WATER QUALITY IMPROVEMENT PLAN FOR HEMPSTEAD HARBOR NASSAU COUNTY NEW YORK

FINAL REPORT

Prepared for:

HEMPSTEAD HARBOR PROTECTION COMMITTEE

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Town of North Hempstead
Town of Oyster Bay
City of Glen Cove
Village of Sands Point
Village of Flower Hill
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Executive Summary

Encompassing over 5.1 square miles (mi^2), Hempstead Harbor is one of the major embayments of western Long Island Sound. Hempstead Harbor is recognized by the Army Corps of Engineers as one of the most commercially important Harbors of Long Island due to the combination of its size, natural resources, and extensive commercial and recreational uses. Unfortunately, Hempstead Harbor has had long standing water quality problems. The more obvious effects of these problems have been the closing or restricted harvesting of shellfish beds, beach closures, fish kills, algae blooms, and a decline in the Harbor's overall aesthetic attributes.

Most often, the occurrence of water quality problems, such as those that have been observed in Hempstead Harbor, can be traced back to the development of the surrounding watershed. The **watershed** can be defined as all the land, streams, wetlands and ponds that drain or flow to the Harbor. The watershed can be likened to a large funnel that collects rainfall and resulting runoff and channels it to a receiving waterbody; in this case Hempstead Harbor. The prevailing topography (the ridge lines and valleys) establish the overall boundaries of the watershed. The watershed may be further divided into **sub-watersheds**; smaller, topographically distinct drainage areas. Sub-watersheds usually have a distinct stream or wetland system that collects the runoff generated during storm events by the surrounding lands, and in-turn directs that runoff to the final receiving waterbody, in this case Hempstead Harbor. However, in some sub-watersheds, runoff may flow diffusely overland runoff or be conveyed via a series of storm drains to the receiving waterbody.

As a watershed becomes developed, factors that have direct impacts on water quality are often experienced. The conversion of forested lands, wetlands, and naturally vegetated areas to impervious surfaces (roads, rooftops, parking lots, and even lawns) decreases the opportunity for rainfall to percolate into the soils. This, in turn, increases the amount of runoff generated by every storm event. The added volume and associated energy of this runoff can cause the erosion of soil, the instability of steep slopes, and the gouging of streams.

Equally important, the additional runoff has the potential to mobilize greater amounts of pollutants, which can then become transported to the receiving waterbody. Due to their diffuse origin, these pollutants have come to be referred to as **Non Point Source (NPS)** pollution. Unlike **Point Source** pollution, which can be traced back to an easily recognized source, such as an industrial outfall or sewage treatment plant, NPS pollutants are much more ubiquitous being associated with such land use activities as farming, land clearing, lawn care, or road de-icing. Sources can be as diverse as septic system leachate, road runoff, roof top drainage, and pet feces. Unlike Point Sources, there are usually no distinct, well defined regulations or permit programs to limit or control the quality of NPS pollutant contributions.

As a watershed progresses from an undeveloped to a developed state, an increase in the generation of a greater array of NPS pollutants and toxins such as petroleum hydrocarbons, bacteria, heavy metals, nutrients, and pesticides, as well as sediments is experienced. Over time, the increased NPS pollutant load causes a decline in water quality. For Hempstead Harbor, this translated into the loss of recreational opportunities, the demise of a commercial shellfishery, and a decline in the aesthetics of this coastal waterbody.

Recently, some improvements of the Harbor's water quality was achieved through the re-routing of the Roslyn sewer treatment plant. Although this has helped, it did not cure all of the Harbor's problems. It was determined that in addition, aggressive action would need to be taken in respect to the control of NPS pollution. It was also recognized that coordinating NPS pollution control on a watershed scale can be difficult. As a result, the Hempstead Harbor Protection Committee (HHPC) was formed in 1995 via an inter-municipal agreement. Voting members of the HHPC are from Nassau County, the Towns of North Hempstead and Oyster Bay, the City of Glen Cove, and the Villages of Roslyn, Sea Cliff, Sands Point, Roslyn Harbor, and Flower Hill. State Senate and Assembly members whose districts are within the watershed are also represented on the Committee. The HHPC receives planning and environmental technical guidance from the professional representatives appointed from Nassau County, the New York Department of Environmental Conservation (NYSDEC), the New York State Department of State (NYSDOS), Division of Coastal Resources and the Project Coordinator. The Coalition to Save Hempstead Harbor is also represented on the HHPC.

The first major steps taken by the HHPC were to apply for State funding and obtain matching fund commitments from the member municipalities. An Environmental Protection Fund grant was awarded to the HHPC by NYSDOS to prepare a Water Quality Improvement Plan. The HHPC, in early 1996, hired a Project Coordinator, and prepared a scope of work for the development of the Water Quality Improvement Plan. The HHPC identified three desired objectives of the Water Quality Improvement Plan:

1. Investigate and quantify characteristics of the watershed that have contributed to the water quality degradation of Hempstead Harbor,

2. Examine the consistency, role and adequacy of existing regulations in the protection of the Harbor from future watershed development related impacts, and

3. Identify both planning and capital improvement projects that could be implemented over time to protect and restore Hempstead Harbor and properly manage its watershed.

Contained within this report is an analysis of the physical attributes of Hempstead Harbor and its watershed, a comprehensive review and interpretation of historical water quality data, quantification of pollutant loading contributions to the Harbor, review of the existing development regulations, and recommended management and restoration projects. Focus was clearly placed on the role of NPS pollution on the Harbor's historical, existing, and future water quality problems. In general, because of the typical lack of a technically sound, definitive NPS regulatory framework, it is NPS pollution that holds the greatest threat to the quality of Hempstead Harbor.

An extensive amount of effort was taken to review the voluminous amount of historical Hempstead Harbor water quality data that had been collected by various entities over the past 30 years. Where possible, trends were examined, problem areas noted, and data gaps identified. Based on observed data gaps and data collection needs, a recommended long-term monitoring program was developed for Hempstead Harbor.

A key element of the study, was the quantification of the Harbor's existing NPS pollutant load. The first step in the quantification process involved the use of Geographic Information System (GIS) methodology to interpret the land use and natural resource features of the watershed. Unit areal loading (UAL) pollutant modeling techniques were then used in conjunction with the GIS synthesized data to compute the annual influx of NPS pollutants contributed by each of the Harbor's major sub-watersheds. Steps were taken in the UAL modeling procedure to carefully select pollutant loading coefficients that were reflective of the Harbor's natural resource attributes, land use, and development intensity characteristics, thereby increasing the accuracy of the computed NPS loads. The modeling effort resulted in annual estimates of phosphorus, nitrogen, sediment, heavy metals and petroleum hydrocarbon NPS inputs to the Harbor. Although the resulting annual loads were considered representative of the yearly NPS pollutant influx, their accuracy was further improved by conducting a sensitivity analysis. The sensitivity analysis involved adjusting the raw UAL loads by accounting for background ("natural") pollutant inputs and the acreage of each subwatershed. Once the pollutant loads were adjusted accordingly, the sub-watersheds were then ranked in respect to their corrected NPS load to the Harbor. The top six sub-watersheds in descending order of NPS load contributions were:

Sub-watershed	**8**	**Sea Cliff**
Sub-watershed	**12**	**Roslyn West**
Sub-watershed	**11**	**Roslyn East**
Sub-watershed	**10**	**Flower Hill**
Sub-watershed	**2**	**Glen Cove South**
Sub-watershed	**3**	**Old Brookville**

Through the data analysis conducted as part of this study, a host of watershed-based causes for the Harbor's degradation were identified and, in most cases, subsequently quantified. In general, it was concluded that a three-phase approach must be taken to control existing and future NPS loading to Hempstead Harbor. Recommended management and restoration measures are discussed in detail in the report, together with the data and findings used to support these recommendations. In summary, in order to satisfy the Harbor's long-term water quality restoration and watershed management, a well orchestrated plan that contains the following elements is needed:

1. Public Education Initiatives,
2. Source Control Strategies, and
3. Delivery Control Strategies.

The following recommendations were made for the Hempstead Harbor Watershed:

Public Education:

Public education initiatives are designed to not only increase public awareness of NPS impacts on Hempstead Harbor, but to identify and implement "grass roots" type activities that actually decrease NPS contributions. Several studies have suggested that "grass roots" measures such as septic management and lawn care management can reduce a water body's pollutant load by as much as 30 to 35 percent. The key to achieving this reduction is to increase the public's understanding that they are largely the cause of NPS pollution to the Harbor, but through their efforts, significant decreases in pollutant inputs can be realized. The first step in this process is the education of the public. The HHPC, in recognition of the role of public education in the overall success of the Water Quality Improvement Plan, has already implemented such public education efforts as:

1. The educational/informational meetings that were conducted at key milestone dates during this project (October 1996 and June 1997)

2. The Long Island Sound Study/New York Sea Grant funded "The Harbor Starts Here" storm drain stenciling and volunteer training program.

The HHPC has also used press releases and public access television to relay the findings and recommendations of this project to the residents of the watershed. These and other similar types of out reach efforts should be continued. In addition, the HHPC should also conduct the following public education activities.

1. Publish a quarterly newsletter, designed to inform the public of on going projects and

initiatives.

2. Publish specific informational brochures that educate the public about “grass roots” NPS source pollution control techniques.

3. Develop of a Watershed Management Curriculum. The curriculum would be used by the local school systems to educate students about the ecology of Hempstead Harbor and the environmental consequences of improper watershed development.

4. Sponsor, coordinate and conduct an annual "Save the Harbor Day". Use such an event to focus attention on the management and restoration efforts of the HHPC. Include activities such as an interpretive nature walk, inspections of watershed management project sites, a shoreline clean-up and other similar types of field events.

Source Control:

Source control strategies are intended to decrease NPS loading, primarily through the use of regulations, laws and policy initiatives designed to reduce the generation of NPS pollutants. Source control strategies can also include educational programs, and site “housekeeping” techniques that are geared towards modifying public perceptions and habits concerning the creation of conditions that increase the opportunity for NPS pollution. The following source control strategies are recommended for use throughout the watershed, but on a site specific, as needed basis.

1. Minimize site disturbance and promote alternative, environmentally friendly landscaping techniques to decrease the potential for soil erosion, decrease pesticide and fertilizer use, and help conserve water.

2. Limit the use of fertilizers and pesticides at municipal fields, common areas, golf courses and other large intensively managed grassed areas by promoting integrated pest management (IPM). Central to the success of IPM as a source control strategy is the use of environmentally conservative methods to maintain pests below defined damage levels, the use of less mobile fertilizers, and the tolerance of less than ideal turf conditions. Limiting fertilizer and pesticide use is most important for properties within 300 feet of any stream, pond or wetland ecosystems, or immediately adjacent to the Harbor. Along with this, the HHPC should educate homeowners of the benefits of reduced fertilizer/pesticide use associated with indigenous (rather than exotic) groundcover and ornamental plantings. Similarly, homeowners should learn of the water conservation and pollutant transport reduction benefits of xeriscaping (use of drought tolerant plantings).

3. Decrease the overall use and insure the proper application of road salts and other de-icing

agents. Legal precedents exist for the implementation of such management practices especially around reservoirs, groundwater recharge areas, and other environmentally sensitive sites throughout the state. Options include minimizing salt applications on roadways that are not extensively utilized, maintaining stringent application controls on roadways immediately adjacent to the Harbor, conduct an aggressive Spring street sweeping program to collect and recycle sand, and consider the cost-benefits of using alternative de-icing products.

4. Institute a septic management ordinance that mandates the routine inspection and pump-out of septic systems for those sub-watersheds where septic systems are the primary means of wastewater renovation (Sea Cliff, Sands Point, etc.). It is recommended that inspections and pump-out be conducted once every three years. Along with this, implement a public education program that stresses the importance of septic management and introduces concepts designed to improve the operation and water treatment efficiency of septic systems. At the municipal and County levels, when evaluating options for the correction of failing systems or the construction of new systems in environmentally sensitive sections of the watershed, become increasingly receptive to the use of alternative on-site waste water renovation/treatment designs (e.g. RUCK systems, intermittent sand filters, recirculating sand filters, batch treatment systems). Where economically feasible, consider extending sewer service to these areas, thereby eliminating potential septic related problems.

5. Increase the consistency and level of environmental analysis associated with site plan, sub-division and land disturbance reviews. Some of the member municipalities of the HHPC currently have certain environmentally judicious development review or land use regulations. One regulation particularly lacking, is an ordinance requiring storm water quality management. In general, the existing policy environment is neither uniform in content nor in application, especially when viewed from a watershed perspective. A regional planning review process should therefore be developed, and along with this, the adoption of uniform site review, zoning, and/or land development ordinances. Since such efforts are not intended to usurp the powers of local or County government, the review process could initially be advisory and non-binding. Over time, as watershed specific ordinances or development policies are adopted, the planning process should evolve to that of a binding status. Since State, County and local representatives would be involved in both the development of the policies and their application, the power of the local boards would not be diminished. The HHPC should use the Chesapeake Bay Initiatives as a model for their efforts.

6. Promote the implementation of general maintenance activities which reduce the amount

of debris, litter and garbage that can be transported by storm water. Such "good housekeeping" practices can be very effective yet relatively inexpensive means of decreasing NPS pollution. This information should be disseminated to the public through brochures, newsletters, TV or radio public service announcements, and similar types of public education techniques. In addition, municipal oriented measures such as anti-litter patrols, street sweeping, cleaning drainage inlets of debris, and good solid waste collection and disposal methods should be promoted by the HHPC. Adopt a Highway programs are one example of this type of source control best management practice (BMP).

7. Prepare, pass and enforce a watershed-wide "pooper scooper" ordinance. Animal feces can contribute to the Harbor's nitrogen load, and in some cases can create localized bacteria contamination problems

8. Prepare, pass and enforce a watershed-wide ordinance that bans the feeding of waterfowl, especially Canada geese. To increase the public's acceptance of the importance of such an ordinance, an aggressive public education program will need to be implemented by the HHPC.

9. Increase the consistency, watershed-wide of ordinances or development regulations pertaining to sediment and erosion control, site clearing, stream corridor buffers, development on steep slopes or unstable soils, application of lawn fertilizers and pesticides (IPM), and the management of storm runoff from the perspective of enhancing water quality.

Delivery Reduction:

Delivery control strategies are those NPS pollution control measures and techniques with which most individuals are familiar. Typical delivery control techniques include storm water treatment basins, recharge basins, sand filters, water quality inlets and other similar structures designed to intercept and improve the quality of storm water before its ultimate discharge to Hempstead Harbor. Unlike the public education and source control practices recommended above, the implementation of delivery reduction BMPs could not be recommended on a global scale. Rather, they were recommended on a sub-watershed specific basis, as determined by the magnitude of the corrected NPS load, the prevailing conditions responsible for the NPS load, and the existence of natural or man-made conditions that could impede the implementation or operation of a certain type of delivery control technique. For a given site, the feasibility and utility of a specific delivery control BMP was determined on the basis of the pollutant loading data, the use of a BMP optimization procedure, and consideration of prevailing site conditions. The selected delivery control techniques have been proven in other applications to be capable of achieving measurable reductions in NPS loading.

The findings and recommendations of this study in respect to delivery control strategies are summarized as follows:

1. Those watersheds most in need of NPS management (as determined by the NPS load ranking analysis) are Sub-watersheds 8 (Sea Cliff), 12 (Roslyn West), 6 (Glen Cove South), 11 (Roslyn East), 10 (Flower Hill), and 3 (Old Brookville). With the exception of Sub-watershed 3, the other five Sub-watersheds are extensively developed and are characterized primarily by mixed residential/commercial land use.

2. Storm drains are found throughout these sub-watersheds, however there is no good, easily accessible record of their inter-connectivity. Although it is possible to identify the location of many storm water outfalls, it is difficult in many cases to identify the contributing catchment area. It is highly recommended that a comprehensive study of the drainage system be conducted, using a combination of Global Positioning (GPS) and Geographical Information System (GIS) to accurately locate, digitize and prepare a detailed, updated map of the watershed's storm water collection system.

3. For Sub-watersheds 1 (Locust Valley), 2 (Glen Cove North), 4 (Sands Point), 5 (Sands Point South), and 7 (Mott Point), all of which are located at the north end of the watershed where development is light, there does not exist a need at this time to engage in any significant delivery reduction activities.

4. Sub-watersheds 3 (Old Brookville) and 6 (Glen Cove South) are part of the Glen Cove Creek watershed. These Sub-watersheds include Cedar Swamp Creek and Mill Pond. The drainage infrastructure improvements needed for Sub-watershed 6 largely involve the removal of the existing storm water inlets (especially along Glen Cove Avenue) and their replacement with sediment sump type water quality inlets. The HHPC also should work closely with the City of Glen Cove, during the planned redevelopment of the Glen Cove Creek water front area ("Gold Coast"), to identify opportunities for the installation of sand filters in new or resurfaced parking areas and the construction of infiltration basins, created wetland basins, and other types of extended detention basins to better manage the quality of storm water runoff discharged to Glen Cove or the Harbor.

5. The City of Glen Cove is currently in the process of obtaining the necessary permits for the reconstruction of Mill Pond into an online wetland biofilter. Located in Glen Cove at the terminus of Cedar Creek, Mill Pond was at one time a highly functional on-line sedimentation/retention basin. The City of Glen Cove has developed recommendations for this pond's restoration as a water quality enhancement basin. The intent of this project is to intercept and pretreat the flow from Cedar Swamp Creek. This project should be viewed as one of the priority projects for the Hempstead Harbor watershed.

6. There are well over 50 storm drains that discharge into Cedar Swamp Creek from portions

of such heavily traveled roads as Northern Boulevard, Cedar Swamp Road (Route 107), and Glen Cove Road. The HHPC should upgrade the Cedar Swamp drainage collection system in concert with the construction of the Mill Pond biofilter. Specifically, basin upgrades appear warranted along Route 107/Glen Cove Road, from the intersection of Cedar Swamp Road and Glen Cove Road, north to its termination at Glen Cove Avenue. Basically, additional engineering design and analysis is required, but it appears that as many as 20 to 25 conventional storm inlets could be replaced with water quality or sediment catch basins along this stretch of the road way. Site inspections conducted during this study determined that many of the existing inlets were sediment filled or contained debris, leaf litter and evidence of petroleum hydrocarbons. In addition, few acted as more than a collection point for road runoff; basically concentrating runoff and directing it directly to Cedar Swamp Creek.

7. The top priority Sub-watershed 8 (Sea Cliff), could greatly benefit from drainage improvements to the storm water collection system that conveys drainage to Scudders Pond. Both the Nassau County data, and data presented in a recently published shoreline study of Sea Cliff, identify storm water drainage problems of significant magnitude that impact Scudders Pond. Scudders Pond and an upstream ancillary retention basin should therefore be dredged. A sediment trap should be installed at the point where storm water from Littleworth Lane is directed into the pond. This should be one of the HHPC's priority projects.

8. Also in Sub-watershed 8, the Nassau County outfall database has identified at least six major storm discharges to Motts Cove. As mentioned, there is also the need to upgrade the collection system to Motts Cove. A series of pipes, including a 60" outfall, discharge into this embayment. A long standing problem site for elevated bacteria, turbid conditions and floatables, the cove is further impacted by the fact that it is located south of Bar Beach in the more flow restricted section of the Harbor. Its ability to self-flush during tidal events is thus somewhat impeded by the sloughing of water within the lower Harbor.

9. A sandfilter, designed in accordance with the specifications of the State of Delaware (Shaver, 1993), is recommended for the Bar Beach Parking Lot (Sub-watershed 9, Port Washington). Although draining only a limited area (+/- 20 acres), runoff, which contains feces from shorebirds, is currently allowed to flow directly into the Harbor. Sediments, heavy metals and petroleum hydrocarbons are also transported with this runoff. A dual-chambered type of sub-grade device, sand filters have been shown to work extremely effectively in urban areas and small, highly impervious catchment areas. It is especially suited for use in parking lots. This project should be used as a model for other sand filter installations throughout the watershed.

10. Roslyn Pond and Silver Pond are two inter-connected waterbodies that receive the combined drainage from sections of priority Sub-watersheds 11 (Roslyn East) and 12

(Roslyn West). The ponds are in need of dredging. In addition, their shorelines require bank stabilization to correct erosion problems. The ponds would also benefit from such management measures as aeration (to improve water quality) and aquascaping (to enhance aesthetics and impede their use by geese). To mitigate the impacts of sediment and road runoff pollutant loading, it is recommended that a properly designed, multi-baffled sedimentation chamber be installed upgradient of Roslyn Pond, at the point where storm water is discharged to the pond.

11. Aquascaping along the shoreline of Roslyn Pond, if properly designed and implemented, could actually reduce the use of the pond by geese. Essentially, by creating a "natural" fence, by using a combination of emergent aquatic vegetation and upland/semi-aquatic plants, restricted access to the pond can be achieved. The aquascape would be functional (goose control and bank stabilization) and enhance the pond's aesthetics.

12. The County, State and municipalities have identified a list of planned roadway improvements. It has not been defined fully by the above entitles where opportunities exist to integrate storm water management practices into these roadway construction projects. Among the projected roadway projects are the reconstruction or replacement the 2,100-foot Roslyn Viaduct and the reconstruction the Pratt Boulevard Connector,

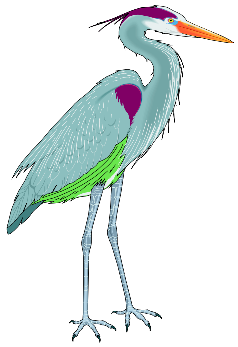
13. Since the status and inter-connectivity of the Hempstead Harbor watershed storm drain infrastructure is questionable, before any storm drain upgrades are initiated videotaping of the drainage collection system in the more urbanized sections of the watershed should be conducted. This includes Roslyn, Roslyn Harbor, Sea Cliff, Glen Cove, and the southern sections of North Hempstead. A preliminary evaluation of conditions, suggests that storm drain retrofits should be conducted. Essentially this would involve the removal of the existing storm drain basins and their replacement with basins that provide an opportunity for the settling of course sediments and other particulate pollutants. Such basins typically have dimensions similar to a standard catch basin, but include a sump set 18" to 24" below the inflow/outflow pipes. The sump helps retain sediments and particulate pollutants. In the scientific literature, these basins are commonly referred to as either water quality or sediment catch basins. It should be noted that Nassau County now requires such basins as part of the drainage for new roads or when upgrading existing storm drain systems.

14. Due to the observed development of localized sediment deltas, it is recommended that sediment traps (similar to that recommended as part of the Roslyn Park Pond project) be constructed on the storm outfalls located near the base of Skillman Street (Sub-watershed 8) and Lumber Road (Sub-watershed 12). Sediment traps are large, multi-baffled sub-grade basins that dampen storm surges and result in the settling and trapping of sediments, litter, and particulate pollutants. In part because of their size and design, these sediment traps are more efficient than water quality or sediment catch basins in the retention of pollutants. Their large size (e.g. 10' x 20' x 6') limits their application or use in sites due to man-made or natural constraints.

In order to facilitate the implementation of these projects, there will be the need for a point or coordinating organization that is recognized by the community and legislators as the "steward" of Hempstead Harbor. The HHPC was formed through an inter-municipal agreement, and is composed of representatives from the State, County and each of the major municipalities that would be effected by the implementation of the Water Quality Improvement Plan. Therefore, the HHPC already represents the partnership of stakeholders involved in the long-term management of Hempstead Harbor. It should thus continue to function as the lead organization in the restoration of Hempstead Harbor and the management of its watershed. As is now the case, the initial role of the HHPC should be advisory. However, overtime, the HHPC could take a more pro-active role becoming directly involved in such watershed management activities as the monitoring of the Harbor, the implementation of public education and delivery control projects, and in the preparation of draft ordinances, as well as in the acquisition and administration of grants. At that point, it may become necessary to hire staff dedicated solely to the management of Hempstead Harbor and its attendant watershed.

One of the first steps that can be taken, is to have the Hempstead Harbor watershed designated a special **watershed management district.** New York State has enabling legislation that facilitates the development of special management districts. This has been used by numerous communities to create park districts (Carmel, NY), septic management districts (Cazenovia, NY) and watershed management districts (Warwick, NY, Lake George, NY). Such special management districts need not have taxation powers. Creation of a Hempstead Harbor watershed management district is beneficial for a number of reasons. It increases the recognition of the Hempstead Harbor watershed as a special natural resource area that, although encompassing a number of municipal boundaries, must be treated as a unit. To some extent, creating a watershed management district will also help reduce potential jurisdictional issues. By officially recognizing the HHPC as the steward of the Harbor and its watershed, and empowering the HHPC to shape and oversee policies that affect NPS loading to the Harbor, a more uniform and watershed-cognizant policy environment could be developed. This could help reduce some of the existing inconsistencies in the regulations and ordinances that affect watershed based planning. It could also hasten the implementation of management measures, and better coordinate the maintenance of structural BMPs. A management district designation should also increase the success of the HHPC in the future in the acquisition of State and Federal funds as it would establish the HHPC as the representative of the stakeholder communities.

As mentioned, the HHPC's role should eventually be expanded so that it can actively function as a watershed management authority board for Hempstead Harbor. In this capacity, the HHPC would participate in the review of new developments, and aid the member municipalities in the preparation of model ordinances pertaining to NPS pollution management. The HHPC role should also be expanded in respect to fiscal management. It should be the lead organization for the preparation of grant applications, and the administration of funds. The HHPC should also serve as the lead organization in respect to the implementation of restoration and management projects. None of the above need usurp the ultimate control of local planning boards or the jurisdictional powers of local government. Rather, it should help strengthen and unify the community by maintaining a focus on the need for watershed management.



1.0 A BRIEF HISTORY OF NONPOINT SOURCE POLLUTION PROBLEMS OF HEMPSTEAD HARBOR AND ITS WATERSHED

Hempstead Harbor, located on the north shore of Long Island, in the southwestern sector of Long Island Sound, is a 5.1 square mile (mi^2) estuarine ecosystem. An estuary is a "semi-enclosed coastal body of water that has a free connection to the sea" (Odum, 1971). Estuaries can be considered transition zones between freshwater and marine habitats. Functioning as an interface between freshwater and marine environments, estuaries are typically highly dynamic, very productive ecosystems. They provide spawning, nursery and feeding areas for many of the important recreational and commercial fish species. Mussels, soft shell clams, hard clams (quahogs) and oysters, as well as crabs, usually flourish in healthy, unpolluted estuaries. Estuarine tidal flats and riparian wetlands serve as home to a wide variety of shore birds, wading birds and ducks that feed on the plentiful array of benthic invertebrates (snails, worms, etc.) and fish.

As is the case with all estuaries, Hempstead Harbor has natural attributes that can be considered either marine or freshwater. Freshwater inflow originates from the streams, wetlands and drainage ways that channel into the Harbor. Likewise, there is a constant tidal influx of saline waters from Long Island Sound. Both strongly influence the chemical characteristics of the Harbor and strongly influence its potential biological assemblage.

The productive nature of an estuary is largely the result of the constant influx of nutrients (nitrogen and phosphorus) from upland, terrestrial areas. Transported to the estuary via streams, rivers or overland flow, these nutrients function as the building blocks of life, stimulating the growth and development of microscopic plants, called algae or phytoplankton. To a large extent, algae and phytoplankton serve as the base of the estuarine foodweb, and are responsible for maintaining the productive nature of estuarine ecosystems. Unfortunately, estuarine productivity is a fine ecological balance that can easily become upset as the result of anthropogenic (human) actions. Most notably, excessive amounts of nutrient inputs can lead to algae blooms and a host of water quality problems. As substantiated by the Long Island Sound Study, excess nutrients are considered to be a primary cause of the reduced dissolved oxygen levels (hypoxia) observed in the Sound (LISS, Fact Sheet #11).

Estuaries have historically been subjected to intensive development pressures. Along with this comes water quality degradation and other environmental impacts, all directly attributable to land development. As is the case with Hempstead Harbor, many of the factors that make estuaries environmentally unique, also make them attractive to development. Bountiful fish and shellfish resources, sheltered ports for maritime commerce, and attractive beaches are among some of the attributes that stimulate the human development of lands adjacent to estuarine embayments.

However, the fertile nature of an estuary is very fragile and easily upset.

The "health" of an estuary can easily be impacted by the development of its watershed. A **watershed** is defined as the land from which both surface and sub-surface drainage to a waterbody originates. The size and expanse of a watershed is determined by the topography (ridge lines and slopes) of the land. A watershed may extend well upland from the waterbody to which it is associated. A watershed, in essence, functions like a large funnel that collects rainfall and subsequently transfers the resulting drainage to a waterbody. In this case, the receiving waterbody is Hempstead Harbor.

It has been clearly shown, through studies and investigations conducted by State and Federal environmental agencies, that strong linkages exist between watershed development and water quality degradation. In a natural, undeveloped state, a watershed will be dominated by land coverages that promote the infiltration of precipitation (**pervious surfaces**). Very little of the watershed is characterized by land coverages that inhibit the percolation or infiltration of precipitation such as roads, roof tops, and paved areas (**impervious surfaces**). As a watershed evolves from a natural, undeveloped state, to a more urbanized state, there is a general increase in the amount of impervious land cover. Impervious cover, because it inhibits the infiltration of precipitation, increases the volume of runoff generated by every storm event. The added volume and associated energy of this runoff can cause erosion of soil, instability of steep slopes, and gouging of streams. The increased volume and energy of the runoff also increases the mobilization of nutrients from the soils. In addition, the conversion of natural vegetated cover to impervious surfaces increases the types of pollutants that can be mobilized and carried by storm water runoff.

Basically, pollutant inputs can be categorized as originating from one of two main sources: **Point Sources** and **Non Point Sources.** Non Point Source (NPS) pollution is viewed as being diffuse in origin. Unlike Point Source pollution, which can be traced back to an easily recognized source, such as an industrial outfall or sewage treatment plant, NPS pollutants are much more ubiquitous in the environment. NPS pollution may be caused by such land use activities as farming, land clearing, lawn care, or road de-icing. Sources can be as diverse as septic system leachate, road runoff, roof top drainage, and pet feces. Unlike point sources, there are usually no distinct, well defined regulations or permit programs to limit or control the quality of NPS pollutant contributions.

Urbanized areas are characterized by runoff having a greater amount and a wider variety of pollutants than are natural areas. This includes bacteria, nutrients, heavy metals, petroleum products, sediment, litter and debris. Thus, as a watershed becomes more developed an increase in the volume of runoff is experienced along with an increase in nutrients, sediments and other pollutants inputs. Over time, the influx of increased NPS pollutant loading causes a decline in the water quality of the receiving waterbody. For Hempstead Harbor, this has translated into the loss of recreational opportunities, the demise of a commercial shellfishery, and general aesthetic problems which detract from the beauty of this coastal waterbody.

Unfortunately, because of their typically large size, inter-connection with the ocean, and their non-potable drinking water status, estuaries have long been perceived as a boundless receiving body into which Point Source (sewage, industrial effluent, etc.) and Nonpoint Source (storm water runoff) pollution could be discharged without too much worry. With the lack of sufficient pollution management controls and the lack of public awareness and concern, estuaries, world wide, have suffered the consequences of human impacts. The negative impacts have been easy to measure: poor water quality, lost fish and shellfish resources, degraded habitats, impaired recreational opportunities, and declining aesthetics.

These types of problems have long plagued Hempstead Harbor. Hempstead Harbor is one of the larger embayments along the north shore of Long Island. Its size and configuration (long and relatively wide) are ideal in respect to providing a sheltered Harbor for ships and boats, and when coupled to its proximity to New York City, it is understandable why it was a target for maritime development. In addition, the Harbor and its attendant watershed have other attributes that increase its development potential. This included extensive shellfish beds, and sand and aggregate resources that could be mined and easy shipped to New York City.

Settled in the late 1700's, the area experienced a large insurgence of growth in the late 1800's when large tracts of farmland were converted into estates (Buckhurst, Fish, Hutton, Katz, Inc., 1989). Subsequently, much of these lands were later sub-divided beginning around the late 1920's, contributing to the rapid development of the area. Along with this residential development came industrial and commercial development. The Glen Cove section of the watershed, in part because of the berthing and port facilities available along Glen Cove Creek, became a magnet for industrial development. Industrial uses also sprang up along the North Hempstead shoreline. Sand and gravel needed to meet the construction demands of metropolitan New York were mined from this section of the watershed. The southern end of the Harbor became especially densely developed, as the small early settlements began to expand and evolve into community centers. Mixed use residential and commercial development became characteristic of the Roslyn, Roslyn Harbor and Sea Cliff sections of the watershed. Later, the construction of such roadways as the Long Island Expressway and the Northern State Parkway also stimulated another cycle of residential and commercial development. To meet the wastewater needs of the community, various utilities were constructed, including sewage treatment plants, a power generating plant, a number of potable water supplies, and sanitary land fills. At one time as many as three sewage treatment plants discharged into Hempstead Harbor, along with numerous industrial wastewater outfalls. Initially, the level of pollutant control and treatment provided by these facilities was at best nominal, leading to the introduction of thousands of pounds of pollutants to Hempstead Harbor. Today the watershed is characterized by a dichotomy of land uses ranging from the highly industrial sections of Glen Cove, to the estate and low density residential developments of Sands Point.

For Hempstead Harbor the watershed's urbanization have led to environmental impacts exemplified by beach and shellfish bed closures, intense summer algae blooms, fish kills, and the loss of riparian habitats due to infilling and the construction of bulkheads. As grave as the impacts and consequences attributable to the effluent discharged from sewage treatment plants and industrial operations on the Harbor have been, the effects of nonpoint source pollution on the water quality of Hempstead Harbor have been equally insidious. As the Long Island Sound Study has documented, the role of NPS pollution in the degradation of the Sound and its embayments has been significant.

The history and pattern of the watershed's development resulted in the evolution of a storm water collection system that is common of many urban/suburban centers in the Northeast. In order to address localized flooding concerns, the storm water system throughout the watershed was designed to collect and concentrate storm runoff, and discharge it as quickly as possible to Hempstead Harbor. Although doing so may have rectified localized flooding problems, it also contributed to the introduction of NPS pollutants to the Harbor. Nassau County has identified over **180 outfall pipes** that discharge storm water runoff either directly to the Harbor or to one of its major tributaries. Along Cedar Swamp Creek alone, there are in excess of 50 storm water outfalls. Each of these outfalls represents a conduit for the transport of NPS pollutants from the surrounding watershed to Hempstead Harbor.

Over time, improvements have been made to the Hempstead Harbor storm water system. Recharge basins are now commonly utilized to manage runoff, and engineering design techniques intended to control the quantity and quality of storm runoff have been instituted by the State and County. However, even with these changes and improvements, the degradation of Hempstead Harbor's water quality has continued. As will be detailed in Section 3 of this report, elevated concentrations of bacteria and nutrients are still routinely measured in Hempstead Harbor. Sediment plumes can be observed following storm events, and the groundwater adjacent to certain industrial sectors of the watershed remains grossly contaminated. The impacts of these and a number of other pollutants on the Harbor's water quality remain apparent. Beach closures still occur, restrictions continue to be placed on the harvesting of shellfish, algae blooms occur during the late summer, fish kills are periodically experienced, and complaints are still voiced about localized oil slicks, floating debris, and impaired recreational uses.

Granted, in response to these problems, the Federal, State and County governments have over the past 20 years begun to implement corrective actions. Effluent limits have been imposed on industrial discharges, sewage treatment plants have been consolidated and upgraded, and major environmental clean ups have been initiated at some of the problem industrial sites and old landfills. These environmental endeavors are discussed in more detail in Section 2 of this report. However, little has been done to resolve the majority of the storm water and NPS related problems. Although these problems may seem obvious, their correction is impeded by their enormity and the fact that neither NPS pollution nor storm water problems runoff respect municipal boundaries. That is, storm water follows topographic contours, and the runoff that originates in one community within the watershed may actually be discharged in another community of the watershed. Thus, unlike point source control, it often becomes difficult to identify those responsible for the problems. In addition, it can be equally difficult to establish who should be responsible for the maintenance and upkeep of storm water management facilities. The complexity of the institutional arrangements and the intricacies of the governmental jurisdictions associated with the management of storm water and NPS pollution management within the Hempstead Harbor watershed can be easily illustrated by simply identifying the major parties involved in the control of development.

Depending on the type of development, Hempstead Harbor's water quality management falls under the jurisdiction of potentially no less than a dozen governmental agencies and groups. This includes the United States Environmental Protection Agency (EPA), the United States Army Corps of Engineers (ACOE), the United States Fish and Wildlife Service (USFWS), National Marine Fishery Service (NMFS), the New York State Department of Environmental Conservation (NYSDEC), New York State Department of State (NYSDOS), Nassau County Department of Health (NCDH), the Nassau County Planning Commission (NCPC),and the Nassau County Soil and Water Conservation District (NCSWCD). Locally, each of the municipalities, through their respective zoning, planning, health and environmental boards or commissions regulates development and related water quality management issues. Added to this is the fact that over the past 20 years various laws and regulations, stimulated in part by the Clean Water Act, have been put into effect to protect water quality, and water quality improvement initiatives, stimulated by the findings of the Long Island Sound Study, have been set in motion. This is all very positive. However, it is representative of the complexities associated with the management and restoration of NPS pollution, especially in an estuarine ecosystem of the size and importance of Hempstead Harbor.

In recognition of this, The Hempstead Harbor Protection Committee (HHPC) was formed through an inter-municipal agreement, in 1995 as a coordinating organization that could provide a uniformed and unified approach to the long term management and restoration of Hempstead Harbor. The HHPC is composed of State, County and local representatives. In addition to Nassau County, the Towns of North Hempstead and Oyster Bay, the City of Glen Cove, and the Villages of Sands Point, Flower Hill, Roslyn, Roslyn Harbor, and Sea Cliff are all members of the HHPC. The HHPC also includes, NYSDOS and NYSDEC representatives. To implement the management and restoration of Hempstead Harbor and its watershed, an Environmental Protection Fund grant was awarded through NYSDOS. Match for these funds were provided by the local participating communities. Following the hiring of a Project Coordinator, the HHPC developed a scope of work for the development of a Water Quality Improvement Plan.

Central to the HHPC's goal of developing a Water Quality Improvement Plan is to provide the direction needed to prioritize NPS management efforts, and coordinate the interests and institutional arrangements needed to successfully improve the Harbor's water quality. As stated by the HHPC in respect to the preparation of a Water Quality Improvement Plan:

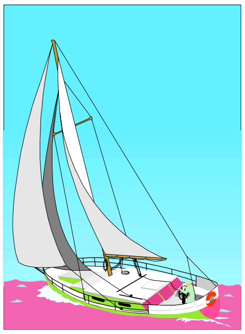
> "The objective of the project is to develop a management plan to reduce nonpoint source pollution entering Hempstead Harbor by avoiding pollution at its source or by intercepting pollution and either treating it or preventing it from entering coastal waters. The primary goal of the program is to reduce pollution to preserve, and where possible, enhance water quality, habitat, economic uses and recreational enjoyment within the Harbor."

The next sections of this report review the pertinent physical, chemical and biological attributes of the Harbor and its watershed, analyze the historical water quality database, and quantify the watershed's NPS pollutant load. A review of the existing policy environment, that is the existing rules and regulations that govern watershed development and NPS pollution management, is also conducted in this report. The resulting data, information and findings are then used to develop recommendations for the management and restoration of Hempstead Harbor and its attendant watershed. Emphasis is placed throughout this report on the relationship of NPS pollutant loading and water quality degradation, and the need to reduce and adequately manage NPS inputs in order to achieve the desired, long-term, successful restoration of Hempstead Harbor.

In order to develop such a plan, it was essential that key data be properly analyzed. This included data pertaining to both the Harbor and its watershed. The analytical process consisted of three major steps. The first step entailed evaluating the pertinent physical, chemical, natural resource and land development characteristics of the Harbor and its watershed. As previously mentioned, water quality impacts can generally be linked directly to watershed development and associated land use attributes. The second step involved quantification of the pollutant load contributed individually from each of the watershed's sub-watersheds. The first two steps of this process obviously focus on the technical elements and data needed to develop an objective, scientifically sound plan. However, without the proper coordination of efforts, even a technically well orchestrated plan will flounder. As previously mentioned, successful NPS pollution control must transcend municipal boundaries and approach the problem from a watershed perspective. This requires proper long-term oversight, conducted in a uniformed, watershed oriented manner. If NPS pollution control is not conducted in a watershed management framework, efforts can become diluted because of inadequate direction. This can also negatively impact on fiscal resources, decreasing the cost-effectiveness of management activities. Thus, the third step in the analytical phase of the plan involved the prioritization of NPS pollution control and abatement projects within a long-term watershed oriented management framework. Once the analytical components were completed, the information was melded into a Water Quality Improvement Plan consisting of a combination of delivery control (stormwater best management practices), source control (pollution prevention regulations, ordinances and voluntary measures) and public education initiatives. The combination of these NPS pollution management techniques provides the HHPC with a long-term, proactive blueprint for the restoration of Hempstead Harbor and the protection of its resources for future generations.

2.0 DESCRIPTION OF THE STUDY AREA

2.1 Physical Characteristics of Hempstead Harbor



Hempstead Harbor, a major cove in southwestern Long Island Sound, is considered by the US Army Corps of Engineers (USACOE) to be one of the most commercially important Harbors on Long Island. Approximately 11.7 km (5.3 mi) in overall length, the Harbor is funnel-shaped, tapering from 3.2 km (1.45 mi) at its mouth, to about 1.4 km (0.6 mi) near its southerly end in Roslyn. At a location slightly south of the mid-point of the Harbor, a peninsula (Bar Beach) extends from the Harbor's western shoreline. This land mass restricts water flow and water exchange in the southern third of the Harbor, exacerbating water quality related problems in this section of the Harbor.

Although the average tidal amplitude (the difference between high and low tides) is 2.2 m (7.3 ft), the average velocity of the ebb and flood tides is weak (Gross, et. al., 1972). The tidal prism has a volume of approximately 30 million m^3 (7.8 x 10^9 gallons), and a corresponding tidal residence time of 4 days. This suggests that it takes 1.4 days for the Harbor to completely flush itself. This calculation, however, does not provide any information about isolated portions of the Harbor, most notably the inner Harbor south of Bar Beach. This area will clearly have a much longer tidal residence time due to its restricted connection with the upper portion of the Harbor. This increases the opportunity for the retention of particulates, floatables and other pollutants, such as nutrients and coliform bacteria. It also increases the propensity for algae to bloom and attain nuisance densities due to excessive nutrient levels.

The average depth of Hempstead Harbor, as reported in a 1984 study by the Nassau County Department of Health, was 5.4 meters (18 feet). The greatest depths, up to 12.2 meters (40 feet) were reported to occur in the outer Harbor area adjacent to Long Island Sound. Depths in the middle Harbor area (north of Bar Beach) reached 9.1 meters (30 feet), while the inner Harbor had reported maximum water depths of 4.6 - 5.8 meters (15-19 feet).

While historical bathymetric data are available, no recent large-scale, comprehensive bathymetric surveys of the Harbor have been conducted. As such, the present day bottom contours of the Harbor are not fully documented. Review of available documents and information obtained from knowledgeable local sources suggests that various activities both in the watershed and within the Harbor itself have led to localized in filling and shoaling. For example, it has been reported that past aggregate and sand mining operations have led to localized sedimentation problems and in-filling has occurred in select areas due to upland soil erosion problems. This has been most obvious in the vicinity of Port Washington (Abeles, Phillips, Preiss and Shapiro, Inc., 1996). Gross, Davies, Lind and Loeffler (1972) reported that as much as 1 km^2 of Harbor bottom was lost due to the in-filling associated with the construction of the old North Hempstead Township incinerator. Similar problems exist throughout the study area due to the construction of docks and piers, because of shoreline erosion and/or the conveyance and deposition of sediment and eroded soils from the watershed. An example of the latter situation is located south of the LILCO station.

The majority of the Harbor is classified by the New York State Department of State (NYSDOS) as a Significant Coastal Fish and Wildlife Habitat (Abeles, Phillips, Preiss and Shapiro, Inc., 1996). For more than 30 years (since 1966), Hempstead Harbor has consistently failed to meet acceptable shellfish water quality standards due to excessive coliform bacteria levels (Buckhurst, Fish, Hutton, Katz, Inc., 1989). The recreational potential of the Harbor has also been impacted by high bacteria levels. Beach closings are a frequent occurrence because of elevated fecal coliform concentrations.

The morphometry (physical characteristics) of the Harbor itself, in part, plays a key role in defining the water quality and in exacerbating environmental impacts. As will be discussed in subsequent sections of this report, the Harbor's long and relatively narrow shape affects its mixing properties. As discussed by Bowden (AAAS, 1967) the size, shape, depth profiles and volume of an estuary have direct bearing on vertical mixing and the entrainment of sediments and particulate pollutants. This impacts dissolved oxygen gradients in the summer and encourage the deposition of sediments, two problems documented in past studies of Hempstead Harbor. In addition, the size and location of the Bar Beach peninsula restricts the flushing of the lower Harbor. This encourages the deposition of sediments and the entrainment of floatable type of pollutants (litter and debris). The Bar Beach peninsula also inhibits the mixing of saline waters with the freshwater inflows originating from the small streams and storm sewers that empty into the lower Harbor. This increases the likelihood of the lower Harbor responding to pollutant inputs, especially phosphorus loading, more like a freshwater impoundment than an estuary.

2.2 The Hempstead Harbor Watershed Boundaries

The Hempstead Harbor watershed encompasses over 23,000 acres. Situated in the western end of Nassau County, the Hempstead Harbor watershed includes portions of the Town of North Hempstead, the City of Glen Cove, and the Town of Oyster Bay. The Villages of Roslyn, Flower Hill, Roslyn Harbor, Sea Cliff, and Sands Point and a number of smaller unincorporated hamlets fall within the boundaries of the Hempstead Harbor watershed.

The history and pattern of land development of the watershed has resulted in a commonly observed condition of older urban/suburban areas: a poorly defined stormwater collection and conveyance system. Since these systems were designed to collect and discharge runoff from upland sites to the Harbor as quickly as possible, very little stormwater quality enhancement is achieved.

As defined in Section 1, a watershed is the land from which stormwater runoff drains to a receiving waterbody. Also, as introduced in Section 1, the types of land use and land use activities (such as land clearing, lawn maintenance, etc.) occurring within a watershed will contribute Non-point Source (NPS) pollutants to a waterbody, in this case the Harbor. It is therefore important to develop an understanding of the inter-relationship between the Harbor and its watershed if pollutant loading and water quality are to be successfully managed.

The watershed, as defined by the NYSDOS and the Nassau County Department of Public Works (NCDPW) and subsequently mapped by Coastal (Map 1), is basically bounded to the west by Middle Neck Road/Port Washington Boulevard, to the south by Wheatley Road/Spring Rock Road, and to the north by Long Island Sound. Map 1 also shows the sub-watershed boundaries delineated by Coastal and reviewed by NCDPW. Although the area's topography primarily defines the boundaries of the watershed and sub-watersheds, roadways and stormwater collection systems also play a role. This is especially true along the watershed's southern limits. Further research of the watershed boundaries conducted by Coastal, with guidance and assistance provided by the NCDPW, confirmed that the NYSDOS boundaries did not accurately reflect current conditions. Adjustments were subsequently made to the boundaries to reflect a refined understanding of the watershed. This resulted in the overall reduction in the total acreage of the watershed. The adjustment consisted of eliminating those sections of the watershed serviced by storm water collection systems or recharge basins that do not discharge to Hempstead Harbor.

Superimposed on the watershed boundary is the state's Coastal Management Program boundary. This is a narrow subset of the main watershed that runs along the Harbor's shoreline. The New York State Coastal Management Program is based on the Waterfront Revitalization of Coastal Areas and Inland Waterways Act, Article 42 of the Executive Law. The legislative findings of this program declare that:

> "The social and economic well-being and the general welfare of the people of the state are critically dependent upon the preservation, enhancement, protection, development and use of the natural and man-made resources of the state's coastal area and inland waterways" (Section 910, Article 42, Executive Law).

Article 42 of the Executive Law, which created the New York State Coastal Management Program, also set the state coastal boundaries within which the enforceable policies of the coastal program would apply. The boundary follows topographic and cultural features, and may be amended either by the state or as part of an approved Local Waterfront Revitalization Program.

Map 1. Sub-watersheds and Drainage

2.3 Characteristics of the Hempstead Harbor Watershed

In order to protect the Hempstead Harbor watershed from future nutrient, sediment and other pollutant loading, sensitive land use planning should be a component of any long-term non-point source pollution control plan. This relates primarily to non-developed areas with characteristics sensitive to development related disturbances, but is also appropriate for currently developed land located in environmentally sensitive locations in the watershed. By protecting undeveloped, environmentally sensitive areas in a *pro-active* fashion, as opposed to *reacting* to their degradation, impacts to the quality of the Harbor can be averted. This approach is highly effective in minimizing future non-point source pollution problems.

In most developed areas, a reactive approach must be taken to protect sensitive lands. Existing development can undergo retrofits or upgrades in order to restore sensitive lands to a more pristine state. Modifications can be made to stormwater infrastructure or zoning may be modified to regulate future development. For example, over 180 stormdrains have been mapped in the Hempstead Harbor watershed (Map 2). Each of these pipes represents a vector by which pollutants can be conveyed, potentially from quite a distance, to Hempstead Harbor or any of its tributary streams, wetlands or ponds.

Environmentally sensitive areas are defined in this study to include sites with slopes in excess of 15%, soils of limited engineering stability and septic suitability, stream corridors and wetlands and the Harbor itself. These areas must be protected by conservation, limiting development, requiring the implementation of special development or site engineering provisions and requiring development mitigation measures. By designating areas as environmentally sensitive, a basis will exist to mandate that when development is allowed that it should be conducted using clearing, erosion control, stabilization and site preparation measures that minimize environmental impacts. The first step in this process is to verify that certain areas, due to their environmental resource attributes, merit special protection. In determining which environmental features should be classified as "sensitive", highest priority was given to those areas which, if disturbed, would result in adverse impacts to the quality of Hempstead Harbor.

In general, environmentally sensitive areas are defined as those areas that are "so naturally valuable, or so important for human use...or so sensitive to impact or so particular in their planning requirements as to merit focused attention", and include areas such as wetlands and wetland buffers, intermittent stream corridors, steep slopes, endangered and threatened wildlife or vegetation species habitats, critical wildlife habitats and public open spaces (New Jersey Coastal Areas Facility Review Act - CAFRA).

