, nitrogen, enterococci bacteria, and fecal coliform bacteria. Measuring these parameters enables Friends of the Bay to better understand changes within the local marine ecosystem. The design of the program was reviewed and approved by the EPA in May of 2006 through Friends of the Bay's *Open Water Body Water Quality Monitoring Program Quality Assurance Project Plan* (QAPP).

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

This Annual Water Quality Report summarizes the data collected during the 2006 monitoring season. This report was produced in 2007 as part of Friends of the Bay's continuing commitment to study the complex forces that impact water quality within the estuary and the surrounding watershed.

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

1.0 MONITORING PROGRAM

Every Monday morning from April through October 2006, Friends of the Bay staff and dedicated volunteers collected data on water quality and ambient conditions at 19 sites throughout the estuary complex. The parameters measured by Friends of the Bay included dissolved oxygen, salinity, water temperature, water clarity, coliform bacteria, and nitrogen species.

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

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

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

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

1.1 Monitoring Locations

Friends of the Bay monitored a total of 19 sites throughout the Oyster Bay/Cold Spring Harbor estuary, including Locations FOB #5 – FOB #12 in Oyster Bay Harbor, Locations FOB #1 – FOB #4 in Cold Spring Harbor, and Locations FOB #13 – FOB #19 in Mill Neck Creek. A map identifying the approximate location of each site, as well as a table of coordinates (latitude/longitude) for each station are included in Appendix B. These station locations and identifiers were revised in 2003, so care should be used when comparing results from 2003 through 2006 to results presented in the 2002 monitoring report.

1.2 Monitoring Methods

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

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

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

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

- Bacteria - Water samples are collected by Friends of the Bay in sterile bottles approximately one foot below the water surface. The bottles, supplied by NCDH, 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 fecal coliform bacteria and enterococci in a water sample is expressed as the most probable number per 100ml (MPN/100ml). A trip blank, supplied by the NCDH laboratory, is used to ensure that proper temperature standards are met. It is placed in the cooler with the ice and, upon arrival at the NCDH laboratory; the trip blank temperature is immediately recorded. If the trip blank exceeds 10°C, NCDH laboratory personnel flag the results on the chain of custody form and then Friends of the Bay flags the data in the electronic database.

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

- Other Parameters - Other information collected at the sites include: the time the sample was collected; qualitative description of rainfall in the previous 24 hours; tidal stage (scale of 1-4), air temperature (°C); wind direction (1 of 8 directions); wind speed (estimated in 5-mph increments); wave height (subjective, on a scale of 0-5); weather conditions (on a predetermined 1-6 scale); water color (subjective color, e.g. yellow-brown), cloud cover (0-5 scale) and any unusual conditions (i.e., odors, fish kills, debris).

1.3 Quality Assurance and Control

The 2006 season was the first in which Friends of the Bay implemented a QAPP that was prepared for the project. The QAPP was prepared with assistance from Fuss & O'Neill, approved by EPA, and was implemented by Friends of the Bay in June 2006. Friends of the Bay performed many of the tasks required by the QAPP in earlier years, but the QAPP provides a procedural framework to ensure that the data collected meets EPA standards. The QAPP includes:

- Formalized monitoring locations and standard parameter list.
- Defined sampling analysis procedures.
- Required collection of duplicate samples.
- Validation of field data through calibration checks and validation with other measurement methods.

The QAPP can be viewed at Friends of the Bay's office in Oyster Bay.

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 24 monitoring dates (19 Mondays, 3 Tuesdays, and once each on a Wednesday and a Friday) from April through October, 2006. Four sites are located in Cold Spring Harbor, eight are located in Oyster Bay Harbor, and seven are located in Mill Neck Creek. Data collected during this season was analyzed both spatially (differences between areas in the estuary) and temporally (changes throughout the season) and compared to results recorded during previous seasons. A more extensive analysis of data collected during several monitoring seasons is planned for the future. The estuary was considered as a whole, and in terms of the three primary water bodies that compose the estuary: Cold Spring Harbor (monitoring locations FB-1 through FB-4), Oyster Bay Harbor (FB-5 through FB-12), and Mill Neck Creek (FB-13 through FB-19).

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

2.1 Physical Parameters

Salinity, water temperature, air temperature, and water clarity were measured at each sampling station throughout the season. These physical parameters can impact environmental and ecological conditions within the estuary. Figure 1 shows data averaged by sampling season (April through October) for parameters monitored in Oyster Bay during 2000 through 2006.

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

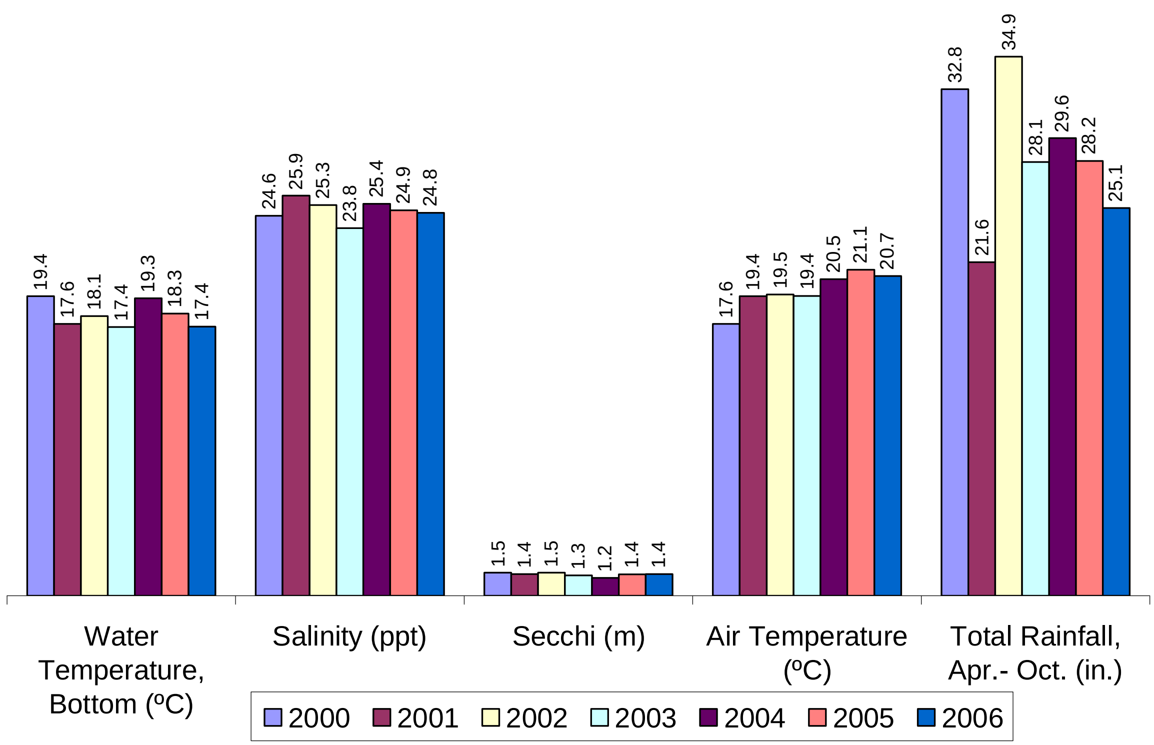

Figure 1. Physical conditions in the Oyster Bay/Cold Spring Harbor estuary for seven monitoring seasons

The seasonal average value for each physical parameter measured by Friends of the Bay in 2006 was within the range of values from previous years. Average bottom water temperatures measured within the estuary were lower than each year except 2003; 17.4ºC was recorded in 2006, whereas the range of values from 2000 through 2005 is 17.4 to 19.4ºC. Cooler temperature waters allow for higher dissolved oxygen levels. These differences are small, however, and would not have a significant impact on dissolved oxygen solubility. It is also notable that the monitoring season begins on different dates from year to year; in 2004, a year of relatively high average water temperature (25.4 ºC), the monitoring season began on the first Wednesday in May, whereas the April start of the 2006 season causes more days with early spring temperatures to be included in the dataset, bringing down the average.

Average air temperature recorded during monitoring in 2006 were near the upper limit of average values recorded in previous years, at approximately 1ºC above 2001 through 2003 levels and 3ºC above 2000 levels. However, the 2006 average is similar to averages from 2004 and 2005.

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 2006 were similar to levels recorded in 2000 through 2005 (measurements range from 24.6 to 25.9 ppt during 2000 through 2002 and 2004 through 2005), and are higher than the unusually low levels recorded in 2003 (23.8 ppt). These differences in salinity are also unlikely to significantly impact dissolved oxygen levels in the estuary.

Rainfall recorded during the 2006 season in the vicinity of the estuary was lower than most of the other seasons of record. At Levittown, Long Island, 25.1 inches of precipitation fell in 2006, whereas the average of seasonal precipitation from 2000 through 2005 was 29.2 inches. However, 2006 was not exceptionally dry; in 2001, only 21.6 inches of precipitation fell during the monitoring season.

