PAPERS PRESENTED AT ANNUAL CONFERENCE
ON BEACH PRESERVATION
October 3-5, 1979
Americana Hotel, Bal Harbour, FL 33154

Twenty-third annual meeting of the Florida Shore and Beach Preservation Association. Co-sponsored by the Coastal Plains Center, Wilmington, NC; Florida Sea Grant Marine Advisory Program; and the Coastal & Oceanographic Engineering Department, University of Florida.

Compiled by:
Stan Tait and Thomas Leahy
TECHNICAL PAPER NO. 16

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November 1979

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WEDNESDAY, OCTOBER 3

4 p.m. Board of Directors meeting.

7 p.m. Welcoming Cocktail Party, sponsored by the Americana Hotel.

THURSDAY, OCTOBER 4

8:30 a.m. Welcome – Art Strock, President, FSBPA

Welcome – Hale Printup, Mayor, Village of Bal Harbour.

First Session

8:45 a.m. **"COASTAL ZONE MANAGEMENT: WHERE IT'S GOING AND WHY WE NEED IT"** – *Robert Knecht, Director, U.S. Coastal Management Program, National Oceanic and Atmospheric Administration, Rockville, MD.*

9:30 a.m. **"WHAT RIGHTS ARE LEFT FOR THE COASTAL PROPERTY OWNER – WHAT HE CAN DO TO PROTECT HIS PROPERTY."** – *Robert Rhodes, environmental attorney, Thompson, Wadsworth, Messer, Turner & Rhodes, Tallahassee, FL.*

10:15 a.m. Coffee Break

11:00 a.m. **"THE PRIVATELY FUNDED BEACH PROJECT – WHAT TO DO WHEN THERE'S NO GOVERNMENT FUNDING."** – *Richard W. Stevens, P.E., Project Manager, Mariner Properties, Ltd., Captiva Island, FL., and Erik J. Olsen, P.E., Senior Engineer, Tetra Tech, Inc., Jacksonville.*

11:30 a.m. **"THE LOCALLY FUNDED BEACH PROJECT – WHEN STATE AND FEDERAL FUNDS ARE NOT AVAILABLE."** – *Robert Vande Weghe, Town Manager, Town of Jupiter Island.*

Noon Luncheon – Keynote Address

Second Session

2 p.m. **HOW THE CORPS OF ENGINEERS IS BUILDING BARGAIN BEACHES FROM INLET AND HARBOUR DREDGING** – *Col. James Adams, Jacksonville District Engineer, U.S. Army Corps of Engineers, Jacksonville, FL.*

2:45 p.m. **ENVIRONMENTAL EFFECTS OF BEACH NOURISHMENT AND COASTAL PROTECTIVE DEVICES – ARE THEY AS DAMAGING AS CRITICS SAY?** – *Jack Pullen, Chief, Coastal Ecology Branch, Corps of Engineers Research Center, Fort Belvoir, VA.*

3:15 p.m. Coffee Break

3:30 p.m. **DREDGING CONTRACTORS VIEWPOINTS CONCERNING BEACH NOURISHMENT** – *Aaron W. Hendry, Vice President, The Hendry Corporation, Tampa.*

4:00 p.m. **BARRIER ISLANDS OF FLORIDA: UNIQUE RESOURCES, PROBLEMS AND PROSPECTS** – *Dinesh C. Sharma, environmental consultant, Fort Myers, FL.*

7:00 p.m. Cocktail party

8:00 p.m. President's Banquet and Awards

FRIDAY, OCTOBER 5

Third Session

8:30 a.m. **LESSONS OF THE "SEA SAT" OCEAN MONITORING SATELLITE** – *Samuel W. McCandless, User Systems Engineering, Anandale, VA.*

9:15 a.m. **WHAT'S NEW IN THE FEDERAL FLOOD INSURANCE PROGRAM – EFFECTS ON FLORIDA'S SHORELINE** – *Richard Krimm, Assistant Administrator for Flood Insurance, Federal Emergency Management Agency, Washington, D.C.*

10:00 a.m. **PRESIDENT'S REPORT: THE STATE OF BEACH PRESERVATION IN FLORIDA** – *Arthur Strock, P.E., President, Arthur V. Strock & Associates, Deerfield Beach, FL and President, FSBPA.*

10:30 a.m. Coffee Break

11:00 a.m. Annual Business Meeting, FSBPA

Noon Luncheon and Beach Tour

(Buses will depart from the hotel entrance for a box lunch at Miami Beach. There will be a brief tour of construction underway on the Miami Beach restoration project and the new landscaping at Bal Harbour beach.)

2:30 p.m. **MIAMI BEACH'S LINEAR PARK – CREATING ONE OF THE MOST BEAUTIFUL BEACHES IN THE WORLD** – *Robert David, Director of Planning, City of Miami Beach and George Smith, President of Stresau, Smith and Stresau, Landscape Architects, Fort Lauderdale, FL.*

3:15 p.m. **COOPERATION BETWEEN PUBLIC BEACH DEVELOPMENT AND PRIVATE BEACH DEVELOPMENT** – *Richard Huffman, Associate Partner, Wallace, McHarg, Roberts and Todd, Philadelphia, PA.*

4:30 p.m. **MODIFICATIONS TO SWASH-BEACH PROFILE INTERACTION IN THE PRESENCE OF SEAWALLS, DUNES AND OVERWASH CHANNELS** – *Dr. Donald K. Stauble, assistant professor, Department of Oceanography and Ocean Engineering, Florida Institute of Technology, Melbourne, FL.*

5:00 p.m. Adjournment

COASTAL ZONE MANAGEMENT: THE FIRST FIVE YEARS AND BEYOND

Robert W. Knecht
Assistant Administrator for Coastal Zone Management
National Oceanic and Atmospheric Administration

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While the Coastal Zone Management Act was passed in 1972, the first planning grants to states were awarded only in 1974. In essence then, this program has been in operation 5 years--a good point at which to take stock.

From my vantage point, I think the accomplishments--and here, I refer mostly to the accomplishments of the coastal states and territories because it is their programs and their efforts that give substance and meaning to coastal zone management--the accomplishments are significant and real and are a reflection of the basic soundness of most of the principles contained in the Act that was passed in 1972.

I do not mean by this that there are not areas where our coastal management efforts cannot be improved--but, I do think it is important for us to recognize what already has been accomplished--for, in my judgment, it is not inconsiderable.

As of today, 17 states have approved coastal management programs, covering almost 70 percent of the Nation's shorelines and half of the Nation's coastal population.

By the end of this year, I expect another three states will have approved management programs. Fully 75 percent of the Nation's shoreline will be covered by federally approved management programs at that time.

But these figures alone tell very little about the quality of coastal management. What, in fact, do these programs do?

While it is still too early to make a full assessment of the effectiveness of the programs we are approving--keep in mind, that the average approved state program has been in effect less than a year, and a good number of programs are yet to be approved--it is not too early to make a preliminary assessment of what state programs already are doing in terms of substantive management results.

Looking at the findings and policies of Sections 302 and 303 of the Coastal Zone Management Act, we can discern 4 major areas where substantive results are expected. First and foremost among these is protection of significant natural resources such as wetlands, beaches, dunes and barrier islands. Second is the concern for more effective management of coastal development so as to minimize loss of life and property due to improper development of floodplains, erosion-prone areas, areas of subsidence and saltwater intrusion, and to promote better management generally by giving priority to coastal-dependent development, and by dealing with energy facility siting needs. A third major focus of the Act is on increasing access to the coast for recreation purposes and of protecting and

restoring historic, aesthetic, and natural resources. Fourth, there is an emphasis in the Act on increasing intergovernmental cooperation and coordination with an expected result in greater predictability and efficiency in public decisionmaking.

I would like to provide you now with some highlights of what states are doing in these four areas. These highlights are the result of our first major overall evaluation effort which is just being completed. A copy of the report will be sent to all of you shortly.

With Regard to the Protection of Significant Natural Resources, our Initial Review Reveals:

* Twenty-three of the 35 eligible states and territories have new wetlands statutes and regulations or improved implementation, in the case of existing laws dealing with wetlands preservation.

* While the enhanced implementation, through CZM funding, of a strong, pre-existing wetlands statute like Oregon's (which has one of the strongest mitigation requirements in the Nation) is impressive and certainly worth noting, even more impressive is the enactment of new wetlands laws or the promulgation of new regulations that are directly attributable to a state's participation in the national CZM program. This is the case with South Carolina, Massachusetts, Alabama and Guam.

* For years, bills aimed at tidelands management were introduced into the Carolina, Massachusetts, Alabama and Guam.
South Carolina Legislature and failed repeatedly. In 1977, however, the South Carolina Coastal Management Act was passed with only a single dissenting vote in both houses. It is stronger and more comprehensive with regard to tidelands protection than the previous bills that failed.

* As a condition of program approval, the Massachusetts Executive Office of Environmental Affairs (EOEA) promulgated, within 4 months of program approval, rules and regulations pursuant to the Commonwealth's Wetlands Protection Act and Coastal Wetlands Restriction Act. The promulgation of these regulations, completed on time, is critical to expedited implementation of these Acts. Promulgation had been delayed for 5 years previous to this.

* The Alabama Coastal Act, passed in 1976, required promulgation of rules and regulations to protect wetlands and submerged grassbeds--the first effort of this type in the State. Regulations pursuant to the Act have been drafted--they prohibit all activities that might degrade wetlands and submerged grassbeds beyond their ability to support present levels of plants and animals.

* Even in advance of NOAA approval of Guam's coastal management program, a direct result of their activities to date is that permits now are required before development may occur in any of the Territory's 12 major wetlands.

* In Rhode Island, the Coastal Resources Council helped re-route a trans-atlantic telephone cable away from a wetland that was a prime fisheries habitat.

* And in Damariscotta, Maine, a wetland destined to become a parking lot was saved because of CZM efforts.

Sixteen states have special protection measures, beyond wetlands statutes, dealing with important, unique, or endangered flora and fauna:

* Five states have or will incorporate their own Endangered Species Acts into their coastal management programs. The additional funds provided through 306 grants should contribute to better enforcement of these Acts.

* Beyond this, several states have protective policies for particularly unique species or have identified their habitats as areas of particular concern:

    * Alaska's program includes protective standards for Hauling Out Grounds for marine mammals;

    * California's Coastal Act has a policy on protecting kelp beds;

    * Guam has designated the habitats of the sooty tern, the brown booby, and the fruit bat as protected areas;

    * Hawaii has established five Marine Life Conservation Districts in order to provide protected habitats for the marine life found in the waters off the islands of Oahu, Hawaii, Maui and Lanai;

    * Under Maine's Critical Areas Program (CAP), 203 areas important to flora and fauna, such as colonial bird nesting sites, have been identified and registered. Information about these areas has been used by the State Department of Transportation to avoid environmentally sensitive areas, by private owners in preventing irreparable damage, and by Tenneco in assessing the environmental impact of their proposed pipeline project.

      In some cases, management agreements and even the sale or donation of property rights have been arranged: the 1400-acre Great Wass Island, and 11-acre Brothers Island Preserves have been purchased by the Nature Conservancy; numerous seabird nesting ledges and islands are being managed by the Maine Department of Inland Fisheries and Wildlife, and the U.S. Fish and Wildlife Service;

    * Before Puerto Rico's coastal zone management program was approved, several unsuccessful legislative attempts were made to designate and protect a number of important habitat areas including Tortuguero and Joyuda Lagoons, and the Islands of Mona and Monita. As part of the Commonwealth's approved coastal management program, 26 areas including those mentioned above have been proposed for Natural Reserve Designation which will provide extra protection to these areas.

The Culebra segment of the Puerto Rico program, which was approved about a year earlier than the rest of the Commonwealth program, identified the nesting grounds of several endangered species. Special protection and surveillance of these nesting areas are provided by the Culebra Ranger Corps, funded with 306 money.

Twenty states are dealing in a positive manner with the need to protect beaches, dunes, and barrier islands:

* Thirteen states have beach protection or shoreline setback laws that limit or prevent development on the beaches and frontal dunes.

* Two states protect their dunes and beaches through sand mining regulations.

* And as a direct result of participation in the CZM program:

    * Rhode Island prohibits future development on presently undeveloped barrier beaches;

    * Alaska's Coastal Management Act of 1977, limits development on barrier islands and beaches;

    * Under Maine's Coastal Island Registry Act, more than 1,300 of the State's 3,000 offshore islands now are clearly in the public domain, and are being protected;

    * South Carolina's Coastal Act covers beaches and primary dunes;

    * And, the Virgin Island's Coastal Zone Management Act of 1978 prohibits building on the beaches.

In the 14 states and territories where protection of reefs is a significant issue, 11 of these states have measures designed to protect reefs for their own intrinsic value and as major fish habitats:

* Coral reefs are important resources of all the islands in the Pacific and the Caribbean:

    * The Virgin Islands prohibits the taking of coral;

      In addition, the Virgin Islands is considering a marine park system, similar to the national underwater park of St. John's, which would include a number of coral reefs;

    * Guam protects its reef systems by regulating fishing methods;

    * Despite the fact that most of the corals surrounding Puerto Rico are in waters currently within the Federal domain, the Commonwealth is developing regulations to protect this resource in anticipation of regaining control over the submerged lands where the corals grow;

* And, three of Hawaii's marine life conservation districts contain important coral reefs which are protected by their inclusion in these districts.

* In the Great Lakes Region, the concern with offshore reefs is primarily for their value as fish habitats:

  * Illinois, Michigan, Ohio and Wisconsin all protect these areas through their lakebed bottoms permits, and all four states have used CZM funds to develop additional fish propogation projects around the reefs;

* Finally, it is worth noting that the establishment of the Key Largo Marine Sanctuary in the Florida Keys was the direct result of the initiative and concern of the State to protect the coral reefs in the waters off Key Largo.

Ten states have measures regulating offshore sand and gravel mining, or oil and gas extraction:

* In the Great Lakes States--Illinois, Michigan, Minnesota, and Wisconsin--lakebed permits cover all mineral extractions as well as oil and gas drilling.

* Massachusetts' Ocean Sanctuary Program--regulations for which have been adopted recently in fulfillment of a CZM grant condition--identifies a number of offshore areas where pipelines and extraction activities will be conditioned and, in some cases, prohibited.

* And the Alaska Coastal Zone Management Act of 1978, establishes a number of goals and standards (enforceable through State permits and local programs) relative to offshore sand and gravel mining, and oil and gas extraction.

Turning now to the second major area where the national Act indicates substantive results are desired--Management of Coastal Development--we find the following:

* Fourteen states address the potential for loss to life and property from inappropriate development in erosion-prone areas, primarily through setback requirements or beach and dune preservation laws.

* Twelve states go beyond the Federal Flood Insurance Administration's (FIA) requirements in order to control development in floodplains or storm surge areas, again through setback requirements, stipulations on permissible uses and mandatory construction techniques in floodplains.

* And,seven states have management controls over areas subject to subsidence or where development could lead to saltwater intrusion.

Here are some highlights of how states are dealing with these issues:

* Erosion is one of the major issues with which the Michigan program deals. Using the authorities provided in several existing Acts--the Soil Erosion and Sedimentation Control Act of 1976, the Sand Dunes Protection and Management Act of 1976, and the Shorelands Protection and Management Act of 1970--Michigan has used CZM funding to identify, designate and more effectively manage over 125 miles of high-risk erosion-prone areas along the shoreline of Lake Michigan.

* Included among the enforceable policies of the California Coastal Act are several dealing with development in erosion- and earthquake-prone areas, and areas where there are important aquifers. These policies all constitute criteria on which the State and Regional Coastal Commissions base permit decisions.

* While Pennsylvania is not presently receiving CZM funding, nonetheless one beneficial result of earlier program funding was the development of erosion control and setback ordinances that have since been enacted into law by three local communities along Lake Erie.

* Under authorities contained in North Carolina's Coastal Area Management Act, the State's Coastal Commission has identified and designated erosion-prone areas as Areas of Environmental Concern (AEC's)... These AEC's are now subject to a permit before any development is allowed in these areas.

* As a direct result of the Guam Coastal Management Program, regulations were developed governing the type and method of construction permitted in floodplains. These regulations have been adopted by the Territory's Planning Commission which must issue a permit for all construction on the island. In addition, the seashore reserve setback that runs around the perimeter of the island assures there will be no construction within ten meters of the shoreline.

* Based on studies funded by CZM, the Maryland Legislature enacted two bills in 1976, that deal with managing development in the State's floodplains. One is the Flood Control-Watershed Management Act, and the other is a State Construction Projects Act which prevents State-funded projects from increasing flood hazards.

* Prior to initiation of the CZM effort in New Hampshire, development of Coastal Flood Insurance Rate Maps (FIRM's) was a low priority for coastal communities. As a result of CZM priorities, all coastal communities in New Hampshire will be in the regular phase of the FIA program two years earlier than previously anticipated.

* In the non-urban areas designated by the Hawaii Land Use Commission, the State's CZM Act contains policies that must be followed by state agencies and local governments to avoid development that will contribute to loss of life or property in floodplains and tsunami zones. The non-urban areas constitute over 90 percent of the State.

* The Alaska Coastal Act includes a hazards policy governing activities in areas of tectonic subsidence.

* Saltwater intrusion is a major environmental problem in Louisiana identified by CZM studies. CEIP funds have been directed at solving this problem in St. Bernard Parish where a freshwater siphon is being built to divert water from the Mississippi River into the marsh. This is a prime oyster and shrimp producing area that has been hard hit by saltwater intrusion.

* And finally, one of the real impacts of approval of the South Carolina coastal management program will be the ability to use 306 funding to implement a State groundwater withdrawal law that's been on the books for a number of years, but never has been implemented effectively because of lack of personnel.

There are two other important aspects related to management of coastal development that we need to look at--what states are doing with respect to energy facility siting and what priority states are giving to water-dependent uses.

Ten states have expedited permit processing procedures, advance site designations or advance purchase programs for energy facilities in the coastal zone:

* Unique among all the states is Maryland's program of advance designation of appropriate sites for power plants and acquisition of these sites when needed. This is probably the most ambitious and sophisticated program of its type in the country. While the program was not initiated in direct response to the CZM Act, it is being incorporated as an integral aspect of the State's coastal management program in response to the new energy facility planning requirements added to the Federal Act in 1976.

