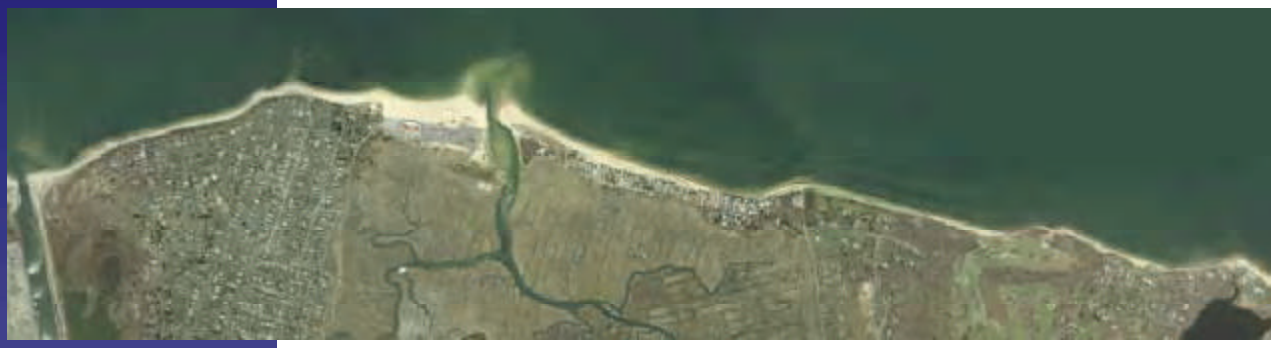
TOWN OF HUNTINGTON
LONG ISLAND, NEW YORK
BEACH EROSION STUDY REPORT

AUGUST 30, 2006
OCC PROJECT # 205073



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EXECUTIVE SUMMARY

The Town of Huntington contracted with Ocean and Coastal Consultants Engineering, P.C. (OCC) and EEA, Inc. (EEA) to complete an erosion control study for a portion of the Town's Long Island Sound shoreline. The location of the study area spans from the Northport Key Span Power Station to the Smithtown – Huntington town line, a distance of approximately 2.75 miles.

In order to complete the erosion control study, OCC with the assistance of EEA, developed a scope of work that included: Historic Data Research (to identify available information to assist in determining historic erosion rates and the impact of erosion control efforts on the erosion rate); Site Investigation (to document existing site conditions); GIS Development and Analysis (to analyze the historic erosion / accretion rates and project future trends); Development of Best Erosion Control Strategies and Summary Report; and, Presentation of Findings to the Town.

Historic Data Research

The North Shore of Long Island has historically had significant coastal erosion related issues, partially as a result of a high population density, intensive use of the coastline and the complex coastal environment. In addition, residential and commercial development, public access, recreation, storm protection and natural resources all compete for use of the limited shorefront.

Huntington's shoreline is dominated by bluffs and features created from sediments supplied by bluff erosion such as barrier beaches and spits. Historically, eroding bluffs have provided a substantial volume of sediment to help maintain the beaches and the other sedimentary features. In this type of setting, reducing erosion at one location is often accompanied by increased or continued erosion at the other. Preservation of the overall character of the North Shore coastline is a delicate balance between maintaining sediment supply and mitigating erosion damage.

Site Investigation

On July 22 and August 23, 24 and 25, 2005, OCC and EEA conducted a site investigation of the Town of Huntington beaches within the study area. Work included documenting the condition of the beach area using a GPS survey to identify existing shoreline features and shoreline protection structures. In addition to documenting the existing site conditions, the field personnel evaluated existing land use patterns and potential concerns for developing an erosion control strategy.

The study area contains both eroding bluffs and barrier beaches (spits). High bluffs are most common on the western portion of the study area and are mainly protected by erosion control structures. Moderate sized bluffs on the central-eastern portion of the study are largely unprotected. In the central portion of the study area, adjacent to Crab Meadow Marsh, there are no bluffs. Beaches, especially in the eastern half of the study area are narrow, providing limited storm protection and public access. Public access to and use of the shoreline is concentrated at Crab Meadow Beach.

There are multiple forms of shoreline and bluff protection present in the study area. The most common are timber bulkheads and/or riprap revetments. Groins are also prevalent in the western and eastern portions of the study area, and many of the groins have been in place since the 1940s. A substantial portion in the middle of the study area (from Crab Meadow Beach to the west end of Makamah Beach) has no shoreline or bluff protection structures.

A well developed maritime dune, maritime shrub and early developing maritime woodlands occupy the upland areas behind the western end of Makamah Beach. Relatively narrow maritime dunes are found along the remainder of the project area, particularly along Soundview Terrace (Waterview East) and east of the Makamah Road (Geissler's Beach).

The area historically known as Broken Ground, which is currently occupied by the Indian Hills Golf Course, has a history of substantial slope failures most likely related to a saturated and weak underlying clay layer. The visible evidence of a deep seated failure plane is a scarp about 2000 feet long that extends inland about 500 feet at its maximum. There is on-going differential soil movement along the scarp, with up to 4 feet of vertical displacement since 2002.

GIS Development and Analysis

An historic analysis of shoreline and bluff change was undertaken to define long and short-term trends using the data collected in the field and historic data.

With regard to beach erosion, the areas of concern are Makamah Beach and the eastern portion of the study area. Comparison of two 30+ year data sets (long-term and recent) clearly shows that the middle of the study area has a consistent erosional signature. Bluff stabilization on the eastern end of the study area, near the Smithtown line, has resulted in a change from erosion rates more than 1 foot per year to less than 1 foot per year. However the beach width in this area has become narrower. Adequate beach width is important for protection of residences, bluffs, dunes, and shore protection structures such as bulkheads and is also critical for public beach access. Across the study area, a comparison of beach widths between 1947 and 2004 shows a dramatic trend of decreasing beach width, from an average of 130 feet (not including Crab Meadow Beach) in 1947 to 55 feet at present.

Over the long-term, the highest bluff erosion rates are concentrated in the eastern portion of the study area including the bluffs at Broken Ground (Indian Hills) and the west end of Geissler's Beach.

A comparison of the historic erosion trends and the present situation was extrapolated out 25 years to help differentiate where the system would be naturally and where it is currently restrained. As expected, Makamah Beach, the bluffs at Broken Ground and along Fresh Pond Beach are highly susceptible to damage based on the historic erosion patterns. Also, based on this scenario, about 30 percent of the study area will have no remaining beach fronting shoreline protection structures by 2030.

The trends of shrinking beach widths and long-term shoreline retreat coupled with recent bluff stabilization are indicators of a sand deficit in the study area. This condition is currently offset by increasingly more robust shoreline protection and localized efforts to stabilize bluffs. Once the beach width is reduced to a critical size, however, the constant interaction between shoreline structures (bulkheads) and the waves may render the present shore protection structures inadequate.