Map 2. Stormdrains

Data were collected from a variety of sources and digitized to create maps depicting environmental characteristics and constraints within the watershed. Some of these data were accessible from various sources such as NYSDOS and Nassau County or from United States Geological Survey (USGS). However, some data were not available digitally and were therefore digitized from the base map data supplied through the sources listed above.

2.3.1 Topography

In the watershed, gently sloping (0-8%) land areas predominate. However, substantial, somewhat localized areas of moderate slopes (8-15%) exist, particularly in the southeastern portion of the watershed, east of Old Westbury. Steep (15-25%) and severe (>25%) slopes occur primarily within or adjacent to the coastal boundary area that borders the Harbor, such as along the Sea Cliff shoreline.

The highest elevations in the watershed occur in the southeastern portion, where elevations approach, and at times exceed, 300 feet above mean sea level. A relatively narrow ridge approaching 300 feet is also present in the western portion of the watershed.

2.3.2 Geology and Soil Associations

The study area is part of the Coastal Plain physiographic province (SCS, 1987). It is underlain by bedrock consisting primarily of Cretaceous sedimentary layers at a depth of several hundred feet. The landforms at higher elevations were glacially deposited as a terminal moraine. As the ice sheets receded, sea level rose to its present level. Currents and wave action modified the shoreline of Hempstead Harbor to its present day configuration.

The Hempstead Harbor watershed is comprised of 56 different detailed soil types (e.g. Enfield soils). These soils can generally be categorized into five soil associations (e.g. Montauk-Enfield soil associations) which are described below (Map 3). Soil associations generally consist of one or more major soil types and several minor soils.

The limitations described for each soil association are very general and may not apply to the entire area of that classification due to local conditions (e.g. types of development, hookup to sewer systems). While in some areas limitations such as those related to slope may not be relevant now, they may have been so in the past and may again be in the future. With appropriate precautions (e.g. erosion control plans), many limitations may be mitigated.

The southeastern portion of the watershed contains Montauk-Enfield soils. These are nearly level to strongly sloping, well drained, very deep soils that are found on upland areas. The texture is medium and medium coarse. The major concern for development in this soil unit is sewage effluent disposal. The Montauk soils have a dense, slowly permeable substratum that hinders efficient disposal of sewage effluent. The Enfield soils have a very rapidly permeable substratum that is a poor filter for wastewater effluent. This represents a potential source of groundwater contamination from septic sources and other pollutant sources.

The land areas immediately adjacent to the Harbor are of the Riverhead-Plymouth and Udipsamments-Beaches-Urban Land soil units. Like the Montauk-Enfield soils, the Riverhead-Plymouth soils are very deep. They are moderately steep and steep, well drained and excessively drained. The texture is moderately coarse and coarse. Where they are adjacent to open water, wave action causes bluffs to form along the shoreline. Their major limitation for residential development is the moderately steep or steep slopes. Removal of the canopy and ground cover (vegetation) creates a severe erosion hazard during construction.

The Udipsamments-Beaches-Urban Land soils are primarily on or near beaches formed by tidal and wave action. These soils are nearly level or gently sloping. They are excessively to moderately well drained and coarse textured. The high sand content of the soil, wind erosion and tidal storms are the main limitations for residential development. Many areas are subject to inundation from severe coastal storms.

The Riverhead-Enfield-Urban Land soils are found in the northwestern and northeastern portions of the watershed. They consist of deep, well drained soils. Slopes range from zero to 25% and the soils are moderately coarse textured and medium textured. Slope is the major limitation of these soils.

The Urban land-Montauk-Riverhead soils occur in the western, southern and central portions of the watershed. They generally consist of urban areas and very deep soils. These soils are nearly level to strongly sloping and well drained. The texture is medium and moderately coarse. Onsite sewage disposal is limited in the Montauk soils due to the previously mentioned moderately slow or slow permeability in the substratum, while the substratum in the Riverhead soils, as with the Enfield soils, provides poor filtration of wastewater.

Map 3. Soil Associations/Erodible Soils

2.3.3 Soil Types

Soils vary from one another largely due to properties arising from their unique internal structure. The structure and composition of each soil determines its suitability for various types of land use activities. The *Soil Survey of Nassau County, New York* (Soil Conservation Service, 1987) lists all the characteristics of each soil type that determine its suitability for plant cultivation (forest and agriculture) and various types of development. By recognizing in advance the limitations associated with different soil types, precautionary measures can be implemented during site development so as to minimize potential environmental impacts. Data synthesized from the soil survey information were used to develop the Soils/Erodible Soils and Slopes Maps.

Soil limitations are variable in many circumstances with the intended nature of site utilization. For example, agricultural use may be limited in certain soils, while residential development may be more problematic in others. Also, problems and limitations that are severe for one type of stated use, such as on-site sewage disposal, may not be so severe for another type of use. The same holds true for the intensity of land use. For instance, if a site is proposed for a seasonal use, a seasonal high water table may not be as great a limiting factor as it would be for a site with year round use. Proposed uses such as recreational areas may not require a large amount of reshaping, grading or construction, and therefore limitations may be manageable.

2.3.4 Sensitive Soils

Sensitive soils contain one or more characteristics that constrain development. These soils include those with hydraulically restrictive substrata, zones of saturation or those considered highly erodible as defined by the USDA Natural Resource Conservation Service (formerly Soil Conservation Service).

Soil erodibility reflects potential soil loss when slope, vegetative cover and wind or rain intensity are held constant. Development often leads to topsoil destabilization through destruction of vegetative cover or changes in slope. As a result, soil is deposited in downgradient waterbodies, adversely affecting aquatic life. The erosion factor, K, indicates the susceptibility of a soil to sheet and rill erosion by water. K values range from 0.05 to 0.69. The higher the K value, the more susceptible the soil is to sheet and rill erosion by water runoff. Highly erodible soils are those with a K value greater than 0.37.

The K-values of the soils in the Hempstead Harbor watershed vary widely and must be evaluated on a site specific basis. Several areas in the eastern portion of the watershed, outside the coastal zone, exhibit severe erodibility (Map 3). Development in highly erodible soils can lead to severe erosion and subsequent downslope impacts, including alteration of waterway profiles, loss of topsoil and vegetation. The lack of highly erodible soils in an area does not negate the need for comprehensive soil and erosion control plans for developing sites. Soil and erosion control measures should be utilized in any situation where soil will be disturbed.

Steep slopes are typically defined as land areas where the vertical change over a horizontal distance is greater than 15%. Severe slopes are typically defined as those greater than 25%. Slopes of less than 8% present few limitations for development purposes, while slopes from 8% to 25% impose various limitations on development, including requirements for grading, the need for specially designed septic systems and restrictions on construction and agricultural activities. In particular, erosion and sedimentation caused by site clearing and grading are highly problematic without implementation of well designed controls. Constraints may be mitigated by appropriate excavation, soil erosion control and stormwater management plans.

For purposes of this study, the slopes within the watershed were delineated based on the soil types detailed in the Nassau County Soil Survey. The majority of the slopes within the watershed are classified as gentle (0% to 8%) (Map 4). A few areas contain slopes classified as moderate (8% to 15%) or steep (15% to 25%) or severe (>25%). It should be noted that small areas of moderate or steep slopes may not be detailed on Map 4 due to their small size compared to the scale of the map and watershed.

2.3.5 Surface Water

Surface waters include all the major ponds and streams that drain to the Harbor as well as Hempstead Harbor itself. Water quality criteria for surface waters have been established by the New York State Department of Environmental Conservation based on designated uses. Although the surface water quality standards established by the Interstate Sanitation Commission (ISC), Nassau County Department of Health and NYSDEC provide a means of protecting the Harbor from degradation, the standards in themselves actually represent <u>the maximum allowable concentration or level of individual pollutants</u>. The standards do not take into consideration cumulative impacts or synergistic effects. They also do not reflect the fact that degradation and impairment can occur even when these maximum levels are not exceeded (i.e. chronic effects). In addition, rarely, with perhaps the exception of fecal coliform standards, does an exceedence from these values result in an direct action being taken by the regulatory agencies. As such, these standards should be viewed as a basic means by which the status of a waterbody can be assessed. These values can also be used to evaluate a waterbody's conformance with the State's designated surface water classifications which are discussed further in Section 3.

Map 4. Slopes

2.3.6 Wetlands

The types and locations of tidal wetlands delineated by the United States Fish & Wildlife Service National Wetland Inventory (USFWS NWI) and freshwater wetlands delineated by NYSDEC are indicated on the Critical Areas Map (Map 5). Due to mapping difficulties, the NYSDEC regulated tidal wetlands are not shown on Map 5. Therefore, Map 5 should not be considered a comprehensive map of the Harbor's regulated wetlands.

Wetlands are areas inundated or saturated by surface water or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions (commonly known as hydrophytic vegetation) (Federal Interagency Committee for Wetland Delineation, 1989). Wetlands often provide critical habitats for various wildlife and vegetation species, and equally important, act as retention areas to reduce flooding and improve water quality through deposition, filtration and bio-uptake.

For purposes of USFWS NWI maps, wetlands are typically classified according to a system developed by Cowardin, et. al. in *Classification of Wetlands and Deep Water Habitats of the United States* (1979). Wetlands are first divided into ecological systems: estuarine, marine, palustrine, lacustrine and riverine, and then into sub-systems. The third division is based on class, such as emergent, unconsolidated bottom, aquatic bed, forested or scrub/shrub. The final division involves subclasses, such as the material the bottom consists of (e.g. bedrock or boulder) or the type of vegetation present (e.g. broad leaved deciduous or evergreen). Modifying terms describing the water regime, water chemistry, soil and other factors may also be added.

2.3.7 Coastal Erosion Hazard

Areas that are subject to coastal erosion hazards have been identified along the shoreline of Hempstead Harbor (LIRPB, 1992). Along the western shore, these occur in a continuous band from Sands Point in the north to just below Mott Point in the south. On the eastern shore, the designation occurs from Glen Cove Landing northward to the extent of the watershed. These areas are those most directly exposed to the wind and wave action from Long Island Sound. They comprise approximately the northern third of the Harbor's shoreline (Map 5).

2.3.8 Important Habitats

Areas known to be inhabited on a seasonal or permanent basis or to be critical at any stage in the life cycle of any wildlife (fauna) or vegetation (flora) identified as "endangered" or "threatened" on official State or Federal lists of endangered or threatened species, or under active consideration for State or Federal listing, may be designated important habitats.

The loss of suitable habitat may result in the extinction of endangered or threatened species. A site investigation would be required to determine the actual presence or absence of any of these species. Such species could potentially use habitats within the watershed for breeding, feeding or migratory stopovers.

The New York State Department of Environmental Conservation began establishing “significant habitat areas” in 1975. These areas are defined as “a specific place, area or location in New York State that has value for fish or wildlife extending beyond its own borders.” While this designation has no regulatory significance, it is indicative of an area that has substantial regional importance in providing fish and/or wildlife habitat. Eight such areas have been designated within the Hempstead Harbor Watershed. These areas and their basis for designation are listed below:

1. Sands Point/Prospect Point (NYSDEC #30-2A, Sub-watershed 4)
The landward portion of this site is home to a large native Long Island cactus, the prickly pear (*Opuntia humifosa*) that is a NYSDEC listed, protected native plant. The beach portion of this site is a breeding ground for diamond back terrapin and a winter resting and feeding area for shorebirds and waterfowl.

2. Marsh south of Prospect Point (NYSDEC#30-2B, Sub-watershed 1)
This site contains a dune community with prickly pear cactus. The productive marsh area is attractive to waterfowl. Goldeneye are present offshore in the wintertime; snowy egrets and black-crowned night herons have also been observed.

3. Dosoris Pond (NYSDEC#30-6, Sub-watershed 1)
This site is utilized by overwintering waterfowl such as scaup, baldpate, canvasbacks, red heads and herons. Great horned owls have been observed inland.

4. Garvies Point (NYSDEC#30-9, Sub-watershed 3)
The waters off Garvies Point are home to gastropods such as periwinkles, hard clams, and oyster drills. The Garvies Point Nature Preserve is a 75-acre woodland.

5. Scudder’s Pond (NYSDEC#30-9, Sub-watershed 8)
This area is a year-round home to many birds, including mallards, wintering teal, sora and Virginia rail, red-bellied woodpecker, king fishers, warbling vireos and snipe.

6. Glenwood Landing to Carpenter Point (NYSDEC#30-9, Sub-watershed 8)
This area is home to wintering scaup.

Map 5. Critical Areas

7. Mott's Cove (NYSDEC#30-9, Sub-watershed 8)
This area contains a heron roost site.

8. Head of Hempstead Harbor (NYSDEC#30-9, Sub-watershed 8, 9, 10, 11)
Scaup feed on mud snails on the tidal flats during the winter.

The New York State Waterfront Revitalization and Coastal Resources Act of 1981 established the Significant Coastal Fish and Wildlife Habitat (SCFWH) program as a component of the New York State Coastal Management Program. This program, which is administered by the New York State Department of State (NYSDOS), is designed to protect the recreational, commercial and ecological benefits of coastal habitats. NYSDEC developed a quantitative evaluation system for the program which utilizes the following criteria:

- Is the habitat essential to the survival of a large portion of a fish or wildlife population?
- Does the habitat support populations of species which are endangered, threatened, or of special concern?
- Does the habitat support populations having significant commercial, recreational or educational value?
- Does the habitat exemplify a habitat type not commonly found in the state or in a coastal region?
- To what extent could the habitat be replaced if destroyed?

If the habitat in question receives a score above a value determined by NYSDEC, the habitat is recommended to NYSDOS for designation as a SCFWH. NYSDOS then has the ability to review and approve or disapprove state and federal actions affecting the SCFWH. Communities that develop Local Waterfront Revitalization Plans (LWRP) must protect SCFWH habitats and are encouraged to institute land use controls.

Hempstead Harbor north of the Roslyn Viaduct is designated by the NYSDOS Coastal Management Program (CMP) as a "Significant Coastal Fish and Wildlife Habitat" (SCFWH), which provides for the limiting or monitoring of discharge from currently undisturbed land (Map 5). This designation encompasses all wetlands and open waters located south of a boundary line extending east from Motts Point to Mosquito Cove. Unlike the NYSDEC significant habitat classifications discussed above, the SCFWH designation has regulatory implications.

Hempstead Harbor is an important waterfowl overwintering area (November through March).

Concentrations of waterfowl are also found in the Harbor during the spring and fall migrations. Midwinter aerial surveys of waterfowl abundance conducted by NYSDEC for 1975 through 1984 indicated concentrations of more than 500 birds in the area each year (1135 in a peak year). Species observed included scaup, canvasback, black duck, Canada goose, common goldeneye, red-breasted merganser, mallard, oldsquaw, bufflehead and American wigeon (NYSDEC, 1987). There have also been reports from local residents of osprey utilizing platforms in the Bar Beach area for nesting and breeding.

While the Harbor in general was classified as having high value as waterfowl habitat, the Dosoris Pond area on the northeastern shore of the Harbor was ranked as providing outstanding habitat value.

The Harbor is also a productive area for marine finfish and shellfish. The area provides nursery and feeding habitat for striped bass, scaup, bluefish, Atlantic silverside, menhaden, winter flounder and blackfish. Sport fishing from boats is generally confined to the outer section of the Harbor, although shore-based fishing from piers and jetties occurs at the Glen Cove breakwater and the Hempstead Harbor Park fishing pier (NCDH, 1984).

Hempstead Harbor is designated as an uncertified shellfishing area by NYSDEC due to the chronic problems with coliform bacteria; however, habitat does exist throughout the Harbor to support a highly productive hard clam (*Mercenaria mercenaria*) shellfishery. Potential production of soft clam (*Mya arenaria*) is limited to Dosoris Pond. The majority of the Harbor is classified as a Transplant Harvest Area by NYSDEC, meaning that shellfish can be harvested in the area for the sole purpose of relaying to certified areas.

No marine mammals are known to utilize Hempstead Harbor on a regular basis; however, occasional Harbor seal sightings have been reported.

Surveys of organisms present in the Harbor have been conducted by LILCO, NCDH, NYSDEC and other groups. Appendix A contains a compilation of these lists of species.

The NYSDEC maintains a list of animal species that are endangered, threatened or of special concern. These rankings are in descending order of threat of extinction. None of these species have been documented by NYSDEC to occur within the project area (NYSDEC, 1987), although, as noted above, local residents have reported the presence of osprey, a threatened species in New York.

A list of protected native plants is similarly maintained by the NYSDEC. The only listed species present within the Hempstead Harbor watershed is the prickly pear (*Opuntia humifosa*). As mentioned previously, this species has been reported to be present in the Sands Point-Prospect Point Significant Habitat Area.

Portions of the watershed containing significant habitat or in which threatened or endangered species have been reported are identified on Map 5.

2.3.9 Special Groundwater Protection Areas

The United States Environmental Protection Agency has designated the aquifer which underlies Nassau County as a sole-source aquifer. NYSDEC designated the best usage of all ground waters in Nassau County as a source of potable water supply. The county has designated several areas within its SGPA boundaries as special groundwater protection areas. The areas are those that are relatively undeveloped and recharge high quality water to the underlying aquifers.

Article X of the Nassau County Public Health Ordinance (Groundwater Protection - Regulation of Sewage and Industrial Wastewater) establishes SGPAs and the policy to control the amount and type of wastewater being discharged to these aquifers to preserve water quality. The regulations require new residential subdivisions and new residential developments that are wholly or partially within a SGPA that utilize septic systems to provide a net area of at least 40,000 square feet per dwelling unit if septic systems are to be utilized. The development may not be within the service area of an existing public sewer system and the soil and groundwater conditions must be "conducive to the proper functioning of individual sewerage systems" (Nassau County Department of Health, 1985). New non-residential developments must have an average daily design rate of sewage discharged per square foot of net area of 0.00375 gallons or less if they are located partially or wholly within a SGPA and septic systems are to be utilized. No industrial wastewater discharges are permitted within SGPAs.

A large portion of the eastern edge of the Hempstead Harbor watershed (adjacent to Sub-watershed 3, Old Brookville), outside the Coastal Zone Management area, is located within the Oyster Bay/North Hempstead SGPA (Map 6). Restrictions on the use of septic systems within this area may reduce the amount of coliform bacteria and other pollutants contributed to surface and groundwater from septic systems.

Map 6. Special Groundwater Protection Areas and Drinking Water Districts

2.4 Current Land Use

As discussed earlier, land uses within a watershed affect the water quality of all surface waters within that watershed. Developed land (e.g. urban/residential) typically has a greater effect on water quality than does undeveloped (e.g. forested) land. The conversion of forested lands, wetlands, and naturally vegetated areas to impervious surfaces (roads, rooftops, parking lots, and even lawns) leads to decreased opportunities for rainfall to percolate into the soil, thus increasing the amount of runoff generated by every storm event. The added volume and associated energy of this runoff can cause the erosion of soil, the instability of steep slopes, and the gouging of streams. Equally important, the additional runoff experienced as a watershed becomes increasingly developed, has the potential to mobilize greater amounts of pollutants, which then become transported to the receiving waterbody, in this case Hempstead Harbor.

Table 2-1 and Figure 2-1 present the land use and land cover characteristics of the study area based on information obtained from NYSDOS and analysis of aerial photographs. These data, along with field reconnaissance, were used as the basis for all the land use analyses in this study. These data are presented graphically on Map 7. It should be noted that hectares were utilized in all calculations. Hectares are the prevailing unit of measure in the majority of published loading analyses. One acre equals 2.47 hectares. Table 2-1 contains the area of each sub-watershed (total and for each land use classification) and the percentage of area within each land classification. The amount of land, presented as a percentage of the total, within each land use classification for the entire watershed is presented in Figure 2-1. These data, and similar data presented for each sub-watershed later in this section, were rounded to the nearest percentage point for graphical purposes.

As discussed in Section 1, the Hempstead Harbor watershed was divided into 12 sub-watersheds. Hempstead Harbor encompasses portions of several municipalities. Watershed management must go beyond these municipal boundaries. The designations used to identify each sub-watershed were arrived at by the HHPC. Although they may not be totally accurate with respect to the municipal boundaries seen within that sub-watershed, they reflect the general geography of each sub-watershed.

The boundaries and general land use characteristics of each sub-watershed are presented below in Sections 2.4.1 through 2.4.12. As introduced earlier, the sub-watershed delineations are based on drainage basin divisions created by topographical features, roadways and stormwater structures. Table 2-2 and Figure 2-1 show a comparison of the developed and undeveloped land within each sub-watershed.

Map 7. Land Use/Land Cover

Figure 2-1. Hempstead Harbor Watershed - Land Use Characteristics

Figure 2-2. Comparison of Developed and Undeveloped Land by Sub-watershed

Table 2-1.
Sub-watershed Areas and Land Use Characteristics

Subwater-shed	Land Use Class (Area in Hectares and Percentage of Total Area)								
	Urban/ Res.	Recreation	Agriculture	Forested	Wetlands	Grass-land	Beach	Surf. Water	Total
1 Locust Valley	167.67 63.25%	59.75 22.54%	0 0%	24.1 9.09%	13.34 5.03%	0 0%	0 0%	0.24 0.09%	265.1
2 Glen Cove North	144.37 75.91%	17.71 9.31%	0 0%	21.64 11.38%	4.32 2.27%	0 0%	1.57 0.83%	0.57 0.3%	190.18
3 Old Brookville	2837.47 82.31%	48.67 1.41%	37.81	458.69 13.31%	10.48 0.3%	30.59 0.89%	4.45 0.13%	19.06 0.55%	3447.22
4 Sands Point North	121.28 58.06%	3.11 1.49%	0 0%	45.15 21.62%	23.77 11.38%	0 0%	14.48 6.93%	1.09 0.52%	208.88
5 Sands Point South	29.24 25.16%	76.94 66.2%	0 0%	5.54 4.77%	0 0%	0 0%	4.21 3.62%	0.29 0.25%	116.22
6 Glen Cove North	129.94 86.98%	8.56 5.73%	0 0%	9.63 6.45%	0 0%	0.13	1.09 0.73%	0.04 0.03%	149.39
7 Mott Point	153.21 75.55%	4.64 2.29%	0 0%	31.4 15.48%	1.09 0.54%	0 0%	12.36 6.1%	0.08 0.04%	202.78
8 Sea Cliff	659.44 89.09%	38.44 5.19%	0 0%	29.43 3.98%	0.88 0.12%	0 0%	7.35 0.99%	4.63 0.63%	740.17
9 Port Washington	348.05 64.45%	112.48 20.83%	0 0%	48.99 9.07%	9.13 1.69%	0 0%	10.26 19%	11.09 2.05%	540
10 Flower Hill	73.5 87.71%	0 0%	0 0%	7.34 8.76%	2.96 3.53%	0 0%	0 0%	0 0%	83.8
11 Roslyn East	131.55 70.56%	27.33 14.66%	0 0%	23.53 12.62%	0.29 0.16%	0 0%	0 0%	3.73 2%	186.43
12 Roslyn West	188.38 91.5%	1.75 0.85%	0 0%	13.94 6.77%	0 0%	0 0%	0 0%	1.81 0.88%	205.88
Total Area	4984.10 78.66%	399.38 6.3%	37.81 0.6%	719.38 11.35%	66.26 1.05%	30.72 0.48%	55.77 0.88%	42.63 0.67%	6336.05

Table 2-2.
Total, Developed and Undeveloped Area by Sub-watershed

Sub-watershed	Area (hectares)	Developed Land	Undeveloped Land
1 - Locust Valley	265.1	227.42	37.68
2 - Glen Cove North	190.17	162.08	28.09
3 - Old Brookville	3447.21	2923.95	523.26
4 - Sands Point North	208.88	124.39	8449
5 - Sands Point South	116.22	106.18	10.04
6 - Glen Cove South	149.4	138.5	109
7 - Mott Point	202.77	157.85	44.92
8 - Sea Cliff	740.17	697.88	42.29
9 - Port Washington	540	460.53	79.47
10 - Flower Hill	83.81	73.5	10.31
11 - Roslyn East	184.83	158.88	27.55
12 - Roslyn West	205.88	190.13	15.75
Total	6334.04	5421.29	914.75

Undeveloped Land = forested+wetlands+grassland+beach+surface water
Developed Land = urban/residential+recreation+agriculture
2.47 hectares = 1 acre

For purposes of this analysis, developed land was defined as urban/residential, recreational and agricultural land. Undeveloped land was defined as forested areas, wetlands, grassland, surface waters and beaches. As depicted in Figure 2-2, the majority of the Hempstead Harbor watershed is developed. The following sections present general descriptions of each sub-watershed and its boundaries. It must be noted that the sub-watershed boundaries are determined by topographic features and influenced by roads and infrastructure. The sub-watershed boundaries do not follow roads or established features. Thus, the sub-watershed boundary descriptions are an approximation of that depicted graphically on Map 2.

For those sub-watersheds where additional important features exist (e.g. Superfund sites, other areas of concern or important landscape attributes) that may impact the water quality of the Harbor, additional details are presented in the following sub-sections.

2.4.1 Sub-watershed 1 - Locust Valley

The Locust Valley sub-watershed (Figure 2-3), located in the northeastern portion of the study area, is comprised primarily (approximately 85%) of developed land (urban/residential and recreation). Small areas of forested land and wetlands exist in this sub-watershed. Sub-watershed 1 is bounded to the southwest and west by a northwesterly line that runs from Woolsey Road to the Harbor, parallel and just east of Crescent Beach Road. The eastern boundary is formed by an easterly line that runs parallel to and north of Landing Road and Forest Avenue to east of Walnut Road. The western and northwestern boundaries are formed by the Harbor.

2.4.2 Sub-watershed 2 - Glen Cove North

The Glen Cove North Watershed (Figure 2-4), located in the northeastern portion of the study area and to the north of Glen Cove Creek, is another sub-watershed that is comprised primarily of developed land (approximately 85%). This sub-watershed also contains small areas of forested land and wetlands. Sub-watershed 2 is bounded to the *southwest and west* by the Harbor. The *southeastern* boundary is formed by an easterly line that runs parallel and just north of Landing Road to just east of the intersection of Crescent Beach Road and Woolsey Road. The *northeastern* boundary is formed by a northwesterly line that runs from Woolsey Road to the Harbor, parallel and just east of Crescent Beach Road.

2.4.3 Sub-watershed 3 - Old Brookville

Sub-watershed 3 (Figure 2-5) covers approximately one-half of the study area and is located on the eastern side of the Harbor. This sub-watershed is also primarily developed (approximately 85%). The Old Brookville sub-watershed contains the only agricultural land delineated within the study area. This area is comprised of horse farms. The undeveloped land which is present within this sub-watershed is relatively fragmented, although several moderately large areas of forested land are present in the southeastern portion of this watershed, southeast of Northern Boulevard.

Sub-watershed 3 is bounded to the *west* by a line along Glen Cove Avenue from the intersection with Bryant Avenue to just north of Sea Cliff Avenue, then turning more north to Greenvale-Glen Cove Road, then west to Glen Cove Creek, along the creek and then north to just northwest of Landing Road. The *northwestern/northern* boundary is formed by an easterly line running from just north of Landing Road and continuing approximately parallel to Landing Road

Figure 2-3. Sub-watershed #1 - Land Use Characteristics

Figure 2-4. Sub-watershed #2 - Land Use Characteristics

Figure 2-5. Sub-watershed #3 - Land Use Characteristics

and Forest Avenue to Skunk's Misery Road to the intersection of Skunk's Misery Road and Weir Lane. The *north/northeastern* boundary is formed by a line beginning just east of the intersection of Skunk's Misery Road and Weir Lane traveling approximately south to approximable Forest Pond Road and Pound Hollow Road, then more easterly to Piping Rock Road to Wolver Hollow Road to the intersection of Swamp Road and Wheatley Road and then traveling more east along Cedar Swamp Road.

2.4.4 Sub-watershed 4 - Sands Point North

This sub-watershed (Figure 2-6) is approximately 60% developed (urban/residential and recreation); however, approximately 25% of the land in this sub-watershed is still forested. A private bird sanctuary is also located on Prospect Point. Overall, this is the least developed sub-watershed in the study area. It should also be noted that the majority of the residential development in this sub-watershed occurs on large (greater than one acre) lots. Sub-watershed 4 is bounded to the *east* by Longwood Road, to the *north* by Hempstead Harbor/Long Island Sound, and to the *west and south* by Middleneck Road.

2.4.5 Sub-watershed 5 - Sands Point South

This sub-watershed (Figure 2-7), as shown in Table 2-2, is primarily developed; however, the development in this area is of a recreational nature, not urban/residential. The Sands Point Park and Preserve comprise the majority of the recreational land. Only 25% of this watershed is developed for urban/residential purposes. Much of the residential development in this area consists of large lots. A large tract of forested land does exist in the western portion of this sub-watershed.

Sub-watershed 5 is bounded to the *west* by Longwood Road, to the *southwest* by Middle Neck Road and to the *north* by Hempstead Harbor/Long Island Sound. The *eastern* border cuts northwest from approximately the intersection of Old House Road and Forest Road, through Shorewood Drive and Elm Court to the Harbor.

Figure 2-6. Sub-watershed #4 - Land Use Characteristics

Figure 2-7. Sub-watershed #5 - Land Use Characteristics

2.4.6 Sub-watershed 6 - Glen Cove South

This sub-watershed (Figure 2-8) is primarily comprised of developed (urban/residential and recreation) land (approximately 92%). The Glen Cove South sub-watershed is located adjacent to Glen Cove Creek, the dominant feature in the sub-watershed. As will be described below, the creek waterfront contains a significant industrial district.

Sub-watershed 6 is bounded to the *northwest* by Glen Cove Creek. The *northern* boundary is formed by an easterly line that runs from the terminus of the creek to the intersection of Greenvale-Glen Cove Road and Town Path. The *southern* boundary is formed by an easterly line from the Harbor just north of Front Street to the intersection of Glen Avenue and Glen Cove Avenue. The *eastern* boundary is formed by a northerly line that runs from the intersection of Glen Avenue and Glen Cove Avenue along Glen Cove Avenue, then parallel to the railroad tracks to the intersection of Greenvale-Glen Cove Road and Town Path.

Glen Cove Creek is an approximately one mile long channel which represents extensive man-made alterations of the tidal estuary by the United States Army Corps of Engineers (ACOE), beginning in 1925. Initial alterations were completed in 1929 and Glen Cove transferred title to ACOE in return for routine dredging of the channel every ten years; the most recent dredging was in 1964/65. A May 1994 bathymetric study by ACOE identified severe shoaling in several portions of the creek. As part of the City of Glen Cove Waterfront Revitalization Plan, the City is planning on dredging the majority of the creek. Phase One of this project, near the mouth of the creek, began in late 1996. The waterfront was designated as a maritime center and an historic maritime center by NYSDOS.

Approximately 85% of the structures within the City of Glen Cove are connected to the sewer system; the remaining 15% include vacant lots and areas of the city not accessible to sewer lines. City ordinances require that all commercial and industrial users be connected to the sewer system; lots not connected to the public system use individual septic systems approved by the Nassau County Department of Health.

2.4.6.1 Glen Cove Sewage Treatment Plant

The Glen Cove Sewage Treatment Plant (STP) located on Morris Avenue (Sub-watershed 6) underwent extensive modifications in 1981. It has a capacity of 8 million gallons per day; approximately 4.5 mgd of that capacity is currently utilized. The STP is designed to provide secondary sewage treatment with additional oxidation of ammonia to nitrate after accelerated bacterial decomposition of organic wastes. An industrial wastewater pretreatment program

Figure 2-8. Sub-watershed #6 - Land Use Characteristics

monitored by NYSDEC and USEPA is in place at the STP.

The 1996 Interstate Sanitation Commission Annual Report described recommended retrofits for the Glen Cove STP as set forth in the Long Island Sound Study (LISS). Basically, this involves upgrade of the plant to tertiary treatment capability. The biological nutrient removal modifications are expected to incur capital costs of approximately $3.5 million.

2.4.6.2 Captain's Cove/Gatsby's Landing

The Captain's Cove site, also known as Gatsby's Landing, is held in trust by the Maryland Deposit Insurance Fund pursuant to federal bankruptcy laws. This proposed housing complex of 238 units located at the end of Garvies Point Road is situated on land formerly used as the City of Glen Cove landfill. Plans to develop the site were proposed when Village Green Realty purchased the site in 1981 from the City of Glen Cove. Construction began in 1984-5, but was halted after test results indicated the presence of arsenic, barium, cadmium, chromium, lead, mercury and silver above safe limits. The condominium shells are still standing. The site is now listed in the New York State Registry of Inactive Hazardous Waste Disposal Sites.

A Remedial Investigation/Feasibility Study (RI/FS) was commenced in 1989 under a Consent Order with NYSDEC; however, remediation efforts were halted when low level radioactive wastes were discovered. A surficial investigation revealed that the radioactive contamination was limited to two discrete portions of the property. EPA has agreed that the source of radioactive materials was residuals of tungsten ore processed at the Li Tungsten site and disposed of at the Captain's Cove site. The City of Glen Cove, State of Maryland and NYSDEC are currently conducting a remedial investigation. There is the potential for contaminated groundwater from this site to reach and impact Glen Cove Creek.

2.4.6.3 Powers Chemco

The Powers Chemco site is located on Charles Street in Glen Cove. This facility is listed as a New York Superfund site due to the presence of leaking drums of solvent waste which were buried by the previous owner (Columbia Ribbon and Carbon). The presence of the drums has resulted in the contamination of soil and groundwater, primarily by toluene. The site is currently undergoing active remediation which was scheduled to be completed by summer 1996. Treated wastewater is presently discharged to the City of Glen Cove STP; however, the treated wastewater was previously discharged to Glen Cove Creek. Currently only non-contact cooling water is discharged to surface waters by Konica Imaging, the current occupant.

2.4.6.4 Li Tungsten

Li Tungsten is an abandoned, industrial facility that is listed on the Federal Superfund (National Priority List) list. The 26-acre site located at 63 Herb Hill Road in Glen Cove was owned from the 1940's to around 1984 by Wah Chang Smelting and Refining Company and was last operated by its wholly owned subsidiary, Li Tungsten Corporation. Prior to 1942, the site was occupied by a coal and lumber yard (late 1800's) and the Ladew Leather Belting Company (early 1900's). The National Reconditioning Company constructed a tungsten processing facility on the site in 1942. Site operations involved the processing of ore and scrap tungsten concentrates to ammonium paratungstate and subsequently formulating metal tungsten powder and tungsten carbide powder. Other products included tungsten carbide powder plus cobalt, tungsten titanium carbide powder, tungsten spray powder, crystalline tungsten powder and molybdenum spray powder.

The Glen Cove Development Corporation (GCDC) purchased the property in 1984 for residential development purposes. The GCDC performed extensive initial cleanup activities in 1988, including the removal of two tanks, one tank truck, over 100 drums, and identifiable lab chemicals; 13 additional monitoring wells were also installed. Sampling of 10 existing monitoring wells identified four contaminant plumes containing chlorides, sulfates, lead, cadmium, tungsten, chromium, arsenic, barium, silver and polychlorinated biphenyls (PCBs). Interim remedial activities have revealed that the majority of the waste was placed above ground; no evidence has been found to indicate the presence of extensive landfilled waste.

This facility held SPDES permit #NY008249, which expired in 1987. This permit conditionally allowed treated wastewater discharges to Glen Cove Creek and two additional discharge points for non-contact cooling water.

The site, which was proposed for the National Priority List (NPL) in 1991 and listed in 1992, is currently in the site stabilization stage in order to ensure worker safety during the remedial investigation, which is also in process. USEPA is conducting a remedial investigation/ feasibility study. The state of Maryland currently holds this property in trust pursuant to bankruptcy laws.

2.4.6.5 Mattiace Petrochemical Company, Inc.

The Mattiace Petrochemical Co, Inc. is a two-acre inactive chemical distribution facility on Garvies Point Road in Glen Cove. It is listed on the Federal Superfund List. From the mid-1960's to 1987 this facility received chemicals by tank truck and redistributed them to customers. The M&M Drum Cleaning company also operated at the site until 1982. In 1980, NYSDEC discovered that drums containing volatile organic compounds (VOCs) were buried onsite and wastewater from drum cleaning operations was being discharged into subsurface leaching pools. VOCs have been found in soil and shallow groundwater. The State seized the property in 1987 and it was listed on the NPL in

1989. USEPA is funding the cleanup of the site.

The site is reportedly saturated with chemicals. USEPA has removed more than 120,000 gallons of bulk or waste liquids from the site. Two remedial investigation/feasibility studies have been completed. A remedial action completed in late 1996 included the removal of all site structures, underground storage tanks (USTs), piping and other buried structures were removed during this action. Final remedial design was scheduled to be completed by November 1996; soil and groundwater remediation units were scheduled to be constructed in the Spring of 1997. The selected remedy includes removal of the groundwater floating product layer, demolition and disposal of site structures, in-situ excavation of pesticide contaminated hot spots and extraction and treatment of contaminated groundwater. The primary threat to the Harbor from this site is via stormwater runoff to Glen Cove Creek.

2.4.6.6 Fuel Storage Facilities

Two fuel storage facilities are located within this sub-watershed: Windsor Fuel and Hawkins Cove Fuel Company, both in Glen Cove.

2.4.6.7 Cedar Swamp Creek

Cedar Swamp Creek drains into Glen Cove Creek. It originates south of Northern Boulevard in Brookville and flows north to Pratt Pond. This creek system drains 8,128 acres, much of it outside the Hempstead Harbor watershed. Cedar Swamp Creek and its watershed (primarily Sub-watershed 3) have long been suspected of contributing to the high coliform levels experienced by the Harbor. This creek has an annual flow of 5.1 million gallons per day and an average coliform level of 9551 mpn/100 ml (most probable number per 100 milliliters), which has led the NCDH to attribute impaired water quality (e.g. elevated coliform levels) at Sea Cliff Village Beach and other local beaches to Cedar Swamp Creek's influence. A 1991 sanitary survey conducted by NCDH suggested no correlation between creek water quality and direct sewage contamination, thus suggesting that the coliform levels are attributable to stormwater runoff or illegal septic connections to the stormwater collection system.

2.4.6.8 Mill Pond/Pratt Pond

Pratt Pond, which is also known as Mill Pond, is the remains of a large man-made pond created by the founders of Glen Cove to provide water power for saw and grist mills. This pond formerly served as a natural sediment trap for the freshwater portion of Glen Cove Creek which drains an 11 square mile area. A re-engineering project in the 1950's resulted in the loss of the pond's role as a natural retention basin. As a result, sediments associated with urban runoff are now no longer retained in the pond, but instead are transported directly into Glen Cove Creek. The pond is currently overgrown with vegetation. The City of Glen Cove is planning to design a restoration project for Mill Pond as part of its Waterfront Revitalization Program.

2.4.7 Sub-watershed 7 - Mott Point

Sub-watershed 7 (Figure 2-9) is primarily developed (approximately 80%). A few relatively substantial forested areas are located adjacent to the Harbor. Sub-watershed 7 is bounded to the *north* by Hempstead Harbor/Long Island Sound and to the *east* by Roslyn-West Shore Road. The *western* boundary is a northwesterly line from approximately the intersection of Old House Road and Forest Road to the Harbor. The *southern/western* boundary is a southeasterly line from the Old House Road/Forest Road intersection to approximately the intersection of Roslyn-West Shore Road and Hillcrest Road.

2.4.8 Sub-watershed 8 - Sea Cliff

This sub-watershed (Figure 2-10) is nearly 95% developed. Small patches of forest exist throughout the sub-watershed. Sub-watershed 8 is bounded to the *south* by an easterly line that runs from the Harbor, just south of Harbor Lane to Motts Cove Road and turns north to the intersection of Bryant Avenue and Glen Cove Avenue. The *eastern* boundary is formed by Glen Cove Avenue from the intersection with Bryant Avenue, north to the intersection with Glen Avenue. The *northern* boundary is formed by a line from the Glen Avenue/Glen Cove Avenue intersection west to the Harbor past Front Street, just south of Glen Cove Creek. The Harbor forms the *western* boundary.

Prior to 1987, the Roslyn STP discharged approximately 0.52 MGD of secondary treated effluent into the Harbor (Sub-watersheds 8, 11 and 12). The Roslyn STP was closed in 1987 and the flow diverted to the Cedar Creek Water Pollution Control Plant. At that time, extensive rehabilitation was performed on the collection system; a pump station and force main were installed at Skillman Street.

Figure 2-9. Sub-watershed #7 - Land Use Characteristics

Figure 2-10. Sub-watershed #8 - Land Use Characteristics

2.4.8.1 Penetrex Company

The Penetrex Company site is located on Shore Road in Glenwood Landing. A dry cleaner leased this site, but shut down and went out of business after being cited by NYSDEC for contaminating a cesspool with tetrachloroethylene; four other halogenated hydrocarbons and toluene were found in the cesspool. The site owner cleaned up the cesspool, but further work may be required. There is currently no indication as to whether Hempstead Harbor was affected.

2.4.8.2 Shore Realty/Applied Environmental Services

The first commercial use of this 3.1 acre Federal Superfund site was as an oil depot in 1939. Prior to 1980, the Shore Realty site was leased and operated by Mattiace Petrochemical. Several spills occurred during that time, including one involving approximately 3,000 gallons of toluene from a tractor trailer. Applied Environmental Services (a.k.a. Phillips Petroleum Co.) recovered fuels from hazardous wastes from 1980 to 1983 and operated a toxic waste facility without a permit until 1983. Spills, leaks and other activities left onsite soil, groundwater and surface waters contaminated. The current owner, Shore Realty, purchased the property in 1983 and evicted AES in 1984; the site has been inactive since. In 1985 and 1988, leachate was observed seeping into Hempstead Harbor through the bulkhead. The site was listed on the NPL in 1986.

The State took over cleanup of this site. The State and EPA have observed leaking barrels, tanks of solvents and an oil sheen in Motts Cove. Three public water systems in the area were monitored and were free of site-related contaminants. Onsite monitoring wells revealed contamination from VOCs, including xylene and toluene in groundwater. Sediments were contaminated with PCBs and VOCs; onsite soils were also contaminated with VOCs. It is believed that toluene seeped into the Harbor. This site has now been classified as remediated, and is now monitored.

The Nassau County Department of Health conducted a study in the wetland area of Motts Cove, near this facility, in the mid-1980's after the Department determined that leachate contaminated with organic chemicals was seeping through the bulkhead of the property. The study focused on the biological component of the ecosystem. Based on the various ecological parameters (e.g. species composition and diversity, total number of organisms) three zones of impact were identified: the most severely stressed biosystem occurs on the bulkhead and in the adjacent sediments of the near shore zone; the next area includes the water column and sediment of the midcove area; the least impacted area was the water and substrate of the outer cove area. The organisms observed were those that would be found in the area under normal conditions. Chemical sampling by NCDH did not indicate the presence of any known constituents of the leachate beyond the immediate cove area, including at the three closest area beaches.

2.4.8.3 Long Island Lighting Company (LILCO)

The LILCO - Glenwood Power Plant is located on the eastern shore of the Harbor in Glenwood Landing. This approximately 13.5 acre electric power generating plant and distribution facility is located on both sides of Glen Cove-Roslyn Shore Road. LILCO maintains an oil storage tank farm south of the substation, on the eastern side of Glen Cove-Roslyn Shore Road. Several high voltage power distribution lines pass under the Harbor near the Bar Beach peninsula and connect LILCO with electric power stations to the west. The primary discharges from this facility are non-contact cooling water and yard runoff. Effluent control parameters are in place for water temperature, suspended solids, oil and grease.

2.4.8.4 Petroleum Facilities

The Harbor Fuels petroleum receiving and distribution depot is located south of LILCO on the western side of Glen Cove-Roslyn Shore Road in Glenwood Landing (Sub-watershed 8). This facility receives large waterborne barge deliveries of oil. Another fuel storage facility, Mobil, is also located in Glenwood Landing.

2.4.8.5 Scudder's Pond

Scudder's Pond has a surface area of 1.6 acres. Water sources to the pond include spring tributaries from a wet forested area to the east, storm flows which join those tributaries and fresh water seepage from the south shore. The pond was created in 1905 when a stream that traveled through wetlands to the Harbor was dammed. The infilling of the pond began when a large estate was cleared in the 1950's. During this period the concrete dam located on the upper pond was destroyed. These activities allowed silt to flow freely into Scudder's Pond. Construction of homes adjacent to Littleworth Lane also allowed additional sediment to flow into the pond. Scudder's Pond was dredged in 1980, but no stormwater treatment measures were implemented. A smaller, rear pond formerly intercepted the forested source, but is now filled with silt and has evolved into a marsh. Scudder's Pond itself has also been impacted by sediment influx. The bottom is characterized by several feet of accumulated organic silts. The outflow from Scudder's Pond empties under Shore Road into Tappen Beach. A 1973 study conducted by the Nassau County Department of Health stated the Department's belief that there was "no doubt the discharge from this storm drain is increasing the coliform concentrations of bathing waters in the immediate area of Tappen Beach" (Mafrici, 1973).

2.4.8.6 Powerhouse Drain

The Powerhouse storm drain, located north of the LILCO facility in Glenwood Landing, is a tributary system that consists of three parts: a stream between Kissam Lane and Glenwood Road, and the Glenwood Road and Kissam Lane storm drainage systems. The system provides storm drainage for approximately 3.5 square miles of Glenwood Landing and discharges more than 1 million gallons per day even in dry weather (NCDH, 1977). Although this system has historically been a major contributor of bacteria to the Harbor, the 1986 *Surface Water Quality Assessment Report* (NCDH) identified no direct sewage violations that would explain the high coliform bacteria levels. The report stated that the department believed private septic systems were likely the cause.

2.4.9 Sub-watershed 9 - Port Washington

The Port Washington sub-watershed (Figure 2-11) is one of the larger sub-watersheds, and is approximately 65% developed for urban/residential purposes. A relatively large portion of the sub-watershed, approximately 21% of the land area, is utilized for recreational purposes. Hempstead Harbor Beach Park and the Bar Beach Park are located within this sub-watershed.

Sub-watershed 9 is bounded to the *west* by Roslyn-West Shore Road and to the *north and east* by the Harbor. The *southwestern* boundary is formed by a southeasterly line from approximately the intersection of Hillcrest Road and Roslyn-West Shore Road, turning east to Woodland Road and becoming more easterly and traveling to the Harbor and ending just above the Roslyn Viaduct.

2.4.9.1 Town of North Hempstead Incinerator/Landfill Facility

The Town of North Hempstead incinerator facility was located on the western shore of the Harbor, along West Shore Road. Constructed in 1967, the incinerator was shut down in the early 1970's after its operation violated air quality standards. The facility was also utilized as a shredding/baling facility for solid waste. A fully enclosed transfer station was recently constructed to replace these facilities.

The Port Washington Landfill, located on the western side of the Harbor in an area that was formerly excavated for commercial sand mining, is an 85 acre site owned and operated by the Town of North Hempstead. Construction of the landfill also began in 1967.

Figure 2-11. Sub-watershed #9 - Land Use Characteristics

Construction of Landfill Cell L4 began in 1972; this cell was utilized until 1981-2 for disposal of municipal solid waste generated in the Town of North Hempstead. Construction and demolition debris and yard waste were also disposed of in L4. L4 was added to the Federal Superfund list in 1983 following the discovery of organic chemicals in groundwater monitoring wells. It is believed that this groundwater contamination is the result of the disposal of spent dry cleaning chemicals in L4. A comprehensive remediation program involving the rehabilitation of the landfill gas combustion system, groundwater remediation and capping is currently in progress.

Following the closure of L4, Landfill Cell L5 commenced operation. L5 is a sanitary landfill and was designed in accordance with State requirements. L5 contains an impervious plastic liner to retain leachate which is treated and discharged to the municipal sewers. The State of New York closed L5 in 1991 following chronic odor problems attributable to the release of hydrogen sulfide. A horizontal landfill gas collection system was installed in 1991 and continues to function effectively. The Town of North Hempstead submitted an initial application for Clean Air/Clean Water bond Act Funding to close and cap the L5 section of the landfill.

Nassau County Department of Health (NCDH) reports from the 1970's indicated that the landfill/incinerator complex historically may have contributed to the water quality problems, in particular high coliform bacterial levels, experienced in Hempstead Harbor. Sources of bacteria from the landfill include surface runoff, seepage through the fill, tidal exchange with the fill and discharge from the treatment lagoon. The *1972 Hempstead Harbor Survey Report* (NCDH) stated that "coincidentally bacteria counts in the Harbor began deteriorating significantly at the same time the incinerator was installed." This was echoed in the 1974 water quality assessment report and a 1973 memo (Scanlon, 1973) regarding bacteriological sampling in Hempstead Harbor. Currently, the incinerator no longer exists and landfill has been closed; final capping of the last landfill cell will be implemented in the near future.

2.4.9.2 Morewood Property

The Morewood Property is an approximately 450 acre site that was formerly mined by the Colonial Sand and Gravel Company. The Town of North Hempstead currently has an approved development plan for this site, which will include a municipal golf course, driving range, 675 units of senior citizen housing and 165 acres of open space.

The initial stages of this project are designed to include the expansion and enhancement of wetlands, stabilization of eroding cliffs and removal of assorted debris. The site restoration will involve several active and passive recreational opportunities for Town Residents, including construction of a golf course. A portion of the site will contain senior citizen housing. The project area will be connected to the Port Washington Water Pollution Control District.

2.4.10 Sub-watershed 10 - Flower Hill

This sub-watershed (Figure 2-12) was the smallest of those delineated within the study area. The Flower Hill sub-watershed is nearly 90% developed land, with only small portions of forested land remaining. Sub-watershed 10 is bounded to the *northeast* by Hempstead Harbor and to the *southeast* by North Hempstead Turnpike. The *northern* boundary is formed by a southeasterly/easterly line from just southeast of the intersection of Country Club Drive and Greenbriar Lane to the Harbor. The *western/southwestern* boundary is formed by a southerly line from just southeast of the intersection of Country Club Drive and Greenbriar Lane to the Roslyn Viaduct/North Hempstead Turnpike.