* Dealing with energy facilities is a major aspect of both the California management program, and the San Francisco Bay segment. Two items are worth noting:

    * The Coastal Commission also has completed recently a review of the California Coastline and is in the process of identifying sites that are inappropriate for power plants.

    * As part of the San Francisco Bay Plan, the Bay Conservation and Development Commission (BCDC) designated sites that would be appropriate for future industrial or energy facility development. Once a site is so designated, the Commission will not issue a permit for a use incompatible with the area's designation.

* As part of its coastal management program, the Virgin Islands designated sites that would be reserved for water-dependent heavy industry, including refineries.

* As part of its 10-year electric facilities plan, Wisconsin identifies sites necessary and appropriate for needed electric-generating facilities.

With regard to priorities for water-dependent uses:

* Ten states use water-dependency or water-relatedness as a primary criterion for granting permits in the coastal zone.

* Demonstration of a use's water dependency or relatedness is the first consideration that must be met before the Department of Conservation and Cultural Affairs will issue a permit under the Virgin Islands CZM Act.

* Oregon's legislatively enacted coastal goals give priority to water-dependent uses along the Oregon coast. Policies contained in coastal acts in effect in South Carolina, Hawaii, and Alaska give similar priority to water dependency.

Numerous states are using their CZM programs to promote such water-dependent uses as fishing and port activities. Worth noting here are:

* The high priority that has been assigned in the Maine CMP to providing fishing facilities. As part of the State's program development efforts, a cooperative effort between coastal communities, the State DOT, and the Governor's Committee on Coastal Development and Conservation was initiated that will result in a $8 to $10 million bond issue to develop four new fishing piers, and renovate/expand two existing ones in the towns of Kennebunkport, Portland, Boothbay Harbor, Rockland, Vinalhaven, and Stonington.

  In addition, the CZM program supported a feasibility study for commercial aquaculture development in the waters of Cobscook Bay surrounding Eastport. A follow-up project now is underway by five towns experimenting with clams, mussels, and scallops.

* With a financial boost from the Wisconsin CMP, two state agencies with key roles and the directors of the four major ports have formed the State Council of Ports. This is the first time all the ports in the State have worked cooperatively on a comprehensive and unified port marketing campaign based on common goals and objectives.

Finally, in the related area of identifying and designating environmentally acceptable dredge spoil disposal sites, seven states have significant activities ongoing:

* Through studies financed by CZM, appropriate disposal sites for dredged materials from Calumet Harbor in Illinois, Duluth Harbor in Minnesota, and Superior Harbor in Wisconsin have been identified.

* More importantly, the goal of the CZM Act to foster greater inter-governmental coordination is being fulfilled by the Wisconsin Coastal

Management Council's present effort to re-examine and reconcile the differences between the State's policy on open water disposal of dredged materials and that of the Corps of Engineers.

* And significantly, the States of Connecticut and New York, using CZM funds, have finalized a Bi-state Interim Dredge Disposal Plan that identified appropriate disposal sites, as well as accceptable disposal methods that are tied to the toxicity of the spoils.

I would like now to turn to the third major area where the Act anticipates substantive outcomes--Increased Access to the Shoreline for Recreation Purposes and Protection of our Cultural, Historic, and Aesthetic Resources. This is probably the area where accomplishments will be the most visible and where the potential exists to give the general public a sense of real benefit from coastal management efforts. If we are to resolve the problem identified by the Coastal Zone Management Advisory Committee, of a lack of committed constituency, then it is through activities that afford the public greater use of the shoreline that a constituency will be created. After all, when we think of the coast, I'm sure for most of the public, the image is that of recreational use and enjoyment--swimming, surfing, fishing, sailing, or walking along a beach.

* Ten states require access be provided as a condition for issuing permits.

* As a result of the requirements in the California Coastal Act, the Regional Coastal Commissions have conditioned permits to provide access to and along the State's shoreline. In the Malibu area alone, more than 125 access easements along the beach and more than a dozen from the public road to the beach have been secured.

  The cities of Redondo Beach, Santa Monica, and Long Beach have approved redevelopment projects which include new public parks and improved beach access.

* Five states have Open Beach laws--(Oregon, Texas, Guam, Hawaii, and the Virgin Islands).

* And through legal analyses funded by CZM, Delaware has been able to identify public lands along the shoreline that have been encroached upon by private development and actually are part of the public domain.

* A major legal survey is underway in Rhode Island to re-establish over 70 public rights-of-way.

* Fifteen states have projects underway that will create new urban waterfront parks and generally will make better use of their waterfronts for recreation purposes.

  * An exciting project is occurring in Detroit, Michigan, where a series of linked river-front parks will be developed using CZM funds to design the linkages. The cost of constructing and landscaping these parks will be picked up by the Heritage Conservation and Recreation Service (HCRS).

  * One outcome of the Duluth-Superior port study, undertaken jointly

by Wisconsin and Minnesota, is the design of a bike path around the harbor areas.

* And through a CZM funded study, the Town of Evans in New York was able to convince the State's Office of General Services not to sell off some surplus land along the Town's Lake Erie shoreline, but rather to retain it as public open space.

* Six states are using their CZM program to more effectively implement existing state historic preservation laws, and

* Five states are in the process of preserving or restoring historic buildings and cultural sites, using CZM funds.

* The State of Wisconsin estimates that its survey of historic structures and potential archeological sites has been accelerated by 2 to 5 years because of the funding that's been made available through the CZM program

* Historic restoration and preservation projects are underway in Wisconsin (the Flambeau Trail), Illinois (Evanston lighthouse restoration), Michigan (restoration of the Schoolcraft House at St. Mary's River, Fort Wayne in Detroit, and the Grindstone City Historic District), and Connecticut (Norwalk's historic seaport and park design).

* And, even in the exceedingly difficult area of protecting scenic views and enhancing visual access to the shoreline, seven states have activities underway.

* New Jersey restricts buildings that would cast a shadow on the beach and would be incompatible with surrounding development.

* The Virgin Islands has policies that provide visual access and seek to preserve scenic vistas.

* The California Coastal Commission and the Bay Conservation and Development Commission in San Francisco both review requests for development in light of their impact on views of the waterfront.

Finally, turning to the fourth major area of the Act where substantive changes are desired--Simplifying and Expediting Governmental Decisionmaking--we find in the area of permit coordination and simplification that:

* Ten states have established joint permit and public hearing procedures with the Corps of Engineers.

* Six states have consolidated several state permits and four states have permit clearinghouses or tracking systems that reduce considerably the time and effort involved in getting a permit decision.

* In the Virgin Islands, where prior to passage of their CZM Act, four permits were required from different agencies, now only a single coastal permit from the Department of Conservation and Cultural Affairs is required.

* South Carolina has established a general permit to simplify the process for individuals who want to construct a private recreation pier or dock.

* And as a result of the South Carolina Management Council's takeover of tidelands permitting, over 30 applications pending at the time the South Carolina Act was passed, have been resolved. Some of these applications had been pending for up to 7 years.

* Both Massachusetts and Wisconsin have experienced a noticeable decrease in the time and effort required to process permit applications as a result of using CZM funds to staff district permit offices.

    * In Massachusetts, two regional coastal offices of the Executive Office of Environmental Affairs provide applicants with all necessary Federal and State forms and assure concurrent processing by Federal and State agencies.

    * In Wisconsin, the average length of time needed to review water quality permits has dropped from 60 to 16 days, as a result of additional staff provided to three district offices.

* And finally, in the Grays Harbor area in the State of Washington, a very exciting process is taking place in which we are intimately involved. we believe what's happening in Grays Harbor has transferability to other coastal states, and will contribute significantly to the process of intergovernmental coordination and permit simplification.

I believe that Grays Harbor will become an example of what coastal management can be at its most effective stage. It involves:

* A partnership process--a task force of Federal and State agencies, local governments, and the port who have worked together for more than 3 years;

* Decisions based on sound technical information--both about the estuarine resources and local economic, development needs;

* Conflict resolution and a balancing of environmental and developmental needs--the Grays Harbor Plan identifies wetlands, mudflats, and other estuarine ecosystems that will be protected and managed for their natural values. It also identifies areas needed to meet requirements for future economic development, including dredge spoil disposal sites. The Plan includes a commitment of 1,700 of the Port's 2,200 acre holdings to conservation purposes for at least 50 years on the assumption that the remaining 500 acres will be available for port and related economic activities.

* And implementation--which will involve amendment of the shoreline management programs by the local governments, amendment of the State's coastal management program, and commitments from the Federal agency task force participants (EPA, The Corps, NMFS, and FWS).

The Grays Harbor Plan provides predictability about what can

happen where. It includes priority for water-dependent uses along the shoreline. It has been an extremely difficult, complex and time-consuming process. But, it will have been time and effort well-spent if, as we hope, the Grays Harbor Plan results in a more rational coastal resource management process.

In my view, these results demonstrate that coastal management is making a difference. While it is true that changes of this type require time and patience, and often are not as sweeping or dramatic as we might hope, nonetheless, they are real changes and, I believe, augur well for the future.

Five years have been devoted to working out the novel concepts contained in the Coastal Zone Management Act. As we know, these years have not been without controversy. This is inevitable for a new effort like coastal management. Disagreements were bound to arise over interpretation and implementation of important provisions.

I recognize that the program has not lived up to expectations in some important areas. In general, these shortcomings fall into two categories: Provisions of the Act that have proven difficult to interpret and administer, and, more importantly, provisions that have not been fully effective in achieving substantive results. Let me elaborate on these.

First, ambiguity in the interpretation of several of the Act's requirements has resulted in prolonged controversy. We have spent inordinate amounts of time discussing--and litigating--the "national interest" and "uses of regional benefit" provisions. What constitutes "adequate consideration of the national interest?" What must states do to ensure that local governments do not unreasonably exclude uses of regional benefit? Do these provisions require states to locate major energy facilities within their coastal zones? We have argued these issues in some cases beyond the point of usefulness.

It is time to put the criticism and controversy surrounding these provisions of the Act behind us. The interpretations we have provided, we believe, are reasonable ones and thus far, they have been upheld by the courts. More importantly, they are consistent with the basic philosphy of the Act--that the process of coastal management results in comprehensive decisionmaking that duly weighs important national and state concerns and results in clear directions on the use and protection of coastal resources. Clarification of the meaning of the "national interest" provision in legislative report language at the time of reauthorization of CZMA would help clear the air on this point.

Second, the federal consistency provisions have proven unnecessarily complex and administratively burdensome. Federal consistency was intended to cement the Federal-State partnership by ensuring that Federal actions be consistent with and, indeed complement, state management programs. But, the vision of Federal-State cooperative management is not yet fully realized because our collective efforts have been diverted by tiresome procedural wranglings arising from confusing provisions in the Act. What is a "Federal activity" or "project" and when has it met the test of being consistent to the "maximum extent practicable?" Who determines consistency? And so forth... Federal consistency will not be an operational reality until there are simple, easily understood and generally-accepted procedures.

It is appropriate to consider removing confusing and complex language and providing simple, uniform procedures for all Federal actions, in order to foster intergovernmental cooperation, minimize duplicative efforts and avoid needless delay. At the same time, the objectives of the consistency provisions must be maintained; inconsistent Federal actions should not proceed in the face of state objections unless overriding national considerations have been clearly established.

We are in the process of considering legislative modifications that would accomplish these objectives. We think the recommendations of the National Advisory Committee on Oceans and Atmosphere (NACOA) that call for the integration of the consistency requirements with the consultation provisions of the National Environmental Policy Act are excellent. However, we also think it would serve the objective of simplification to go further than the NACOA recommendations and establish an uniform process covering all Federal actions currently encompassed by the federal consistency provisions.

Third, and most importantly, the Act is not sufficiently clear or specific as to its desired outcomes. Nor, does it tie the incentives available through the Act to achieving these outcomes. While approved state programs meet the minimum requirements of the Act, critics argue that some of these same programs fall short when compared to the implicit goals of the Act. Regardless of what you or I believe the Act intended, we have only generalized policies to follow: "To preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone..."

Moreover, achievement of substantive and specific results is doubly difficult because no guidance is provided in the Act on how state programs should be evaluated. Should they be monitored simply for compliance with minimum program approval requirements? Or should they be measured according to the incremental changes they effect, or the progress they make toward solving specific coastal problems? More importantly, should state programs be held accountable for protecting natural coastal resources, managing coastal development, increasing access and ensuring simplified permit procedures in coastal areas? The Coastal Zone Management Act is silent on these matters, yet, I suspect the national program ultimately will be judged by the answers we provide to these questions.

To remedy these shortcomings, we think there are several changes that would have the effect of clearly defining the national policies and desired outcomes of the Act, and ensuring that sufficient Federal funds are targeted to state efforts that further these policies. And, as we shift our emphasis from planning to management, it is critically important that we utilize our program evaluation mandate to ensure that federally supported programs successfully address nationally important coastal management problems.

We are examining three changes to the Act that we think would accomplish these objectives. First, Section 303 of the Act—the National Policy section—could be modified to set forth in greater detail our national policy objectives. I think we need more detailed policies on the four areas I cited in the beginning of my speech:

* Protection of significant natural systems
* More effective management of coastal development

* Increasing access to the coast for recreational purposes, and
* Achieving greater predictability and efficiency in public decisionmaking

Further, I think amending Section 318--the Authorization section--to tie a substantial portion of Federal assistance to state efforts relative to the national objectives would serve as an incentive in accomplishing these objectives. This will focus coastal management efforts on critical national problems as well as significant state and local concerns.

In conjunction with these two changes, modifications of Section 312--the Evaluation provision--to measure state progress in relation to the achievement of national objectives would be beneficial. This would result in federally supported state programs expending funds in a manner that achieves measurable national benefits.

I offer these proposals with an open mind. Naturally, they are based on our experiences in administering the Act. But, we have tried, as well, to take into account the many valid and constructive criticisms that have been made of the program that would serve to strengthen it. Given the nature of coastal management, I don't expect that these proposals will be entirely satisfactory to everyone here. But, I welcome your reactions to these ideas and look forward to discussing proposals that others will have.

In closing, I want to emphasize my belief that any changes that ultimately are made to the Act should result in a strengthening of its present foundations: A voluntary, but comprehensive process, implemented at the state level of government, that balances competing national concerns regarding the protection and development of significant coastal land and water resources. This basic structure and approach is sound and should be given a full opportunity to prove itself.

Our job for the next few days is to consider whether coastal zone management is fulfilling its promise. As we begin to tally the results, we find that a considerable amount of progress is being made. But, we have a long way to go before the program accomplishes all we can and should expect of it. Together, I believe, we can build on the momentum already generated.

WHAT RIGHTS REMAIN FOR THE COASTAL PROPERTY OWNER--WHAT HE CAN DO TO PROTECT HIS PROPERTY

Robert M. Rhodes
Thompson, Wadsworth, Messer & Rhodes
P.O. Box 1876
Tallahassee, Florida 32302

The Florida Constitution insures citizens the "inalienable right to acquire, possess and protect property." (Article I, Section 2). It further guarantees that "no person shall be deprived of life, liberty or property without due process of law." (Article I, Section 9). Like its federal counterpart - Article 10, Section 6, Florida Constitution, prohibits a governmental taking of private property except for a public purpose and with full compensation.

Complimentary to the constitutional due process and taking clauses is the authority of government to regulate in the interest of the public health, safety and welfare--to exercise police powers. Key among recent employment of the police power has been state and local enactment of land use regulations, including zoning and subdivision laws, sophisticated wetland protection regulations, coastal construction control lines, and an extensive system of governmental regulation and permitting of individual and business activity. Enforcement of such regulations often draws together through litigation the due process and taking clauses and the police powers, requiring judicial construction and resolution of competing private and public interests in a particular land parcel or activity.

There is little doubt the police powers are constrained by constitutional due process and just compensation requirements. "The General Rule," wrote Justice Holmes in Pennsylvania Coal Co. v. Mahan (260 U.S. 410), ". . . is that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking." The challenge in the 55 years following Pennsylvania Coal has been to determine the critical point at which regulations "go too far" and become confiscatory.

What factors have the courts considered in reviewing police power regulations? In a nutshell, police power regulations must be reasonable and may not be arbitrary, confiscatory or discriminatory. It is worthwhile to further explore these standards.

At the outset, we must recognize that the exercise of regulatory police powers must necessarily clash with the full enjoyment of property by an owner. Yet, it is established in Florida that all property rights are held and enjoyed subject to the reasonable exercise of the police power in furtherance of the general welfare.

However, the police power must be exercised in reasonable manner to further the general welfare. Examination of the cases indicates that police power regulations will not be deemed reasonable if they are arbitrary. There must be a rational relationship between the applied regulation and the desired legislative aim. Moreover, the detriment to the regulated owner should be outweighed by the public benefit realized by the regulation's application. Additionally, the courts have required a showing of substantial need for the restrictions before an owner must sacrifice property rights. Regulations may not exceed the bounds of necessity for protecting the public welfare.

Police power regulations will not be deemed reasonable if they are confiscatory. Regulations may not deprive the regulated land of all reasonable value. However, reduction in the value of property caused by regulations will not, of itself, render the regulations confiscatory. Moreover, the courts have dismissed the proposition that a property owner is always entitled to the "highest and best use" of his property. Regulations that have substantially depreciated property value have been upheld.

Returning to Justice Holmes' warning that too much regulation may require compensation, various analysts have attempted to develop a numerical assessment of the amount of loss in land value that courts will find acceptable. In the early 60's, a Pennsylvania study indicated that a loss of two-thirds of the property's value represented the average point where a taking occurred. However, another study suggested that value loss in cases where ordinances were upheld was about the same as the loss shown in cases where regulations were invalidated. Land use regulations have been upheld when the difference in land value was as great as 8 to 1 based on pre and post regulation value. An early U.S. Supreme Court case sustained a regulation which diminished value from $800,000 to $60,000. Hence, it must be concluded that in assessing the validity of police power regulations, financial loss is certainly a relevant judicial consideration, but is not the single, decisive criteria.

Nonetheless, a property owner may not be completely deprived of the beneficial use of his land. All uses, or the only use to which the property is reasonably adapted, may not be precluded by regulation unless

compensation is paid to the owner. In 1978, the U.S. Supreme Court in Penn Central Transportation Company v. New York City assessed the impact of the city's landmark preservation law on Penn Central terminal. Upholding the application of the ordinance to the terminal, the Court nonetheless recognized Penn Central's right "to profit from the terminal [and] to obtain a 'reasonable return' on its investment." These terms "profit" and "reasonable return" have stimulated substantial controversy in the legal, land use community. Property rightists believe the Court has instructed that post regulation use must enable the owner to turn a profit and to receive a reasonable return on his investment.

