TOWN OF PALM BEACH

BEACHES: THE OVERVIEW

BEACHES: THE MANUAL

Prepared by

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TOWN OF PALM BEACH
BEACHES : THE OVERVIEW

The Town of Palm Beach, located on a barrier island, has been concerned about erosion for over 70 years beginning with construction of the Lake Worth Inlet jetties and navigational channel in the 1920s. Prior to 1970 all material dredged to maintain the channel was deposited offshore, meaning nearly two million cubic yards of sand were lost to the beaches. In the late 1950s, a sand transfer plant was constructed to capture some of the sand that could not pass around the inlet and place it on the beaches to the south.

In addition, a series of hurricanes from 1903 to 1933 further eroded the beaches to the point where the Town authorized a seawall and groin construction program in 1926. The seawalls have continued to provide storm protection, yet many of the groins have deteriorated or have been removed.

Responding to the need for an overall program to protect the island, the Town of Palm Beach authorized development of a Comprehensive Coastal Management Plan (CCMP) in April 1986.

In March 1997, the Town of Palm Beach decided to update the Town's CCMP. The purpose of the update is to consider the changes which have occurred to the island of Palm Beach shoreline over the last decade and develop new shoreline management goals and objectives. Implementation of the Plan will help the coastal communities on the Island restore and sustain a healthy shoreline on a regional basis -- from inlet to inlet--which is more stable, provides storm protection, supports recreational use and enhances property values.

While many of the shoreline management initiatives from the original CCMP have been implemented, most of the Island's beachfront is still eroding at a significant rate. The Island's average erosion rate computed based on 1990 and 1997 beach profiles are 6.7 cubic yards per linear foot of shoreline per year. The causes of the erosion have been well-documented and include inadequate transfer of sand south across Palm Beach Inlet and deteriorating, non-functional erosion management structures.

The need to eliminate or manage the causes of the erosion have been given the highest priority in this Plan. The Island has continued to lose approximately 550,000 cubic yards of sand per year. The effects of this loss have cumulatively reduced the storm protection capabilities of the existing beach. It has been calculated that more than seven million cubic yards of sand have been impounded north of Lake Worth Inlet since its construction. This sand would have naturally flowed to Palm Beach if it were not for the inlet jetties.

While it is not likely that the Island's shoreline can be restored to pre-inlet conditions, it is very important that the beaches be nourished to provide a reasonable level of storm

protection. Beach nourishment has been recommended along much of the island to restore the eroded beachfront to a degree where storm protection is provided to substantially protect coastal properties for a 15-year storm which is typical for beach restoration projects. A 15-year storm is a severe coastal storm having wind speeds, wave heights and a duration with a 1 in 15 chance of occurring in any given one-year period, roughly comparable to a Category 2 hurricane.

Individual recommendations were formulated considering the principles and regulations relied upon by the state and federal governments when evaluating a proposed project for environmental and natural resource impacts. An effort was also made to recommend management initiatives consistent with state and federal guidelines for shore protection and inlet management projects. These factors are important when seeking permits and funding support from these entities.

When developing the management recommendations for each shoreline segment (reach), various alternatives were considered. An effort was made to maximize the net project benefits in a cost-effective fashion while considering completeness, effectiveness, efficiency, and acceptability.

Specifically, the CCMP update recommends the following key action elements:

- Implement the Lake Worth Inlet Management Plan (adopted by the Town Council on March 4, 1995 and by the State of Florida on November 25, 1995)

- Construct sand retention structures and restore and maintain beaches along the designated reaches;

- Implement a comprehensive coastal monitoring program;

- Maintain, restore and/or replace existing coastal structures; and

- Renourish restored reaches periodically to sustain project benefits.

A preliminary implementation schedule calls for undertaking the above elements over a 10-year period. Beach renourishment will be necessary to sustain the restored beach segments typically at eight year intervals thereafter.

Six individual beach restoration efforts are proposed in the CCMP. These are the most significant improvements from a cost, benefit, and scale perspective. The initial beach restoration component of the plan proposes to place approximately five million cubic yards of sand over a total shoreline length of 13.45 miles at an estimated cost of $52,000,000. It is important to note that these totals are for the entire Island, not just the Town of Palm Beach. The cost for the Town of Palm Beach alone is estimated to be $48,491,000.

Included with the sand placement is the construction of approximately 40 sand retention structures. The maintenance or rehabilitation of existing coastal structures is in many cases also recommended; however, estimating the costs for this work will require more detailed evaluations.

Preliminary Storm Protection Benefits Analysis

The benefits associated with undertaking the plan recommendations are significant.

Recreational benefits, contributions to the Island's economy attributable to a high quality beach, and reduced requirements for private upland shore protection structures are a few. Partial restoration of the sand transport deficit is another physical benefit which will accrue to the Island. A major benefit, however, will be to provide island properties (estimated assessed value of more than six billion dollars) with improved storm protection, seawall protection and land loss prevention at an annualized cost of approximately 3.6 million dollars (assuming a 30-year project life) for the Town of Palm Beach.

Implementing the plan will provide approximately $8.5 million in annual benefits. at an annualized cost of $4.2 million from inlet to inlet.

The average benefit/cost ratio calculated for all recommended beach restoration projects for the Island of Palm Beach is estimated at 2.44 to 1. This means that over the project life, the communities will derive $2.44 of benefits for each dollar of costs.

The net present value of the storm protection benefit over a 30-year project horizon is $79,855,060 and the annual storm protection value is $5,201,169.

Preliminary Recreational Analysis and Apportionment Plan

- The costs and benefits of the program are based on initial nourishment and structure placement and maintenance for a period of 30 years. Funding, however, will probably be based on intervals of eight years to coincide with renourishment intervals.
- Because of cost savings derived from fewer mobilizations and the benefits of longer projects, the schedule should be modified to complete initial nourishment over approximately two to three years.
- Within the Town of Palm Beach, Regional Research Associates developed a special assessment program that includes an ad valorem tax on all properties to pay for the benefits to publicly owned lands and the recreational benefit of the project. The millage rate would be the same for all properties for this community benefit. In addition, oceanfront property owners would be assessed on a front foot basis for the storm protection benefit derived from any project.
- Regional Research Associates also outlined the advantages and disadvantages of

using a flat rate ad valorem tax to fund the project.

- # Storm protection benefits were determined by reach for each oceanfront property based on front footage. The percentage of benefits were then turned into costs to determine assessment.
- # There are concerns about the costs for Reaches 2 and 5, because of the frequent renourishment intervals. The economist recommends that the engineer be authorized to revise the plans for those reaches to see if costs can be reduced.
- # The economist suggests the Town of South Palm Beach consider an ad valorem special assessment for both storm protection and recreation benefits.

The Next Steps

- # **Funding**: Once the funding method is finalized and costs are more refined, the Town may ask the voters of Palm Beach to approve funding for the plan.
- # **Sand Search**: Approximately five million cubic yards of sand are necessary to initially restore the shoreline as outlined in this update. A borrow area which appears to have sufficient sand has been identified, but will require further analysis to determine its compatibility. This has been approved and is underway.
- # **Start-up Costs:** The Town should consider the feasibility of combining the various reaches into two projects constructed within a two to three year time period. This would reduce these start up costs and at the same time reduce losses at the project's ends.
- # **Grants**: Potential funding is available from Palm Beach County, Florida Inland Navigation District, the state of Florida, and the federal government. Other sources may also be available. The Town should look at what funding sources are available without changing parking or accesses from what is in place now.
- # **Modify Reaches 2 and 5:** Based on improved technology and improved mitigation, consider modifying the projects recommended in Reach 2 and 5 to increase their cost to benefit ratio.
- # **Hardbottom Resources**: Mapping and defining the nearshore hardbottom resources located within the project area is important. Permitting agencies require mapping to determine how to mitigate the construction impact on these resources. The mapping should follow the proposed restoration schedule.
- # **Mitigation and Monitoring**: The actual project impacts and solutions approved by the permitting agencies will dictate the requirements for mitigation and monitoring.

The estimate of the actual 1997 cost of initial recommended beachfill/groin field plan improvements (less monitoring) was approximately $52 million. With the addition of recommended initial implementation elements associated with Lake Worth Inlet, total 1997 costs are approximately $55.9 million. The costs for the Town of Palm Beach would be $48,491,000.

In the resolution forming the Shore Board, the Town of Palm Beach stated that its beaches are its greatest natural asset. To protect that asset, like any other, a comprehensive approach from inlet to inlet is needed rather than a piecemeal or crisis management approach. A program has been developed that will increase property protection and provide aesthetic and recreational opportunities for the next 30 years at a benefit that exceeds costs by over 2 to 1. Through the efforts of Applied Technology and Management and peer review by the Woods Hole Group and an economic study by Regional Research Associates, the Town has a program that is based on technical analysis and study. The time is coming for the community as a whole to determine the future of the beaches on the island of Palm Beach for the next 30 years.

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Introduction

In the fall of 1997, Gooderham & Associates was requested to prepare a lay version of the Applied Technology & Management, Inc. (ATM) Comprehensive Coastal Management Plan (CCMP) Update. In the meantime, it became clear that other aspects of coastal management that were a part of the ATM contract were also necessary to understand and make cogent decisions about the future of the beaches in the Town of Palm Beach.

This report includes both a lay version of the CCMP as well as general economic and special assessment information, a glossary, and a question and answer section. It emphasizes the recommendations, assumptions, and other thought processes utilized by the Town, the Shore Board, the engineers and economists and others in their decision making. It should be noted that the Corps of Engineers, the Florida Department of Environmental Protection, Cubit Engineering, Applied Technology and Management, and the Woods Hole Group have all recommended beach restoration for Palm Beach.

History

The Town of Palm Beach has been concerned about erosion for over 70 years. It began with the construction of the Lake Worth Inlet jetties and navigational channel in the 1920s. The numerous subsequent increases in the depth of the channel's entrance to benefit the Port of Palm Beach seriously hampered the north to south movement (littoral transport) of sand along the beaches from inlet to inlet on the island of Palm Beach.

To make matters worse, until 1970 all material dredged to maintain the channel's depth was dumped offshore, meaning nearly 2 million cubic yards of sand were lost to the beaches of the island of Palm Beach. In the late 1950s, a sand transfer plant was constructed to capture some of the sand that could not pass around the inlet and place it on the beaches to the south; however, it could not restore the 7 million cubic yards lost due to the inlet. (ATM Executive Summary, page i, page 1)

In addition, a series of hurricanes in 1903, 1926, 1928 and 1933 further eroded the beaches of Palm Beach to the point where the Town authorized a seawall and groin construction program in 1926. The seawalls have continued to provide storm protection, but many of the groins have deteriorated.