Development of Best Erosion Control Strategies

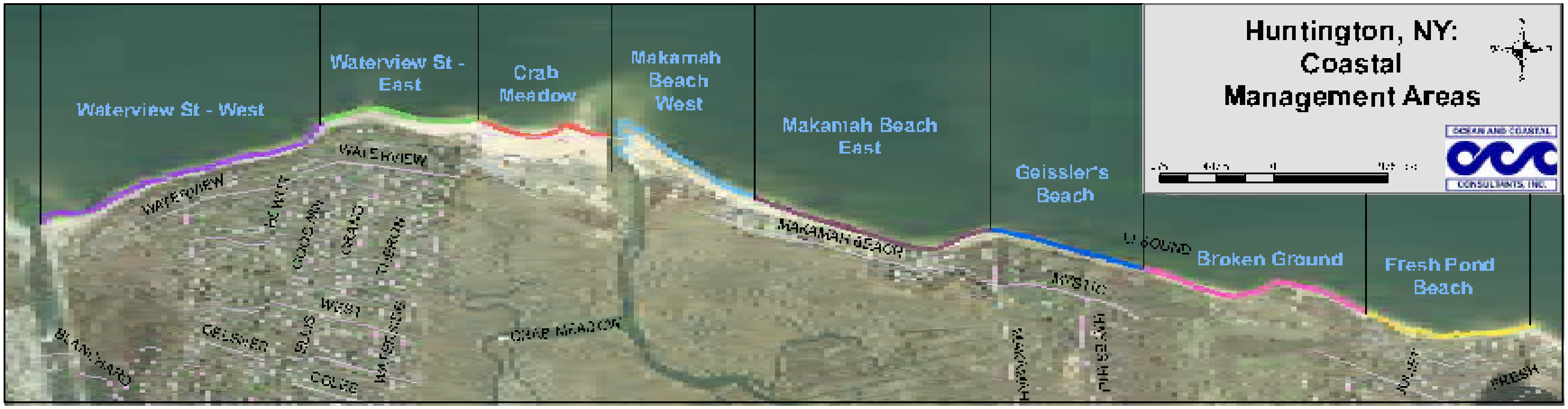
There are multiple levels of regulation (Federal, state and local) for erosion protection projects to be undertaken within the study limits. Agencies with jurisdiction include the US Army Corps of Engineers, the Federal Emergency Management Agency, the New York State Department of Environmental Conservation, New York State Department of State and the Town of Huntington (primarily under the Coastal Erosion Management Regulations). Erosion management strategies presented below were developed in light of and commensurate with the best practices and policies typically deemed acceptable by NYSDEC and USACE. However, for a specific project, coordination will be required between the various agencies in order to confirm that the proposed erosion control strategies are consistent with all of the applicable regulations.

Erosion and flood damage shoreline stabilization alternatives range from doing nothing to constructing various structures (including beachfills) for modifying the behavior or supply of coastal sediments. One of the primary goals of this study was to develop management recommendations for erosion control along the entire study area as a whole. However, during the course of the work it became apparent that there is a need for distinct “management areas” within the study area. The management areas were primarily defined based on physical conditions and upland uses. As the physical condition of the beach system and upland use changes, different management approaches are required. Each management area was evaluated based on nine (9) characteristic features which were identified during the course of the study. The extents of the management areas and specific management recommendations are presented in the following figure.

Significant findings of the erosion control report include:

- The eastern end of Makamah Beach has a critical beach erosion problem and additional storm damage to the adjacent residential properties can be expected unless significant shore protection management strategies are implemented.
- The beach nourishment program at Crab Meadow Beach is a success in providing both public beach access and shore protection.
- The Broken Ground area, including the bluff at Indian Hills Golf Course is expected to continue to have soil movement issues. The observed scarp is likely the result of a deep seated failure along a clay layer. While there are both structural and non-structural measures that can be implemented to reduce or mitigate the likelihood or rate of soil movement, an engineering solution to provide long term stability may not be feasible.

- Public use of the beach is currently limited by narrow beach widths in many areas. This trend is expected to become worse unless additional beach material can be added to the system.
- Given the sand deficit along the eastern portion of the study area, some level of beach nourishment will be required for long term stability of the area.
- An important component of the management program will be replacing sediment lost to the system by bluff and shore protection structures. We recommend a program of sediment mitigation to offset these losses.



Management Area	Geologic Feature	Shore Stabilization Structures	Beach Erosion	Beach Width	Bluff Erosion	Existing Building Setback from Shoreline	Dunes	Storm Damage Risk	Public Beach Access	Management Recommendations
Waterview St. Beach (West)	Bluffed Shoreline	Prevalent	Stable - Typically less than 1 foot per year	Portions are narrow	Stable - Typically less than 1 foot per year	100-200 feet	No	Moderate	Fair	1) Maintain existing shore protection structures; 2) New or substantially repaired shore protection structures to require beach material mitigation; 3) Consider stormwater controls and/or vegetative stabilization to reduce bluff erosion; 4) Provide for public access across existing groins; 5) preserve existing bluff vegetation
Waterview St. Beach (East)	Bluffed Shoreline	Moderate/Set back	Stable - Typically less than 1 foot per year	Wide	Stable - Typically less than 1 foot per year	More than 200 feet	Yes	Low	Good	1) Soft shore protection measures preferred; 2) New or substantially repaired shore protection structures to require beach material mitigation; 3) Protect and enhance existing dune system (i.e. snow fence and elevated walkovers)
Crab Meadow Beach	Barrier Beach	Minimal	Stable - Typically less than 1 foot per year	Wide	Not Applicable	Not Applicable	No	Low	Good	1) Maintain public access to beach; 2) Continue beach nourishment program as needed
Makamah Beach (West)	Barrier Beach	Minimal	Stable - Typically less than 1 foot per year	Wide	Not Applicable	100-200 feet	Yes	Low	Good	1) Manage as an environmentally sensitive area; 2) Soft shore protection measures only (i.e. beach nourishment, vegetative stabilization); 3) Protect and enhance existing dune system (i.e. snow fence and elevated walkovers)
Makamah Beach (East)	Barrier Beach	Prevalent	High erosion - Typically greater than 1 foot per year	Narrow	Not Applicable	Less than 100 feet	No	High	Poor	1) Maintain or improve existing shore protection structures to provide immediate protection for homes; 2) New or substantially repaired shore protection structures to require beach material mitigation; 3) Investigate innovative shore protection measures (i.e. offshore breakwater / shoals); 4) Consider beach nourishment at Makamah Road public access to improve beach access and provide only if feasible
Geissler's Beach	Bluffed Shoreline	Minimal	Long term erosion greater than 1 foot per year - currently stable	Portions are narrow	Portions greater than 1 foot per year	More than 200 feet	Yes (some)	Moderate	Fair	1) Soft shore protection measures preferred; 2) New or substantially repaired shore protection structures to require beach material mitigation; 3) Protect and enhance existing dune system (i.e. snow fence and walkovers); 4) Consider stormwater controls and/or vegetative stabilization to reduce bluff erosion; 5) Limit irrigation at top of bluff to reduce slope hazards
Broken Ground	Bluffed Shoreline	Prevalent	High erosion - Typically greater than 1 foot per year	Narrow	Portions greater than 1 foot per year - currently stable	More than 200 feet (100-200 feet)	No	High - slope failures likely	Poor	1) Manage for continued slope failures; 2) Manage stormwater and utilities to prevent excess water from reaching the clay layer; 3) Maintain existing shore protection structures and enhance toe protection where lacking; 4) New or substantially repaired shore protection structures to require beach material mitigation
Fresh Pond Beach	Bluffed Shoreline	Prevalent	Moderate Erosion - Typically greater than 1 foot per year	Narrow	Stable - Typically less than 1 foot per year	Less than 100 feet	No	Moderate	Poor	1) Maintain existing shore protection structures; 2) New or substantially repaired shore protection structures to require beach material mitigation; 3) Consider stormwater controls and/or vegetative stabilization to reduce bluff erosion; 4) Groins may not be appropriate for this zone (limited longshore transport evident)