Figure 2 presents the 2006 Secchi disk depth results as averaged for Mill Neck Creek, Oyster Bay Harbor, and Cold Spring Harbor for each week in the monitoring season when data was collected. Average Secchi disk depths for these areas were 1.08, 1.64, and 1.47 m, respectively. Mill Neck Creek is generally less clear than Oyster Bay Harbor and Cold Spring Harbor, possibly a result of increased biological activity due to it shallow depth, marshy areas, and close proximity to tributary discharges. Secchi disk depths were variable throughout the season, and it is difficult to discern any trends (e.g., in several previous years, such as 2003 and 2004, clarity generally increased during the season).

Measuring Secchi disk depth is an indication of water clarity. Light that penetrates the surface of the water passes through the water column, reflects off the disk, and passes back through the water column to the eye of the observer. The Secchi disk depth is the depth where enough light is scattered (by objects, such as sediment particles) or absorbed (by being converted to heat or chemical energy, such as by algae) within the water column that the light reflected by the disk can no longer return to the surface. Dissolved solids, particulate solids, algae, and other biota can impact clarity in a water column. Secchi disk depths in the Oyster Bay/Cold Spring Harbor 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 to be caused by algal growth fueled by nitrogen inputs to the bay.

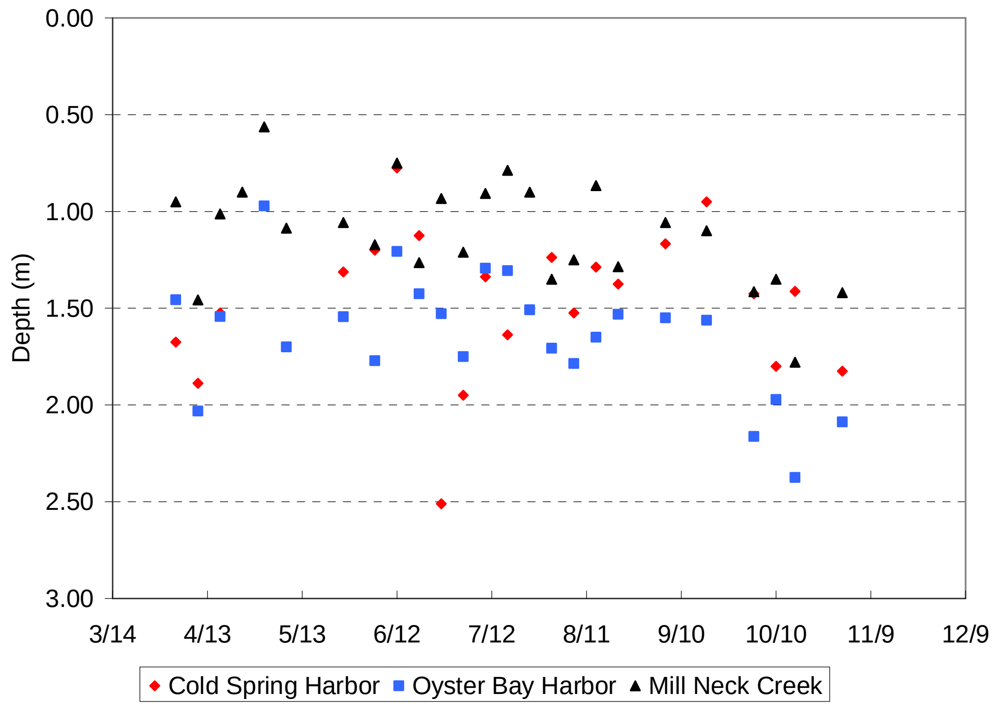

Figure 2. 2006 Secchi disk results, averaged locationally

2.2 Bacteria

Bacteria are ubiquitous in the environment. Certain types, however, can be used to indicate the possible presence of human pathogens. Common environmental indicator bacteria include fecal and total coliform and enterococci. 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 discharges. The New York Code of Rules and Regulations (NYCRR) specify 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.

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

Friends of the Bay collected bacteria data during 24 of the 31 weeks during the 2006 monitoring season. The completeness of monitoring runs, calculated by dividing the number of runs performed (23 in 2006) by the number of possible runs (31 in 2006) and expressed as a percent, is 77%[9]. In comparison, completeness of monitoring runs in 2003, 2004, and 2005 was 81%, 88%, and 96%, respectively. As a result, it is possible that the missed weeks in 2006 could affect comparison of the data to prior years, especially since several of the runs were cancelled due to inclement weather, when bacteria loadings to the estuary could be elevated. However, the cancelled weeks were generally in late April and May, and late August and September. These are times of year when bacteria levels in the estuary are generally lower; peak bacteria levels in the estuary generally occur in July based on observations from 2000 through 2005.

Table 1 summarizes shellfish standards for total and fecal coliform bacteria that are enforced by New York State (NYS). In 2004, new beach closure standards were implemented that are based on measured levels of enterococci, an alternate indicator bacteria, and fecal coliform (although a total coliform standard is still included). The new standards are summarized in Table 2.

Table 1. NYS Coliform Bacteria Standards

	Shellfishing *
Total Coliform	LOG AVG < 70 MPN/100ml and If < 10% of samples do not exceed 230 MPN/100 ml
Fecal Coliform	LOG AVG <14 MPN/100 ml and If < 10% of samples do not exceed 43 MPN/100 ml

* 6 NYCRR §47.3

Table 2. NYS Coliform Bacteria Standards, effective 2004

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

†10 NYCRR Section 6-2.15 - Water quality monitoring

[9] Completeness is typically calculated as the number of total datapoints collected divided the number of datapoints planned. However, completeness calculated in this manner is less meaningful for Friends of the Bay, since several monitoring locations cannot be sampled under certain tidal conditions.

Fecal coliform and enterococci levels were measured and reported at all nineteen locations during the 2006 monitoring season. Fecal coliform has been measured by Friends of the Bay since the inception of the monitoring program, while enterococci has been measured since 2004.[10] Samples were collected for enterococci as well, but a different laboratory method was used in 2004 than in 2005 and later. The method used in 2004 resulted in elevated values compared to these later years, so 2004 enterococci results are not included for comparison in this report.

Table 3 presents a summary of the season's bacteria results compared to the New York State Shellfishing Standards presented in Table 1. Although only fecal coliform data was collected in 2006, in earlier years of the monitoring program, total coliform exceedances were generally accompanied by exceedances in fecal coliform as well, so the results are not likely to be significantly different if total coliform data was also collected.

Table 3. Comparison of 2006 Monitoring Results to State Shellfishing Standards

Station	Fecal Coliform Seasonal Geomean	Fecal Coliform 90th Percentile	Location
FB-1	43.9	380.0	CSH
FB-2	24.1	251.0	CSH
FB-3	8.7	66.8	CSH
FB-4	2.6	10.4	CSH
FB-5	1.6	5.0	OBH
FB-6	1.4	4.0	OBH
FB-7	5.3	28.6	OBH
FB-8	3.7	14.0	OBH
FB-9	2.6	7.4	OBH
FB-10	15.3	67.0	OBH
FB-11	2.5	8.8	OBH
FB-12	2.0	9.6	OBH
FB-13	12.5	57.8	MNC
FB-14	16.5	80.7	MNC
FB-15	32.6	250.0	MNC
FB-16	20.7	228.0	MNC
FB-17	19.2	192.0	MNC
FB-18	4.9	26.6	MNC
FB-19	6.7	40.0	MNC
Shellfish Standard	14	43	

Bacteria levels exceeded the fecal coliform standard at FB-1, FB-2, FB-3, FB-10, FB-13, FB-14, FB-15, FB-16, and FB-17. These results are encouraging, since the majority of Oyster Bay Harbor met the standard for fecal coliform (FB-1, FB-2, and FB-3 are located in Cold Spring Harbor, FB-10 is located near Beekman Creek, and FB-13, FB-14, FB-15, FB-16, and FB-17 are located in Mill Neck Creek). Oyster Bay Harbor is where the majority of shellfishing

[10] The NCDH laboratory, which performs bacterial analysis for Friends of the Bay, changed analysis methods from the 2004 to 2005 season. As such, data from 2004 is not comparable to data from later years.

occurs in the estuary. In 1983, the New York State Department of Environmental Conservation closed Mill Neck Creek to shellfishing due to the elevated coliform bacteria levels found there, which is likely to be a result of the sewage overflows from "The Birches" (also known as Continental Villa) housing development in Locust Valley that have plagued Mill Neck Creek.

Figure 3 and Figure 4 present seasonal geometric means (i.e. May through October) for fecal coliform and enterococci, respectively, for each of the estuary's embayments. A slight decrease occurred in fecal coliform geometric mean levels measured in Mill Neck Creek, Oyster Bay Harbor, Cold Spring Harbor as compared to 2005. A slight increase in enterococci geometric means occurred in Cold Spring Harbor and Mill Neck Creek as compared to 2005. However, the differences in both parameters were small and are likely not indicative of a trend.