They further suggest that regulations prohibiting all commercial, residential and industrial use, such as the shoreland regulations validated in the Wisconsin case of Just v. Marinette Co., may no longer pass constitutional muster without compensation. The Supreme Court's standards await construction and application in individual cases. Nonetheless, the Court's recognition of profit and return on investment within the context of the taking issue is heartening.

A recent Florida Supreme Court case of Village of Tequesta v. Jupiter Inlet Corporation is instructive. In Tequesta, the Court determined a land owner does not have a constitutionally protected property right in water beneath his property, requiring compensation when a taking of water is used for a public purpose. The Court determined there is no private ownership in underground waters and the land owner only has a right to use the water and does not have a particular property right in groundwater. However, the Court left open the possibility of a taking action if a deprivation of use renders the land unsuitable for particular uses. Unfortunately, the Court did not specify the degree or extent of use deprivation that would constitute a taking.

A final consideration in evaluating the validity of police power regulations is whether a particular restriction discriminates against an individual property owner. Regulations must apply uniformly to all similarly situated owners.

In view of our focus on land use and natural resource restrictions, we must appreciate the distinctions

between eminent domain or condemnation, inverse condemnation and the police powers. Article X, Section 6 states that: "no private property shall be taken except for a public purpose and with full compensation therefore paid to each owner . . ." It forms the basis for governmental exercise of eminent domain power or condemnation. Through eminent domain, physical possession and use of property are taken from a private owner and transferred to the public. The private party is compensated for the property loss.

Inverse or reverse condemnation occurs when property is "taken" by government action without formal exercise of the eminent domain power. Inverse condemnation can arise through a particularly stringent exercise of police powers resulting in a taking. In such cases, courts may require the regulating government to compensate a property owner, drawing together the taking clause and police powers. However, the cases awarding compensation for inverse condemnation based on police power regulations are rare. Florida courts are reluctant to require compensation in non-eminent domain situations which involve depreciated value due to loss of uses, when actual governmental expropriation or physical invasion is not involved. The California Supreme Court recently concluded that inverse condemnation damages are not available in police power taking cases. Agins v. City of Tiburon, 591 P.2d 514 (1979). The national trend is toward the California position.

The police power - inverse condemnation - eminent domain distinction has been explained by the Florida Fourth District Court of Appeal:

> " . . . There is a clear distinction between the appropriation of private property for public use in the exercise of the power of eminent domain, and the regulation of the use of property under the police power exercised to promote the health, morals and safety of the community . . . we hold that enactment of a zoning ordinance under the exercise of the police power does not entitle the property owner to seek compensation for the taking of the property through inverse condemnation."

Hence, private property may be subordinated to the public interest without compensation through exercise of the police power. Like eminent domain, action taken pursuant to the police power must benefit the public:

however, as distinguished from eminent domain, a valid exercise of the police power may restrict the use of private property without payment of compensation. Mailman Development Corp. v. City of Hollywood, 286 So.2d 614.

Certainly, one of the seminal issues facing coastal property owners is whether the Mailman "clear distinction" is valid. Is it good public policy? If property provides value due to present and potential use, and governmental action restricts such use, either for a public purpose through eminent domain, or to further the public health, safety and welfare through police power, are property rights not similarly restricted? And subject to the same compensation? Is the only true distinction between eminent domain and regulation semantic? Hence, should not a taking effected through regulation be as compensable as stripping private rights through condemnation? Mailman says no; if reasonable use is deprived by regulation, governmental action may be judicially invalidated; however, the owner may not receive damages.

Perhaps the court's protective posture toward police power regulation is bottomed on the perception that first generation regulations, such as zoning, apply comprehensively through a comprehensive plan to all owners, who ultimately share the burden as well as the benefit of regulation.

With the advent of second generation land use restrictions focusing on resource protection, such as wetlands, beaches, floodplains, dunes, wildlife and aquifers, must we re-examine the traditional non-compensation deference granted police power? Since resource protection regulations generally are not aimed at preserving a minimum reasonable, beneficial use for property that includes a protected resource, do these regulations provide the same community equity as land use regulations implementing a comprehensive plan? Or, will owners suffer discrimination simply because of property location?

In sum, is the compensation-non-compensation distinction between police power and eminent domain taking still "clear?" Should compensation, per Mailman and other state appellate decisions always be denied if a police power regulation is invalidated?

In the absence of specific statutory authority, courts have refused to award monetary damages for a police power taking. A Florida Senate committee concluded that without statutory authority, Florida courts cannot presently direct compensation to be paid to a landowner whose land is confiscated by government action. At least one appellate court has invited the legislature to change this policy. In 1978, the Florida legislature did so.

Chapter 78-85, Laws of Florida, Florida's property rights legislation, is a remedies bill. It establishes a cause of action and a trial court forum to resolve taking claims engendered by denial of certain state environmental permits. The Act is aptly described as "police power taking compensation" legislation. Let me outline the major provisions.

The Act enables any person substantially affected by final agency action on a covered permit to initiate a circuit action requesting monetary damages and other relief.

Key operational definitions of "agency" and "permit" limit the court action to state agency permits or licenses involving Chapters 161, 253, 373, 380 and 403, Fla. Stat. Hence, the Department of Natural Resources decisions regarding coastal construction control lines, Trustees of Internal Improvement Trust Fund decisions regarding dredge and fill permit appeals and sale and lease of state owned lands, land and water adjudicatory commission and regional water management district decisions regarding water permits, land and water adjudicatory commission decisions regarding developments of regional impact and areas of critical state concern, and environmental regulation commission decisions regarding pollution control permits are subject to the circuit court action established by the Act.

The Act envisions prior exhaustion of Chapter 120 administrative remedies. The trial court action triggers only after final agency action on a permit and an administrative appeal, if the appeal raises a taking issue. The circuit court review is confined solely to determining if final agency action is an unreasonable exercise of the state's police power constituting a taking without just compensation. Hence, all existing administrative remedies and requirements are preserved.

If the circuit court determines agency action is an unreasonable exercise of the state's police power constituting a taking, the court will remand the matter to the agency, which, within a reasonable time must:

(1) agree to issue the permit; or
(2) agree to pay appropriate damages; or
(3) agree to modify its decision to remedy its unreasonable action.

Note that the court must first determine there is a police power taking. The Act does not attempt to provide courts with a legislative definition of a taking; the body of case law defines a taking.

If the court holds there is a taking, the matter is remanded to the agency to consider further action.

As noted, three options are available to the agency.

By granting the agency first option to take further action, the agency may avoid paying damages. It may issue the permit, or modify its decision to avoid an unreasonable exercise of police power. If the permit is issued, the case will terminate upon issuance of the court's final order recognizing the agency's action. However, if the agency chooses to modify, it must incorporate proposed action in a proposed order to the court. If the court determines the proposed action is a reasonable police power exercise, it will enter a final order approving the proposed order.

As a third option, the agency may agree to pay appropriate monetary damages.

If the agency opts to compensate, the court, in determining the amount of compensation, must consider any enhancement to the value of the land attributable to governmental action. This provision is a windfall deterrent mechanism designed to at least bring before the parties and the court value that may have been conferred by government. The Act does not require a setoff for such value against value lost due to government action. Neither does the Act establish a statutory formula for assessing damages, deferring this determination to the courts based on individual case factual inquiry.

If the agency fails to submit a proposed order within 90 days following the court's invalidity holding, advising the court of future action it desires to take, the court may order the agency to exercise any of the three statutory options.

The court's final order presumably could mandate modified agency action and compensation, depending on the court's assessment of the appropriate mix required to attain validity.

The Act provides that the court must award attorney's fees and costs to the prevailing party.

The cause of action is cumulative to other legal remedies and does not preclude an inverse condemnation action authorized under other statutory provisions.

Finally, the legislation supplements Chapter 768, which waives the state's sovereign immunity; hence, legislative creation of a specific cause of action for damages further waives immunity for claims specifically referenced in the Act.

In summary, what rights remain for coastal property owners? Well, police power regulations are alive and well and increasingly restrictive. The coastal protection elements of the Local Government Comprehensive Planning Act will encourage further regulation. Per the existing cases, property value may be severely depreciated without compensation provided a beneficial use remains with the owner. The Penn Central case suggests that the remaining beneficial use must afford the owner a profitable opportunity and a return on investment.

Still, to quote the U.S. Supreme Court, "there is no set formula to determine where regulation and taking begins." Goldblatt v. Town of Hempstead, 369 U.S. 590 (1962).

Lacking a legislative definition of a taking, or a policy mandating when compensation must be paid, courts will continue to decide taking issues in diverse, and often disparate, ways. And, lacking further legislation authorizing compensation for local government police power takings, harsh local regulations will remain non-compensable. The 1978 property rights

legislation, dealing with state and regional environmental permits, may provide beneficial precedent for future action.

What can an owner do to protect his property?

First, you must become educated as to the extent of your legal rights. Understand the basic legal concepts outlined today and do not be afraid to impart your basic knowledge to regulators and elected officials.

Second, consider whether additional state property rights legislation is required to establish a definitive compensation policy, and let your professional associations and legislative delegations know your views.

Third, participate in hearings and workshops on your local government comprehensive plans. These plans will provide the basis for future regulations which must be consistent with, and implement, the plans.

Fourth, band together in professional and neighborhood groups and participate intensely in local government decisions relating to additional regulations. Give your elected officials a real world view of property values and the regulatory maze.

Finally, do not sit on your rights. The trend is toward more intense, sophisticated regulation--things are not going to get better. Understand that zoning alone is not sufficient to guarantee a future vested right to develop. Keep ahead of the regulatory action.

I hope this overview of the present state of the law and suggested action proves helpful in your upcoming battles.

THE PRIVATELY FUNDED BEACH PROJECT
WHAT TO DO WHEN THERE'S NO GOVERNMENT FUNDING

Richard W. Stevens, P.E.
Mariner Properties, Ltd.
Captiva Island, Florida, 33924

and

Erik J. Olsen, P.E.
Tetra Tech, Inc.
7825 Baymeadows Way
Jacksonville, Florida 32216

ABSTRACT

THE PRIVATELY FUNDED BEACH PROJECT

WHAT TO DO WHEN THERE'S NO GOVERNMENT FUNDING

Private financing of beach restoration can offer a viable alternative to public financing for those communities faced with critical erosion problems but unwilling to provide public access and attendant facilities necessary for significant State and Federal financial aid. Funding of the South Seas Plantation Beach Improvement Project at Captiva Island, Florida, will be through the establishment of a municipal service taxing unit (MSTU). This paper will discuss the objectives, procedures and advantages associated with the development of such a funding plan as well as any attendant special problems.

The beach nourishment project under consideration consists of the placement of approximately 800,000 cu. yd. of sediment along 10,000 ft. of gulf-front shoreline. The designated borrow site is the seaward shoals of Redfish Pass an unimproved inlet immediately adjacent to the northern boundary of the project. This paper will likewise discuss the history of erosion on Captiva, the design details of the nourishment project and the geotechnical exploration involved.

AUTHORS: Richard W. Stevens, P.E.
Project Manager, Mariner Properties, Ltd.

Erik J. Olsen, P.E.
Senior Engineer, Tetra Tech, Inc.

INTRODUCTION

About 210 miles of the 782 miles of recreational beach in Florida are in a critical state of erosion. The $81 million in government funded beach restoration projects now underway or committed are considered a "drop in the bucket" when compared to the total requirements. Moreover, many small beach communities are unable to provide the local assurances necessary for Federal and State funded projects. Private financing of beach restoration offers a viable alternative to public financing for these communities faced with critical erosion problems but unwilling to provide public access and attendant facilities necessary for significant Federal and State financial aid. This presentation concerns a privately funded beach project for South Seas Plantation on Captiva Island, and will discuss how the project was developed, the financial plan and certain engineering aspects of the project of general interest.

CAPTIVA ISLAND

The State of Florida occupies a portion of a much larger geographic unit, the Floridian Plateau. During geological time the plateau has been alternately dry land or covered by shallow seas. Each retreat of the sea left marine deposits which, during subsequent advances of the sea, were moved about by waves and currents to form beaches, offshore bars, and barrier islands. Captiva is one of the barrier islands.

Captiva Island is located between Pine Island Sound and the Gulf of Mexico and is bounded on the north by Redfish Pass and on the south by Blind Pass (see Fig. 1). The island is 4.7 miles long with elevations averaging about five feet and highest elevations of less than 10 feet above sea level. Prior to 1926 the island extended to Captiva Pass about 4.1 miles further north. In 1926, a severe hurricane caused a breakthrough in the narrow center portion of the island, forming Redfish Pass and two distinct islands, Captiva and North Captiva. Redfish Pass is a relatively stable inlet and has remained open and navigable since 1926. Blind Pass is an unstable inlet and has opened and closed several times since 1926. Presently, Blind Pass is closed and there is an accumulation of sand beneath and westward of the bridge over the Pass to Sanibel Island.

Data from as far back as 1876 indicate net shoreline erosion of Captiva Island over the entire period of record. Following the hurricane of 1926 and the opening of Redfish Pass, the northernmost one-third of Captiva Island experienced dramatic rates of erosion and shoreline recession. In some areas south of the pass, average annual recession rates has exceeded 39 feet per year and total shoreline recession has been greater than 700 feet.

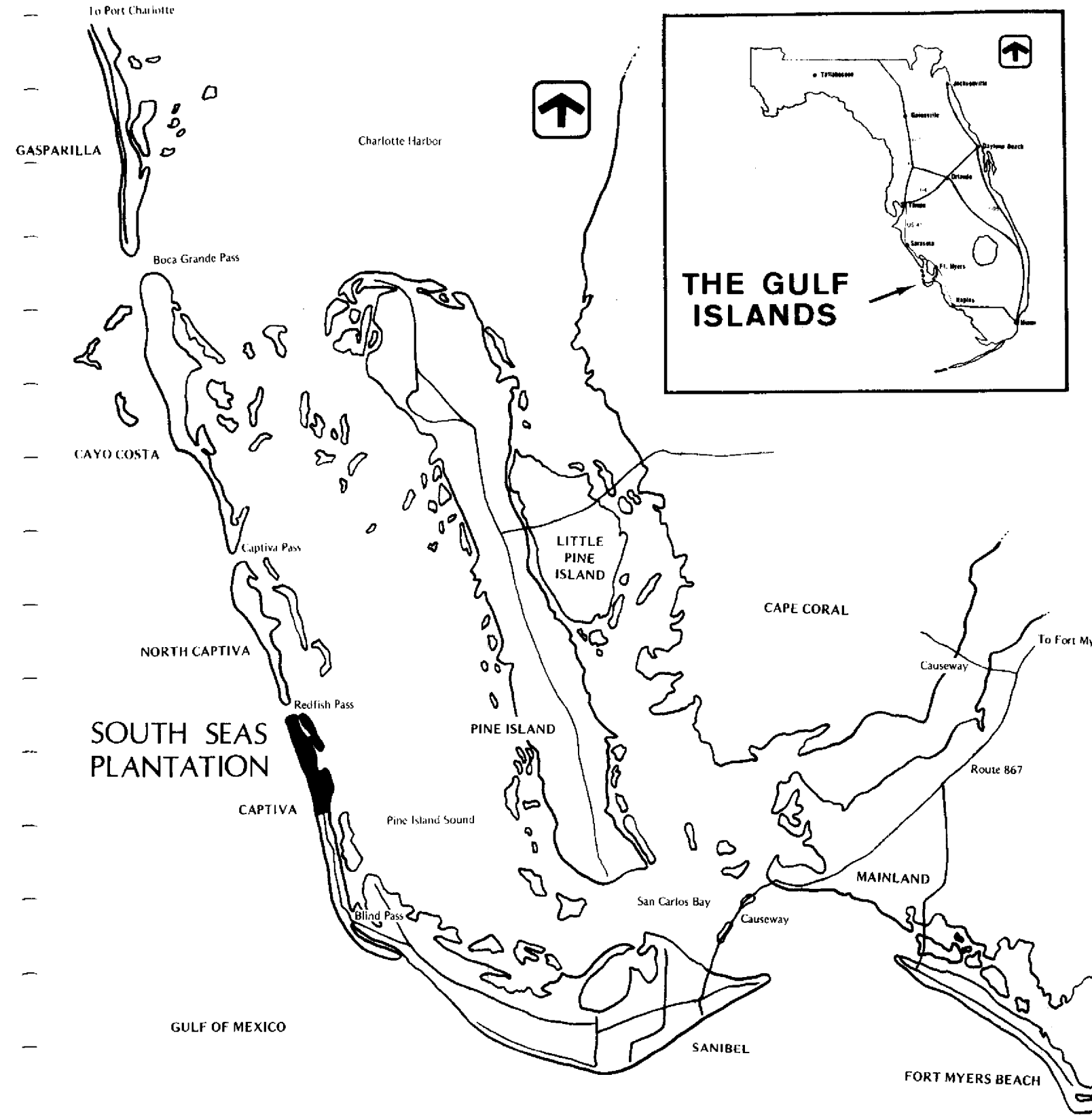

To Port Charlotte
GASPARILLA
Charlotte Harbor
Boca Grande Pass
CAYO COSTA
Captiva Pass
NORTH CAPTIVA
Redfish Pass
SOUTH SEAS PLANTATION
CAPTIVA
Pine Island Sound
PINE ISLAND
LITTLE PINE ISLAND
CAPE CORAL
To Fort My
Causeway
Route 867
MAINLAND
San Carlos Bay
Causeway
Blind Pass
GULF OF MEXICO
SANIBEL
FORT MYERS BEACH
THE GULF ISLANDS

FIGURE 1

Historical beach and offshore profiles plotted from the surveys of 1878/79, 1956/61 and 1967 have been compared with those surveyed in 1979 in conjunction with the design of this project. Comparison shows the continuous recession and steepening of the nearshore profile along the majority of the Captiva shoreline over the period of record. An analysis of average annual volumetric changes and shoreline translations for the period between 1967 and 1979 is shown in Figure 2. Average annual erosion rates for the shoreline within the limits of the South Seas Beach Improvement Project are relatively uniform between 3 and 4 cu. yd./yr. per foot of shoreline. The shoreline is approaching a form of dynamic equilibrium by exhibiting a trend toward this steady state net annual erosion.