As a result of state encouragement and funding (totaling $75,000) in the late 1970s and early 1980s, numerous groins were removed in the midtown area. Since then, research has shown that more sophisticated groins can be successfully incorporated into a beach

management program if they are filled with sand through beach nourishment and adequately maintained. Obtaining permits for groins from state and federal agencies during the 1980s was next to impossible. The state has begun to relax its anti-groin stance and agrees that adjustable groins have their place in beach restoration.

A variety of beach protection studies for Palm Beach have taken place over the years, beginning with a 1936 cooperative study by the Town and the U.S. Army Beach Erosion Board that led to the monitoring of an experimental groin field from May 1937 through July 1946. In 1940, the U.S. Army Corps of Engineers (USACOE) and the University of Florida completed a jointed study followed by an additional Corps study in 1946.

Another study, approved in 1955, considered several alternatives intended to restore the Town's eroded beaches and a general investigation of the effectiveness of a sand transfer program. Based on this study, a sand transfer facility was constructed which reportedly transferred approximately 2.7 million cubic yards of sand across the inlet between 1957 and 1985. (Recent investigations suggest the actual amount of sand transferred was closer to 1.3 million cubic yards.) The various studies also concluded that the groins were ineffective without additional sand and a maintenance program.

Table 1
HISTORICAL SAND PLACEMENTS

Year	Sand Quantity	Area
1944	282,000 cubic yards	Adjacent to Mediterranean Avenue
1948	2.3 million cubic yards	Eden Road, Tangier Ave., Banyan Road
1948	225,000 cubic yards	South of Lake Worth Inlet
1949	100,000 cubic yards	South of Sloan's Curve
1949	380,000 cubic yards	Adjacent to Mediterranean Avenue
1953	463,000 cubic yards	South of Lake Worth Inlet
1970-78	450,000 cubic yards	South of Lake Worth Inlet
1976	100,000 cubic yards	Sloan's to Widener's Curves
1976	86,000 cubic yards	Chilean Avenue
1985	131,000 cubic yards	South of Lake Worth Inlet
1985	2 million	Dumped offshore

1986 10-Year Comprehensive Coastal Management Plan (CCMP)

While seawalls and groins were constructed during over the years in accordance with a Town ordinance adopted in 1932, no comprehensive shoreline management program had been developed. Responding to the need for an overall program to protect the island, the Town of Palm Beach authorized development of a Comprehensive Coastal Management Plan (CCMP) on April 1986. The plan was completed by Cubit Engineering Ltd. in 1986.

The 1986 Plan was based on the following:

- Evaluating the relevant coastal processes which govern the transport of sand along the shoreline.

- Establishing requirements for upland property protection and recreation.

- Evaluating past erosion management techniques.

- Analyzing environmental and economic considerations.

- Charting historical and projected shoreline trends.

- Assessing Town, county, state and federal shore protection programs and funding.

- Meeting the objectives of the Town of Palm Beach with respect to beach use and preservation.

The plan consisted of the following elements:

- Upgrading the Lake Worth Inlet sand transfer plant to increase sand pumping to and approximate the littoral flow at its natural rate. **Status**: Partially completed in May 1996 in conjunction with the Mid-Town beach restoration project.

- Requiring all beach-quality sand from maintenance dredging of the Lake Worth Inlet to be placed on the beaches south of the Inlet. **Status**: Ongoing.

- Restoring the Mid-Town public beach. **Status**: 880,000 cubic yards of sand were placed on the beach along with 11 adjustable groins in 1995-96.

- Planning for restoration of the Town's shoreline south of Sloan's Curve on an as-needed basis. **Status**: This project was not pursued by Palm Beach County.

- Removing derelict groins which were a safety hazard to beach users. **Status**: Derelict groins were removed in the Mid-Town area in 1995 – 96.

- Encouraging dune growth at appropriate areas south of Southern Boulevard.

Status: The County proposed a dune project, but property owners in the area opposed it.

- Repairing and maintaining public seawalls. **Status**: The Mid-Town seawall was repaired in 1994.

- Encouraging inspection and maintenance of private seawalls. **Status**: Not an active project.

Shore Protection Board

In 1995, at the end of the 10-year planning period, the Town Council formed the Shore Protection Board "to serve as an advisory committee to the Town Council on all matters relating to the maintenance, protection, and preservation of the beaches within the Town of Palm Beach." The Town Council, in its resolution forming the Board, stated its rationale:

- The greatest natural asset in the Town of Palm Beach is its beaches.

- The maintenance, protection and preservation of the beaches in the Town are interests vital to the Town's residents and visitors.

- There are major unresolved issues relating to the maintenance, protection and preservation of the beaches within the Town of Palm Beach.

- The issues relating to the maintenance and preservation of the beaches in the Town of Palm Beach are varied and complex.

Shore Protection Board Recommendations

The Board held numerous meetings and hearings, reviewed the 1986 CCMP and the 1996 Lake Worth Inlet Management Plan, and followed the permitting, construction and performance of the Mid-Town Beach Restoration Project and the repair of the Lake Worth Inlet Sand Transfer Plant. The Shore Board also considered the implications of the Section 111 of the Federal Rivers and Harbors Act and the legal issues related to projects adjacent to privately owned upland property. In addition, the Board interviewed numerous coastal professionals, government agencies, and top experts in the industry over the next year. This led to a preliminary report with 12 conclusions:

1. The Lake Worth Inlet is the primary cause of Palm Beach's accelerated beach erosion; it blocks the natural migration of sand from north to south.

2. The Lake Worth Inlet Transfer Plant should remain operational at all costs to help maintain the Town's beaches.

3. A beach chief should be appointed as soon as possible; primary responsibility would be beach and shoreline protection and coordination of all future projects and monitoring.

4. Any Town beach projects should be combined in an overall plan involving other communities from the Lake Worth Inlet to the Boynton Inlet -- the "Inlet to Inlet" concept." No more crisis management or spot projects.

5. Beach and shoreline protection projects should be funded locally at first, with any county, state or federal reimbursements viewed as secondary funding and applied for after projects are completed. Palm Beach should consider establishing a special taxing district and educate private landowners on the benefits of placing sand upland on their property.

6. The Comprehensive Coastal Management Plan is an excellent historical study and basis upon which to develop an effective beach and shoreline protection plan. The plan should be updated and considered in tandem with the recent Town-approved Lake Worth Inlet Management Plan.

7. The best way to proceed with beach and shoreline protection is with adjustable nourished headland structures (ANHS), a special groin recommended by experts, for areas identified by coastal engineers. Other areas can be protected through nourishment alone.

8. To create continuity of information, an ongoing Beach and Shoreline Protection Committee should be maintained and meet regularly to advise the Mayor and Town Council. It must be stressed that no plan available offers maintenance-free operations.

9. The Town should continue to monitor the progress of the Canaveral lawsuit against the USACOE to determine whether Palm Beach has any past or future recourse concerning the Corps' responsibility for erosion of Palm Beach's coastline.

10. Any beach and shoreline protection project must contain an ongoing monitoring program. Lack of solid historical data is one of the Town's biggest problems and has crippled its ability to determine which programs have been successful or not.

11. Beach and shore protection is paramount to the protection of lives and property in the Town. With proper procedures and monitoring in place, beach and shoreline protection projects can and should be installed with minimal detrimental effect to the environment.

12. The Town should hire what it, the beach chief and the Shoreline Protection

Committee determine to be the best coastal engineer(s) to implement an inlet-to-inlet plan, while also hiring a coastal consultant to review any plan design.

The Shore Protection Board concluded that the long-term plan should be continuous and implemented immediately. Actions should occur as soon as possible, with specific projects finished in one-, five-, and 10-year time frames, and any interim emergency measures should be implemented giving consideration to an overall 50-year plan.

CCMP Update

Based on the Board's recommendations and keeping in mind that the Town position is "The greatest natural asset in the Town of Palm Beach is its beaches," the Town agreed to update the 1986 Comprehensive Coastal Management Plan. Applied Technology & Management, Inc. was contracted to prepare the update.

Determining how best to manage the sand from inlet to inlet, as well as the inlets themselves, is critical to any storm protection plan. In addition, identifying and choosing suitable sand for beach restoration and renourishment is essential to the long-term success of the proposed comprehensive program.

As mentioned previously, since the Lake Worth Inlet was excavated earlier this century, the Town of Palm Beach and other municipalities on the island have experienced difficulties maintaining a stable shoreline suitable for protecting the lives and property of all island residents. Sand deprivation in this system is the primary cause of the island's erosion problems from inlet to inlet. Reduced storm protection, reduced property values and inhibited recreational usage are some of the negative results of erosion.

Coastal features affecting the island of Palm Beach include four unique challenges:

- The Gulf Stream in the Atlantic Ocean is close to the mainland of Florida east of the Town of Palm Beach, causing many anomalies such as eddies and currents that are not present elsewhere.

- Lake Worth Inlet, with a 35-foot deep navigation channel, is one of the deeper inlets in Florida.

- The island of Palm Beach is in the "shadow" of the Bahama Islands, which act as a wave reduction reef for the island shoreline.

- Extensive freshwater runoff from the center of the state increases surge and carries sediment (sand) through the canal system into Lake Worth and then from the inlet to the ocean.

The purpose of the CCMP update is to:

- Determine the amount of shore protection required to restore the beachfront after its 70 years of erosion, and then what maintenance will be required.
- Define the overall need for shore protection from inlet to inlet.
- Determine the priority and sequence of activities.
- Estimate the total cost.
- Outline recommended actions for the Town of Palm Beach and the neighboring municipalities to effectively manage the shoreline of the island of Palm Beach from inlet to inlet.
- Consider whether regional planning reduces long-term maintenance costs.

Three principal goals and objectives have been identified in developing this plan update:

1. Maintaining a stable beach on the entire island to provide adequate storm protection, conserve property values and support recreational usage.
2. Designing projects which secondarily limit the impact on environmental resources or adversely affect neighboring shorelines.
3. Cost-effectively following current regulations.