In Cold Spring Harbor and Oyster Bay Harbor the 2005 and 2006 fecal coliform seasonal geometric means were comparable to the 1982 through 1991 geometric mean, and geometric means from 2000 through 2002. It is unclear why levels in 2003 and 2004 were elevated. Similarly, fecal coliform geometric means in Mill Neck Creek were generally lower than in previous years. Note that in 2001 and prior, fewer locations were sampled by Friends of the Bay, so locationally averaged data cannot be directly compared. Although the shellfish and swim standards are included on the figures, the locationally-averaged geomeans cannot be used to directly determine compliance with the standards.

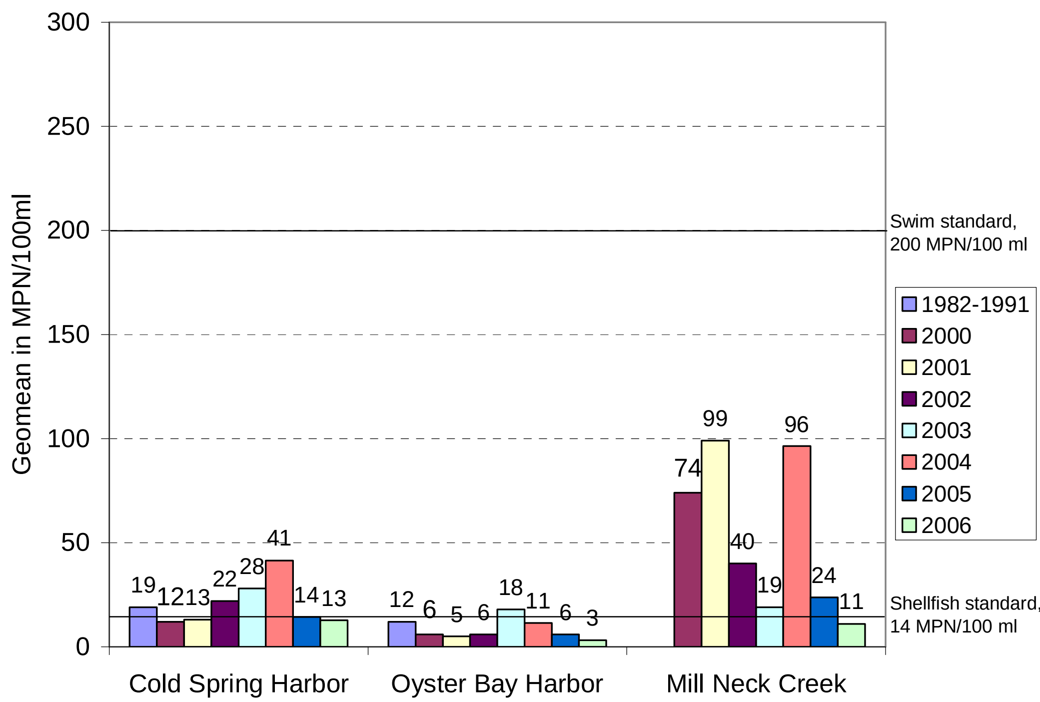

Figure 3. Seasonal geomeans of fecal coliform data by location

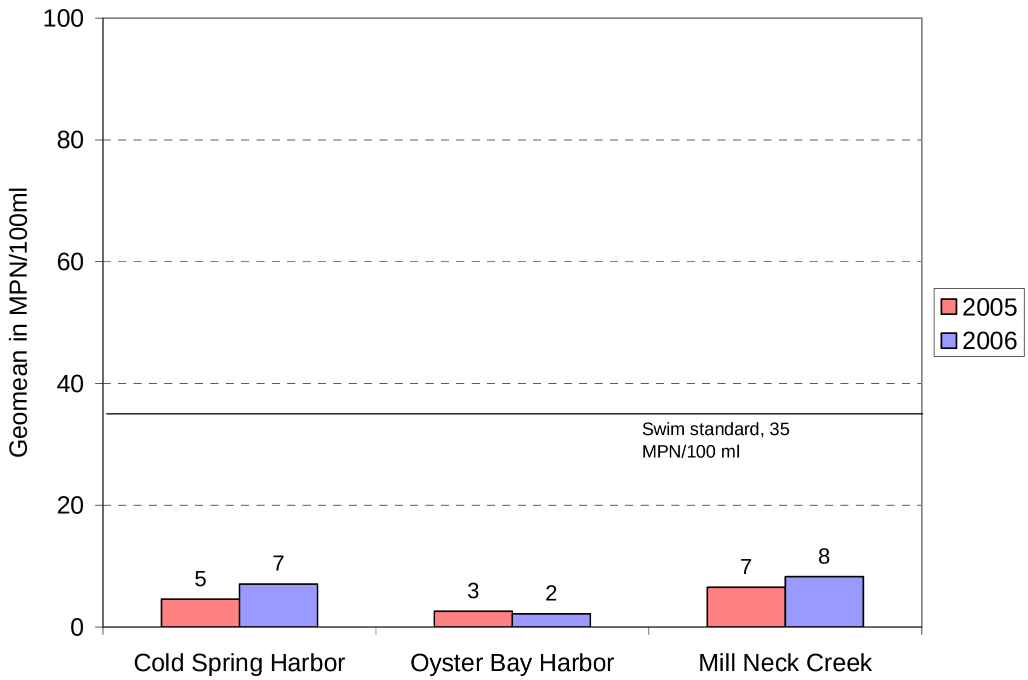

Figure 4. Seasonal geomeans of enterococci data, by location

Figure 5 presents total monthly precipitation as recorded at a precipitation station in Levittown (data was not available from the Muttontown station that was used as a data source in prior reports). Total monthly precipitation during 2006 was relatively evenly distributed. Precipitation quantities ranged from 2.4 inches in September to approximately 4.5 inches in July. Distribution of precipitation through the monitoring season is important since stormwater runoff can transport bacteria pollution to receiving waters.

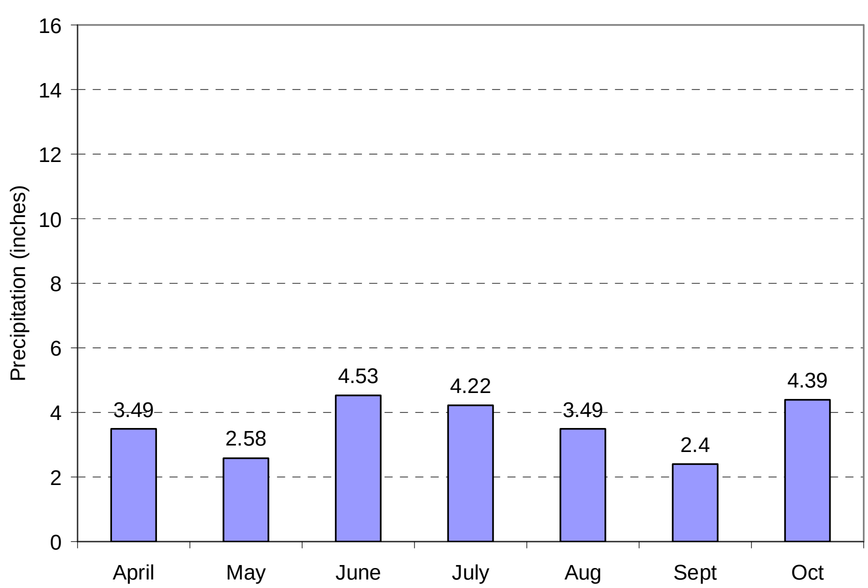

Figure 5. Precipitation recorded at Levittown, Long Island

2.2.1 Cold Spring Harbor Results

Four stations were monitored for coliform bacteria in Cold Spring Harbor in 2006. Figure 6 and Figure 7 present the 2006 total and fecal coliform 30-day running bacteria geometric means for each station. In some cases, fewer than two samples were collected in the preceding 30-day period, so some breaks in the line are present.

The results for shellfishing agree with those presented in Table 3; only one station in CSH (FB-4) complied with the fecal coliform NYS shellfish geometric mean standard for the duration of the season. The other three stations failed to comply with this standard for both total and fecal coliform bacteria for portions of the monitoring season.

FB-3 and FB-4 met both the fecal coliform and enterococci geometric mean components of the swim standards for the season, and FB-1 and FB-2 only exceeded the standards during a few weeks in August. No fecal coliform samples at the Cold Spring Harbor locations exceeded 1,000 MPN/100 mL swim standard. However, the 104 MPN/100 mL single sample standard for enterococci was exceeded twice at FB-1 and once at FB-2. These results would have resulted in beach closures.