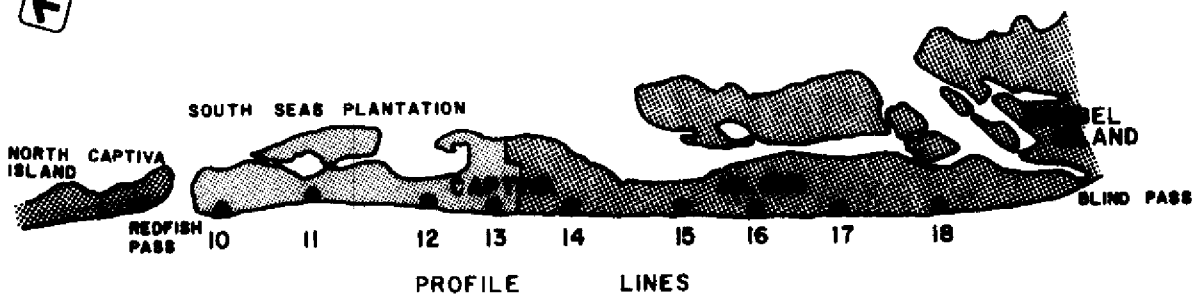
SOUTH SEAS PLANTATION

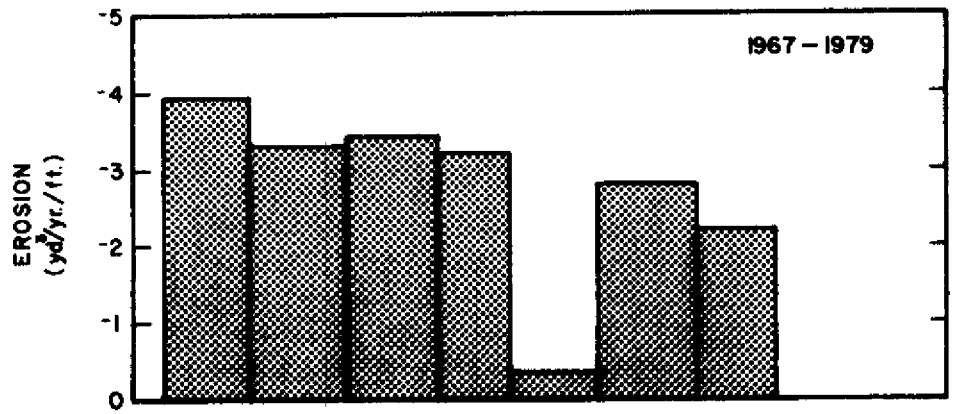
South Seas Plantation is a privately owned resort on the northern tip of Captiva Island. Last year the Florida Shore and Beach Preservation Association held its annual meeting at South Seas Plantation and the year before the combined annual meeting of the Association with the American Shore and Beach Preservation Association was held there. The resort offers a wide variety of accommodations (about 400) from hotels to individual cottages, complete recreational facilities (tennis, golf, swimming, marina, offshore and charter fishing, boat rental) and excellent restaurants. And, of course, 1.7 miles of gulf front beach excellent for swimming and shelling. The tone and atmosphere of the resort is that of privacy and peace. The resort is very popular with tourists and convention groups and those of you who visited there might agree that it's a high quality and very successful resort.

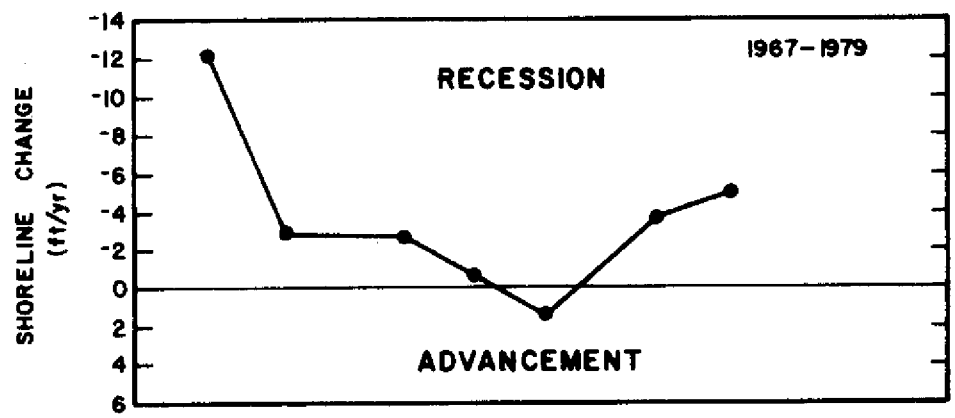
One aspect of the resort not commonly known is that much of the resort is privately owned. The developer, South Seas Plantation Company, constructed single and multi-family units gradually and in stages, and then sold them either as individually owned or condominium units. For example, the Beach Homes are single family units; the Beach Cottages are duplexes and quadruplexes and the Beach Villas, Tennis Villas and Bayside Villas vary from eight to sixty units per building. Also, there is an interval ownership cluster, the Plantation Beach Club, and individual homesites. The developer offered many purchasers the option of leasing back their unit to the resort as a rental unit for tourist accommodations, in which case the resort and purchaser would share the rental income. This proved to be a successful and profitable arrangement. At any rate, the individual owners and the developers have a mutual interest in the property.

PRIOR BEACH EROSION CONTROL EFFORTS

Captiva Island residents have been aware of erosion problems for over forty years. As the island developed and more built-up areas were







AVERAGE ANNUAL SHORELINE VARIATIONS
ALONG CAPTIVA ISLAND (1967–1979)

FIGURE 2

threatened, the community became more concerned. Beach erosion during severe winter storms in 1957-58 caused loss of sections of the county road. As a result, the Captiva Erosion Prevention District was formed in 1958 by an Act of the Florida Legislature. The District investigated various coastal works installed for erosion prevention throughout the United States and concluded that some sort of groin installation was the best solution. Further investigation determined the Budd Wall type of groin to be the most effective for the price inasmuch as it cost a third less than any comparable type of installation. A bond issue for $200,000 was approved in 1959. In 1961, 134 concrete "dog bone" Budd groins were installed. Many are still in place today. Their effectiveness has been minimal. In 1966, the District installed two timber groins near the center of the island at a cost of $20,000 and later added 110,000 cubic yards of sand fill at a cost of $38,000 in an effort to prevent loss of the county road. In 1964, another 50,000 to 100,000 cubic yards of fill was added at a cost of $100,000. Several other District sponsored erosion control structures have been installed since 1964, and some private property owners on the southern end of the island have installed rock revetments and concrete sea walls.

In 1969, at the request of the Lee County Commission, the Jacksonville District, U.S. Army Corps of Engineers, prepared a study on beach erosion control for Lee County. The study reported that the beaches of Captiva Island were severely eroding and recommended a Federal project for beach erosion control. Basically, the project called for improvements to most of the island's beach consisting of placement of 1.8 million cubic yards of sand to make the beach about 100 feet wider at mean high tide, and to add sand periodically to maintain that width. Congress authorized the project in 1970. Federal aid for beach improvements is based on the amount of publicly owned or publicly used beach and can be as much as 50%, provided there would be significant public benefits arising from public use or from direct protection of nearby public facilities. Similarly, the State of Florida will fund 75% of the remaining cost. In 1970, at the time of the study, due to private ownership of the beach and lack of public access, Federal aid would have been only about 9%, leaving the remaining cost to be paid from non-Federal funds.

In March 1973 the District contracted with the Coastal and Oceanographical Engineering Laboratory of the University of Florida to conduct a coastal engineering study of Captiva Island. That study also recommended placement of sand on the beaches and added the construction of a terminal groin at Redfish Pass. The University of Florida study concluded that the terminal groin would help to prevent sand from Captiva beaches from washing into Redfish Pass. The terminal groin was of particular interest to South Seas Plantation in that its construction would serve to get started on an important phase of the beach restoration project. The groin also afforded a direct

means of erosion control for part of the South Seas Plantation property. For those reasons, South Seas assisted the erosion district in getting permits and agreed to pay for construction of the groin.

Since 1970 the District, as local government sponsor of the project, has not been able to provide the assurances required for State and Federal government funding. The basic problem is lack of support by Island residents due to the requirement to establish public accesses and parking along the beach at approximately one-half mile intervals. Lack of support was demonstrated most recently in February 1978 when the majority of the Island residents voted against the Federal project.

In December 1978, the South Seas Plantation Company Board of Directors, acting in its own interest as a major property owner, and in response to the requests of many other property owners, voted to initiate actions required to obtain permits and develop a privately funded program for nourishment of the resort's 1.7 miles of beach, the northern one-third of the island. In effect, it was decided to start the program immediately with or without support of the rest of the island. This included also a commitment to provide up-front money for engineering and design on the premise that the owners would support the project and this money would be recouped later from owner contributions. Although this is not necessary for a privately funded project, there are certain benefits to this procedure, as will be explained. Whether provided in advance and recouped later, or included as part of the total project at the time owner approval is completed, these costs are eventually paid for by the owners involved with the privately funded project. For the case of a government funded project implemented by the Corps of Engineers, these expenses are included in the formulation of cost sharing and are required of the local sponsor prior to the initiation of project construction.

The following is an outline of how the South Seas Plantation privately funded project was developed and how owner support is being obtained.

PLAN OF ACTION

It was recognized that about six months lead time was needed to accomplish engineering and design before approaching the owners for approval of the project and financial support. With that in mind, the following plan of action was implemented:

1. Appoint a full time project manager to coordinate activities and be responsive to the owners.

2. Award contracts for engineering, design, and permitting activities.

3. Develop a funding plan that would be acceptable to the owners.

4. Develop a cost proration plan that would be acceptable to owners.

5. Keep owners informed of plans and progress.

6. Obtain owners' approval and financial support.

FUNDING PLAN

It was assumed that all owners would consider their share of the cost to be similar to purchasing insurance for protection of their investment. Because the value of individual properties varied considerably, depending on type of unit, proximity to the beach and other resort amenities and income potential, it was concluded that the funding plan must be financially feasible for all categories of owners, but fair and equitable to minimize dispute. Objectives of the funding plan were established as follows:

1. A sharing in the cost by all property owners who use the South Seas beach.

2. A significantly greater share of the cost being borne by the beach front owners versus those who own property not directly on the beach.

3. The beachfront share being proportionally distributed based on the amount of footage owned rather than the value or sales price of the property affected.

4. A desire to create a plan under which payments would be tax deductible.

5. An objective to spread the cost over a period of several years rather than a one time cost.

Based on these objectives and using an estimated cost of $2 million, a cost proration plan was developed as shown in Table 1. Payments vary from $1,285 for non-beach front owners to $16,515 for owners of 100 foot gulf front lots. As can be seen, there are 466 individual property owners, and 2,856 one-week interval owners at the Plantation Beach Club. The plan has the following features:

1. Allocation of about 87% of the cost to beach front owners.

2. Allocation of about 13% of the cost to non-beach front owners.

TABLE 1

COST PRORATION PLAN

	Consolidated Payment		Individual Payment		
	Total Units	Total Allocation	Individual Allocation	Installment Annual	Installment Monthly
Property Owner Beachfront					
South Seas Resort	-	$ 722,600*	$ 722,600	$131,628	$10,969
Plant. Bch. Club	2856 (wks)	144,000	50	9	1
Gulf Cottages	8	59,250	7,405	1,344	112
Beach Homesites	13	214,700	16,515	3,012	251
Beach Homes	33	314,000	9,515	1,728	144
Beach Cottages	26	96,000	3,690	672	56
Beach Villas	160	272,100	1,700	312	26
Private Lots	12	192,000	16,000	2,916	243
Non-Beachfront					
Bayside Villas	102	131,000	1,285	228	19
Tennis Villas	60	77,100	1,285	228	19
Marina Villas	40	51,400	1,285	228	19
Beach Homesites	4	5,100	1,285	228	19
Private Lots	8	10,300	1,285	228	19
Units/Lots	466	$2,289,550*			
Weeks	2856				

*Includes $289,550 for pre-project studies and construction of terminal groin at Redfish Pass.

3. Lump sum payment for those desiring a large, single tax deduction.

4. Payments over an eight year period with interest at 10% for those who desire a term arrangement.

It was next necessary to find a vehicle by which the funding plan could be implemented and administered and still meet the objectives. State law allows a designated area to create a special taxing or assessment unit - called a Muncipal Service Taxing Unit (MSTU) - to provide certain services not currently provided by the County. The State Statute authorizing this specifically includes beach erosion projects as an eligible service. Here's how an MSTU is formed and operates:

1. Created via ordinance by the County Board of Commissioners upon petition by at least 65% of the affected parties and a public hearing.

2. Upon establishment, the County Commissioners appoint a five member advisory board to conduct the affairs of the MSTU. This board will consist of property owners of the designated area.

3. Upon establishment, the MSTU has taxing and assessment authority for all property owners involved. The MSTU also has bonding and borrowing capability using the taxes or assessments as security.

4. Properties within the MSTU can be assessed at differing rates, depending on the value they derive from the service.

5. Property taxes or assessments paid by property owners via the MSTU process are deductible for income tax purposes.

OWNER INVOLVEMENT

It is proposed to establish an MSTU for the South Seas project. The key to a privately funded project is owner support and approval. This requires owner involvement from the beginning, which goes back to an earlier statement about the benefits of having up-front money for project management, design, and permitting. This is beneficial because when the MSTU is formed, the owners will know exactly what the project consists of, when it will be done, how much it will cost and what will be the benefits to them. Otherwise, it could be difficult to obtain petitions from 65% of the owners for a project as complicated as beach erosion control. For South Seas this was accomplished in the following manner:

1. Owners were informed by letter of the intent to develop and accomplish a privately funded project.

2. Newsletters were sent to owners, keeping them advised of progress in design, permitting and financing. Owners were encouraged to express their opinions about the project.

3. A project manager's office was established which served as an information center. Owners could visit the office at their convenience, review files and cost expenditure reports and discuss the project with the project manager.

4. At the time of petitioning for the MSTU, owners will be provided an information brochure giving the background of the erosion problem, details on the design of the beach fill and how the project will be accomplished.

5. The bottom line is owners are made to feel it is their project.

ADVANTAGES OF PRIVATELY FUNDED PROJECTS

The advantages of a Federal and State supported beach erosion project are that technical and administrative support is furnished, and, of course, cost to property owners is minimized. Because of the requirements for public benefits, however, there can be distinct disadvantages to government sponsored projects and in many cases worthwhile projects are "shelved". By comparison, the privately funded project offers the following advantages and is therefore a viable alternative:

A. Privacy is maintained. There is no requirement for additional public access to be provided.

B. There is no requirement for the local assurances as with Federal projects.

C. There are fewer regulatory controls and, therefore, more flexibility in procurement activities, less stringent contract and specifications requirements and hence, cost savings.

D. Time frame is short. One year from design to construction compared to three to five years for a Federal project.

E. Some of the new beach becomes the property of the owners. Florida Statutes provide for the location of the erosion control line seaward of the existing mean high water line in order to provide for an equitable distribution of the restored beach where riparian upland owners are furnishing

financial assistance.

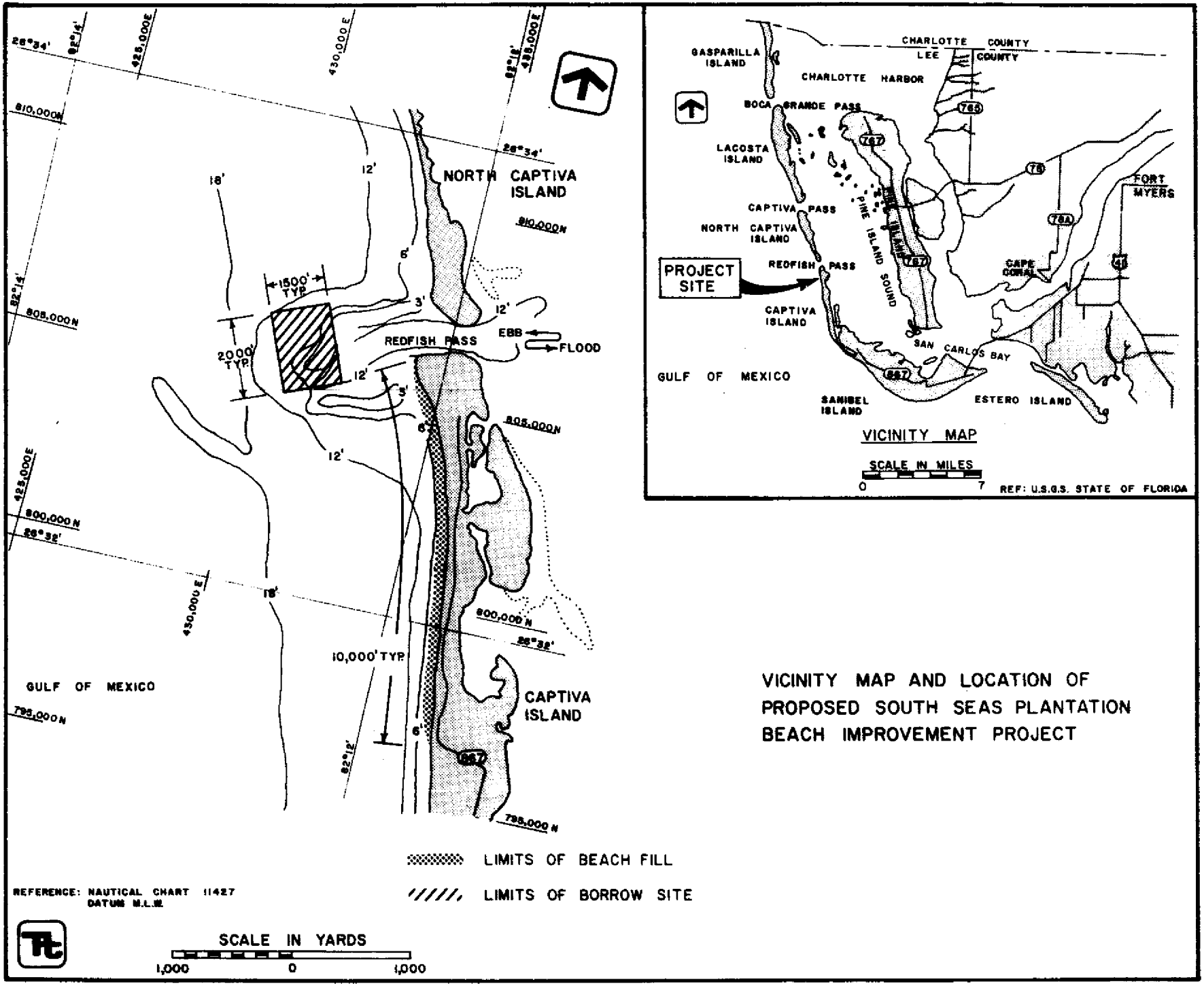
F. There is no requirement to pay for dredged material taken from sovereignty land.