CCMP Update Components

The necessary tasks to update the existing Comprehensive Plan are as follows:

1. Acquire and evaluate existing aerial photography, beach profile, sand source and environmental resource data for the entire island of Palm Beach and perform beach profiles of those areas of shoreline not currently being monitored.
2. Update the coastal structures' inventory (groins, seawalls, jetties) along the Town of Palm Beach shoreline and expand it to identify structures on the remainder of the island's beaches. Assess the condition and effectiveness of these structures.
3. Revise the sand budget for the island of Palm Beach, considering the effects of existing management practices (i.e., beach areas bypassed by the sand transfer system but renourished through maintenance), the performance of the Mid-Town

Beach Restoration Project, inlet maintenance dredging projects and the operation of inlet sand transfer plants.

4. Identify distinct shoreline segments (reaches) from Lake Worth (Palm Beach) Inlet to South Lake Worth (Boynton) Inlet according to erosion rates, sand movement and other coastal processes as well as upland development and environmental resources. This information will be used to develop management strategies and to prioritize shoreline segments based on their need for additional protection.

Based on available information, determine the location, quality and environmental issues associated with available sand sources (borrow sites) for beach restoration.

Provide a preliminary cost to construct the needed shore protection.

Evaluate regulatory requirements and their potential limitation for each recommended objective.

Estimate the amount of sand needed, the potential need for new structures or maintenance of existing structures and environmental impacts when developing designs for project segment(s).

Recommend a coastal monitoring program which assesses erosion/accretion trends, environmental resources, sand migration, inlet sand management and project performance. This information is critical to fine-tune future projects.

Prepare a schedule to implement all phases of the management plan, including conducting field investigations, obtaining permits, constructing the projects and monitoring.

Aubrey & Associates of the Woods Hole Group would conduct a peer review of the full ATM report.

Data Gathering/Structures Inventory

Determining the health of the Town's beaches for this update required extensive data-gathering, which included locating, collecting, reviewing and interpreting shoreline study and monitoring information gathered over the last 10 years by numerous public and private entities. Aerial photography, pre- and post-dredge records for Lake Worth Inlet and the USACOE "Coast of Florida" study are a few of the data sources which were investigated.

In addition to reviewing the abovementioned historical information, research into existing conditions was also important. To accomplish that required acquiring beach profiles for

the entire island and completing an extensive coastal structures inventory. The structures inventory helped in the assessment of the condition and performance of existing coastal structures (i.e, groins and seawalls) between Lake Worth and Boynton Inlets. It also helped in the determining whether additional storm protection was needed along each individual reach and to evaluate whether adjustable groin fields are needed to help stabilize beachfill. Based on the beach profiles, the engineers updated how much sand moves along the shoreline, known as the "sediment budget."

Shoreline Reach Identification

The engineers, recognizing, the variety of shoreline conditions affecting the island of Palm Beach, divided the island into 11 different reaches or areas of similarity based on the following:

- Predominant coastal features affecting a shoreline including sand movement and erosion rates.
- Reefs, hard bottom and other natural resources that need special protection.
- The number and condition of existing shore protection structures (e.g., groins and seawalls)
- Existing adjacent land use.

They delineated distinct zones for each of the above four parameters. Those were then reviewed and merged to designate individual shoreline management reaches. All shoreline management recommendations coincide with these reaches:

Table 2

Shoreline Reach Boundaries and Proposed Projects

Reach	Upland Parcel/Street/Feature Reference	Proposed Project
1	Lake Worth Inlet south jetty to Onondaga	Inlet Management
2	Onondaga Avenue to 1,080 feet north of Wells Road	Beach Nourishment and Groins
3	1,080 feet north of Wells Road to Via Bethesda	Beach Nourishment
4	Via Bethesda to 270 feet south of Banyan Road	Beach Nourishment
5	300 feet south of Banyan Road to 170 feet north of Widener's Curve	Beach Nourishment and Groins
6	170 feet north of Widener's Curve to Sloan's Curve	No Project
7	Sloan's Curve to the Ambassador Hotel	Beach Nourishment and Groins
8	Ambassador Hotel to La Bonne Vie	Beach Nourishment and Groins
9	La Bonne Vie to Lantana Avenue access	Beach Nourishment
10	Lantana Avenue access to Chillingsworth Curve	Beach Nourishment
11	Chillingsworth Curve to South Lake Worth Inlet	No Project (Inlet Management Plan being prepared)

Source: Regional Research Associates Report, January 1999, page 2

Island Sediment Budget

ATM determined the sediment budget, the amount of sand moving along the shoreline, for the island of Palm Beach, by comparing beach profile surveys conducted in 1990 and 1997 and computing volumetric changes between the profiles. For the purposes of this budget, engineers utilized three generally accepted erosion levels: a high erosion rate is the net loss of more than 4 cubic yards of sand per linear foot of beach per year, while a moderate erosion rate is the net loss of 1.5 to 4 cubic yards of sand per foot per year. A low erosion rate is the loss of less than 1.5 cubic yards of sand per foot per year.

With the exception of the northern 2,000 feet of shoreline (adjacent to the south jetty at Lake Worth Inlet) and the Mid-Town Project shoreline, the remainder of the island loses more sand than it gains. The 15.7-mile long island of Palm Beach lost a total of 555,000 cubic yards per year, or 6.7 cubic yards per foot per year, between 1990 and 1997. The highest erosion rates on the island occurred immediately south of Sloan's Curve, where the shoreline lost approximately 15 cubic yards per foot per year.

Sand pumped for the Mid-Town Beach Restoration Project, the newly restored sand transfer plant and Lake Worth Inlet maintenance dredge disposal operations reduced this loss by 54 percent, but did not make up for the loss of approximately 7 million cubic yards since construction of the Lake Worth Inlet. The Mid-Town Project placed 882,158 cubic yards of sand between on Reach 4 (from approximately adjacent to Via Bethesda to Banyan Road) in December 1995, representing an average of 133,156 cubic yards per year over the 6.6-year period of analysis (Applied Technology & Management Summary Report, page 7).

Table 3

1990-1997 SEDIMENT BUDGET
ANNUAL VOLUME CHANGE RATES
BY REACH DESIGNATION

REACH NO.	START	END	LENGTH (FEET)	VOLUME CHANGE CY/YR	CY/FT/YR	COMMENTS
1	R-76	R-78	2,410	36,104	15.3	2,400 feet south of Lake Worth South jetty; sand bypassing
2	R-78	R-90+400	13,660	(90,889)	-6.7	High erosion rates
3	R-90+400	R-95	5,800	(12,157)	-2.1	
4	R-95	R102+300	8,065	64,566	8.0	Mid-Town project: change without fill = (8.5) cy/ft/yr.
5	R102+300	R110+100	9,065	(23,832)	-2.6	
6	R110+100	R116+500	6,685	(41,460)	-6.2	High erosion rates
7	R116+500	R125	8,725	(74,723)	-8.6	Highest erosion rates on the island
8	R125	R134	10,690	(66,054)	-6.2	High erosion rates
9	R134	R137+400	3,655	(16,114)	-4.4	La Bonne' Vie to Lantana Ave. access
10	R137+400	R145+740	8,560	(30,113)	-3.5	
11	R145+740	Inlet (R151+300)	5,530	(5,339)	-1.0	Accretional above MHW
TOTAL			**82,845**	**(260,011)**	**-3.1**	

Measured annual shoreline volume change:	**(260,011)**	**-3.1**
FILL ADDED:		
Bypassing plant:	39,525	0.5
Channel maintenance:	122,305	1.5
Mid-Town project:	133,156	1.6
Actual annual shoreline volume changes	**(554,997)**	**-6.7**

Annual Volume Change Rates by Reach Designation

Source: Applied Technology & Management Summary Report, page 8

SHORELINE MANAGEMENT INITIATIVES BY REACH

Once ATM identified the 11 shoreline reaches on the entire island of Palm Beach, the next step was to determine management solutions for each based on the principal objectives to provide storm protection for the island and to re-establish sand transport across Lake Worth Inlet. Additional benefits include maintenance and enhancement of property values and recreational enhancement of the beach.

The most economical and environmentally feasible means of maintaining the island's beaches is beach restoration, which includes adjustable groins in some areas and subsequent renourishment. Because each reach may have a much different rate of sand movement than its neighbor, and to protect near-shore hardbottom resources, each shoreline reach is treated and designed individually to consider funding, political, environmental and legislative issues. Designing a beach involves balancing these four interrelated factors.

Table 4

SHORELINE MANAGEMENT RECOMMENDATIONS

PRIORITY	DESCRIPTION	LOCATION	SHORELINE LENGTH (FEET)	SCHEDULE	INITIAL RESTORATION COST (1997 DOLLARS)
1	Implement inlet management plan	Lake Worth Inlet to 3,500 feet south	----	Years 1-5	$3,500,000
1	Perform structure maintenance	Island-wide	----	Years 1-10	TBD
2	Perform data gathering and monitoring	Island-wide	----	Years 1-10	$735,000
3	Restore Reach 7 and construct to the groin field	Sloan's Curve to Ambassador Hotel	10,315	Year 2	$10,935,500
4	Renourish/restore Reaches 3 & 4	El Mirasol to Via Bethesda	12,704	Year 3	$8,030,000
5	Restore Reach 2; construct and rehabilitation groins	Onondaga Avenue extending 13,660 feet south	13,660	Year 3	$10,780,120
6	Restore Reach 8 and construct groin field	Ambassador Hotel to La Bonne' Vie	10,690	Year 4.5	$9,212,300
7	Restore Reaches 9 & 10	La Bonne' Vie to Chillingsworth Curve	14,250	Year 6.5	$6,028,775
8	Restore Reach 5	Banyon Road to Widener's Curve	9,415	Year 8.5	$6,649,400
TOTALS:			**71,024** (13.45 miles)		**$55,871,095**

Source: Applied Technology & Management Summary Report, page 17

Assumptions

Without completing the engineering, design and bidding for a project, it is impossible to determine exact specifications and costs. Yet, using generally accepted guidelines, Palm Beach can make appropriate decisions based on these assumptions:

- The beach will be designed to withstand a 15-year frequency storm (having a 1 in 15 chance of occurring each year). To provide this protection, the added beach width should be adequate to accommodate erosion of the beach during the time between renourishments (approximately eight years) plus storm-induced erosion losses statistically expected to occur for a 15-year return period hurricane (approximately a Category 2 hurricane). Most beach restoration projects are designed for the 15-year storm and these designs enhance storm protection for more severe storms.