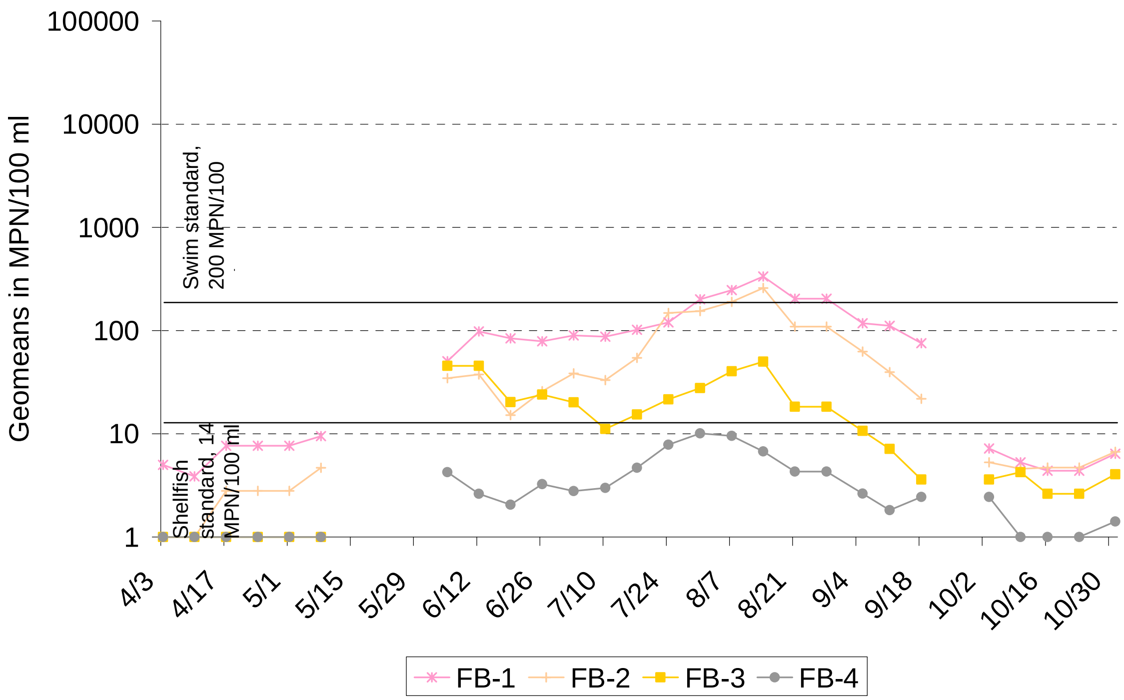

Figure 6. 30-day running geometric mean of 2006 Cold Spring Harbor fecal coliform samples

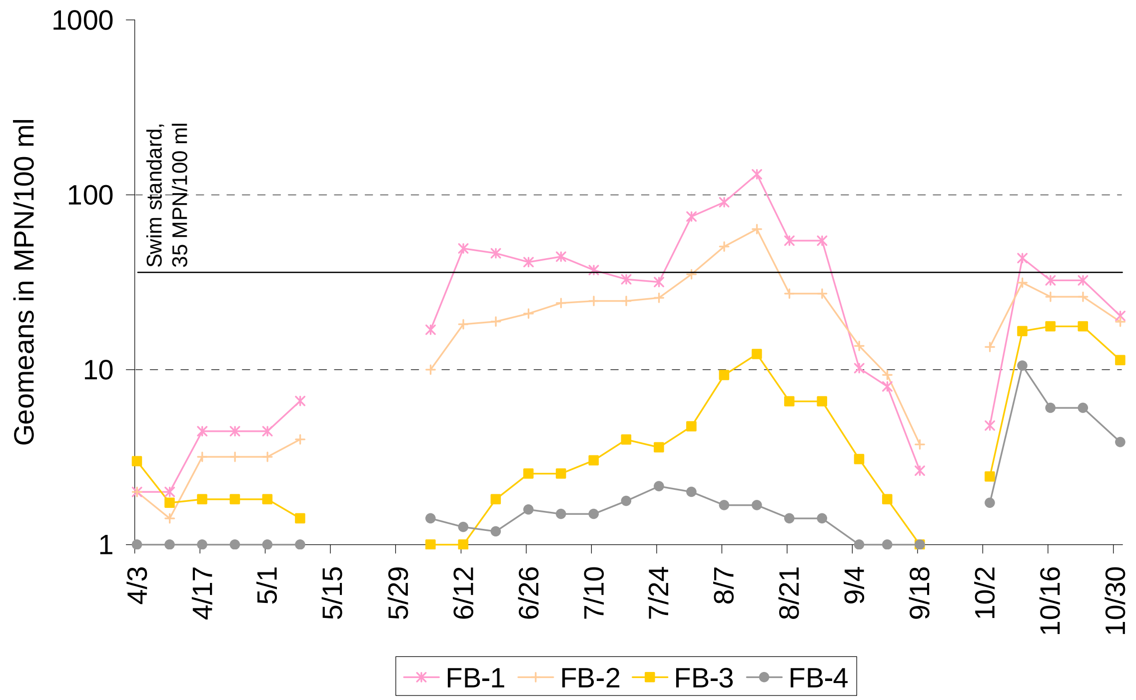

Figure 7. 30-day running geometric mean of 2006 Cold Spring Harbor enterococci samples

2.2.2 Oyster Bay Harbor Results

A total of eight stations were monitored for coliform bacteria in Oyster Bay Harbor in 2006. As shown in Figure 8 and Figure 9, the geometric mean of fecal and total coliform results at all but two stations (FB-7 and FB-10) met the geometric mean component of the NYS water quality criteria for shellfishing for the season. FB-7 only exceeded the standard for several weeks in September, while FB-10 exceeded the standard for the June through early September.

The single sample exceedance levels of 1,000 MPN/100 mL for fecal coliform and 104 MPN/100 mL for enterococci were not exceeded at FB-5 through FB-12 in 2006. Although the running 30-day fecal coliform geometric mean standard (200 MPN/100 mL) was not exceeded for fecal coliform, the 30-day enterococci geometric mean standard (35 MPN/100 mL) was exceeded at FB-10 in parts of June and October.

Bacteria levels were elevated at FB-10, for both fecal and total coliform. The cause of these elevated levels is unclear. However, this site is located near the outflow of the Mill Pond, which supports a substantial population of waterfowl, and Beekman Creek, which discharges to Oyster Bay Harbor via the Mill Pond outflow. It is possible that either of the outflows or the waterfowl population is contributing to elevated bacteria levels.

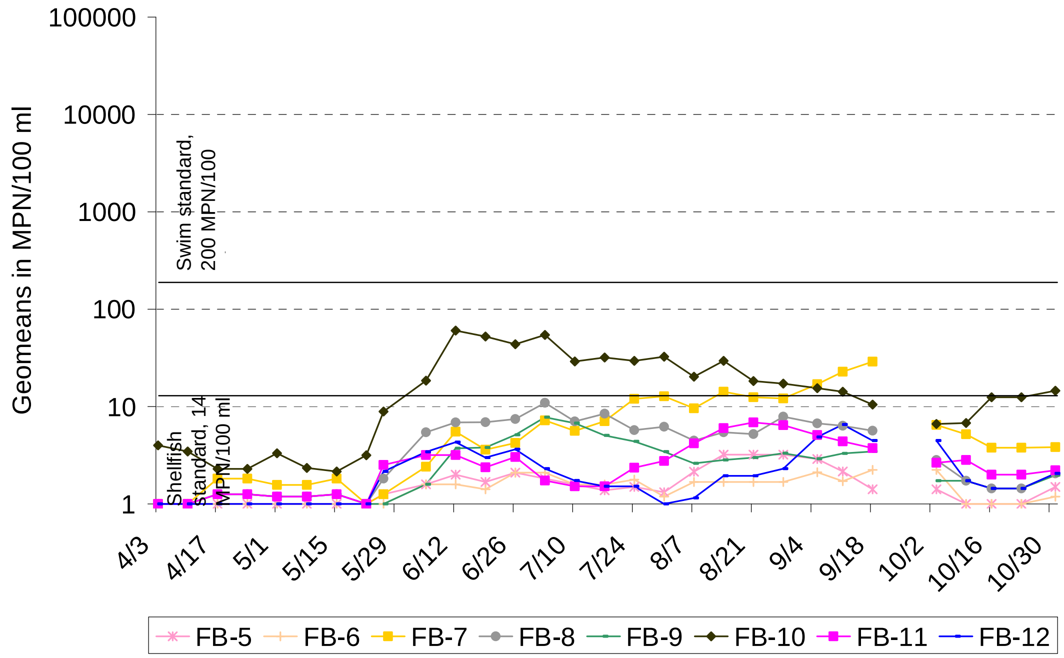

Figure 8. 30-day running geometric mean of 2006 Oyster Bay Harbor fecal coliform samples