ENGINEERING

The South Seas Plantation Beach Improvement Project described by this paper can be considered as the first phase of a comprehensive beach restoration effort necessary for the stabilization of the entire gulf shoreline of Captiva Island. The project development as presentely conceived proposes the placement of approximately 765,000 cu. yd. of beach quality sand along the northernmost 10,000 feet of gulf-front shoreline immediately south of Redfish Pass (see Figure 3). It is important to note, however, that the "project" as discussed herein, is designed to rebuild and protect only the northern end of the island, and that southward of the limits of fill, shoreline recession at historical, or near historical rates is expected to continue without the implementation of further beach restoration.

It has been well documented by previous coastal engineering studies that the hurricane of 1926 caused a breakthrough in the narrow center portion of Captiva Island at the site of Redfish Pass thereby causing the formation of two distinct islands. Since 1926, both shorelines immediately adjacent to Redfish Pass have receeded extensively as a form of adjustment to the hydraulic regimen of the tidal inlet. At the present time, however, both shorelines proximate to the Pass are approaching a form of dynamic equilibrium by exhibiting a trend toward a steady state net annual erosion. The majority of the sediment eroded from both shorelines has been redeposited in the form of extensive shoals gulfward and bayward of Redfish Pass. The total volume of material considered to have accreted within this shoal system since 1926 exceeds 5 million cu. yd. The establishment of Redfish Pass as a hydraulically efficient tidal inlet has created a barrier and corresponding sediment sink to littoral material transported southward on North Captiva Island and northward along the shoreline of Captiva Island. The resultant deposition of sediment at the inlet in the form of gulfward shoals further modifies littoral transport by the interruption and refraction of alongshore wave energy. Since the inlet can be considered as a total barrier to littoral drift, the shoals are expected to continue to increase in size.

As with many of the barrier island coastlines found in southwest Florida, there is no significant source of littoral material along the gulf shores of Lee County other than what is derived from the Keys themselves, from the adjacent offshore shoals or from biogenic origin. Qualitatively, the extremely high percentage of shell measured from sand samples taken from the foreshore and backshore of the beach within the study area would indicate the importance of



VICINITY MAP AND LOCATION OF PROPOSED SOUTH SEAS PLANTATION BEACH IMPROVEMENT PROJECT

FIGURE 3

biogenic sediment sources. The relative age of this fraction of the beach sediment is unknown. It is therefore not possible to determine whether the shell originates in significant volume due to the natural attrition of living organisms, or whether its accumulation is primarily the resultant of long-term sorting processes.

As previously noted, the estimated volume of material required for initial construction at South Seas Plantation is about 765,000 cu. yd., including 5 years advance nourishment. It is estimated that the restored beach will require renourishment with about 500,000 cu. yd. on 10 year intervals assuming suitable textural characteristics of the future borrow source sediments. The specified design berm is 6.0 feet above NGVD and 4.7 feet above mean high water. The average width of the design berm selected is approximately 105 feet. This minimum width will provide adequate protection of upland improvements from minor storms and will initially create about 140± feet of dry beach above the MHWL for recreational purposes. The design of the project berm is based on an average annual sediment loss rate over the project life of approximately 5 cu. yd./ ft. per year. The estimate accounts for historical average annual erosion as well as additional sediment losses resulting from sorting processes and nearshore slope adjustments.

The slopes of the design beach are estimated as 1:6 from the crest of the beach berm to approximately mean low water, and about 1:22 from MLW to the intersection with the existing bottom. Beyond this point natural slopes average 1:50. The design slopes are based upon a comparison of existing slope trends within the project limits. It is acknowledged, however, that post-project beach slopes along the shoreline of northern Captiva Island will be primarily a function of the textural characteristics of the in-place beach sediments and long-term sorting processes. Historically, shell content has been extremely high in the beach berm landward of existing mean low water. Geotechnical exploration of the proposed borrow area has revealed that the project beach will likewise contain an appreciable percentage of shell. Accordingly, it is anticipated that subsequent to initial sediment losses due to immediate adjustment of the construction profile, fill slopes will again approach those typical of the existing native beach.

Post-placement behavior of designed beach fills is recognized as being directly related to the differences or similarities between the textural characteristics of the native beach material and those of the sediments to be derived from the borrow site. In the nearshore zone of the Captiva shoreline, the sorting action of the waves and currents has removed most organic matter to deeper water, so that the remaining surface material is almost all sand and shell. Accordingly, the medium grain size of sediments decreases from the littoral zone seaward. The materials encountered in offshore core borings

parallel to the coast taken by the Jacksonville District Corps of Engineers in 1967 were principally sand, silty sand, and small amounts of clayey sand. The preliminary results of the COE investigation indicate that the average depth of offshore overburden available for beach nourishment purposes is approximately 10 feet, with the initial two to three feet containing a substantial silt content. Although the majority of this sediment is suitable as beach fill, it exhibits a small median grain size which based on theoretical models of sand transport would result in a relatively high overfill ratio. The need for a more texturally compatible sediment source, therefore, led to the extensive geotechnical exploration of the area seaward of Redfish Pass performed by Tetra Tech in March, 1979. Preliminary sampling and computations by the University of Florida in 1973 indicated the potential volume and quality of the sediments deposited within the high energy zone. Subsequent VIBRACORING of the inlet shoal has verified the available depth and textural characteristics of the material involved and has consequently resulted in its selection as the primary borrow site. Sediments deposited above the pre-inlet bottom are composed primarily of coarse shell and medium to fine sand. Suitability analyses of sediment samples derived from the proposed Redfish Pass borrow site and the native beach indicate that no overfill will be required. Accordingly, the depth of dredging within the borrow area will be limited to an average pre-inlet depth of 15 feet below NGVD in order to maximize the quality of sediment placed as beach fill and to minimize the potential for the suspension of silts or clays into the water column.

In summary, the improvement selected for beach erosion control will serve two primary purposes:

- the protection of upland real estate and structures, and
- the preservation of ample beach areas for present and future recreational needs.

The environmental impact of the proposed project will be limited primarily to temporary minor increases in turbidity during construction as well as short-term disruption of the benthos associated with the borrow and fill sites. The beach improvement project will replenish sand transported from Captiva Island by natural littoral processes as well as by the influence of Redfish Pass. Analyses indicate that excavation within the selected offshore borrow area will not adversely affect normal littoral transport on North Captiva, Captiva or Sanibel Islands. Both the initial project and the proposed periodic renourishment program will, in effect, augment the natural function of the net littoral forces that move sediment southward along Captiva Island toward Sanibel Island.

LOCALLY FUNDED BEACH PROJECT WHEN STATE AND FEDERAL FUNDS ARE NOT AVAILABLE

Robert F. Vande Weghe
Town Manager
Town of Jupiter Island
P.O. Box 7
Hobe Sound, Florida 33455

I have been asked today to talk about the two major beach renourishment projects that the Town of Jupiter Island completed, one for 2½ million cubic yards in 1972-3 and the other for 1 million cubic yards in 1978, but expressly, I've been asked to explain how a small town like ours was able to finance these tremendous projects without Federal financial help and only limited State aid. I must say from the start that what our Town did may not be applicable in full to other Towns since we are rather unique. However, it is an example of what can be done when the Towns' people work together.

Before I start, let me describe the Town of Jupiter Island. The Town itself is located about 20 miles north of Palm Beach. It is bounded on the north by 5 miles of Wildlife area and on the south by 1 mile of Nature Conservancy. The Island is bounded by the Atlantic Ocean on the east and the Intracoastal Waterway on the west. It is connected by two bridges to the mainland. The Town itself is approximately 7 miles long and ½ a mile in width. We have approximately 350 single family residential homes, no condominiums, no apartments and no highrises. The only commercial or business area is a private club to which about 80% of the residents belong. Approximately one third of the people live on the Ocean, one third on the Intracoastal Waterway and one third in the area between.

As to the make-up of our residents, the majority live in the Town on a part-time basis. Most of them reside there from December through April. There are only 229 registered voters. Approximately 50% of the residents would be classified as millionaires. About 40% are retired with well above average income and the other 10% are people, like myself, who are still working for a living. In short, Jupiter Island is as close to a tropical paradise as you'll find in these United States.

Even an Island such as ours in not total paradise. Every Eden has its serpent. Ours happens to be beach erosion. In 1900 the St. Lucie Inlet was created by man. This was the start of our erosion problem. This erosion increased in 1930 when a stone jetty was built at the Inlet. In 1967, recognizing the horrendous problems that confronted us, the Town applied to Tallahassee for legislation which would allow the Town to take certain steps to protect the shore line. On August 4, 1967

House Bill #2759, Chapter 67-1588 was passed. This bill authorized the Town Commission to construct sea walls, groins, breakwaters, etc. and perform renourishment projects as required to protect our Town's beaches. It gave the Commission authority to require property owners to construct and maintain sea walls, groins, etc. at their own expense. It divided the Town into two erosion districts for millage purposes on a three to one basis with the Ocean front property owners paying 3 and the Inland properties paying 1. It established a 6 mill maximum and it allowed the Commission to appoint an Erosion Committee of 3 people to administer the act. By 1969 this Town with its residents had constructed almost 3 miles of sea walls and accompanying groins. These kept the Island in pretty fair shape for a couple of years; but the Ocean is a powerful opponent and while we were able to slow the erosion we could not stop it and we found ourselves fighting a never ending battle. The Island is currently losing about 250,000 cubic yards of sand each year and the dune line, where there are no sea walls, is receding from 5 to 7 feet per year.

Prior to 1971 the Town had performed at least 5 renourishment programs taking sand from the Intracoastal Waterway and pumping it onto the beaches. These averaged from 60,000 to 100,000 cubic yards each. We also, for three years, used a drag scraper to drag 30,000 cubic yards of sand per year from the Ocean bottom up on to the beaches. But it doesn't take a mathematician to figure that you can't lose 250,000 cubic yards per year, while replacing an average of 60,000 cubic yards per year, without having serious problems.

By 1971 our beaches were eroded so badly that in the month of October alone, we lost 1400 linear feet of sloping revetment sea walls and 3 vertical sea walls collapsed. At least 10 homes were in serious danger of falling into the Ocean. This was not due to a hurricane or a major storm. It was caused by the constant day to day erosion of our beaches. Something had to be done and done fast. We decided the only feasible solution was an immediate massive sand renourishment project. Fortunately we had a good idea of what had to be done. Several years before, a Corps of Engineers made a complete study of our shoreline in which they recommended that 2½ million cubic yards of sand be pumped

onto our beaches. They described where the sand should be placed, the contour of the beach and they described the areas from which the sand could be gotten. Unfortunately the study also said that there could be no Federal assistance, since there were not enough public accesses.

In November 1971, we hired Arthur Strock to be the project engineer. We gave him the simple task of obtaining the necessary permits, finding a contractor and starting the project. By June 1972, eight months later, believe it or not, he did just that. This is the type of thing you can do if you don't have to wait for Government studies and funding. I will say though, that none of it would have been possible without a great deal of help from Tallahassee, especially Beaches and Shores; and the Corps of Engineers in Jacksonville. All of them bent over backward to rush through the permits and approvals. Their advice and help were invaluable.

But now back to the purpose of this talk. There we were in 1971 facing a project with an estimated cost of 3½ million dollars that had to be done immediately with only $60,000 in our Erosion Account. Where could we get over 3¼ million dollars? We investigated bank loans; but Municipal Law states that you can't borrow more than one year's tax revenue, in our case about ½ million dollars. We talked to Municipal Bond experts; but floating a bond issue takes time, of which we had little, and it is expensive. Our only hope was to go to the residents and ask for the money. We needed, on the average, $10,000 per home.

Our first step was to establish a General Improvement Fund. This would allow the residents to give tax deductable contributions. The fund was controlled by the Town to be used in whatever manner they felt would best benefit the Town. It also insured that the IRS couldn't say that an Ocean property owner was protecting his own home, and disallow the deduction.

Our second step was to call the residents into the Town Hall in small groups, no larger than 20 people. I would open the meeting with slides describing the problem and what had to be done. I would describe the beaches as they were then and as they would be after renourishment and what they would look like a year later. I would

describe the pumping operation and the tremendous costs involved.

The Mayor would then explain the dangers of doing nothing and the effect of the erosion on property values, not only on the Ocean properties but throughout the whole Town. By the way, at that time, Ocean property values on Jupiter Island were about half that of similar properties in areas further south, mainly because of the erosion, and it was effecting the whole Island; after all, people just won't buy a home if the house across the way was falling into the Ocean. He described our lack of finances and how the residents could contribute tax deductible monies to the General Improvement Fund. He explained that the Town could accept stock whereby no capital gains were paid and the resident could deduct the full market value as a tax deduction.

Let me give an example: John Doe had stock from a family Corporation which he had gotten at $1.00 par value. Today the stock sells for $100. If John Doe was in the 70% tax bracket, as many of our citizens are, he would have had to pay capital gains of $35 if he sold the stock, leaving him a net of $65.

Instead he donates the stock to the Town and takes the full $100 tax deduction. This gives him a net return of $70 or $5 more than if he sold it himself and the Town receives the full $100 per share.

Tax rules have changed somewhat since 1971, but the principle is still the same.

Then one of our prominent residents, who everyone liked and respected as a leader in the Community, would point out that the future of the Island was at stake and that anyone who did not give to their maximum ability did not belong on the Island and should move to the mainland.

These meetings continued until every property owner had been contacted. They must have been successful for pledges, checks and stock almost flooded us.

Ninety percent of the property owners contributed something. A few gave as little as $250. Many gave $1000 and others gave $10,000 to $20,000. Over 50 families

gave $50,000 or more. The highest contributor gave $230,000 and he doesn't even live on the Ocean. Within 6 months our residents had pledged over $3,000,000 to be paid over a 3 year period. Most of it was collected in the first 6 months.

We had also arranged with the First National Bank of Palm Beach to borrow up to 1½ million dollars at 4½% or just over half the prime rate at that time. This money was borrowed against pledges and was to be used until our pledges had been received. In case you didn't know it, Municipalities can get a very favorable short term loan from most banks, since the interest from the loan is tax free for the bank.

We did receive a pledge from the State for approximately $700,000 to help pay for that portion of the beaches that had public access. This money, while greatly appreciated, was not received in full until 1977.

To make a long story short, the Town of Jupiter Island raised $3,500,000, mostly from contributions and restored 5 miles of beach with 2½ million cubic yards of sand pumped from the Ocean bottom.

Unfortunately, this is not the end of the story. Most of you know that a renourished beach is just as vulnerable as the eroded beach that was there before. The Town recognized that our beaches would have to be renourished about every 5 years. Not in the same magnitude of quantity and cost but probably 1,000,000 cubic yards each time. Where do we get that additional money? We can't pass the hat too often because even the most generous citizens have their limits. What could we do?

If you'll remember before I said that in 1967 the Town had an Erosion Bill passed. Part of that Bill specified that Ocean front residents would be assessed on a 3 to 1 millage basis with their off Ocean neighbors. This put too heavy a burden on them and limited the tax revenue to the Town. We went back to our people with a referendum to modify that Bill so that all property owners would each be assessed 6 mills per year, regardless of whether they lived on the Ocean or not.

Again we held meetings and explained our problems. The

Referendum passed by an overwhelming majority and the 1967 Bill was modified. Currently that 6 mills generates approximately $400,000 a year to our Erosion Account or about $2,000,000 over a 5 year period. This is the money which was used in 1978 to complete our second major beach project of 1 million cubic yards without State or Federal help and it is the money that will continue to finance future projects.

I don't pretend to tell you that all our residents are happy to pay 6 mills a year for erosion; after all, on a $100,000 house, that is $600, but the majority know that the future of our Town is tied very closely with the condition of our beaches and they are all more than willing to support our renourishment program.

You might be interested to note that the erosion problem now has little effect on property values. Today there are only two Ocean homes for sale, compared to 15 in 1971 and these are priced at values comparable to Palm Beach and elsewhere.

To sum up, I recognize that what we did in our small Town of 350 homes is much more difficult to do in a Town of 10,000 residences. Certainly there is not the same closeness and willingness to work together. But on the other hand, few Towns have more than seven miles of beach, such as we have, and 3½ million dollars divided by 10,000 is only $350 per home rather than our $10,000 per home that we needed.

Maybe asking for contributions isn't appropriate to your town; but certainly collecting a small millage is. Sooner or later people will recognize that beaches are just as important as roads, parks, etc. that we now collect special taxes for. Maybe you may decide to assess the tourist as certain towns now do; or you may place a special millage on the residence. Either way, it's a nice feeling to get the job done when you need it without waiting for endless studies and appropriations from Federal and State Agencies.

We were fortunate to have a great majority of our people willing and able to support our beach project. I hope you will be too.

BEACH NOURISHMENT: ITS EFFECT ON COASTAL ECOLOGY

Edward J. Pullen
and
Robert M. Yancey
Marine Biologists
U.S. Army, Corps of Engineers
Coastal Engineering Research Center

ABSTRACT

Results of the Coastal Engineering Research Center's (CERC) studies on the ecological effects of beach nourishment that date from 1971 to the present are presented. The studies indicate the area impacted by nourishment and dredging should be considered as three zones for quantitatively sampling because of the physical and biological conditions of the beach and nearshore areas. Based on CERC's results, nourishment operations (if properly planned) have only minor impacts on coastal resources, unless especially sensitive resources are involved (coral reefs, turtle habitat, shellfish beds, etc.). Nearshore organisms are better adapted to covering with sediment than the offshore organisms.