The narrow beaches that characterize most of the study area preclude extensive use of this alternative. However, there are opportunities to utilize dune nourishment to enhance some of the smaller dune systems that are currently found in the study area.

8.0 MANAGEMENT RECOMMENDATIONS

One of the primary goals of this study was to develop management recommendations for erosion control along the entire study area. While the original intended purpose of the study was to provide erosion management recommendations for the entire study area as a whole, during the course of the work it became apparent that there is a need for distinct "management areas" within the study area. As outlined in Section 8.2, the management areas were primarily defined based on physical conditions and upland uses. As the physical condition of the beach system and upland use changes, different management approaches are required. As outlined in Section 8.1, each management area was evaluated based on nine (9) characteristic features which were identified during the course of the study. Specific management recommendations for each management area are presented in Section 8.2 and are summarized in Figure 1 in the Executive Summary.

The spatial characteristics of the study area are important considerations for consistent coastal management decisions (New York Secretary of State, 1999). Management of safe development is contingent on characterizing both the coastal "climate" (long-term genetic trends) and spatially specific trends such as the effects of groins and seawalls on localized erosion or bluff retreat. Since shore and bluff protection structures are prevalent in the study area they represent an important management concern. It will be increasingly important to document the types of structures, location, and condition. As the shoreline erodes structures will incur more wave energy and the potential for failure will increase.

The spatial variables detailed in the previous sections, Historic Coastal Trends Analysis and Existing Uses and Conditions, have been combined with pertinent information from the Regulatory Climate and Options for Shoreline Stabilization sections to define management recommendations. The amount of variables examined in the study has been condensed to provide a workable management scale. The data supports property level management recommendations; however, this level is not-appropriate for application of regionally consistent management decisions. The matrix of Management Areas, Coastal Concerns, and Management Recommendations (Executive Summary) is an overview of the findings and recommendations.

8.1 CHARACTERIZATION OF COASTAL CONCERNS

8.1.1 Geologic Feature/Geomorphology

From a landform or geomorphologic (geologic) perspective there are two distinct feature types. Much of the shoreline is backed by bluffs of varying heights that are part of the glacial landforms found throughout the region. The remaining shoreline consists of low lying barrier beach-type spits that have developed from longshore transport of sediment eroded from bluffs. Effective

coastal management of these two landforms (erosional and depositional) requires a combination of proactive regulations, incentives, and emergency contingencies.

8.1.1.1 Barrier Spit Shorelines

Development on barrier spit shorelines presents several management challenges. As previously discussed, long term erosion, sediment deficits, and rising sea level makes sustainable development difficult without a long-term commitment to maintaining an adequate beach. Development on barrier shorelines also creates the potential for life and property loss during storms such as yearly Northeaster's that affect the area. Ground elevations on spit shorelines in the study area are rarely above 10 feet based on the available topographic data while the still water elevations for the 1- and 2-percent chance annual storms straddle this elevation. For this reason, shore protection and/or a large buffer between the shoreline and infrastructure are important in limiting storm damage. In the longer term, there is the issue of sustainability; those areas that have consistent recent trends of shoreline retreat at or above 1 foot per year are in jeopardy of being exposed to, and incurring constant damage from increasing wave attack as the beaches continue to diminish. If, as reports suggest (Heinz Center, 2000), FEMA becomes increasingly stretched thin, the cost of flood insurance for this category of properties may place it beyond the means of all but a few home owners in coming years.

8.1.1.2 Bluffed Shorelines

Bluffs represent the bulk of the local sediment source. They are also naturally protective features and residences located behind them are much more protected from storms than those on barrier spits; in all but a few cases the residences are out of the 100 year (1 percent chance annual occurrence) flood zones. An important safety issue is protection of bluffs from rapid failure, which is contingent on continued toe protection (revetments and bulkheads). This must be tempered by the long-term supply of sediment to the system that would naturally occur from bluff erosion.

8.1.2 Shoreline Stabilization Structures

Shoreline stabilization structures are common along residential portions of the study area. Their existence and continued use is an important management consideration. For example, permitting new or modified structures in areas with limited shoreline stabilization should be approached differently than those areas where they are currently pervasive.

8.1.3 Beach Erosion

Beach erosion is and will be an ongoing problem given the lack of sediment sources and relative sea-level rise. The general trend of erosion has slowed, but the amount of buffer in front of many properties has dropped to a level where each foot is important. Areas with chronic erosion trends will require some sort of beach stabilization within the next decade. For other portions of the study area, erosion may only represent a long-term problem.

8.1.4 Beach Width

Beach width is a short-term safety consideration and indicator of upland infrastructure damage potential. The level of infrastructure damage caused by direct wave attack, even areas with limited shoreline change, is a function of beach width. Beach width is also an indirect measure of beach elevation, such that the bases of most bluffs, dunes, or shoreline structures on wide beaches is greater than those for narrow beaches.

An important consideration for human safety and property damage in the near-term is the location of habitable structures in relation to upland, bluff, or shoreline protection structures and their first-floor elevation. A generalized assessment of structure location has been performed, however, a detailed analysis is beyond the scope of the present project; it is recommended that follow-on work include this metric.

Beach width is also an important consideration for public access. Wider beaches allow for more public use (wide areas below mean high water). As beach width narrows, there is less time during a tide cycle when pedestrians can pass.

8.1.5 Bluff Erosion

Bluff erosion is a natural process in the study area which has been greatly reduced in the past 30 years. Bluff erosion is a function of soil type, elevation, and underlying geology. High rates of retreat are associated with the glacial out-wash deposits and areas with underlying clay. Areas with high retreat rates are critical management areas, such that building on or modifications to the bluff slopes have safety implications.