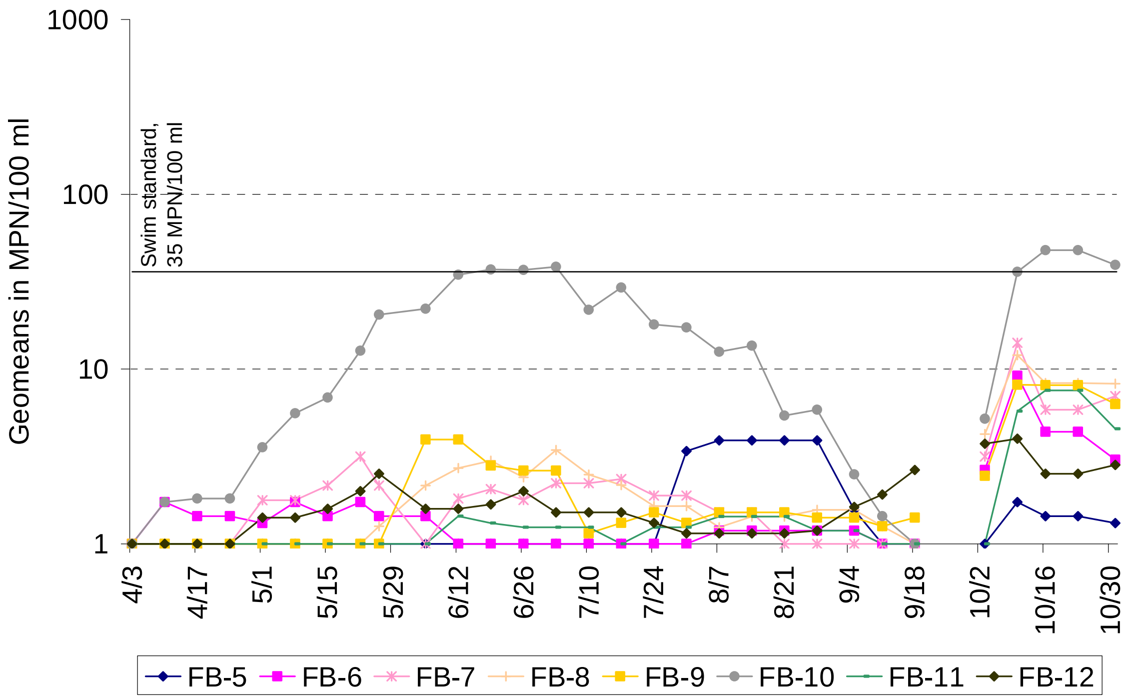

Figure 9. 30-day running geometric mean of 2006 Oyster Bay Harbor enterococci samples

2.2.3 Mill Neck Creek Results

In 2006, seven stations were monitored in Mill Neck Creek for fecal coliform and enterococci, and monthly geometric means were calculated for the data. Figure 10 and Figure 11 present the results of this analysis.

FB-15, FB-16, and FB-17 are difficult to monitor since low tidal conditions often prevent access; FB-15, FB-16, and FB-17 were only successfully sampled on 45%, 48%, and 42% of the monitoring events during 2006, respectively. Therefore, the analysis is based on a much smaller pool of data, which may affect the analysis of the resulting data. In general, sample collection at these sites was consistent; samples were collected at each location at least once a month during the monitoring season.

None of the Mill Neck Creek locations met the geometric mean component of the State shellfishing standards for the entire monitoring season. Locations FB-14, FB-15, FB-16, and FB-17 did not meet the geometric mean component of the State swimming enterococci standard for the majority of the season as well. Locations FB-14 and FB-19 were the only location that met the fecal coliform geometric mean swim standard, but not the enterococci standard. Although none of the Mill Neck Creek monitoring locations exceeded the single sample fecal coliform standard, locations FB-14, FB-16, and FB-17 exceeded the standard one time each and location FB-15 exceeded the standard twice.

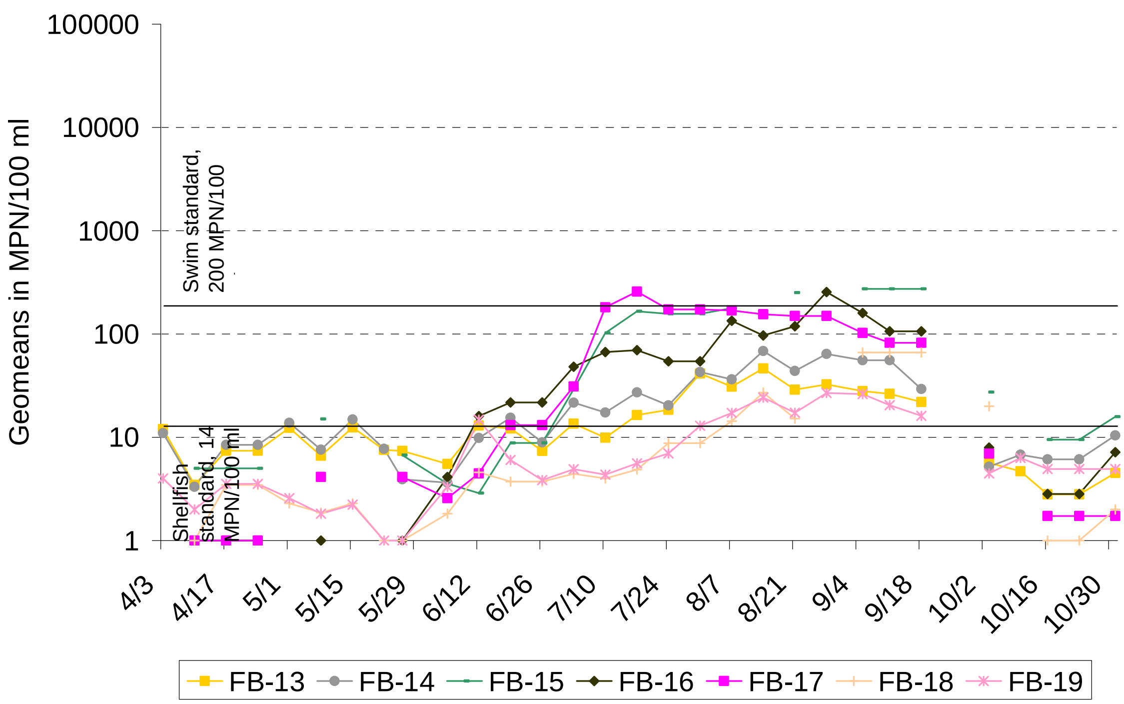

Figure 10. 30-day running geometric mean of 2006 Mill Neck Creek fecal coliform samples

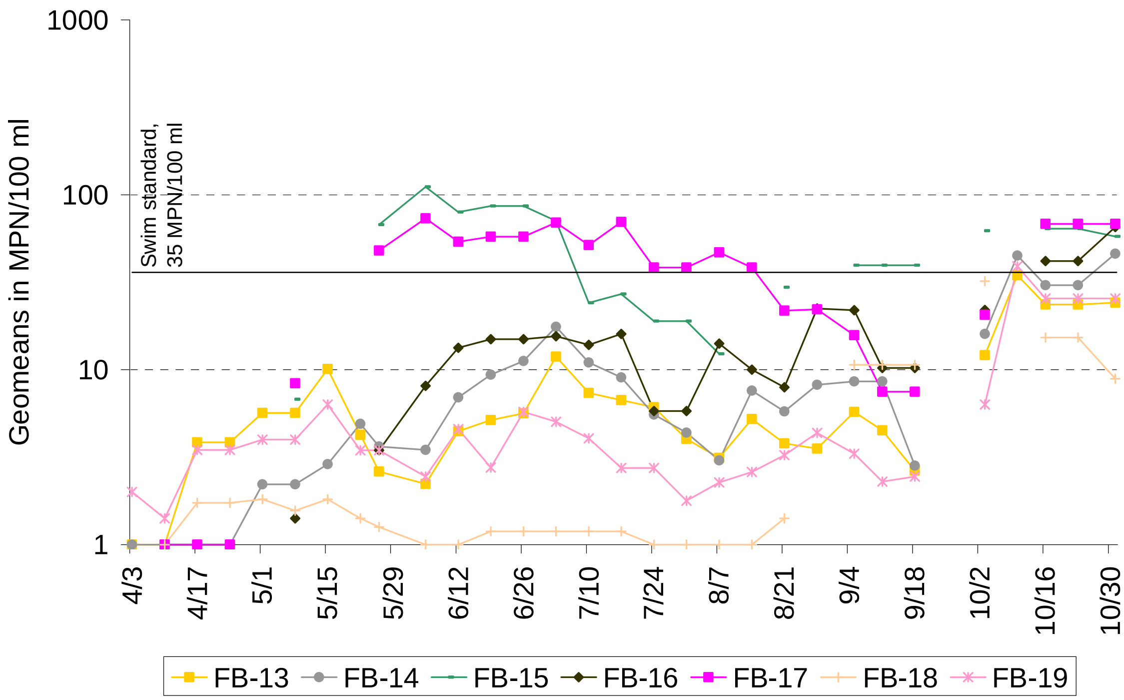

Figure 11. 30-day running geometric mean of 2006 Mill Neck Creek enterococci samples

An unusual trend appears to be present in enterococci data collected at FB-15 and FB-17. At these locations, peak 30-day geometric mean results occurred in late May and early June, while at the other Mill Neck Creek locations, results generally increased throughout the monitoring season, and the highest levels were measured in October. This result was not observed in the fecal coliform 30-day geomeans for these locations, which followed similar trends to results from the other locations. However, since these locations were monitored less than the other locations due to tidal conditions, it is unclear if these trends are significant. It is notable that FB-17 is the closest location to the untreated sewage discharge from the Birches, which could account for the high levels. Additionally, both FB-15 and FB-17 are located in tidal flats that could accumulate bird droppings during periods of low tide.