- Studies have shown that all other things being equal, longer restoration projects erode less quickly than short ones. The reasons include overall stability of the beach system and reduced loss of sand at the ends in comparison to the remainder of the project.

- Restoring the island from inlet to inlet restores the island's natural protective system. This is comparable to painting an entire home vs. painting only those areas that look the worst.

- Choosing an appropriate interval between restoration and renourishment results in cost effectiveness, maximum funding participation by the state (for those projects which are eligible for state support), and appropriate quantities of sand. While this interval is typically about eight years, storm activity and site specific constraints such as hardbottom and sand compatibility often require modifications.

- Beach elevations are established at elevation +9 feet above the National Geodetic Vertical Datum of 1929, or NGVD (sea level), the same height as specified for both the Mid-Town Beach Restoration Project (constructed in 1995/96) and the Ocean Ridge Shore Protection Project (construction in 1998).

- Beachfill construction slopes will mimic a natural slope as much as possible.

- Based on recent bids, ATM engineers assume sand prices are $6.50 per cubic yard in place. Start-up costs (mobilization and demobilization) for restoration are assumed to be $750,000 per event to allow for transportation and preparation of dredging equipment and work crews at each restoration site. Combining reaches reduces these costs.

- Groin fields (or adjustable nourished headland structures), will be configured in the shape of a “T” in more or less continuous fields to help hold the sand on the beach and reduce the differences in speed of sand transported between adjacent reaches.

- All T-head groins will be constructed of armor stone placed on a geotextile mattress or fabric to limit settling following construction.

- Armor stone costs are assumed at $100 per ton furnished and installed. Stone used to fill void spaces created by the armor stone, or “chinking" stone, is assumed to be $70 per ton installed.

- The orientation, length, individual weight specification of armor stone and the center spacing of the individual groins, as well as the total number of groins in a groin field, will be determined after the detailed design is completed.

Specific shoreline management recommendations are more specifically delineated in Appendix A.

Monitoring Plan

To evaluate a coastal management program, the goal must be defined. The overall goal is to develop and sustain a stable shoreline that provides storm protection and recreation. The engineer defines how the project should respond under normal circumstances. Adequate and reliable data to support sound engineering decisions associated with coastal management is critical to that success. This can be accomplished by initiating a comprehensive monitoring program to perform periodic, consistent data collection which will form the basis for future decision-making and long-range planning.

No one can determine the success or failure of a specific project without monitoring to evaluate performance and impacts to adjacent shorelines. A detailed monitoring plan would include annual beach profiles, supplemental bathymetric surveys to help verify the Lake Worth Inlet sediment budget, sand quality monitoring, aerial photography, periodic coastal structure and dune assessments, hardbottom characterization and mapping, and protected species monitoring.

While beach nourishment has had a mixed record in other parts of the country, it has been highly successful in Florida. Successful projects range from large projects including Duval, Broward, Dade, and Pinellas county shorelines to smaller projects like Anna Maria Island, Naples, Marco Island, and Captiva. In those few cases where projects have not performed as anticipated, it has been due to inadequate quantity of sand, fine grain size, short project length or other extraordinary circumstances.

The Town staff should maintain these results in a data base for future reference. This information be helpful in assisting with the permitting and design of the proposed shoreline management improvement projects.

Economic Value of Beaches

The main benefits of restoring beaches include storm protection and enhanced property values. On the narrow island of Palm Beach all property values are enhanced economically by a restored beach. Additional benefits include environmental, community and recreational improvements, contributions to the Island's economy attributable to a high-quality beach and reduced requirements for shore protection structures. Mitigating the long term sand deficit caused by the Lake Worth Inlet is another physical benefit.

It is clear that restored beaches contribute to the economy in a number of ways. They also benefit properties not adjacent to the beach with the benefit reduced as distance from the beach expands.

Although each beach community is unique and so are its array of benefits, examples of the kinds of benefits beaches have provided to other Florida island communities include property value increases even on the mainland in Manatee County after island beaches there were restored. Studies in Manatee and Broward Counties found that sales and employment increased after beach restoration projects. Both counties also saw increased contribution to the tax base, an argument in support of county funding for the project.

Funding Sources

The Town is looking into the possibility of applying for grants to lessen the project's cost to the property owners. The Town will accept only those grants that are based on existing parking and existing accesses. Sources of possible contributions include:

- Port of Palm Beach: If Lake Worth Inlet were purely a recreational inlet, the depth would be 12 feet instead of the existing 35 feet. This extra depth increases the impact of the inlet on the sand transport to Palm Beach Island. If sand bypassing is not continued, the inlet will become difficult to navigate. The Port has entered into a tri-party agreement with the county and federal government to facilitate the restudy of the bypassing system.

- USACOE: If the inlet and its jetties had never been constructed and maintained by the Corps, the Island of Palm Beach would have a significantly reduced erosion problem. In addition, the 2 million cubic yards that the Corps dredged from the channel and dumped offshore is a lost resource.

- Local Governments: The five municipalities on the Island and the county all benefit

from the beach in terms of recreation for their residents and visitors, hazard mitigation, increased tax collections, increased employment. Public infrastructure is also protected.

State: The state benefits by the increased tourism which creates sales and jobs and increased tax revenues including sales taxes, car rental surcharges, and gasoline tax. In addition, restored beaches would provide storm damage protection for the state-owned road and seawall.

Tourists: Tourists clearly benefit from beaches. Beaches are the number one reason people visit Florida. Beaches are the number one recreational area.

Florida Inland Navigation District: FIND is now making restoration projects eligible for grants if the sand is removed from a channel. Sand transfer or channel maintenance dredging may also be eligible.

Island Property Owners: Island property owners benefit in varying degrees. Clearly the storm protection afforded to those closest to the beach is the most significant. Plus, the character of the communities on the island is also impacted by the health of the beach. Recreation is a significant benefit to both property owners and guests, even those whose only use of the beach is visual benefit from it. Finally, an ecologically healthy beach environment is aesthetically desirable.

Island Businesses: While off-island businesses do benefit from beach management, on-island business, and oceanfront businesses in particular, benefit significantly more.

Preliminary Storm Protection Benefits Analysis

Before recommending the beach management plan, ATM performed a preliminary analysis to examine the overall economic viability of the six identified beach restoration projects on Palm Beach Island and to determine the associated project benefits over the project design life.

The properties on the Island benefitting from restoration have an estimated value of over $6 billion. Assuming a the project is maintained over its 30-year plus life, implementing the Plan will provide approximately $8.5 million in annual benefits at an annualized cost of $4.2 million.

Storm damage protection is a critical benefit. For example, the 1928 hurricane damaged $11 million in property in Palm Beach. In 1997 dollars, that damage would equal $111 million. That excludes the value of any construction since 1928. Following Hurricane Opal in 1996, the USACOE estimated that had Panama City Beach's beach restoration project

been constructed prior to the storm, upland damage could have been reduced by up to 70 percent.

A 1987 University of Florida study was the first to quantify the storm protection benefits for a variety of beach restoration projects in Florida. It concluded that a 100-foot wide beach reduced damage substantially. But even a 50-foot beach reduced storm damage.

Table 5

REDUCTION IN STORM DAMAGE

	50 feet of beach	100 feet of beach
25-year storm event	29% reduction	51% reduction
50-year storm event	24% reduction	39% reduction
100-year storm event	17% reduction	25% reduction

It is clear that the wider the beach, the more protection it offers upland property. On the Island of Palm Beach, the initial average beach width will exceed 100 feet after construction.

In terms of the beach management study update, the average benefit/cost ratio calculated for all recommended beach restoration projects for the Island of Palm Beach is estimated at 2.44 to 1. This means that over the project life, the communities will derive $2.44 of benefits for each dollar of costs.

The storm protection benefits derived from a beach nourishment project reflect the engineering design features of the projects. The beach restoration project design life was based on maintaining the beach for 30 years. Storm protection benefits to upland properties are based on the prevention of land loss and the anticipated cost savings realized by reduced maintenance or repair of the existing seawalls fronting individual properties.

Table 6

SUMMARY OF STORM PROTECTION BENEFITS TO OCEANFRONT PROPERTIES BY REACH

30-YEAR PROJECT DESIGN LIFE

REACH	REACH LENGTH (FEET)	BEACHFILL PROJECT LENGTH (FEET)	TOTAL OCEANFRONT PROPERTY VALUE (1996 VALUE)
1	2,290	N/A	$44,914,743
2	13,544	13,544	$268,854,443
3	6,008	4,200	$399,533,146
4	9,750	9,750	$131,210,266 *
5	7,180	7,180	$181,032,349
6	5,785	N/A	$125,290,876
7	9,100	9,100	$322,594,527
8	10,715	10,715	$427,294,601
9	3,324	3,324	$132,045,841
10	8,661	8,661	$182,960,966
11	5,645	N/A	$65,025,669
TOTALS	**82,002**	**66,474**	**$2,280,757,427**

REACH	LAND LOSS BENEFIT (PRESENT $s)	SEAWALL REPAIR MAINTENANCE/ NEW/BENEFITS ECS (PRESENT $s)	TOTAL STORM PROTECTION BENEFIT (PRESENT $s)	TOTAL STORM PROTECTION BENEFIT (ANNUAL $s)
1	$0	$0	$0	$0
2	$963,938	$8,990,851	$9,954,789	$648,057
3	$2,457,539	$4,631,517	$7,089,056	$461,498
4	$0	$6,696,316	$6,696,316	$435,930
5	$1,053,949	$3,259,758	$4,313,707	$280,822
6	$0	$4,117,976	$4,117,976	$268,080
7	$17,268,479	$4,684,851	$21,953,330	$1,429,162
8	$8,672,204	$5,689,488	$14,361,692	$934,946
9	$884,784	$2,123,870	$3,008,654	$195,863
10	$145,713	$6,419,711	$6,565,424	$427,409
11	$1,096,817	$737,301	$1,834,118	$119,401
TOTALS	**$32,543,423**	**$47,351,639**	**$79,895,062**	**$5,201,168**

*__NOTE__: Value of roadway and utilities not included

Benefits are a direct result of the presence of a wide beach that acts as a buffer against

both normal yearly erosion and destructive storm waves resulting from hurricanes and northeasters.

The storm protection benefits of the proposed beach restoration projects were calculated and reduced to net present value. On the basis of these calculations, the net present value of the storm protection benefit over a 30-year project is $79,895,062 and the annual storm protection value of $5,201,168 have been calculated for the proposed beach restoration projects along Palm Beach Island.