8.1.6 Building Setback from Shoreline

Building setback distances are extremely important from a safety perspective. Not only are geologic feature/geomorphology management decisions based on this measurement, but there is human safety as well as infrastructure damage implications. For bluff areas, low setbacks from the shoreline indicate high slopes; on spit areas, low setbacks have high wave-impact potential. Decisions on protective and/or management techniques should be tailored to encourage increased shoreline setbacks.

8.1.7 Dunes

Dunes are both protective and habitat features in the study area. The west end of Makamah Beach has the largest dunes and property owners rely on their existence for protection. In other areas, the dunes primarily provide habitat and are highly sacrificial, providing sediment to the system during storm periods.

8.1.8 Storm Damage Risk

Storm damage risk is a qualitative assessment of the overall conditions as they relate to short-term risks; this is the single-most important management measure. Areas with a high storm damage risk have associated human safety concerns. Location of emergency personnel during storms and/or mandatory evacuation priority is an example of the types of management decisions that can be defined based on the overall risk. Quantitative storm damage assessment can be obtained through the use of numerical models to predict the impact of storm damage on structures, roads and other utilities on a probabilistic basis.

8.1.9 Public Beach Access

At the other end of the spectrum from storm damage risk, beach access is a public interest issue. Areas with limited beach width can restrict pedestrian use of public lands. A good example is the eastern end of Makamah Beach, which is bounded on both ends by public property. Parking and public crossover to the beach are also important.

8.2 MANAGEMENT AREAS

Management areas have been defined (Figures 8.2-1, 8.2-2, 8.2-3 and 8.2-4) to promote practical use of management recommendations based on location and unique combinations of coastal concerns as discussed above. The management matrix (see Executive Summary) has been divided into areas that reflect these zones.

Figure 8.2-1: Management zone overview map.

8.2.1 Waterview Street West

8.2.1.1 General Management Conditions

This area has some of the highest bluffs, a fairly stable beach, and a high degree of shoreline stabilization structures including groins. The area, however, has a narrow beach and a low building setback. The storm damage risk is moderate and reflects the potential for slope failure if shoreline stabilization structures are damaged by waves.

8.2.1.2 Management Recommendations

It is important that the shore protection structures are maintained. As a requisite for building new structures or substantially repairing older ones, beach material mitigation (small scale nourishment) is recommended to offset the natural bluff erosion process. Since the bluffs are among the highest in the study area, storm water control and vegetative stabilization should be encouraged to reduce slope failure. The high level of groin construction in the area may restrict public use of the beach. A method for allowing public access across some of the larger groins should be implemented.

The primary management goal for Waterview Street West is maintaining shore protection for the existing upland development. Given the stable beach and high level of existing development, a combination of moderation, armoring and restoration erosion management appears best.

With residential development located near to the top of the bluffs, the toe of the bluffs will require armoring to prevent slope failures during severe storm conditions. Although armoring of bluffs is generally more difficult to permit than vegetative measures, it can, at times, be justified when residential development is in imminent danger. Mitigation in the form of beach nourishment and/or plantings can help offset potential adverse impacts and make the project more consistent with regulatory policies. Existing erosion protection structures along the toe should be maintained and new structures meeting the requirements of local Law No. 7-1989 should be allowed. The toe protection system will be limited by the "weakest link" or the structure most susceptible to storm damage along this reach. As such, and to promote a unified shore protection approach, the local properties owners association should be encouraged to develop and implement an inspection and maintenance program for the bluff protection structures (see Section 8.3). An inspection and maintenance program is a requirement for new or reconstructed erosion control structures under the regulations of 6 NYCRR Part 505.

As part of the restoration program, repairs to, reconstruction of and new structures should have a requirement for beach material mitigation. Bluff toe protection structures should be required to place a volume of material equivalent to the volume of bluff material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, an historic bluff erosion rate of about 1 foot per year and an assumed bluff height of 30 feet, the required mitigation volume would be 900 cubic feet of beach material per linear foot of shore protection structure. Repairs to or reconstruction of groins should have a requirement for adding beach material equivalent to the entrapment capacity of the groin. This will minimize down drift impacts from the groins. The beach material utilized for this management area should be sand, with a grain size equal to or slightly larger than the existing beach material. Placement of material as mitigation to offset potential adverse impacts of structures is generally consistent with best practices of NYSDEC and USACE. This type of mitigation is often a special condition requirement of a permit.

Appropriate moderation measures including vegetative slope stabilization measures such as live stakes, live fascines and brush mattresses should be encouraged, as should storm water and irrigation runoff controls to prevent slope failures. There is good vegetative coverage throughout this reach. Avoid planting non-native trees and shrubs on or near the bluff face, particularly on

the western end to avoid escape of horticultural varieties into natural communities. If a woody plant dies, consider replacement with a native species.

As previously discussed repairs and/or reconstruction of the existing groins should be allowed as part of the moderation erosion control methods. In some cases, modification of the groin to bypass more sand should be encouraged.

Repairs to or reconstruction of groins should also include provision for public access at the mean high water line. This will improve public access and use along this section of beach. Since maintaining public access is an important provision of most regulatory agencies policies, incorporating means to increase public access with reconstruction and/or new construction of coastal structures should facilitate the permitting of these structures.

New or expansions of existing residential development should not occur within the Coastal Erosion Hazard Area, as defined in NYSDEC Article 34 and Local Law No. 7-1989.

8.2.2 Waterview Street East

8.2.2.1 General Management Conditions

This area has high bluffs, a stable beach, a moderate level of set-back shoreline stabilization, and several large groins. The area has a wide beach and a considerable building setback. The storm damage risk is low and reflects the wide beach, set-back, and stable long-term erosion trend.

8.2.2.2 Management Recommendations

Given the stable beach and high level of exist development, a combination of moderation and restoration erosion management appears best. The primary management goal for Waterview Street East is improving the natural shore protection features to provide adequate erosion protection for the existing upland development.

Soft shoreline stabilization is preferred in this area given its natural character. As a requisite for building new structures or substantially repairing older ones, beach material mitigation (small scale nourishment) is recommended to offset the natural bluff/dune erosion process. The dune system should be protected and enhanced (i.e. use of dune walkovers and temporary snow fencing). Soft stabilization including beach nourishment and dune enhancement is generally a permittable activity that is favored over structural solutions by the regulatory agencies as long as vegetation and wildlife are not adversely impacted.

With residential development located behind the top of the bluffs, the toe of the bluff requires protection to prevent slope failures during severe storm conditions. The existing dune system, wide beach and some bluff protection structures along the toe provide the required protection. Projects to enhance the dunes should be encouraged. Dune enhancement can include dune nourishment, dune vegetation planting, dune fence installation, and installation of dune walkovers. Enhance maritime dunes by planting beachgrass, coastal panicgrass, beach pea,

seaside goldenrod, and dusty miller; and extend snow fencing. Protect dunes by installing elevated walkways, rather than cutting paths through the dunes.