2.3 Nutrient Enrichment by Nitrogen

2.3.1 The Nitrogen Cycle

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

A common rule of thumb is that the ratio of nitrogen to phosphorus in biomass is approximately 7 to 2. This means that, if the nitrogen concentration divided by the available phosphorus is less than 3.5, biological growth will be limited by the amount of nitrogen (Chapra 1997) in the water. If this ratio is greater than 3.5, then phosphorus will limit biological growth (other nutrients, such as silica, are known to limit growth as well in less common instances).

In marine ecosystems, such as the Oyster Bay/Cold Spring Harbor complex, phosphorus is generally abundant. The amount of biological growth that occurs is directly related to the amount of nitrogen that is present in the water. For this reason, Friends of the Bay monitors nitrogen parameters in the estuary.

Several algal blooms may occur during the year, depleting the nutrient concentrations within the water column. When the nutrients are depleted, phytoplankton populations die off and sink to the bottom, contributing to large amounts of organic matter in the water column. This organic matter decays while sinking and is further decomposed by bacteria in the estuarine sediments.

While decomposing dead phytoplankton, bacteria consume oxygen. This depletion of oxygen may result in hypoxia (DO less than 3 mg/l) at the harbor bottom. Typically, hypoxia occurs in summer, when the water column stratification hinders oxygen replenishment in deep water.

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

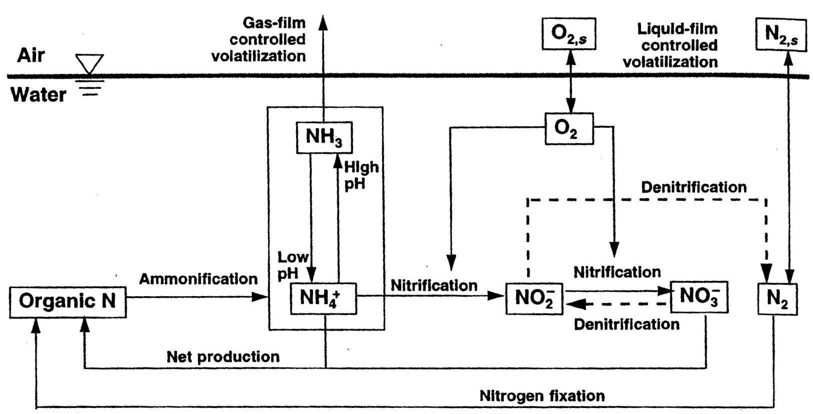

Figure 12. Nitrogen species and processes in marine environments (Source: Chapra 1997)

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

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

2.3.2 Nitrogen Criteria and Standards

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

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

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

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

With the intent of reducing nitrogen discharges into Oyster Bay and Long Island Sound, the Oyster Bay Sewer District began construction of a nitrogen removal process for its wastewater treatment plant in 2004. The plant was fully operational in March of 2006 and has reportedly reduced the nitrogen concentration in the treated wastewater discharge by up to 75%.

2.3.3 Monitoring Results

FOB began monitoring nitrogen in 2002 with the goal of establishing a baseline of data and identifying possible areas of concern in the estuary. In 2006 FOB monitored three species of nitrogen at nineteen sites in the Oyster Bay estuary, including ammonia-N, nitrate/nitrite-N and TKN. Samples were collected approximately once per month as scheduled. From these analyses, Organic Nitrogen levels (TKN minus ammonia) and total nitrogen (i.e., TKN plus nitrate and nitrite) can be calculated.

Figure 13 shows averages of nitrogen species for the monitored stations. Following the NYS DEC guideline for the Peconic Bay estuary, all of the Cold Spring Harbor, Oyster Bay Harbor, and Mill Neck Creek monitoring locations would have exceeded the total nitrogen seasonal mean of 0.5 mg/l in 2006. By comparison, in 2002, 2003, 2004, and 2005, 17, 11, 12, and 19 locations, respectively, would have exceeded the standard.

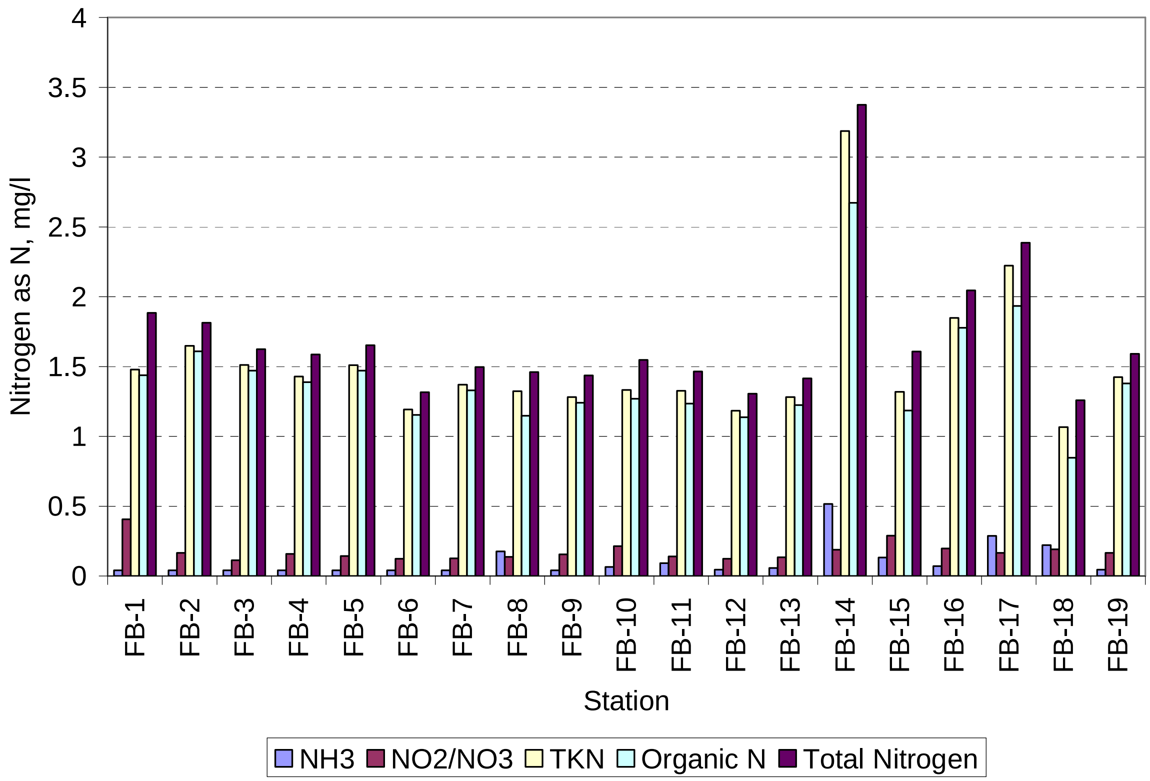

Figure 13. Seasonal average nitrogen species results for 19 stations in the Oyster Bay/Cold Spring Harbor Estuary

Organic-N is typically present in larger quantities in the Oyster Bay/Cold Spring Harbor estuary waters than ammonia and nitrate plus nitrite, generally accounting for more than 50% of total nitrogen at the sites that FOB monitors. In 2006, organic nitrogen accounted for more than 80% of total nitrogen at many locations. The highest organic nitrogen seasonal averages were in Cold Spring Harbor and Mill Neck Creek, where organic nitrogen levels approached or exceeded 1.5 mg/L. At FB-14, organic nitrogen levels exceeded 2.5 mg/L. Organic nitrogen levels in Oyster Bay Harbor were generally lower in concentration.

In general, ammonia and nitrate/nitrite levels were low compared to organic nitrogen levels. At FB-17, however, ammonia levels were elevated, likely due to the proximity of the sampling location to the Birches sewage discharge. At FB-14, average ammonia levels exceeded 0.5 mg/L, which could exceed the EPA ambient water quality criterion under certain conditions (Friends of the Bay does not monitor pH, so the criterion cannot be calculated).

Total nitrogen levels in Cold Spring Harbor, Oyster Bay Harbor, and Mill Neck Creek were significantly elevated as compared to previous years. Figure 14 presents seasonally and locationally-averaged total nitrogen data for seasons 2002 through 2006. Total nitrogen levels appear to have been increasing in the estuary since 2003. The elevated levels were described in Friends of the Bay's 2004 Water Quality Report, but nitrogen samples were only collected on two occasions in that year and the elevated results could not be verified.