BEACH NOURISHMENT: Its Effect on Coastal Ecology

EDWARD J. PULLEN
and
ROBERT M. YANCEY

Introduction

Shore erosion is a major problem along the U.S. east and west coasts. Beach erosion results in significant property damage, loss of land, and the loss of recreational beaches. The need to reduce or repair erosion damage has been expressed by local and State governments; the U.S. Army Corps of Engineers has a responsibility for beach erosion studies and projects, when requested by the local authorities and approved by Congress.

In 1930, Congress authorized the Corps to study means of preventing shoreline erosion and established the Beach Erosion Board (BEB) as the major element of the Corps' beach erosion capability (Quinn, 1977)[1]. The BEB functioned until 1963 when it was abolished and replaced by the Coastal Engineering Research Center (CERC) and the Coastal Engineering Research Board (CERB). CERC was given the coastal engineering research mission and the CERB was to advise the Chief of Engineers on the Corps' coastal engineering research program. In response to the public's increasing environmental awareness, reinforced by the enactment of Public Law 91-190 (1969 Environmental Policy Act), CERC began a Coastal Ecology Research Program in 1970. The program's mission is to ensure that biological resources are adequately considered in coastal projects along with engineering considerations.

This paper summarizes the results of CERC's research on the effects of beach nourishment on coastal ecology. The research dates from 1971 to the present and covers pre- and post-construction studies of several coastal projects. Studies have been completed at Imperial Beach, California, and Broward County, Florida. Pre-construction studies at Panama City Beach and Sand Key Beach, Florida, have also been completed and a post-construction study at Panama City Beach was initiated this fall. More research is needed along the North Atlantic coast and the Great Lakes. There is a need for greater emphasis on evaluating the impacts of taking beach nourishment material from offshore sources.

Beach and Nearshore Environment

The beach and nearshore environment may be divided into three zones based on the physical environment and associated resident inhabitants: the beach, surf, and offshore zones (Fig. 1).

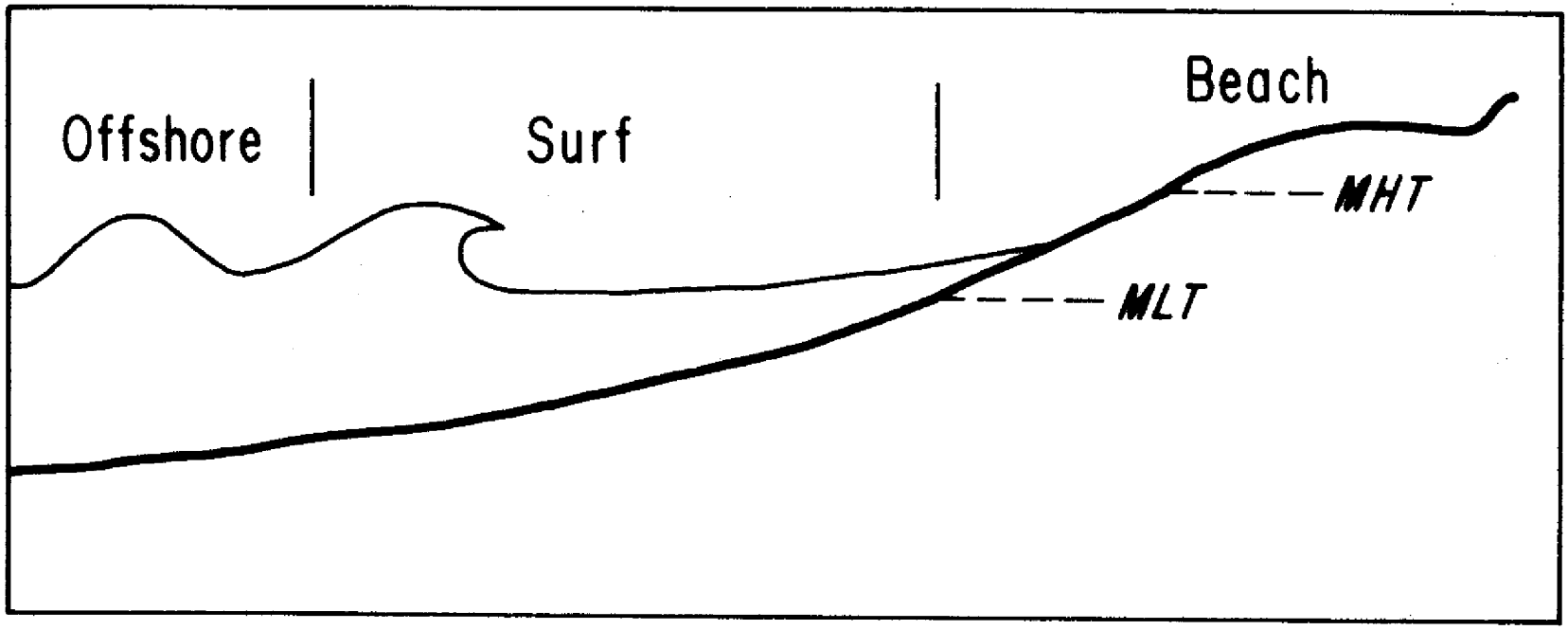


Figure 1. Beach, Surf, and Offshore Zones of a High-Energy Beach Showing Mean low Tide and Mean High Tide Lines.

Beach Zone. The beach zone is defined as the area landward from the low water line to the foredune line. It is an area subject to harsh environmental and physical changes. This zone is subject to wide temperature and salinity fluctuations and wave action that causes cycles of erosion and accretion. The upper beach zone is generally dry except during storms. Storms can significantly modify the physical environment by eroding or accreting the upper beach and altering the beach animal communities. Because of the extremes of the surface environment most of the permanent residents of this zone are burrowers. The number of species and population size is limited and the organisms generally have a clustered distribution. They are accustomed to the harsh, changing environment and are able to adjust to this in their daily lives. Resident species of this zone usually emerge from their burrows only at night. Characteristic species are ghost crabs, sand crabs, and beach hoppers. The low density of animals in this zone is related to the extreme and variable conditions. Of the three zones, this zone is the easiest to quantitatively sample.

Surf Zone. The surf zone is defined as the area of breaking waves; it varies in location and size. Seasonal wave patterns, sediment movement, and storms are the major physical forces that influence the distribution and abundance of animals in this zone. Most of the benthic animals in this zone are burrowers and good diggers; these are excellent characteristics to maintain position in the bottom. Benthic animal populations are generally small and have a clustered distribution. As an adaptation to this unstable environment, intertidal benthic organisms tend to be short lived and have a high rate of reproduction. Some of the animal may also move onshore and offshore with seasonal sediment movement. Animal populations characteristic of this zone are also limited by lack of cover and food supply. This is the most difficult and hazardous zone to quantitatively sample.

Offshore Zone. The offshore zone extends seaward of the surf zone. This is physically a more stable environment where fish and benthic animal populations are more stable and diverse. Typical animals include fishes, clams, shrimps, sand dollars, snails, crabs, and corals. This is the area of greatest abundance of commercial and sport fish and shellfish, and the zone most susceptible to physical perturbation. Animal populations in this zone are more randomly distributed (less patchy) than in the intertidal zone. Offshore organisms are generally less subject to impacts of waves and natural sediment movement than those in the surf zone.

Beach and Nearshore Organisms

CERC's studies have evaluated the impacts of beach nourishment on two major groups of animals: benthic and motile animals. Coral and sea turtles are discussed as special cases since they present a specific concern in Florida as well as in the Caribbean and the Pacific.

Benthos. Benthic animals live in or on the subaquatic bottom and are

distinguished as either meiofauna or macrofauna. Meiofauna are animals that are small enough to pass through a sediment sieve with a mesh size of 0.5 millimeter. They are generally found in the interstitial space between sediment grains. These populations are numerous and diverse, but generally comprise only a small part of the community biomass (Parr, et al., 1978)[2]. Meiofauna of exposed sandy beaches appear to be an isolated system within the sediments, and there is little evidence of outside predation on their populations (Cox, 1976)[3]. These microscopic animals are extremely difficult to separate, and decantation and filtration are required to isolate them from the sediments. Even after separation, the sorting and identification of the organisms are extremely time consuming and difficult. Many of the meiofauna species have not been described or named. Because of the uncertainty in identifying some species and obtaining statistically reliable, quantitative data on the meiofauna, CERC's evaluations have keyed principally on the macrofauna. Parr, et al. (1978)[2] also noted that the meiofauna comprise usually less than 5 percent of the community biomass and for this reason are usually ignored in sampling programs.

Benthic macrofauna are the group of animals retained by a 0.5 millimeter mesh sieve. They are important to the beach and aquatic system because they play an important role in the transfer of energy up the food chain to higher organisms. Their importance is reflected by the high predation rates on their populations by fishes, birds, and man (Cox, (1976)[3].

Motile Animals. Some motile animals, such as fishes, crabs, lobsters, and shrimps, are also adapted to survive in the intertidal and nearshore environment. These animals are capable of moving onshore and offshore under seasonal and stressed conditions. Because of this movement, it is difficult to develop dependable, quantitative data on their populations for beach nourishment impact analysis. The most valuable species for evaluating impacts are residents such as burrowers and fish that live closely associated with a specific type of beach and nearshore habitat.

Corals. The corals are very susceptible to sediment damage from man's activities in the coastal zone. Reefs parallel to the Florida east coast are composed of hard and soft corals that exhibit morphological differences that influence their susceptibility to accumulations of sediments. The hard corals are inflexible, with horizontal surfaces, whereas the soft corals are nearly vertical, flexible and sway with the currents and waves. The flexibility and growth habit of the soft corals assure their success in areas of higher sediment load than the hard corals can withstand. Corals that survive in the nearshore areas are under a constant threat of sand movement and have adapted to minor sediment loads. High turbidities can also affect algae that have a symbiotic association with the corals (Courtenay, et al., 1974)[4]. Reduction of light below an adequate level for photosynthesis by the algae adversely affect the corals. Because many of the Florida corals

are at their extreme northern limit of range, care must be taken to maintain their critical life balance (Courtenay, et al., 1972)[5]. After corals are lost, a key community element is disrupted with major consequences to the marine ecosystem and a potential loss of shore protection in some coastal areas.

Sea Turtles. Many North Carolina, South Carolina, Georgia and Florida beaches are major nesting grounds for endangered species of sea turtles. The turtles migrate to the beaches almost exclusively at night to deposit their eggs in the sand and, after about two months, young turtles hatch and migrate to the sea. This nesting activity occurs in the late spring and summer during the period of man's greatest activity along the coastal beaches.

Sampling the Beaches and Nearshore

Sampling Methods. There have been few quantitative studies on marine communities along the high-energy coastal beaches, particularly in the surf and swash areas. These beaches are difficult and hazardous to sample; hence, there have been no standard, quantitative methods for study. CERC's biologists have recently prepared a technical report in which is developed a standardized system for sampling macroinvertebrates on high-energy sand beaches (Hurme, et al., 1979)[6]. On the upper beach it is suggested that samples be taken by excavating 0.1 square meter quadrats with a trenching shovel and sieving the samples through an 0.5 millimeter mesh soil sieve. In the dynamic surf zone, a coring device assures a better sample than do other types of equipment. Offshore of the surf zone, cores, grabs, and dredges may be used. Cores taken by a diver give the best and most consistent samples.

When working in the surf zone, the investigator must use a lifeline to stay on station. Range markers on the beach are also needed to aid divers in the surf and offshore zones to keep on station. Samples are generally collected along lines or transects perpendicular to the beach and are stored in plastic bags, labeled, and preserved. The animals are sorted from the sediments on the beach or in the laboratory. The animals preserved are later identified and counted.

In clear water, diver observations and photos provide additional valuable information to supplement core samples. Divers can observe and count attached reef animals, burrowing and reef fish which tend to be territorial, and other pelagic fish.

Sampling Plan. Sampling plans for a specific area depend upon the animals to be used as impact indicators. They may be fixed or motile. Their populations may vary seasonally and their distributions may be random or clustered. These kinds of information are necessary to determine the required sampling equipment, sampling frequency, number of samples, and

the number of stations needed. The length of a study will vary depending upon the time required to determine base-line conditions prior to beach nourishment and the time required for animal populations to stabilize following nourishment.

Population Analysis. The level of reliability of population analysis depend on the quantitative accuracy of the samples. Good quantitative data collected before and after beach nourishment can be analyzed for changes in species diversity, abundance, and biomass using valid statistical approaches (Hurme, et al., 1979)[6]. Diver observations are less quantitative than core samples, but provide indices that will give valuable aid in interpreting biological changes that may not be readily detectable from samples from cores or other collecting gear.

Effects of Beach Restoration

Physical Effects. There are three major ways that beach nourishment physically impacts the beach environment. The deposited material covers the existing beach sediments, modifies the beach interface, and frequently increases the turbidity of the nearshore area (Fig. 2). Waves and currents winnow sediments and suspended them in the water along the nourished beach and increase the turbidity of the water. Parr, et al. (1978)[2] observed at Imperial Beach, California, that the fine sediments were rapidly sorted out of deposited material and that sediment grain-size distribution after about 4 months was comparable to that before nourishment. The fine sediments were transported offshore. Courtenay, et al. (in preparation, 1979) also observed the movement of sediments that lodged against and partly covered low profile coral reefs off the Florida east coast. Regardless of origin, sediment movement and changes in grain-size distribution may create changes in the benthic environment that require marine organisms to adjust or perish. Turbidities resulting from beach nourishment generally create only a minor impact in the surf and offshore zones, except in areas of environmentally sensitive resources that easily smother or are dependent on light for photosynthesis.

Effects on Benthic Communities. The nearshore marine bottom communities on most high-energy coastal beaches survive periodic changes related to the natural erosion and accretion cycle and storms. However, offshore communities are in a more stable environment and are less adaptable to such perturbations. It is generally assumed that most bottom animals perish from burial by sediments, but CERC studies indicate those organisms in the nearshore environment are better able to survive than offshore populations because of their adaptation to unstable sediment conditions. Some intertidal animals may be able to migrate up through the deposited sediments and survive if the sediment layer is not too thick. Maurer, et al. (1978)[7] observed in a laboratory study that some benthic animals were able to migrate vertically through over 30 centimeters of sediment.

Figure 2. Beach Nourishment and Associated Nearshore Turbidity

The immediate impact of beach nourishment on the nearshore benthic community is to reduce species diversity and number of animals. However, inshore populations appear to recover rapidly by migration of organisms from adjacent unaffected areas and survival of some animals. Because of the short life cycle of most nearshore benthic animals and their high reproductive potential, colonization of the nourishment area may occur within weeks of the nourishment operation. Recolonization occurs first by opportunistic species that increase both the number of species and individuals to levels generally above the original populations. These species are poor competitors and are eventually displaced by community dominant species (Oliver and Slattery, 1978)[8]. The newly re-established community may differ considerably from the original community. This will depend on many factors. Recolonization will depend on availability of larvae, suitable conditions for settlement, and mortality. Many species have specific life requirements that must be met before the larvae will settle and juveniles develop. Therefore, an attempt should be made to approximately match the sediment used for nourishment to the original sediment to help meet these requirements. Matching the sediments may in some cases conflict with the project purposes and a trade-off between engineering and ecological considerations may be necessary.

Effects on Motile Animals. Motile animals appear to be least affected by beach nourishment as they are capable of moving out of the nourished area; however, it is possible under some experimental conditions for fish to suffer gill damage or blockage (O'Connor, et al., 1976)[9]. CERC's studies have indicated no such impact on motile animals in nature.

Destruction of desirable habitat rather than suspension of sediments seems to be the major danger to nearshore motile animals. Most of these animals have the ability to migrate from an undesirable environment and reappear when disposal ceases (Courtenay, et al., in preparation, 1979; and O'Connor et al., 1976)[9]. Species which are closely associated with the beach for some part of their life cycle, such as the grunion on the west coast and some burrowing and reef species with limited power of mobility, would be most likely affected by beach nourishment. In the case of the grunion, Parr, et al. (1978)[2] observed that beach nourishment did not prevent subsequent spawning at Imperial Beach, California. However, the dusky jawfish, a burrowing species with a limited power of mobility and a requirement for a certain sand-grain size, was displaced by fine sediments on the Florida east coast (Courtenay, et al., in preparation, 1979).

The loss of a food source by burial nearshore may have had some effect on motile populations, but it was not detected in the present research. Maragos, et al. (1977)[10] observed that fish moved into an area disturbed by dredging and actively fed on uncovered food organisms.

In general, there is little evidence of long-term adverse impacts of

beach nourishment on nearshore motile populations, unless sensitive communities such as those associated with a coral reef are affected.

Effects on Corals. Corals are sensitive to covering by fine sediments. The hard corals are more sensitive than soft corals because they are unable to cleanse themselves of heavy sediment loads and are easily smothered. As a result, soft corals are better adapted to survival in the nearshore environment in areas subject to beach nourishment. Courtenay, et al. (1972)[5] observed that some hard corals were damaged by excessive sediment settlement following beach nourishment at Hallandale Beach, Florida, but 7 years later Marsh, et al. (in preparation, 1979) found no evidence of reef damage. It appears that if damage is relatively minor the reefs do recover.

High turbidities resulting from prolonged beach nourishment and/or mechanical degredation of nourishment material may indirectly affect corals by reducing sunlight penetration into the water. The reduction of light reduces photosynthesis of algae that is associated with the coral and manufactures a part of its food. In CERC studies at Hallandale Beach, Florida, no significant long-term impacts of turbidities resulting from beach nourishment were detected.

Effects on Sea Turtles. Sea turtle nesting and beach nourishment operations conflict in many coastal areas, particularly along the Florida coast. Although CERC has not studied the sea turtle, the U.S. Army Engineer District, Jacksonville, has worked with the National Marine Fisheries Service, the State of Florida and turtle experts to minimize damage that might result from covering turtle nests with beach-fill material. These agencies, and Corps personnel trained to recognize turtle nests, survey project sites and locate nests. National Marine Fishery Service and the State personnel transfer the turtle eggs to a suitable beach site outside the beach area to be filled. The adverse effects of beach nourishment on turtles may also be avoided by proper timing of the operation so as not to conflict with turtle nesting during the spring and summer.