2.4.11 Sub-watershed 11 - Roslyn East

Approximately 70% of this sub-watershed (Figure 2-13) is utilized for urban/residential purposes. An additional 15% is designated as recreational land, primarily within the William Cullen Bryant Preserve. This sub-watershed also contains a relatively high percentage (13%) of forested land, which is fairly fragmented. Sub-watershed 11 is bounded to the *west* by the Harbor and a line that runs south from the Harbor to a point perpendicular to Garden Street. The *eastern* boundary is formed by a line that begins slightly south of Roslyn Road and follows just east of the railroad tracks to the intersection of Glen Cove Road and Northern Boulevard, then turns more northwest and continues to the intersection of Glen Cove Avenue and Bryant Avenue. The *northwestern* boundary is formed by an easterly line that runs from the Harbor just south of Harbor Lane to Motts Cove road and turns north to the intersection of Bryant Avenue and Glen Cove Avenue.

2.4.11.1 Roslyn Creek and Roslyn Pond Complex

Roslyn Creek, which extends from Old Mill on Northern Boulevard approximately 1,000 feet northwest to the terminus of Hempstead Harbor, is largely bulkheaded. Riparian areas over time have been filled and developed. Due to its position at the base of Hempstead Harbor, the creek serves as a sediment and nutrient trap. The creek bottom is composed of fine silts that are likely the accumulation from former sand mining operations on West Shore Road. The sediment deposition from these operations severely limits entrance to the creek.

The Town of North Hempstead's Roslyn Pond Park complex consists of two main and four smaller ponds. The upper main pond is known as Roslyn Pond. The lower main pond, known as Silver Pond, is surrounded by private property. Fifteen stormwater outfalls discharge to Roslyn Pond and the tributary ponds and streams. The pond complex receives runoff from the adjacent residential areas.

Figure 2-12. Sub-watershed #10 - Land Use Characteristics

Figure 2-13. Sub-watershed #11 - Land Use Characteristics

Roslyn Creek is fed primarily by stormwater runoff. The creek's configuration reduces flushing which in turn increases the opportunity for the deposition and retention of silts and sands (Abeles, Phillips, Preiss and Shapiro, Inc., 1996). Water quality in the creek has deteriorated as a result of runoff.

Coliform levels in Roslyn Creek tend to be high, due to contamination from the upstream ponds. A chlorination system was formerly utilized to treat water as it flowed past the old mill into the pond; however, NCDH personnel indicated that this system is no longer in operation (Personal Communication, February 1997).

2.4.12 Sub-watershed 12 - Roslyn West

The Roslyn West sub-watershed (Figure 2-14), located at the western side of the base of the Harbor, is more than 90% developed. Very little forested land exists within this sub-watershed. Sub-watershed 12 is bounded to the *northwest* by North Hempstead Turnpike and to the *west* by Searingtown Road. The *northeastern* border is formed by the Harbor and a line running south from the Harbor to south of Garden Street. The *southern* boundary is formed by a line from Searingtown road across Dianas Trail to Willis Avenue and continuing parallel to and south of Warner Avenue and Garden Street to a point perpendicular with the Harbor.

2.4.12.1 Viaduct Drain System

The Roslyn Viaduct Drain System, another historical contributor of coliform bacteria to the Harbor, consists of three concrete pipes that discharge stormwater from below the western side of the creek. These pipes drain West Shore Road from an area just south of the Roslyn water works to the area of the Town of North Hempstead transfer station and extends as far west as Willis Avenue.

Figure 2-14. Sub-watershed #12 - Land Use Characteristics

2.5 Recreational Land Uses

2.5.1 Marinas

Hempstead Harbor supports a fleet of approximately 750 recreational vessels. In general, these are berthed at nine marinas throughout the Harbor, seven of which are in the immediate vicinity of Glen Cove. However, the data suggest that there may be small (e.g. five to ten boats) clubs/docks that are not included in the inventories contained within the major data sources.

The majority (8) of the marinas in Hempstead Harbor are private facilities (Table 2-3). There is one (1) public marina in the Harbor. The marinas are serviced by a total of three pumpouts and one dump station. The Harbor would benefit from a public awareness program to encourage the use of these facilities.

There is some dispute as to the impact of recreational vessels on overall water quality. Congress has determined in its findings of the Clean Vessel Act that, in general, the "sewage discharged by recreational vessels because of an inadequate number of pumpout stations is a substantial contributor to localized degradation of water quality in the United States." However, although boating may be responsible for localized water quality problems, it is only a minor contributor to the degradation of overall water quality in the United States. Studies have found that water pollution attributable to boating is minimal when compared to non-point sources such as runoff (Faust, 1978).

Table 2-3.
Marinas in the Hempstead Harbor Watershed

Name/Address	# slips	Pumpout[4]	Dump Station[5]	Fuel	Repairs	Public/ Private
Glen Cove Marina **76 Shore Road** **Glen Cove**	170	YES	NO	G/D	YES	Private
Glen Cove Yacht Service **88 Shore Road** **Glen Cove**	200	YES	YES	G/D	YES	Private
Brewer Yacht Yard **128 Shore Road** **Glen Cove**	130	YES	NO	NO	YES	Private
Glen Cove Yacht Club (1) **McLaughlin Street** **Glen Cove**	40	YES	YES	NO	NO	Private
Hempstead Harbor Yacht Club(1) **Garvies Point Road** **Glen Cove**	100	NO	NO	NO	NO	Private
Sea Cliff Yacht Club(1) **42 The Boulevard** **Sea Cliff**	80	NO	NO	NO	NO	Private
Glen Cove Angler's Club **Garvies Point Road** **Glen Cove**	36	NO	NO	NO	NO	Private
Burtis Boatworks(2) **Glenwood Landing**						
Tappen Beach and Marina(3) **Oyster Bay**	279	YES	NO	G/D	NO	Public

(1) Utilizes the federal "special anchorage" area to the west of and adjacent to Glen Cove
(2) Coastal has attempted to contact this boatyard, but phone calls have not been returned.
(3) Disposal facility for used oil.
(4) pumps or receives sewage from Type III MSD's
(5) facility designed to receive sewage from portable toilets
G = gasoline, D = diesel

2.5.2 Golf Courses

Golf courses occupy more than 5,000 acres of land in Nassau County and are the "predominant recreational use in the Hempstead Harbor Reach " (Shoreline Reach Analysis No. 3, LISCMP, 1985). Eleven private courses and one public golf course lie within the watershed:

Brookville Country Club	Cedar Brook Country Club	Christopher Morley Park (public)
Engineers Country Club	Glen Head Country Club	Glen Oaks Country Club
Meadow Brook Club	Nassau Country Club	North Hempstead Country Club
North Shore Country Club	Old Westbury Country Club	Village Club of Sands Point

Of interest in many watersheds is the effect that golf courses have on surface and groundwater resources. With the advent of Integrated Pest Management (IPM), there has been an increasing awareness within the golf course industry to better manage and judiciously utilize pesticides and fertilizers. As such, many recently constructed or IPM-managed facilities generate no more, and often less, pollutant loading than a typical suburban development. IPM should thus be required watershed-wide as a means of limiting the pollutant load from golf courses.

2.5.3 Hempstead Harbor Shoreline Trail

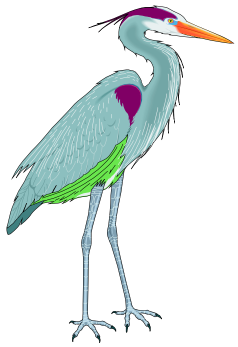
The Town of North Hempstead is currently designing a 1.75 mile recreational trail along the Harbor shoreline from Bar Beach to Flower Hill. The project will include creation of wildlife habitat and the improvement of waterfront access for residents. Several abandoned structures that pose a safety hazard have been removed.

2.5.4 Beaches

There are five permitted bathing beaches located on Hempstead Harbor:

- Hempstead Harbor Park Beach - north of Bar Beach, western side of Harbor
- Bar Beach - just south of Hempstead Harbor Beach, western side of Harbor
- Tappen Beach - south of Mosquito Cove, eastern side of Harbor
- Sea Cliff Beach - north of LILCO, eastern side of Harbor
- IBM Beach - northwestern portion of Harbor

As will be discussed further in Section 3, these beaches have often been closed due to high coliform bacteria levels. Hempstead Harbor Beach, Bar Beach, Tappen Beach and Sea Cliff Beach were all closed for at least one day during the 1991 and/or 1992 swimming seasons (LIRPB, 1993).



3.0 WATER QUALITY STATUS OF HEMPSTEAD HARBOR

Water quality monitoring provides a direct means of measuring the environmental status of a waterbody. By collecting key physical, chemical and biological data, and comparing these data to established standards and/or criteria, it is often possible to quantify water quality degradation. However, to be informative, a water quality monitoring program must be consistent, properly designed and include those parameters that are capable of accurately characterizing a waterbody's condition.

An estuarine environment such as Hempstead Harbor, is a highly dynamic ecosystem. Daily variations are experienced due to tidal exchange in respect to salinity and temperature, both of which can greatly influence mixing processes that effect a host of other key environmental parameters. As such, the water column of an estuary is not uniform in chemical or physical composition from surface to bottom.

Seasonally, because of the use of estuaries by marine organisms as spawning and nursery grounds, significant difference in the biological community's composition can be expected. Equally important, depending on the size and configuration of the estuary, and the daily volume of freshwater inflow, very noticeable differences in the biological community may be observed as one proceeds from the origin to the mouth of the estuary.

These attributes of the estuarine ecosystem are mentioned to highlight the potential natural variability in conditions typical of an estuary. The natural spatial and temporal variability in chemical and biological composition, emphasizes the need to properly design a sampling program for an estuarine environment. Sample station location, sampling depths, and sampling frequency must all be thoroughly developed if the resulting database is to be informative.

Pollutant inputs to Hempstead Harbor originate from point and non-point sources. Documented sources include sewage effluent, runoff from construction sites and storm water runoff from developed areas and roads. In addition, septic systems have been theorized to impact the Harbor's quality as well. For the most part, storm water runoff is responsible for the mobilization and transport of NPS pollutants from upland areas to the Harbor. Thus, inputs from non-point sources are generally greatest during periods of significant rainfall.

Historically, the most important point source inputs to the Harbor, in respect to degradation of water quality were sewage treatment plants. Fortunately, with the decommissioning of the Roslyn sewage treatment plans, the impact of point sources on the Harbor's water quality has declined. However, in the early 1970's, two municipal sewage treatment plants discharged to the Harbor. Studies documented that at least some of the Harbor's problems could be directly attributable to sewage treatment discharges (Gross, et. al., 1972). The Long Island Sound 208 Study (1978) concluded that 72% of the Harbor's nitrogen load was due to sewage treatment plants (Cashin, 1993). This was also clearly demonstrated in the results reported by Gross, et. al. (1972).

Currently, only the Glen Cove sewage treatment plant discharges into the Harbor. It should be noted that, while shortly following the closure of the Roslyn Sewage Treatment Plant, the Nassau County Department of Health (1991) reported that increased coliform counts were measured in the Harbor south of Bar Beach, investigation of the problem was found to be caused by a faulty pump station. Today, only 2% of the Harbor's bacteria load is reported to originate from sewage treatment plants (Cashin Associates, 1993), and most of the attention on pollution management is being focused on NPS pollution inputs.

3.1 History of the Hempstead Harbor Water Quality Monitoring Program

An extensive amount of water quality data has been amassed over the past 30 years on Hempstead Harbor. These data are the result of studies conducted by State, Federal, Interstate and local agencies. Some data compiled on Hempstead Harbor are ancillary components of monitoring efforts associated with various Long Island Sound studies. Other data were generated from studies commissioned specifically for Hempstead Harbor.

In the 1960's, concerns over declining water quality conditions in Long Island Sound stimulated a host of studies and investigations. Many of these studies initiated in the 1960's and 1970's included the establishment of water quality monitoring stations in Hempstead Harbor or at the interface of the Harbor and Long Island Sound. In general, the data compiled in these studies documented Hempstead Harbor as having impacted water quality. Elevated nutrient, bacteria and algal concentrations were commonly reported. Likewise, depressed dissolved oxygen, turbid conditions and localized sedimentation were documented. Data collected during the past 30 years include those of the Interstate Sanitation Commission (ISC), the Nassau County Department of Health (NCDH) and the Coalition to Save Hempstead Harbor (CSHH). All three organizations have maintained designated water quality monitoring stations within the Harbor itself. Although the frequency of sampling has varied over time, as have the monitored parameters, the compiled data provide excellent documentation of the Harbor's status over the past 20 plus years. Selected portions of the data most relevant to the objectives of this study are presented in the main text of this report; the remainder are contained in Appendices B, C and D.

Presently, Hempstead Harbor's water quality is monitored by the Interstate Sanitation Commission (ISC), Nassau County Department of Health (NCDH), the Coalition to Save Hempstead Harbor (CSHH), and the United States Geological Survey (USGS). In the following paragraphs, a description is provided of the standard monitoring efforts of these groups.

The Interstate Sanitation Commission (ISC), an organization founded in the 1930's to monitor pollution in waters shared by New York, New Jersey and Connecticut, monitors water quality at two sites within Hempstead Harbor (Stations HC and HD) and one site near the interface of Hempstead Harbor and Long Island Sound (Station HC1). Monitoring conducted by ISC focuses on temperature, salinity, dissolved oxygen, chlorophyll *a*, and notes unusual occurrences such as algae blooms, floatable debris or biological events. Data are generally collected on a weekly basis during the summer season, with data collected at three stations; Station HC, Station HC1, and Station HD (Map 8). In addition, ISC annually monitors effluent from the Glen Cove STP for total suspended solids, biochemical oxygen demand, settleable solids, total coliform, pH, temperature and turbidity.

The Nassau County Department of Health (NCDH) monitors physical and chemical parameters in accordance with collection and analysis procedures outlined in the 12th Edition of Standard Methods. Sampling has at times been conducted at as many as 13 locations in Hempstead Harbor (Upper Harbor - Stations 10-42, 10-43, 10-44, 10-48, 10-49, 10-49.1, 10-50, 10-50.1 and 10-51; Lower Harbor - Stations 11-45, 11-46, 11-47, 11-402, 11-403 and 11-47.1) The location of each station is shown on Map 8. The NCDH water quality sampling program was significantly reduced in 1991 following the elimination of the County's Bureau of Water Pollution Control due to county budgetary constraints. The NCDH has continued to monitor water quality at many locations, but at a lower level of frequency. Beach areas are still monitored for coliform levels on a bi-weekly basis. Since 1991, the data collected as part of these monitoring efforts have not been published by the NCDH (NCDH, personnel communication, May 1997).

The Coalition to Save Hempstead Harbor (CSHH), also monitors the water quality of Hempstead Harbor using a team of trained, volunteer staff members. The CSHH monitoring program has been in effect since 1992. Five years of data have been collected at three locations that correspond closely with one ISC station and two NCDH stations (Map 8). CSHH monitors water temperature, dissolved oxygen, pH, salinity, air temperature and nutrients.

The United States Geological Survey (USGS) has maintained a flow gauging station on Glen Cove Creek since 1966. Samples have been taken by the USGS at this station, which is within the Mill Pond preserve, adjacent to Glen Cove Avenue. A wide range of chemical and physical parameters is monitored.

Map 8. Sampling Stations

Limited water quality data also has been collected as part of several studies conducted by individuals or groups such as LILCO. In addition to their routine monitoring activities, both ISC and NCDH have conducted various studies (e.g., the Long Island Sound 208 Study) that required intensive sampling in some areas at the expense of others.

For the purpose of this study an extensive amount of water quality data were reviewed. The majority of these data are presented in Appendices A, B, C and D. These data were in part made available through the ISC, NCDH, CSHH and the HHPC. The following analysis (contained in Section 3.4) is based almost exclusively on the ISC and NCDH data owing to the longevity of these data sources. In addition, given the quality control practices followed by both agencies, it could be assumed that the reported data were accurate and representative of the Harbor's water quality trends.

3.2 Water Quality Classifications and Standards

The water quality of Hempstead Harbor is classified by the NYSDEC and the ISC under two different classification systems. Both the NYSDEC and ISC water quality classification systems relate the water quality of the Harbor to its "best usage", such as shellfish production, contact recreation and fishing. Therefore, these two classification systems were designed with an emphasis on protection of human health and aquatic biota.

In addition, both of these agencies have established separate water quality standards as they pertain to their respective water quality classification systems. In order to maintain its current classification, a water body must meet the water standards established by the NYSDEC and ISC.

The NYSDEC classifies the lower Harbor (south of Bar Beach) SB, the upper Harbor SA and the area outside Glen Cove Creek SB. Glen Cove Creek is classified as I. Title 6, Chapter X, Part 701 of the New York State Water Quality Regulations defines these classifications as follows:

> **Class SA saline surface waters**: "The best usages of Class SA waters are shell fishing for market purposes, primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival."
>
> **Class SB saline waters**: "The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival."
>
> **Class I saline waters**: "The best usages of Class I waters are secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival."

The ISC water quality classification system ranks Hempstead Harbor as a Class A water body. Class A water bodies must meet the following definition:

> "Suitable for all forms of primary and secondary contact recreation and for fish propagation. In designated areas, they also shall be suitable for shellfish harvesting."

Table 3-1 provides a synopsis of the standards established by both the ISC and NYSDEC for some of the more important, frequently monitored indicators of environmental "health". As shown in Table 3-1, the ISC has not established standards for the many of the water quality parameters that it currently monitors in the Harbor.

When reviewing this information, it should be noted that these standards function as guidance values. With the exception of bacteria, exceedence of a particular parameter rarely triggers an enforcement action, unless of course the exceedence is caused by a point source discharge. If the bacteria standards are exceeded, beaches may be closed and other water dependent activities may be curtailed. If a point source can be identified, enforcement may occur; however, NPS pollution cannot be traced back to a single source, and therefore the only enforcement is the closure of beaches. Thus, these standards primarily are utilized to establish the consistency of a waterbody's current condition with its designated use. In terms of gauging the impacts of NPS pollution on water quality, these standards have very little relevancy. In fact, the use standards are based on what has been determined by the NYSDEC and/or ISC as the allowable level of degradation, more so than a desirable minimum level of pollution.

Also, it should be noted that although the ISC and NYSDEC utilize the state fecal coliform standard of 200 colonies/100 ml to define the ability of a waterbody to sustain contact recreation, the NCDH relies on a total coliform count of 2400 mpn/100 ml for beach closures. The NCDH has considered using the fecal coliform standard of the State as opposed to their total coliform count. However, given the historical database which exits, the County has decided to continue to monitor and report total coliform counts. The American Public Health Association consider both the County's MPN and the State's and ISC's direct plating technique to be equally appropriate for appraising the sanitary quality of water. A discussion of the State and County data, and their inter-relationship is discussed in more detail in section 3.4.6.

Table 3-1.
Water Quality Standards - ISC and NYSDEC

Parameter	ISC	NYSDEC
Dissolved oxygen	5 mg/L	SA, SB, SC: 5 mg/L
Total Coliform	Log mean for 5 or more samples in a 30 day period shall not exceed 2,400 and 2% of samples in a 30 day period shall not exceed 5,000	SA: The MPN in any series of representative samples shall not be in excess of 70. SB, SC: Monthly median value and more than 20% of the samples, from a minimum of 5 examinations, shall not exceed 2,400 and 5,000, respectively. I: Monthly geometric mean, from a minimum of 5 examinations, shall not exceed 10,000.
Fecal Coliform	Log mean of 5 or more samples in a 30 day period shall not exceed 200 and a single sample shall not exceed 1,000	SA, SB, SC: Monthly geometric mean, from a minimum of 5 examinations, shall not exceed 200. I: Monthly geometric mean, from a minimum of 5 examinations, shall not exceed 2,000.
Suspended, colloidal and settleable solids	No standard has been established	"None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages."
Turbidity	No standard has been established	5 n.t.u.
Phosphorus	No standard has been established	"None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages."
Nitrogen	No standard has been established	"None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages."
pH	No standard has been established	"The normal range shall not be extended by more than 0.1 of a pH unit"

3.3 Overview of Monitored Parameters

The following subsections discuss the relevancy of each water quality parameter in respect to either the appraisal of water quality or the evaluation of biological impacts. The discussion which follows is designed to introduce the reader to the ecological or environmental significance of each parameter. A detailed discussion then follows in Section 3.4 of the relevancy of these parameters based on actual in-filed data reported for Hempstead Harbor.

3.3.1 Chemical and Physical Parameters

Dissolved oxygen is the amount of oxygen present in water in a dissolved state. The concentrations of dissolved oxygen are primarily a function of oxygen inputs, for the most part by atmospheric diffusion and as a by-product of photosynthesis via aquatic plants (including algae). Dissolved oxygen levels are influenced by water depth, turbulence, water temperature (an inverse relationship) and microbial respiration. In general, shallower waters receive larger quantities of atmospheric oxygen since they are closer to the water-air interface. Turbulent waters allow for greater rates of oxygen exchange than calm waters and the solubility of dissolved oxygen increases with decreases in water temperature. Conversely, dissolved oxygen in water can sometimes be completely depleted by excessive rates of microbial respiration. Microorganisms (e.g. bacteria) decompose accumulated organic matter in water through respiration, which requires the use of dissolved oxygen. Therefore, when large amounts of organic matter are present, microbial respiration may result in severe dissolved oxygen depletions.

The relative importance of each of the above factors varies on a time scale of hours to months. Complicating this characterization is the fact that algae and plant growth can elevate dissolved oxygen concentrations during the day through photosynthesis and subsequently deplete dissolved oxygen concentrations during the night via respiration. In addition, both point and non-point discharges often have large oxygen demands, and therefore can depress dissolved oxygen concentrations in waters. Overall, most organisms can grow and reproduce if dissolved oxygen levels are above 5 milligrams per liter (mg/l). Levels below three mg/l are considered hypoxic and below 0.5 mg/l are considered anoxic.

Water temperature is a function of depth, ambient temperature and the amount of mixing due to wind, storms and tides, the degree of stratification, the temperature of water flowing into the water body and human influences. Many estuarine environments become stratified during the summer months. During the spring and summer, the upper layer becomes warmer while cooler waters remain near the bottom. As surface water temperatures increase, the resistance of these two water layers to mix increases due to density differences. This results in a stratified water column with distinct layers. As water temperatures cool in the autumn, surface waters become colder and their density increases. The surface water mass eventually sinks when its density becomes greater than that of the bottom water. As the surface water sinks, mixing occurs and nutrients are carried from the bottom of the estuary to the surface. Temperatures typically remain relatively uniform from top to bottom through the winter. In the spring, the water again mixes and the temperature becomes more uniform. Surface waters then begin to warm and the cycle begins again. It should be noted, as will be discussed below, that in an estuarine environment, stratification patterns are influenced not only by temperature but by salinity as well.

Salinity is the measure of the amount of salts dissolved in the water. Salinity typically exhibits a gradual change throughout the length of an estuary as fresh water from tributaries mixes with salt water. The movement of the tides, precipitation and mixing by wind also affects salinity. Salinity generally increases with depth. Typically a pronounced "salt wedge" exists in estuarine environments. The more saline water, due to its greater density, tends to be toward the bottom, whereas the less dense, less saline water is closer to the surface. Except in situations where the estuary is well mixed, the salt wedge is quite evident and easily measured. Overall, different types of aquatic organisms are adapted to different ranges of salinity. Therefore, some types of organisms may be present only in waters with high salinity, while others will only be present in waters with low salinity.

pH is a measure of the amount of the free hydrogen ions (H^+) and describes the overall acidic or basic nature of waters. The pH of water is defined as the negative log of the hydrogen-ion concentration and is expressed on an exponential scale ranging from 0 to 14. A pH value of 7 is considered neutral, while pH values above or below 7 are considered basic or acidic, respectively. The pH of water is very important and can determine the overall survival of many species of aquatic organisms. For example, pH values below 6 may often result in reductions in reproductive success for a variety of aquatic organisms, while pH values below 5.5 to 5 can often result in death. The pH of an estuary is typically 7.0-7.5 in the less saline areas, but can range from 8.0-8.6 in the more saline reaches.

The pH of water can be altered by the addition of acidic or basic substances from the surrounding environment. Some substances can increase the concentration of hydrogen ions (H^+) resulting in more acidic water conditions. Conversely, some substances can decrease the concentration of H^+ thereby increasing the pH and resulting in more basic water conditions. In addition to being influenced by discrete inputs from point sources, atmospheric deposition, or storm runoff, the pH of estuaries can be influenced by photosynthetic activity due to the fixation of carbon dioxide. This process results in a decrease in the concentration of H^+ and an associated increase in the pH. pH is also affected by bacterial activity, water turbulence, components of runoff and human activities.

Chlorophyll *a* is the most important photosynthetic pigment found in both aquatic plants and algae (both filamentous and phytoplankton). Chlorophyll *a*, which gives plants their green color, is the only pigment which can produce chemical energy. Chemical energy is subsequently used for plant growth and reproduction. Plants and algae also have accessory pigments such as chlorophyll *b*, chlorophyll *c*, carotenes, and xanthophylls, which assist chlorophyll *a* in the process of photosynthesis.

Chlorophyll *a* concentrations are often used as a means of quantifying the phytoplankton community. In general, increases in chlorophyll *a* corresponds to increases in the amount of algae present. Normally, elevated concentrations of chlorophyll *a* occur following with elevated nutrient levels, simply because the nutrients fuel algae and aquatic plant growth. In general, algae and aquatic plants form the foundation of the aquatic food web; however, under extreme conditions, excessive amounts of these plants may result in severe water quality problems such as taste and odor problems or dissolved oxygen depletions. Low dissolved oxygen levels may in turn affect the survival of some aquatic organisms and accelerate the release of nutrients from deposited sediments.

The particulate material, both organic and inorganic, present in the water column is referred to as **total suspended solids** (TSS). Total suspended solids are expressed on a mass per volume basis as milligrams per liter (mg/l). Algae, sediments and various micro-organisms are classified as suspended solids. Waters with elevated suspended solids may be aesthetically unpleasing, can adversely impact the reproductive success and survival of fish and aquatic organisms, and can affect water temperature and density. Suspended solids are subdivided into two types: inorganic or organic. Sources of inorganic suspended solids are eroded soils from the watershed and the resuspension of bottom sediments. Organic suspended solids are often composed of phytoplankton.

Turbidity is related to water clarity and is the interference of light passage through the water. Insoluble particles of soil, organics, microorganisms and other materials impede the passage of light through water by scattering and absorbing the rays. Turbidity is often expressed in nephelometric turbidity units (ntu). In general, high levels of TSS will result in high turbidity levels. In the outer Harbor closer to its interface with Long Island Sound, turbidity should tend to be associated with planktonic algae and other suspended organic materials. In the lower Harbor, south of Bar Beach, sediments carried in with storm water and re-suspended during tidal events (due to this area's shallow nature) are probably responsible for the majority of the turbidity. This can be evidenced by examining aerial photos of the Harbor which clearly show noticeable sediment plumes in the lower Harbor.

Nutrients are the chemical building blocks of the entire aquatic food web. Nutrients are used by aquatic organisms (plants and animals) for growth and development. In aquatic environments, nutrients are commonly recycled within the water body itself. Nutrients are also imported from the surrounding watershed via streams, shallow groundwater, surface runoff and point source discharges (e.g., wastewater treatment facilities, industrial facilities). Common nutrients needed in large quantities for cell development are carbon dioxide, oxygen, ammonia- nitrogen, nitrate-nitrogen, orthophosphate phosphorus, silicon dioxide, sulfate and iron. Important minor nutrients which may occasionally be in short supply include manganese, cobalt, molybdenum, copper and zinc.

Nitrogen and *phosphorus* compounds are the two most important nutrients in regard to the overall abundance of plants and algae in estuaries. Under most circumstances, nitrogen is the nutrient which limits the growth of aquatic plants and algae in an estuarine environment. The five major forms of *nitrogen* found in aquatic systems are elemental nitrogen (N), organic nitrogen, ammonia (NH_3), nitrate (NO_3), and nitrite (NO_2). Elevated surface nitrogen concentrations (i.e., ammonia, nitrate) are often associated with wastewater discharges and fertilizer runoff. Ammonia-nitrogen is a metabolic by-product of the decomposition of organic material. Ammonia, in the unionized form, can be toxic to aquatic organisms. Factors which influence the amount of ammonia in the unionized form are temperature and pH. Nitrates generally occur in trace quantities in surface waters and fresh domestic wastewater but may be found in high concentrations in the effluent of nitrifying biological wastewater treatment plants. At these facilities, ammonia is biologically converted to nitrate when ammonia toxicity is a concern. Of the various forms, ammonia followed by nitrite and nitrate are the preferred forms of nitrogen used by algae and plants.

Phosphorus occurs in waters as orthophosphates, condensed phosphates, and organically bound phosphates. These different forms of phosphate occur naturally and arise from a variety of sources. Orthophosphates are typically used by the agricultural industry to increase crop yields. During storm events, surface runoff from agricultural lands can transport high amounts of orthophosphate to receiving waters. Condensed phosphates are added to some water supplies during treatment. Larger quantities of condensed phosphates are used in laundry detergents and other cleaning agents. Condensed phosphates are used extensively in the treatment of boiler waters. Organic phosphates are often discharged into receiving waters from wastewater treatment facilities used to process raw sewage and food wastes. Overall, elevated levels of orthophosphate in a waterbody are typically attributed to high loadings of orthophosphates, condensed phosphates and/or organic phosphates from the surrounding watershed. Of the various forms, orthophosphate is the preferred form of phosphorus for uptake by algae and plants.

Total phosphorus is defined as the sum of all the different forms of phosphorus, namely orthophosphates, condensed phosphates and organically bound phosphates. Total phosphorus is determined in the laboratory by performing an acid digestion on a water sample which is subsequently analyzed for orthophosphates.

As discussed earlier in Section 1, in an estuarine environment nitrogen will play the biggest role in determining productivity and influencing the frequency and intensity of algae blooms. However, in the lower Harbor where more freshwater like conditions can prevail either due to the Harbor's morphometry or the occurrence significant sources of freshwater inflow, phosphorus can play a significant role in the regulation of algal densities.

Heavy metals such as copper, zinc and lead, are a major concern because of their toxic effects on aquatic life. Their negative impacts on the reproduction, development, or longevity of fish and shellfish (particularly the larval stages). Heavy metals are often common constituents of surface runoff originating from diverse sources as tires, auto emissions, roof drains, and pavement.

Floatables is the term used to refer to debris, litter or other such macrosolids suspended or floating in the upper layer of the water column. It is possible to measure and quantify the amount of floatables, but generally a qualitative scale is used. Floatables typically originate from two sources: land based sources such as storm sewers (street litter), illegal dumping and litter on beaches; and ocean based sources such as boats. Floatables can endanger the health of humans and aquatic organisms and can make beaches and waterways aesthetically displeasing. Annex V of the MARPOL Treaty, which was passed in 1989, bans the disposal of plastic into the ocean. United States laws also prohibit the disposal of plastics into navigable waterways.

3.3.2 Biological Parameters

Besides the above chemical/physical parameters, most estuarine studies include the measurement, monitoring or reporting of the biological community, that is the resident organisms. An aquatic ecosystem can be divided into seven major groups of organisms: bacteria, plankton (zooplankton and phytoplankton), benthos, grazing fish, predatory fish, waterfowl and aquatic vegetation. Although mammals (both marine and semi-terrestrial) may also occur in estuaries, they typically do not constitute a major component of the biological community.

Bacterial examination of waters is intended to indicate the degree of contamination with wastes. Rather than testing for pathogens (a disease causing agent), tests for the detection and enumeration of indicator organisms are used. The **coliform bacteria** are the principal indicator group of organisms used to assess the suitability of waters for domestic, industrial, or other uses. **Fecal coliform** are a group of coliform bacteria that reside in the intestinal tracts of birds and mammals. These bacteria require elevated temperatures (>30°C) to survive. They are thus used as indicators of contamination or pollution attributable to fecal materials and wastes.

Coliform bacteria data are commonly presented as colonies per 100 milliliters (colonies/100 ml) or as the Most Probable Number (MPN) depending on the methodology employed. When the membrane filter (MF) technique is used, coliform numbers, whether total or fecal are typically expressed as the number of colonies/100 ml. When the fermentation tube technique is used, the results are reported as Most Probable Number (MPN). MPN values are derived from standardized tables that provide a value dependent upon the number of fermentation tubes for which a positive test was obtained, the volume of sample, and the statistical confidence limit. Although MPN and MF data can be compared, the techniques used to both test for the presence of bacteria and report the results are quite different. The data presented in this report are expressed in terms of MPN/100 ml, largely due to the fact that most of the reviewed data were either collected by the NCDH or are older ISC data developed before the common use of MF techniques by sanitarians.

The most important primary producers in an estuarine system are the **phytoplankton**. Phytoplankton are free-floating unicellular microscopic plants (algae) that form the foundation of the aquatic food chain. They are primarily composed of diatoms, chlorophytes (green algae) and dinoflagellates. They are consumed by **zooplankton** which are microscopic or nearly microscopic aquatic animals. Phytoplankton growth depends on physical parameters such as light, temperature, salinity and circulation and chemical parameters such as nutrient availability. Changes in these parameters can cause changes in species composition, phytoplankton densities ("algal blooms"), or limit plankton growth.

Nitrogen is typically the limiting macronutrient for phytoplankton in estuaries; however, very low phosphorus concentrations may also limit growth. Non-point source inputs of nutrients in runoff typically stimulate algal biomass and can lead to the development of nuisance blooms.

Zooplankton are microscopic or nearly microscopic animals such as rotifers, copepods cladacerons. These organisms consume phytoplankton and are in turn consumed by invertebrates and fish. Although not at the actual base of the food web, zooplankton are an extremely important component. They are a particularly important source of food for young fish as well as certain commercially important shellfish and crustaceans.

Benthic invertebrates are the snails, insect larvae, worms and other organisms that live on or within the sediments and substrate of an estuary. They may burrow into the mud, attach to stones, sticks and other debris, or live on the sediment surface. These organisms are preyed upon extensively by fish and many of the commercially important **macroinvertebrates** such as oysters, clams and lobsters. For the most part, many of these organisms have limited mobility. They are usually confined to a defined area, either due to their physiology/morphology or life history habits. Many benthic invertebrates have also become very specialized either in terms of feeding habits, habitat requirements or behavioral factors. As a result of their lack of mobility and specialized life styles, benthic invertebrates can be seriously impacted by even minor environmental changes. As such, ecologists have found that benthic invertebrates are good indicator organisms of environmental perturbations. The community assemblage, density and absence/presence of various species of benthic organisms, therefore, may be used to analyze whether an aquatic system has been subject to pollution impacts. Benthic organisms play a significant role in the channeling of energy from detrital (decaying) material to the upper levels of the food web.

Macroinvertebrates are typically mobile or semi-mobile organisms that often have commercial importance. This group encompasses a wide variety of organisms such as clams, crabs, lobsters and starfish. Their occurrence, or lack thereof, in an estuary is used much in the same way as the benthos to quantify or characterize water quality. Interestingly, marine water quality standards often reflect the ability of the waters to support a commercially viable, non-polluted macroinvertebrate community. The filter feeding mechanism of many of these organisms lends itself to the uptake and bioaccumulation of pollutants such as bacteria, heavy metals and petroleum products.

Waterfowl play an important role in the estuarine food web. They prey on fish, benthic infauna, insects and macrophytes. Waterfowl observed in the watershed may utilize the Harbor for overwintering or as a stop during migration, while some are year-round residents. The Harbor also is visited by waterfowl species that are classified as threatened or protected. In general, waterfowl use of an area is an indication of its overall wildlife habitat value. In the Hempstead Harbor, wildlife habitat is one of the reasons for its SCFWH designations.

Aquatic vegetation forms a highly productive community that provides valuable habitat and food for many other species of organisms. Aquatic vegetation is subdivided into two groups: **macrophytes** and **algae**. Rooted, complex forms of plant life are commonly referred to as macrophytes. Non-rooted plants having somewhat less complex cell structures are referred to as algae. Vegetation can also serve to slow water currents and decrease shoreline and near shore erosion. Aquatic vegetation can uptake large quantities of nutrients (typically via the sediments) during the growing season. These nutrients remain locked in the biomass through the summer. As plants die and decompose in the fall, the nutrients are released back into the ecosystem. The decomposition of the plants can also lead to depletion of dissolved oxygen levels. Both algae and macrophytes can be impacted by poor water quality. Macrophytes, especially submerged aquatic vegetation such as eelgrass and widgeon grass, can be severely impacted by pollution.

3.4 Water Quality Trends

The water quality data discussed in this section of the report are the result of the monitoring efforts of a number of both public and private entities. For the most part, the following discussion is based on the review of ISC and NCDH data.

The database, although extensive both in respect to its history and content, is highly variable. Differences exist not only in the frequency and location of sampling, but, more importantly, in the methodologies employed to develop the data, and the quality control measures followed during collection and analysis.

Differences among various water quality monitoring programs are typically discussed in terms of spatial and temporal variations. Spatial variation addresses the location of monitoring stations and sample collection water depths, while temporal variation addresses the time of year that water samples were collected and the frequency of sample collection. In general, water quality data comparisons become increasingly more difficult as both spatial and temporal variations increase among monitoring programs.

In reviewing the historical water quality data for Hempstead Harbor, both spatial and temporal differences were noted. Spatial variation in the historical database exists since the various organizations have monitored the water quality of the Harbor at different locations (i.e., stations). Some of the earliest efforts had stations located at the mouth of the Harbor only. There has been an attempt since the mid-1980's to standardize sampling station locations. This has been accomplished primarily by siting the stations adjacent to navigational aids.

Another spatial variation which arises in the database is associated with the location within the water column at which the samples are collected. For the most part, sampling tends to be restricted to the uppermost (surface) strata of the water column. However, certain critical parameters, such as dissolved oxygen, temperature and nutrients, may fluctuate significantly from surface to bottom. The database does not always allow for the analysis of the vertical heterogeneity of water quality parameters.

In addition to spatial variations, temporal variations also exist in the historical water quality database for Hempstead Harbor. For example, in the 1970's, the Interstate Sanitation Commission (ISC) often sampled as frequently as biweekly; however, in the 1980's, sampling became restricted to two to three times per year, with monitoring only occurring during the summer months. Currently, ISC monitors the Harbor on a weekly basis during the summer months. Thus, inconsistencies and incongruities exist in the database due to these temporal variations.

The accuracy of these data may also vary with their source due to differences in sampling methodology, training of sampling personnel, analytical methodologies and the amount of Quality Assurance/Quality Control (QA/QC). More significant than the differences associated with temporal/spatial inconsistencies, these factors can have very strong bearing on the data. As such, in reviewing these data, some attempt was made to acknowledge these differences. Basically, the data set was reviewed in respect to trends and consistency with water quality standards. In addition, peak values (low and high values) for the various water quality parameters were also evaluated. Presently, peak values are of limited use because their validity has not been confirmed through proper data validation. It is recommended that peak value data be validated by carefully evaluating all sample collection and analytical testing methodologies employed throughout the entire database in conjunction with a thorough review of the environmental conditions in the watershed both during and prior to the sample collection dates.

Overall, the Hempstead Harbor database, consisting of both historic and recent data, is extremely valuable and provides a wealth of insight into the water quality status of the Harbor. In the following paragraphs, water quality trends for key parameters are presented and discussed in detail. Peak value data for these parameters are also discussed when they provide a better understanding of the water quality in the Harbor.

3.4.1 Dissolved Oxygen

The seasonal dissolved oxygen concentrations for both surface and deep waters in the Harbor are shown in Figures 3-1 through 3-4. These dissolved oxygen data in the above figures were collected by the ISC. Station HC is located near the mouth of the Hempstead Harbor and Station HD is located near the center of the Harbor. At Station HC, surface concentrations from 1991 through 1996 were typically above the NYSDEC water quality criterion of 5 mg/l (Figure 3-1); however, deep water concentrations were often below this criteria (Figure 3-2). At Station HD, dissolved oxygen concentrations were more often below the water quality criterion than at Station HC, reflecting the restrictive nature of the Harbor (Figures 3-3 and 3-4).

The annual average dissolved oxygen data collected by the NCDH from 1976 through 1991 are presented in Figure 3-5. As stated previously, the NCDH monitors the water quality in the Harbor at 13 different stations. As shown in Figure 3-5, all annual average dissolved oxygen concentrations in the upper and lower portions of the Harbor exceeded the NYSDEC water quality criterion of 5 milligrams per liter (mg/l) for dissolved oxygen. Though exceeding the NYSDEC standard, the annual average concentration data do not reflect temporary dissolved oxygen depressions which may adversely impact the aquatic biota.

Figure 3-1. Seasonal DO Concentrations in Surface Waters - Station HC

Figure 3-2. Seasonal DO Concentrations in Deep Water - Station HC

Figure 3-3. Seasonal DO Concentrations in Surface Water - Station HD

Figure 3-4. Seasonal DO Concentrations in Deep Water - Station HD

Figure 3-5. Annual Average DO Concentrations - Upper and Lower Hempstead Harbor

The NCDH dissolved oxygen data from 1973 through 1990 is presented as "percentage points in conformance" with the NYSDEC classification standard in Figure 3-6. The NYSDEC classification standard for dissolved oxygen concentrations in Class SA and SB saline waters is 5 mg/l. The percentage points in conformance is defined as the percentage of NCDH stations in a given year that met the NYSDEC dissolved oxygen standard. In upper Hempstead Harbor, no conformance (zero conformance) occurred during the years of 1975, 1976, 1978, 1980, 1983, 1985, 1986, and 1989. With the exception of 1984, no conformance (zero conformance) occurred in the lower Hempstead Harbor. As stated previously, the upper Harbor is that portion of Hempstead Harbor extending north of Bar Beach to Long Island Sound. The lower portion of the Harbor is that portion of Hempstead Harbor that is south of Bar Beach.

In general, dissolved oxygen depressions occur at the mouth of the Harbor where it meets Long Island Sound (Station HC) and the Harbor proper itself (Station HD) through the year. The data suggest that anoxic conditions (zero dissolved oxygen) are at times experienced at the mouth of the Harbor and more frequently in Harbor proper. Equally important is the fact that depressed dissolved oxygen conditions, although commonly occurring, appear to be very transient and temporary. Examination of the dissolved oxygen data show that even in mid-summer, the Harbor can fluctuate from a state where bottom dissolved oxygen concentrations are very low to a state where concentrations are satisfactory in a matter of a few days. Likewise, the process can reverse in a relatively short period of time. These data indicate that the water column is relatively unstable and prone to full horizontal mixing even during mid-summer. As such, an intense storm event appears capable of circulating the water column, and replenishing bottom dissolved oxygen concentrations. However, the data also show that the Harbor's oxygen demands during the summer are intense. Thus, during periods of stagnation, dissolved oxygen levels, especially near the sediment interface, can become rapidly exhausted. Based on these data, Hempstead Harbor undergoes extended periods of hypoxia (dissolved oxygen levels below 3 mg/l) in deeper waters. The worst dissolved oxygen depressions occur within the Harbor proper itself. Under such conditions, it is expected that the reproductive success and possibly the survival of sensitive aquatic organisms such as shellfish and fish, may be adversely affected.

3.4.2 Nutrients

The annual average concentrations of ammonia nitrogen, nitrate nitrogen, organic nitrogen and total Kjeldahl nitrogen (TKN) from 1973 through 1991 are shown in Figure 3-7. TKN is the combined measurement of ammonia-nitrogen and organic-nitrogen. In general, the annual average concentrations of total Kjeldahl nitrogen and organic nitrogen have steadily declined over the past fifteen years, while ammonia and nitrate nitrogen annual average concentrations have fluctuated slightly from 1973 to 1991.

Figure 3-6. Percent of Sampling Points in Conformance with DO Classification Standards

Figure 3-7. Annual Average Ammonia, Nitrate, Organic and Total Kjeldahl Nitrogen Concentrations

Based on these data, decreases in total Kjeldahl nitrogen are apparently related to decreases in organic nitrogen concentrations. As discussed, ammonia concentrations have slightly fluctuated since 1973, but organic nitrogen concentrations, although fluctuating, have steadily declined since the late 1970's. Therefore, this general decreasing trend in organic nitrogen concentrations may be attributed to a slight overall decrease in phytoplankton biomass in the Harbor.

Over the years, the annual average ammonia and nitrate nitrogen levels in the Harbor are considered moderately high. As previously discussed, nitrogen is most often the "limiting nutrient" in estuaries. Of the different forms, it is the ammonia-nitrogen and nitrate-nitrogen that are most readily available for the growth of phytoplankton (microscopic free-floating aquatic plants). Therefore, based on these data, sufficient amounts of ammonia and nitrate nitrogen are available to promote the occurrence of nuisance algal blooms.

The annual average total phosphorus concentrations in Hempstead Harbor from 1973 to 1991 are shown in Figure 3-8. Overall, the annual average total phosphorus concentrations in the Harbor are considered moderately high. The annual concentration in 1973 may be an aberration within the historical water quality data set. This is primarily due to the fact that over the past nineteen years, no other annual average total phosphorus concentrations even come close to the 1973 value. Since 1988, the annual average total phosphorus concentrations have declined. This recent trend may be due to lower phosphorus exports to the estuary from the surrounding Hempstead Harbor watershed. It may also have been influenced by the closure of the Roslyn sewage treatment plant. Non-point source reductions to the Harbor may be simply related to lower than normal rainfall amounts or through the implementation of best management practices. In order to further explain this recent phosphorus trend, more investigation is required.

Overall, the total phosphorus levels in the Harbor are considered moderate to high. Phosphorus is second only to nitrogen in importance with regard to algal abundance. Based on the data in Figure 3-8, moderately high phosphorus levels and a surplus amount of ammonia and nitrate in the Harbor will continue to result in the occurrence of algal blooms.

3.4.3 Chlorophyll

The seasonal chlorophyll *a* concentrations from 1991-1996 at the mouth of the Harbor (Station HC) and within the Harbor proper (Station HD) are presented in Figures 3-9 and 3-10. As previously discussed, chlorophyll *a* is a photosynthetic pigment in phytoplankton and provides a simple means of quantifying the amount of phytoplankton in a water body. In general, the chlorophyll *a* concentrations at both stations fluctuated (widely) during the summer months. This phenomenon is simply related to the population dynamics of phytoplankton. In general, phytoplankton populations will rapidly increase (growth and reproduction), peak and crash

Figure 3-8. Annual Average Total Phosphorus Concentrations (starvation and death) throughout the growing season. In the northeast U.S., the growing season typically extends from May through September. Once the population crashes, nutrients that are released during cell lysis (algae cells rupture) become readily available for other phytoplankton in the estuary and the cycle continues.

In comparing the two stations, chlorophyll *a* concentrations at Station HD (the Harbor proper) are typically higher than Station HC (mouth of Harbor near Long Island Sound). Higher chlorophyll *a* concentrations indicate that the Harbor itself contains higher amounts of phytoplankton. These higher chlorophyll *a* concentrations in the Harbor are likely attributed to higher concentrations of available nutrients for algal growth, namely nitrogen and phosphorus, and the more stagnant nature of the Harbor.

Under most circumstances, algal bloom-like conditions occur when chlorophyll *a* concentrations exceed 20 milligrams per cubic meter (mg/m^3).

3.4.4 Heavy Metals

The only heavy metals data collected near Hempstead Harbor were at Station LI-33. Station LI-33 is located in Long Island Sound and is monitored for only copper, lead and zinc by the ISC. Therefore, no heavy metals data have been historically monitored at the mouth of the Harbor or in the Harbor itself.

At Station LI-33, total metal concentrations from 1977 to 1986 ranged from 0.005 to 0.130 mg/l for copper, 0.020 to 0.167 mg/l for zinc, and 0.010 to 0.400 mg/l for lead. During this time period, metals concentrations varied substantially both spatially and temporally. These data contain no definitive trends; however, in September of 1984 a major peak in all three metals (copper, lead, zinc) was experienced. Apparently these extremely high concentrations are aberrations to the metals data set. These aberrant 1984 metal concentrations may possibly be attributed to sample collection and/or laboratory errors.

Excluding the 1984 data, the average total concentrations of copper, zinc and lead at Station LI-33 from 1977 to 1986 were 0.010, 0.058 and 0.012 mg/l respectively. The NYSDEC has established standards for both SA and SB saline waters within the document entitled Water Quality Regulations, Surface Water and Groundwater Classifications and Standards (NYS Codes, Rules and Regulations, Title 6, Chapter X, Parts 700-705). Under these regulations, "aquatic based" standards for heavy metals have been established in order to protect the aquatic biota. The NYSDEC standards for metals are generally listed according to their dissolved or acid soluble fractions.

Figure 3-9. Seasonal Chlorophyll *a* Concentrations - Station HC

Figure 3-10. Seasonal Chlorophyll *a* Concentrations - Station HD

Since no dissolved or acid soluble concentrations were analyzed, the average total concentrations were compared to the NYSDEC "aquatic based" standards for copper, zinc and lead. For both SA and SB classes of saline waters, the NYSDEC aquatic based standards for dissolved copper, dissolved zinc and acid soluble lead are 2.9 ug/l (0.0029 mg/l), 66 ug/l (0.066 mg/l) and 8.6 ug/l (0.0086 mg/l), respectively. Based on these standards, the total concentrations for all three metals exceeded the NYSDEC standards. More importantly, this implies that the average dissolved or soluble fractions of these metals may have also exceeded the state standards. Therefore, it is recommended that in the future the above heavy metals be analyzed as both total and dissolved/acid soluble concentrations in Long Island Sound (Station LI-33) and within Hempstead Harbor.

3.4.5 Turbidity

Although many of the various reports reviewed by Coastal discussed the occurrence of turbid conditions in the Harbor, the data compiled by the ISC from 1979 through 1985 show turbidity to be slight. Typically, the ntu (nephelometric turbidity units) values reported by the ISC were extremely low (1-2).

It should be realized that these data were collected at the mouth of the Harbor where mixing and dilution are likely to be more pronounced and as such, turbidity less problematic. Similarly, these same reports document that few floatables were present in the water column, regardless of season. As such, because aesthetic complaints attributable to floating debris and turbidity are commonly voiced, the ISC data, due to the location of the monitoring station, may not be reflective of the conditions that are commonly experienced in Hempstead Harbor. Also, the timing of the sampling events may have been such that the ISC data were not collected during or shortly after storm events when turbidity is often at its worst.