Existing bluff and shore protection structures should be maintained and new structures meeting the requirements of local Law No. 7-1989 may be allowed. The toe protection system can be limited by losses of beach material or dune damage. As such, and to promote a unified shore protection, the local properties owners association should be encouraged to develop and implement an inspection and maintenance program (see Section 8.3). An inspection and maintenance program is a requirement for new or reconstructed erosion control structures under the regulations of 6 NYCRR Part 505.

As part of the restoration program, repairs and reconstruction of existing structures and new structures should have a requirement for beach material mitigation. Bluff toe protection structures should be required to place a volume of material equivalent to the volume of bluff material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, an historic bluff erosion rate of about 1 foot per year and an assumed average bluff height of 15 feet, the required mitigation volume would be 450 cubic feet of beach material per linear foot of shore protection structure. The beach material utilized for this management area should be sand, with a grain size equal to or slightly larger than the existing beach material. It is anticipated that the mitigation material would be used to nourish the existing dune system.

Repairs to and reconstruction of groins that are still functional are generally permittable by NYSDEC and USACE if adverse impacts are eliminated or minimized. Therefore, repairs to or reconstruction of groins should have a requirement for adding beach material equivalent to the entrapment capacity of the groin. This will minimize down drift impacts from the groins.

Appropriate moderation measures include vegetative slope stabilization measures, such as live stakes, live fascines and brush mattresses, should be encouraged, as should storm water and irrigation runoff control to prevent slope failures.

As previously discussed repairs and/or reconstruction of the existing groins should be allowed as part of the moderation erosion control methods. Repairs or reconstruction of groins should also include provision for public access at the mean high water line.

New or expansions of existing residential development should not occur within the coastal erosion hazard area, as defined in NYSDEC Article 34 and Local Law No. 7-1989.

8.2.3 Crab Meadow Beach

8.2.3.1 General Management Conditions

This area is a public barrier beach with a stable beach, no residential development, the highest level of public access, a history of renourishment, and several large “terminal” groins to reduce longshore transport. The storm damage risk is the lowest in the study area and reflects the wide

beach, lack of private development, and stable long-term erosion trend, which is a function of the renourishment program.

8.2.3.2 Management Recommendations

Given the stable beach and high level of public use, a restoration erosion management program appears best. The primary management goal for Crab Meadow Beach is maintaining the public access beach. This area represents a valuable public holding and should be maintained as such. The nominal costs of yearly renourishment should continue to ensure public access and damage mitigation (beach pavilion).

The critical component of the erosion management program will be the continuation of annual beach nourishment. The beach nourishment program provides a wide stable beach to support the public access activities. In addition, the wide beach provides storm protection to the upland public infrastructure and to the adjacent Crab Meadow marsh.

New shore protection structures are not anticipated to be required if the nourishment program is maintained. The existing groins should be maintained as they provide stability to the beach and help retain the sediment.

Maximize use of native plants in park landscaping, and label natives to increase public awareness and education.

New or expansions of existing commercial development should not occur within the coastal erosion hazard area, as defined in NYSDEC Article 34 and Local Law No. 7-1989.

The proposed beach nourishment recommendation is appropriate given the best practices and policies of the NYSDEC and USACE and consistent with activities typically permitted.

8.2.4 Makamah Beach - West

8.2.4.1 General Management Conditions

This barrier beach is mostly public; it has a stable beach, limited residential development, public access, and a considerable coastal dune habitat. The storm damage risk is low and reflects the wide beach, lack of private development, and accretional to minimally erosional long-term trend.

8.2.4.2 Management Recommendations

Given the relatively stable beach, developed dune system and low level of existing development, a combination of moderation and restoration erosion management appears best. The primary management goal for Makamah Beach West is maintaining the natural shore protection features that promote both erosion protection for the existing upland development and habitat for the rare and endangered species that nest in this portion of the beach.

Any shoreline stabilization should be required to be soft (nourishment, dune stabilization) given this area's natural character. The dune system should be protected (limit dune crossing) and enhanced (use of temporary snow fencing).

With residential development located behind the dunes, measures to protect and enhance the dune system should be a priority. Dune enhancement can include dune nourishment, dune vegetation planting, dune fence installation, and installation of dune walkovers. Enhance maritime dunes by planting beachgrass and extend snow fencing. Protect dunes by installing elevated walkways, rather than cutting paths through the dunes. Restrict foot traffic through the dunes and maintain piping plover and least tern protection and monitoring protocols.

New shore protection structures should be discouraged, unless there is a justified need. Maintenance of existing shore protection structures and any necessary new structures should meet the requirements of Local Law No. 7-1989. As such, and to promote a unified shore protection, the local properties owners association should be encouraged to develop and implement an inspection and maintenance program (see Section 8.3). An inspection and maintenance program is a requirement for new or reconstructed erosion control structures under the regulations of 6 NYCRR Part 505.

As part of the restoration program, repairs to, reconstruction of and new structures should have a requirement for beach material mitigation. Shore protection structures should be required to place a volume of material equivalent to the volume of upland or dune material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, a historic beach erosion rate of about 1 foot per year and an assumed average dune height of 10 feet, the required mitigation volume would be 400 cubic feet of beach material per linear foot of shore protection structure. The beach material utilized for this management area should be sand, with a grain size equal to or slightly larger than the existing beach material. It is anticipated that the mitigation material would be used to nourish the existing dune system.

Appropriate moderation measures include dune enhancement with snow fence installation, vegetation plantings and / or dune nourishment.

New or expansions of existing residential development should not occur within the coastal erosion hazard area, as defined in NYSDEC Article 34 and Local Law No. 7-1989.

This combination of management recommendations has been made in light of the best practices and policies generally accepted by the regulatory agencies. In particular, dune enhancement and beach nourishment are preferred over structural solutions whenever possible.

8.2.5 Makamah Beach – East

8.2.5.1 General Management Conditions

This part of the barrier beach is mostly private and unlike the western portion it has a highly erosional beach, high residential development and shoreline stabilization structures, limited

public access, a very narrow beach, and a shrinking coastal dune habitat. The storm damage risk is the highest in the study area and reflects the narrow beach, low building set-back, and high erosional long-term trend.

8.2.5.2 Management Recommendations

Makamah Beach East is the most critical management area in terms of immediate erosion control. The chronic erosion of the beach, narrow beach width and minimal setback for the residential development has resulted in a situation where damage to property can be expected on a regular basis. Armoring has been employed to provide some protection for the residents. However, given the sand starved condition of the beach, armoring alone is not likely to provide a long term erosion control solution. A combination of armoring, moderation, restoration, and possibly adaptation will be required to provide long term erosion management. The primary management goal for Makamah Beach East is to provide sustainable, long term shore protection for the existing upland development.