However, in other years, a similar number of samples were collected, so the limited 2004 sample set is unlikely to significantly contribute the result. Figure 14 shows the number of nitrogen samples collected in each year. In general, 19 nitrogen samples are collected during one monitoring event per month, although weather and tidal conditions often reduce the number of samples that can be collected.

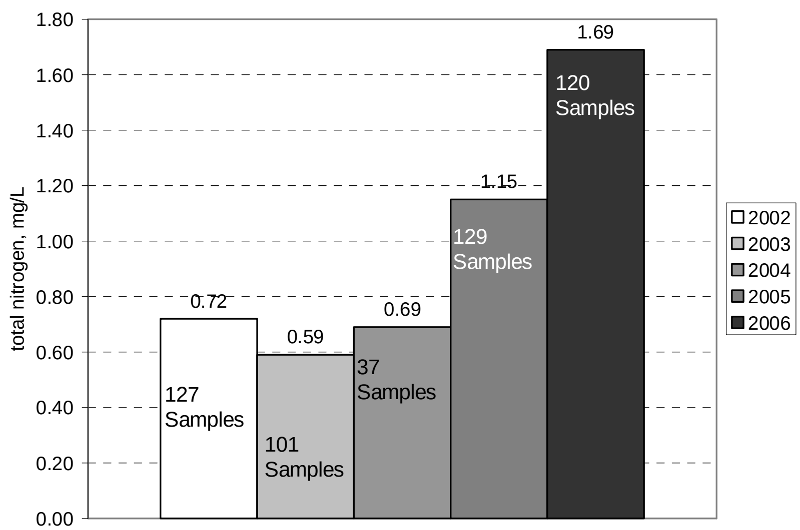

Figure 14. Seasonal averages for total nitrogen

The cause of this increase in nitrogen levels is unclear. Other water quality indicators monitored by Friends of the Bay did not show significant declines in water quality during this period. It is notable that ammonia and nitrate/nitrite levels were not elevated during 2006, although TKN levels were elevated, and organic nitrogen values were calculated from TKN values.

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

Table 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.
- 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 (DO) levels at the top and bottom of the water column at 19 sites in the Oyster Bay estuary. Unfortunately, during the monitoring season the Quanta instrument began to measure dissolved oxygen inaccurately during July. As a result, the instrument was returned to the manufacturer for repairs, and DO was not monitored when levels are typically the lowest. As such, the results for the season are not appropriately representative or complete for additional analysis. The problem with the instrument was identified by program personnel using their knowledge of typical conditions in the estuary and by implementing the program's quality assurance and quality control procedures presented in the program's QAPP. Figure 15 presents DO data collected at the bottom of the water column throughout the season.

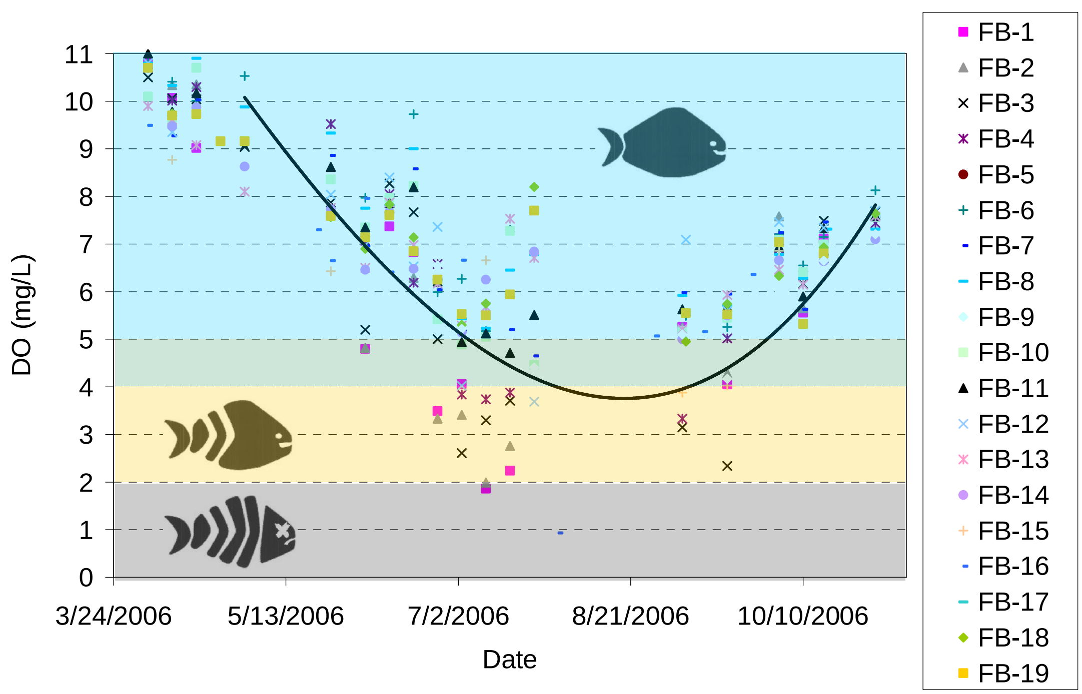

Figure 15. Dissolved oxygen time series plot for all monitoring locations. The black curve represents average bottom DO values from 2005

Also presented is a curve that was generated by a polynomial regression of average weekly DO results from 2005. It should not be interpreted as a model for the data shown, nor as values that occur throughout the season, but just as a visual representation of a trend that average DO values may follow.

The data that was collected in 2006 follows these general trends, with the highest DO values occurring in spring, levels declining through the early summer, and then rising again in late summer and into the fall. The high DO values for the weeks in late July were one of the indicators that suggested problems with the instrument.

While hypoxic and anoxic conditions are likely to have occurred in the Oyster Bay/Cold Spring Harbor estuary complex, based on past experience and the trends suggested by the data that was collected, it is important to remember that no fish kills were reported. As such, it is likely that the existing ecologic community has adapted to low DO levels, and that parameter levels did not deviate beyond typical ranges.. Low dissolved oxygen levels are a symptom of over enrichment by nutrients and not a problem that can be solved directly. Reducing nutrient inputs from the surrounding watershed into the estuary would likely improve water quality and could reduce the occurrence of low DO levels.

3.0 PROGRAM RECOMMENDATIONS

A. Proposed Changes to Monitoring Procedures

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

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

B. Take Action

Friends of the Bay should work to implement a Stream and Outfall Monitoring Program to monitor inputs from the watershed to the estuary, to identify potential sources of pollutants, and to provide a basis for assessing the impact of new local programs and development on the water body.

Friends of the Bay should also prepare a "State of the Watershed Report" for the Oyster Bay/Cold Spring Harbor estuary. This report would document an assessment of the existing environmental conditions in the watershed and represents the first step in the U.S. EPA's widely accepted "watershed approach" for the Oyster Bay/Cold Spring Harbor estuary. Once these conditions are assessed and documented, Friends of the Bay could then prepare a Watershed Action Plan for implementing positive change.

C. Continue Partnerships

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

We had a great volunteer base in 2006. Friends of the Bay volunteers have diverse backgrounds and hometowns. Among the careers represented are retired teachers, an automotive engineer, and a filmmaker. They come from as far as the south shore of Long Island and Huntington Harbor, and as close as Bayville and Oyster Bay. All are united in their intellectual curiosity and compassion for the environment.

In 2006, as in prior years, Friends of the Bay's Water Quality Monitoring Program was made possible by supporting members, businesses and volunteers. For example, partnerships with the Nassau County Department of Health, Frank M. Flower & Sons, Inc., and on boat-volunteers were invaluable this monitoring season. Additionally, the new partnership with South Mall Analytical Labs in 2002 enabled Friends of the Bay to test for nitrogen species, thereby establishing a nitrogen baseline to help identify trends and high nitrogen areas in the Oyster Bay/Cold Spring Harbor estuary.

Friends of the Bay has been assisted in water quality monitoring efforts by students and teachers from Locust Valley High School. During the 2006 season three students, supervised by their teacher, participated in monitoring during July and August. They used the data compiled by Friends of the Bay to develop their own research projects. Two other students, from Jericho High School and Oyster Bay High School, also participated in our program during 2006.

D. Look to the Future

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

- Long-Term Data Analysis - Friends of the Bay intends to perform an analysis of data collected by the program during the last several monitoring seasons. Such an analysis will be used to look for any long-term variations or trends in conditions within the estuary.

- Stationary Probes - Consider the installation of several stationary probes, perhaps one in Oyster Bay Harbor, one in Cold Spring Harbor, and one in Mill Neck Creek. Stationary probes will allow FOB to continuously monitor fluctuations of dissolved oxygen, salinity, and water temperature. Such an instrument would also allow FOB to identify how long the selected locations remain hypoxic and to compare dissolved oxygen readings with that of other stations.