Effects on Water and Sediment Quality. Problems with anoxic sediments and nutrient release in the nearshore zone of a high-energy beach as a result of beach nourishment do not appear to be a major concern because the fine materials high in organics are moved offshore and sulfides are rapidly oxidized. The material remaining on the beach is generally similar in grain-size to that before nourishment. High-energy beaches are usually composed of coarse material that allows oxygenated water to penetrate, thus preventing the accumulation of sulfides and saturating the sediment pore space with oxygen (Cox, 1976)[3]. Some nutrients may be released into the water as a result of nourishing a beach, but because of the dynamic mixing processes they are rapidly diluted. In CERC's studies, no problems have been reported from anoxic sediment or excess

nutrients. To minimize potential problems, sediments used for nourishment should closely match the composition of the natural beach sediments, have a low percentage of fine material, and be low in organic content.

Effects of Offshore Borrowing

This is the area where CERC has the least amount of information. However, using results of CERC's research and other studies of offshore dredging, some preliminary conclusions can be drawn on the effects of offshore borrowing.

Physical Effect. Dredging at borrow pits increases the suspended sediments and turbidity of the offshore waters. Courtenay, et al., (1974)[4] and Maragos, et al., (1977)[10] described sediments suspended during offshore dredging as generally localized and rapidly dissipating when dredging ceased. Factors that will control sediment spread and turbidities are water currents and water depth.

Another possible adverse effect associated with offshore dredging is the change in bottom topography by creating deep borrow areas. Fine sediments may settle in the borrow pit and further change the composition of the bottom. Many species of marine animals are found closely associated with specific sediment types and may be excluded by changes in the sediment interface. This can sometimes be prevented by shallow dredging to minimize topographic changes or by selecting borrow sites in unstable areas that are under the influence of strong currents (Thompson, 1973)[11]. In unstable areas, benthic populations are generally low and more adaptable to change. The borrow areas are also more likely to fill and return to near predredging conditions under the influence of strong currents if there is adequate transport of sediment.

Biological Effects on Animals. The most serious impact of offshore dredging can be the loss of major commercial species of benthic shellfish or damage to coral reefs. These damages can be minimized by proper selection of borrow areas and by precisely locating dredging equipment to avoid these resources. Repopulation of the dredged areas by benthic animals will depend on the magnitude of the disturbance, the new sediment water interface, and water quality at the borrow site. The borrow areas will likely be recolonized by migration of organisms from adjacent areas; however, the population may not be of the same magnitude or species diversity as formerly. Stability and bottom geology of the site are major factors in determining species recolonization.

Observations on dredging impacts on offshore fish populations indicate little effect on fish (Courtenay, et al., in preparation, 1979; and Maragos, et al., 1977)[10] . Prior studies also indicate fish and other motile animals are able to avoid disturbed areas, and, in some instances where food is suspended and the bottom topography is changed, some fish are

attracted to the dredged area.

Water and Sediment Quality Effects. Changes in water and sediment quality at offshore borrow pits have not been identified as problems in the projects CERC has studied. However, water and sediment quality problems may occur if not considered in early project planning. Where possible, deep borrow pits in stable areas should be avoided to prevent possible stagnation of the bottom water in the pit. Depth of the pits should be determined by currents and mixing processes to prevent their stagnation. Shallow borrow pits in areas of low currents and slow mixing would generally be more desirable. Also shallower pits would be less likely to cause major sediment changes that could adversely effect resident bottom animals. Nutrient release apparently is not a problem offshore because of current action and dilution after dredging ceases.

CONCLUSIONS

1. Turbidity related to beach nourishment and offshore dredging is usually localized and dissipates when dredging ceases, unless there is a mechanical breakdown of some of the deposited material that causes long-term leaching from the beach.

2. Fine sediments are sorted out of the nourishment material and are rapidly transported offshore.

3. Burial of offshore benthic organisms by fine material transported offshore has a greater potential for adverse impact than burial of intertidal organisms during beach nourishment because subtidal animals are more sensitive to stress.

4. Nearshore benthic animals appear to rapidly recover following nourishment by repopulating from adjacent unaffected areas and survival of some animals.

5. Motile animals are least impacted by nourishment as they are able to move from the nourishment area and reappear when disposal ceases.

6. Corals are especially sensitive to smothering with sediments and high turbidities and should be given special consideration in planning beach nourishment projects.

7. Sea turtle nests may be covered by beach nourishment material, but the impact can be minimized by trained people transferring the eggs to suitable undisturbed beaches or by timing the nourishment to avoid the nesting period.

8. Biological impacts of beach nourishment can be minimized by selecting nourishment material that closely matches the composition of the natural sediments of the beach to be nourished, and depositing the material as near the intertidal zone as possible to ensure the least harm to the more stable offshore benthic populations.

9. Dredging of offshore borrow material from shifting rather than stable bottom areas is more ecologically desirable.

10. Selection of borrow areas in deep water minimizes turbidities and sedimentation caused by currents and wave winnowing and allows the suspended sediments to settle in the area of dredging activity.

11. Water quality changes related to beach nourishment are generally minor and of short durations in the nearshore environment because of the currents and mixing processes.

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Two unpublished CERC contract reports "Ecological Monitoring of Beach Erosion Control Projects, Broward County, Florida" by Courtenay, Hartig and Loisel and "Benthic Invertebrate Fauna Adjacent to a Restored Beach in Broward County, Florida" by Marsh, Courtenay, Bowen, Deis and Turbeville completed this summer were referenced in this paper. These reports are presently in preparation (1979).

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DREDGING CONTRACTORS INSIGHTS CONCERNING BEACH NOURISHMENT

Aaron W. Hendry
Vice President
The Hendry Corporation
P.O. Box 13228
Tampa, Florida 33681

DREDGING CONTRACTORS INSIGHTS CONCERNING BEACH NOURISHMENT

I sincerely appreciate being afforded the opportunity to share with the group the dredge man's viewpoints concerning beach nourishment projects, and would like to compliment the Shore and Beach Preservation Association for the excellent job they do in organizing and programming these annual get-togethers. I will always remember the first meeting that I attended over at the Tides Hotel on Reddington Beach in 1969 when beach nourishment was just coming into vogue. Some of the attendees there were Joe Koperski, the now retired Chief of the Engineering Branch of the Jacksonville District of the Corps of Engineers; Douglas Carter, who was then the Pinellas County Engineer who pioneered beach enrichment work on the West Coast of Florida; and Kenneth Thompson, the City Manager at Sarasota who was instrumental in getting the Lido Beach restoration work programmed. Coincidentally, at that time my firm was then engaged in the restoration of the Treasure Island and Indian Rocks Beaches which was the first Corps of Engineer administered project performed in Florida as beach nourishment, per se. The Corps did an excellent job in preparing the engineering documents for that project. They had to write a new set of special technical specifications to cover beach nourishment work. A major portion of the present day beach nourishment contract specifications stemmed from these. When I was researching this paper, I went into our archives and found the old job specifications. The bid itself was extremely complex, wherein there were some four bid schedules containing a total of twenty separate bid items. We found out later that the primary reason for this was that Pinellas County and the Corps were working jointly on a set budget and did not have any accurate

forecast yet on what the contract cost might be. Colonel John McIlhaney was the District Engineer in Jacksonville at this time.

There had been a recent storm in this reach of the Gulf Beaches which had eroded the beach so badly that beach-front structures were being threatened from Blind Pass to John's Pass and also along the Indian Rocks Reach. One of the basic problems encountered in designing the project was that the Indian Rocks area was obviously named appropriately in that the entire gulf bottom off-shore reach, abeam of Indian Rocks Beach is rock bound, with virtually no sand cover. The Intercoastal Waterway borrow area, like a number of the gold mines of the 1800's, did not "pan out". We commenced dredging in the Intercoastal Waterway just South of the Narrows Reach and soon discovered that only silt, clay and rock materials prevailed in the selected borrow area. However, the West Coast Inland Navigation District was nice enough to furnish us one of their existing Intercoastal Waterway spoil islands in Boca Ceiga Bay, from which we obtained a good grade, "used" sand and crushed shell. We pumped approximately 17,000 feet maximum distance, and the spoil island was depleted the same day the fill was completed. The basic project problems encountered there have not changed. These obstacles were, and still are: weather unknowns (the winds and the waves), finding a good grade of beach sand, pumping on long pipelines, and achieving the desired design cross sectional shape of the beach fill. Initially, it was found very difficult to arrive at the proper and equitable method of measuring and paying for the beach material. This first job was set up to measure the material in the borrow pit rather than on the fill, which meant that the contractor would not be responsible for hydraulic transport, subsidence, and shrinkage loss contingencies.

Since its advent in the mid sixties, the decade of the 70's has proven to be the time frame of the maturing of the environmental movement, and has had a pronounced effect on the dredging industry. What is now accepted, understood and appreciated going into the 80's was virtually unknown in the 60's, became a sometimes brutal reality to us dredgers in the early 70's, and then began to slowly mature and in the instance of beach nourishment, was consummated in the formation of a workable coalition between the environmental interests, the regulatory agencies and the dredging industry. The phraseology JTU's, which stands for Jackson Turbidity Units and is a measure of turbidity (degree of cloudiness) was first measured as scaled from the degree of light penetration from a wax candle lit at the bottom of a beaker when viewing the flame of the candle from the top of the beaker. A few years later, mechanical measuring devices were put on the market, such as the Hach Turbidimeter which greatly increased the ease of making these tests.

Turbidity levels are now closely controlled as a routine procedure in the industry today, utilizing a complex system of dikes and weirs in confined containment areas. On beach fills, it has been demonstrated that only moderate and localized temporary turbidity levels occur. The silt curtain device has been used periodically on several beach projects, but the results have steered us away from its usage.

In the late 60's the Florida Department of Transportation, then known as the State Road Department, developed the silt barrier. They had been doing a number of causeway road fill projects across the shallow bays and estuaries of the State and were constructing a causeway known as the Pineda Causeway, on a contract in the Indian River at Melbourne. Criticism of the turbidity

caused by this dredging prompted the Road Department to develop and place the first "diaper" around the turbidity plume, which development has now come into its own as today's silt barrier. It was at least showing signs that the builders were beginning to respond to the environmental interests in making a consciencious effort to minimize turbidity.

The State later declared a moratorium on dredge fills under the administration of Governor Claude Kirk. The effect of this was profound and traumatic for the dredging industry in Florida, wherein nearly one-third of the viable markets were abruptly lost. In a short period of time, as a further example, the State increased the charges to the owner for the submerged land borrow from as little as 3¢ a cubic yard obtained up to $1.25 or more, just for the fill material itself, thereby rendering the process economically unfeasable. Trucked-in fills began to replace dredging methods.

Along about this time, beach nourishment came into its own in Florida. It soon became clearly evident that the dredge was the ideal tool to use in nourishing our beaches. It was immediately demonstrated that our eroding beaches could be periodically nourished and maintained. Some of the as built examples of beach projects, such as Lido Beach, Mullet Key, Treasure Island, Longboat Key, Canaveral and Jacksonville will defy one's discerning whether or not the beach was artificially placed.

In the summer of 1978, the Corps of Engineers and the State of Florida sponsored a joint seminar at Miami Beach which I attended. The mix of some 400 or more attendees consisted of the entire spectrum of interests concerning dredging and filling, such as environmentalists, regulatory agency officials, engineers, scientists, and developers. It was clearly in evidence from my

conversations and observations at the seminar that most people now affiliated, pro and con, with dredging and filling now understand and appreciate each other's interests and know each other's strengths and weaknesses. A colleague of mine who represented the industry at the seminar alluded during his talk to the fact that the industry had indeed risen to the challenge of building beaches. I remember back in the late 60's there was a great deal of skepticism amongst beach nourishment sponsors and engineers that the industry did not possess adequate tools for performing beach work. The question was unanswered as to what the response of the industry would be to this new market. The entrepreneurial abilities of the dredgers were indeed challenged. In the 70's there ensued several recent improvements and special adaptations of dredging equipment to render then suitable to beach work. Some of the most notable ones were the "Hydro-Barge", which is a molded seagoing all-weather and self-propelled vessel akin to the hopper dredge, which is also known as a pump-out dredge. In connection with the Tampa Harbor Deepening, this dredge removed millions of yards from the fairway deepening and placed it through hydraulic pipelines on Egmont Key. A ship's hull was converted to a conventional dredge, has been used on the East Coast of Florida. Many dredging plants have added the submerged ladder pump adaptation, which acts as a dual purpose booster unit for deep dredging. I noticed quite recently in the World Dredging magazine pictures of a giant offshore platform type dredging rig which the Dutch have recently developed.

However, one of the first special offshore dredges was literally a submarine. It was developed as an experimental rig in the late 60's and was very innovative, even though it did not prove to be economically successful. It consisted of a cylindrical, watertight body mounted on a set of crawler tracks,

complete with an electrically powered dredge pump and ladder structure hinged on the front end. A vertical access way and periscope arrangement were fitted on the top of the tube. I had occasion one day at Fort Pierce to watch the crew shift change. The men were wearing scuba diving "wet suits", and were geared up to make any hasty underwater machinery repairs needed.

There are a special set of problems which plague the dredging contractor on beach nourishment. I believe the most pressing problem is that of the weather (the wind and the waves). As an example, I remember when our firm was constructing the Longboat Key and Pass Causeway and Bridge Project in 1955. We had completed about one-half of the causeway when a hurricane struck the West Coast of Florida over the weekend. The effects of the storm were devastating on the work in process. The fill itself was almost wholly obliterated and we had to start over again. The pipeline which conveys the material ashore in the hydraulic transport process is the most tender part of the plant and therefore the most susceptible to heavy seas. For this reason, the dredgers have developed special all-weather pipelines to combat these natural forces effectively.

The obtaining of sufficient quantities of a high quality, clean beach sand with the desirable shell content is problematic. For instance, at Treasure Island the hydraulic transport losses were shocking. Through measurements taken both in the borrow pit and on the fill, it was determined that nearly double the quantity of material was removed from the borrow pit as was found within the design template fill section on the beach. The lower East Coast of Florida contains numerous parallel offshore reef formations known as the first reef, second reef, third reef, etc. These reefs are coral rock formations and most of the desirable beach sand is found only in valleys between these reefs.

Virtually no sand is available inside of the first reef. Consequently, the dredging contractor finds that the existing depth of water in the borrow area is some fifty to sixty feet deep and two or more miles offshore. Therefore, we are forced to pump distances of several miles and dredge to depths sometimes in excess of 100 feet to obtain sufficient material. Additionally, in some places scattered rock outcroppings are found lurking in the sand formation which makes it extremely awkward to obtain a sand beach fill which contains no rock fragments. Let's face it, high grade beach sand can be hard to find, and in a native bank of soil, contains some impurities and lenses of silts and clays.

One of the mitigating aspects of the hydraulic dredging process is that a nominal amount of less desirable material, when blended with a matrix of high quality beach sand, will undergo a thorough process of washing and cleansing, with the result that the end product fill placed on the beach is as clean as it would be after being run through a Maytag washing machine. Additionally, hydraulically placed beach sands are thoroughly compacted in the runoff process. A number of beach fill projects have been constructed using borrow areas which contained a large percentage of clays and/or rock, such as the Tampa Municipal Beach fill in Old Tampa Bay, and at Honeymoon Island Beach above Clearwater. In both instances, the projects were designed to initially place "run of bank" mixtures of sand, clay, and rock to form a stable sub-grade section and then to place a two foot thick layer of high quality select beach sand topping over the sub-grade for the surface.

Another special problem in constructing a beach fill is controlling the geometric cross section of the fill to meet the engineering requirements. Unfortunately, natural underwater slopes can vary from as steep as five to one

(horizontal to vertical) due to the high percentage of shell content up to as flat as twenty to one, depending on the local characteristics of the material being placed. This variation makes it extremely difficult for the contractor to construct the actual slope of the beach being placed to conform to the design section. We ended up one time using an underwater bulldozer blade rigged on a barge mounted crane to grade the underwater portion of the slope in order to conform to the design section. Also, the natural slope of the material will generally be found considerably steeper below the water level than the slopes achieved above the water level due to the presence or absence of the water pressure against the material. This phenomenon will produce a beach with the appearance of a scalloped shoreline which delineates the resultant narrower portions placed at high tides as compared to the wider portions placed on low tides. The dredger has to shut down during very low tides at times, and may construct training levees to contain the slope within the design section limits. The slope of the fill, especially in the wave zone, has a tendency to flatten as it weathers, and form shell windrows with a natural appearance. The design criteria on the Treasure Island Beach was to make every effort to place the construction slope somewhat steeper than the ultimate design slope so as to allow the natural weathering and flattening process to occur without detracting too much from the design width of the berm.

Many of us are aware of the extreme turbulence that exists around our natural inlets, such as in evidence at the John's Pass Bar and the Big Sarasota Bar. This is the primary reason that channels through inlets must be jettied to maintain depth and abate shoaling. The shifting sands that we have seen the tides and wave action move around through inlets can do the same thing to beach

fills while under construction. It has been determined that the larger dredges which produce considerably more volume of fill a day have much less trouble maintaining completed reaches than smaller machines.

Another problem sometimes encountered in producing a uniformly graded texture of beach fill is the segregation of the coarser grained sands and shell deposits closer to the discharge point, and the resultant runoff of the finer grained materials down the slopes. The hydraulic transport of sands can sometime defy the engineering laws of hydraulics. Theoretically, the flow of water in a pipeline is treated as an incompressible fluid under flow. The addition of solids to the water, however, sometimes causes the fluid to act as a variable density slurry, quite susceptible to localized density variations within the length of a closed pipeline system. The Indian Rocks Beach Fill project was a good example of maintaining a uniform material structure on the beach using a combination of heavy shell and a matrix of fine silty sand.

The Coast Guard is now strictly enforcing the dredging equipment certification requirements for working offshore. A few years ago the lines of demarcation between international waters and inland waters were moved shoreward from the sea buoy to the shoreline, thus placing dredges working on beach fill work offshore of the beach in the category of international waters under Coast Guard regulations. I have been told that there are currently only a half dozen or so dredges in the United States which have a Coast Guard certification. The National Dredging Association is now endeavoring to have the stringent requirements relaxed.

The public has shown a pronounced curiosity for exploring around the end of the discharge on a beach fill, especially when there is a large percentage of shell content being deposited. I have personally observed groups of a hundred or so people gathered around the pipeline discharge area, amidst bulldozers and other dangerous heavy equipment. At times, they seem almost oblivious to being in the middle of a heavy construction area. The Corps has recently been requiring their contractors to close off the beach through fencing and signs and employ policing of the area for safety purposes. Down at Longboat Beach a couple of years ago, we ended up hiring almost the entire off duty Bradenton Beach Police Department to keep the spectators and shell collectors away from the fill area, especially after the job superintendent banished the Editor of the Bradenton Beach newspaper and his wife from the site of the work one Sunday afternoon.