The management recommendations in this area are geared toward human safety and infrastructure protection. It is important that the shore protection structures are maintained. As a requisite for building new structures or substantially repairing older ones, beach material mitigation (small scale nourishment) is recommended to offset the natural dune erosion process. Since the long-term sustainability of the area is limited, residents of the area should begin to investigate larger scale (compatible) shore protection techniques that include innovative as well as contemporary measures. The western portion of the area is public and may benefit from nourishment such as is occurring at Crab Meadow.

With residential development located close to the high water line, the existing development will require armoring to reduce structural failures and potential safety issues during severe storm conditions. Existing erosion protection structures should be maintained and new structures meeting the requirements of Local Law No. 7-1989 should be allowed. The shore protection system will be limited by the "weakest link" or the structure most susceptible to storm damage along this reach. As such, and to promote a unified shore protection approach, the local properties owners association should be encouraged to develop and implement an inspection and maintenance program, which would be consistent with the requirements of 6 NYCRR Part 505 for erosion control structures(see Section 8.3).

As previously noted, armoring alone will not provide long term protection to the existing residential structures due to the chronic erosion problem and lack of beach sediment in the system. Armoring alone is also likely to be discouraged by the regulatory agencies. A combination of management techniques will be more consistent with the policies of NYSDEC and USACE.

As part of the restoration program, repairs and reconstruction of existing structures and new structures should have a requirement for beach material mitigation. Shore protection structures should be required to place a volume of material equivalent to the volume of dune material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, a historic erosion rate of about 1.5 feet per year

and an assumed dune height of 10 feet, the required mitigation volume would be 800 cubic feet of beach material per linear foot of shore protection structure. The beach material utilized for this management area should be a mix of sand, gravel and cobble, matching the existing beach material. The mixed beach material will provide additional erosion protection over pure sand nourishment.

Another restoration measure that should be given serious consideration is a beach nourishment program for the public access area at the end of Makamah Road. The beach nourishment program would have a dual purpose: improve public beach access at this under-utilized access point; and introduce sediment into a sand starved section of shoreline. For a minimal annual cost, public access and shore protection could be improved. Without some form of beach nourishment, public access along this section of shoreline will continue to diminish and eventually there will be almost no public access due to a reduced beach width.

Due to the severe nature of the existing shoreline erosion problem, structural moderation measures should also be considered. Offshore submerged or segmented breakwaters would provide much needed shore protection and would also help to retain sand on the beach by limiting cross and long shore sediment transport. These type of structures are expensive to construct and difficult to permit. However, as the erosion and storm damage problems in this management area worsen, substantial, non-traditional protection measures will be required. Another structural moderation measure that may be considered is groins. A groin field in combination with a substantial beach nourishment program would also improve the existing erosion problem. New groin fields will be difficult to permit unless proper studies are provided to justify their need and to show that adverse impacts have been minimized with the addition of beach nourishment.

While a strict adaptation approach is not recommended, some adaptation measures may be incorporated as part of a long term approach. Raising flood prone structures to reduce storm damage risk and implementing recommendations of the FEMA Coastal Construction Manual should be encouraged as part of the management program. It should be noted that if the recommended mitigation and restoration measures are not implemented, an adaptation approach, such as outlined in the Article 34 “Structural Hazard Areas”, may be the only long term alternative.

New or expansions of existing residential development should not occur within the coastal erosion hazard area, as defined in NYSDEC Article 34 and Local Law No. 7-1989.

Due to the on-going critical erosion, limited vegetative opportunities exist, except for promoting use of native species instead of horticultural varieties. Xeriscapes should be encouraged in home gardening along this reach as well.

8.2.6 Geissler's Beach

8.2.6.1 General Management Conditions

This area has high, mainly unprotected bluffs, a long-term erosional trend, a high level of building set-back, and is largely public. The area, however, has a fairly narrow beach and a high bluff retreat signature. The storm damage risk is moderate and reflects the narrow beach, long-term erosion trend, and presence of unstable soils in bluffs.

8.2.6.2 Management Recommendations

Given the relatively low level of existing development, a large setback for existing structures, but a narrow beach and unstable bluff sediments, a combination of moderation and restoration erosion management appears best. The primary management goals for Geissler's Beach are to improve the natural shore protection features to provide erosion protection for the existing upland development and to continue public access to the beach.

Soft shoreline stabilization is preferred in this area given its natural character. As a requisite for building new structures or substantially repairing older ones, beach material mitigation (small scale nourishment) is recommended to offset the natural bluff/dune erosion process. Since the bluffs are in areas of, or near known areas of high bluff retreat, storm water control and vegetative stabilization should be encouraged to reduce slope failure. The dune system, where existing, should be enhanced through plantings and use of temporary snow fencing. Any toe protection afforded by dunes will help slow the bluff erosion process. Dune enhancement is consistent with the shore protection and best management policies of the NYSDEC and USACE.

With residential development located behind the top of the bluffs, the toe of the bluff requires protection to prevent slope failures during severe storm conditions. The existing dune system and some bluff protection structures along the toe provide limited erosion protection. Projects to enhance the dunes should be encouraged. Dune enhancement can include dune nourishment, dune vegetation planting, dune fence installation, and installation of dune walkovers. Dead Christmas trees have been placed along the toe of the eroded bank through this section, and provided limited success for bluff stabilization. Consider enhancing toe protection by installing a brush mattress that is properly tied down, using groundsel-bush for live stakes. Cut away the overhanging lip at the bluff crest to establish a flatter slope angle and plant a native grass mixture, erosion control blanket, vines, live stakes and/or facscines on the bluff face above. Plant wetland species (i.e., pussy willow, gray dogwood, highbush blueberry, groundsel-bush, chokeberries) on the lower portion of the bluff face and toe of the bluff where clay slumps occur. Eliminate lawn irrigation at the edge of the bluff face that throws water down over the crest.

New shore protection structures should be discouraged, unless there is a justified need. Maintenance of existing shore protection structures and any necessary new structures should meet the requirements of local Law No. 7-1989. As such, and to promote a unified shore protection, the local properties owners association should be encouraged to develop and implement an inspection and maintenance program, which is consistent with the requirements of 6 NYCRR Part 505 for new or reconstructed erosion control structures (see Section 8.3).

As part of the restoration program, repair and reconstruction of existing structures and new structures should have a requirement for beach material mitigation. Shore protection structures should be required to place a volume of material equivalent to the volume of upland or dune material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, an assumed bluff erosion rate of about 1 foot per year and an assumed average bluff height of 20 feet, the required mitigation volume would be 600 cubic feet of beach material per linear foot of shore protection structure. The beach material utilized for this management area should be sand, with a grain size equal to or slightly larger than the existing beach material. It is anticipated that the mitigation material would be used to nourish the existing dune system. Placement of material as mitigation to offset potential adverse impacts of structures is generally consistent with the best practices of NYSDEC and USACE and is often a special condition of the permit.