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

- Chlorophyll a and/or algal enumeration - In addition to measuring apparent color, it would benefit the monitoring program to measure chlorophyll levels within the estuary. 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.

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 2006, four stations were monitored in Cold Spring Harbor, eight in Oyster Bay Harbor and seven in Mill Neck Creek. All waters in the Oyster Bay estuary need protection. However, based on bacterial and nitrogen monitoring results, additional management efforts should be focused on areas of concern such as Cold Spring Harbor, Mill Neck Creek/Beaver Lake and Oak Neck Creek.

Three major water quality parameters were monitored in 2006: bacteria, dissolved oxygen and nitrogen. Analysis of this season's data provided many useful insights into the estuary's water quality.

In 2006, bacterial levels were generally lower than 2004, when coliform bacteria levels were unusually high, and similar to 2005 levels. As observed in previous years, bacteria levels in Mill Neck Creek and Cold Spring Harbor were generally higher than in Oyster Bay Harbor. Locations FB-18 and FB-19 in Mill Neck Creek met the state shellfishing standard for fecal coliform on a geometric mean basis for the entire season, although the standard level was exceeded for a portion of August and September based on the 30-day running geometric mean.

The fifth year of nitrogen monitoring also suggested dramatic increases in nitrogen levels in the estuary in 2006, a trend that was first observed in 2004 and continued in 2005. None of the monitoring locations would have met the nitrogen standard for salt water that New York State applies to the Peconic Bay estuary, if that standard were to be applied to Oyster Bay as well. The cause of these increased levels is unclear and warrants additional study.

Construction and start-up is complete of the new $10.6 million advanced wastewater treatment facility serving the Oyster Bay Sewer District (OBSD). The plant went online in December 2005. Microorganisms used to seed the plant were delivered in mid-January 2006, and the plant was fully operational in March 2006. The facility, a Sequencing Batch Reactor, is already achieving the 2014 nitrogen limits imposed by the New York State Department of Environmental Conservation. The upgrade has reduced the daily nitrogen by as much as 75%.

With the completion of this plant the Friends of the Bay nitrogen data collected in 2002 through 2006 and subsequent years will provide a valuable baseline in evaluating the effect of reduced nitrogen loading on the estuary. The upgrade represents an important improvement in infrastructure available to the public, which should improve estuary water quality.

Dissolved oxygen data was collected throughout the Oyster Bay estuary during the monitoring season. In past years, DO trends indicate that the waters of the estuary are enriched with nutrients, since dissolved oxygen levels decrease steadily from spring through late summer, and then begin to increase in late summer. Nutrient enrichment can result from inadequately treated sewage discharges, polluted stormwater runoff, over-fertilization of lawns and gardens, agricultural runoff, and atmospheric deposition of air pollutants. Long-term reductions in nitrogen inputs should reduce the occurrence of extremely low DO conditions in the bottom of the harbor.

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

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APPENDIX A

OYSTER BAY/COLD SPRING HARBOR ESTUARY COMPLEX FACT SHEET

Post Office Box 564 ● Oyster Bay, NY 11771

Oyster Bay/Cold Spring Harbor Estuary Complex

Background Information

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

What is a Significant Coastal Fish & Wildlife Habitat?

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

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

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

What is a Regionally Important Natural Area?

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

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

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

Additional information:

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

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

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

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

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

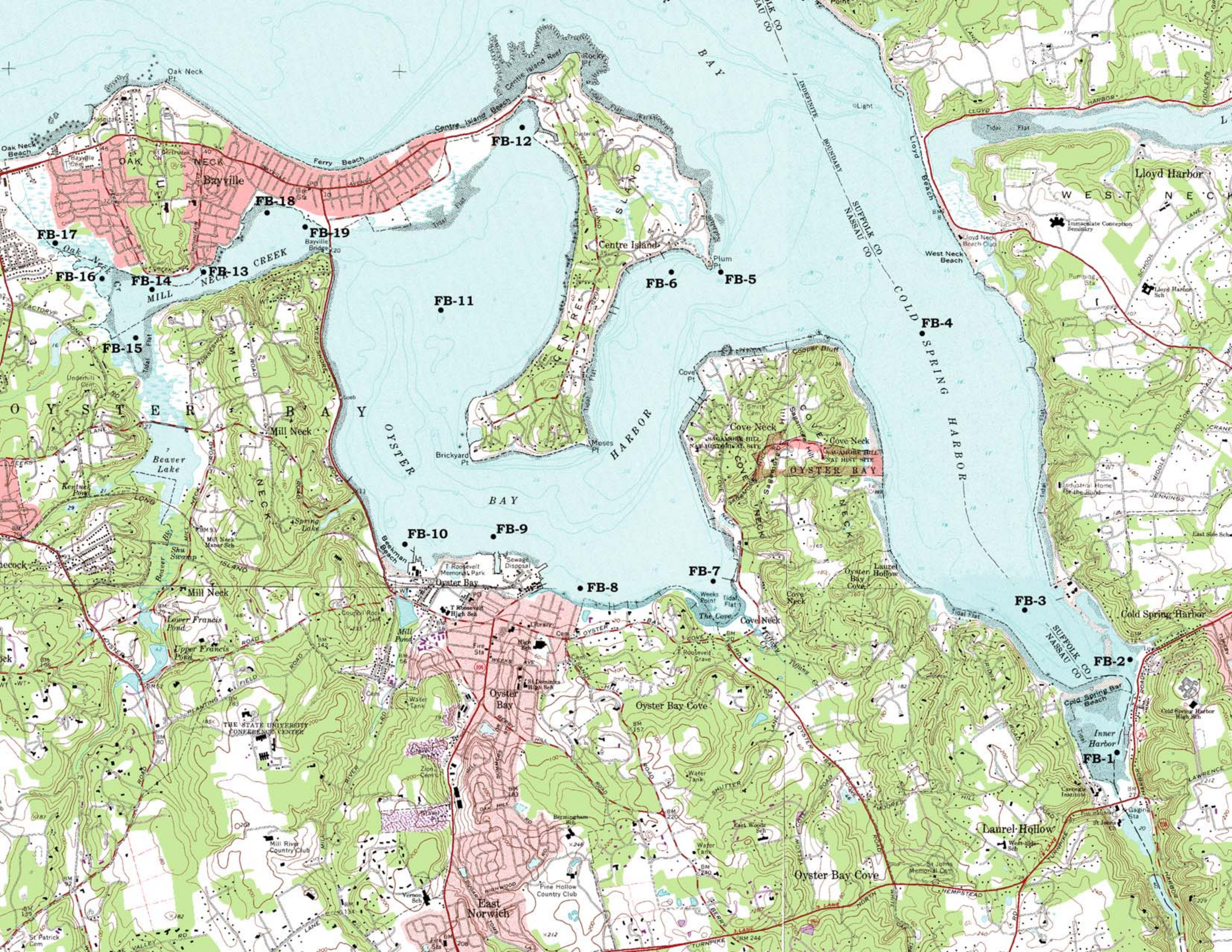
[16] *Pathogen Total Maximum Daily Loads For Shellfish Waters in Oyster Bay Harbor and Mill Neck Creek*, New York State Department of Environmental Conservation (September 2003) http://www.dec.state.ny.us/website/dow/oystbay.pdf

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

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

APPENDIX B

SAMPLING LOCATIONS MAP AND DESCRIPTION



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

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

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

File: Post2003site_numbers.xls

APPENDIX C

WATER QUALITY MONITORING DATA SHEETS

Friends of the Bay

Volunteer Water Quality Monitoring Data Sheet

DATE: ______________________________

Captain: ______________________________ Field Sampling Leader: ______________________________

Samplers: ____

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

Bacteria Sample Duplicate

GPS Reading: 40°______________ 073°______________

Nitrogen Sample Duplicate

DO Sample collected DO sample preserved

Rainfall in previous 24 hours: **0**= none **1**= light **2**= moderate **3**= heavy

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
	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**= North **2**= Northeast **3**= East **4**= Southeast **5**= South **6**= Southwest **7**= West **8**= Northwest
	Weather	**1** = fair **2** = partly cloudy **3** = cloudy **4** = rain **5** = snow **6** = fog

FIELD MEASUREMENTS

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

SECCHI DEPTH

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

COMMENTS

____

____

____

____

____

____

____

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APPENDIX D

TIDE TABLE FOR OYSTER BAY

TOWN OF OYSTER BAY
2006
NORTH SHORE HIGH TIDE TABLE

JUNCTION OF OYSTER BAY AND COLD SPRING HARBOR

John Venditto
Town Supervisor

Date of NEW MOON ______
Date of FULL MOON (shaded)

KEEP OUR WATERWAYS CLEAN

- * **Free Dockside Pumpout at Roosevelt and Tappen Marinas**
- * **Free Pumpout Vessel Service - Call on Marine Channel 9**

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

EASTERN STANDARD TIME
January 1 through April 1
October 30 through December 31

EASTERN DAYLIGHT SAVINGS TIME
April 2 through October 29

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.