3.4.6 Bacteria

Over the years, both total and fecal coliform bacteria data have been collected in Hempstead Harbor by the NCDH In general, coliform bacteria data in this report were analyzed in order to historically assess the overall degree of bacterial contamination in the Harbor. Data analysis primarily focused on evaluating water quality trends in order to detect significant changes in water quality (i.e., improvement or degradation). Therefore, coliform bacteria data were not analyzed to specifically address localized short-term problems, such as temporary beach closures.

The average annual total coliform concentrations for the entire Harbor and both the lower Harbor and the upper Harbor are presented in Figures 3-11 and 3-12, respectively. As seen in Figure 3-11, the average annual total coliform concentrations for the entire Harbor fluctuated

Figure 3-11. Annual Average Total Coliform Levels

Figure 3-12. Comparison of Annual Average TC Levels - Upper and Lower Hempstead Harbor from 1973 through 1991. Similarly, the total coliform concentrations in the upper and lower Harbor also fluctuated during this time period. Overall, the total coliform data (Figures 3-11 and 3-12) indicate that the biological water quality in the Harbor is neither degrading nor improving.

The "percent of sampling points" in conformance with the NYSDEC classification standard for total coliform bacteria are presented in Figure 3-13. The "percentage points in conformance" is defined as the percentage of NCDH stations that have met the NYSDEC total coliform bacteria standard in a given year. The NYSDEC classification standard for total coliform bacteria in Class SA saline waters shall not exceed 70 MPN/100ml. The state standard for total coliform bacteria in Class SB saline waters shall not exceed a monthly median value of 2,400 MPN/100ml and more than twenty percent of the samples shall not exceed 5,000 MPN/100ml. Therefore, the more stringent standard applies to those saline surfaces waters classified as Class SA. With regard to Hempstead Harbor, the upper and lower portions of the Harbor as classified as SA and SB, respectively.

Based on Figure 3-13, the lower Harbor was generally in higher conformance than the upper Harbor with regard to total coliform concentrations. Higher conformance in the lower Harbor is probably not related to water quality conditions, but rather to the NYSDEC's water quality classification system. The annual average total coliform concentrations in the lower Harbor were consistently higher than the upper Harbor. Therefore, the higher conformance for the lower Harbor is due to the fact that the lower Harbor has less stringent water quality standards than the upper Harbor.

The annual fecal coliform concentrations in the upper and lower Harbor from 1973 through 1991 are shown in Figure 3-14. These data show that the upper Harbor tends to have lower fecal coliform concentrations than the lower Harbor, as would be expected. Higher fecal concentrations in the lower Harbor are likely attributed to higher loadings from the surrounding watershed and a lower flushing rate when compared to the upper Harbor. Furthermore, the fecal coliform concentrations in the lower Harbor have widely fluctuated and indicate no signs of water quality improvement.

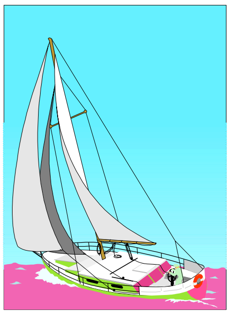
It should be noted that although coliform are monitored twice/week by the NCDH, these data are no longer published. Discussion of beach closures with the NCDH revealed that since 1991, no beach closures have occurred because of elevated coliform counts. Any closures which have occurred followed storm events and were precautionary in nature.

Figure 3-13. Percent of Sampling Points in Conformance with NYSDEC TC Standards

Figure 3-14. Comparison of Annual Average FC Levels - Upper and Lower Hempstead Harbor

4.0 NONPOINT SOURCE POLLUTANT LOADING ASSESSMENT

4.1 An Introduction to Pollutant Load Modeling



The water quality sampling program and resulting chemical and biological data discussed in Section 3 identify the extent to which the water quality of Hempstead Harbor has been impacted. This information quantifies existing water quality conditions and helps define relevant water quality trends. These field data are also important because they can be compared to State or Federal water quality standards or criteria. Field data can also be used to set water quality management goals and can be extemely useful in the objective evaluation of the success of watershed management projects and initiatives. However, these data normally fall short of identifying the causes for observed water quality degradation. Basically, field data can be considered a "snap shot" of existing conditions or a history of changes in water quality. In order to successfully manage a watershed's pollutant contributions, it is imperative that the analytical database also include information that can be used to document the causes of water quality impacts, such as STP overflows and significant rainfall events.

As introduced in Section 1, and discussed elsewhere in this report, nonpoint source (NPS) pollution is indiscrete and ubiquitous in its origin. That is, it is often difficult to pinpoint or identify where the pollutants come from. Runoff is often collected from a large area and then discharged into the Harbor via a discrete pipe or outfall structure. This can confuse the casual observer. Thus, it must be emphasized to the public that the pollutants emanating from a particular pipe may have originated from a location far removed from the outfall. In addition, the pollutants may have been generated from a seemingly harmless source such as a lawn. This also reinforces the need to focus beyond in-field water quality monitoring.

Successful NPS pollution management or NPS load reduction cannot be achieved without a comprehensive understanding of how and where these are generated. To do this successfully necessitates investigating the inter-relationships and linkages between land use/watershed development patterns and pollutant loading. The most effective means of accomplishing such a task involves modeling the quantity of pollutants, or NPS pollutant load of the watershed.

4.2 Modeling the Hempstead Harbor NPS Load

Although it would be possible to design a sampling program capable of actually measuring the amount of pollutants contributed to the Harbor by each individual storm sewer and drainage swale, it would be extremely expensive and difficult to implement. Aside from the need to sample frequently and at multiple locations, there are variables associated with rainfall intensity, rainfall frequency, seasons, and weather or precipitation patterns that can complicate a watershed-oriented sampling program.

In the 1970's, the USEPA initiated the National Urban Runoff Program (NURP). The program essentially consisted of a large number of inter-related storm sampling projects, that involved the collection of storm water samples from a variety of different types of watersheds (e.g. agriculture, low density residential, commercial, etc.). It was the USEPA’s objective, through NURP, to create an empirical data base that could be used to characterize the pollutant load typically generated under different land use scenarios. Following the statistical analysis of the NURP data by other scientists, pollutant loading coefficients were developed for each major type of land use.

Pollutant loading coefficients consist of a delivery rate value; usually a given amount of pollutant generated by a unit area of land over a given amount of time. Normally these coefficients are expressed in kilograms/hectare/year (kg/ha/yr). By multiplying the loading coefficient by the area of the land cover or land use in question an estimate of the annual pollutant load can be obtained without the need for extensive, costly field sampling. Typically, a watershed contains a variety of land uses or land covers. In such a situation, to calculate the pollutant load, the area associated with each land use or land cover must be delineated and computed. Coefficients are then assigned to each land type, and a cumulative total developed for the watershed. Thus, a straightforward, simple technique can be used to compute a watershed’s pollutant load.

This technique has become the primary means by which NPS pollutant loads are quantified. Of course, the quality and accuracy of the pollutant load data generated by this methodology is only as good as the data, parameters and assumptions used in the modeling process. It is thus imperative, prior to modeling a watershed's NPS pollutant load, to have a good understanding of the inter-relationship of land cover, the intensity of land use and the natural resource attributes of a watershed.

Fortunately, a large amount of natural resource, land cover, and land use intensity data and information exists for Hempstead Harbor. Much of this data is available through the NYSDOS, NYSDEC, and Nassau County. The database is sufficiently detailed and recent to enable the modeling of the Hempstead Harbor watershed's NPS pollutant load to be conducted in a highly accurate manner. For the Hempstead Harbor watershed, it is thus possible to not only quantify the NPS pollutant load but to have the confidence in the data needed to formulate a watershed management plan.

There are numerous pollutant loading coefficients available in the literature. Coastal has extensive experience in modeling NPS pollutant loads and has had an opportunity to evaluate the appropriateness and accuracy of many past modeling projects in the Mid-Atlantic and metropolitan New York/New Jersey area. The pollutant loading coefficients provided in the various NURP studies, the USEPA 314 Clean Lakes Manual and Schueler (1987) served as the basis for the coefficients selected for the Hempstead Harbor watershed. The selected pollutant loading coefficients were refined using a hierarchal approach to assure their consistency with the conditions characteristic of the Hempstead Harbor watershed. Natural resource attributes such as soil types, slope, and vegetative land cover were evaluated and utilized to modify the literature coefficients to better characterize the watershed. In addition, a considerable amount of field reconnaissance was conducted to better assess localized development patterns, development intensity, and the overall nature of land use throughout the watershed prior to assigning loading coefficients. Consideration was also given to the intensity and age of urban development as both are recognized to also influence pollutant regeneration (Schueler, 1987). These steps increased the accuracy of the resulting NPS pollutant loading estimates. The actual coefficients assigned to each land use are presented and discussed further in Section 4.2.3 of this report.

The above analyses obviously focus on the impacts of existing watershed development characteristics of the watershed on NPS loading. Concerns were also raised by the HHPC as to whether unforseen increase in NPS pollution inputs could occur as a result of future development of the watershed. As such, a build out analysis was conducted. The buildout analysis consisted of a collaborative examination of existing zoning maps and existing land use patterns. The intent was to identify any sections of the watershed where large scale development could occur within the near future (e.g. the next 20 years) and compute the projected increase in NPS pollution loading associated with this development. The same methodology as detailed above was used in the computation of the watershed build out pollutant load.

In addition to the NPS pollution contributed from storm runoff, consideration was also given to the calculation of the estimated annual contributions of NPS pollution associated with septic systems and marina operations. In formulating the scope of work associated with the development of a Water Quality Improvement Plan, the HHPC identified the need to address pollutant inputs from both these sources. Some of the concerns relative to septic and marina inputs arose from the HHPC's initial review of historical water quality problems of the Harbor as well as lessons learned from other studies conducted within the Long Island Sound study.

4.2.1 Data Sources

A variety of data sources were utilized to characterize the Hempstead Harbor watershed and assign pollutant loading coefficients. This included the review and analysis of aerial photos, Geographic Information System digital data supplied by the NYSDOS and Nassau County, mapped data made available from the State, County and local government planning authorities, and site reconnaissance of the watershed. Previously published reports were also reviewed. In addition, valuable insight and information was obtained through the interview of individuals recognized as authorities or knowledgeable sources of information on the Hempstead Harbor watershed.

4.2.2 Current (1997) Land Use Conditions

The primary means of evaluating and quantifying land cover types and land use practices in the watershed included the review and analysis of aerial photographs and USGS topographic quadrangles, and field reconnaissance, but relied primarily on the interpretation of the Nassau County GIS database . The USGS-Anderson technique was employed to provide an acceptable level of land cover/land use (LC/LU) classification detail for the project area. As per the County's classification scheme the following coverage categories occur within the Hempstead Harbor watershed:

- Urban/Developed
- Wetland
- Forested Wetland
- Cemetery
- Forested
- Surface Water
- Recreation
- Recreation - Park
- Unclassified Wetland
- Agriculture
- Grassland
- Beach

Once compiled, the GIS land use data for each sub-watershed were then used in conjunction with the selected loading coefficients to calculate the total annual pollutant load for each sub-watershed. Pollutant loads were calculated for six pollutants of concern, Total Nitrogen (TN), Total Phosphorus (TP), Total Suspended Solids (TSS), Lead (Pb), Zinc (Zn) and Petroleum Hydrocarbons (PHC). These pollutants were selected for three main reasons. First, these pollutants, in general, are common constituents of storm water runoff. Second, there are loading coefficients available in the literature for these particular pollutants that are applicable for a wide variety of land uses and land cover types. Third, these pollutants cause significant environmental problems, and have impacted the perceived or measured water quality of the Harbor. Although bacteria (fecal coliform) have seriously impacted the Harbor (e.g. beach closures and shellfish bed closures) there are no reliable loading coefficients available for this pollutant.

4.2.3 Surface Runoff Pollutant Loading Coefficients

As discussed above, the pollutant loading coefficients used in the Hempstead Harbor watershed's UAL calculations were selected based on a comprehensive review of published literature values and modified accordingly to reflect site-specific conditions. A total of twelve sub-watersheds were delineated (Sections 1 and 2). Since each sub-watershed encompassed a variety of land use and land cover types, it was necessary to assign multiple coefficients in order to calculate their pollutant load contributions.

Also, the County GIS data mapped all the urban land as a single class, Urban/Residential. No distinction was made for commercial land. It was therefore necessary to re-evaluate the land development characteristics of the individual sub-watersheds before assigning loading coefficients. Four Urban/Residential sub-sets were used; low density residential (<2 houses/acre), moderate density residential (2 or more houses/acre), high density residential (>2 houses/acre with some mixed commercial use), commercial (primarily business type development), and industrial. These sub-sets were qualitatively assigned to the urban areas using a weighted averaging approach following in-field reconnaissance and the inspection of detailed recent aerial photos supplied by the NYSDOS. Given the observed level of development, a set of pollutant coefficients representative of suburban, low intensity land use were used for Sub-watersheds 1 (Locust Valley), 4 (Sands Point North), 5 (Sands Point South) and 7 (Mott Point). The remaining urban areas were assigned pollutant coefficients representative for an urban mixed use setting (commercial/residential). As previously mentioned, although somewhat subjective, consideration was also given to the intensity, age and patterns of the urban areas before assigning a coefficient. Although refined, and very representative of Hempstead Harbor, it should be realized that these coefficients are estimates of the pollutant load generated by each unit of land use. The selected coefficients are presented in Table 4-1.

Table 4-1.
Pollutant Loading Coefficients (kg/ha/yr)

Zone	TN	TP	TSS	Zn	Pb	PHC
Urban/Residential Sub-watersheds 1,4,5, 7	1.6	0.43	1000	1.8	1.8	2.6
Urban/Residential Sub-watersheds 2, 3, 6, 8-12	5	0.8	2000	1.8	1.8	2.6
Recreation	5	0.3	400	NA	NA	NA
Agriculture	10	0.6	1600	NA	NA	NA
Forested	2.5	0.2	250	NA	NA	NA
Wetlands	(-0.25)	0	0	NA	NA	NA
Grassland	5	0.3	400	NA	NA	NA
Beach	0	0	0	NA	NA	NA
Surface Water	10	0.25	0	NA	NA	NA

TN = Total Nitrogen
TP = Total Phosphorus
TSS = Total Suspended Solids
Zn = Zinc
Pb = Lead
PHC = Petroleum Hydrocarbons
NA - no coefficients available

Kg/ha/yr=Kilograms/hectare/year
Coefficients modified to account for lower density residential land use in Sub-watersheds 1, 4, 5, 7

When reviewing Table 4-1, it will be observed that the loading coefficients for certain land use or land cover types share some similarities. This is both acceptable and is to be expected. The coefficients are a function of storm event export dynamics. As discussed, they have been derived from in-field sampling studies and are representative of the amount of pollutant load generated on average, by monitoring storm events. Similar coefficients simply indicate that rainfall either mobilizes, leaches or otherwise liberates pollutants from a site in such a manner that a similar amount of pollutant is generated per unit area. However, it must be stressed that the processes responsible for the reported export rates may be radically different for each land use/land cover or for each pollutant. This is an important factor that must be taken into consideration when evaluating the feasibility or utility of alternative NPS management techniques. In this study, this was taken into account by carefully matching prevailing land use practices, the types of NPS pollutant inputs, the magnitude of the computed load NPS loads, and the performance/pollutant removal characteristics of various potential NPS pollutant load reduction techniques (Section 6). It should also be noted that the table generally shows that pollutant loading rates increase as the amount of impervious surface increases. One notable exception is in certain vegetated areas, such as forests. In these instances, the organic nitrogen load tends to be higher due to the amount of nutrients contained within leaf litter. This type of load tends to be seasonal.

In addition, the lack of heavy metals and petroleum hydrocarbon loading coefficients (N/A designation) is due to the lack of adequate field studies and research. Intuitively, with the exception of agricultural land use, the remaining land uses can be expected to generate very little in the way of lead, zinc or petroleum hydrocarbons.

4.2.4 Septic Contributions

In addition to storm-related pollutant loading, it has been theorized that on-site wastewater disposal systems (referred to herein as septic systems) have also contributed to the Harbor's water quality degradation. The impact of septic systems on water quality is primarily associated with the influx of nutrients and bacteria. Bacteria inputs create public health problems, and trigger the need to close beaches or condemn or otherwise prohibit shellfish harvesting. Nutrient loading increases the occurrence, frequency and intensity of algae blooms. Associated with these blooms are a decrease in clarity, odor problems, degraded aesthetics, and the nocturnal depletion of dissolved oxygen. In estuarine environments, nitrogen plays the important role in determining the extent of algal bloom development. Studies conducted in the early 1950s of Moriches Bay and Great South Bay on Long Island found even relatively small additions of nitrogen greatly stimulated the development of algae (Ketchum, 1967). Phosphorus, although not as important, can influence algal development, especially in the freshwater dominated sections of an estuary. For the flow restricted lower Hempstead Harbor (south of Bar Beach), phosphorus probably plays a significant role in the occurrence of algae blooms. Its negative impact on water quality is even more significant in respect to the watershed’s freshwater impoundments (e.g Roslyn Park Pond and Mill Pond).

Based on the review of available information and discussions with local experts, it is clear that the age, size, status and design of septic systems in the watershed are highly variable. In addition, the predominant soils of the area tend to be sandy and the localized topography relatively steep; both of which can decrease the nutrient and bacterial treatment efficiency of septic systems. Thus, given the age and questionable design of some septic systems, and watershed’s environmental features, it is reasonable to assume that some degree of water quality impact to the Harbor is attributable to septic systems.

As mentioned previously, whether for storm runoff or septic systems, there are no reasonably accurate published bacteria loading coefficients available in the literature. Therefore septic load analyses focus solely on the quantification of nutrient (TN and TP) inputs. It should also be stressed at this point that even non-failing septic systems generate a nutrient load. Although a well-designed, properly sited septic system should have a negligible impact on water quality, research has verified that even non-failing septic systems do not completely attenuate nitrogen and phosphate. A number of environmental and design factors determine the time frame over which this occurs, but nutrients are exported to the environment well before the system becomes incapable of removing bacteria from wastewater. Conveyed first to the shallow groundwater, these nutrients can be readily transported to a nearby stream, wetland or even the Harbor itself. Thus, health department records of failing systems cannot be used as the only means of evaluating the extent of septic related pollutant loading problems.

The effectiveness of a septic system in the immediate coastal areas of Hempstead Harbor to attenuate nutrients was determined by accounting for several factors including soil type, depth to groundwater, wastewater loading rate, population density, soil attenuation capacity, volume of soil prism, and distance of the septic leach field from the shoreline of the Harbor. There are a number of modeling studies that have focused on the pollutant loading problems associated with septics. The quantification methodology detailed in the Connecticut Areawide Waste Treatment Management Planning Manual (1982), and the export coefficients and retention capacity information documented by the USEPA (1980, 1984 and 1987) and Rodiek (1979) were used in concert to develop a reasonable estimate of the septic load associated with each Hempstead Harbor sub-watershed in which septic systems provide the primary means of wastewater renovation. The potential on-site septic system nutrient load was thus evaluated independent of the unit areal loading (UAL) surface runoff NPS loads.

The technical literature concerning the on-site treatment of domestic wastewater indicates that septic systems readily contribute nitrogen (usually as nitrate) and may contribute a phosphorus load to the surficial groundwater table. Typically, as reported by Otis (1978), if three feet of suitable soils exists between an adequately sized and maintained septic system and the groundwater, and that if at least 50 feet separates the leaching area from a waterbody, phosphorus contributions will be negligible. Phosphorus attenuation rates of 98% within 30 feet of septic systems have been measured for loamy soils and 97% to 99% attenuation has been measured within 45 to 80 feet in coarse to medium sandy soils (USEPA 1980b). The Maine Department of Environmental Protection assumes 100% attenuation if systems are properly installed and maintained. Thus, phosphorus loading is usually a problem primarily when the system is located in very sandy soils, in soils with shallow separation to bedrock or groundwater, or when close to a surface water or wetland.

The impact of both nitrogen and phosphorus loading also increases when clusters of septic systems are located adjacent to a water body (USEPA, 1983 and USEPA, 1980b). A 300 foot "zone of influence" has therefore typically been utilized by the USEPA as the septic loading threshold distance. Systems located greater than 300 feet from a surface water or wetland are expected to contribute a nominal nitrogen or phosphorus load due to the existence of a soil prism of sufficient size, or adequate separation between the shallow groundwater table and the leaching area.

For the above reasons, focus was placed exclusively on the coastal sections of the watershed, especially where dwellings serviced by septic systems occur within 300 feet of the shoreline of the Harbor. It would appear, given the proximity of septics within the coastal zone to the Harbor, reported and perceived problems with these systems, the age and questionable design of these systems, and the prevailing natural resource attributes (i.e. soils, slope, proximity to streams and wetlands, etc.) that limiting the septic load analysis to this area was reasonable. In this study, the USEPA's standard loading coefficient for nitrogen (6.5 kg/dwelling/yr) was used. However, a modified the standard coefficient was used for phosphorus to reflect 50% on-site attenuation (0.5 kg/dwelling/ yr). This distinction was made in part because of the affinity of phosphorus binding on soils particles, and the less significant role of phosphorus in dictating algae and productivity related problems in estuarine environments

4.2.5 Marina Contributions

Nine major marinas exist within Hempstead Harbor. These marinas provide approximately 800 slips and moorings. As documented by the USEPA (1985), marinas can themselves contribute to water quality problems. Sediments, nutrients, petroleum hydrocarbons and heavy metals are pollutants associated with marina operations. Some of these pollutants are generated due to ancillary activities (such as vehicle parking), whereas others are directly attributable to marina operations (such as refueling). The boats themselves which utilize these marinas can also create environmental impacts due to prop wash (turbidity, nutrient resuspension from sediments), spills or illegal discharge of sanitary wastes.

Pollutant loading attributable to marinas was modeled utilizing the method contained in the USEPA Coastal Marina Assessment Handbook (1985). The number of boats utilizing the Harbor was estimated using numbers contained in the New York Clean Vessel Act Plan and those obtained through the analysis of aerial photographs. Loading coefficients for coliform bacteria, heavy metals and petroleum hydrocarbons were multiplied by the estimated number of boats to yield the estimated annual pollutant loads. Estimated loads for each of these pollutants were calculated by first assigning the following loading coefficients (as per USEPA, 1985):

Coliform bacteria	0.13 billion/hr
Volatile Hydrocarbons (gas/diesel)	37.8 g/hr
Heavy metals (Lead)	0.4 g/hr

These pollutants were selected due to their direct potential impact on the water quality and living natural resources (shellfish in particular) of the Harbor. Following the review of marina and anchorage data, and actual vessel counts arrived through the interpretation of aerial photographs of the Harbor, it was determined that approximately 800 boats can be considered resident of the Harbor. This number was reviewed and approved for use by the HHPC in this analysis. It was assumed that of these vessels, only 50% would meet the general criteria used by NYSDEC to evaluate marine pollution problems (i.e in-board motor and large enough to have an on-board marine sanitation device). It is acknowledged that this may underestimate the nature of the Harbor's recreational fleet, but the available data restricted a more definitive assessment. In general, the recreational boating season in Long Island is six months long (April through September). It was assumed that on average, the Harbor's recreational fleet would log approximately 350,000 operational hours/year. Applying the above coefficients to this figure yielded the potential pollutant contributions attributable to marina related boating activities. Obviously, the resulting data should be viewed as extremely preliminary in nature. The USEPA (1985) provides a means of more accurately calculating the actual concentration of these pollutants in the water column; however, this method requires hydrodynamic data specific for the Harbor and for the marinas to compute freshwater replenishment rates, vertical and horizontal mixing, and the decay rates of the pollutants of concern. These data have not yet been compiled for Hempstead Harbor. This is a particular area of study that the HHPC could focus more attention on in later projects.

4.3 Results

4.3.1 Surface Runoff Related Nonpoint Source Pollutant Loading

The results of the pollutant loading analysis can be used as a means of identifying the most appropriate nonpoint source pollutant management strategies for the Hempstead Harbor watershed. Delivery control techniques are usually a mandatory component of a well-designed pollutant management strategy. However, such practices can be difficult to implement, expensive, and/or require considerable inter-municipal support. From a practical implementation standpoint, it is thus important that management efforts be prioritized. This means elevating the implementation rank of projects such that those that will result in the greatest overall benefit to the Harbor will be conducted first. Doing so increases the cost-effectiveness of watershed management programs, as it directs funds and efforts to those sub-watersheds most responsible for the water quality problems. However, the magnitude of the pollutant load should not be the only deciding factor; the feasibility, practicality, and public acceptance of watershed management efforts need also be considered.

Thus, for this study, the results of the pollutant loading analysis were used in the development of a priority ranking scheme for management efforts. As will be detailed below, the ranking scheme, was based largely on the magnitude of the contributed pollutant load, but also took into consideration the source of the pollutant load, technical feasibility in respect to its control, and practical feasibility in terms of the ability of responsible parties to actually implement the required measures. The ranking was achieved by using a combination of objective and subjective assessments tied together through a non-linear, weighted averaging procedure.

The Hempstead Harbor NPS data reflect the projected pollutant loads for each of the delineated sub-watershed using the pollutant loading coefficients and subwatershed land use described in Section 4.2.3. The pollutants originate from such sources as road runoff, soil erosion, residential lawn fertilizers, runoff from impervious surfaces and a minor amount of agricultural contributions. It should be noted that loads for zinc (Zn), lead (Pb) and petroleum hydrocarbons (PHC) were calculated only for urban/residential land. Other land types typically do not contribute significant amounts of these pollutants. The total annual loads, computed by land use aggregates for each sub-watershed, are presented in Tables 4-2 and 4-3. Figures 4-1 through 4-4 display this information graphically.

Table 4-2.
Pollutant Loading by Sub-watershed (kilograms per year)

Class	Hectares	TN (kg/yr)	TP (kg/yr)	TSS (kg/yr)	Zn (kg/yr)	Pb (kg/yr)	PHC (kg/yr)
Sub-watershed 1 Locust Valley							
Urban/ Residential	167.67	838.34	134.13	335336.03	301.80	301.80	435.94
Recreation	59.75	298.74	17.92	23899.60			
Agriculture	0.00	0.00	0.00	0.00			
Forested	24.10	60.25	4.82	6025.30			
Wetlands	13.34	-3.34	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	0.00	0.00	0.00	0.00			
Surface Water	0.24	2.39	0.06	0.00			
Total	265.10	1196.39	156.94	365260.93	301.80	301.80	435.94
Sub-watershed 2 Glen Cove North							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	144.37	721.84	115.49	288736.84	259.86	259.86	375.36
Recreation	17.71	88.56	5.31	7085.02			
Agriculture	0.00	0.00	0.00	0.00			
Forested	21.64	54.09	4.33	5408.91			
Wetlands	4.32	-1.08	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	1.57	0.00	0.00	0.00			
Surface Water	0.57	5.71	0.14	0.00			
Total	190.17	869.12	125.25	301230.77	259.86	259.86	375.96

TN = Total Nitrogen TP = Total Phosphorus TSS = Total Suspended Solids
Zn = Zinc Pb = Lead PHC = Petroleum Hydrocarbons

Sub-watershed 3 Old Brookville							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	2837.47	14187.33	2269.97	5674931.17	5107.44	5107.44	7377.41
Recreation	48.67	243.36	14.60	19468.83			
Agriculture	37.81	378.10	22.69	60495.55			
Forested	458.69	1146.72	91.74	114672.06			
Wetlands	10.48	-2.62	0.00	0.00			
Grassland	30.59	152.96	9.18	12236.44			
Beach	4.45	0.00	0.00	0.00			
Surface Water	19.06	190.61	4.77	0.00			
Total	3447.21	16296.45	2412.94	5881804.05	5107.44	5107.44	7377.41
Sub-watershed 4 Sands Point North							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	121.28	194.05	52.15	121283.40	218.31	218.31	315.34
Recreation	3.11	15.53	0.93	1242.11			
Agriculture	0.00	0.00	0.00	0.00			
Forested	45.15	112.87	9.03	11287.45			
Wetlands	23.77	-5.94	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	14.48	0.00	0.00	0.00			
Surface Water	1.09	10.93	0.27	0.00			
Total	208.88	327.44	62.39	133812.96	218.31	218.31	315.34
TN = Total Nitrogen TP = Total Phosphorus TSS = Total Suspended Solids Zn = Zinc Pb = Lead PHC = Petroleum Hydrocarbons							
Sub-watershed 5 Sands Point South							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/	29.24	46.79	12.57	29242.91	52.64	52.64	76.03

Residential							
Recreation	76.94	384.72	23.08	30777.33			
Agriculture	0.00	0.00	0.00	0.00			
Forested	5.54	13.86	1.11	1385.63			
Wetlands	0.00	0.00	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	4.21	0.00	0.00	0.00			
Surface Water	0.29	2.87	0.07	0.00			
Total	116.22	448.24	36.84	61405.87	37.64	37.64	76.03
Sub-watershed 6 Glen Cove South							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	129.94	649.70	103.95	25978.54	233.89	233.89	337.84
Recreation	8.56	42.79	2.57	3423.48			
Agriculture	0.00	0.00	0.00	0.00			
Forested	9.63	24.08	1.93	2407.89			
Wetlands	0.00	0.00	0.00	0.00			
Grassland	0.13	0.67	0.04	53.44			
Beach	1.09	0.00	0.00	0.00			
Surface Water	0.04	0.45	0.01	0.00			
Total	149.40	717.68	108.50	265763.36	233.89	233.89	337.84
TN = Total Nitrogen; TP = Total Phosphorus; TSS = Total Suspended Solids; Zn = Zinc; Pb = Lead; PHC = Petroleum Hydrocarbons							
Sub-watershed 7 Mott Point							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	153.21	245.14	65.88	153210.53	275.78	275.78	398.35
Recreation	4.64	23.20	1.39	1855.87			
Agriculture	0.00	0.00	0.00	0.00			

Forested	31.40	78.50	6.28	7850.20			
Wetlands	1.09	-0.27	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	12.36	0.00	0.00	0.00			
Surface Water	0.08	0.81	0.02	0.00			
Total	202.77	347.38	73.57	162916.60	275.78	275.78	398.35

Sub-watershed 8 Sea Cliff

Class	Hectares	TN (kg/yr)	TP (kg/yr)	TSS (kg/yr)	Zn (kg/yr)	Pb (kg/yr)	PHC (kg/yr)
Urban/ Residential	659.44	3297.21	527.55	1318882.59	1186.99	1186.99	1714.55
Recreation	38.44	192.19	11.53	15374.90			
Agriculture	0.00	0.00	0.00	0.00			
Forested	29.43	73.57	5.89	7357.29			
Wetlands	0.88	-0.22	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	7.35	0.00	0.00	0.00			
Surface Water	4.63	46.32	1.16	0.00			
Total	740.17	3609.06	546.13	1341614.78	1186.99	1186.99	1714.55

TN = Total Nitrogen TP = Total Phosphorus TSS = Total Suspended Solids
Zn = Zinc Pb = Lead PHC = Petroleum Hydrocarbons

Sub-watershed 9 Port Washington

Class	Hectares	TN (kg/yr)	TP (kg/yr)	TSS (kg/yr)	Zn (kg/yr)	Pb (kg/yr)	PHC (kg/yr)
Urban/ Residential	348.05	1740.26	278.44	696105.26	626.49	626.49	904.94
Recreation	112.48	562.41	33.74	44992.71			
Agriculture	0.00	0.00	0.00	0.00			
Forested	48.99	122.48	9.80	12247.98			
Wetlands	9.13	-2.28	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			

Beach	10.26	0.00	0.00	0.00			
Surface Water	11.09	110.89	2.77	0.00			
Total	540.00	2533.76	324.76	753345.95	626.49	626.49	904.94
Sub-watershed 10 Flower Hill							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	73.50	367.51	58.80	147004.05	132.30	132.30	191.11
Recreation	0.00	0.00	0.00	0.00			
Agriculture	0.00	0.00	0.00	0.00			
Forested	7.34	18.36	1.47	1836.03			
Wetlands	2.96	-0.74	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	0.00	0.00	0.00	0.00			
Surface Water	0.00	0.00	0.00	0.00			
Total	81.81	385.13	60.27	148840.08	132.30	132.30	191.11
TN = Total Nitrogen TP = Total Phosphorus TSS = Total Suspended Solids Zn = Zinc Pb = Lead PHC = Petroleum Hydrocarbons							
Sub-watershed 11 Roslyn East							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	131.55	657.77	105.24	263109.31	236.80	236.80	342.04
Recreation	27.33	136.64	8.20	10931.17			
Agriculture	0.00	0.00	0.00	0.00			
Forested	23.53	58.82	4.71	5881.58			
Wetlands	0.29	-0.07	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	0.00	0.00	0.00	0.00			
Surface Water	3.73	37.29	0.93	0.00			
Total	186.43	890.44	119.08	279922.06	236.80	236.80	342.04

Sub-watershed 12 Roslyn West							
Class	**Hectares**	**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**	**Zn (kg/yr)**	**Pb (kg/yr)**	**PHC (kg/yr)**
Urban/ Residential	188.38	941.88	150.70	376753.04	339.08	339.08	489.78
Recreation	1.75	8.77	0.53	701.21			
Agriculture	0.00	0.00	0.00	0.00			
Forested	13.94	34.85	2.79	3484.82			
Wetlands	0.00	0.00	0.00	0.00			
Grassland	0.00	0.00	0.00	0.00			
Beach	0.00	0.00	0.00	0.00			
Surface Water	1.81	18.10	0.45	0.00			
Total	205.88	1003.59	154.47	380939.07	339.08	339.08	489.78

TN = Total Nitrogen TP = Total Phosphorus TSS = Total Suspended Solids
Zn = Zinc Pb = Lead PHC = Petroleum Hydrocarbons

Table 4-3.
Summary Sub-watershed Pollutant Loading (kilograms per year)

No Correction for watershed size

Water shed	Area (hectares)	Area (acres)	TN (kg/yr)	TP (kg/yr)	TSS (kg/yr)	Zn (kg/yr)	Pb (kg/yr)	PHC (kg/yr)
1	265.1	654.8	1196.39	156.94	365260.93	301.84	301.84	435.94
2	190.17	469.7	869.12	125.28	301230.77	259.86	259.86	375.36
3	*16296.45*	*40268.5*	*16296.45*	*2412.94*	*5881804.05*	*5107.44*	*5107.44*	*7377.41*
4	208.88	515.9	327.44	62.39	133812.96	218.31	218.31	315.34
5	116.22	287.0	448.24	36.84	61405.87	52.64	52.64	76.03
6	149.44	369.0	717.68	108.5	265763.36	233.89	233.89	337.84
7	202.77	500.4	347.38	73.57	162916.6	275.78	275.78	398.35
8	740.17	1828.2	3609.06	546.13	1341614.78	1186.99	1186.99	1714.55
9	540.0	1333.8	2533.76	324.76	753345.95	626.49	626.49	904.94
10	83.81	207.0	385.13	60.27	148840.08	132.3	132.3	191.11
11	186.43	460.5	890.34	119.08	279922.06	236.8	236.8	342.04
12	205.88	508.5	1003.59	154.47	380939.07	339.08	339.08	489.78
Total	19185.32	47403.3	28,624.68	4,181.7	10,076,856.48	8,971.38	8,971.38	12,958.69

Italics signify Sub-watershed with highest pollutant load per parameter
2.47 hectares = 1 acre

TN = Total Nitrogen
TP = Total Phosphorus
TSS = Total Suspended Solids
Zn = Zinc
Pb = Lead
PHC = Petroleum Hydrocarbons

Sub-watersheds:
1 Locust Valley
2 Glen Cove North
3 Old Brookville
4 Sands Point North
5 Sands Point South
6 Glen Cove South
7 Mott Point
8 Sea Cliff
9 Port Washington
10 Flower Hill
11 Roslyn East
12 Roslyn West

Figure 4-1. Sub-watershed Pollutant Loading - TN

Figure 4-2. Sub-watershed Pollutant Loading - TP

Figure 4-3. Sub-watershed Pollutant Loading - TSS

Figure 4-4. Sub-watershed Pollutant Loading - Zn, Pb and PHC

Table 4-4 presents the rank of each sub-watershed as determined by the cumulative NPS loading data presented in Tables 4-2 and 4-3. Table 4-4 is useful in establishing which sub-watersheds are responsible for the greatest pollutant loads. Given that the uncorrected total load is biased by land area, the loads presented in Table 4-2 and summarized in Table 4-3 are typically greater for those watersheds that encompass larger areas. For example, Sub-watersheds 3 (Old Brookville), 8 (Sea Cliff) and 9 (Port Washington) had the highest pollutant loads for all six parameters. These sub-watershed are also the largest in terms of land area. These data thus document that the larger the sub-watershed, the greater the expected pollutant load. Thus management of the watershed's pollutant inputs on a size ranked prioritization basis has significant merit. In many ways, this is both sensible and desirable. By attacking these sub-watersheds first, the Harbor's largest pollutant loads can be reduced. If it were possible to achieve a 50% decrease in the nitrogen load contributed by these three sub-watersheds alone, nearly a 40% overall reduction in the Harbor's NPS nitrogen load could be realized.

Table 4-4.
Sub-watershed Rank By Total Pollutant Loading

No Correction for watershed size							
Sub watershed		**TN kg/yr**	**TP kg/yr**	**TSS kg/yr**	**Zn kg/yr**	**Pb kg/yr**	**PHC kg/yr**
1	Locust Valley	4	4	5	3	3	5
2	Glen Cove N	7	6	6	5	5	7
3	Old Brookville	1	1	1	1	1	1
4	Sands Point N	12	10	11	10	10	10
5	Sands Point S	9	12	12	12	12	12
6	Glen Cove S	8	8	8	9	9	9
7	Mott Point	11	9	9	6	6	6
8	Sea Cliff	2	2	2	2	2	2
9	Port Washington	3	3	3	3	3	3
10	Flower Hill	10	11	10	11	11	11
11	Roslyn East	6	7	7	8	8	8
12	Roslyn West	5	5	4	4	4	4

However, the size of a watershed alone cannot be the only factor governing management prioritization. NPS load management plans that are solely based on the size of a watershed may unduly, and inappropriately allocate too many resources to a single sub-watershed. This occurs for two main reasons:

1. The unit areal loading (UAL) methodology is size biased. Thus the larger watersheds, some times regardless of their level of development, will typically be given top ranking.

2. There is a "natural" background nutrient and sediment load, that cannot be cost-effectively managed or feasiblely reduced.

The next step in developing a management plan for the Harbor thus involved conducting screening processes that eliminated the size bias from the sub-watershed ranks, and accounted for the "natural" pollutant load.

The background or natural load represents the "minimum" nitrogen, phosphorus, and sediment loads potentially generated by a watershed in its undeveloped state. These values are arrived at by calculating the pollutant load generated by a sub-watershed assuming total forested land cover. The pollutant load generated under a non-developed condition should reflect the "natural" pollutant load. In most cases, it is unwarranted and/or nonsensical to attempt to manage or reduce a watershed's pollutant load to a level less than this natural load. As such, when attempting to rank sub-watersheds for management prioritization, a determination of the background pollutant load can be used to provide a baseline, "best case" loading level.

Table 4-5 presents the background load for each sub-watershed. Figures 4-5 through 4-7 display the background load graphically.

Figure 4-5. Background Sub-watershed Pollutant Load - TN

Figure 4-6. Background Sub-watershed Pollutant Load - TP

Figure 4-7. Background Sub-watershed Pollutant Load - TSS

Table 4-5. Background Pollutant Load (kilograms per year)				
Sub-watershed		**TN (kg/yr)**	**TP (kg/yr)**	**TSS (kg/yr)**
1	Locust Valley	627.87	50.36	62880
2	Glen Cove North	463.9	36.88	45927.5
3	Old Brookville	8721.03	687.41	853305
4	Sands Point North	428.81	34.18	42385
5	Sands Point South	282.2	22.42	27930
6	Glen Cove South	371.08	29.66	37067
7	Mott Point	473.63	37.87	47310
8	Sea Cliff	1864.36	146.62	181827
9	Port Washington	1382.42	104.68	127380
10	Flower Hill	201.39	16.17	20212
11	Roslyn East	493.25	37.41	45602
12	Roslyn West	528.28	41.27	51017.5

Examining Figures 4-8, 4-9, and 4-10 reveals that the background load can constitute a fairly significant percentage of a watershed's existing pollutant load. For example, comparison of the background and actual TN load for the Old Brookvillle sub-watershed show that the background load actually comprises about 50% of the existing pollutant load. It is therefore unrealistic to expect to cost-effectively manage this sub-watershed's TN such that much more than a 50-60% load reduction is achieved. The magnitude of the background load relative to TP and TSS inputs is not as great as that associated with TN. This suggests that both phosphorus and sediment loading can be expected to greatly increase on a per unit area as a watershed evolves from a natural to a developed state. Again using Sub-watershed 3 as an example, the background TP load is about 25% of the existing TP load, while the background sediment load is only about 15% of the existing load. It should be noted that similar background/actual pollutant load relationships exist for the other sub-watersheds, however; the graphical scale of the Figures 4-8,4-9 and 4-10 impacts the visual representation of these relationships.

Figure 4-8. Comparison of Background and Actual Pollutant Loads - TN

Figure 4-9. Comparison of Background and Actual Pollutant Loads - TP

Figure 4-10. Comparison of Background and Actual Pollutant Loads - TSS

Even though Figures 4-8 through 4-10 compare the background and existing land use loading rates, they still contain the previously mentioned size bias. As such, the relative ranks of the sub-watersheds have not changed. To address this, the sub-watershed rankings were modified to eliminate the size-related bias associated with the UAL modeling technique. Once corrected in this manner, it was possible to arrive at a watershed prioritization rank truly representative of the relative nonpoint source pollutant impact. Table 4-6 presents the corrected sub-watershed ranks. As shown in this table, with the size bias was removed, Sub-watershed 12 exhibited the highest pollutant load for TP, TSS, Zn, Pb and PHC. Sub-watershed 8 exhibited the highest TN load. Overall, Sub-watersheds 8, 12, 6, 10, 3 and 11 were found to be the highest ranked of the 12 sub-watersheds, indicating that management efforts should be prioritized in these sections of the Hempstead Harbor watershed.

Table 4-6.
Sub-watersheds Ranked by Total Pollutant Loading and Corrected for Size

Sub-watershed		TN	TP	TSS	Zn	Pb	PHC
1	Locust Valley	9	9	9	10	10	10
2	Glen Cove North	8	6	6	6	6	6
3	Old Brookville	5	5	5	5	5	5
4	Sands Point North	12	12	11	11	11	11
5	Sands Point South	10	11	12	12	12	12
6	Glen Cove South	3	3	3	4	4	4
7	Mott Point	11	10	10	7	7	7
8	Sea Cliff	*1*	*2*	*2*	*2*	*2*	*2*
9	Port Washington	6	8	8	9	9	9
10	Flower Hill	7	4	4	3	3	3
11	Roslyn East	4	7	7	8	8	8
12	Roslyn West	*2*	*1*	*1*	*1*	*1*	*1*

4.3.2 Septic Loading

As discussed above, a modeling technique was utilized to quantify the annual nutrient contributions of septic systems on a sub-watershed basis. The results of the analysis are presented in Table 4-7 and Figures 4-11 and 4-12. The most substantial septic-related nutrient contributions are associated with Sub-watersheds 4, 7 and 8. Respectively, these sub-watersheds correspond to the Sands Point, Mott Point and Sea Cliff areas. The nutrient load generated by septic systems in Sub-watershed 8 is the most significant, constituting nearly 69% of the entire TN load and about 20% of the entire TP load (Figures 4-13 and 4-14). These data stress the need for aggressive septic management. The septic systems of the small bungalow community located off of Beacon Hill in Sub-watershed 9 have been mentioned as a potential contributory source of nutrients and bacteria to the Harbor. The total TN related septic load generated by this sub-watershed was computed to be 373.5 kg. This amounts to about 12% of the total NPS TN load associated with this sub-watershed. These data support the need for the implementation of septic management initiatives in this watershed.

Table 4-7.
Nutrient Load Attributable to Septic Systems

Sub-watershed		TN (kilograms/year)	TP (kilograms/year)
1	Locust Valley	0	0
2	Glen Cove North	0	0
3	Old Brookville	0	0
4	Sands Point North	2275	39.9
5	Sands Point South	650	11.4
6	Glen Cove South	812.5	14.25
7	Mott Point	4582.5	80.37
8	Sea Cliff	7995	140.22
9	Port Washington	373.5	6.5
10	Flower Hill	0	0
11	Roslyn East	0	0
12	Roslyn West	0	0

Figure 4-11. Total Nitrogen Load Attributable to Septic Systems

Figure 4-12. Total Phosphorus Load Attributable to Septic Systems

Figure 4-13. Comparison of TN Load Attributable to Runoff and Septic Sources

Figure 4-14. Comparison of TP Load Attributable to Runoff and Septic Sources

4.3.3 Marina Loading

Analysis of the marina NPS load was conducted using an EPA/NOAA method for quantifying boat-related pollutant loading (EPA, 1985). The details of this analysis are presented above in Section 4.2.5. The results of this analyses were significant. Coliform bacteria loading was computed to exceed 45,000 billion colonies per year, based on the potential inputs from only one-half of the Harbor's boating community computed over a 6 month time frame. This number translates to an average, in water concentration of approximately 500 colonies/100 ml, when one accounts for the full volume of the Harbor. In addition, the annual heavy metal and petroleum hydrocarbon loads were computed to be as much as are approximately 122 kg and 12,720 kg, respectively. Based on a six month recreational boating season, this equates to a daily influx of about 0.7 kg of heavy metals and about 70 kg of petroleum hydrocarbon (volatile oils). On a comparative basis, the influx of lead and petroleum hydrocarbons for the entire watershed resulting from storm water runoff, is approximately 24 kg and 35 kg per day respectively (Table 4-3). The differences are in part due to the differences in the loading coefficients used in both analyses and the much more direct delivery mechanisms by which these pollutants enter the Harbor from boats as opposed to from storm water runoff. However, as stressed in 4.2.5 and reiterated above, the marina related pollutant loads are extremely preliminary and contain an admittedly high degree of variability and standard error. As such, the validity of these data, in contrast to the NPS pollutant loads computed for the watershed, are low. The estimate of the marina contributions needs to be improved. However, in order to do so, it will be necessary to conduct relatively detailed hydrodynamic analyses of the Harbor and each of the marinas.

The marina-related load is recognized to be an over-estimate of actual pollutant inputs. As previously discussed, the hydrodynamic attributes of both the estuary and the marinas must be modeled and computed if realistic in-water concentrations are to be developed. In addition, the inputs of pollutants attributable to boat maintenance activities has not been accounted for in this analysis. More information is required relative to daily operations at the marinas to quantify such a load. Also, the resulting values do not account for sanitary waste pumpout or take into consideration environmentally sound refueling and/or maintenance practices.

Even though these data are thus extremely preliminary and require extensive field study to improve their utility, they indicate the degree to which boating activities can potentially effect water quality. These data underscore the need to properly educate the boating community of the measures that can be taken on an individual scale to reduce NPS loading. In addition, the data establishes the need for the HHPC to pursue marina oriented NPS management techniques related to their siting, storm water quality management, location and design of storage and maintenance facilities.

4.4 Watershed Buildout Analysis

In analyzing the magnitude of NPS loading, a watershed buildout analysis is often used. This analysis establishes on a relative scale the potential additional amount of pollutant inputs that would arise if the watershed was developed to its full zoning limits. This pollutant modeling exercise attempts to establish what the future potential impact to the receiving water will be if further development occurs. This can be a very useful means of identifying sub-watersheds at risk of environmental perturbations. It can also be used as a means of identifying sub-watersheds where more stringent zoning is needed or where attention should be focused to insure that potential environmental impacts attributable to new development is properly mitigated.

The Hempstead Harbor Watershed is approximately 85% developed (urban/residential and recreational land types). Few large tracts remain available for residential or commercial infill development. Regardless, a buildout pollutant loading analysis was conducted to evaluate the potential negative impact of this infill development. In order to calculate these data, the current land use statistics were modified. The assumption was made that the majority of the forested land in any given watershed would be utilized for infill development if possible. Areas classified as parks and preserves were taken into account, and were assumed to remain forested in the future. Small scattered areas of forested land were also left unchanged in the buildout analysis. This was done largely due to their relatively small size and speculation that some of these lands were non-conforming lots, had environmental limitations, or were otherwise restricted from being developed. The buildout analysis did not attempt to correct the loading for size bias. Table 4-8 presents the resulting pollutant load data. Figures 4-15 through 4-20 present the data graphically. These figures show that compared to existing conditions (actual load) there is relatively little difference with near-complete buildout loads. This is primarily due to the fact that the Hempstead Harbor watershed is nearly completely developed at this time.

Table 4-8.
Pollutant Loading Following Buildout Analysis
(kilograms/hectare)

	Sub-watershed	TN	TP	TSS	Zn	Pb	PHC
1	Locust Valley	1231.4	165.34	389476.4	327.01	327.01	472.34
2	Glen Cove North	913.12	135.83	332017.52	291.53	291.53	421.1
3	Old Brookville	17318.2	2656.16	6597020.81	5843.09	5843.09	8440.02
4	Sands Point North	300.44	69.29	156309.61	272.3	272.3	393.33
5	Sands Point South	448.24	36.84	61405.87	52.64	52.64	76.03
6	Glen Cove South	717.68	108.5	265763.36	233.89	233.89	337.84
7	Mott Point	341.97	74.95	167415.87	286.58	286.58	413.95
8	Sea Cliff	364656	555.13	1367862.4	1213.99	1213.99	1753.54
9	Port Washington	2603.74	341.55	802340.21	676.89	676.89	977.73
10	Flower Hill	385.13	60.27	148840.08	132.3	132.3	191.11
11	Roslyn East	922.93	126.88	302663.67	260.19	260.19	375.83
12	Roslyn West	1016.11	157.47	389696.12	348.08	348.08	502.79

The data show that of the 12 sub-watersheds, only Sub-watershed 3 (Old Brookville) will experience a measurable increase in pollutant loading if totally built out. This is the only sub-watershed that has open space areas conducive to development and zoning that would enable these sites to be developed. Although Sands Point has a considerable amount of open space as does Locust Valley, these sub-watersheds have more restrictive, large lot zoning. In addition, some of the open areas are parks or preserves.