Economic Study

In January 1998, the Town contracted with Regional Research Associates (RRA) to develop an economic study and apportionment plan. The RRA report includes various options for collecting local funds to maintain the island's beaches. That study will determine the beneficiaries and their level of benefit. The Shore Board recommended this action for the following reasons:

- Defining stakeholders and their benefit will bolster the case for financial assistance from Palm Beach County and the State of Florida

- Developing an economic model is necessary before requesting voter approval for the projects.

- Defending the apportionment plan against potential legal challenges will be strengthened by the statistics and rationale supplied through the economic model should that be the Town Council's choice.

- Increasing community acceptance of the apportionment plan will be improved if a study is conducted by experts in the field.

- Charging only oceanfront property owners for the project will eliminate a substantial number of people who financially benefit from participating.

Basic Models for Special Assessments

What are the island of Palm Beach's choices in assessment models?

- Ad Valorem Taxes: Funds for the beach project are collected as part of ad valorem taxes. The beach project is treated as an infrastructure construction project in a capital improvements program. This is the most appropriate method when most of the property upland of the beach is publicly owned or at least readily accessible to the community. In addition, the cost of the project should be a relatively small portion of the local government budget so that taxpayers who are off the beach or

do not use it do not feel they are bearing an unfair burden. These conditions prevail in the City of Boca Raton, which uses this method.

Special Assessments: Special assessments are levied on oceanfront property owners based on front footage. This is similar to the assessments levied to pay for water and sewer hookups in many municipalities. This is a good choice when oceanfront owners obtain the bulk of the benefits from the restored beach and land uses and conditions of the structures on the upland properties are similar (e.g., all single family or all condominiums of similar value).

Tiered Assessment Rates: This method levies separate millages based on distance from the beach. Tiered assessments work well in cases where most of the upland property is privately owned. Tiers may include oceanfront, walking distance from the beach, and everyone else. They are preferred over straight ad valorem when most of the beachfront is privately owned so that private oceanfront property owners receive substantial storm damage prevention benefits for a project.

This method has been used on Longboat Key and Amelia Island in Florida and on Bald Head Island in North Carolina. Its simplicity is its greatest attribute as long as no one perceives that the different assessment rates were the result of compromise, rather than a comprehensive analysis of benefits.

Benefit-Based Assessments: This method is based on an economic analysis of the benefits of the beach nourishment project. Generally it results in a categorization of properties into different geographic benefit groups such as oceanfront properties and properties within walking distance of the beach (as in the Tiered Assessments case); but properties may also be grouped by land use to distinguish between hotels and restaurants and residential properties, for example, and to distinguish between single family homes and condominiums. Hotels and condominiums often generate more beach use than single family homes. These assessments can also distinguish among oceanfront properties based on their vulnerability to storm damage.

Benefit-based assessments may be complex, or they may result in simple variations of tiered assessments. They have been applied by the City of Sanibel and on Captiva Island. Often they are based on a combination of property value, front footage and land use.

Funding Using Ad Valorem Property Taxes

One of the approaches RRA reviewed for funding the CCMP is to use ad valorem property taxes. This would involve one millage to be applied to each property in a municipality.

Table 7

Funding the CCMP through Millage

Municipality	1996 Value	Required Revenue	Millage
Town of Palm Beach	$4,403,468,000	$3,615,753	0.8211
South Palm Beach	$ 159,709,000	$ 92,085	0.5766
Manalapan	$ 332,618,000	$ 295,999	0.8899

Source: Regional Research Associates January 1999 Report: page 5

The value of utilizing ad valorem millages was outlined in the previous section. It has some additional advantages over special assessment funding. It is simpler to execute because it works with the standard process of taxation local governments utilize. This method would still require a referendum. It also does not require the placement of liens against properties which often must be paid off at the time of sale. Property taxes are deductible against federal income taxes while special assessments are generally considered not deductible. Finally ad valorem is based on property value which correlates with ability to pay.

Ad valorem property taxes are considered "fair," when the benefits of the project roughly correlate with property values. Even if the benefits do not correlate, they may be perceived as "fair," when the project is part of a package where is does reasonably correlate.

Other considerations include whether the off beach property values are lower than the on beach values; whether commercial values are higher than residential, and whether the cost of the coastal management plan is small relative to the overall ad valorem taxes.

Preliminary Recreational Analysis and Apportionment Plan

Neither the Town Council nor the Shore Board have reviewed the following findings. These are an analysis and recommendations.

The costs and benefits of the program are based on initial nourishment and structure placement and maintenance for a period of 30 years. Funding, however, will probably be based on intervals of 8 years to coincide with renourishment intervals.

Because of cost savings derived from fewer project costs and the benefits of longer

projects, the initial construction schedule should be modified to complete initial nourishment over an approximately 2-3 year period.

Within the Town of Palm Beach, RRA suggests two distinct methods to fund the plan. The first includes an ad valorem tax on all properties to pay for the benefits to publicly owned lands and the recreational benefit of the project. The millage rate would be the same for all properties. Oceanfront property owners would be charged additionally for the storm protection benefits. The second is an across the board millage to all properties regardless of location.

Storm protection benefits were determined by reach for each oceanfront property based on front footage. The percentage of benefits were then turned into costs to determine assessment.

Table 8
Benefits of CCMP Update
30 Year Plan

	Benefits	Benefits	Benefits	Costs	Benefits to Cost Ratio
	Storm Protection	Recreation	Total		
Town of Palm Beach	$61,453,094	$22,499,884	$ 83,952,978	$55,582,991	1.51
South Palm Beach	$ 1,669,638	$ 2,220,424	$ 3,890,062	$ 1,474,994	2.64
Manalapan	$ 8,103,629	$ 475,843	$ 8,745,354	$ 4,514,770	1.49
Lake Worth	$ 1,031,336	$37,253,510	$ 38,284,846	$ 1,466,147	26.11
Lantana	$ 1,634,729	$ 4,569,345	$ 6,204,074	$ 339,656	18.27
Palm Beach County	$ 1,884,773	$15,300,549	$ 17,185,322	$ 602,167	28.54
Total	$75,777,199	$82,319,555	$156,262,636	$63,980,726	2.44

Note: Recreation benefits include all users of beach within the local government jurisdiction. Kreusler and Lantana public beaches would need seawalls in absence of the project. No benefits were included for Reach 6, the area where the road is revetted. Benefits-cost ratios are less than 1 for Reach 2 and the lower part of Reach 5. These costs are with no county or state grants and are expressed in 1996 dollars.

Because of the similarities in land use and benefits, the economist grouped projects in the Town of Palm Beach into two oceanfront areas for assessment: projects north of the revetted road (Reaches 1 through 5) and projects south of the revetted road (Reaches 6-8). In the north area, the predominant land use is single family, but it also contains significant public beach. In the south area, the

predominant land use is multi-family (condominium) and has a smaller public beach. In addition, the Town of South Palm Beach/Lantana and the Town of Manalapan are each an area.

- Because of the difference in benefits, a distinction was made between hotels and single family homes in the North zone. The benefits for beach clubs and condominiums were similar to single family homes, so no distinction was made. This method most accurately reflected the benefit shares (see Table 9).

- In the South zone a distinction was made between single family and condominiums, again, because of a difference in benefits. In that area hotel benefits were similar to condominium benefits, so no distinction was made. This method most accurately reflected the benefit shares (see Table 9).

- There are concerns about the costs for Reaches 2 and 5, because of the frequent renourishment intervals recommended in the CCMP Plan Update. This leads to a benefit cost ratio less than 1 in Reach 2 and barely over 1 in Reach 5 which skews the cost/benefit ratio. About 30 properties in these reaches have very high assessments relative to property values. This could result in an equivalent annual millage of 1.5 mills these properties versus 0.5 mills for the average oceanfront property in the northern half of Palm Beach. As a result, these reaches should be studies further.

- Because of the benefits for The Town of South Palm Beach for both single family and condominium are nearly identical, the Town of South Palm Beach should consider an ad valorem special assessment for both storm protection and recreation benefits.

- The Town of Manalapan has only single family homes except for the Ritz Carlton and a couple of adjacent condominiums, so no distinction between types of property is recommended should they decide to participate.

- If Manalapan declines to participate, the Ritz Carlton should be offered the opportunity to participate in the project. If it is interested, the boundary for Reach 9 would be relocated to include the Ritz Carlton and possibly a few adjacent properties. Participation might enable a dune buffer to be built between the Lantana Public Beach and the Ritz Carlton.

- The cost estimates are based on a worst case scenario - -that is, no funding from Palm Beach County except for Kreusler storm protection and no funding from the state of Florida.

- Average millages and equivalent millages for the worst case scenario are in the

table below.

TABLE 9
AD VALOREM TOTAL MILLAGES BY ISLAND MUNICIPALITY
1996 DOLLARS

Municipality	Ad Valorem	Property Tax Base	Millage Rate
Town of Palm Beach	$35,972,631	$4,403,468,339	0.5109
South Palm Beach	$ 1,559,015	$ 159,709,465	0.7804*
Manalapan	$ 437,238	$ 332,617,871	1.7068*

* Oceanfront rate, non-oceanfront would be 0.6350 for South Palm Beach and 0.0855 for Manalapan

TABLE 10
ANNUAL ASSESSMENTS PER OCEANFRONT
FRONT FOOT BY TYPE OF PROPERTY*

Municipality	Single Family Properties	Condominium Properties	Hotel Properties
Town of Palm Beach - North	$24.20	$24.20	$51.87
Town of Palm Beach - South	$13.80	$37.12	$37.12
South Palm Beach	$ 6.63	$ 5.16	$ 5.16
Manalapan	$31.03	$31.03	$31.03

*The community benefits millage would be added to the assessments for the Town of Palm Beach

In many of the land uses (e.g., single family) there are a small number of other land uses that have the same benefits. As a result these are categorized together. This includes a small number of condominium and institutional properties grouped with single family in Town of Palm Beach - North Project; a small number of hotel and institutional properties grouped with the condominium properties in the Town of Palm Beach - South Project; a hotel grouped with the condominium properties in the South Palm Beach Project; a small number of hotel and condominium properties grouped with the single family properties in the Manalapan project. Again, the benefits of properties which are combined together are similar, so it is appropriate.