Appropriate moderation measures include dune enhancement with snow fence installation, vegetation plantings and / or dune nourishment. Other important moderation measures include vegetative bluff stabilization, bluff storm water controls and limiting irrigation at the top of the bluff.

New or expansions of existing residential development should not occur within the coastal erosion hazard area, as defined in NYSDEC article 34 and Local Law No. 7-1989.

8.2.7 Broken Ground

8.2.7.1 General Management Conditions

This area has high set-back bluffs, a history of massive slope failures, a long-term erosional trend, and very little beach fronting the bluffs. Most of the area, however, has been armored with revetments and there is a significant building set-back. The storm damage risk is high and reflects the narrow beach, long-term erosion trend, presence of unstable soils in bluffs, and high wave exposure.

8.2.7.2 Management Recommendations

Broken Ground is a critical management area in terms of bluff erosion. The chronic bluff failure and erosion problem has been exacerbated by the erosion of the beach and resulting narrow beach width. The primary management goal for Broken Ground should be to minimize the frequency and severity of soil movement and bluff failures which are likely to occur over time. Further investigation would be necessary to arrive at viable engineering solutions to minimize soil movement. A combination of armoring, moderation, restoration, and adaptation is recommended to provide long term erosion management.

It is important that shore protection structures are maintained where present. As a requisite for building new structures or substantially repairing older ones, beach material mitigation (small scale nourishment) is recommended to offset the natural bluff erosion process. Since the bluffs are the most unstable in the study area, storm water and ground water controls should be used in

conjunction with vegetative stabilization to reduce slope failure. Excess water between the clay layer and overlying glacial moraine acts like a lubricant that increases slope failure risk. The long groin extending from the golf course may be excessive and rob down-drift areas of protective beach material and may help public access in front of the western portion of the revetment.

Armoring has been employed on portions of the bluff toe to provide some protection bluff erosion protection. Vegetative stabilization and runoff control has also been implemented to some degree with varying levels of success. However, given the historic bluff erosion rates, unstable underlying soil, continuing movement of the bluff, and sand starved condition of the beach, armoring and mitigation are not likely to provide a long term erosion control solution. There are engineering techniques that could be applied to stabilize the underlying clay layers. These include installing drilled shafts or caissons through the failure plane, excavation and re-grading to a stable slope, replacement of low strength material, installation of drains, and experimental techniques such as electro-osmosis to dewater and strengthen the clay layer. Further engineering study would be required to determine the cost and effectiveness of these techniques.

The existing erosion protection structures do provide some protection and should be maintained and new structures meeting the requirements of Local Law No. 7-1989 should be allowed to slow toe erosion. The local properties owners association should be encouraged to develop and implement an inspection and maintenance program to ensure long term viability of the shore protection structures (see Section 8.3). An inspection and maintenance program is a requirement for new or reconstructed erosion control structures under the regulations of 6 NYCRR Part 505.

As previously noted, armoring alone will not provide long term protection due to the chronic erosion problem and lack of beach sediment in the system. Armoring alone is also not likely to be favored by the regulatory agencies. A combination of management techniques including nourishment for mitigation as described below will be more consistent with the policies of NYSDEC and USACE.

As part of the restoration program, repair and reconstruction of existing structures and construction of new structures should have a requirement for beach material mitigation. Shore protection structures should be required to place a volume of material equivalent to the volume of bluff material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, an assumed bluff erosion rate of about 2 feet per year and an assumed bluff height of 30 feet, the required mitigation volume would be 1800 cubic feet of beach material per linear foot of shore protection structure. This would be a substantial volume of material to place on the beach, and would provide additional storm protection. The beach material utilized for this management area should be a mix of sand, gravel and cobble, matching the existing beach material. The mixed beach material will provide additional erosion protection over pure sand nourishment.

Beach material mitigation will also improve public beach access. Without some form of beach nourishment, public access along this section of shoreline will continue to diminish and eventually there will be almost no public access due to a reduced beach width.

Moderation measures should also be continued and improved to lessen bluff erosion. The existing vegetative stabilization is ineffective in some areas, and better storm water control is needed. Specific moderation recommendations include: Repair the gully at western end of golf course. Divert and/or dissipate runoff above the bluff face to reduce overland flow. Eliminate irrigation in low-lying areas above the gully and in close proximity to bluff crest elsewhere. Raise the height at the center of the rock revetment to eliminate overwash during storm events. Plant woody wetland species at the top of the revetment to function as joint plantings. Re-grade rills above the center of the revetment, seed to a warm season grass mixture, apply thin erosion control blanket or jute net and install fascines. Install toe protection at eastern end of reach; investigate feasibility of brush mattress technique or rock revetment with joint plantings, versus other structural measures such as a low profile bulkhead. While we understand the some irrigation controls have been implemented, these should be reviewed to ensure that minimal amount of water reaches the bluff face and underlying unstable sediments.

The groin located near the eastern limit of this management area is another moderation measure that actually may be contributing to the erosion problem on the western end of the management area. The current length of the groin appears to be longer than is needed. The additional length effectively prevents any long shore sediment transport, keep sand from moving to the western end of the management area. If the length of the groin was reduced, some bypassing of sand would occur. It should be noted that the groin does provide shore protection for the eastern end of the management area by retaining sediment. As such, the length of the groin should be a balance between retaining sediment on the east side and allowing some movement of sediment to the west. Reducing the length of the groin would most likely be seen as a positive endeavor and is likely to be easily permitted by NYSDEC and USACE.

A strict adaptation approach should also be considered for this area. Preventing future development on the unstable and erosion prone bluff areas by implementing an adaptation approach, such as outlined in the Article 34 “Structural Hazard Areas”, is recommended.

8.2.8 Fresh Pond Beach

8.2.8.1 General Management Conditions

The area has fairly large bluffs that decrease in height from the west to east, significant use of shoreline stabilization, and a very narrow beach. Shoreline erosion is moderate to high and there is also limited building setback. Unlike the Broken Ground area, the bluffs have remained fairly stable in the long-term. Accordingly, the storm damage risk is moderate and reflects the potential for slope failure if shoreline stabilization structures fail.

8.2.8.2 Management Recommendations

The primary management goal for Fresh Pond Beach is maintaining shore protection for the existing upland development. Given the narrow beach and high level of exist development, a combination of moderation, armoring and restoration erosion management appears best.

It is important that the existing shore protection structures are maintained. As with other bluffed shorelines with narrow beaches, building new structures or substantially repairing older ones should be accompanied by beach material mitigation (small scale nourishment). Since the bluffs are relatively high and residences are built on or near their edge, storm water control and vegetative stabilization should be encouraged to reduce slope failure. The use of groins should be discouraged in this area as longshore transport is limited. Vegetative stabilization and storm water control are likely to be the preferred alternative for bluff stabilization by the regulatory agencies, although it is understood that structural measures cannot be avoided in all cases. Placement of material as mitigation to offset the perceived potential adverse impacts of structures is generally consistent with the best practices of the NYSDEC and USACE.