Figure 4-15. Sub-watershed Pollutant Loading - Actual vs. Buildout Concentrations - TN

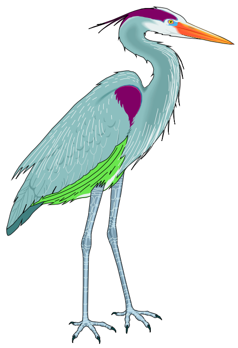
Figure 4-16. Sub-watershed Pollutant Loading - Actual vs. Buildout Concentrations - TP

Figure 4-17. Sub-watershed Pollutant Loading - Actual vs. Buildout Concentrations - TSS

Figure 4-18. Sub-watershed Pollutant Loading - Actual vs. Buildout Concentrations - Zn

Figure 4-19. Sub-watershed Pollutant Loading - Actual vs. Buildout Concentrations - Pb

Figure 4-20. Sub-watershed Pollutant Loading - Actual vs. Buildout Concentrations - PHC



5.0 POLICY ENVIRONMENT

5.1 Introduction

The primary objectives of the Hempstead Harbor Water Quality Improvement Plan are to:

- correct the Harbor's water quality problems,
- control existing and future non-point source pollutant inputs, and
- restore or enhance the recreational, ecological and aesthetic attributes of the Harbor.

In the previous chapters, a foundation upon which the plan can be based was constructed. The history of the watershed's development was discussed, water quality trends were analyzed, and the influx of pollutants to the Harbor was quantified. With this information, it becomes possible to develop a plan that identifies what must be done to correct the Harbor's water quality problems and provides guidance for its restoration and long-term management. However, such a plan is of little value if the means to implement it do not exist.

Implementation of the Hempstead Harbor Water Quality Improvement Plan will inevitably be the responsibility of the HHPC, State, County and local government. The **Policy Environment** of the Harbor watershed will largely influence the extent to which the plan is successfully implemented. Policy environment refers to the laws, regulations, ordinances and initiatives that govern land use, development, and non-point source pollution control within the watershed. As discussed in the introductory section of this report, non-point source pollution does not respect municipal boundaries. Pollutants that originate in one municipality may create problems in another. As a result, water quality and resource protection goals may never be realized unless all the municipalities within a watershed participate in NPS control efforts. To be successful, the plan developed for the purpose of reducing NPS pollutant loading and protecting the Harbor's water quality must be implemented uniformly throughout the boundaries of the watershed. As such, the success of the Water Quality Improvement Plan for Hempstead Harbor is, to a large extent, dependent on a well structured Policy Environment that is relatively consistent throughout the entire watershed.

5.1.1 The purpose of a regulatory framework for watershed management

Until recently, NPS pollution control was rarely regulated by local governments. Some of this was due to the lack of understanding of the impacts of NPS pollution, some due to the evolving science of its management, and some due to the political complexities associated with instituting and enforcing NPS control regulations. Instead, the responsibilities of NPS pollution control were left primarily to Federal and State agencies. On a local scale, NPS problems were indirectly dealt with through regulations intended to address other local concerns (e.g. anti-litter ordinances and flood control standards).

On a local scale, land development ordinances and guidelines are the typical legislative vehicles by which NPS pollution control can be achieved. Land use and land development regulations can reduce NPS pollution in two principal ways:

- By preventing NPS pollution through source control strategies (e.g. restrictive zoning, open space preservation, resource buffer zones, cluster development, overlay zoning etc.).

- By decreasing the transport of pollutants to a receiving waterbody or wetland through the implementation of delivery control techniques (e.g. soil and erosion control, storm water quality management, etc.).

The ability of practically any regulation intended to reduce NPS loading and protect the environment is dependent upon the degree to which the regulations are applied and the extent to which they are enforced. This is particularly true in respect to programs that are somewhat voluntary (e.g. pooper scooper laws) or difficult to police (e.g. septic management, integrated pest management). As such, public education and the dissemination of information that emphasizes the communal benefits of NPS and watershed management initiatives cannot be overlooked when discussing the regulatory aspects of watershed management.

In addition, the successful implementation of any of the management tools that fall into the Policy Environment category is dependent on the existence of a well defined institutional framework. The existence of "home rule" and the need to address local concerns increases the probability for the inconsistent management of NPS pollution on a local scale. Also, because the concept of watershed management is an evolving practice, there rarely exists a single governmental body whose intent is to pursue and implement regulatory mandates and initiatives on a watershed scale. In many cases, this need for a lead agency has resulted in the formation of a regional coordinating entity, composed of municipal representatives of the watershed and empowered to address NPS and land development issues from a watershed perspective. The Long Island Sound Study is a perfect example of a number of government agencies, each with its own set of concerns, creating an institutional framework and developing a policy environment for the protection of communally shared resources. The same is true of the Hempstead Harbor Protection Committee, even in its existing context.

Over time, Federal, State, County and local government have promulgated laws and regulations to control or manage development within the Harbor's watershed. Some have been passed to safeguard the public, while others are intended to protect the environment. In general, these regulations in some form or another control the intensity, manner and pattern of watershed development and land use. Individually, these laws and regulations are meaningful and important; however, on a watershed scale, they may be inconsistent and, in some cases, contradictory.

5.1.2 Study methodology for the analysis of existing Policy Environment

The purpose of the Policy Environment section of the Hempstead Harbor Water Quality Protection Plan is threefold:

1. To examine the consistency of the existing laws, regulations, programs and administrative responsibilities pertaining to development, the control or management of NPS pollution and the protection of the Harbor's environmental resources.

2. Where possible and practical, to compare the existing Policy Environment to "benchmark" guidelines developed for water quality management, and

3. Where appropriate, to suggest modifications or improvements to the Harbor's existing Policy Environment that will facilitate the successful long-term implementation of the Plan.

It should be stressed that neither the review nor the subsequent recommended changes to the existing policy environment are intended to usurp the existing regulatory authority of the municipalities encompassed within the Harbor's watershed boundaries. Nor is this section intended to do away with local regulations and policies that address the unique needs of each community. Rather, it is intended to maximize the ability of the member communities to properly manage, on a watershed scale, NPS pollution to Hempstead Harbor.

For this study, the Policy Environment is considered to consist of two very fundamental elements:

1. The regulations governing watershed development and environmental protection.

2. The administrative framework responsible for the implementation and enforcement of these regulations.

As previously mentioned, while it is not necessary for each municipality to have precisely the same regulations, a high degree of uniformity will facilitate the implementation of the Hempstead Harbor Water Quality Improvement Plan. Thus, the analysis of existing development regulations, whereby their strengths and consistencies are examined, is an important step in the formulation of a Policy Environment that emphasizes watershed management. This section provides the following information that is critical to a sound Policy Environment:

- An overview of the basic elements of a watershed-based regulatory framework.
- A discussion of the legislative basis for NPS management.
- A review of the governmental agencies involved in NPS management, land use regulation and the protection of natural resources with emphasis placed on the control of watershed development activities.
- An analysis of the existing policies that govern land use, development, watershed management, and resource protection critical to the long-term quality of the Harbor.

To obtain the basic information needed to identify and evaluate the existing Policy Environment, particularly in respect to NPS policies and regulations, a survey was forwarded to each of the member municipalities of the HHPC (Appendix E). The survey was designed by the NYSDOS and NYSDEC. Following the receipt of the survey responses, follow-up interviews were conducted with the technical staff from NYSDOS, NYSDEC, Nassau County and each municipality. In addition, zoning maps, coastal erosion hazard area laws, erosion and sedimentation control regulations, master plans and other similar materials provided by the municipalities were reviewed in respect to NPS control, watershed management, and resource protection.

The HHPC members who served as initial contacts are listed below. A full listing of municipal staff contacted in connection with this Chapter of the report is given in Appendix F.

Nassau County	Kenneth Arnold, Department of Public Works
Town of North Hempstead	Denise Harrington, Planning and Economic Development
Town of Oyster Bay	Richard Lenz, Deputy Comm. Environmental Control
City of Glen Cove	Rosemary Olsen, Deputy Mayor
Village of Flower Hill	Bill Clemency, Board of Trustees
Village of Roslyn	Marlene Freeman, Deputy Mayor
Village of Roslyn Harbor	Benjamin Corin, Deputy Mayor
Village of Sands Point	Kay Ullman, Trustee
Village of Sea Cliff	Tom Bellingham, Village Administrator

Once compiled, the survey results and the individual regulations were analyzed. The analysis focused on establishing whether the existing Policy Environment is consistent with the long-term management and restoration of the Harbor. It must be stressed that the analysis was not intended to be a critique of the rules and regulations governing the development practices or environmental protection policies of each of the HHPC member municipalities. As acknowledged above, home rule government initiatives are needed to address the concerns of the local populus. The analysis is intended to identify whether the existing Policy Environment should be expanded or strengthened to better achieve the NPS pollution control objectives of the HHPC. Recommendations that strengthen the watershed management attributes are presented and discussed in the following sub-sections. These recommendations are integrated in Section 6, along with recommendations pertaining to delivery control techniques, public education, resource restoration, and the institutional needed to create a complete, proactive, long-term Water Quality Protection Plan.

5.2 Developing a Watershed Cognizant Policy Environment

5.2.1 Legislative Basis for Watershed Management

The passage of the Clean Water Act amendments in 1987 included a modified Section 319 that authorized federal funding for NPS pollution control programs. Section 319 directed Federal agencies to focus attention on the impacts of NPS pollution on surface water quality and to prioritize nationwide the development and implementation of NPS pollution control programs. States were mandated to identify those water resources impacted by NPS pollution. The States were also directed to develop programs to control NPS pollution, particularly in areas where applicable water quality standards could not otherwise be achieved. In addition, States were required to provide funding for the implementation of various programs, and to work with local municipalities to develop NPS pollution control programs. Local governments, concerned with enhancing the quality of life within their communities, were encouraged to take advantage of state and federal funding and develop programs or conduct projects that reduced NPS pollutant loading and/or restored resources impacted by NPS pollution.

The Federal Coastal Zone Management Act (CZMA) of 1972 was established to support and protect the distinctive character of the waterfront. The law set forth standard policies for reviewing proposed development projects along the coastline. The 1990 re-authorization of the CZMA included Section 6217, which required states to develop new Coastal Zone NPS Management Programs based on technical guidance from the Environmental Protection Agency. The re-authorization also included Section 6217(b), which required the identification of critical areas adjacent to immediate coastal areas where land uses may contribute to future impairment. In these areas, the law provides for additional management measures that are land use oriented, such as siting and density requirements.

5.2.2 Establishing Policy Environment Objectives for Hempstead Harbor

Although the CZMA and the Clean Water Act provide some of the legal basis for watershed management, they do not provide standards by which successful watershed management can be gauged. In addition, neither discuss in detail the benefits and impacts of implementing various policy environment (i.e. source control) techniques in respect to watershed management and NPS control.

Horsley and Whitton (1996) provide examples of techniques and tools that can be used to strengthen the watershed management capabilities of the Policy Environment. They divide these into Regulatory and Non-Regulatory tools. Regulatory tools include:

- Zoning regulations (land use/development restrictions)
- Growth controls (policies intended to slow the rate and intensity of development)
- Performance standards (development guidelines that account for environmental sensitivity)
- Health regulations (designed to protect the health and welfare of the public)
- Subdivision rules and regulations (limitations on where and how development occurs)
- Wetland ordinances and regulations (designed to limit or avoid loss of wetlands)
- Drainage ordinances (regulates post-development storm water quality and quantity)
- Erosion control

Non-regulatory tools may include:

- Land donation/acquisition
- Conservation easements
- Public education
- Monitoring programs (to track environmental impact or the success of NPS initiatives)

Obviously, there are other Policy Environment management tools that can be utilized in the protection of Hempstead Harbor. Likewise, the utility of some of the above tools may be greatly diminished in watersheds, such as that of Hempstead Harbor, where extensive development has already occurred and the opportunities for extensive future development may be limited.

As part of the policy environment analysis, generalized "benchmarks" that can be used to gauge the NPS pollution control and watershed management attributes of the Hempstead Harbor watershed's existing regulatory framework are provided. In addition, a bibliography of model and/or ordinances or regulations that could be adopted by the HHPC is provided in Appendix J. Both the "benchmarks" and the referenced legislation can be used as the starting points for amending, modifying or otherwise expanding the existing policy environment to increase its ability to facilitate better long-term management of the watershed.

5.3 Governmental Responsibilities for Watershed Management and NPS Control Within the Hempstead Harbor Watershed

Improvement of the Hempstead Harbor Policy Environment must begin with definition of the existing governmental responsibilities for the control of NPS pollution, the protection of environmental resources, and the regulation of land development activities.

5.3.1 Federal Agencies

The U.S. Environmental Protection Agency (EPA) is typically the Federal agency that takes the lead role in the protection of water quality, wetlands and other natural resources. In coastal areas, other Federal agencies such as the Army Corps of Engineers (ACOE), the Fish and Wildlife Service (FWS), and the National Marine Fishery Service (NMFS) may also become involved in the regulation, protection, maintenance and restoration of environmental resources. The Federal agencies most involved with water quality and watershed management issues affecting Hempstead Harbor and their role to date are as follows:

- The EPA provides funding to New York for the implementation of the Clean Water Act Provisions of Section 319. EPA has a lead role in the Long Island Sound Study (LISS), overseeing the collaborative efforts of the participating State agencies, universities and local government or volunteer entities. EPA also maintains jurisdiction over the assessment and remediation of Federal Superfund sites.

- The ACOE maintains jurisdiction over Federal waterways and navigable waterbodies. The ACOE, in conjunction with the NYSDEC, reviews permit applications involving shoreline construction, waterfront development, wetland encroachment, and impacts to riparian lands. The ACOE may also become involved in remediation projects at Federal waterfront Superfund sites. The ACOE is responsible for the maintenance of two Federal navigational channels in Hempstead Harbor: Glen Cove Creek and the Roslyn Navigational Channel.

- The Federal Emergency Management Agency (FEMA) determines flood plain boundaries and sets requirements for construction elevations via the National Flood Insurance Program. Local municipalities may use the flood plain boundaries in setting up protected overlay districts, within which stricter codes or review procedures are applied.

5.3.2. State Agencies

State agencies may work with, or independent of, Federal agencies in matters affecting coastal resources. In respect to Hempstead Harbor, the functions of key State agencies in the control of water pollution and the protection of the environment are described below:

- The NYSDEC has statutory authority for the management of water resources and control of water pollution in the State, and as such, plays an important regulatory role in the control of NPS pollution. This includes the award of NPS program grants. NYSDEC is responsible for determining acceptable water quality standards, and may become directly involved in monitoring existing pollutant levels and developing management plans for non-point pollutant sources.

- The NYSDEC administers the State Pollutant Discharge Elimination System (SPDES). They establish discharge limitations for sewage treatment plants and industrial facilities, and issue and administer the permits. The NYSDEC also reviews the consistency of point source discharges with the permit limitations. NYSDEC's SPDES permit program also encompasses groundwater discharges, including the construction or modification of on-site sewage disposal systems for commercial properties that handle greater than 1000 gallons per day. A SPDES permit is also required for storm water runoff from construction sites of five acres or larger.

- NYSDEC administers the Coastal Erosion Hazard Areas Program, which restricts development of natural, protective coastal features.

- The New York State Department of State (NYSDOS) administers the New York State Coastal Management Program in accordance with the Federal Coastal Zone Management Act, and the State Waterfront Revitalization and Coastal Resources Act. The State Coastal Management Program (CMP) implements the legislature's objectives for coordinated and comprehensive policy planning to ensure the wise use of coastal resources. The foundation of the CMP is the coastal policies that reflect all State laws affecting environmental, cultural and economic resources of the coast. Among these are policies to protect coastal water quality and related policies aimed at protecting coastal wetlands and habitats and restricting the introduction of toxic materials into coastal waters. Both Federal and State statutes require that actions within the State's coastal area be consistent with the CMP's policies.

- NYSDOS also provides technical assistance to local governments in the areas of land use regulations, site plan review and design guidelines, and provides general information on new planning techniques. One focus of the NYSDOS Division of Coastal Resources and Waterfront Revitalization is in providing assistance to municipalities for development of

Local Waterfront Revitalization Programs (LWRPs). The LWRPs are comprehensive local coastal programs that substitute in full for state coastal management plans. They provide a blueprint for action and a strategy for coastal management through prioritized projects. All federal, state and local activities must be consistent with the coastal policies written into the LWRP. A major source of funding for the development of this Plan comes from the NYSDOS through the Local Waterfront Revitalization Program.

- The New York State Department of Health (NYSDOH) develops statewide specifications and guidelines for septic waste management. It is also responsible for closing beaches if monitoring reveals unacceptable levels of coliform bacteria and/or other pollutants. This responsibility may be shared with a County or local agency.

- The New York State Department of Transportation (NYSDOT) designs, owns, and maintains state highways and arterial routes and their associated storm water drainage. In conjunction with the State Environmental Quality Review Act (SEQRA), the NYSDOT is required to review and develop projects which are consistent with local and regional plans. Although the NYSDEC has developed guidelines for storm water quality management (*Reducing the Impact of Stormwater Runoff from New Developments*, NYSDEC, 1992), the DOT's review of new roadways or roadway-related issues continues to focus on the attenuation of the peak flow (flood control). Comparison of pre- and post-development conditions involves analysis of peak flows for the 2, 10 and 100 year frequency of occurrence storms, and the management of the post-development peaks such that they are attenuated to the pre-development condition. As such, most mitigative measures required by NYSDOT are for flood control and not water quality enhancement.

5.3.3 Regional Organizations

Environmental concerns pertaining to the status, restoration and long-term ecological protection of the water quality and natural resources of Long Island Sound have led to the formation of different cooperative partnerships among State and Federal government agencies. In general, this has involved the combined technical efforts of the USEPA, NYSDEC and the Connecticut Department of Environmental Protection (CTDEP).

- The Long Island Sound Study (LISS) is a cooperative effort among the U.S. Environmental Protection Agency and the states of Connecticut and New York. Shared activities and responsibilities include the research of the Sound's problems, water quality monitoring, and the development of a comprehensive management plan. Phase III of the nitrogen reduction plan, which sets nitrogen reduction targets for management zones throughout the Sound, is currently being completed. Both New York and Connecticut are responsible for developing plans to achieve the reduction target set for each watershed management zone. The States will continue to control point source inputs of nitrogen primarily through permit limitations and improved sewage treatment plant design.

- The recently (1997) completed Long Island Sound Coastal Management Program will eventually replace the NY State CMP along the Sound shoreline. The Long Island Sound CMP is intended to guide Federal, State and local actions specifically in the management of the Sound. It incorporates the enforceable recommendations of the LISS Comprehensive Conservation and Management Plan, and contains specific recommendations for the preparation of watershed management plans. Its policies call for the application of best management practices (BMPs) to reduce NPS pollution.

- Using the Long Island Sound CMP as a guidance document, the States will also continue to work with County and local government to control NPS pollution through implementation of BMPs. The development of a Hempstead Harbor Water Quality Improvement Plan is consistent with the goals of the LISS.

5.3.4 Interstate Sanitation Commission

Founded in the 1930's, the Interstate Sanitation Commission (ISC) monitors water pollution in the Tri-State (New York/New Jersey/Connecticut) area, particularly in respect to the effects of sewage treatment facility impacts. As discussed in Section 3, the ISC has developed their own Water Quality Regulations. They have used these regulations to forge a classification scheme for the State's waters against which to evaluate water quality monitoring data. Although the ISC works as an independent entity with regional interests, they routinely interface with the NYSDEC, USEPA and local government in the regulation and enforcement of water pollution control mandates.

- The ISC has maintained sampling stations within the boundaries of Hempstead Harbor for over 25 years. The data generated by the ISC are provided to both the State and the USEPA, and have been used in the past to not only evaluate water quality trends, but to forge and support legislative water quality improvement initiatives for the region.

- Bacteriological data collected by the ISC have been used to determine the suitability of the Harbor's shellfish beds for harvesting

- Dissolved Oxygen data collected by the ISC are used to evaluate the occurrence and severity of hypoxic conditions in the Long Island Sound

5.3.5 Nassau County

The County plays both an advisory and a participating role in regulating land use and development which contribute to non-point source pollution in Hempstead Harbor.

- The Nassau County Planning Commission maintains jurisdictional authority for subdivisions of five or more lots proposed in the unincorporated areas of the County. When the Planning Commission determines that a subdivision requires the approval of the Commissioner of Public Works (as per the Real Property Law, Section 334a), it forwards the plans to the appropriate division(s) of the Department of Public Works and the Nassau County Health Department for review and approval. Subdivisions of four lots or less which do not include a proposed roadway that intersects a County road may be waived for review by the Planning Commission.

- The Department of Public Works is responsible for the design and maintenance of the County roadway system. When requested by either the Planning Commission or a municipality, the DPW will participate in the review of a subdivision. Depending on the nature of the request and the specifics of the proposed subdivision, the review may be conducted by any or all of the following DPW Divisions:

    1. Water Management,
    2. Hazardous Waste,
    3. Highways & General Engineering,
    4. Traffic,
    5. Sanitation & Water Supply,
    6. Land Acquisition.

The review may include an assessment of impacts on County and local roadways, road and lot grading details, storm water management, on- and off-site storm water drainage structures and appurtenances, availability and design of sanitary facilities and traffic engineering.

- Under Section 239J and K of the Municipal Law, the divisions of the County Department of Public Works must review any construction for which a municipality is issuing a building permit that fronts on or abuts County roads, properties or right-of-ways (*Rules and Regulations Governing Approval for Erection of Buildings on County Highways*, Nassau County Department of Public Works). This review is similar in context to a subdivision review, but is generally conducted on a smaller scale. Likewise, proposed municipal plans for any road and/or street drainage improvements must be submitted to the Department of Public Works for review and approval. Such reviews focus on the potential impact of the proposed improvements on County roads and drainage infrastructure. It must be stressed that the County's primary concern in respect to storm water management is in quantity control in order to ensure that the proposed activity will not result in the flooding of properties and roadways, and that discharge of runoff from a proposed development will not impact the collection and conveyance design attributes of the storm water system network. Any onsite detention, retention or recharge of stormwater is to satisfy primarily water quantity and not water quality concerns.

- The County Department of Health must review and approve residential septic system designs for subdivisions of five lots or greater. This applies regardless of whether the subdivision is proposed for an incorporated or unincorporated section of the County. The Nassau County Department of Health also responds to complaints regarding any illegal discharges of sewage or septic, and alleged violations of public health and welfare ordinances.

- The Department of Health's responsibilities also include bathing beaches with respect to the protection of public health. The Department of Health monitors coliform levels and will close beaches when bacteria levels exceed the State's contact recreation standard (200 colonies/100ml). In Hempstead Harbor, coliform monitoring is conducted by the County in coordination with the City of Glen Cove and the Towns of North Hempstead and Oyster Bay.

- Nassau County DPW is directly responsible for the maintenance of County roadways and their associated storm water drainage infrastructure. The County owns and maintains roughly 90% of the recharge basins in the Hempstead Harbor watershed. The County roadways are typically the primary traffic routes within a residential or commercial area that connect smaller local roadways to arterial highways. The County and New York State Department of Transportation specifications for roadway and storm water system design are used by local municipalities when constructing new roads or conducting roadway improvements.

- The Nassau County Soil and Water Conservation District provides technical assistance and information on land use practices and NPS reduction methods.

5.3.5 Local Government

Local government may establish jurisdiction over many land use and watershed development activities that can affect water quality and natural resources. For example, local government may be responsible for establishing regulations which govern zoning, site plan review, subdivision review, sediment and erosion control, vegetation protection, open space preservation. In a watershed as large as that of Hempstead Harbor, that encompasses a number of local government entities, it is not unusual for gaps or even conflicts to exist in the local Policy Environment in respect to NPS control and watershed protection. In order to better address the established responsibilities of local government in administering NPS control and watershed protection, municipal laws and regulations are examined in detail in the following section.

5.4 Existing Municipal Laws and Programs Governing NPS Control

As previously detailed, portions of the City of Glen Cove, the Towns of North Hempstead and Oyster Bay, and the incorporated Villages of Flower Hill, Roslyn, Roslyn Harbor, Sands Point, and Sea Cliff fall within the CMP boundaries of the Hempstead Harbor watershed (Map 1) . The inland section of the Harbor's watershed encompasses portions of the Villages of Roslyn Estates, East Hills, Old Brookville, Upper Brookville, and Lattingtown, and unincorporated sections of North Hempstead (the hamlet of Roslyn Heights) and Oyster Bay (Map 1). As illustrated in Map 1 and Figure 1, the Harbor's sub-watershed boundaries do not coincide with political boundaries.

With such a diversity in local government, it is not unusual that the existing NPS control and watershed management Policy Environment is not uniform. First, watershed management and NPS control are evolving concepts that many local government entities have yet to fully understand. Second, local regulations are typically passed to address specific problems that affect the health and welfare of the residents of a given municipality.

The following sections describe the municipal laws and programs in use today which relate to the control of NPS pollution.

5.4.1 Land Use Regulations

5.4.1.1 Zoning

Land use and land development are regulated at the local level primarily by the means of zoning, zoning codes, and development regulation ordinances. Although not a prerequisite, zoning is typically based on data and guidance contained in a municipal Master Plan. Zoning is normally used to establish appropriate lot sizes, define allowable or permitted land use activities, and minimize land use conflicts. Bulk standards, such as minimum lot size, minimum building setbacks, maximum building height, off-street parking requirements, etc., are usually included in the zoning code. Zoning codes may also establish limits on the percentage of impervious surfaces allowed for different types of land use. Appendix H contains copies of the zoning maps for each municipality.

Zoning restrictions vary greatly throughout the Hempstead Harbor watershed, with lot size limitations ranging from small lot (e.g.<1/4 acre lots) to large lot (5 acre) development. A summary of existing zoning requirements within the watershed is presented below proceeding from the western end of the watershed counter-clockwise to the east.

- Those sections of Sands Point contained within the boundaries of the Harbor's watershed are zoned for 1,2 or 5 acre residential development. The five acre lot zones are unlikely to be developed as residences, as they primarily consist of the County owned Sands Point Preserve, the Village owned Village Country Club, and the privately owned Sands Point Golf Club.

- Flower Hill is primarily zoned residential. Lot sizes tend to be small (7,500 ft^2, 12,000 ft^2, and 15,000 ft^2). There is a small commercially zoned district between Route 25A and Old Northern Boulevard.

- In Roslyn, the new Master Plan (July 1997) includes a number of zoning changes. The hills west of Old Northern Boulevard/Roslyn Road and east of Broadway/ Bryant Avenue are zoned for single family residential, with a minimum lot size of 10,000 ft^2. The lands adjacent to the western shore of the Roslyn canal are zoned for office and light industrial uses. These lands along the eastern shore are zoned for a mixture of residential and commercial uses.

- In Roslyn Harbor, roughly 90 percent of the Village, including the privately owned Engineers Country Club and all of the coastline, is zoned for one acre residential lots. There is also an area at the southwest corner of the Bryant Preserve which is zoned for quarter-acre residential lots. The minimum lot size for commercial and industrial use is 10,000 ft^2.

- The Glenwood Landing area on the east side of the harbor is zoned for both industrial uses and residential development (lots of 7,000 to 10,000 ft^2).

- In the City of Glen Cove, single family residential zoning dominates those lands directly abutting the Hempstead Harbor shoreline. Within the single family residential districts, minimum lot sizes include ½ acre, 1 acre and 2 acre. Further inland are 6,500 ft^2 and 6,500-7,500 ft^2 lot residential districts. The shorelines of Glen Cove Creek are zoned for industrial use, with the area just north of the creek zoned for townhouses and two-family residences.

- In Sea Cliff, the waterfront area outside of downtown is zoned as residential B, with a minimum lot size of 10,000 ft^2. The North Shore Country Club is zoned for 20,000 ft^2 residential lots. Neighboring areas have lot sizes of 15,000 ft^2. The downtown area consists of a mixed use of primarily older homes and businesses. The minimum lot sizes for residential and business use are 7,500 ft^2 and 4000 ft^2 respectively.

5.4.1.2. Overlay Zoning

In respect to watershed management, zoning can also be used to create special “overlay” districts. Overlay districts are usually created to encourage certain types of development or to protect sensitive environmental features. From the perspective of watershed management, overlay districts can be very effective in furthering NPS control objectives.

Horsley and Whitton (1996) discuss the benefits of creating overlay zones, especially in respect to the protection of sensitive water resources. For example, the Town of Kent, NY developed the Lake Carmel Park District in part as a means of requiring special land development-related precautions to be taken within the lake’s watershed. The Town of Falmouth, MA created a Coastal Pond Overlay District (Article XXI, Town of Falmouth Code) specifically for the purpose of preserving the water quality of the Town’s coastal ponds and harbors. The Town of East Amwell, NJ developed a Hamlet Zone Overlay as a means of encouraging cluster development in a section of the municipality where the prevailing natural resources (soils, slopes, groundwater supply, etc.) could better tolerate more intensive development, while preserving open space and lower density development in other sections of the Town where natural resources were more at risk. An actual example of an existing overlay zone within the Hempstead Harbor watershed is the Special Groundwater Protection Areas (SGPA). The Oyster Bay/North Hempstead SGPA (Map 6) encompasses a portion of the eastern edge of Sub-watershed 3 (outside of the Coastal Zone Management area). Within the SGPA, specific design criteria for septic system construction are required for the purpose of controlling the types and amounts of wastewater discharged to the aquifer (see Section 2.3.9).

Besides the SGPA, five other special zoning areas currently exist in the Hempstead Harbor Watershed:

1. Coastal Erosion Hazard Area (Glen Cove, Sands Point)
2. Waterfront Development Overlay District (Roslyn)
3. Hillside Protection Overlay (Roslyn)
4. Flood Hazard Overlay District (Glen Cove, Roslyn, Sands Point, Town of North Hempstead)
5. Planned Unit Development Zone (Town of North Hempstead)

- Glen Cove and Sands Point require that a Coastal Erosion Management Permit be obtained for regulated activities within the Coastal Erosion Hazard Area. In Glen Cove, the Coastal Erosion Hazard Area law is enforced by the Glen Cove Harbor Master. The law generally restricts new permanent construction or alteration of land within the area. All approved activities occurring within the zone must comply with the general standards and requirements of the law.

- The new Roslyn Master Plan (adopted in July of 1997) includes a Hillside Protection Overlay district. It is intended to regulate development on steep hillsides and includes a formula for establishing the maximum allowable building density. The Master Plan also establishes a new Waterfront Development Overlay district intended to encourage revitalization of the waterfront while simultaneously providing protection for the harbor's water quality and and natural features.

- Flood hazard overlay districts were established in Glen Cove, Roslyn and Sands Point, and North Hempstead has passed Floodplain Management Regulations. These districts and regulations were established through the municipal floodplain management laws. Intended to primarily protect life and property, these regulations also serve to limit development in floodplains. In general, these laws require that a floodplain development permit be obtained prior to construction in areas of special flood hazard. Flood hazard areas are defined by the Federal Emergency Management Agency (FEMA). The review focuses on whether the proposed development will be reasonably safe from flooding and whether proposed development may result in physical damage to any other property (e.g. stream bank erosion or increased flood velocities). Although these regulations establish standards for construction within the FEMA flood hazard area, they are not intended to directly address either water quality or flooding concerns that typically arise as a result of floodplain encroachments. As such, they should not, in their existing state, be viewed as NPS pollution management tools.

- The Glen Cove zoning code includes a Hillside Protection Article (Article XII of the Zoning Code), that restricts development of land having a slope 30% or greater over a horizontal distance of 25 feet or greater and encompassing a contiguous area of 10,000 ft^2 or greater. The Hillside Protection Article can be applied throughout Glen Cove, with the exception of parcels of 20,000 ft^2 or less that were held in separate ownership at the time the Article was enacted (1989). However, the Hillside Protection Article does not fully preclude development. It does allow for a building wall or retaining wall of a maximum of 20 feet high to be recessed into the toe of a hillside with a slope of 30% or greater, but otherwise does not allow any alterations to protected land. Key provisions prohibit the disturbance of natural vegetation on the protected land and prohibit the extension of projections such as porches, cantilevers, balconies, etc. over the protected land. In addition, a maximum of 30% defined by the Article as protected can be considered as developable for the purpose of determining density or minimum lot size.

- The unincorporated sections of North Hempstead, located along the western shore of the Harbor, are zoned primarily for residential and industrial uses. Within this section however, is a 458 acre tract, located along the western side of West Shore Drive, that the Town has zoned for Planned Unit Development (PUD). As discussed in Section 2.4.9, Morewood is an approved development slated for construction on this tract. Residential development on this parcel will consist of 675 units clustered on only 42 acres (less than 10% of the entire site). Development of the site in this manner will minimize the creation of impervious surfaces and decrease the generation of runoff and NPS pollutants typical of most large scale, suburban developments. This PUD also promotes open space preservation. An 18 hole municipal golf course will be part of this development, and an additional 165 acres of open space will be set aside.

- Also occurring with the unincorporated section of North Hempstead is a waterfront strip of land east of West Shore Road. This section of North Hempstead is not part of the PUD zone. It includes areas zoned both for residential (the 41 unit Beacon Hill Colony) and (sand and gravel, and maritime operations).

5.4.2 Analysis of Existing Zoning Laws

In municipalities where large, privately owned tracts of contiguous land exist, zoning can play a significant role in determining watershed development patterns. Inappropriate zoning can result in a variety of impacts to a watershed, including:

1. The development of sensitive land and loss or degradation of important natural resources,
2. The development of significant sources of pollution (e.g. industrial facilities) adjacent to sensitive natural resources, and the subsequent loss or impairment of these resources,
3. A marked increase in the generation of NPS pollution,
4. Significant increases in the volume and rate of storm water runoff, and
5. Loss of buffer areas, recharge zones, or other natural mitigative watershed features.

Environmentally sensitive zoning is cognizant of how changes in land use effect natural resources or put sensitive environmental features at greater risk of impact. Large lot zoning can help avoid many of the environmental impacts associated with land development. This is reflected to some degree in the modeling that was conducted in Section 4 which shows that the more intense the development (both in terms or use and impervious cover) the greater the NPS load per unit area. However, large lot zoning is not the only solution. Under certain land use scenarios it may not be feasible (e.g. for commercial development). In other cases (e.g residential development), it can actually be detrimental by promoting suburban sprawl and the cumulative loss of open space.

Although large lot zoning should be maintained where it exists, it should be augmented by other zoning techniques, such as:

1. Resource protection overlay zones,
2. Open space (Greenway or Blueway) plans and zoning provisions,
3. Cluster zoning, modifications of setback standards, and other similar planning techniques that emphasize the conservation of <u>natural</u> open areas (not lawns),
4. Commercial node zoning, whereby commercial development is limited to heavily travel roads or major intersections.

These, and other recommended planning and zoning techniques that encourage sound watershed management, the preservation of open space, and the protection of natural resources are discussed in more detail in Venno, 1991; Smith and Kehde, 1991; and, in particular, Yaro, Arendt, Dodson, and Brabec, 1988.

For the Hempstead Harbor watershed, future development of the open lands could increase the generation of NPS pollution. However, due to its long history of development, very little of the Hempstead Harbor watershed can currently be considered undeveloped. In fact, most of the watershed supports relatively dense residential development or clusters of commercial or industrial uses. The Sea Cliff and Glen Cove South sections of the watershed (Sub-watersheds 8 and 6 respectively) are the most densely developed (>90%). Of the entire watershed, Sands Point (Sub-watersheds 3 and 4) is the least developed. Sub-watershed 3 (Old Brookville), which encompasses portions of the Towns of Oyster Bay and Glen Cove, is 85% developed (Table 2-2). However, it does include over 1000 acres of undeveloped land, including a few farms. Although the Port Washington section of North Hempstead (Sub-watershed 9) is currently only 65% developed (Section 2.4.9),when the Morewood development is factored in, the percent developed land increases to approximately 85% (Table 2-2).

In general, these data suggest that altering the current zoning will have little effect on the control of NPS pollution. In fact, the future pollutant loading Buildout Analysis (Section 4.4, Table 4.8) showed that under the existing zoning conditions only Sub-watershed 3 (Old Brookville) would experience a measurable increase in NPS pollutant loading under a full buildout scenario.

Thus, since most of the watershed is already developed, imposing large lot zoning on the watershed is non-sensible, and after the fact. Although re-zoning the watershed to large lot zoning is not a feasible option for the Hempstead Harbor watershed, preservation of large lot zoning in the Sands Point and Locust Valley sections of the watershed is highly recommended. Neither of these areas are densely developed, and as long as the existing zoning prevails, their development intensity should not change. In addition, cluster development zones, natural resource protection overlay zones or the use of special environmental overlay districts appear to be feasible management tools for the

Hempstead Harbor watershed. Each of these zoning provisions could help preserve remaining open areas or areas characterized by low density zoning (e.g. Sands Point) from being re-zoned for intensive development. These provisions could also aid in the protection of sensitive areas such as steep slope, stream corridors, and both freshwater and coastal wetland buffers. In reviewing the current zoning practices, the following were considered feasible long-term watershed management, zoning-related options:

- Creation of overlay districts for the protection of environmentally special features which specifically prohibit development on lands meeting specific environmental criteria (e.g. within 50 feet of a stream). Doing so will help protect sensitive environmental areas and potentially enhance the aesthetic attributes of the community. Two examples of such special overlay districts are the Inland Wetlands and Watercourses Regulations, promulgated by The Town of Fairfield, CT and the Coastal Pond Overlay District and Water Resource Protection District developed as an amendment to the Zoning Code of Falmouth, MA. Locally, the Glen Cove Hillside Protection District is a good example of an overlay district that protects sensitive environmental features.

- Zoning regulations which exclude some portion of the unbuildable property from the lot size used to calculate allowable lot coverage should also be considered. For example, the Glen Cove Hillside Protection Article allows developers to factor up to 30% of the steep slope areas into the formula used to determine total developable land and maximum lot coverage. Such sensitive lands <u>should not</u> be included in the lot coverage equation. Rather, the acreage of all non-developable land (e.g. wetlands, steep slope, stream corridors, etc.) should be deducted, and lot coverage computed for the remaining lands. Doing so would decrease the amount of impervious cover allowed for a given parcel. Since parcels containing large amounts of sensitive lands are probably more prone to environmental impact, limiting building densities in this manner would further protect sensitive resources.

- Conversely, development credits should be given to developers who choose to cluster develop for the purpose of preserving or protecting sensitive lands. Under such a scenario, a developer would be allowed to increase the lot coverage in a smaller "footprint" area of the parcel, with the remaining areas preserved as open space. This concept, is promoted quite extensively in Prince George County, Maryland. Referred to as LID, Low Intensity Development, it also promotes the use of narrow roads, road side swales (in place of curb and gutter) and localized, small-scale detention/infiltration stormwater systems called water gardens. Suburban sprawl development, even where lot size is relatively large (5 acres), can result in the loss of more open space than a cluster design that promotes intensive development over a smaller foot print of the parcel. This is particularly true when measures are incorporated into the design to protect sensitive lands, preserve lands in their natural state, or create buffers that separate resources from development or aid in the management of NPS pollution.

- The Flood Overlay regulations should be amended to further preserve floodplain areas and mitigate both the qualitative and quantitative impacts of stormwater discharge to floodplain and floodway areas. An example would be the creation of a Stream Corridor Overlay Zone. The Natural Resource Conservation Service (NRCS) recommends the protection of all stream corridors with a 50' buffer. The New Jersey wetland laws require the maintenance of at least a 50' buffer adjacent to all streams and wetlands regardless of size. Within such buffer zones or setback areas, stormwater management structures can be built, public access greenway corridors can be created and other similar activities that do not result in the impairment of the buffer area can be allowed. When properly implemented, these buffers can further reduce the direct impacts of NPS pollution while protecting, and in many cases, enhancing the properties of the stream or wetland ecosystem. The Cedar Swamp Creek and Glen Cove Creek corridor should be evaluated for consideration as a special overlay district. Where possible, a greenway buffer should be established along the stream corridor. This could help mitigate over-the-shoulder roadway runoff impacts, decrease the opportunity for erosion and scouring, and promote improved wildlife and aquatic habitat.

- The incorporated villages, in coordination with their towns and with the Nassau County Planning Commission, should consider contingency plans for purchasing large lots for the purpose of their preservation or conservation. The two private facilities nearest the harbor which merit this type of consideration are the Engineer's Country Club in Roslyn Harbor, and the North Shore Country Club in Sea Cliff. In the event of the development of large land parcels, an alternative would be to work with the property owners to preserve valuable open space and create environmental buffer zones. Land development concessions (e.g. as is done with cluster zoning) could be provided as an incentive to the developer to enter into such an agreement with the municipality. This is exemplified locally by the Morewood development in North Hempstead. The opportunity to acquire property for the construction of municipal water quality management structures should also be considered. This could involve the purchase of even relatively small (1/2 acre) parcels upon which recharge basins, detention basins, and biofilters could be constructed. Although land purchases of this nature do not really preserve open space, they do provide opportunities for the reducing NPS loading to the Harbor.

- The current zoning regulations focus on minimum lot sizes and maximum building density (e.g 4 units/acre). Lot size restrictions should be augmented by limits on the total amount of impervious cover. Regulating impervious cover facilitates the recharge of aquifers, while decreasing the production of surface runoff and the generation of NPS pollutants. This is especially true in respect to the generation of heavy metals, sediments and petroleum hydrocarbons common of the runoff generated from parking lots, roadways and driveways. The data developed in Section 4 clearly show that as impervious cover increases, so does the amount of pollutant loading. Many communities now include provisions in the zoning code that is sensitive to the percent of allowable impervious cover, or the maximum allowable floor area ratios as a means of further controlling the intensity to which a lot is developed. Such zoning measures are more consistent with NPS pollution management than simple lot size restrictions.

- Consideration should be given to the creation of open space greenways or right-of-ways to promote public access while at the same time preserving open space. An example of this is the Hempstead Harbor Shoreline Trail proposed by the Town of North Hempstead, and the public access provisions being discussed as part of the proposed assisted care facility in Roslyn.

5.4.3 Site Development Rules and Regulations

As discussed above, zoning and alternative zoning techniques can be effective tools by which to manage watershed development and avoid land development conflicts that encourage NPS pollution. This is especially true of cluster development zoning initiatives and special protection overlay districts. Such zoning tools are designed to protect the environment and minimize NPS pollution, while not necessarily impeding land use and land development. As well as zoning techniques, there are other, additionally effective development management tools that can be used prior to actual development to minimize both short- and long-term NPS pollution contributions. For convenience sake, these techniques can be considered part of the Site Development review procedure. These include:

- Site Plan Review
- Environmental Assessment
- Soil and Erosion Control
- Storm Water Management

Providing that the appropriate local regulations exist and are applicable, each or all of these tools could be utilized to minimize environmental impact or protect the health and welfare of the public. In addition, these regulations need not apply solely to new construction, but can be triggered as a result of many types of site alteration activities. From the perspective of watershed management and NPS control, these types of regulations have more meaning in respect to the long-term restoration of the Harbor than does zoning. This is especially true given the degree of prevailing development in the watershed and the relatively small percentage of contiguous open land upon which intense development could occur. The consistency and comprehensiveness of the Policy Environment in respect to Site Development Rules and Regulations are reviewed below. Table 5-1 provides a synopsis of the existing site plan review tools used by local government in assessing development and development related activities in the Hempstead Harbor watershed.

Table 5-1

Municipal Land Use Controls Within the Hempstead Harbor Watershed

	North Hemp-stead	Oyster Bay	Glen Cove	Flower Hill	Roslyn	Roslyn Harbor	Sands Point	Sea Cliff
On-Site Storm Water Management Requirements/Storm Water Management Plans	X	X	X	X	X	X	X	X
Erosion and Sediment Control Plans	X	X	X	X			X	X
Site Plan Review	X	X	X	X	X	X	X	X
Environmental Assessment	X	X	X	X	X	X	X	X

5.4.3.1 Site Plan Review

At the municipal level, the approval process for new development begins with Site Plan Review. Site Plan Review provides an opportunity to evaluate whether the design of a proposed development is consistent with municipal land use, land development and building codes. It also provides a means of assessing whether the proposed development will negatively impact the environment and whether all the required environmental safeguards have been incorporated into the plan. As previously discussed, Nassau County has complete jurisdiction over any subdivision of five or more lots proposed for the unincorporated areas of the County, or for projects which front or abut a County road, right-of-way, or property. At the municipal level, different criteria trigger the need for Site Plan Review. The following examples illustrate how various municipalities within the watershed determine when a site plan review is required:

- Sands Point requires site plan review under any of the following conditions:
    - All new dwellings or other principal structures and land uses permitted in the Residence A, B and C Districts
    - All buildings, structures and land uses accessory to a residential land use permitted in the Residence A, B or C District prior to issuance of a Certificate of Occupancy (CO) for the principal building/structure
    - All buildings, structures or land uses accessory to a non-residential land use permitted in the Residence A, B or C Districts
    - All new buildings, structures or land uses for which a use variance has been granted
    - Any addition to or reconstruction of all or part of a principal structure which a)equals or exceeds 50% of the square footage of the gross floor area of the structure as originally constructed or as last modified pursuant to site plan approval, or b) equals or exceeds a gross floor area limitation imposed by decision of the Board of Appeals
    - Any reconstruction of a principal structure damaged by fire or other incident, the cost of which equals or exceeds 50% of the market value of the structure at the time the damage occurred.

- North Hempstead requires site plan review for:

    - All commercial and multi-residence (3-family dwelling or greater) developments that are larger than one acre in size. (Chapter 70, Section 219 of Town of North Hempstead Code).

    - For the re-development of sites greater than 1 acre, the thresholds which invoke site plan review are as follows. A site plan must be submitted for projects greater than 1 acre proposed for a Residence District where the principal use of the site is other than a dwelling or 2 family attached residence building, or if the proposed work involves any 1 or more of the following: construction or addition of a new building or structure greater than 750 ft^2, alteration of an existing building(s) so as to change 1 or more of the uses on the site in a manner which will increase the number of required off-street parking spaces for the site by more than 33% or add at least 10,000 ft^2 of retail or public assembly use at the site, alteration of an existing single retail use greater than 40,000 ft^2 at the site so as to create 4 or more retail or public assembly uses and/or a change in access to the site or a change in the circulation within the site affecting at least 20% of the paved area.

- Roslyn requires site plan review for all new construction.

- Glen Cove requires site plan review by the Planning Board for the development or enlargement of all buildings (other than one and two-family residences in residential developments), for all development in the Flood Hazard Overlay District, for all uses of vacant land, for any change in use or intensity of use which will affect the characteristics of the site in terms of parking, loading, access, drainage, utilities, or other city services, or for any applications that requires a special use permit or exception. (Chapter 280, Zoning, of the Code of the City of Glen Cove).

- In 1996, the Town of Oyster Bay adopted a "Site Plan Review and Site Design" amendment of Article XXVIII of the Code of the Town, that is intended to formalize the site plan review process. It details the review and approval process for changes of zone, special use permits, and major building permit applications, all of which are conducted under the review authority of the Town Board. More specifically, site plan review is required under any of the following conditions:

  - The Department of Planning and Development and the Planning Advisory Board conduct site plan reviews for "as-of-right" uses.
  - Review by Department of Planning and Development and approval by the Town Board is required for any proposed structure/use required to provide 50+ off-street parking places or any proposed enlargement/expansion of structure/change of use or occupancy which would increase off-street parking required by 25+ spaces to a minimum total of 50 places
  - Review by Department of Planning and Development and approval by Planning Advisory Board is required for any proposed structure/use which does not meet the requirements of the above [246-326.B(1)] and which is situated on a lot that abuts a Residential District. If the project does not abut a residential district, it must still be reviewed by Department of Planning and Development.
  - All uses in Zones E-2, E-3, G-1, R-O, O-1 and uses defined in Section 246-62 require the review of the Planning Advisory Board prior to approval by Town Board.

As illustrated above, there are potentially a number of factors that necessitate the preparation of plans and their submittal to a review board. However, it should be stressed that in many of the above cases, the site plan review might not focus on environmental impact. Again, the municipalities within the Harbor's watershed use different criteria to trigger the need for an Environmental Assessment or an Environmental Impact Statement. What is common to all the municipalities is compliance with SEQRA (5.3.2). The New York State Environmental Quality Review Act (SEQRA, 6 NYCRR Part 617) was enacted in 1996. With the passing of this regulation, NYSDEC intended agencies to:

> "Incorporate the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies at the earliest possible time."

Agencies must determine if any actions they undertake, fund or approve may have a significant impact on the environment. If the agency determines that any impact may be significant, an environmental impact statement must be prepared. There are three categories of actions under SEQRA:

- Type I
- Type II
- Unlisted.

If an action is determined to be Type I or Unlisted, it is presumed to be likely to have a significant impact on the environment. In such cases, a full Environmental Assessment Form (EAF) must be prepared to determine the significance or nonsignificance of the action, and an EIS may be required. For Unlisted actions, a short EAF may be used to determine significance. If an agency determines that an action falls within the Type II category, no further action is required.

Type I actions are identified in Section 617.4 of SEQRA; agencies may also adopt their own lists of additional Type I actions or may adjust the thresholds to be more inclusive. Examples of Type I activities include:

- Acquisition, sale, lease, annexation or other transfer of 100 or more contiguous acres of land by a state or local agency.
- Construction of new residential units that meet or exceed the following thresholds:
  - 10 units in municipalities that have not adopted zoning or subdivision regulations;
  - 50 units not to be connected (at commencement of habitations) to existing community or public water and sewerage systems including sewage treatment works;
  - in a municipality having a population of less than 150,000, 250 units to be connected to existing community or public water and sewerage systems including sewage treatment works;
  - in a municipality having a population of greater than 150,000 but less than 1,000,000, 250 units to be connected to existing community or public water and sewerage systems including sewage treatment works;
- Activities, other than the construction of residential facilities, that meet or exceed any of the following thresholds, or the expansion of existing nonresidential facilities by more than 50% of any of the following thresholds:
  - project or action that involves the physical alteration of ten acres

- project or action that would use ground or surface water in excess of 2,000,000 gallons per day
- parking for 1,000 vehicles
- in a city, town or village having a population of 150,000 persons or less, a facility with more than 240,000 square feet of gross floor area.