Peer Review

In order to be appropriately cautious about the integrity of the CCMP, the Shore Board went through an extensive process to obtain a second opinion. As a result, the time, the Town secured the services of the Woods Hole Group from Massachusetts to provide peer review of the draft CCMP Update prepared by ATM. Most of the comments provided by the reviews suggested completing more detailed planning or design efforts to optimize the project design, implementation and resulting benefits.

It was generally agreed that individual recommendations for shoreline modeling, detailed field surveys and the like would best be undertaken during the first phase of project design. The overall shoreline management concepts did not change as a result of the peer review exercise. It did, however, acknowledge that more detailed analyses should be undertaken when accomplishing the detailed design for individual shoreline restorations.

Disclosure of Risks

The Town of Palm Beach Shore Board and Town Council have made every effort to limit the risk the town and the property owners will incur in implementing a CCMP through retaining coastal engineering consultants and an economist. As the process continues, other professional services will be utilized to continue to limit liabilities while providing beach management. Risk management requires balancing the assets and liabilities of doing something versus the assets and liabilities of doing something else or nothing at all.

The Shore Board has determined the follow risks:

- Sand sources: Based on previous work by the U.S. Army Corps of Engineers, the Town's engineers believe adequate sand sources are available for the 30-year project. The content and location of these sand sources will be a part of the sand source study which Coastal Planning and Engineering should complete in the fall of 1999.

- Inflation: In determining net present value to ascertain costs for the 30-year project, ATM utilized an inflation factor of 3 percent. An increase or decrease in inflation will change the cost.

- Interest rates: In determining net present value to ascertain costs for the 30-year project, ATM utilized an interest rate of 8 percent. An increase or decrease in the interest rate will change the cost.

- Fifteen year storm protection: The beach will be designed to withstand a 15-year frequency storm (having a 1 in 15 chance of occurring each year). To provide this protection, the added beach width should be adequate to accommodate the

landward movement of the beach during the time between renourishments (approximately eight years) plus storm-induced erosion losses statistically expected to occur for a 15-year return period hurricane (approximately a Category 2 hurricane). Most beach restoration projects are designed for a 15-year storm and these designs enhance storm protection for more severe storms.

Sea level rise: In Florida, a one-foot rise in sea level will cause a shoreline recession of 50 to 100 feet. The flatter the slope of the land, the greater the flooding and the greater the area subject to erosion near or under the sea water.

Upland structures: The storm protection benefits to upland properties are based on prevention of land loss and the anticipated cost savings realized by reduced maintenance or repair of the existing seawalls.

The Next Steps

Funding: Once the economic apportionment plan is finalized and costs are more refined, the Town may ask the voters of Palm Beach to approve funding for the plan.

Sand Search: Approximately 5 million cubic yards of sand are necessary to initially restore the shoreline as outlined in this update. In 1993, Palm Beach County identified a borrow area which appears to have sufficient sand to satisfy this requirement. Sand quality will require further analysis to determine its compatibility to the beach and its anticipated project performance.

Should all the preliminary sand source areas identified be viable sources, total sand search costs expected to be approximately $700,000. These activities will determine the quality and quantity of available sand necessary for good design, as well a being a permit requirement.

Start Up Costs: Mobilization and demobilization costs are assumed at $750,000 per reach to be restored. Therefore, total mobilization/demobilization for the 6 discrete shoreline restoration “projects” identified herein would equal $4,500,000. The Town should consider the feasibility of combining the various reaches into two projects constructed within a two to three year time period. This would reduce these start up costs and at the same time reduce the losses at the project ends.

Grants: Potential funding is available from Palm Beach County, Florida Inland Navigation District, the state of Florida, and the federal government. Other sources may also be available. The Town should look at what funding sources are available without changing parking or accesses from what is in place now.

Modify Reaches 2 and 5: Based on improved technology and improved mitigation, consider modifying the projects recommended in Reach 2 and 5 to increase their cost to benefit ratio above 1:1. This could be accomplished if more sand is placed in each reach which would reduce the renourishment intervals. It may be possible to mitigate impacts of the additional sand on the hardbottom.

Hardbottom Resources: Mapping and defining the nearshore hardbottom resources located within the project area is important. The permitting agencies require mapping to determine how to mitigate the construction impact on these resources. Costs to survey, map, and characterize all the areas recommended are expected to cost between $250,000 and $350,000.

Mitigation and Monitoring: The actual project impacts and solutions approved by the permitting agencies will dictate mitigation and monitoring costs . Assuming hardbottom mitigation is required, mitigation construction costs of $50,000 per acre, and required mitigation for only those hardbottom areas which are directly impacted by the construction projects recommended, an expenditure of approximately $1,500,000 would be expected.

These prices are an estimate of the actual 1997 cost of initial recommended beachfill/groin field plan improvements (less monitoring) of approximately $52,000,000. With the addition of recommended initial implementation elements associated with Lake Worth Inlet, total 1997 costs are approximately $55,900,000.

In the resolution forming the Shore Board, the Town of Palm Beach stated that its beaches are its greatest natural asset. To protect that asset, like any other, needs a comprehensive approach from inlet to inlet rather than a piecemeal or forest file approach.

The CCMP has been updated with a plan that will increase property protection and provide aesthetic and recreational opportunities for the next 30 years at a benefit that exceed costs by over 2 to 1. Through the efforts of Applied Technology and Management and peer review by the Woods Hole Group and an economic study by Regional Research Associates, the Town has a program that is based on technical analysis and study. The time is coming for the community as a whole to determine the future of the beaches on the island of Palm Beach for the next 30 years.

Appendix A

SHORELINE MANAGEMENT INITIATIVES BY REACH

Reach 1 - Lake Worth Inlet South Jetty to Onondana Avenue (500 feet north of Reef Road)
(ATM Summary Report, page 10)

The first segment of shoreline south of the Lake Worth Inlet south jetty covers approximately 2,400 feet of Atlantic Ocean frontage to Onondana Avenue. Sand from the Lake Worth Inlet and Lake Worth Inlet maintenance dredgings were placed along this reach. In May 1996, Palm Beach County and the Town completed repairs to the sand transfer plant located adjacent to the north jetty at the extreme south end of Singer Island. Sand pumping operations resumed in May 1996. As a result, there has been a buildup of sand when analyzed over the September/October 1990 to April/May 1997 period.

While the refurbishment of the sand transfer plant has re-instituted sand transfer from the south end of Singer Island to the north end of island of Palm Beach and the deposit of beach-quality sand in this area by the USACOE, two principal objectives of sand bypassing across the Inlet are now, at least partially, being satisfied. However, in addition, the following steps are necessary to appropriately manage the Lake Worth Inlet and its adverse impacts to the island of Palm Beach shoreline:

- Modify current USACOE dredge spoil (sand) disposal practices. (This is almost accomplished as the County, USACOE and the Town have agreed in principle to a specific area on the north end of the island in which to place all dredged sand until full).

- Place future dredged sand further south of the Inlet.

- Monitor the Inlet littoral processes, sand transfer plant operations, and verify the Lake Worth Inlet sediment budget (maintenance dredge spoil disposal quantities, sand transfer plant by-passing volumes), and assess the amount of sand moving from the north end of the island into the Inlet and to the south.

- Complete improvements to the sand transfer plant capacity to enable it to achieve annual sand bypassing goals.

- In an aesthetically acceptable manner, extend the sand transfer plant pipeline discharge further south of its current location.

<u>Shoreline Management of Reach 2 - Onondaga Avenue to 1,080 feet north of Wells Road</u>
(ATM Summary Report, page 13)

- Because of relatively high erosion rates averaging 6.7 cubic yards per foot per year over this 13,600-foot shoreline segment, ATM recommends beach restoration for Reach 2.

- Extensive near-shore hardbottom is prevalent over the entire reach. Until the hardbottom features are adequately mapped and their quality determined, the

extent of an actual beachfill impact is largely unknown.

Assuming the reef is all quality hardbottom habitat and thus, under existing environmental laws, may not be disturbed with beachfill, ATM reduced the beachfill volume from optimal to a more modest quantity of sand to restore this shoreline.

Two sections of shoreline are recommended for construction of groin fields with a total of approximately 22 groins. To minimize near-shore hardbottom impacts, an average beachfill volume of approximately 45 cubic yards per front foot is projected to withstand a 15-year storm event.

Because hardbottom areas are extensive and close to shore, and the erosion rate is high in this area of the island, the beach restoration project for this reach will be designed for a 3-year beach renourishment interval rather than the targeted 8-year interval. If future mapping results in less exposed near-shore hardbottom, more sand could be placed within this reach with each dredging, and the renourishment interval could be increased. Based on Palm Beach County Department of Environmental Management (PBCDERM) information and a three-year interval renourishment program, (45 cubic yards per front foot) covers approximately 17.6 acres of near-shore hardbottom.

Shoreline Management of Reaches 3 and 4 --1,080 feet north of Wells Road to Via Bethesda and from Via Bethesda to 300 feet south of Banyan Road (ATM Summary Report, Page 13)

In the 1990-1997 evaluation, the northern 5,800 feet of these two combined reaches of approximately 13,850 feet has one of the lowest average annual loss rates on the island at 2.1 cubic yards per foot per year. However, the existing shoreline is heavily and almost continuously armored by seawalls and several groins, ranging from derelict to functional.

Both the high development density of Reach 3 and the lack of beach suggests a higher priority for construction in this area. In terms of cost-effectiveness, it makes sense for both the management solution for Reach 3 and the renourishment of the Mid-Town Project, which comprises the majority of Reach 4, to occur simultaneously.

The condition of the groins near the Breakers Hotel and Beach Club should be evaluated, as these structures may require maintenance or redesigning to increase their effectiveness in holding sand.

The Mid-Town groin field should be inspected and maintained to support the approximately 990,000 cubic yards of beachfill projected for this portion.

- With the existing structures in place, no additional groins are planned. A beachfill averaging 78 cubic yards per foot should restore the Mid-Town Project at its first anticipated renourishment interval in 2000.

- Equivalent placement of groins in Reach 3 will provide protection from a 15-year storm with an eight-year renourishment program.

- The boundary of the Mid-Town Project should be extended south to coincide with the Reach 4 boundary located approximately 350 feet south of R-102. Less than 0.4 acres of mapped near-shore hardbottom are expected to be directly affected by the beachfill.

Shoreline Management of Reach 5 -- 300 feet south of Banyan Road to 170 feet north of Widener's Curve (ATM Summary Report, page 14)

Moderate erosion rates of approximately 2.5 cubic yards per foot per year were calculated for the 9,065 feet of Reach 5, which terminates immediately north of Widener's Curve and the north edge of the Florida Department of Transportation (FDOT) rock revetment which fronts Route A1A.