With residential development located near to the top of the bluffs, the toe of the bluffs will require armoring to prevent slope failures during severe storm conditions. Existing erosion protection structures along the toe should be maintained and new structures meeting the requirements of Local Law No. 7-1989 should be allowed. The toe protection system will be limited by the "weakest link" or the structure most susceptible to storm damage along this reach. As such, and to promote a unified shore protection approach, the local properties owners association should be encouraged to develop and implement an inspection and maintenance program for the bluff protection structures (see Section 8.3). An inspection and maintenance program is a requirement for new or reconstructed erosion control structures under the regulations of 6 NYCRR Part 505.

As part of the restoration program, repair and reconstruction of existing structures and construction of new structures should have a requirement for beach material mitigation. Bluff toe protection structures should be required to place a volume of material equivalent to the volume of bluff material that the structure would prevent from entering the system over the design life of the structure. With the CEHA requirement for a 30 year design life, a historic bluff erosion rate of about 1 foot per year and an assumed bluff height of 20 feet, the required mitigation volume would be 600 cubic feet of beach material per linear foot of shore protection structure. The beach material utilized for this management area should be a mix of sand, gravel and cobble, matching the existing beach material. The mixed beach material will provide additional erosion protection over pure sand nourishment. If efforts are not made to introduce additional sand into the system at this location, this area could face future problems similar to what the east end of Makamah Beach is currently experiencing.

Beach material mitigation will also improve public beach access. Without some form of beach nourishment, public access along this section of shoreline will continue to diminish and eventually there will be almost no public access due to a reduced beach width. Public access is an important provision of most regulatory policies; therefore, the nourishment should be viewed favorably.

Appropriate moderation measures including vegetative slope stabilization measures such as live stakes, live fascines and brush mattresses should be encouraged, as should storm water and irrigation runoff controls to prevent slope failures. Avoid planting non-native trees and shrubs at the eastern end adjacent to Fresh Pond, to avoid escape of horticultural varieties into natural

communities. If a woody plant dies, consider replacement with a native species. Maintain good vegetative coverage on bluff faces.

The existing groins do not appear to be providing a substantial shore protection benefit as there was no obvious long shore transport in this area. As such, repairs, reconstruction or new groins should be discouraged.

New or expansions of existing residential development should not occur within the Coastal Erosion Hazard Area, as defined in NYSDEC article 34 and Local Law No. 7-1989.

8.3 INSPECTION PROGRAM

As outlined in the Article 34 regulations (6 NYCRR Part 505), inspection and maintenance is a key component of a successful long term structural erosion measure. While it is important for new structures permitted under the Article 34 regulations, inspection and maintenance is even more important for existing, older structures.

The inspection and maintenance program should include at a minimum: an annual visual inspection of all structures and a survey of dunes; a visual inspection of the dunes and all structures following significant storm events; inspection of all structures every 5 years by a licensed professional engineer with experience in the inspection and design of coastal protection structures, addressing structural deficiencies or sediment loss as soon as possible; and emergency/contingency planning.

8.4 SEDIMENT MITIGATION PROGRAM

The sediment mitigation program is an important component of the overall erosion management system. Many of the beaches in the study area exhibit a sand starved profile, even during the summer months. As such, a source of sediment needs to be identified and added back to the system. With the increasing stabilization of the shoreline, beach material that was once available from bluffs and dunes, is no longer available to the beach system. A sediment mitigation program can balance the loss of material from the system with the increased shoreline stability that the structures offer.

The previous management recommendations sections contain recommended volumes of sediment to mitigate structure construction for each management area. It may be more practical that the mitigation volume be placed on the beach in increments rather than all at one time. For example one half of the required volume could be placed at the time of structure construction and the remaining volume place on the beach 5 to 10 years after structure construction.

9.0 CONCLUSIONS

The following conclusions are drawn from the data gathered and analyzed in the previous sections.

- Much of the study area exhibits properties that indicate a sand deficit, especially in the eastern half of the study area.
- Bluff stabilization measures along with natural processes have contributed to the sand deficit in the study area.
- Beach and bluff erosion are part of a historic pattern of shoreline change in the study area and North Shore of Long Island in general.
- Underlying geology contributes to high bluff erosion rates especially along Geissler's Beach and at Broken Ground.
- The eastern end of Makamah Beach has a critical beach erosion problem and additional storm damage to the adjacent residential properties can be expected unless significant shore protection management strategies are implemented.
- The beach nourishment program at Crab Meadow Beach is a success in providing both public beach access and shore protection.
- The Broken Ground area, including the bluff at Indian Hills Golf Course, is expected to continue to have soil movement issues. The observed scarp is likely the result of a deep seated failure along a clay layer. While there are measures that can be implemented to minimize the severity, rate and frequency of soil movement in the Broken Ground area, achieving long term stability is questionable.
- Public access to the beach is currently limited by narrow beach widths in many areas. This trend is expected to become worse unless additional beach material can be added to the system.
- Erosion management for the existing shoreline should consist of a combination of management techniques including armoring, moderation and restoration.
- Given the sand deficit along the eastern portion of the study area, some level of beach nourishment will be required for long term stability of the area.
- No single management solution is appropriate for the entire study area, as different portions of the study area have different physical characteristics and uses.
- An important component of the management program will be replacing sediment lost to the system by bluff and shore protection structures. OCC recommends a program of sediment mitigation to offset these losses.
- Dune protection and enhancement measures should include a combination of strategies including elevated walkway replacing paths cutting through the dune, extensions or additions of snow fencing to promote dune creation; dune plantings; restrictions on foot traffic;
- Landscaping with drought-resistant native plants tolerant of salt spray should be promoted throughout the study area to avoid the escape of horticultural and non-native varieties into natural plant communities and to minimize erosion caused by irrigation.
- Long term stability of the shoreline may be achieved by implementing Local Law No. 7-1989

A combination of the armoring, moderation and restoration alternatives described in Section 8.0 can be viewed as a multidimensional regional approach such that actions to slow or halt erosion are flexible depending on location and erosion processes such that the entire shoreline ultimately functions as a system. Given the variable land-use (residential, commercial, and public), collective coordination of individual stakeholders is a difficult task; however, documentation of the regional shoreline character included in this report is an important first-step in unifying the coastal residents. Without a concentrated management effort, continued erosion is imminent over most of the developed shoreline in the study area.

The management recommendations outlined for each area were developed in light of and commensurate with the best practices and policies typically deemed acceptable by NYSDEC and USACE. However, it is recommended that a pre-application meeting with the agencies be held during the early stages of planning to determine potential permitting issues and assessment requirements of individual shore protection measures.

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