Type II actions are not subject to SEQRA review. As noted elsewhere, municipalities can amend their Type II list to reflect local needs. Type II actions are those that were determined not to have a significant impact on the environment. Examples of Type II activities include:

- Maintenance or repair involving no substantial changes in an existing structure or facility
- Replacement, rehabilitation or reconstruction of a structure or facility, in kind on the same site, including upgrading buildings to meet building or fire codes, unless such action meets or exceeds any of the thresholds in section 617.4 of this Part;
- Agricultural farm management practices, including construction, maintenance and repair of farm buildings and structures, and land use changes consistent with generally accepted principles of farming;
- Repaving of existing highways not involving the addition of new travel lanes;
- Construction or expansion of a single-family, a two-family or a three-family residence on an approved lot including provision of necessary utility connections as provided in paragraph (11) and the installation, maintenance and/or upgrade of a drinking water well and a septic system.

All municipalities are bound by the requirements of SEQRA; however, each municipality has the option of adopting a local version of SEQRA. Municipalities may adapt the Type I list to local needs, for example designating additional actions as Type I or adjusting the thresholds. Municipalities may also personalize the Type II list to meet local needs. Actions may be added to the Type II list as long as the action does not have a significant adverse impact on the environment based on the criteria contained in SEQRA and is not defined as a Type I action as defined by SEQRA. Those municipalities within the watershed that have not already done so, should review the SEQRA list and personalize it for their community. The following exemplifies the conditions under which local governments require an environmental review:

- In Glen Cove, an EIS is required as part of all site plan review application.

- In Flower Hill, besides Type II projects, no project can be approved unless, to the extent applicable, it complies with SEQRA. An application for permit or funding of Type I projects must be accompanied by an Environmental Assessment Form (EAF). Projects falling into neither of the above categories may be accompanied by a short or long form EAF. An applicant may prepare a Draft Environmental Impact Statement (DEIS) to accompany an application in place of the EAF.

- In Sands Point, an EAF is required for Type I projects (Section 617.12 NYCRR and the Rules and Regulations) for which a site plan review application has been submitted. For other projects (Type II) Village law states that applicants must file a written statement (using a form prescribed by the Rules and Regulations) of a proposed action and the effect that the action may have on the environment. Upon review of the statement, the Village may require an EIS if it is determined that the proposed action may have a significant effect on the environment.

- In Oyster Bay, The Town Environmental Quality Review (TEQR) Commission reviews all applications in accordance with SEQRA and acts in an advisory capacity to the lead agency. For the purpose of determining whether a project may or may not have a significant effect on the environment, applicants filing for permits, submitting site plans, or requesting other approvals including Special Uses and Change of Zone must prepare and file an EAF unless the project is found to be exempt, excluded or Type II (no further action).

- For the Town of North Hempstead, an application for a site plan review must include a full EAF as required by SEQRA.

- In Sea Cliff, the Planning Board maintains jurisdiction over the environmental review of development projects and related activities having potential environmental impact, for example, the repair of a bulkhead or the placement of fill.

5.4.3.2 E&S Control Plans

Soil erosion is one of the leading causes of water quality problems. During the construction phase of a project, large quantities of soil may become eroded and transported off-site. Short term significant impacts can occur to wetland and open water environments as a result of the influx of sediments. Besides reduced aesthetics, the impacts can include impaired water quality, loss of habitat, occlusion of benthic organisms and even fish kills. The influx of excessive sediment into the waters of the State is in violation of NYCRR, Title 6, Chapter X. The Empire State Chapter of the Soil and Water Conservation Society has developed standard guidelines for the prevention and control of soil erosion. Likewise, *New York Guidelines for Urban Erosion and Sediment Control* (USDA, 1991) details the proper steps that are to be taken to avoid soil erosion problems. However, as with Site Plan Review and Environmental Review, the local regulations requiring the preparation of Erosion and Soil (E&S) Control Plans are variable. In many cases, the State and/or County will establish jurisdiction on a project. This is particularly true of roadway construction or projects that trigger County review (Section 5.3). Those municipalities that have promulgated local regulations concerning E&S control are as follows:

- For Flower Hill, all site preparation and construction activities requiring a building permit are subject to the local E&S law. This includes, but is not limited to the following activities:

  - Site preparation within wetlands
  - Site preparation on slopes which exceed one foot of vertical rise to 4 feet of horizontal distance (or in areas known to be subject to severe erosion)
  - Site preparation within the 100 year floodplain of any watercourse
  - Excavation which affects more than 100 yd^3 of material within any parcel or any 1 subdivision
  - Stripping of more than 0.25 acre within any parcel or 1 acre of any single subdivision
  - Grading of more than 0.25 acre within any parcel or 1 acre of any single subdivision
  - Filling which exceeds 300 yd^3 of material within any parcel or any single subdivision.

  The E&S permit application must include maps showing:

  - All excavation, filling, grading, stripping (and nature of vegetation),
  - Areas where topsoil is to be removed, stockpiled, and ultimately placed,
  - All temporary and permanent vegetation, drainage, E&S control facilities,
  - Anticipated pattern of surface drainage during periods of peak runoff, upon completion of site preparation and construction, and
  - A schedule showing initiation and completion of major phases and site preparation activities, including the installation of temporary and permanent vegetation and drainage E&S facilities, anticipated duration of exposure of all major areas of site preparation before installation of E&S measures. The schedule must minimize potential of erosion by exposing the smallest practical area of the site at any given time.

  In addition, the E&S plan must comply with standards and specifications of the Empire State Chapter of Soil and Water Conservation Society.

- In the Town of North Hempstead, site plan review law requires the preparation of a sediment and erosion control plan that describes methods and materials to be used to address erosion and sediment and slope stabilization both during and after construction. As part of the Tree Removal permit process, the Building Commissioner will evaluate the erosion controls that will be implemented during the removal of a tree, and the potential erosion related impacts that the removal of the tree could have on neighboring properties.

- The Town of Oyster Bay requires, as part of every application for which site plan review is required, the submission of details of the proposed erosion and sediment control measures that will be utilized over the course of the project. The applicant is to design these measures to prevent the transport or migration of dust, erosion or drainage onto adjacent properties during and after construction. The E&S plan must include specifications regarding the post-construction stabilization of all disturbed surfaces.

- Glen Cove is one of the two municipalities in the Hempstead Harbor watershed contained within NYSDEC's designated Coastal Erosion Hazard Area. Glen Cove has also developed a very comprehensive set of regulations governing soil disturbance activities in areas outside of the Coastal Erosion Hazard Area. It encompasses excavation, grading and filling. There are a number of actions exempt from the regulations including those involving:

  - Less than three vertical feet of excavation,
  - Less than 1000 ft^2 of grading or filling, and
  - Fills of less than 10 yds^3 or less than three vertical feet, provided that all of the above do not involve slopes greater than 5:1.

  In addition, the regulations include exemptions for certain types of excavations (driveways, swimming pools, basements, etc.) authorized by building permits, as well as single family dwelling sites that satisfy specific criteria established in the building code. Those projects requiring a permit, must file a site plan and comply with the standards for excavation, fill, grading, site rehabilitation and construction related stormwater drainage as detailed in the regulation.

- Sands Point, like Glen Cove, has been designated by NYSDEC as a Coastal Erosion Hazard Area. The Sands Point Coastal Erosion Hazard Area law is enforced through the Sands Point Building Inspector. The law generally restricts new permanent construction or alteration of land within the area, and establishes a coastal erosion permitting system for regulated activities which comply with the general standards and requirements of the ordinance.

- Roslyn's sediment and erosion control measures are contained in the Hillside Conservation District law.

- In Sea Cliff erosion and sediment control measures must be provided as part of the site plan review process.

5.4.3.3 Storm Water Management

Local regulations concerning the management of storm water runoff, both during and after development, have been enacted by all of the municipalities within the Hempstead Harbor watershed. These local ordinances and regulations are consistent in concept with guidance provided in both State and County regulations. Since the State and County regulations serve as guidelines, it is of value to review the elements contained in those laws.

The NYSDEC has directed the Nassau County Department of Health (NCDH) to review and approve drainage plans for realty subdivisions. Under the County's regulations, the direct discharge of storm water drainage from developed areas to the surface waters of Nassau County must be minimized. For the most part, this is accomplished in the Hempstead Harbor watershed by discharging runoff into recharge basins. Nassau County owns and maintains roughly 90% of the recharge basins in the Hempstead Harbor Watershed. The County's minimum storm water management requirement for all projects subject to County review is as follows:

> "dry wells for storm water runoff should be provided, having sufficient volume to retain runoff for a 2-inch rainfall using site specific runoff requirements to quantify runoff from the entire site. In larger developments, a collection system with catch basins, pipes and a storm water storage basin may be required." (*Rules and Regulations Governing Approval for Erection of Buildings on County Highways*, Nassau County Department of Public Works.)

Some of the specific requirements of the County include:

- Storm water shall not be directly discharged to any fresh or salt surface water.

- All development having a gross property area in excess of 5 acres shall dispose of all storm water by means of a recharge basin. For developments of 5 acres or less, in lieu of a recharge basin, storm water may be disposed of by means of one eight (8) feet diameter by eight (8) feet deep drywell per each 10,000 ft^2 of area. An equivalent volume drywell may be substituted.

- Roof areas shall be drained to drywells. For roof areas up to 2000 ft^2, at least one eight (8) feet deep by eight (8) feet diameter, or its volumetric equivalent, precast drywell shall be provided. For roof areas in excess of 2000 ft^2, additional drywell volume shall be provided to contain two (2) inches of precipitation with a 100% runoff coefficient.

- All storm water disposal structures and appurtenances, including drywells and recharge basins under the jurisdiction of the Nassau County Department of Public

Works (NCDPW), shall conform to the requirements of and be approved by the NCDPW.

- Drywell construction shall conform to the requirements of sanitary leaching pool construction as much as is practical. Specifically, drywells must be installed so as to have communication with rateable leaching soil.

At the municipal level, the focus again of storm water management initiatives is to collect and infiltrate storm water using dry wells or recharge basins. The specific requirements of each municipality are as follows:

- North Hempstead requires that all properties must retain storm water on site. For those developments which require site plan review, the Town code mandates the on site storage of a minimum of 2.5 inches of rainfall. North Hempstead is also attempting to implement storm water quantity control techniques that are more land use oriented. Specifically, cluster type development, intended to preserve open space and reduce the amount of impervious surfaces, was utilized as part of the Morewood development plan. Reducing impervious cover and preserving natural areas where rainfall can percolate will reduce the overall volume of runoff. This, in turn, decreases the mobilization of pollutants and results improved storm water quality.

- In Oyster Bay, as part of the site plan review process, a drainage plan must be submitted. Proposed developments must meet Nassau County standards for retaining storm water runoff. In addition, the site plan review process includes a requirement that natural features of the site be preserved to the greatest extent feasible. Again, by doing so, the potential post-development volume of storm water runoff can be reduced.

- For the City of Glen Cove, the site plan review process includes an analysis of the storm water management system proposed for all new developments.

- All new developments within Flower Hill are required to provide adequate drainage, so that surface water from rooftops and driveways is retained on site. This is typically accomplished through the construction/installation of underground drywells. No provisions for guaranteeing maintenance of storm water management facilities, or for adequate easements for inspection, are explicitly included in Flower Hill's regulations.

- Roslyn requires all storm water runoff to be retained on site and discharged to the ground via a drywell. An exception is made for driveways; those within 100' of a street storm drain may be pitched so as to direct any runoff directly into the storm drain.

- All storm water runoff from the roof of any structure and from any driveway is required by Roslyn Harbor to be retained on site. This can be done using drywells, recharge basins, or other similar structures, including retention ponds. Long established easements allow for the preservation and maintenance by the Village of retention ponds located on private property.

- The zoning code of Sands Point contains provisions which require all water draining from the roof of any structure and from any driveway to be directed into underground dry wells so that no water drains onto private or village streets. If a developer feels that natural drainage is sufficient to absorb rooftop water, a written application must be submitted to the Building Inspector. Both new developments, and alterations of existing structures (any roof additions, replacements, or building design modifications) are subject to the provisions of this regulation. Driveways which are sloped toward the street or which exceed 100' in length are required to be crowned and constructed with a curb and gutter. Dry wells are to be provided along the length of the curbing to facilitate the retention and infiltration of runoff.

- In Sea Cliff, new developments must retain all storm water drainage on site. All drainage is required to be recharged, and pitched to its own drywell; no outlets to street stormdrains are permitted.

5.4.4. Analysis of Site Development Rules and Regulations

As discussed in Section 1 and elsewhere throughout this report, Source Control and Delivery Control are two fundamental strategies by which NPS pollution impacts can be mitigated and reduced. The site plan and environmental review process in combination with the implementation of soil erosion control and storm water management requirements can be very effective in the reduction of NPS pollutant loading. The site plan review and environmental review processes provide an opportunity to identify if particularly sensitive environments will be effected by the proposed development (e.g. steep slope, erosion prone soils, wetlands, mature trees, etc.). In effect, these reviews serve as a Source Control technique, reducing or preventing the opportunity for environmental disruption or the generation of pollutants. When adequately detailed, soil erosion and storm water management requirements can provide Delivery Control, minimizing the offsite transport of pollutants both during the construction phase and under post-development conditions.

As described above, all of the municipalities in the Hempstead Harbor watershed have some type of requirement for site plan review prior to the issuance of most building and related development permits. The municipalities vary somewhat in the size and type of development that triggers site plan review. This is to be expected, since site plan reviews, especially for smaller projects, tend to focus on compliance with zoning and building codes, as opposed to consistency with watershed management initiatives or protection of the environment. Without making the site plan review process onerous, the HHPC should consider working with the member municipalities to augment, where needed, the existing site plan review processes to encompass not only new development, but the construction of accessory structures, development which requires a zoning variance, and the reconstruction or alteration of existing structures that results in a significant increase (>50%) in floor space. This last qualifying condition is particularly important, and refers back to the negative effects that increased impervious cover has on NPS pollutant generation. In many communities, conversions of summer homes or expansion of old homes on undersized lots often fail to be subject to site plan review. However, there are numerous examples of how such changes in land use and development intensity can lead to water quality degradation. The Sands Point and Glen Cove site plan review procedures are among the more progressive of the HHPC member municipalities and could be used as a benchmark for other member communities.

In order to protect the environment and to comply with the requirements placed on the municipalities by the State Environmental Quality Review Act (SEQRA), most municipalities have a requirement for preparation of an EIS or EAF as part of their site plan review process. The requirements for what projects necessitate review is relatively uniform, again due to the existence of SEQRA. Even though all of the HHPC member municipalities require the compliance of certain projects with SEQRA, not all of the communities have "personalized" their Type II list of projects. As such, certain projects that could have an environmental impact (e.g. certain types of expansions to existing buildings) are not required to submit an EAF. It would be useful to develop an environmental checklist that would be required of all applicants whose projects are Type II but require site plan review. The checklist could consist of simple yes/no answers to such questions as to whether the site contained a stream, had steep slopes, was adjacent to or contained wetlands, occurred in any of the existing overlay areas, etc. This information could be reviewed as part of the site plan process and a determination made at that time as to whether a more detailed environmental assessment would be required for the project.

In addition, the HHPC should expand its role to serve in advisory manner similar to that of Oyster Bay's TEQR Commission. That is, the HHPC should take a pro-active role in the review of all major projects to assess whether they may cause deleterious impact to the Harbor or to the unique resources of the Hempstead Harbor watershed. This is the type of role that the Greenwood Lake Watershed Management District and the Lake Hopatcong Regional Planning Board play in the oversight of development activities within their respective boundaries. The findings and recommendations of these groups are not binding, but through years of interaction with the municipal entities within their respective watersheds, their recommendations are often acted upon. The majority of the input from both groups to municipal or county agencies occurs during the site plan review and environmental review processes.

In regards to the prevailing requirements for erosion and sediment control, improvements could be made in respect to most of the municipal requirements. The purpose of an erosion control plan is to reduce, to the extent possible, the potential effects of soil erosion and associated sedimentation that may occur during project preparation and construction. The construction phase of a project, particularly those involving the large scale disturbance of vegetation and the excavation or import of large quantities of soil, has the potential to generate large amounts of sediments; sometimes 100 fold more than is experienced from vegetatively stabilized areas of similar size (Schueler, 1987; NYSDEC, 1992). Associated with these sediments can be an array of particulate pollutants ranging from nutrients to heavy metals. It is thus important to avoid conditions that promote erosion and to implement the proper safe guards to intercept soils and sediments from erosion prone sites. A well designed erosion control plan should:

- limit or phase site disturbance activities,
- utilize mitigative measures designed for the specific site,
- include a clear time table for implementation, and
- require the rapid re-stabilization of disturbed sites either on a temporary basis during construction or on a final scale upon completion of earth moving activities.

Erosion and Sediment Control Plans, similar to those that are required in Flower Hill, should be adopted by the municipalities within the watershed. The Flower Hill ordinance is especially fitting for implementation throughout the watershed because it is triggered by even relatively minor degrees of disturbance (1/4 acre - approximately 11,000 ft^2 or 100 yds^3 - about 5 dump trucks). It is also cognizant of the fact that disturbance of wetlands or steep slopes has environmental ramifications different than the disturbance of flat, upland areas. Also, the ordinance requires the applicant to submit site specific information regarding how erosion is to be controlled, including a schedule of when actions are to be taken from the time of disturbance through final site restoration. Furthermore, the ordinance requires compliance with the Empire State erosion control guidelines and specifications. Equally important to the technical elements of the ordinance is that provisions are included for inspections and a clear time table is set, along with fines, for the correction of violations.

In addition, an authorized official should be designated to inspect each project. This helps ensure that a project remains in compliance with the plan, and decreases the likelihood that large scale problems will occur. This also helps avoid conflicts with contractors or property owners by having a clearly defined point of contact.

Although the County and municipal storm water control regulations for new developments do not directly deal with water quality and NPS pollution, the fact that recharge of runoff to the groundwater is required, decreases the opportunity for the offsite discharge of pollutant laden runoff. It would be beneficial, from the perspective of improving the Harbor's water quality, if specific storm water quality management requirements were adopted. As concluded from the above review of the existing storm water management policy environment, the following changes and or additions are recommended:

- The sizing criteria used for the construction of drywells or recharge basins does not appear to be uniform. As such, it is recommended that a defined standard be used (e.g. 2.5" of rainfall, runoff volume of the 2 year storm, etc.).

- In order to promote improved storm water, detention or retention type structures, as well as vegetated swales and created wetlands should be designed in accordance with the standards provided in the NYSDEC's storm water guidance manual (NYSDEC, 1992). These standards should be adopted watershed-wide. The intent should be to intercept and detain the runoff generated by the 1 year storm, as well as the first-flush of larger storm events. For detention, retention and created wetland systems, at least 18 hours of detention time should be provided for the runoff volume of the 1 year storm.

- For larger projects (e.g those that require a detailed SEQRA review), the municipalities should require applicants to submit data which quantify the project's post-development Total Suspended Solids, Total Nitrogen, Total Phosphorus, Heavy Metals (Pb and Zn) and Biological Oxygen Demand pollutant loads. These data should be calculated as per NYSDEC's storm water guidance manual (NYSDEC, 1992). The Applicant should also supply data detailing the projected pollutant removal capability of any BMP proposed for the development. Again the criteria provided in NYSDEC's storm water guidance manual (NYSDEC, 1992) should be followed in respect to quantifying BMP performance. Since the failure of most BMPs occurs as a result of improper maintenance, Applicants should be required to supply a maintenance schedule for any proposed BMP. This schedule should provide details pertaining to the frequency of inspection and maintenance, the party responsible for BMP inspection and maintenance, and the anticipated cost of maintenance.

- Consideration should be given to the promotion of street sweeping in the more urbanized sections of the watershed where floatables, sediments and other debris tend to accumulate between storm events on impervious surfaces. The periodic collection of these particulate pollutants, not only from road ways but from parking lots, would not only decrease pollutant loading to the Harbor, but would extend the longevity of recharge structures by decreasing clogging and sediment buildup. Critical time periods for intensive sweeping are in the spring (to collect road grit and sand) and in the fall (to collect leaf litter). The first step in accomplishing this involves Public Education, as many parking lots are private property. As part of this program, all property owners should be educated not to sweep or blow debris, grass clippings, etc. into catch basins or storm water collection structures. Doing so decreases the functionality of the structures, increases the opportunity for flooding, and exacerbates pollutant loading to the Harbor.

5.4.5 Health Regulations/Sanitary Sewage Disposal

Due to historic development patterns, portions of the watershed rely on septic or cesspool systems, collectively referred to as on site disposal systems, for sanitary waste disposal (Table 5-2). On site wastewater treatment and disposal systems can vary greatly in design and sophistication. On site sewage disposal systems are designed to treat sewage by some type of soil absorption. A basic system consists of a settling tank followed by some form of waste water infiltration area. This could be in the form of a leaching pool, bed, trenches or lines. Disposal systems need to be site specific and their design must take into consideration the volume of effluent, the infiltration characteristics of the prevailing soils, the depth to seasonal groundwater and/or bedrock, topography, the distance to wells, streams and wetlands, and other factors pertaining to the shape and site of the building lot and the arrangement of structures thereon. Specific design requirements are provided in a *Manual of On-Site Sewage Disposal* available through the NCDH.

For convenience sake, within this report, any system intended to provide on site wastewater management has been termed a septic system (Section 4). Properly operating septic systems can effectively treat waste water and protect the environment. Certain nutrients, in particular nitrate, are not readily removed by septic systems. Older systems may also liberate large amounts of phosphorus into the groundwater. The inability of a septic system to remove nutrients is due to the reliance on absorptive capabilities of soils. These attributes can vary because of the soil's physical composition as well as because of the hydrologic load being exerted by the septic system. As discussed in Section 4, septic-related nutrient loading has the ability to cause localized water quality problems, primarily the stimulation of algae blooms. Even a system that functions properly in the removal of pathogens and bacteria, may still be contributing nutrients to the Harbor. These types of problems, as previously discussed, are more prevalent of older systems, systems that were not properly designed or sized, or systems constructed in areas where prevailing natural conditions (slope, bed rock, depth to groundwater) compromises the system's operation. Obviously, failed systems (those incapable of removing pathogens and protecting public health) allow leachate to enter ground water and exacerbate water quality problems. Illegal connections to the storm sewers are obvious violations of health codes and have grave ramifications on the health and safety of the public, as well as the quality of the Harbor.

Glen Cove, Roslyn, and most of Port Washington are currently connected to sewage treatment plants. North Hempstead plans to connect the new Morewood development into the Port Washington sewer district. In contrast, Sands Point, Sea Cliff and Roslyn Harbor rely entirely on septic systems.

Once constructed and operational, septic systems are not regulated, except in the case of a reported failure. The County Department of Health is responsible for inspecting any complaints pertaining to suspected failed systems. This may entail the use of dyes to locate septic breakouts.

County staff noted, however, that because of staff reductions, they no longer have enough available personnel to perform extensive investigations of systems (Personal Communication, February 1997).

Table 5-2
Means of Waste Disposal Within the Hempstead Harbor Watershed

	North Hempstead	Oyster Bay	Glen Cove	Flower Hill	Roslyn	Roslyn Harbor	Sands Point	Sea Cliff
Septic	Bungalow Colonies	X	10%	X		X	X	X
Sewer	All other existing and proposed developments		90%		X			

X signifies that the system is used by over 90% of properties within the watershed portion of the municipality

New on site wastewater systems must meet Town/Village permit requirements, in accordance with County Health department regulations. Since the County plays a key role in the regulation of septic systems, it is important to review their role as well as discuss their interaction with local municipal government.

As discussed earlier, The Nassau County Department of Health (NCDH) regulates design and installation requirements of on-site sewage disposal facilities in such a manner that:

- Drinking water supplies will be protected from direct contamination,
- A breeding place will not be created for disease vectors,
- It will not be exposed to the atmosphere,
- Recreation and shellfishing waters will be protected from contamination,
- A nuisance resulting in obnoxious odors or unsightliness will be avoided.

The NCDH, as NYSDEC's designated agent, reviews and approves septic system engineering plans and issues on-site permits for on-site sewage disposal systems for realty subdivisions. The NCDH functions in the same capacity in respect to lateral sewer extensions for realty subdivisions. Title 7, Section 17-0701 of the New York State Environmental Conservation Law requires that a SPDES permit be obtained to create a groundwater discharge or construct a new or modified on-site sewage disposal system. A SPDES Permit is required for the discharge of sewage from:

- A three-family house or larger; or
- A residential building occupied by more than 10 persons; or
- Any commercial, industrial, or residential facility where the design flow is 1000 gallons per day or more.

All new lateral sewer extensions for realty subdivisions require approval from NCDH. The County requires that all realty subdivisions and commercial facilities located within an existing sewer district, and in proximity to an active sewer line, be provided with public sewers.

5.4.6 Analysis of Septic System Programs

NCDH regulations establish criteria to be used in constructing new septic systems. The County also is responsible for the inspection of new septic systems during their construction. There is no existing program at either the County or local level that involves the periodic inspection of existing systems. Inspections are only conducted as a result of a complaint. Likewise there is no program that mandates routine pumpout. In addition, until recently, little has been done on the local level to inform or educate people about septic systems or the maintenance measures that individual home owners can implement to improve system operation or avoid failures. Enactment of a watershed wide septic management program appears warranted.

The development of municipal septic management authorities is one of the recommendations contained in the draft Long Island Sound Coastal Management program (NYSDOS, March 1994). The septic system authority would assume responsibility for overseeing the maintenance of septic system's within the municipality as a whole, or perhaps only in areas of particular concern to the watershed. The authority could be funded through a special tax or assessment. Another alternative identified by the NYSDOS is to treat septic systems as a public utility. Septic systems would be "purchased" by a municipality or by the septic system authority, but leased back to the homeowners. The septic system authority would then assume maintenance and operating responsibilities for the septic systems, thereby relieving the homeowner of the burden. Although an interesting concept, to implement such a program would most likely prove to be more expensive and meet with more public outcry than a septic management program; even one involving mandatory inspections and routine pumpout.

For the Hempstead Harbor watershed, it is strongly recommended that the municipalities, or sections thereof, still serviced by septic systems adopt a Septic Management Ordinance. Although the ordinance would need to be tailored for each municipality, it should contain the following common elements:

- Property owners should file a site plan that identifies the location of the septic tank, leaching area and any other related appurtenance (e.g. distribution box).

- All systems must be inspected and pumped out every three years. A receipt documenting that the inspection and pumpout were conducted must be submitted by the property owner to the County and/or municipality.

- Upon sale of a property, the septic system (or alternative on-site waste water system) must be inspected and pumped out, and a receipt submitted to the County and/or municipality.

- To defer the costs of inspections and record keeping, it may be necessary for the municipality or County to levy a nominal inspection fee. The cost of pumpout would be solely the responsibility of the property owner.

- A vigorous public education program should be implemented by the HHPC informing property owners of the economic and environmental benefits associated with pumpout and septic management. Part of this educational effort should be the dissemination of information pertaining to the disposal of chemicals, paints and other potentially harmful products down septic systems.

It should be noted that currently Glen Cove provides for one free pumpout per year for all municipal residents serviced an on-site waste water system.

5.4.7 Source Controls

5.4.7.1 Trash Disposal (trash, recycling, leaf and grass clippings)

As a general rule, a comprehensive and convenient recycling plan can help reduce the amount of floatables and other pollutants. Such programs decrease the improper disposal of trash and toxic products into storm sewers or septic systems. Comprehensive programs exist in each of the municipalities surveyed.

5.4.7.2 Pet and Bird Waste Ordinances

Oyster Bay, Glen Cove, Flower Hill and Sea Cliff all have pet waste ("pooper scooper") laws. However, the enforcement of such laws can be difficult. To be successful, these laws require the cooperation of residents. This in turn requires public education, and a clear definition of the benefits associated with complying with the regulations.

Fecal waste from geese is a problem for almost all waterfront communities in the northeast. North Hempstead's Town Park, which encompasses Roslyn Pond and Silver Pond, is extremely attractive to geese. The deposition of fecal material from geese on the park grounds impacts park use. It also presents a serious pollution problem for the park ponds as well as the Harbor itself. Posted signs request park users to refrain from feeding the geese, however, the practice persists.

To encourage the cooperation of residents in the Town of Oyster Bay's effort to prohibit the feeding of geese and waterfowl, the Town recently produced a video entitled "Don't Feed the Quackers Crackers or Bread". Aimed at elementary school children, the video is intended to educate everyone about the water quality impacts caused by waterfowl and how feeding ducks and geese contributes to the problem.

5.4.7.3 Analysis of Pet and Bird Waste Programs

Pet waste disposal laws have not yet been adopted in each of the municipalities within the watershed. A standardized pet waste law should be adopted by each, with enforcement through fines combined with public education initiates. Advisory signs to refrain from feeding geese should be backed up intermittently by staff who can explain why the geese present a hazard and win support.

The success of pet waste laws will ultimately depend on the general public's awareness of the law and their willingness to participate. Certainly most citizens know that pet waste creates a nuisance. However, not all community members are aware of the negative impacts to sensitive surface and ground waters, and to the Harbor. Increased education regarding pet and bird waste in schools, and through public service messages on television or in newspapers, could generate additional support for these programs.

Nevertheless, residents should be encouraged to report areas where pet waste accumulates, and enforcement initiatives should be targeted at those areas. Preventive measures such as installing a community dog run might be considered for high density areas. The Town of Belmar, New Jersey, recently instituted a "Mutt Mitt" program. Dispensers containing plastic mitts were placed in various locations around the town. Pet owners can take a mitt from the dispenser and dispose of pet waste in the garbage in a sanitary and environmentally sound manner.

5.4.7.4 Integrated Pest Management (IPM)

Integrated pest management (IPM) involves the combined use of biological, chemical and physical pest control techniques. The objective of IPM is to systematically manage and/or is to reduce pests to tolerable levels using control practices that are environmentally safe. The basis for IPM begins with a knowledge of the pests that require control. Problems are tracked and control techniques utilized in a manner that reduces the pest in a cost-effective and environmentally friendly manner. IPM should not be associated with non-chemical pest control. In addition, IPM practices do not eliminate the use of chemicals that can negatively impact the environment. However, IPM does strive to minimize the use of such chemicals. In addition, many IPM programs are designed around the use of pesticide that are not mobile, have low biotoxicity, rapidly biodegrade, and tend not to bioaccumulate.

Fundamental to any successful IPM program is tolerance and monitoring. This may translate to lawns that are less green and less perfect However, it may be possible to overcome declining aesthetics by using native vegetation or seed strains developed for the climate and soil conditions of Long Island. In respect to monitoring, before any pesticide is used, the applicator should identify the pest, assess if some other management activity (e.g. irrigation) is responsible for the outbreak, and accurately identify the type and amount of pesticide needed to control the problem. Monitoring pest populations and applying pesticides during sensitive developmental life-stages are effective means of controlling chemical usage. Monitoring may also extend to the evaluation of weather conditions to insure that pesticides or fertilizers are not applied prior to a impending storm. Again, this reduces the potential for the impact of the environment due to improper application of chemicals.

For the most part, IPM tends to be practiced at sites having rigorously maintained lawns or fields. Corporate centers, recreational fields, parks, and especially golf courses would benefit from the implementation of IPM. In fact, many golf course superintendents voluntarily practice IPM for cost-saving reasons or to avoid permit conflicts. The reduction of fertilizer and pesticide pollutants can also be achieved on the individual homeowner level. This may require the education of not only the homeowner but of professional landscapers and lawn services.

Any pesticide applied in the State must be registered for use by NYSDEC and applied in a manner consistent with the directions and limitations stated on the product's label. In addition, the commercial application of many pesticides must be conducted by an applicator licensed in the state and often a special use permit must be obtained. This is especially true when pesticides applications are conducted in wetland and aquatic environments.

At present, none of the Hempstead Harbor municipalities have IPM regulations limiting the application of pesticides or other lawn care chemicals. North Hempstead has however taken the lead within the watershed. The Town is in the process of finalizing an IPM program. The program encompasses pest monitoring, biological pest control and plantings and the reduced use of chemical pest control products. In addition, the Town has already begun to implement IPM practices as part of the routine management of municipal grounds. Roslyn Harbor has also taken some steps to limit the introduction of pest control chemicals into the environment as is evidenced by their ordinance that regulates the application of pesticides for tree spraying.

There are a number of compelling reasons to implement a comprehensive Integrated Pest Management (IPM) Program for the Hempstead Harbor watershed. In order to be successful, the IPM program must be thorough and well designed, yet it cannot be too restrictive. In addition, as policing of compliance with such a regulation could be difficult, the education of homeowners, lawn care professional, and licensed applicators is essential. Unless properly educated as to the need and importance of IPM, there may be the tendency to openly defy an IPM ordinance. Any watershed wide IPM ordinance or regulation should will need to be responsive to the pest control requirements of the different land uses within the watershed (i.e. public open space, recreation areas, golf courses, and privately owned facilities). It should also include special provisions that accommodate special or emergency situations.

5.4.7.5 Stormwater Collection/Treatment System and Roadway Maintenance

A uniform maintenance program for the watershed's storm water facilities does not exist. Storm drain and catch basin maintenance by the municipalities is generally performed as a result of complaints or semi-annually on the based on the results of scheduled inspections. Maintenance of the Nassau County's recharge basins is generally performed following a visual inspection that confirms that the basin is not discharging runoff effectively. The following provides a more concise description of existing maintenance responsibilities.

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The roadway network within the watershed is comprised of State, County, Town and Village roads. At the municipal level of government, municipalities design, maintain, and repair roadways and associated storm water drainage systems for the local roadway system. As was evidenced during our field reconnaissance of the watershed, storm runoff may be conveyed along the street network in a variety of ways. Open grassed channels or swales, pipe and storm drain networks, located under the street or right-of-way. Storm drains are fed by a system of curbs and gutters that channel street runoff into a pipe inlet. Open channels and storm drains typically are designed to carry the runoff from a ten-year rainfall event. Maintenance consists principally of periodic street cleaning and the cleaning catch basin grates and sumps (areas below the outlet pipe where trap leaves and sediment become trapped).

Both local and State storm sewer lines typically feed into the County trunk lines. Roadways and drainage systems must meet New York State Department of Transportation specifications and

Nassau County standards, although each municipality has the option to choose more stringent standards. All Nassau County catch basins are required to have two-foot sumps. Catch basin hoods, a device which may be used to reduce the introduction of floatables into the system, are not required by the County and are not used by any of the watershed municipalities.

The State owns and maintains two highways the (Long Island Expressway and Route 25A) and two minor arterial roadways which run north-south connecting the municipalities on either side of the Harbor (Route 101, which connects Route 25A with Sands Point; and Route 107, which connects Route 25A with Glen Cove). The Northern State Parkway, also owned by the state, runs just south of and outside of the watershed boundaries.

The County is responsible for numerous roads throughout the watershed, and maintains jurisdiction over most collector-distributor roads. There are also a few local connecting streets that are under the County's jurisdiction..

With the exception of a few private residential and institutional roads, the incorporated villages and the Towns of North Hempstead and Oyster Bay maintain the remaining local roads. These local roads make up the majority of the roadway network.

Table 5-3 compares the linear miles of roadway maintained by the State, County, and local municipalities. Table 5-4 describes the maintenance of roadway catch basins performed by each municipality.

Table 5-3
Roadway Jurisdiction Within the Hempstead Harbor Watershed

	Approximate Linear (miles)	Percentage
New York State	24	9
Nassau County	57	22
Local Municipalities (City/Town/Village)	180	69
Watershed Total	261	100

Table 5-4
Storm Drain/Catch Basin Maintenance

	Nassau County	North Hempstead	Oyster Bay	Glen Cove	Flower Hill
Frequency of cleaning for catch basins and storm drains	As requested	Annually	As Needed	As needed	At least twice a year per catch basin
	Roslyn	**Roslyn Harbor**	**Sands Point**	**Sea Cliff**	
	On Inspection (drivebys conducted in the course of duty)	On Inspection (drivebys conducted in the course of duty)	Yearly	No Response	

As shown in the above table, and confirmed by public works staff at the various municipalities, catch basin maintenance is often performed following an inspection and/or upon receipt of a complaint. Typically, the complaints are the result of localized flooding problems.

Regular cleaning of storm drains and catch basins is recommended for all municipalities. Sediment and debris accumulated in these structures will reduce the effectiveness of the drainage system. No guidelines exist for determining appropriate maintenance routine for all drainage structures, since the amount of debris entering different structures may vary widely. Instead, it is recommended that a staff member of the Village or Town roadway department keep a log of problem areas. Grates should be kept clear during the autumn months, and, if possible, cleared after snowfall. Residents should be encouraged to report clogged or overflowing catch basins to the municipal highway department. More specifically, a uniformed, scheduled approach should be taken in regard to the maintenance of the watershed's storm water collection and treatment system. It is recommended that:

Maintenance of both existing and proposed storm water facilities is essential for managing the runoff generated by the watershed. Therefore, a maintenance program should be developed to ensure that the storm water facilities continue to function as originally envisioned. The maintenance program should include but not be limited to the following:

- Inspections be conducted at regularly schedule intervals, preferably once in the spring (because of the accumulation of road grit from sanding operations) and once in the fall (because of the accumulation leaf and lawn litter);

- For storm inlets and catch basins, where an appreciable amount of debris has accumulated (e.g. enough to clog outlet structures, fill 30% of a water quality sump or impede recharge) remove accumulated debris and restore the structure's water collection and detention functions;

- For recharge basins that can no longer safely infiltrate storm runoff, under direction of the County DPW, accumulated sediments should be removed, emergency outlet structures inspected, and, if necessary, the basin re-graded and returned to a serviceable condition, and;

- Removal of sediment from swales, biofilters and storm water collection ponds. Such structures should be re-vegetated as needed to prevent subsequent scouring and erosion, and to promote biological filtration, uptake, or similar NPS pollution control processes.

- A Harbor-wide storm drain stenciling program was implemented by the Hempstead Harbor Protection Committee. The purpose of the program is to raise public awareness of the connection between storm drain dumping and Harbor pollution. The HHPC's program also involves monitoring the status of the storm water basins and the mapping of their location.

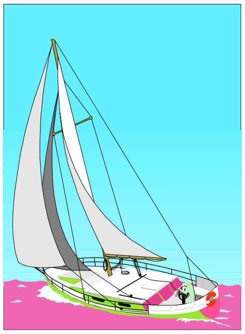
- In investigating and attempting to document the watershed's existing storm water drainage system, it became evident that due to the multiplicity of State, County, and local jurisdictions, no single depository exists for Storm Water Drainage Documentation. In addition, those plans that do exist are difficult to obtain and have not been prepared in a single, universal format. More importantly is the fact that the storm drainage not under County jurisdiction may not be mapped or the maps may not have been routinely updated. It is recommended that the existing collection system be better documented. A combination of GPS and GIS technologies could be used to accurately locate and map all major recharge basins, dry wells, retention ponds and other similar storm water features, as well as the pipe network. This would provide not only a better way of evaluating sections of the watershed in need of water quality related drainage improvements, but also aid in responding to spills or water quality impacts attributable to storm water discharges.

Each of the municipalities surveyed described using some mixture of road salt and sand to de-ice roadways in winter time. None of the survey respondents noted use of any newer or experimental products, such as calcium magnesium acetate, which are currently being promoted by many watershed management groups.

Use of de-icing materials is essential to automobile and pedestrian safety, however, their extensive use, particularly mixtures with high salt concentrations, conflicts with the goal of reducing non-point source pollution. The HHPC may be an appropriate forum for municipalities to develop experimental plans to limit road salt usage in environmentally sensitive areas (e.g roadways that drain directly to the Harbor), and to develop plans to test alternative de-icing materials as they are developed.

6.0 RECOMMENDED MANAGEMENT PRACTICES FOR NPS POLLUTION CONTROL

6.1 The need for NPS Control for Hempstead Harbor



As discussed in Section 1 and reinforced throughout this report, non-point source (NPS) pollution is ubiquitous. Although it may eventually be conveyed to Hempstead Harbor via a discrete, easily identified outfall pipe, its origin is diffuse. Not only does this complicate attempts to establish the origin of pollutants, but increases the difficulty of quantifying each potential source. The significance of NPS environmental impacts was clearly demonstrated by he National Urban Runoff Program (NURP) studies of the mid-1970's. Based on actual field sampling of numerous storm events throughout the country under different land use settings, the NURP studies documented that the concentrations of contaminants in NPS pollution often exceeded established public health and/or environmental protection standards. Furthermore, the NURP findings also showed that as watershed development increased, so did NPS pollution and the severity of the resulting water quality impacts.

Examination of Hempstead Harbor's history of water quality problems (Sections 2 and 3) revealed a relationship between water quality impacts and the increased urbanization of the watershed. The following exemplify some of the Harbor's water quality problems that can be largely attributed to NPS pollution:

- Elevated concentrations of fecal coliform bacteria, floatables and total suspended solids immediately following storm events.
- Degraded riparian habitat caused by sedimentation, pollution and shoreline alterations.
- Dense algal blooms due to excessive nutrient loading.
- Depressed dissolved oxygen concentrations and periodic, late summer fish kills.
- Impaired recreational and economic utilization.

NPS modeling techniques, such as those used in Section 4, increase the ability to objectively analyze the inter-relationship of pollutant contributions and water quality degradation. The data generated by the models concluded that NPS contributions from sub-watersheds comprised primarily of industrial and commercial land use and/or mixed residential land use are responsible for the majority of the nutrient, sediment, heavy metals, and petroleum hydrocarbon loading to Hempstead Harbor (Table 4-2). Although pollutants are also contributed by point source outfalls, septic systems

(Table 4-7), and marina/boating operations (Section 4.2.5), the pollutant loadings from these sources are far less than those associated with runoff from urban/residential lands (Table 4-2). Once the sub-watershed specific NPS loads were corrected for both size bias and the "natural"load, the most intensively developed sub-watersheds proved to be the most significant NPS pollutant contributors (Table 4-6). As discussed in Section 4, the intensity of development and the degree of impervious cover exert a combined effect on the generation of NPS pollutants. The Sea Cliff (8), Roslyn West (12), Roslyn East (11), Flower Hill (10) and Glen Cove North (6) sub-watersheds were found to be the <u>greatest per unit area</u> generators of NPS pollutants, and accordingly have been identified as sub-watersheds of concern (Map 8).

Even though some of these data need to be further refined (e.g. the NPS inputs from marinas need to be better quantified) the watershed modeling data proved extremely useful in the development of a long-term NPS management plan for Hempstead Harbor and its watershed. The results of Section 4 helped identify those sections of the watershed most in need of NPS management, land use activities that exacerbate NPS loading, and areas where further monitoring and analysis is required to better define NPS management needs.

Although knowing what has caused and continues to contribute to the degradation of the Harbor's water quality is extremely important, it is only part of the process of implementing a watershed NPS management plan. As previously stated, the extent to which a NPS plan will actually be put into effect requires a supportive policy environment. In Section 5, the Federal, State and local regulations governing activities that contribute to NPS pollution problems were reviewed and analyzed. Recommendations were provided for a more watershed cognizant policy environment.

In this section of the report, the Hempstead Harbor Water Quality Improvement Plan will be formulated. The plan is intended to correct existing NPS problems and protect the Harbor from future impacts. However, it also includes suggested projects that restore natural resources of the Harbor impacted by past watershed practices or development, enhance the Harbor's aesthetics, and improve its recreational potential. Although most of the recommendations are objectively based on the findings of past water quality studies and the results of the NPS modeling effort, some are based on a more subjective assessment of the community's perceptions and needs for NPS pollution control.

The projects and initiatives discussed herein are consistent with the NPS and Coastal Zone Management recommendations of the EPA and NOAA as stated respectively in Section 319 of the Clean Water Act and Section 6217(g) of the Coastal Zone Reauthorization Amendments of 1990. The Hempstead Harbor Water Quality Improvement Plan calls for NPS loading to be managed through the combined use of revised development policies, public education, source control and delivery reduction techniques. There were many factors that were evaluated in the selection of a particular NPS technique, including cost, physical site characteristics, land availability, level of effort required for operation and maintenance, regulatory permits, design considerations, policy environment and public acceptance. It should be stressed that since this document is to function as a planning and management tool, specific construction designs or ordinances are not within its scope. However, as was the intent of this project, guidance is in fact provided herein as to how each of the problem areas or significant non-point source contributions should be addressed and prioritized.

6.2. The Effects of NPS Pollutants on the Harbor's Water Quality

Significant improvements in the Harbor's water quality and the long-term protection of its resources can only be achieved by reducing, controlling and managing NPS pollution. Before discussing how Hempstead Harbor's NPS load should be managed, it would be beneficial to quickly review the major types of NPS pollution that impact Hempstead Harbor. For this study, focus was placed on four major categories of NPS pollutants: nutrients, sediments, bacteria and contaminants (pesticides, toxins, heavy metals). Each of these pollutants have impaired water quality, impacted aesthetics and impeded the recreational usage of Hempstead Harbor. Table 6-1 provides a synopsis of the effects of each of these pollutants on the Harbor's quality. Detailed description of the environmental impacts attributable to each pollutant are provided in Section 3. In addition, Section 4 provides the results of the pollutant modeling effort, which can be reviewed for details pertaining to the amounts of various NPS pollutants contributed by each of the Harbor's sub-watersheds.

6.2.1 Contaminants of Concern

The basic environmental impacts that each of these pollutants has on Hempstead Harbor are as follows:

- **Nutrients** - Nitrogen and phosphorus, when present in excessive amounts, can stimulate algae blooms. Excess nitrogen stimulates blooms in the estuarine sections of the Harbor, whereas phosphorus stimulates blooms in the more freshwater sections (south of Bar Beach) of the Harbor as well in the ponds and streams of the watershed. In urbanized areas, nutrients may originate from lawn fertilizer, pet droppings, detergents, septic leachate, road litter, and leaf litter (Schueler, 1987). Even "dust" (caused by vehicular emissions, the combustion of fossil fuels, wind erosion of construction sites, etc.) that is "washed" from the atmosphere during storm events contributes nutrients (USEPA, 1974). In areas where there is a high percentage of impervious cover, nutrients associated with particulate material and sediments will accumulate on paved surfaces between storm events, and be mobilized during the initial storm surge ("the first flush"). The concentration of nutrients in the first flush greatly exceeds that measured in the effluent of secondary treatment sewage plants.

- **Sediments** - Suspended sediment refers to inorganic and organic particulate material found in the water column. Most of the time, suspended sediments occur as a result of the erosion or transport of soil particles from upland areas following a storm event. Sediments may also become suspended in the water column due to tidal currents, storm surges and boat traffic that sweep up fine silts and clays from the bottom of the Harbor. Besides increasing the turbidity of water, suspended sediments negatively affect estuarine biotic communities, either as the result of direct biological damages or by the loss or degradation of habitat. Suspended sediments also are a transport vehicle for many pollutants that readily adsorb to, or are absorbed by, sediment particles. These include pesticides, heavy metals, nutrients, bacteria and petroleum products. Approximately 1.5 million kg per year (roughly 3.4 million lbs.) of sediment is contributed from the southern section of the watershed, sub-watersheds 9, 10 , 11 and 12 (Table 4-2). Given that a cubic yard of sediment weighs approximately 1000 lbs, and the volume of a tandem dump truck is 20 cubic yards, this equates to as much as over 1700 truck loads of sediment being dumped into the lower Harbor annually! Inputs of this magnitude can be expected to cause both localized turbidity and infilling problems

Table 6-1
Overview of NPS Pollution Impacts to Hempstead Harbor

Pollutant	IMPACTS AND SOURCES			
	Impacts To The Environment	Impacts To User Community	Common Sources of Pollutant	Major Contributing Sub-watershed*
Nitrogen	Algae blooms, Contaminated groundwater	Algal scums, contaminated drinking water and potable wells, toxicity of aquatic organisms	Septics, sewer overflows, road runoff, vehicle emissions, pet & waterfowl feces, leaves, grass clippings	9, 10, 11, and 12
Phosphorus	Algae blooms	Algal scums, Accelerated eutrophication of ponds and streams	Fertilizers, pet & waterfowl feces, leaves, grass clippings road runoff	9, 10, 11, and 12
Sediment	Loss of aquatic and wetland habitats, foul the gills of fish and aquatic organisms, shading of beneficial aquatic vegetation	Turbid water, Build-up of deltas impede boating, loss of shellfish or recreational fishery	Construction sites, unstable steep slopes, road grit and sand, eroded stream channels, illegal filling, farms	3, 9, 10, 11, 12
Heavy Metals	Toxicity of aquatic organisms and waterfowl	Build-up (bio-concentration) in tissues of shellfish and fish	Emissions, road and parking lot runoff, industrial discharge, marinas (paint/fuel)	
Petroleum Hydrocarbons	Toxicity of aquatic organisms and waterfowl	Build-up (bio-concentration) in tissues of shellfish and fish	Fuel spills, leaky crankcase pan, marinas (fuel/lubri-cants), illegal disposal of used oil	
Bacteria	Introduction of communicable diseases, shellfish contamination	Loss / impact to shellfishery, no contact recreation, contaminated wells, sickness	Pet & waterfowl feces failing septics, sewage plants, pump station overflows, road and parking lot runoff	7, 8, 9, 10, 11, 12

*refer to Section 4

- **Bacteria** - Pathogens, both viral and bacterial, are found in the intestinal tracts of warm blooded animals and are excreted with fecal waste. Pet feces, goose and seagull feces, failing septic systems or sanitary sewer overflows are all potential sources of bacterial loading. Coliform bacteria are easier to detect than pathogens, and are thus utilized as indicators of the potential presence of pathogens. The State has set a standard of 200 colonies/100ml as the maximum allowable concentration of fecal coliform in contact recreation waters. Since 1991, the NCDH has not been required to close beaches because of elevated coliform levels. The elimination of discharge from the Roslyn sewer treatment plant to the Harbor is largely attributed for this improvement. However, bacteria problems still exist. Restrictions continue to be placed on the harvesting of shellfish, and beaches are periodically closed following intense storm events as a precautionary measure by the NCDH. Although it was not technically possible to model and quantify bacterial loads, based on the level of development characteristic of each sub-watershed, the loads can be expected to be very high (Schueler, 1987). Runoff from street and impervious surfaces in densely developed watersheds generates **100 times more total coliform bacteria than a typical secondary sewage treatment plant** on a per unit (e.g. gallon per gallon) basis (NYSDEC, 1993).