- Approximately 620,000 cubic yards of beach sand should be placed along Reach 5. The sand will be anchored at the south edge by a 1,850-foot groin field of 4 or 5 T-head groins to lessen the amount of fill that moves from Reach 5 to the highly erosional Reach 6 shoreline. It will also allow a design using less sand to minimize near-shore hardbottom impacts. Approximately 3.7 acres of near-shore hardbottom are located within the beachfill project.

Shoreline Management of Reach 6 -- 170 feet north of Widener's Curve to Sloan's Curve (ATM Summary Report, page 14)

Reach 6, the area of the FDOT rock revetment constructed in 1987, is currently experiencing the third-highest erosion rates on the island of Palm Beach. The shoreline over this time period has lost 6.2 cubic yards per foot per year on average over the 6,685-foot shoreline. While beachfill would seem to be a logical solution to offset the erosion problem, a large near-shore profile trough approximately one mile long parallel to the revetment has expanded since the revetment was constructed. To stabilize the beach with sand placement, it would be necessary to provide enough sand to both fill the trough and fill the beach which is not cost-effective.

Additionally, extensive hardbottom occurs within 200 feet of the 1997 Mean High Water shoreline. Some of this hardbottom is actually visible from the shoreline

- The condition of the FDOT revetment should be carefully assessed and the

structure maintained to protect the roadway (A1A), the only hurricane evacuation route from this area. Sand placement by beach restoration is not recommended, due to the high erosion rate evident in this reach, coupled with the large trough located between 70 and 350 feet from shore and the extensive hardbottom feature of the seabed. The trough would act as a sink, swallowing replacement sand. Because the hard bottom is so extensive, it is would be difficult to artificially develop sufficient hardbottom or other mitigation to compensate for that loss.

How the sand moves up and down the beach within Reach 5 and Reach 7, if those projects are constructed, should be monitored to determine beachfill longevity and the impacts on the near-shore hardbottom. Because sand movement in this reach is high, the time sand spends after entering the surf zone between the west edge of the near-shore hardbottom and the revetment is reduced.

Shoreline Management of Reach 7 -- Sloan's Curve to the Ambassador Hotel (ATM Summary Report, page 15)

Managing Reach 7, the reach of shoreline with the highest erosion rates (8.6 cubic yards per foot per year) on the entire island of Palm Beach over the last 6.6 years includes placing an average of 140 cubic yards per front foot of sand on the beach and constructing an approximately 1,900-foot long groin field consisting of 8 T-head rubble-mound structures. Restoring this area with 1.16 million cubic yards of sand is necessary to raise the height of the beach to further stabilize and eliminate the near-shore sand deficit.

Since a proposed federal shore protection project which extends south of the Reach 7 south boundary only recommended beachfill, the proposed addition of structures to assist with retaining sand along Phipps Ocean Park, Harbor House and the Par 3 Golf Course will require review and approval by both the state and federal governments, particularly with regard to potential federal participation in the cost of constructing the groin field.

The proposed Reach 7 restoration includes placement of 1.16 million cubic yards of sand over a 1.95-mile long shoreline extending from R-116 to R-126. These quantities are substantially higher than proposed in the federal project, in large part due to the additional sand volume necessary to stabilize the shoreline given the presence of the near-shore sand deficit. A total of 1.5 acres of near-shore hardbottom are located within the proposed construction site.

Shoreline Management of Reach 8)Ambassador Hotel to La Bonne' Vie (ATM Summary Report, page 16)

Reach 8, extending from FDEP Reference Monument T-125 to R-134, terminates at the La Bonne' Vie, which is also at the approximate southern boundary of the Town of Palm

Beach.

- A proposed 965,000 cubic yard beachfill, which includes the construction of a 2,000-foot long groin field consisting of 6 T-head structures, represents an average beachfill volume at construction of approximately 90 cubic yards per front foot of shoreline.

- Approximately 0.7 acres of near-shore hardbottom are located within the construction area.

- Due to the similarities in the fill volumes and erosion rates, as well as proximity, it may be cost-effective to combine the Reach 8 and Reach 7 restorations into a single project to reduce dredge mobilization costs.

Shoreline Management of Reaches 9 and 10-
La Bonne' Vie to Lantana Avenue Access (Reach 9) and Lantana Avenue Access to Chillingsworth Curve (Reach 10) (ATM Summary Report, page 16)

The communities of South Palm Beach and Lantana are included in the approximate al boundaries of the 3,655-foot shoreline in Reach 9, which is bounded by FDEP monuments R-134 to 400 feet south of R-137. Because the relatively short length of shoreline may not result in a cost-effective beachfill restoration as a separate and distinct project, it is recommended that the restoration of shoreline in Reach 10 be constructed concurrently. The 8,300-foot-long Reach 10 has similar shoreline erosion rates as Reach 9 and should provide a more cost-effective and continuous beachfill project providing storm protection and a recreational beach.

- A total of approximately 718,000 cubic yards of sand will provide approximately 50 cubic yards of sand per front foot of shoreline.

- Depending upon the quality of the near-shore hardbottom located east of the shoreline, a limited groin field consisting of 6 to 7 T-head groins should reduce the amount of sand moving outside the project area, both along shore and offshore toward the hardbottom in the area of FDEP Monuments T-141 to T-144.

Shoreline Management of Reach 11)Chillingsworth Curve to South Lake Worth Inlet (ATM Summary Report, page 16)

The southernmost segment of the island of Palm Beach is erosional over the entire reach on average, but is actually accretional above the Mean High Water (MHW) line, thus allowing time to evaluate the impact of other activities on this reach.

- Given the presence of dune vegetation, the absence of shoreline-fronting seawalls

along this reach and the fact that it is accretional above MHW, the shoreline would appear to be best managed by maintaining present practices until such time as the South Lake Worth Inlet Management Plan is adopted by the FDEP and implemented. The shoreline will additionally benefit from the north to south movement of sand following the restoration of Reach 10.

Appendix B

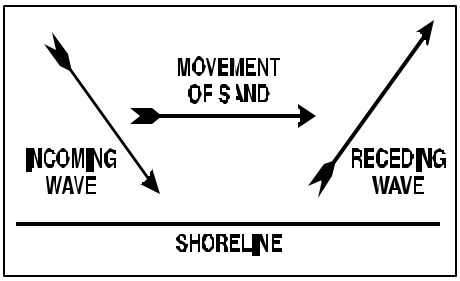
QUESTIONS AND ANSWERS

What is erosion?

Erosion on the barrier islands and the sandy beaches of Florida is caused by wind-generated waves and currents and tidal currents. Beaches are the products of wave action and most beach materials derive from the shoreline itself or from rivers. The movement of beach material goes on continuously, and only is considered erosion when the net loss in an area exceeds the net gain.

How do waves cause erosion?

The predominant migration of sand (littoral drift) is most often from north to south along the island of Palm Beach. Generally waves break at an angle to the shoreline, producing turbulence by lifting bottom materials into suspension and carrying them forward. As the wave energy dissipates, the water flows back down the beach at an angle, moving beach material downdrift. This is accelerated when other longshore currents are moving in the same direction, as is often the case.



Why does the beach recede in the winter and partially return in the summer?

Storm winds produce predominantly destructive waves in the winter. Powerful destructive waves have a strong seaward motion after the wave breaks, which pulls out tremendous amounts of sand into offshore bars. As the back surge slows down, the material is deposited onto offshore bars; the greater the wave, the further the offshore bars from the beach.

In the summer, waves are mainly constructive, in that the landward wave motion is greater than the compensating seaward motion. Sand grains are pushed forward shoreward off the offshore bars and the beach builds up again.

Does the shoreline recover as quickly as it erodes?

Whereas a severe storm with high tides and high waves may cause significant erosion in 6 to 18 hours, recovery may require months to years of normal wave and water conditions.

How do currents cause erosion?

Currents also are prime agents of erosion, moving like streams with a continuous forward motion. Currents are formed by winds and tides, deflected by continents, and affected by the earth's rotation.

At inlets, such as the Lake Worth Inlet, tidal currents can cause the formation of ebb shoals offshore, and flood shoals on the intracoastal side. These currents have a major negative influence on islands, diverting sand moving southward into such shoals and keeping some of it from reaching downdrift beaches. This impact is exacerbated by the dredged depth of the inlet and the length of the jetties.

Rip currents, which are localized flows of water moving seaward, may carry away larger amounts of sand than undertow, which is a non-localized seaward flow.

What is the role of man-made inlets?

Tidal currents have the same effects at man-made inlets as they do in natural inlets. However, the construction and maintenance of inlet channels and Intracoastal Waterway channels by dredging sand and dumping it far offshore has further exacerbated erosion downdrift of these projects. Dredging operations performed in this way remove sand from the beach system, which is unlikely ever to be returned to the system. Recently, efforts have been directed towards having such dredging operations place the dredged material on the eroded downdrift beaches instead.

What is the role of natural inlets?

On both coasts in Florida the net alongshore movement of sand is usually from north to south. Inlets, often formed by hurricanes, interrupt this flow, allowing tidal currents to carry sand into the ebb or bay shoals.

How does sea level rise effect erosion?

Typically in Florida, a one foot rise in sea level will cause a shoreline recession of 50 to 100 feet. The flatter the slope of the land, the greater the flooding, and the greater the area subject to erosion near or under the sea water.

Can hard structures control erosion when there is an inadequate supply of sand?

Not usually. In the absence of an adequate sand supply, hard structures such as seawalls, bulkheads, and revetments have been used to protect the uplands, but usually at the expense of the beach. Hard structures which interrupt the beach system, especially vertical ones, tend to reflect waves sharply, causing greater turbulence, increased material

in suspension, accelerated longshore currents, and thus a greater erosion rate.

Under what circumstances can hard structures preserve the beach?

Breakwaters and groins are used to trap sand to preserve the beach when there is an adequate supply of sand moving through the system, but this may be at the expense of unprotected downdrift beaches. Groins fields may be effective if they are adjustable, permeable and built in conjunction with a beachfill. However, it is important that they be built to bypass enough sand so as not to starve downdrift beaches.

What is the most environmentally acceptable, economic and effective way to prevent erosion?

According to the Skidaway Institute of Oceanography Conference on Eroding Shorelines (1985), a wide beach is itself the best way to dissipate wave energy and thus reduce erosion. The large oscillatory, destructive waves break far out, and thus cannot reach the shore or the uplands. Since the mid-1950s, beach restoration has been the method recommended for shoreline stabilization.

Beach restoration and revegetation maintain the natural habitat for wading birds, sea turtles, intertidal zone creatures and plants and grasses. To restore a beach, good quality, beach compatible sand is placed on the beach in order to move the shoreline seaward and to provide a protective buffer against severe storms. A very large amount of material is typically used to allow for settling, compaction, adjustment by waves and revegetation. The rate of erosion slows as the beach profile flattens and particularly after about one year when the beach reaches equilibrium.

The benefits of beach restoration include the minimization of upland erosion, the protection of lives, roads, utilities and structures, the recreational value of the restored beach, a healthy economy, and the environmental benefits to creatures living in the beach habitat.

What are the alternatives to beach restoration?

Essentially there are three alternatives to beach restoration: hard structures, retreat and abandonment. Hard structures such as seawalls and revetments are effective in providing long term protection of upland structures**.** They are effective for individual parcels when beach restoration is not an option. They are expensive and have continued long term maintenance. They may have an adverse impact on the adjacent shoreline and cause a loss of turtle nesting habitat, recreational beach and diminish the aesthetics of the beach. They are also difficult to permit.

The second alternative to beach restoration is retreat. This includes relocating exposed structures landward, demolishing damaged or destroyed structures without reconstruction,

and acquiring private properties with exposed or damaged structures by government for conversion to public use. In sparsely developed areas where only a few structures are adversely impacted by erosion, this can be effective. In areas where the erosion rate is extremely high (e.g. 20 feet per year), it may be the only alternative.

The final alternative is no action or abandonment. This methodology places the responsibility for damage from erosion with the beachfront property owner. It allows government to take a passive approach to erosion problems, avoiding the costs for relocation and overall responsibility for any long term impacts. This method is the least cost in the short term, but results in long term impact to property values, reduces the tax base, and diminishes the community's amenity values including an ecologically healthy beach environment and the ability to view the beach.

What is the correlation between beach nourishment projects and coastal floodplain hazard mitigation?

According to Beach Nourishment and Protection by the National Research Council, there is no correlation between the protective benefits of beach nourishment projects and the hazard mitigation aspects of the National Flood Insurance Program (NFIP). The capability to reduce hazards to meet NFIP objectives are on a project-by-project basis. Lee County, for example, has been successful in utilizing "points" from their beach restoration project as part of the total package that resulted in lowering county-wide flood insurance costs. Once a project has been constructed, FEMA has contributed to replacing that project when damaged by a hurricane.

What is a construction easement?

In Florida, the seaward property line for oceanfront property owners is the mean high water line (MHWL). Although this is a line that must be surveyed to know its exact location, most people think of the debris line as the mean high water line. When a beach is restored, most of the sand is placed on both the state-owned land (seaward of MHWL) and on property landward of MHWL. The Town needs the upland private property owners' permission to place sand on the beach above the MHWL and utilize the necessary construction equipment on the beach. Before construction begins, the Town will send easements to these owners and request their signatures. These easements are for construction and only include the beachfront portion of the property. They do not allow any other use of private property.

Appendix C
GLOSSARY

Adjustable Nourished Headland Structures (ANHS) - A type of groin field comprised of adjustable, permeable T-head structures in a grouping where the end structures are tapered in length. These structures are filled with sand in conjunction with a beach restoration project.

Accretion - Accumulation of sand or other beach material at a point due to the natural action of waves, currents and wind. A build-up of the beach.

Background - The circumstances or events antecedent to a phenomenon or development (e.g. prior to beach nourishment monitoring is performed to determine the pre-dredging or background conditions).

Bathymetric survey - The measurements of depths of water in oceans, seas, and lakes; also information derived from such measurements.

Beach - Zone of sand extending from the low water line to a point landward where either the topography abruptly changes or permanent vegetation first appears.

Benthic - Of, relating to, or occurring at the bottom of a body of water.

Biomass - Amount of living matter in a unit area or volume of habitat.

Breakwater - Structure aligned parallel to shore, sometimes shore-connected, that provides protection from waves.

Coastal Construction Control Line - Line along the shoreline bordering the Gulf of Mexico, the Straits of Florida and the Atlantic Ocean established by the Florida Department of Natural Resources "to define that portion of the beach-dune system subject to severe fluctuations based on a 100 year storm surge, storm waves, or other predictable weather conditions (chapter 161.053 F.S.)." It is a line of jurisdiction.

Cross Section - View of a structure on beach as if it were sliced by a vertical plane. The cross section should display structure, ground surface, and underlying material.

Downdrift - Direction of alongshore movement of littoral materials.

Erosion - The carrying away of beach material by wave action, tidal currents, littoral currents or wind action.

Groin - Shore protection structure built perpendicular to shore to trap sediment (sand)

and retard shore erosion.

Groin Field - Series of groins acting together to protect a section of beach. Also called a groin system.

Hardbottom - An amorphous nontransitional substrate sustaining benthic habitat that is sedentary in nature (e.g., barnacles, oysters, algae).

Inlet - A short, narrow waterway connecting a bay or similar body of water with a parent body of water.

Jetty - A structure extending into a body of water, which is designed to prevent shoaling of a channel by littoral materials and to direct and confine the stream or tidal flow.

Littoral Drift - The material transported in the near shore zone by waves and currents. Includes movement parallel (longshore transport) and perpendicular (on-offshore transport) to the shore. The primary factor which determines long-term changes in the shape of the beach.

Long term - As used in environmental monitoring, over two years, often five years or more.

Mean High Water Line (MHWL) - Average height of the daily higher-high waters over a 19- year period. For semidiurnal or mixed tides, the two high water of each tidal day are included in the mean. For diurnal (daily) tides, the single daily high water is used to compute the mean.

Overtopping - Passing of water over a structure from wave run up or surge action.

Profile, Beach - Intersection of the ground surface with a vertical plane that may extend from the top of the dune line to the seaward limit of sand movement.

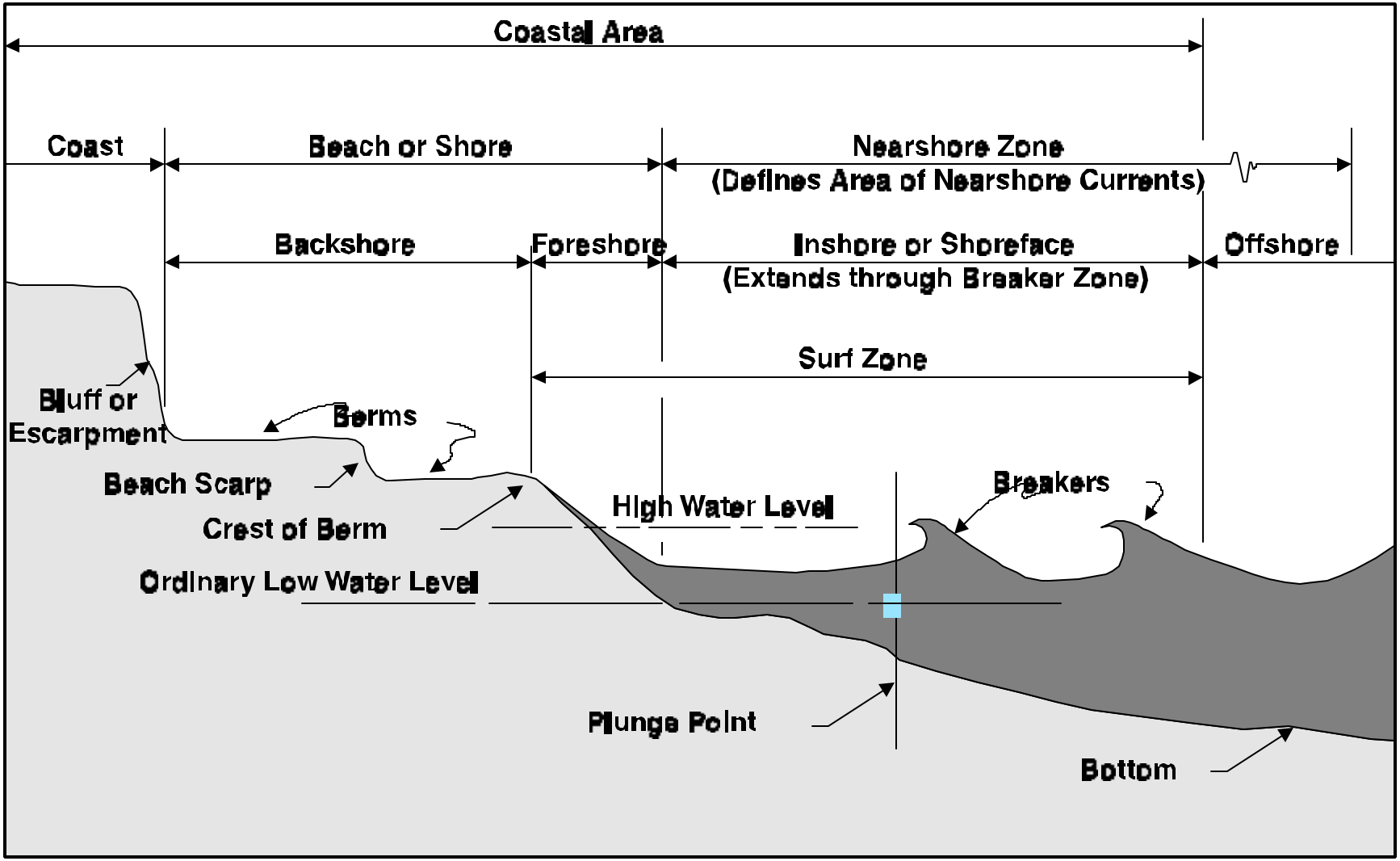
Revetment - Facing of stone, concrete, etc., built to protect a scarp, embankment, or shore structure against erosion by waves or currents.

Sand - Generally, coarse-grained soils having particle diameters between 0.18 and approximately 0.003 inches. Sands are intermediate between silt and gravel.

Seawall - Structure separating land and water areas primarily to prevent erosion and other damage by wave action.

Shoal- A detached elevation of the sea bottom, composed of any material except rock or coral. In Florida, these are generally comprised of sand.

Silt - Generally refers to fine-grained soils.



Beach Profile - Related Terms
(Adapted from USACOE, Shore Protection Manual)