- **Contaminants** - The contaminant category encompasses a wide variety of chemicals, including pesticides, fungicides, herbicides, petroleum hydrocarbons (PHC), heavy metals and road salts. These pollutants can originate from agricultural operations, residential, recreational and commercial property maintenance, and the operation and maintenance of motor vehicles (cars, trucks, boats, etc.). Most contaminants become adsorbed to sediment particles, and accumulate between storm events on urban impervious surfaces (e.g. rooftops, driveways, sidewalks, roads and parking lots). The transport of contaminants from the terrestrial to the aquatic environment occurs when these chemicals are leached from soils or plants, or are mobilized by runoff. The influx of many of the above contaminants, especially petroleum hydrocarbons and heavy metals, increases proportionately with sediment loading. Thus, management practices that decrease the influx of sediment also significantly decrease heavy metal and petroleum hydrocarbon loading.

6.2.2 Land use and NPS loading relationships

As illustrated in Table 6-1, each of the categories of contaminants is associated with some land use activity. However, in the Hempstead Harbor watershed land use is not uniform throughout the watershed (Map 7). As detailed in Section 4 and summarized in Table 6-1, certain sub-watersheds contribute greater amounts of certain types of NPS pollutants than others. Understanding how different land use activities contribute to the generation of NPS pollutants aids in the preparation of a technically feasible watershed management plan. Along with Table 6-2, the following provides an overview of the inter-relationship of land use, the generation of NPS pollution and the appropriate techniques for the control of NPS loading.

- **Industrial Sources -** Large volumes of wastewater from on-site processes (point sources), as well as site runoff contaminated with assorted pollutants (non-point sources)can be generated by industrial operations. Although there are a number of commercial and industrial facilities located throughout the Hempstead Harbor watershed, only six facilities have regulated (SPDES permit) storm water outfalls (Section 3). Oil/water separators are the primary means used by these facilities to treat storm runoff and meet their SPDES permit limitations. Although the operational longevity of oil/water separators is excellent (<2% failure in the first five years), they do require a high degree of maintenance, specifically in respect to the routine removal of accumulated grit. In general, because of their small storage volume, grit should be removed as often as monthly. In addition, any captured product (oil, chemicals, sludge, etc.)should be removed on a regular basis and disposed of properly. An alternative to oil/water separators is sand filters. Sand filters provide an excellent means of treating the runoff from highly impervious areas, and are especially efficient in the removal of particulate pollutants and petroleum hydrocarbons (Shaver, 1992). They require a moderate amount of routine maintenance, usually the bi-annual removal of the top two inches of sand and entrained debris.

Industrial/commercial NPS pollutant loading can also be reduced by implementing improved site management measures. There are a number of industrial site-management techniques that are easily implemented, inexpensive, and effectively decrease pollutant generation. These include:

- Covering source materials and stored products,
- Preventing and/or minimizing spills both of liquid and solid materials,
- Sweeping of loading/transfer areas and parking lots,
- Implementing spill containment and cleanup procedures, and
- Practicing proper solid waste disposal practices.

Table 6-2
Examples of Potential NPS Pollution Management Techniques for Hempstead Harbor

Pollutant Source	POLLUTANT MANAGEMENT TECHNIQUES			
	Source Control	Public Education	Regulations and Ordinances	Delivery Control
Industrial Discharge and Runoff	Proper storage and cover of material, spill prevention, sweep parking lots &transfer areas	Educate facility managers on containment procedures, solid waste management, spill response	SPDES permit process for discharge of runoff	Sand filters, detention basins, oil/water separators
Agricultural Runoff	Soil conservation farming practices, feedlot/manure management	Relationships between surface and groundwater impacts and agriculture	Stream corridor protection, erosion control	Detention basins, filter strips, stream buffers
Commercial Land Use	Street sweeping, spill containment	Solid waste management., spill response, erosion control	Zoning, storm water quality management. ordinances, erosion control	Sand filters, water quality inlets, recharge basins
Residential Land Use	Reduced use of fertilizers and pesticides, water conservation	Environmentally friendly lawn care, septic management., pet & waterfowl bacteria problems	Zoning, conservation easements, septic management. and pet waste ordinances	Recharge basins, water quality inlets, filter strips,
Marinas and Boating	Fueling/ painting operations, site maintenance, erosion protection, habitat conservation	Storage of fuel, toxic materials, spill response, solid waste management, use of MSD pumpout stations	MSD pumpout, EIS and env. review, storm water quality management ordinances	Pumpout stations, sand filters, detention basins, oil/water separators
Waste Water Plants and Other Point Sources	N/A	N/A	SPDES permit process	STP upgrades emphasizing nitrogen removal

- **Residential and Commercial Development -** Runoff from residential and commercial areas may transport pesticides, nutrients, sediments, heavy metals, bacteria, organic and inorganic debris, and other assorted chemicals and pollutants into the Harbor. These pollutants and debris accumulate on impervious surfaces between storms and are then washed off by rain. The sources of these pollutants are numerous. Some nutrients and bacteria inputs are associated with pet droppings, leaf litter, and debris that collect in road gutters and swales. Heavy metals and petroleum hydrocarbons are in part contributed by automobile crank case drippings and vehicular exhaust. Septic systems contribute nutrients and, in some situations, bacteria. Even simple lawn maintenance can lead to the generation of nutrients and pesticides. Land use within the Hempstead Harbor watershed is dominated by residential and commercial applications. Thus, pollutant loading from residential/commercial sections of the watershed is of particular significance in this study. Some of the most densely developed (mixed use commercial/high density residential) sections of the watershed are located in close proximity to the Harbor (Map 7). Runoff from these areas is generally discharged directly into the Harbor (Map 2) with little detention or pre-treatment. Adding to the problem, is that these areas are often characterized by steep slopes that either exacerbate the generation of NPS pollutants or facilitate their rapid transport to the Harbor. This is true of the coastal sections of the Town of North Hempstead, the Town of Glen Cove, the Village of Roslyn, and Village of Sea Cliff (Map 4). The prevailing terrain, density of development, lack of available open space and existing infrastructure impede the ability to implement certain structural, delivery control BMPs. This stresses the need to utilize planning, regulatory and educational techniques, in addition to structural BMPs, to control NPS pollution loading.

- **Agriculture** - Agricultural non-point sources are not very common in the Hempstead Harbor watershed; however, they do exist (Map 7). Small parcels of farmland or agricultural use were identified in the eastern portion of the watershed, specifically in Sub-watersheds 3 (Old Brookville) and 12 (Roslyn West), with most of these being horse farms. Although the modeling effort (Section 4) documented that the agricultural pollutant loads were not a significant source of pollutant loading to the Harbor, or a major contributory source of pollutants in the Old Brookville sub-watershed, it would be prudent to manage NPS loading from the horse farms. Feed lot and pasture runoff is recognized by the USEPA (1974) to be high in organics, bacteria and nutrients, all of which can locally impact stream water quality. Data collected by the NCDH revealed higher than expected coliform counts in Cedar Swamp Creek. Although these data are in no means confirmatory, they do suggest the need for the implementation of manure or feedlot management efforts at the horse farms in the Cedar Swamp Creek watershed. The BMPs that have been developed for use in agricultural settings include:

- Segregation of sources (e.g feed lots, manure storage areas) from receiving waters using vegetative buffers,
- Routing of drainage through created wetlands and similar biofilters, and
- Erosion control practices.

Many agricultural BMPs can be implemented with grants or cost-share monies supplied by the USDA, the Natural Resource Conservation Districts (formerly the SCS) and other Federal agencies. This includes funding for manure and feed lot management, creation of riparian buffers, stream fencing and the reclamation of wetlands.

- **Marinas and Boating** - As discussed in Section 4, the pollutant contributions to the Harbor directly attributable to boating needs to be calculated more accurately than was possible as part of this study. Marinas can contribute a variety of pollutants ranging from heavy metals and petroleum hydrocarbons to bacteria. It is recommended that a dilution/dispersal study (as detailed in USEPA, 1985) be conducted by the HHPC for both the confined marinas and dense open water anchorages. Such a study would assess not only the amount of marine related pollutants contributed to the Harbor, but their ultimate concentration in the water column by including the dilution and flushing properties of the Harbor. These data could be used to identify water quality problem areas, and, more importantly, to support pumpout station use and environmentally friendly boating practices.

- **Waste Water Treatment Plants -** Although sewer treatment plants and point source discharges have impaired the Harbor's water quality, neither are dealt with in this report. Point source management and reduction is largely a regulatory activity, dictated by State imposed discharge limits based on a facility's waste stream, daily discharge volumes and maximum pollutant concentrations. There is only one municipal sewage treatment plant still discharging to the Harbor. The Glen Cove STP discharges, on average, 4.5 MGD of effluent to Hempstead Harbor. A recommendation of the LISS is that the Glen Cove STP be upgraded from a secondary to a tertiary treatment facility. By providing nitrification/denitrification capabilities, this STP's nutrient contributions to the Harbor will be decreased. This should help reduce the Harbor's mid-summer algae bloom and hypoxia problems.

6.3 Evaluation of NPS Control Alternatives for Hempstead Harbor

What is evident from the above synopsis of NPS pollution and its impacts to Hempstead Harbor, is that significant improvements in the Harbor's water quality and the long-term protection of its resources can only be achieved through the implementation of a well designed, aggressively implemented Water Quality Improvement Plan. The focus of the Water Quality Improvement Plan for Hempstead Harbor must be <u>the control of existing and future non-point source pollutant loading</u>.

Fortunately, in response to the continued documentation of the significance of NPS pollution, scientists, engineers and regulators have developed a wide array of NPS pollution abatement and management techniques. Data confirming the water quality improvement benefits associated with many of these techniques have been compiled, thereby providing technical support for their utilization. The array of techniques by which NPS pollution can be managed are commonly referred to as Best Management Practices (BMPs). BMPs can be divided into three main categories: **education, source control, delivery reduction**. Each category of BMP has its positive and negative attributes and given levels of efficiency.

In the NYSDEC's storm water management manual (NYSDEC, 1993), examples of some of the more commonly utilized structural (delivery reduction techniques) BMPs are discussed, including many listed in Table 6-2. In addition, the manual identifies BMPs other than structural delivery control techniques that are useful in the management of NPS pollution. These include local government planning strategies, ordinances, and regulations (source control techniques) that prevent or decrease the NPS pollution. The USEPA (1991) promotes the combined use of source control and delivery control techniques as an "integrated, holistic approach" to watershed protection. Furthermore, the USEPA emphasizes that public education play an important role in the management of NPS pollution, and identifies educational programs as part of the Federal government's agenda for the management of NPS pollution (USEPA, 1989). Public awareness programs should be considered "the key to action" in the control of NPS pollution.

Thus, as emphasized by both the State and Federal governments, successful NPS management extends beyond the implementation of structural BMPs. It includes public education, land use planning and regulation, schedules of activities, prohibitions of practices that cause NPS pollution, as well as maintenance procedures and other practices that prevent or reduce NPS pollution (NJDEP, 1994).

As previously discussed, runoff from parking lots, roof tops, roadways and lawns, soil erosion from construction sites, as well as leachate from septic systems, are examples of non-point source pollution. Most of the pollutants contributed from these sources arise as a result of individual and/or community practices. With this in mind, it becomes increasingly obvious that <u>every resident, in some form or another, is responsible for the Harbor's NPS pollution problems</u>. Thus, <u>every resident must be involved in the correction of the Harbor's NPS pollution problems</u> if the quality of Hempstead Harbor is to be restored. The USEPA recently announced that in 1996, 66% of the nation's waters were fit for contact recreation and fishing; a 30% improvement from conditions that existed in 1970. Increased public awareness, improvements in environmental laws and regulations, and refinements in the technology available for water quality enhancement were all identified as being responsible for these improvements. The USEPA stressed that it has been the individual contributions and efforts of the public that have in fact led to these observed nation-wide improvements in water quality. As such, **public education and public awareness** must be a prominent component of the Hempstead Harbor Water Quality Improvement Plan.

Together with public education, **source control** techniques must be implemented throughout the watershed if NPS pollution is to be effectively managed. Basically, source control involves decreasing the actual generation of pollutants by altering existing practices or habits. Most source control techniques focus on the creation of a policy environment that is watershed cognizant. This means having fairly unified local planning, zoning, and environmental regulations that work in unison, regardless of political boundaries, to decrease pollutant loading before it actually occurs. To some extent, source control strategies also involve public education, as it is necessary to garner public acceptance and approval for the adoption, and passage of environmental regulations and ordinances. In addition, since the actual enforcement of certain ordinances may be difficult or cumbersome (e.g. "pooper scooper" laws, water fowl feeding prohibitions, or septic management), public support will greatly determine the success of certain source control measures.

Beyond the public education and source control techniques of NPS management are **delivery reduction strategies**, that intercept, detain, and passively treat storm water runoff prior to its discharge to a receiving waterbody. In some ways, delivery control strategies function as the last line of defense in the protection and/or enhancement of water quality.

A better understanding of delivery reduction strategies can be achieved by reviewing the multiple interactions that exist between watershed development and the generation of NPS pollution. As previously detailed, increased development, or urbanization, results in the alteration of the hydrology of a watershed, modifying the watershed's response to rainfall events. As impervious surfaces increase and the opportunity for infiltration decreases, more runoff becomes created with every storm event. To accommodate this added flow and resolve potential flooding problems, natural flow paths and natural drainage ways become replaced by paved gullies, storm sewers and other constructed waterways. This reduces the time of concentration for runoff, and leads to an increase in peak discharge rates, increased runoff volumes and an increase in the inherent energy associated with runoff. Overall, these hydrologic changes facilitate the mobilization and/or leaching of pollutants and the transport of pollutants from their source to the receiving waterbody.

The construction or installation of delivery reduction measures along the route taken by storm water runoff will help decrease the pollutant load eventually discharged to the Harbor. Some examples of delivery reduction techniques are vegetated buffers, grassed swales, water quality inlets, sand filters, detention basins, infiltration basins, and created wetlands. Obviously, some of these measures are expensive, some are land intensive, and all require, to some degree, a commitment to maintenance. Each of these BMPs has the potential to reduce the influx of NPS pollution to Hempstead Harbor.

A goal central to this project is the restoration and protection, over the long term, of the water quality and natural resources of Hempstead Harbor. As such, a component of the Water Quality Improvement Plan should be the **environmental restoration** of those sections of the Harbor that were impacted by NPS pollution. Emphasis should be placed on the restoration of significant natural resources, the enhancement of recreational areas, or the protection of aesthetically unique sections of the Harbor. Doing so is beneficial for a number of reasons. First, it mitigates the environmental damage caused by past NPS related problems. Second, it results in very high profile, easily recognized improvements; important in respect to fostering public support for less obvious source control and delivery control watershed management activities. Third, projects of this nature raise public awareness and public involvement in the efforts of the Hempstead Harbor Protection Committee.

In general, any combination of the BMP options highlighted above appears to be of value in the control of the Harbor's NPS loading. However, not every BMP, regardless of its ability to reduce NPS inputs, is appropriate for Hempstead Harbor or its watershed. In order to develop a Water Quality Protection Plan that was realistic and achievable, it was therefore necessary to carefully evaluate possible factors that could limit the utility of potentially feasible BMPs. Many factors were considered in preparing the Hempstead Harbor Water Quality Improvement Plan. A screening procedure was conducted to evaluate the technical applicability of each potential BMP. Among those factors taken into consideration were the magnitude and origin of each sub-watershed's NPS load, and the engineering feasibility and the efficiency of potential BMPs. The resource characteristics of each sub-watershed, such as prevailing soils, topography, existing infrastructure, and predominant land use were also factored into the evaluation process. For the source control BMPs, their consistency with the existing policy environment was assessed. Finally, each BMP was evaluated relative to cost, public acceptance, and long term maintenance responsibilities.

The selection of delivery control BMPs is often affected by the availability of land or the existence of land use conflicts. Land availability is of particular importance when siting and designing surface basins (detention, retention, infiltration and recharge). <u>For water quality purposes, such basins should be sized to accommodate the runoff volume of the one year design storm.</u> Through the analysis of the watershed's natural resource attributes (Maps 3, 4, 5 and 7) it was possible to identify physical limitations or conflicts caused by prevailing natural site conditions that could decrease the performance or applicability of structural BMPs. Slope and topography, the depth to bedrock and groundwater, or the proximity to wetlands or floodplain were some of the natural resource features that were considered. On a site specific basis, other factors also had to be evaluated. The successful integration of a BMP into a site can be affected by the existence of nearby wells or foundations, roadways, or may negate the possible use of certain structural BMPs.

Planners and engineers must also recognize that environmental impacts can result <u>from the implementation of a BMP</u>, magnifying the need to properly integrate delivery control BMPs with prevailing environmental characteristics. Although water quality could be complemented by the utilization of a structural BMP, in some cases, a secondary environmental impact may arise due to its construction. For example:

- A BMP that promotes infiltration, may decrease baseline flow during critical periods resulting in a negative impact to the resident biota.

- Improperly timed storm releases from a detention basin may exacerbate downstream storm surges, thus worsening or accelerating stream bank erosion.

- The storage and subsequent release of water from a retention basin may result in the artificial warming of the receiving waterbody and impact heat-sensitive fish.

Conversely, some structural BMPs may have a secondary benefit not directly related to water quality enhancement. For example:

- Wet ponds, created wetlands and even well designed filter strips may create or enhance wildlife, wetland or open water habitats.

- Buffer areas can be managed as meadows, reducing mowing costs and providing habitat for terrestrial wildlife species.

- Between storm events certain BMPs may also be suitable for use as active or passive recreation areas, such as playing fields, walking paths, fishing ponds or bird sanctuaries.

- The aquascaping of ponds, restoration of eroded stream corridors, or the restoration of wetlands while NPS control measures are also aesthetic enhancements.

Public acceptance, commitment and community participation were also considered prior to the recommendation of either a delivery control or source control BMP. Public acceptance can complicate the selection and implementation of source control and/or delivery control BMPs. When selecting delivery control BMPs, the cost of both construction and maintenance must be considered. Source control BMPs, such as fertilizer and pesticide regulations, septic management initiatives, and other similar measures, can directly affect day to day community activities or practices. In such cases, negative public response can be expected. Public education programs can help increase support, acceptance, and implementation of NPS control initiatives.

6.4 The Hempstead Harbor Water Quality Protection Plan

In the following sub-sections, recommended public education, source control, delivery control, and restoration projects are presented and discussed in respect to the long-term restoration and management of Hempstead Harbor. The recommended BMPs and restoration projects were selected following the screening procedure discussed above and following extensive dialogue amongst the members of the HHPC. The resulting plan addresses the Harbor's existing NPS problems, provides for the long-term, cohesive management of the watershed, and serves as a vehicle for the restoration of the Harbor's impacted resources.

6.4.1 Public Education

Several studies have suggested that 'grass roots' measures such as septic management and lawn care management can reduce a water body's pollutant load by as much as 30 to 35 percent. Public education is the key to successful implementation of source control strategies. By educating, empowering and providing the residents of the Hempstead Harbor watershed with the proper information, direct, significant positive effects on the control of NPS can be achieved. In recognition of the importance of public education to the success of the Water Quality Improvement Plan, the HHPC has already conducted the following outreach efforts:

1. The scheduling of educational/informational meetings at key milestone dates during this project

2. Publication of articles in the Coalition to Save Hempstead Harbor newsletters, Newsday and local newspapers.

3. Coordination of "The Harbor Starts Here" storm drain stenciling and volunteer monitoring program, funded by The Long Island Sound Study and Sea Grant.

4. The scheduling of project status meetings designed to keep State, County and local legislators appraised of the HHPC's accomplishments.

The HHPC has also used press releases and public access television to relay the findings and recommendations of this project to the residents of the watershed. These and other similar types of educational efforts should be continued. In addition, the HHPC should also conduct the following public education activities.

- The LISS has published a series of facts sheets that are excellent technology transfer vehicles. These fact sheets, although very informative, are still quite lengthy and intimidating for most lay people. In addition, they do not always directly deal with issues that are specific to Hempstead Harbor. It is recommended that the HHPC publish a quarterly newsletter, highlighting the status of management and restoration projects, funding efforts, etc. The newsletters could also be used as a technology transfer media to "re-package" USEPA, NYSDEC or LISS information into a more condensed, easier to understand format. The newsletter would also be an excellent means of soliciting public involvement in watershed activities.

- Produce and publish educational brochures as a complement or supplement to the newsletter to either announce project accomplishments or promote HHPC initiatives.

- The need to strengthen the watershed's policy environment in respect to IPM, water conservation, erosion control, septic management, buffers and greenways, and the environmental conservation and preservation of open space requires education of not only the public but also of local lawmakers. The HHPC should schedule routine presentations with local planning boards, environmental commissions and town government to discuss these issues. At each seminar, the findings of the HHPC's study could be discussed along with the need to implement the above policy related matters. Printed materials could be distributed at each meeting.

- The HHPC should also develop a Watershed Management Curriculum for watershed's school systems. Although some watershed and NPS educational materials have been developed for use in the local school system, these fall far short of a true curriculum that deals with the ecology of the Harbor or the inter-relationships of the watershed and the Harbor. Individual curricula that include a detailed Teacher's Manual along with specific lessons, activities experiments, and field projects should be prepared for the grammar, middle and high school age groups. Individual units dealing with the physical, chemical and biological attributes of the Harbor, characteristics of the watershed, the impacts of point and NPS pollution, and management and restoration techniques could be prepared and the details contained in each tailored for each targeted age group. The curriculum would serve as an excellent means of stimulating community involvement, and be an excellent means of educating future generations about the ecological uniqueness of the Harbor and the environmental linkages that exist between the Harbor and its watershed.

- The HHPC should coordinate and sponsor an annual "Save the Harbor Day". Such an event could be used to focus attention on the management and restoration efforts of the HHPC. It could include an interpretive nature walk, inspections of watershed management project sites, a shoreline clean-up and other similar types of field events. The event would provide an opportunity to disseminate information from the HHPC, NYSDEC, NYSDOS, Nassau County Health Department and Planning Board, Soil and Water Conservation District and other similar groups. If tied together with an activity such as a 2 or 5 mile running race along the Harbor, it would probably be widely attended by the public. Given the size of the watershed, it would be advisable to hold two such events: one on the east shore and one on the west shore of the Harbor.

Funding for most of the above public education and public outreach programs may be available through Section 319 NPS Education Grants, Coastal Zone Management Pass-Through Grants to Coastal Communities, USEPA Environmental Education Grants, and Office of Environmental Justice Small Grants Program (this program includes several types of projects under the Safe Drinking Water and Clean Water Acts).

6.4.2 Source Control Best Management Practices

Source controls are highly effective BMPs as they reduce or eliminate pollutants <u>before they are mobilized by storm water runoff or are discharged to the environment</u>. Limiting the entry of pollutants into the environment is ultimately preferable to post-discharge mitigation or management. These BMPs are inherently preventative in nature and can be applied to both new or existing developments. As such, they are suitable for the low density developed sections of the watershed such as Sands Point, as well as the intensively developed sections such as Roslyn, Glen Cove and North Hempstead.

It was concluded, following a detailed review of the Hempstead Harbor watershed policy environment (Section 5) that it was not uniform in respect to many type of source control NPS management regulations. For example:

- Although the Town of North Hempstead has developed Integrated Pest Management guidance recommendations, no municipality in the study area has an IPM ordinance. In North Hempstead, IPM is practiced at municipally maintained facilities, but is not binding and need not be implemented at non-municipal facilities.

- Storm water management requirements are variable at the municipal level, and <u>focus more on water quantity control as opposed to water quality enhancement.</u>

- Regulation of soil erosion control is typically left to the County.
- Oyster Bay, Glen Cove, Flower Hill and Sea Cliff are the only municipalities within the watershed to have a pet waste ordinance.
- Septic management, in terms of mandatory scheduled inspections and pumpout, is not practiced within the watershed. Glen Cove does, however, offer residents one free septic system pumpout each year

Based on the analysis conducted in Section 5, there exists the need to improve the existing policy environment if the watershed's existing and future NPS loads are to be reduced through source control strategies. Source control must be an integral component of the Harbor's Water Quality Protection Plan. Implementation of the following source control techniques would be highly beneficial and consistent with the objectives of the Water Quality Improvement Plan.

6.4.2.1 Land Use Planning

Zoning ordinances can prevent incompatible adjacent land uses, limit development in environmentally sensitive areas, and guide more intensive development to sections of the watershed where environmental impacts can be minimized. Typically the rate of growth and location/type of development is largely determined by lot size. The minimum lot size requirements of each of the municipalities within the study area were discussed in Section 5, and zoning maps are presented in Appendix H. Most of the watershed is zoned for small lot development (generally 7,500 ft^2 to 10,000 ft^2). A notable exception is Sands Point (Sub-watersheds 4 and 5) where 2 to 5 acre minimum lot size zoning prevails. Small lot zoning was historically responsible for much of the intense development and extensive imperviousness that characterizes the watershed, especially the southern portion. As detailed in Sections 2, 3 and 4, this type of development intensity also increased the opportunity for pollutants including heavy metals, petroleum hydrocarbons and contaminants to be generated and conveyed into the Harbor.

As discussed in Section 5, it is somewhat too late, because of the extent of existing development, to extensively control future NPS pollution through zoning initiatives. Measures should be taken to preserve the large lot zoning that characterizes the relatively undeveloped sections of the watershed (Sub-watersheds 1, 2, 3 and 4). Development regulations that are sensitive to environmentally important areas are also encouraged. This has been the stimulus for the creation of special overlay areas in many of the municipalities. Examples include the Glen Cove and Sands Point Coastal Erosion Hazard Area, and Roslyn's Hillside Conservation District. Construction activities in the most sensitive areas should be avoided, for instance, in areas with steep slopes (Map 4), adjacent to drainage ways, wetland or critical coastal habitats (Map 5). Some specific examples of sensitive environments are the coastal bluffs along the Sea Cliff and Glen Cove shorelines, the tidal wetlands along the Harbor's northeastern shoreline, and the steep sloped sections of the Roslyn East (Sub-watershed 11) and Port Washington (Sub-watershed 9). Areas characterized by mature vegetated cover (Map 7) should also be preserved, or at least mitigated in-kind, to the fullest extent possible and the disturbance of erodible soils (Map 3) should be minimized.

Section 5 presented specific zoning strategy recommendations that control NPS pollution. These included:

- Creation of overlay districts that preclude development in environmentally sensitive areas. Focus should be given to creating a greenway zoning overlay to protect the Cedar Swamp Creek and Glenn Cove Creek corridors from further development.

- Zoning regulations that exclude environmentally sensitive areas (e.g. steep slopes, wetland buffers, etc.) from the calculated "buildable" envelope of lots.

- Give credits or allowances for cluster development, when done to preserve open space or protect sensitive lands.

- Amend the existing Flood Plain Overlay regulations to preferably prohibit or, at a minimum, greatly limit development in floodplain areas.

- Identification of remaining large open lands, and development of contingency plans for the purchase of these lands (for the preservation of open space) in the event that they are to be sub-divided and intensively developed.

- Augment lot size limitations to include limits on the total allowable percent impervious cover.

- Use State and/or Federal funds to create public access greenways such as the Hempstead Harbor Shoreline Trail.

In particular, as the watershed undergoes further development or re-development, particular attention should be given to promoting cluster development and other land use practices that diverge from typical "cookie cutter" type development practices. This will decrease overall land disturbance and stormwater related impacts. By concentrating development within a smaller portion of the site and preserving adjacent open areas, it becomes possible to decrease the amount of potential soil erosion, the volume of storm water runoff, and the loss of natural vegetated areas. Morewood, located in North Hempstead (Sub-watershed 9), is an example of cluster design development. In exchange for a higher density development in a smaller portion of the site, the developer will leave much of the site in its natural state or as public open space. Under this scenario, construction related erosion problems are minimized, stormwater runoff better managed, and natural buffer areas and wildlife areas are left intact. This would not have been possible had the site been developed using the typical small lot approach.

6.4.2.2 Site Plan Review

Site plan reviews are another vehicle by which development related conflicts with the environment can be assessed. This process can be used as a means of insuring that the minimum NPS control measures have been incorporated into every phase of a proposed development. In the Hempstead Harbor watershed, the Nassau County Planning Commission is responsible for the review of major sub-divisions (5 lots and greater) in the unincorporated communities of the County. The County DPW will also review projects that front on County roads or abut County lands. Review of existing local environmental regulations revealed that a site plan review and environmental review process exist for each of the municipalities contained within the watershed's boundaries (Section 5). Although the development related threshold may vary somewhat among the municipalities, all conduct site plan reviews for major developments. Development in delineated sensitive areas, development of a certain intensity, or commercial developments are examples of land development activities also trigger site plan review. In accordance with SEQRA, some form of environmental review is also conducted, the level of detail dictated to some extent by the magnitude of the proposed development. All municipalities except Roslyn and Roslyn Harbor have local soil erosion and sediment control requirements.

The site plan review process can also be used to evaluate whether special environmental mitigation measures required by the County or a municipality have been included in the plan. The hillside protection ordinances that exist in Roslyn and Glen Cove are designed to limit the disturbance of steeply sloped areas along the coast line. These areas are prone to soil erosion during construction, or generate a greater than normal pollutant load once developed. In general, these types of development ordinances help promote developments that are "designed with nature". They encourage or regulate development in a manner that site disturbance is minimized, soil erosion is controlled, and storm water volumes are managed.

Master plans and natural resource inventories (NRI's) play a big role in the site planning/land use planning approach to NPS pollution control. These documents can assist in identifying sensitive areas and directing development away from them, or planning development in such a way as to minimize impacts to sensitive areas. For instance, streams and coastal shorelines may be protected by creating riparian buffer zones. Park land or open public space can be directed to these areas, thereby minimizing their development. As such, these documents should be up-dated on a regular basis; for example once every 10 years. Increased use should be made of the County's and State's GIS data base in preparing NRIs, even to the extent of creating dynamic files that could be called up on a computer during planning board or environmental commission meetings to specifically address watershed conflicts.

6.4.2.3 Storm Water Quality Management

What is notably lacking in the watershed's existing policy environment, are storm water quality management regulations. All the municipalities require some form of stormwater assessment. However, the focus of these regulations is on flood management (peak flow attenuation). Basically, this is limited to the on-site storage or containment of runoff through the use of recharge basins. No existing ordinances currently include storm water quality management provisions.

Successful stormwater quality management in urbanized areas largely relies on the ability to intercept and pre-treat runoff prior to its discharge to the environment. As part of the environmental review associated with major sub-divisions, opportunities often arise to evaluate the potential water quality impacts of storm water and NPS loading, and mandate the implementation of storm water quality management measures. The following are recommended stormwater related practices for the Hempstead Harbor watershed:

- A priority action item for the HHPC should be the passage of local regulations that either limit the increase in development related pollutant loading following development or establish performance standards for the detention of runoff. The NYSDEC storm water manual (NYSDEC, 1993) discusses the need to design structural BMPs to treat the "first flush" or the first ½" of runoff generated by the 1-year, 24 hour storm. However, specifics are not provided as to how the receiving basins or structures are to actually manage this inflow so as to maximize pollutant removal efficiencies. The New Jersey storm water management regulations (NJAC 7:8) provide better detail of performance requirements of storm water management basins thus increasing the likelihood that structural BMPs will be properly constructed and will actually work. These documents should serve as the basis for the development of stormwater quality management regulations for the watershed. Guidance is provided in NYSDEC's storm water manual for the preparation of a storm water quality management ordinance.

- As part of the Chesapeake Bay initiatives, certain counties in Virginia and Maryland now require developers to conduct pre-and post-pollutant loading analyses (using similar methodologies to that used in the Hempstead Harbor project). These data are utilized to quantify the magnitude of anticipated pollutant influx and support the need for storm water quality management BMPs. The Lake Carmel Park District, through the auspices of the Town of Kent, NY Planning Board, has done the same as part of their evaluation of potential development related impacts on Lake Carmel. The member municipalities of the HHPC should require NPS pollution loading analyses as part of all major sub-division reviews. As with the examples noted above, in some situations the request for such an analysis could be made during either the municipal or county level of review. Within the Hempstead Harbor watershed, it is advisable that initially that the County take the lead in requesting such analyses. Based on the review of the existing Policy Environment, it would appear that currently only Glen Cove and North Hempstead have the degree of authority available through municipal ordinances to request such data as part of the overall development review process.

- In the case of industrial facilities, local planning boards and the HHPC should use to the fullest extent possible the State Pollutant Discharge Elimination System (SPDES) permit process as a means of maximizing on-site water quality management practices. Basically, this could be accomplished by petitioning the State, via public comment, to require stricter discharge standards or mandate the implementation of sophisticated storm management systems (oil/water separators, sand filters, etc.) for all industrial discharges to the Harbor. In addition, since the maintenance of such structures is key to their long-term function and pollutant removal efficiency, a management/maintenance plan should be in effect.

- Soil erosion control, IPM and other similar source control regulations or ordinances facilitate stormwater quality management and should therefore be promoted. Limiting, in the first place, the amount or types of pollutants generated from the watershed works perfectly in concert with the construction or implementation of structural stormwater management techniques. The overall end product is the creation of a policy environment aimed at the reduction of NPS loading through the use of both source and delivery control strategies. Maloney, et al. (1980) provides excellent guidance for the creation of storm water and erosion control ordinances.

6.4.2.4 Septic Management

The vast majority of the watershed's population is serviced by sanitary sewers (Section 2 and 4). In those sections of Sub-watersheds 4 (Sands Point North), 5 (Sands Point South), 7 (Mott Point), and 8 (Sea Cliff) where septic systems provide waste water treatment, septic management initiatives should be implemented. Sub-watersheds 4, 5, 6, 7, 8, and 9 cumulatively contribute approximately 16,700 kg of nitrogen annually (36,711 lbs.) from septic systems. Sub-watersheds 4 (Sands Point North), 7 (Mott Point), and 8 (Sea Cliff) are responsible for the majority of this load. There is little likelihood that these sub-watersheds will become sewered in the near future. Septic management should therefore be implemented to help minimize nutrient loading to the Harbor and protect against septic failures that could result in bacterial inputs.

Successful septic management involves the integration of public education, product modification, septic system inspection and maintenance, and water conservation practices. In addition, it may rely on the use of advanced on-site waste water renovation/treatment designs to correct failing systems or to dictate the construction of new systems in environmentally sensitive sections of the watershed. Although septic management is often associated with the control of nutrient loading in freshwater ecosystems, it can be a very useful management tool even in an estuarine watershed such as Hempstead Harbor. Septic management can reduce nitrogen loading, the nutrient responsible for stimulating algal blooms in marine environments. Also, because the lower Hempstead Harbor has freshwater like characteristics (Section 3 and 4), managing the performance of septic systems to decrease phosphorus loading and associated water quality problems, would also be consistent with the Harbor's overall NPS reduction objectives.

Product modification usually refers to the use of non-phosphorus or low phosphorus products that minimize septic-related phosphorus loading to the environment. However, it also applies to the use of septic tank chemical additives, or the disposal of paint, solvents or left over household chemicals and cleaning products in septic systems. In reviewing the local Policy Environment, it was found that none of the municipalities have regulations pertaining to the disposal of such materials in septic systems. Public education fliers and brochures would prove beneficial in this respect. An excellent example of such is the Town of Oyster Bay's S.T.O.P. brochure that discusses the environmental and health consequences of pouring contaminants on the ground or into septic tanks or cesspools. Additional related public information fact sheets of this nature can be obtained through the USEPA's Small Flows Clearing House, which specializes in the dissemination of information pertaining to septic systems and other types of on-site waste water treatment systems.

All residents who rely on some form of on-site wastewater disposal system should be educated about the serious impacts of household chemicals and degreasing agents improperly disposed of in septic tanks. These products can cause serious upsets to the biological treatment processes that occur in cesspools, septic tanks and in the soils of the leaching area. Equally important, these products can result in serious groundwater pollution and the contamination of drinking water wells.

Also, public education concerning the lack of any benefit associated with enzymes, bacteria innoculants, or other products advertised as septic tank supplements should be made available by the HHPC to residents relying on on-site disposal systems. These products do very little to enhance septic system operation (USEPA, 1997). In addition, garbage disposal units should not be used in any dwelling serviced by a septic system or cesspool. Doing so results in an additional organic load that further stresses the system by adding to both the sludge and grease layers. Once ground up, the disposed solids can be converted into fine particulate material that resists settling. This can decrease the operational efficiency of a septic system and accelerate the clogging of the leach field.

Inspections and routine maintenance are usually the two controversial elements of most septic management programs. Currently, Glen Cove offers one free pumpout per year to all residents serviced by septic systems. These pumpouts, however, are voluntary and not linked with any type of inspection process. There is an innate resistance by homeowners to allow periodic inspections or to comply with a mandatory pumpout schedules. Basically, the prevailing thought among most homeowners is "if it flushes, it's OK". However, as has been demonstrated in studies conducted as part of septic management programs, routine inspections help decrease the occurrence of large scale failures by identifying the more easily corrected, less costly problems early on (NYSDEC, 1994; Township of Frankford BOH, 1994). Similarly, routine pumpouts decrease the build up of sludge and grease, both of which can be transported into the leach field and create clogging problems. In general, the inspections and pumpouts should be viewed as an insurance policy for the long-term proper operation of the septic system and not an imposition of the property rights of a home owner. It should be noted that for older tanks, there may be some liability associated with their pumpout. Metal tanks that have become corroded or hand built cesspools can collapse once the liquid and sludge has been removed.

Water conservation measures are intended to reduce hydrologic loading to the leach field. Included in this category are the use of low flush toilets, flow reduction fixtures and other similar devices designed to reduce water usage. It can also encompass lifestyle habits such as spreading out laundry wash loads over a number of days, shorter showers, and other similar cooperative techniques.

The NYSDEC, Cornell Extension Service, USEPA Smallflows Clearing House, and the Soil and Water Conservation Districts have extensive amounts of information in print on septic management. In addition, there are model septic management ordinances available through the NY Federation of Lakes and the Village of Cazenovia, NY that could be used as the basis for a septic management ordinance for the Hempstead Harbor watershed.

Given the above, it is therefore recommended that the HHPC conduct the following in respect to minimizing septic loading:

- Implement a public education campaign on proper septic system care. This should include maintenance, product modification, and water conservation. Use to the fullest extent possible print information available through the EPA's Small Flows Clearing House. NYSDEC, Cornell University Extension Service, and the LISS.

- Work with the local municipal governments to implement mandatory pumpout and inspections. This should be done on a three year cycle or upon the sale or realty transfer, or as part of any major remodeling/redevelopment application.

- Work with the NCDH and the local municipal governments to give greater consideration to the use of advanced forms of on-site waste water treatment systems such as RUCK, recirculating sand filters, and intermittent sand filters. Many alternative on-site wastewater treatment systems provide a higher degree of nutrient removal than do conventional systems even in soil limited conditions. This is particularly true in respect to the removal of nitrates. For a coastal watershed, such as Hempstead Harbor, a reduction in nitrogen loading is desirable due to that nutrient's role in the stimulation of algae blooms.

6.4.2.5 Minimizing Site Disturbance and Utilizing Alternative Landscaping

Minimizing disturbance and utilizing alternative landscaping are preventative pollutant load management techniques. If these techniques are properly implemented they can eliminate the need for the repeated fertilization of lawns, decrease the rate or frequency of pesticide applications and decrease irrigation requirements. The review of existing zoning relative to existing land use suggests that Sub-watershed 3 (Old Brookville) probably has the greatest potential for further in-fill type development, the impacts of which could be greatly reduced by the implementation of alternative landscaping and site clearing source control strategies.

Site disturbance activities can be most critical in the steeply sloped sections of the watershed [Map 4, Sub-watersheds 6 (Glen Cove South), 8 (Sea Cliff), 9 (Port Washington), 10 (Flower Hill), and 11 Roslyn West)]. However, because of the sandy type soils that prevail throughout the watershed, care must be taken whenever site clearing and grading is conducted. Flower Hill in particular has an excellent local soil erosion control ordinance that could serve as a model for the other municipalities lacking such regulations. Areas with natural, native vegetation (forested areas, beach grasses, riparian vegetation, naturally grassed stream corridors) should remain undisturbed during construction. At a minimum, disturbance of vegetation in these areas should be minimized, and if disturbed, replaced using vegetation similar to that which originally existed. Clearing and grading should be allowed only within a prescribed area, and disturbed areas should be re-vegetated immediately following construction with native or well-adapted species that require little or no maintenance. These practices decrease erosion and promote infiltration. The use of site-appropriate vegetation leads to minimal watering, pesticide and fertilizer use.

In already developed areas, homeowners should be encouraged to allow nature to take its course in a portion of the property. Focus should be placed on maintaining natural ground covers in lieu of manicured lawns, and supplementing areas having sub-optimal ground cover with selected plantings. This practice can help minimize lawn areas and the associated use of nutrients and pesticides. By maintaining properly stabilized vegetative cover, a reduction in localized soil erosion can be achieved. Such measures should especially be promoted at transition points to wetlands, streams or ponds. By utilizing a combination of design, plants and mulches, homeowners and landscapers can create a landscape that decreases maintenance, is aesthetically pleasing and is environmentally suited to the area.

6.4.2.6 Fertilizer and Pesticide Management

As discussed in Section 4, environmental conditions conducive for the direct transport of nutrients and pesticides into the Harbor prevail in the coastal sections of the watershed. This reinforces the need for the implementation of IPM techniques in upland areas within 300 feet of the Harbor, its streams, ponds, wetlands, and tributaries. Integrated pest management (IPM) is a common sense, but technically well structured approach to the use of fertilizers and pesticides. It can be used at the individual home level, but is more commonly utilized in respect to the maintenance of large intensive use areas such as golf courses, public parks, and ball fields. Central to the success of IPM as a source control strategy is the employment of environmentally friendly methods to maintain pests below defined damage levels. Unfortunately, a considerable amount of over application of pesticides and fertilizers occurs during the routine care of residential lawns. Homeowners often operate under the assumption that if "a little is good, more is better". This leads to the over-application of products and an increased potential for off-site transport of pesticides and fertilizers.

A lawn and garden are part of the ecosystem. Actions within these areas should complement natural checks and balances, not necessarily completely eliminate pest species. The mere presence of a pest species is not a cause for alarm. An acceptable damage level or pest level must be determined. Beyond that level, the proper pesticide level to control the pest that is present may be selected. Potential environmental impacts must be weighed against the effectiveness of the chemical.

A key element of IPM is limitation of the use of fertilizers, or the use of specific types of fertilizers. By applying only the quantity of fertilizer necessary for optimum plant growth, the amount that can potentially be mobilized and transported to surface and groundwater resources is minimized. Use of non-phosphorus fertilizers or slow-release nitrogen fertilizers also decreases the loading to receiving waters. The effectiveness of fertilizer management is dependent upon cumulative effects within the watershed, and requires commitment on an area-wide basis. Not only is non-point source pollution (fertilizers, nutrients) reduced with this practice, but the homeowner will also save money.

Homeowners and lawn care services must be educated regarding proper lawn maintenance. For example, slow release lawn fertilizers are the most appropriate to use. They allow for more complete utilization of nutrients by lawns. Fertilizer applications must also be timed properly to account for plant needs and to anticipate rainfall events. For example, nutrients are most needed in the spring and fall, not throughout the summer. Also, rain induced fertilizer losses are greatest immediately following an application because the material has neither become adsorbed by the soil or taken up by the plants. NYSDOS, in conjunction with Sea Grant, recently published a brochure entitled "A Guide To Sound Gardening in the Oyster Bay-Cold Spring Harbor Outstanding Natural Coastal Area". The brochure discusses, in layperson terms, the potential harmful effects of lawn and garden care on the environment. Emphasis is placed on controlling runoff, applying fertilizers properly and minimizing the use of pesticides. The brochure even provides a contact number for additional information on IPM.

Pesticide management practices are similar to those described above for fertilizer management. A well designed pest management program can reduce the amount of pesticide applied, thereby preventing surface and groundwater contamination, avoiding destruction of non-target organisms and decreasing pesticide costs.

An additional means by which to decrease fertilizer and pesticide use and the subsequent transport of these pollutants to the Harbor is through the use of alternative lawn cover. Where appropriate, the HHPC should recommend the use of native plants or plants that have lower irrigation needs than typical suburban lawns. As part of the ongoing strategy to reduce the influx of lawn related pollutants into Chesapeake Bay, the National Park Service has started to use native ground covers to reduce the need for fertilization and irrigation (NPS News-Notes, 1996). Similar types of low maintenance vegetative cover have been promoted by New Jersey DEP (NJDEP, 1996) and the Metropolitan Council of Governments (Schueler, 1987) as part of an overall strategy of reducing NPS loading. Xeriscapes, plantings that are drought tolerant, can also help minimize the off-site transport of pollutants. By requiring less water than conventional ground covers or plantings, the occurrence for the mobilization, leaching and subsequent transport of pesticides, fertilizer, and even soil can be reduced.

Fertilizer use and potential nutrient liberation and transport can also be reduced by following simple lawn management guidelines. Testing of soil nutrient chemistry can greatly aid in limiting the use of fertilizers or in properly identifying how best to amend soils to increase their affinity to retain nutrients. A detailed survey of homeowners in Virginia commissioned as part of the Chesapeake Bay initiatives, found that less than 20% actually tested their soils to determine whether fertilization was actually necessary (Watershed Protection, 1994). Although soil pH can have a significant bearing on the ability of soils to retain nutrients, such testing is not commonly conducted by homeowners. The application of lime can improve phosphorus uptake and retention. Other non-chemical lawn care treatments such as de-thatching and aeration are also rarely conducted (Watershed Protection, 1994). Urban soils, even those associated with lawns, can become compacted and function almost no differently in respect to the generation of runoff than impervious surfaces (Schueler, 1995). Aerating lawns helps promote better infiltration and the generation of less runoff.

Limiting fertilizer and pesticide use is most important for properties within 300 feet of a stream, a pond or wetland ecosystems, or immediately adjacent to the Harbor. The potential for the rapid mobilization of these pollutants exists because of the steeper slopes, sandier soils and the shallow depth to ground water that characterize these sections of the watershed. However, the entire Hempstead watershed could greatly benefit from the implementation of IPM type practices. It is therefore highly recommended that a uniform IPM ordinance be developed. Guidance for the development of IPM regulations can be obtained through a variety of sources including Cornell University Extension Service and the US Golf Association. The North Hempstead Integrated Pest Management Insect Guide is a good starting point. A watershed wide IPM strategy must encompass fertilizer, pesticide, and irrigation practices. It should also identify the need for the integration of soil nutrient chemistry and testing data. It is recommended that initially, the IPM ordinance apply only to large, intensively managed sites, (ballfields, golf courses, commercial properties, etc.) but also include provisions for the control of product applications conducted by lawn care services on private lawns.

IPM and fertilizer management ordinances, especially those that pertain to private, residential lawns, tend to be highly contested, and subject to extensive public opposition. These ordinances, similar to littering or pet waste ordinances, tend to be difficult to police and enforce. The public's voluntary participation is therefore needed if IPM and fertilizer management ordinances are to be successful. This starts with the implementation of a well structured public education effort. It is therefore recommended, that prior to drafting ordinance language requiring IPM to be practiced in the management of residential lawns, that an extensive education campaign be conducted. As mentioned above, Oyster Bay's Guide to Sound Gardening is a perfect example of the type of educational material needed to promote IPM.

Specific recommendations developed for the Hempstead Harbor watershed relating to fertilizer management are as follows:

- Develop a true IPM ordinance for application initially at all commercial properties or large, intensively managed public open space areas (ballfields, golf courses, etc.). As the public becomes educated about the importance of IPM, extend the ordinance to include private lawns.

- Conduct a public education program that informs all the residents of the benefits of fertilizer and pesticide management, stressing the low cost alternatives and environmental benefits of such techniques. Encourage soil nutrient testing be performed before engaging in fertilization and emphasize the benefits of nutrient retention as a result of liming, aeration, thatch control, and other non-chemical lawn care measures.

- Encourage xeriscapes, native vegetation, and alternative ground covers and ornamental plantings that require less maintenance and less chemical management than conventional lawns.

6.4.2.7 Roadway De-icing/Salt Reduction

This management practice promotes the "wise use" of road salts and other de-icing agents. Precedents exist for the implementation of such management practices, especially around reservoirs, ground water recharge areas, and other environmentally sensitive areas throughout the state. Options include minimizing salt applications on low traffic roads and maintaining stringent application controls in sensitive areas. Levels of service and application rates for various locations can be determined prior to the winter season. Levels may include no salt use, plowing and sanding, or salting.

Proper operation of storage facilities can eliminate a large portion of the concentrated runoff. The County currently covers salt stock piles, and reportedly, municipal DPWs also properly contain salt and sand piles. Such practices help reduce the mobilization and transport of salt and sand from stock pile areas into nearby streams, storm water drains, or the Harbor.

Alternative de-icing products have been promoted by many watershed management groups for use in sensitive areas. The County and local DPWs should at least investigate the utility of these products. For example, calcium magnesium acetate (CMA), a combination of dolomitic limestone and acetic acid, is currently being tested nation-wide. The components of this salt alternative contribute little, if any, to the degradation of water quality. However, this product costs approximately 10 fold more than road salt. Its use would primarily benefit the streams, ponds and freshwater wetlands environments of the watershed, as opposed to the Harbor itself, by tempering the "salt shock" that occurs during the spring thaw. Therefore, it would be more appropriate for consideration in the Old Brookville, Roslyn East, Roslyn West and Sea Cliff sub-watersheds where road runoff is channeled into prominent freshwater features (e.g. Cedar Swamp Creek or Roslyn Pond).

6.4.2.8 Marina and Boating Related NPS Control

According to the *New York State Clean Vessel Act Plan* (NYSDOS, 1996), "sewage discharged by recreational vessels because of an inadequate number of pumpout stations is a substantial contributor to localized degradation of water quality in the United States." Vessel waste pumpout stations are facilities that pump or receive sewage from Type III marine sanitation devices (MSD) installed on vessels. Type III MSDs include equipment such as recirculating and incinerating MSDs and holding tanks, and are defined as any equipment specifically designed to receive, retain and discharge sewage (Figure 6-1). A dump station is a facility designed to receive sewage from portable toilets that are carried on vessels.

The Clean Vessel Act requires that coastal states, such as New York, prepare a plan for distributing funding for pumpouts and dump stations to the appropriate parties. Under this act, funds are provided to states for grants for public and private marina operators to install, renovate, operate and maintain pumpout stations and other vessel waste discharge facilities.

The Hempstead Harbor Protection Committee (HHPC) and member municipalities have discussed the potential for the Harbor to be designated a "No Discharge Zone." No Discharge Zones (NDZ), as designated by USEPA, require all craft with installed toilets to have holding tanks or sanitation systems that are secured to prevent overboard discharge. Before a waterbody can be designated as a no discharge zone, sufficient vessel waste pumpout facilities must be present to serve the number of boats equipped with onboard MSDs. The EPA suggested ratio of pumpout facilities to boat is one per 300 to 600 boats (16 feet or greater). Based on the number of boats present in the Harbor (752 based on aerial photograph count, 800 based on survey responses, NYSDOS, 1996), Hempstead Harbor should have two pumpout facilities. In fact, three pumpout stations should be operational by the beginning of the 1997 boating season (Tappen Marina, Brewer Yacht Yard, and Glen Cove). A typical pumpout station is represented in Figure 6-1. The Harbor thus exceeds the pumpout station criteria needed for the NDZ designation. If properly implemented and enforced, declaring the Harbor as a NDZ should aid in reducing boat related bacterial loading to the Harbor.

However, even if the Harbor is designated a NDZ, boater education concerning their role in nutrient and bacterial loading will be needed. Tanski (1989) reported that even if an adequate number of pumpout stations are provided they may not be used by boaters. Only five percent of the boaters surveyed as part of the Tanski study reported actually utilizing pumpout facilities on a regular basis. This lack of use is clearly a function of inadequate boater education. Again, this reinforces the need to include education and public awareness type initiatives as part of the Hempstead Harbor Water Quality Improvement Plan. Public education regarding the effects of boat waste on local water bodies must be an integral part of the overall plan if the positive benefits of the pumpout stations on water quality are to be realized.

In addition, enforcement problems are common because of the lack of any clearly defined jurisdictional responsibilities. The policing of boaters by an individual municipality is logistically difficult, and potentially costly, especially for a waterbody the size of Hempstead Harbor. Even State and County government may not have the needed resources. This is not too much different from enforcement problems associated with anti-littering ordinances, and emphasizes the need for public awareness and participation, stimulated as a result of well designed boater education programs.

Besides the wastewater related nutrient and bacterial loading, other NPS pollution problems associated with marinas can be mitigated through source control and delivery control techniques. The influx of oil, grease, heavy metals, and sediments from vehicular parking areas can be controlled through the aggressive implementation of storm water management BMPs. This includes the use of sand filters, water quality inlets, oil water separators, and the maintenance of vegetated buffers between impervious surfaces and the water's edge. Petroleum hydrocarbon and heavy metals inputs can be reduced by practicing "good housekeeping" around boat refueling and maintenance operations.

The specific recommendations developed for Hempstead Harbor concerning the control or management of marina related NPS pollution loading are as follows:

- Proceed with the designation of the Harbor as a No Discharge Zone. An adequate number of pumpout stations to service the Harbor now exist, and the Harbor's environmental sensitivity and need for NPS pollutant management has been definitively established and is supported by a substantial database.

- As discussed in Section 4, conduct a more detailed modeling analysis of the pollutant contributions associated with the Harbor's marinas and dense anchorages. Focus on quantifying bacterial, heavy metal and petroleum hydrocarbon loading.

- Require the installation of stormwater quality management devices (e.g. water quality inlets, oil/water separators, sand filters, etc.) at all new marinas, marinas that are proposing significant expansions, or marinas that appear before planning or zoning boards for variances or exemptions.

- Prepare public educational materials concerning the proper use and maintenance of MSDs and the implementation of other boating and marina operational "housekeeping" practices. Disseminate this material to boaters and marina operators. Use a "Save the Harbor" type forum to distribute these materials, in addition to mass mailings and other types media (public access TV and radio spots, local newspaper articles, etc.).

6.4.2.9 Other Source Control Practices

There are additional practices that could be practiced by local government DPWs and/or the general public on a daily basis that are very effective and relatively inexpensive source control measures. These practices include the following:

- Roadway and parking lot maintenance activities which reduce the amount of debris and litter that can be mobilized during a storm event. This can be as simple as HHPC organized or sponsored Harbor-wide cleanups, Adopt a Highway programs, and anti-litter patrols.

- In the more highly impervious sections of the watershed, as well as along all the main roadways, street sweeping, cleaning of drainage inlets, and appropriate solid waste collection and disposal methods should be conducted by the DPWs or by maintenance personnel at corporate and commercial sites. In this respect, the HHPC should attempt to coordinate a more aggressive street sweeping program with the County. Although street sweeping in itself may not significantly reduce NPS loading (Schueler, 1988), it can be very beneficial when used in conjunction with delivery reduction techniques such as water quality inlets, infiltration basins and sand filters. In addition, the HHPC should work closely with County and local government to insure that all storm drains are being routinely monitored and cleaned out, as opposed to being, for the most part, cleaned out on an as need basis. This will help decrease the influx of not only sediments, but floatables and other debris that detract from the Harbor's aesthetic attributes.

- Oyster Bay, Glen Cove, Flower Hill, Roslyn Harbor and Sea Cliff all currently have pet waste ordinances. As discussed in Section 5, although problems may exist with the enforcement of these regulations, they are very useful in controlling bacteria loading. It is therefore prudent that the HHPC work toward the implementation of watershed wide uniform "pooper scooper" ordinance.

- A waterfowl feeding ordinance is recommended. Waterfowl impacts on water quality are well documented, especially in respect to the accelerated eutrophication of ponds and excessive bacterial loading that lead to beach closures. The section of the watershed that is most in need of a waterfowl feeding ordinance is the southern sector encompassing Roslyn East and Roslyn West (Sub-watersheds 11 and 12). The impacts of geese are most obvious throughout Roslyn Pond Park. Canada geese are particularly significant sources of both bacteria and nutrients. Four geese produce as much nutrients as one properly operating septic system (Uttormark, et al., 1974). Appendix J includes a reference to an ordinance prohibiting the feeding of waterfowl that could be adopted for use in the Hempstead Harbor watershed.

- The HHPC should intensify public education regarding the impacts of pet wastes and the feeding of waterfowl on the bacteria and nitrogen loading problems of the Harbor. Doing so will increase in the public's acceptance of regulations and their participation in voluntary initiatives. Both "pooper scooper" regulations and waterfowl feeding regulations require extensive public education if they are to be successful. The Town of Oyster Bay produced a video entitled "Don't Feed the Quackers Crackers or Bread" that promotes participation in anti-feeding efforts.

6.4.3 Delivery Control Reduction Best Management Practices

Delivery reduction BMPs have traditionally been used for flood control purposes to control storm water volume and attenuate discharge rates. Most are structural in design, such as detention basins, sand filters and water quality inlets. However, some, such as filter strips and shoreline aquascaping, can be considered non-structural, because of the greater dependence on vegetation to slow flows and remove pollutants. Delivery reduction BMPs may be designed during the site development process, or added at a later date, as a retrofit application. Obviously, more flexibility exists for the selection and implementation of delivery reduction BMPs during the site planning stage, than once development has taken place. New and innovative design features that efficiently improve water quality and remove pollutants continue to be developed. There are a wide variety of delivery reduction BMPs. Schematic representations of some of the more commonly used are provided in Figures 6-2 through 6-10, and discussed in detail in Appendix K. A more basic description and the typical pollutant removal efficiency of some of the more widely used delivery reduction BMPs, including those recommended for Hempstead Harbor, are presented in Table 6-3.

However, as discussed previously, pollutant load reduction capabilities alone do not dictate the applicability of a particular BMP. The utility of any of these delivery reduction BMPs for the management of NPS pollutant runoff from the Hempstead Harbor watershed, unlike the public education and source control practices, cannot be recommended on a global scale. Rather, they should be identified for implementation on a sub-watershed specific basis. Selection of a specific delivery control technique should be determined in part by the types and amount of pollutant loading, the prevailing site conditions, and commitment to long-term maintenance. Many of the BMPs that have been recommended for Hempstead Harbor are highly efficient in the removal of suspended sediments and associated heavy metals and petroleum hydrocarbons. Even the more simplistic BMPs have removal efficiencies in the range of 50% (Table 6-3). However, more sophisticated BMPs are required for elevated nutrient and heavy metal removal efficiencies. It is thus important to also establish early in the planning process, the water quality objectives that the BMPs being considered should achieve.

In order to achieve higher nutrient removal efficiencies, extended detention times that facilitate the bio-uptake or assimilation of dissolved nutrients are required. This is particulary true for nitrogen compounds (e.g. nitrate and ammonia) which do not tend to be adsorbed to sediment particles. The scientific literature does not contain extensive reports or confirmatory data concerning the bacteria removal efficiency of BMPs. The lack of definitive removal efficiency data is due to the fact that bacteria concentrations in storm water are greatly affected by site specific conditions. In general though, it is acknowledged that biological treatment systems (e.g. created wetlands, biofilters, wet ponds, as depicted in Figures 6-3,6-4, and 6-6), as well as BMPs that have high particulate removal efficiencies (e.g. sand filters) will have a very positive effect on reducing bacteria levels in storm water runoff (Schueler, 1987). In concert with these delivery reduction techniques,

Table 6-3
Common BMPs and Their Average Pollutant Removal Efficiencies*

BMP	Description of BMP	TSS	TP	TN	Heavy Metals (Pb)
Vegetated Filter Strips	Natural or created vegetated areas adjacent to waterways, ponds or wetlands, used to filter runoff; usually at least 15 feet wide;	65	40	40	65
Grassed Swale	Grassed channels that collect and convey runoff usually to a basin or another BMP	60	20	10	60
Water Quality Inlets	Catch basins equipped with an 18" to 24" deep sump designed to trap sediment and debris transported with runoff	30	10	10	30
Sand Filter	Underground chambers that use a sand media to filter and remove contaminants from stormwater runoff	80	50	35	65
Oil/Water Separator	Specially designed, baffled inlets, remove or segregate petroleum hydrocarbons and road grit from stormwater	15	5	5	5
Infiltration and Recharge Basins	Designed to collected runoff into the groundwater table, may be dry between storm events	90	60	50	65
Detention Basins and Extended Detention Basins	Dry, usually grassed basins that temporarily store and slowly release runoff through a designed outlet structure	50	20	15	50
Retention Basins and Wet Ponds	Wet ponds with a permanent pool, can be shallow and contain created wetlands	60	45	45	60
Created Wetland	Constructed wetlands that use biological processes to remove pollutants runoff	65	25	20	35

**NJDEP 1994, Best Management Practices Manual*

Table 6-4
A Synopsis of Delivery Control BMP Recommendations For The Hempstead Harbor Watershed

Sub-Watershed	Storm-water Quality Basins	Created Wetland	Sand Filter	Water Quality Inlet	Oil Water Separator	Sediment Chamber	Filter Strips/ Aqua-scaping
1 - Locust Valley	◆	◆		◆			◆
2 - Glen Cove No.				◆			
3 - Old Brookville	◆	◆		◆			◆
4 - Sands Point So.	◆	◆		◆			
5 - Sands Point No.	◆	◆		◆			
6 - Glen Cove So.	◆	◆	◆	◆	◆	◆	◆
7 - Motts Point	◆			◆			
8 - Sea Cliff	◆	◆		◆			
9 - Flower Hill	◆			◆			
10 - Port Washington	◆		◆	◆			
11- Roslyn East		◆		◆		◆	◆
12 - Roslyn West				◆		◆	◆
Cedar Swamp Creek				◆	◆		◆
Roadway Improvements			◆	◆	◆	◆	◆

source control and public education initiatives should also be implemented to further enhance bacteria removal.

Engineering analyses must be conducted prior to the implementation of any delivery reduction BMP. This is necessary to insure that the systems are properly sized, will not cause flooding problems, conform to design specifications developed by the State and County, and function in concert with the remainder of the storm water conveyance system. Typically this involves some form of hydraulic and/or hydrologic modeling (e.g. TR-55, BASINOPT, Rational Method, or possibly HECII). In addition, there may be the need to obtain environmental permits from NYSDEC and possible the ACOE and NYSDOS prior to the construction of of the majority of the structural BMPs.

6.4.3.1 Recommended Delivery Control BMPs and Upgrades

A combination of data and information were utilized in development of the recommend BMPs and storm system upgrades presented herein, with emphasis placed on the results of the modeling effort (Section 4). The recommended BMPs and upgrades are technically feasible, cost-efficient and consistent with the overall goals of the Hempstead Harbor Water Quality Improvement Plan: to decrease and provide for the long term management of NPS pollution to the Harbor.

In evaluating the appropriateness and application of delivery control strategies for the Harbor, it became readily apparent that no uniform detailed source of information existed pertaining to the stormwater collection system. This creates an engineering design problem, for although it is possible to identify the location of a storm water outfall, it is difficult to establish the contributing catchment area. It also makes it difficult to ascertain how best to prioritize and implement delivery control upgrades. It was concluded that it would be useful, from the perspective of planning, design and maintenance, that a detailed, accurate, and easily updated map of the watershed's catch basins, storm water inlets and storm water outfalls be developed. The County recently located and mapped the major outfalls that discharge to the Harbor (Map 2), but little is known of the associated collection network of catch basins and pipes. The County does have as-built drawings of all new roadway improvements on file. Although these maps identify drainage infrastructure, the information is on numerous individual engineering drawings which are difficult to deal with on a watershed scale. Detailed documentation of the storm water system, similar to what should be done for the balance of the watershed, does exist for Sub-watershed 8 (Sea Cliff) (Cashin Assoc., 1996). As such, it is highly recommended that an updated study and detailed mapping of the watershed's stormwater infrastructure system be conducted. Mapping should utilize GPS technology, and the findings of the study should be digitized and prepared in map form using GIS. A comprehensive watershed drainage mapping project could also involve videotaping the storm drain collection system in the more urbanized southern section of the watershed. Doing so could better establish the operational status and inter-connectivity of the storm drainage infrastructure, as well as help locate illegal sanitary connections or discharges.

Based on the data compiled in this report and the review of site specific conditions, the following delivery control BMPs and upgrades are recommended for the Hempstead Harbor watershed. Those watersheds most in need of storm water quality management (as determined by the NPS load ranking analysis) are Sub-watersheds 8 (Sea Cliff), 12 (Roslyn West), 6 (Glen Cove South), 11 (Roslyn East), 10 (Flower Hill), and 3 (Old Brookville). With the exception of Sub-watershed 3, the other five sub-watersheds listed above are extensively developed and are characterized by mixed residential/commercial land use. Table 6-4 provides a sub-watershed specific synopsis of the types of delivery control BMPs best suited for implementation.

- ***Sub-watersheds 1, 2, 4, and 5***

For Sub-watersheds 1 (Locust Valley), 2 (Glen Cove North), 4 (Sands Point), 5 (Sands Point South), and 7 (Mott Point), all of which are located at the north end of the watershed where development is light, there does not exist the need at this time to engage in any significant delivery control management upgrades or retrofits. Although storm water inlets were observed in these areas, most were serving relatively small drainage areas. In addition, many were infiltration structures that had no defined outfall, but rather recharged the water table. However, most of the observed inlets were in need of maintenance as evidenced by the accumulation of leaves and sediment. Based on the findings of this study, the NPS loads from these sub-watersheds are best managed through public education and source control strategies, as discussed above in Sections 6.3.1 and 6.3.2. However, as opportunities arise, for example as part of roadway repairs or re-pavement projects, the operational efficiency of catch basins should be evaluated, and upgrades to water quality basins conducted on an as need basis. In addition, a more concerted, definitively scheduled maintenance program should be in effect to insure that sediments, debris and other particulate pollutants are regularly removed and the basins remain in top operational condition.

As these areas also contain most of the watershed's remaining large tracts of open space, any new development that occurs in these sub-watersheds must be required to install stormwater basins that fully provide for the management and treatment of the one year, water quality storm event. Recharge basins, extended detention basins and created wetlands would all be appropriate BMP techniques, although selection or application of each BMP is dependent upon site conditions.

- ***Sub-watershed 7***

Similar to the conditions observed in the above sub-watersheds, land development for the most part is relatively light in Sub-watershed 7, Mott Point. Again, catch basins should be upgraded to water quality inlets on an as needed basis in association with roadway improvements. This is especially true for the steeply sloped sections of Beacon Hill Road that run close to the Harbor. Again, the existing NPS loads from these sub-watersheds are best managed through public education and source control strategies, as discussed above in Sections 6.3.1 and 6.3.2.

If new development does occur, water quality basins (recharge, extended detention or created wetlands) must be required. Emphasis must be placed on the ability of such basins to manage and treat the one year, water quality storm event.

- ***Sub-watersheds 3 and 6***

Sub-watersheds 3 (Old Brookville) and 6 (Glen Cove South) are part of the Glen Cove Creek drainage. These Sub-watersheds include Cedar Swamp Creek and Mill Pond. The City of Glen Cove has developed plans to conduct a total rehabilitation of most of the area encompassed by the boundaries of Sub-watershed 6, including the dredging of Glen Cove Creek and the clean up of a number of industrial and/or contaminated sites along the waterfront. The drainage infrastructure improvements needed for Sub-watershed 6 pertain largely to the removal of the existing storm water inlets, especially along Glen Cove Avenue, and their replacement with water quality inlets. The HHPC should work closely with the City of Glen Cove to identify opportunities to install sand filters in new or resurfaced parking areas, promote the creation of vegetated buffers along the shore line, create vegetated buffers along the banks of Glen Cove Creek, and construct recharge or created wetland basins during the revitalization of the waterfront areas.

Similarly, the City of Glen Cove is currently in the process of obtaining the necessary permits for the reconstruction of Mill Pond into an online wetland biofilter. Located in Glen Cove at the terminus of Cedar Creek, Mill Pond was at one time a highly functional on-line sedimentation/retention basin. Although originally constructed to provide energy for a mill, the pond over time functioned as a pollutant removal mechanism for drainage from the Cedar Swamp Creek watershed. Over 8,000 acres drain to this pond, much of it urbanized land. Enhancement, as proposed by Glen Cove, involves the dredging of the pond, the re-design of its outlet structure to facilitate storm water storage and retention, and the introduction of specific types of wetland plants thereby creating a storm water quality biofilter. The redesign of Mill Pond has the potential to greatly benefit not only the environmental quality of Hempstead Harbor, but also of Glen Cove Creek. As such, this project should be viewed as one of the priority projects for the watershed. Cost estimates for this project are being developed independently by the City of Glen Cove.

As previously detailed, there are well over 50 storm drains that discharge into this waterway. Runoff from portions of such heavily traveled roads as Northern Boulevard, Cedar Swamp Road (Route 107), and Glen Cove Road is discharged into Cedar Swamp Creek. The Mill Pond project is fully consistent with the long term management objectives of the HHPC. However, given the size of Mill Pond relative to the size of Sub-watershed 3 (Old Brookville), the pollutant removal efficiency of the proposed biofilter could be increased by retrofitting the drainage collection system along Cedar Swamp Creek.

It is thus recommended that upgrades to the Cedar Swamp drainage collection system be conducted in concert with the construction of the Mill Pond biofilter. Specifically, basin upgrades appear warranted along Route 107/Glen Cove Road, from the intersection of Cedar Swamp Road and Glen Cove Road, north to its termination at Glen Cove Avenue. Additional engineering design and analysis is required, but it appears that as many as 20-25 existing inlets could be replaced with water quality or sediment catch basins along this stretch of the road way. In contrast to the existing inlets, water quality and sediment basins are equipped with a sump or a baffle system that helps retain sediments and particulate pollutants. In developed areas, these basins provide a means of improving water quality without requiring the extensive reconstruction of the existing storm water collection system. Site inspections conducted during this study determined that many of the existing inlets were sediment filled or contained debris, leaf litter and evidence of petroleum hydrocarbons. However, the majority appeared to have little if any pollutant load management capabilities. Most of the inspected inlets were simple connection points along the pipe network or simply functioned as a means of capturing runoff and directing it with no detention into Cedar Swamp Creek.

Along with the replacement of the catch basins, work should be done to restore badly eroded sections of the stream. Cut banks, sediment deltas, and evidence of scouring were observed along many sections of the stream, especially those immediately adjacent to Route 107. On an as need basis these sections of stream corridor should be restored. This will involve the use of bioengineering techniques (combined use of vegetation, synthetic geo-textile fabrics, and coconut fiber materials) along with rip-rap to correct erosion problems and restore habitat. Typically, the cost to conduct stream channel repairs using these techniques is in the vicinity of $1,000/ linear foot, excluding any dredging costs.

- ***Sub-watershed 8***

The top priority Sub-watershed 8, Sea Cliff, could greatly benefit from drainage improvements to the storm water collection system that conveys drainage to Motts Cove and Scudders Pond. The Nassau County outfall database identified at least six major storm discharges to Motts Cove. In addition, both the Nassau County data and data presented in a recently published shoreline study of Sea Cliff (Cashin Associates, 1996), identify that storm water drainage problems of significant magnitude are impacting Scudders Pond.

As part of the recently completed shoreline study, Cashin Associates (1996) identified the need to restore Scudder's Pond. The plan essentially calls for the dredging of the pond and an upstream ancillary retention basin, and the installation of a sediment trap at the point where storm water from Littleworth Lane is directed into the pond. Following inspection of this site by Coastal personnel, it was determined that the proposed project should be one of the HHPC's priority activities. The proposed plan appears to be technically sound, and an EPF grant application was recently submitted by the Village of Sea Cliff for $222,000 for the restoration of Scudder's Pond.

As mentioned there is also the need to upgrade the collection system to Motts Cove. A series of pipes, including a 60" outfall, discharges into this embayment. A long standing problem site for elevated bacteria, turbid conditions and floatables, the cove is further impacted by the fact that it is located south of Bar Beach in the more flow restricted section of the Harbor. Its ability to self-flush during tidal events is thus somewhat impeded by the sloughing of water within the lower harbor. Based on a site inspection of this site, the hydrology of the contributing watershed and the inter-connectivity of the existing storm water collection system must be more intensively investigated before delivery reduction recommendations can be made. Intuitively, it would appear that focus needs to be placed on the large storm water outfall. Given the size of this pipe, it must service a relatively large section of Sub-watershed 8. A hydrologic analysis is recommended as part of any attempt to size a BMP for this cove. Although a sand filter, sedimentation chamber or perhaps even a small created wetland are potentially feasible options for this site, it is not clear if there is either adequate room for their construction or if they could be sized to properly manage the hydrologic load.

- ***Sub-watershed 9***

A sandfilter, designed in accordance with the specifications of the State of Delaware (Shaver, 1993), is recommended for the Bar Beach Parking Lot (Sub-watershed 9, Port Washington). Although draining only a limited area (approximately 20 acres), runoff, which contains feces from shorebirds, is currently allowed to flow directly into the Harbor. Sediments, heavy metals and petroleum hydrocarbons are also transported with this runoff. A dual-chambered type of sub-grade device, sand filters have been shown to work extremely effectively in urban areas and small catchment drainage basins (such as parking lots associated with fast food restaurants, gas stations, and strip malls). As such, this methodology has high potential for use in other sections of the entire Hempstead Harbor watershed. It could be implemented to improve existing infrastructure, or used to treat runoff from commercial in-fill type development. The basin itself, due to its non-intensive use of land is relatively inexpensive when compared to the cost of a conventional detention basin, created wetland basins and wet ponds (Shaver, 1993).

For the Bar Beach installation, some additional site topographic and sub-surface survey work should be conducted prior to construction. The data generated from these studies would better define how to site the sandfilter to avoid problems caused by tidal flooding or a periodically elevated groundwater table. It is estimated that the design and construction costs for the Bar Beach sandfilter should be in the $80,000 range.

There are other potential sites throughout the watershed where sand filter technology could be used. These would include, but not be limited to the parking areas of some of the marinas, Hempstead Harbor Beach Park, and the Village of Roslyn's library parking lot. The Bar Beach installation should be used as a model for other potential sand filter installations.

- ***Sub-watersheds 11 and 12***

Located in the southern end of the watershed, Roslyn Pond and Silver Pond are two inter-connected waterbodies that serve both a storm water management and aesthetic role. They receive the combined drainage from sections of priority Sub-watersheds 11 (Roslyn East) and 12 (Roslyn West). Both ponds are part of North Hempstead's park system. Silver Pond is located hydraulically down gradient of Roslyn Pond and is surrounded by private homes and businesses. Both have been impacted by sediment infilling and both display conditions associated with eutrophication and degraded water quality. The County recently performed some restoration dredging of Roslyn Pond that involved the removal of accumulated sediment.

In general, the ponds are in need of dredging, the shorelines require bank stabilization and they would benefit from in-lake management measures such as aeration and aquascaping to improve their water quality and enhance their aesthetics. Overall, the cost of their combined restoration is estimated to be in the range of $1,000,000, with the majority of this associated with dredging ($25-$35/cu. yd.). It would be possible to conduct this project in phases (for instance restore Roslyn Pond and then restore Silver Pond) as a means of deferring some of project costs over time. This could help decrease the cost outlay for a given year or provide a longer time-frame over which to amass in-kind match for State/Federal funding. If such an approach was taken, it is not advisable to conduct the aquascaping or shoreline stabilization until all the earth moving and site disturbance associated with pond dredging was completed.

In addition, although the analysis of the Harbor watershed's drainage pathway indicates much of the potential runoff to Roslyn Pond from Sub-watersheds 11 (Roslyn East) and 12 (Roslyn West) is diverted to recharge basins, a fair amount of sediment and road runoff does in fact get directed to the pond. To mitigate this, it is recommended that the existing basin located up-gradient of Roslyn Pond be removed and replaced with a multi-chambered sedimentation chamber. The new chamber would be installed on-line just at the point where storm water is discharged from the storm water collection system into the pond. The multi-chambered, multi-baffled collection basin would facilitate the effective removal of road grit, floatables, petroleum hydrocarbons, heavy metals, bacteria and even to some extent, nutrients. A sediment chamber of this nature would cost in the vicinity of $125,000 to install.

The aforementioned aquascaping along the shoreline of Roslyn Pond, if properly designed and implemented, could actually reduce the use of the pond by geese. Essentially, by creating a "natural" fence using a combination of emergent aquatic vegetation and upland/semi-aquatic plants, restricted access to the pond can be achieved. The aquascape would be functional (goose control and bank stabilization) and would enhance the pond's aesthetics. Aquascaping the pond would cost between $50,000 and $80,000. As mentioned above, aquascaping of either Silver Pond or Roslyn Pond should not be conducted until the dredging of the respective ponds is completed.

Construction of larger sediment chambers (similar to that recommended as part of the Roslyn Park Pond project) on two storm water outfalls that discharge directly to Hempstead Harbor is also recommended. The sediment chambers would be constructed upland of the storm outfalls located near the base of both Skillman Street and Lumber Road in Roslyn (Sub-watershed 12). As previously discussed, sediment chambers are large multi-baffled sub-grade basins that dampen storm surges and promote the settling and trapping of sediments, litter, and particulate pollutants. These structures would greatly aid in the removal of sediments and particulate pollutants that are washed down from the roads and parking lots of these two highly developed sub-watersheds. The chambers should cost in the range of $30,000 each, including installation.

- ***Roadway related improvements***

There are a number of roadway improvement projects proposed throughout the watershed (Section 5.4.3.1). These include:

- New York State DOT's reconstruction or replacement of the 2,100-foot Roslyn Viaduct. There is an opportunity to combine drainage improvements into the construction contract, and possibly to obtain state funding for some improvements.

- New York State DOT is planning the reconstruction of Route 107. The Superintendent of Public Works in Roslyn Harbor has expressed concerns regarding drainage overflows from Route 107 and Glen Cove Avenue in the vicinity of Back Road in Roslyn Harbor.

- The Glen Cove master plan includes construction of a new Pratt Boulevard Connector roadway and reconfiguration of several roadways in the Glen Cove Creek area. Reconstruction should be coordinated with drainage improvements to the street system. The Pratt Boulevard Connector should include new catch basins with sediment traps. The reconfiguration of waterfront roadways should include, if possible, buffer vegetation between the roadway and the waterfront, and a design which minimizes the amount of impermeable surfaces by reducing roadway and parking lot widths and maximizing use of gravel or crushed stone.

- Glen Cove is planning to repave and resurface three roads within the watershed: Elm Avenue, area from Cedar Swamp Road to the vicinity of Johnell Place; Knott Drive, from Valentine Avenue to dead end; and Elliot Place, from Dosoris Way to Forest Avenue. As discussed above, water quality or sediment catch basins should be installed as part of any improvements to Cedar Swamp Road.

For the above projects, a preliminary evaluation of conditions suggests basin retrofits, essentially involving the removal of the existing catch basins and their replacement with either water quality inlets or sediment catch basins would be desirable. Such a modification is consistent with the drainage modifications routinely performed by the County as part of roadway upgrades or construction. The water quality inlets and sediment catch basins are somewhat larger than standard drop inlets and, more importantly, are equipped with a sediment sump to enhance the trapping and retention of sediments, road grit, floatables and other particulate pollutants. The cost per inlet for such upgrades is $2,000 to $3,500 depending on the volume of the inlet, the size of the drainage area, extent of excavation, the need for special grating. Upgrades to inlets along Beacon Hill Road, West Shore Drive, Main Street (Roslyn), East Broadway, Bryant Avenue, and Glenwood Road all appear warranted. The majority of the existing inlets observed along these roadways were undersized and lacked sediment sumps. In addition, the majority contained a substantial amount of accumulated road grit, leaves and litter, and did not appear to have been recently maintained.

In addition, as part of any planned upgrades to the Roslyn Viaduct, consideration should be given to the installation of curb side scuppers similar to those utilized as part of certain bridge designs in the Chesapeake Bay watershed. On most elevated roadways, collected runoff is allowed to free flow into the receiving waterbody. This is done for design convenience and to inhibit roadway flooding. Basically these structures are similar to the water quality inlets, having a small sediment trap in which debris can collect. The negative attribute of these structures is that they do require frequent cleanout in order to prevent them from surcharging and causing flooding problems.

Unit pricing information and estimated project costs for the above delivery reduction BMPs are provided in Tables 6-5 and 6-6, respectively. This information is provided for guidance only, but does reflect a very reasonable estimate of the projected costs as based on literature values.

Table 6-5
Typical Unit Prices for Storm Water and Watershed Restoration Activities

Item	Units	Cost
Dredging [1]	Per Cubic Yard	$25.00 to $70.00
Storm Sewer Videotaping/ Cleaning [2]	Per Day	$2,500.00
Catch Basin/ Inlet Cleaning [3]	Each	$250.00
Sediment traps [4]	Each	$25,000.00
Catch Basins (Type C WQ Inlets)	Each	$2,000 to $3,500.00
Bulkhead	Square Foot	$20.00
Rip - Rap	Cubic Yard	$2.00
Excavation	Cubic Yard	$10.00
Slope Stabilization (Fabric/ Geo-grid)	Square Foot	$1.25
Planting Material	Square Foot	$3.50
Bulkhead Removal	Square Foot	$10.00
Temporary Sheeting	Square Foot	$10.00

Notes:

(1) The unit price for dredging assumes that this operation would be performed from land. Costs include excavation, temporary stock piling of the material at a nearby site, reloading the material into trucks and disposing of the material at a sanitary landfill.

(2) The unit price for sewer cleaning assumes a two-man crew, a closed circuit television van and jet cleaner for sewer videotaping. If cleaning of the sewer is required, the cost per day could be increased by $1,500 plus the cost of material disposal.

(3) The unit price for catch basin and inlet cleaning assumes a two-man crew, VacAll equipment and material disposal at a nearby sanitary landfill. A total of ten catch basins could be cleaned per day.

(4) The unit price for water quality inlets includes installation of an inlet structure (approximately 8 feet wide by 20 feet long) as discussed for the Skillman Street and Lumber Road storm water outfalls to Hempstead Harbor.

Table 6-6
Estimated Project Cost (1997 Dollars)

Project	Construction Costs[1]
Installation of Sand Filter / Sedimentation Basin in Bar Beach Parking Lot	$80,000
Restoration of Roslyn Park Pond/Silver Pond	$1,000,000
Restoration of Roslyn Park Stream Channel, Including Aquascaping of Stream Channel	$100,000
Inlet retrofits along Cedar Swamp Creek, Restoration of Stream Channel	$2,000 to $3,500/each inlet plus $1,000/linear foot for stream channel restoration
Inlet retrofits, esp. in Glen Cove /North Hempstead and Sea Cliff areas	$2,000 to $3,500/each inlet
Restoration of Scudder's Pond	$425,000 to $500,000
Construction of Skillman Street and Lumber Road water quality inlets	$30,000/ each sedimentation chamber
Storm Sewer Condition Survey, involves GPS mapping and videotaping of select sections	$2,500/day

(1) Exclusive of soft costs such as permitting, conceptual designs, EIS preparation, etc.

Some of the delivery reduction type projects listed above are currently being pursued by the individual municipalities. The most notable are Mill Pond and Scudders Pond. Both of these projects can be considered priority projects, for which funding is being sought by Glen Cove and Sea Cliff respectively.

Based on need (as determined by the pollutant loading analysis), feasibility of implementation, and potential use at other sites in the watershed, the projects listed in Table 6-6 are considered to be the priority capital improvement projects for the Hempstead Harbor watershed. The HHPC should prepare State Environmental Bond Act grant applications or pursue funding through other sources for each of these projects.

Table 6-6
Recommended Capital Improvement Projects

Location	Proposed Activity	Cost	Priority
Roslyn Pond/Silver Pond Improvements	Installation of sedimentation chamber, dredging, and aquascaping ponds and their connecting waterway	**$1,600,000**	1
Bar Beach	Installation of Sand Filter	**$80,000**	2
Cedar Swamp Creek	Retrofit of storm drains, replace existing with water quality inlets or sedimentation basins. Restore as needed degraded sections of stream channel	$2,000-$3,000/inlet, (**$150,000 for water quality inlet upgrades**) Estimate **$80,000 for restoration of severely degraded sections of stream channel** using bioengineering techniques	3
Skillman St and Lumber Road	Sedimentation basins	**$60,000**	4

6.5 Restoration of Currently Impacted Environments and Resources

The projects and programs discussed in Section 6.2 are intended to decrease the NPS pollutant influx to Hempstead Harbor through a combination of public education, source control and delivery reduction/control techniques. When implemented in their totality, the recommended projects will provide for both the short term and long term management and reduction of the Harbor's NPS pollutant load. There are however, additional projects that could be conducted. The objective of these projects would be the **restoration** of the Harbor's natural resources that have been significantly degraded over the past as a result of the discharge of point and non-point source pollutants.

6.5.1 Restoration of Roslyn Creek

Either in combination or ancillary to the above discussed restoration of Silver Lake and Roslyn Pond, it would be advisable to restore and enhance the condition of the stream channel which connects these two waterbodies. This stream channel is located within the boundaries of Roslyn Park. As are the ponds, the stream is a passive recreational aesthetic amenity to the park. Park users can be found walking along the banks of the stream. The stream's biggest problems are bank erosion that appears to have resulted from the de-vegetation of the shoreline. Correcting this problem will primarily involve stabilization of erosion problems and the re-establishment of bank vegetation. It is recommended that both to maintain restoration costs at a reasonable level, and provide for a more aesthetically pleasing end product, that this project be conducted without the use of sheet piling, gabions, bulkheading, or other hard edge restoration techniques. Rather, it is proposed that bioengineering techniques be employed to correct the erosion and instability problems. Specifically, this will involve the use of coconut fiber logs, perhaps supplemented in some sections with geotech fabric and rip-rap. To accomplish this, it may be necessary to re-grade, to some extent, the top of the stream bank, particularly along more highly eroded sections. The entire stream corridor, once stabilized, would then be replanted using a combination of attractive, but functional wetland plants (e.g. sedges and bulrush) and low growing shrubby plantings (e.g. red osier dogwood and perhaps even select types of Hosta). The combination of the bioengineering measures and the plantings would result in the stabilization and beautification of the stream's banks. Plant selection could also be tailored to minimize mowing and maintenance needs along the stream corridor. The use of bioengineering techniques should result in restoration costs in the vicinity of $100,000 (including labor), far less than if bulkheading or some other type of hard edge technique was conducted (Tables 6-5 and 6-6).

6.5.2 Restoration Dredging of the Lower Harbor

The inspection of aerial photos clearly reveals the existence of significantly sized sand bars and sediment deltas in the lower section of Hempstead Harbor (south of Bar Beach). These accumulations of sediment impede navigation and negatively affect the flushing dynamics of the lower Harbor. Although a project of significant magnitude, it is recommended that this area be dredged and deepened so as to restore its navigational, recreational and natural resource attributes.

This section of the Harbor, from Bar Beach south to the Roslyn viaduct, is identified by the ACOE as a navigation channel. In its present state, it does not satisfy potential navigation needs, and therefore should be considered for dredging. However, this project will be very expensive. The volume of dredge spoil, the fact that the sediments could be contaminated, and the need to locate a suitable disposal site all complicate this project and make it impossible without further study to establish project costs. There will be the need to obtain a wide array of environmental permits and conduct in depth environmental studies prior to the implementation of this dredging project. Thus, it should be viewed as a long-term restoration project.

6.3.3 Tappen Beach Restoration

The Town of Oyster Bay, with funding obtained through the Environmental Bond Act plans to conduct a restoration project in the Tappen Beach section of Hempstead Harbor. The project entails the creation of dunes, the restoration of tidal marshes and the construction storm water filter strips. In concert, the planned restoration elements will serve to not only upgrade and enhance near shore, coastal habitat, but will also aid in the long-term reduction of the NPS load contributed to the Harbor from priority Sub-watershed 8.

6.5.4 Glenwood Road Shoreline Restoration

The Town of Oyster Bay, also with funding obtained through the Environmental Bond Act, will conduct shoreline restoration work along and near the base of Glenwood Road in Sub-watershed 8. The project actually involves an extensive amount of storm water management as it includes the construction of retention ponds, recharge basins and the introduction of plantings, all of which are intended to filter storm water runoff.

6.6 Recommended Monitoring Program

In order to provide an objective means of evaluating the environmental status of Harbor water quality, it will be necessary to continue a water quality monitoring program. Currently, data are collected by the ISC, Nassau County Health Department, and the Coalition to Save Hempstead Harbor. Each collect data for various reasons. The monitoring conducted by all three of these entities has been impaired by budgetary limitations. In general, this has affected the frequency of sampling, and has limited the water quality parameters that are tested.

Obviously, cost plays a big role in defining a monitoring program. The following recommended monitoring program does not reflect any such funding limitations.

At least three monitoring stations should be established: upper, central, and lower Harbor. Each of these stations should be monitored monthly from April through October, the period within which water quality impairment tends to have the greatest impact to recreational use and biological utilization of the Harbor.

Each station should be monitored *in-situ* (using a meter)for dissolved oxygen, temperature, pH, and salinity. Data should be collected in profile, at 1-foot increments from the surface to the bottom. Water column transparency should be measured, using a secchi disc, at each of the three stations. Discrete water samples should be collected at each station at the surface, at mid-depth and at a depth of 2 feet above the bottom (to avoid inaccuracies caused by the resuspension of bottom sediments). These samples should be analyzed for Total Suspended Solids, Ammonia-Nitrogen, Nitrate-Nitrogen, Total Kjeldahl Nitrogen, and Total Phosphorus. Additional samples should be collected at the surface and analyzed for Total Coliform Bacteria, Fecal Coliform Bacteria, and Chlorophyll.

Along with the above physical, water chemistry and bacteriological tests, samples should also be collected to assess the zooplankton and phytoplankton community composition. Both could be sampled either by towing plankton nets (63*u* for phytoplankton, 163*u* for zooplankton) or by collecting discrete water samples using a Van Dorn Bottle or Schindler Sampler.

Once in the spring and once in the summer, at each of the three stations, at surface, mid and bottom depths, samples should also be collected and analyzed for Lead, Copper, Zinc, and Petroleum Hydrocarbons.

The above monitoring program would provide a database suitable for tracking the overall condition of Hempstead Harbor. In general, it is similar to the monitoring program that was conducted in the late 1970's by the ISC in respect to sampling frequency. It is similar to the current sampling activities of the ISC and Coalition to Save Hempstead Harbor (CSHH), in respect to sampling station locations. However, it defers radically from existing monitoring efforts in respect to the frequency of sampling, and the multiple-depth nature of the sample collection.

Data collected through such a monitoring effort would enable the HHPC to evaluate short and long-term water quality trends, examine the spatial water quality relationships of the Harbor, and analyze chemical/biological interactions. It would not, however, be capable of examining definitively the impacts of individual storm events or providing the data needed to identify contravention of State contact recreation bacteria standards. Even so, the resulting database would be adequately detailed to satisfy the HHPC's needs. It would also be sufficiently robust to allow for its statistical analysis.

It is estimated that a monitoring program of this intensity (3 stations, 7 sampling dates, and the combination of physical, chemical and biological data involving *in-situ* and discrete sampling) would be in the vicinity of $25,000 to $30,000/year in field labor and laboratory costs. Data analysis and preparation of an annual detailed report would add approximately $4000 to $6000 to the total cost.

6.7 Available Project Funding and Technical Expertise

The main sources of funding for the projects considered in this Plan are grant programs, loan programs and demonstration projects. Existing programs are described below. With the exception of the Roslyn Viaduct Project, it does not appear that any of the projects described above are eligible for inclusion in State Highway projects.

A number of grant programs exist for non-point source pollution reduction projects. The most recent source of grants is the Clean Air/Clean Water Bond Act which was approved by public referendum in November 1996. However, the federal government is in the process of reshaping many of its grant programs. According to grant administrators at the Department of Environmental Conservation, Section 319 grants may not exist in the future; instead, all the money that comes to the Department of Environmental Conservation may be lumped together, and therefore money previously earmarked for non-point source programs may end up being reduced. A description of existing grant programs follows:

- The Clean Air/Clean Water Bond Act was created as a supplement to the existing state Environmental Protection Fund. Of the Bond Act proceeds applicable to the Hempstead Harbor projects, $200 million is available for water quality projects on Long Island Sound. An additional $50 million is available for municipal park or open space programs, but is not at this time allocated by region. The Department of State, Department of Environmental Conservation, and Environmental Facilities Corporation are the principal agencies involved in selecting grant criteria and administering the program.

  Funding applications have already been submitted for different projects within the Hempstead Harbor watershed under the Clean Air/Clean Water Bond Act. These include Restoration of Scudder's Pond, Retrofit of the North Hempstead Transfer Station Retention Pond, and Construction of the Shoreline Trail. In some cases, the scope of these projects may change, based on the results of the Hempstead Harbor Water Quality Improvement Plan.

- The Department of State administers Environmental Protection Fund monies for various programs within the coastal zone. Selection criteria which best correspond to the goals of the Committee are: restoring water quality, improving natural areas and scenic resources, and increasing public participation and enjoyment of a coastal resource. A 50% match is required from the applicant municipalities. To date the HHPC has received a $50,000 grant, which was locally matched with $50,000. These funds are slated for use for the implementation of the recommendations set forth in this Plan, and for completion of a *Spartina alterniflora* tidal marsh restoration project.

- The Department of Environmental Conservation administers a Non-point Source Implementation Grants Program with funds provided by Section 319 of the federal Clean Water Act (CWA) and the State Environmental Protection Fund (EPF). A 50% match from the applicant municipalities is required in the form of direct funding or in-kind services. The most recent deadline for this program was January 1997. It is unclear whether this program will be renewed or replaced by block grants. However, if it is renewed, the next request for proposals will not be issued for a minimum of two years.

- The Environmental Protection Agency also provides a number of small grants for education related projects. These include the Long Island Sound small grants program administered by Sea Grant, as well as the Environmental Education, Environmental Justice, and EPA/NASA Joint Project on Ecosystem Rehabilitation. The Committee applied for and obtained a grant of $4,000 from LISS and the New York branch of Sea Grant. The grant has thus far funded a project that involved the use of volunteer groups around the watershed to collect information on the condition of catch basins leading to the Harbor. Completed in September of 1997, the project also was designed to heighten public awareness of watershed-water quality linkages, as the volunteers stenciled the message “The Harbor Starts Here” as part of the catch basin inspection process.

- Additional funds may be available from Section 604B of Title 6 of the Clean Water Act. There is no formal application process or criteria. Application letters can be sent directly to Mr. Phillip DeGaetano, the Director of the Bureau of Watershed Management at the Department of Environmental Conservation.

- The Environmental Facilities Corporation administers the State Revolving Fund (SRF), which provides low interest loans for water pollution control projects. Projects are eligible to receive an SRF loan once they are listed on the SRF Intended Use Plan, which is a prioritized list of projects from communities expected to apply for a loan in the next year.

A number of public and non profit agencies, as well as private organizations, can be consulted for technical assistance in non-point source pollution reduction. The following is a list of sources.

American Society of Civil Engineers
Federal Emergency Management Agency
Long Island Regional Planning Board
Metropolitan Washington Council of Governments
Nassau County Soil and Water Conservation District
New York State Department of Environmental Conservation
New York State Department of State

Storm water equipment manufacturers
USDA Soil Conservation Service
USEPA, Office of Water, Non-point Source Branch, Washington D.C.

The HHPC should try to develop innovative means of obtaining funding from private sources. The following sources are suggested:

- Manufacturers of environmental products may be interested in using HHPC projects to test new products or for high visibility advertising. Recently, the Nassau County Soil and Water Conservation District was able to obtain donated silt fence from the BioFence company, which was then used at a local construction site. The Nassau County Soil and Water Conservation District has also been involved with the replanting of the Sea Cliff bluffs.

- Private donations or trusts may be established for popular and highly visible parks or habitat restoration projects.

- Glen Cove has identified the need to develop incentives for private land owners to make improvements on their waterfront property. The possibility of low cost state loans for private infrastructure improvements should be discussed with appropriate state representatives. Additionally, incentives could be provided by the local municipality in the form of tax relief to homeowners associations and to individual property owners.

- Municipalities may consider the creation of special tax districts to obtain revenues for maintenance of storm water facilities.

6.8 The Future Role of the Hempstead Harbor Protection Committee

Central to the success of any NPS control and watershed management effort is the coordination of all project efforts through one, easily identified group, recognized as the authority on the Harbor and its watershed. It is thus highly recommended that the HHPC's role in the management of the Harbor and its watershed be elevated over time. That is, the HHPC should become the key entity recognized as responsible for the Harbor's restoration. Initially, it should continue to function in an advisory capacity, so as not to further complicate existing local government control. However, even in this capacity it should become recognized as the source for information and guidance, and the local authority on the management of the Harbor and its watershed. Over time, if the HHPC is to be truly successful, it will be necessary to increase its linkage to and involvement in planning and development issues. Initially, this should involve getting all the municipalities in the watershed, not just those in the Coastal Zone, to become members of the HHPC. The HHPC should continue to become increasingly technically involved with the Nassau County Planning Department, NYSDEC, NYSDOS, Long Island Sound Study, and other similar agencies or initiatives, to insure that issues specific to the management of Hempstead Harbor are identified and properly addressed. Establishing the HHPC as the coordinating organization may also aid in the acquisition of funding by confirming the existence of strong watershed partnerships and a long-term commitment to the management, restoration and protection of Hempstead Harbor.

As documented throughout this report, the challenges involved with managing a watershed and controlling NPS pollution are complicated and difficult. Above all else, a point organization is required to direct and implement the Water Quality Improvement Plan. It is important, given the inter-municipal issues that will arise in attempting to manage Hempstead Harbor, that this point organization be empowered to represent each municipality within the watershed. The HHPC fills this role. However to be successful over the long term, it will be necessary for the HHPC to become recognized as the primary authority on issues pertaining to the management and restoration of Hempstead Harbor and its watershed. As it includes representatives from the State, County and each of the major municipalities that would be affected by the implementation of the Water Quality Improvement Plan, the HHPC already is a partnership of the stakeholders interested in the long-term management of Hempstead Harbor. Thus, it should continue to function as the lead organization in the restoration of Hempstead Harbor and the management of its watershed.

The first step that should be taken in order to develop a strong leadership for the restoration of the Harbor is to have the Hempstead Harbor watershed designated a special **watershed management district.** New York State has enabling legislation in place that facilitates the development of special management districts. This has been used by numerous communities to create park districts (Carmel, NY), septic management districts (Cazenovia, NY) and watershed management districts (Warwick, NY, Lake George, NY). Doing so is beneficial for a number of reasons. It increases the recognition of the Hempstead Harbor watershed as a special management area that, although overlapping a number of municipal boundaries, should be treated as a unit. To some extent, creating a watershed management district will help reduce jurisdictional issues. By enabling the HHPC, as the recognized steward of the Harbor and its watershed, to shape and oversee policies that affect NPS loading to the Harbor, a more uniform and watershed cognizant policy environment could be developed. This could help reduce some of the existing inconsistencies in the regulations and ordinances that currently affect watershed based planning. A management district designation would also increase the success of the HHPC in the future in the acquisition of State and Federal funds as it would establish a recognized partnership among the stakeholder communities. Doing so is viewed as a critically important step by the USEPA, and increases the opportunity of obtaining funding.

For now, the HHPC should continue to function in an advisory role, coordinating the efforts of the member municipalities. In general, this should not require any special staffing needs. Over time, the HHPC's role should be expanded so that it can function within an expert capacity as the recognized watershed advisory. In this capacity, its role would be more pro-active and include such responsibilities of administrating large grants, overseeing the construction or implementation of structural, delivery control BMPs, and actively participating in the review of new development. The HHPC could also aid the member municipalities in the preparation of model ordinances pertaining to NPS pollution management. In this capacity, the HHPC would need to have permanent dedicated staff members. This is equally true as the HHPC role expands in respect to fiscal management. As it becomes the lead organization for the preparation of grant applications, and the management of grant funds the daily job load will probably be beyond that can be supplied on an in-kind basis by the member municipalities. Eventually, as the HHPC gains more experience in the management of capital improvement projects, it should also coordinate all aspects associated with the implementation of restoration and management projects. None of the above need usurp ultimate control of planning or the jurisdictional powers from the affected local governments. Rather, it should help strengthen and unify the community by maintaining a focus on the need for watershed management.

Figure 6-1. Examples of Pumpout Devices

Figure 6-2. Wet Pond Schematic

Figure 6-3. Enhanced Wet Pond System

Figure 6-4. Extended Detention Pond Design Features

Figure 6-5. Dry Extended Detention Pond Schematic

Figure 6-6. Filter Strip Schematic

Figure 6-7. Off-Line Infiltration Basin Schematic

Figure 6-8. Alternative Inlet Design (MD)

Figure 6-9. Underground Sand Filter

Figure 6-10. Underground Sand Filter