In conclusion, let me state that the industry stands ready and willing to respond to the demands of the market and the continued success of the beach nourishment projects on Florida's beaches, and will continue to respond to the challenges of this market. I wish the Florida Shore and Beach Preservation Association continued success in your endeavors.

SEASAT SERVES MARINE USERS

Samuel Walter McCandless, Jr.
User Systems Engineering
4608 Willet Drive
Annandale, VA, 22003

ABSTRACT

SEASAT sparked to life on the twenty sixth of June 1978 providing heretofore unavailable coverage of the worlds oceans. For the first time a space platform used an array of active and passive microwave sensors which could penetrate weather and cloud layers and were impervious to day/night conditions. As a brand new star in our technological galaxy, SEASAT uniquely mapped the global oceans every 36 hours until a tragic power failure caused its untimely death barely more than 100 days after its birth. What survived was a collection of incredible radar images of surface conditions; a continuous synoptic view of global surface wind and temperature measurements; important topographic data ranging from the essentially stable geoid to the varying behavior of currents, tides and daily sea state surface roughness conditions; and more importantly the unquenched interest of thousands of users that had been preparing for over five years for SEASAT. The early data that poured forth from SEASAT fanned the already eager interest of domestic and international scientists and industrial users. What remains is a rare and valuable data set that proves that such a system will work, balanced with an unfullfilled need to apply these technologies for the public good in future open ocean, coastal and polar regions.

USERS AND THE SEASAT SYSTEM

The nations users were the architects of the SEASAT program. Beginning as early as 1969, during a conference at Williams College in Williamstown, Massachusetts, the needs and requirements for a global "Proof of Concept" remote sensing system were established by the users.

Not since 1872 when scientists set out on a four year voyage to explore the worlds oceans on the HMS Challenger had scientists banded together to sponsor an oceanographic mission with such singleminded purpose. Challenger was, in a way, a voyage to prove that scientists could study the ocean from ships; SEASAT was also a "Proof-of-Concept Mission" - to see if microwave sensors in space could provide clear, accurate, understandable information of direct use to a variety of oceanographic and meteorologic diciplines and to users of the oceans as well.

Program ascendance took nearly six years before SEASAT was ready to stand on its own as an approved program in

1975, and 30 months later the system was ready to begin its mission. Condenced in this one statement were years of hard work and painstaking committment by a large group of users with wide and diverse interests and needs. Meeting several times a year, first as a non-affiliated User Working Group, later as a NASA sponsored advisory group and finally on their own again during the last year after the advisory group was disbanded by NASA, the users created, defined and protected the program. Many times a meeting would draw more than a hundred participants representing government institutional and industrial interests, and when the program encountered difficulty during House appropriations sub-committee hearings in 1975 these users addressed the issue with direct appeals to the Congress and the program was re-established by the Senate and emerged victorious from a House/Senate conference. Why were so many users with different affiliations and seemingly diverse interests so devoted to the concept of SEASAT?

In the decade preceding SEASAT, Satellite remote sensing of physical phenomena had been advanced by research and development programs in the fields of meteorology and land observations with emphasis on visable and infrared remote sensing technologies. With the exception of surface and cloud cover images and infrared derived surface temperatures, little use had been made of remote sensing techniques to obtain oceans data. Suddenly, modest aircraft and skylab experiments with active microwave sensors - radars - and passive microwave sensors - radiometers, and the highly successful GEOS-3 application of a radar altimeter presented a technology that would be capable of collecting synoptic surface observations in spite of cloud cover and lighting conditions. In addition to focusing on a technology that opened new frontiers for many users of ocean data, the objectives of the SEASAT program indicated an awareness of the needs of more than a narrow corridor of potential users.

SEASAT-A OBJECTIVES WERE:

1. To demonstrate the capability for:

    a. Global monitoring of wave height and directional spectra, surface winds, ocean temperature and current patterns.

    b. Measuring precise Sea-Surface topography.

c. Detecting currents, tides, and storm surges.

d. Charting ice fields and navigable leads through ice.

e. Mapping the global ocean GEOID.

2. To provide for user applications such data as:

a. Predictions of wave height, directional wave spectra and wind fields for ship routing, ship design, storm-damage avoidance, coastal disaster warning, coastal protection and development, and deep water port development.

b. Maps of current patterns and temperatures for ship routing, fishing, pollution dispersion and iceberg hazard avoidance.

c. Charts of ice fields and leads for navigation and weather prediction.

d. Charts of the ocean GEOID fine structure.

3. To determine the key features desired in future operational systems for:

a. Global sampling

b. Near real-time data processing and dissemination.

c. User feedback for operational programming.

4. To demonstrate the economic and social benefits of user agency products.

Users from government agencies such as the Departments of Commerce, Defense, Interior, and Transportation were joined by users from the National Science Foundation, National Academy of Science and universities and scientific institutions such as Scripps Institute and Woods Hole and from the private sector users representing shipping, oil, gas, fishing, mining, and other areas of marine commerce. They began to plan and develop programs to transfer and assimilate SEASAT data into the environs of their special interests and in most cases they were willing to devote not just time but investment to the cause. The system fueled by this interest began to take shape.

SEASAT was more than just a satellite. Although the space system was largely the result of NASA managed efforts, the ground system was concieved and participated in by many users as shown in Fig. 1. SEASAT was an "End to End" system coupling a unique microwave space based observing system with the needs of a variety of users via both new and in place ground systems. The global extent of ocean measurements proved to be an alluring prospect for both real time users, such as weather and sea condition forecasters whose past included extrapolating sparce data sets into regions where data was simply unavailable due to lack of observing ships or buoys, and non-real time data users such as scientists wishing to study the behavior of current systems like our Gulf Stream. The high utility assimilation of data was the first goal of the program after the "Proof of Concept" phase of the program was completed. So beginning during the early phases of program planning both non real time users, such as government, university and institutional scientists; and real time users, such as the nations weather forecasters and industrial interests engaged in commerce in or on the worlds oceans, were served by the system. In fact, SEASAT became an International program with large installations and investments in Canada and Europe and around the world interest in the promise of previously unavailable data products. What triggered this ground preparedness?

A satellite with an interesting appearance compared to our expected view of what a satellite should look like based on earlier payloads using visable and infrared sensors with relatively small earth viewing apertures. A large 12 meter by 2 meter radar antenna dominated the profile of the satellite as shown in Fig. 2. This dominating feature was the business end of the Synthetic Aperture Radar; the most untried but heralded member of a royal family of sensors housed in the SEASAT satellite. If this radar worked it would be capable of producing 25 meter by 10 meter images of surface conditions with picture-like clarity, no matter what the weather or lighting conditions. As pioneering efforts go - it worked better than anyone expected, producing over 15,000 frames of 100 Kilometer by 100 Kilometer data of ocean, coastal, arctic, and geological data during SEASATS lifetime.

The rest of the sensors were just as successful. All of these new microwave sensors were nested in separate modular sections of a sensor module. The sensor module was mated to a satellite bus which in addition to providing

SEASAT-A
OCEAN DATA DISTRIBUTION PLAN

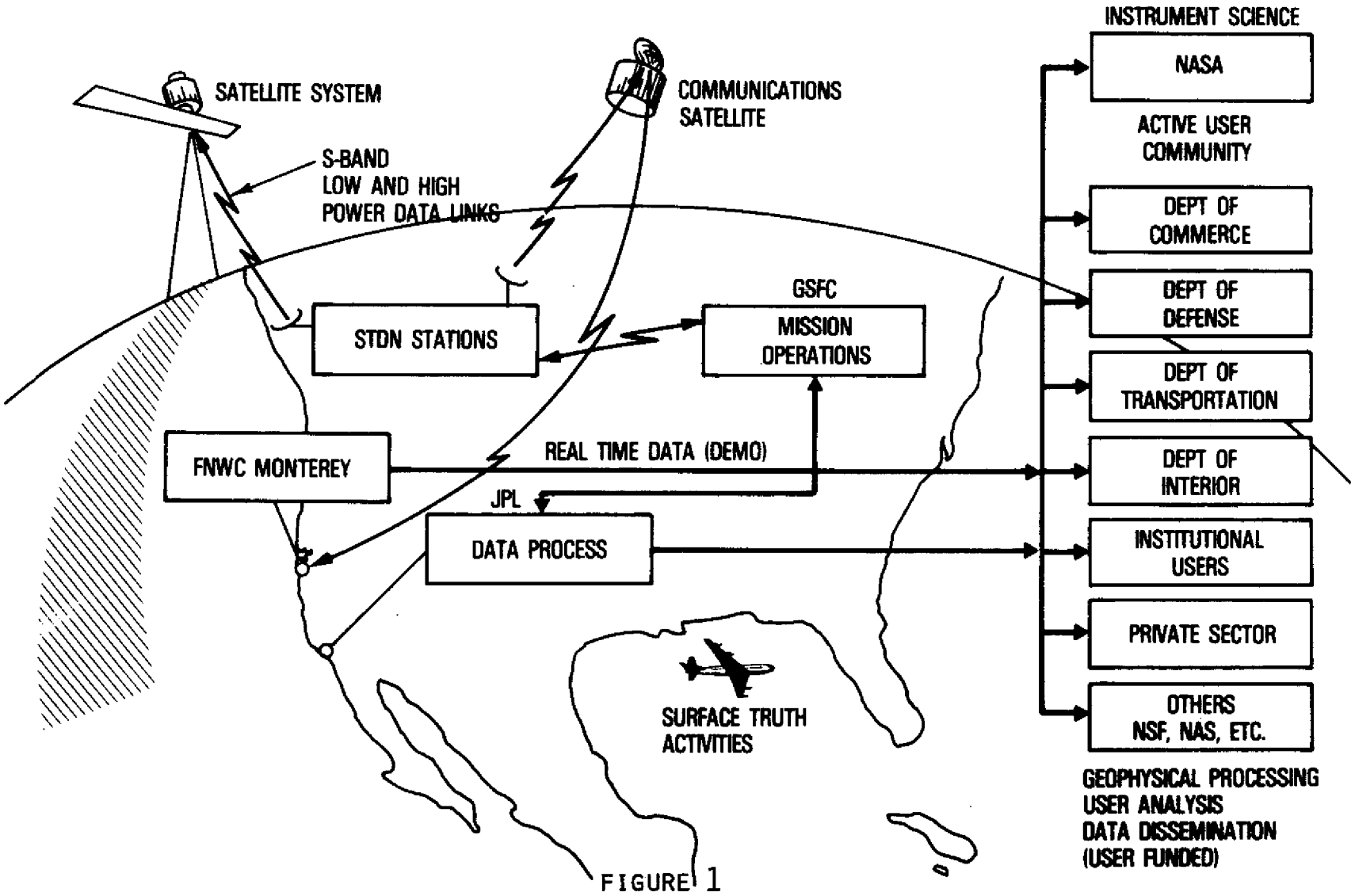
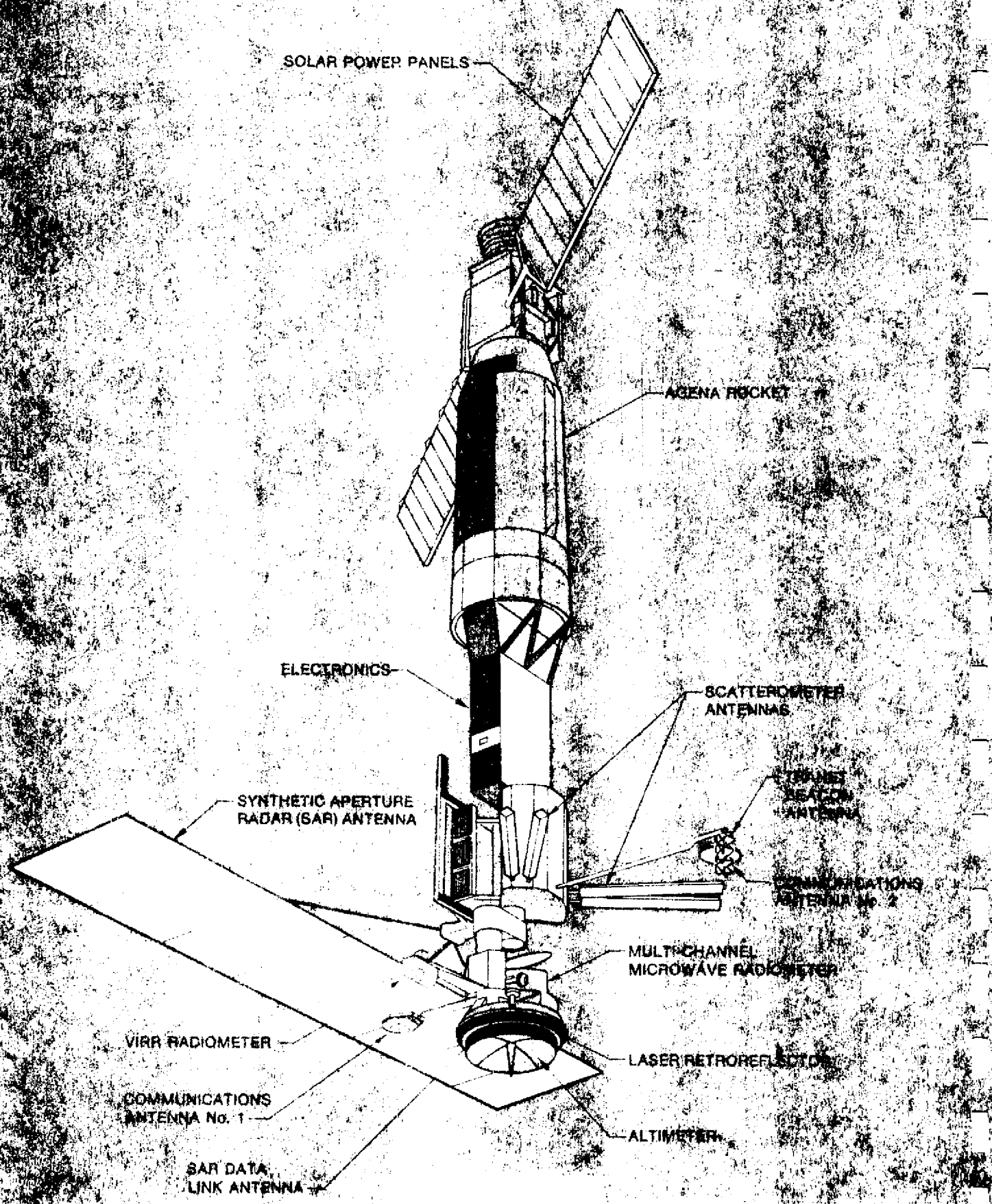


FIGURE 1


SOLAR POWER PANELS
AGENA ROCKET
ELECTRONICS
SCATTEROMETER ANTENNAS
SYNTHETIC APERTURE RADAR (SAR) ANTENNA
MULTI-CHANNEL MICROWAVE RADIOMETER
VIRR RADIOMETER
LASER RETROREFLECTOR
COMMUNICATIONS ANTENNA No. 1
ALTIMETER
SAR DATA LINK ANTENNA

power, attitude stability, orbit control and adjustment, data processing, storage and transfer to ground stations; helped propel the satellite to its 800 Kilometer circular orbit with 108° inclination.

As specific requirements evolved within the using community, candidate remote sensing instruments were evaluated jointly by the users and NASA for SEASAT-A applications. A set of three active radars and two passive radiometers were ultimately selected. The active sensors included a pulse-compressed radar altimeter, a microwave radar scatterometer and the aforementioned synthetic aperture imaging radar. Passive sensors consisted of a scanning multifrequency microwave radiometer and a visible/infrared scanning radiometer.

The SEASAT Radar Altimeter served two functions. It monitored average wave height to within 0.5 to 1 meter. It also measured, to a precision of tens of centimeters, the changes in the ocean GEOID and topography due to gravity variations and ocean tides, surges, and currents. It covered an area of a few Kilometers directly below SEASAT.

As surface winds increase, so does fine scale surface roughness; the Radar Scatterometer measured this feature which can be converted directly into wind speed and direction. The scatterometer measured wind speeds from 6 to 50 knots with 4 knot accuracy, and direction within 20 degrees over two 500 Km swaths on either side of the spacecraft ground track.

The SEASAT Multifrequency Microwave Radiometer served four functions; it measured surface temperature with a precision of 1 Deg. C; it measured foam brightness which can in turn be converted into a measurement of high (up to 100 knot) wind speed; it mapped ice coverage and extent; it provided atmospheric correction data to the active radars by measuring liquid and gaseous water content in the upper atmosphere. The surface swath of the microwave radiometer was 600 Km.

The SEASAT Visible and Infrared Radiometer provided clear weather surface temperature data, cloud coverage patterns, and corroborative images of ocean and coastal features with a resolution of 5 Km over a swath of 1500 Km.

These four sensors, known as the global sensors, were collecting data 100% of the time, monitoring the oceans and adjacent coastal waters globally, and were left on as well as over ground areas providing data of selective interest. Their data was recorded on magnetic tape recorders onboard SEASAT and played back while the satellite was over one of the ground stations supporting SEASAT.

Virtually complete global coverage was achieved by the scatterometer, the microwave radiometer, and the visible and infrared radiometer every 36 hours. The fifth sensor, the synthetic aperture radar, provided all-weather imagery of ocean waves, ice fields, icebergs, ice leads, and coastal conditions and dynamic wave processes to a resolution of 25 m over a 100 Km swath. Because of the very high data rate of the radar imagery, (110 megabits per second) this sensor with its own separate data system, was operated in real time while within line of sight of specific tracking stations equipped to receive and record its data at Fairbanks Alaska, Goldstone California, Cape Kennedy Florida, St. Johns Newfoundland,and London England.

Imagine, if you will, the uncertainty about the quality and kind of data that the synthetic aperture radar, a first time in space sensor, would produce, and then waiting anxiously for the first data collection in the Atlantic on a propitous day the Fourth of July 1978 and hours later being able to see a rough but spectacular view of the coast of the Baja Penninsula shown in Fig. 3.

Important coastal zone, open ocean, land and ice information was collected during the 100 day mission.

The exciting prospect of being able to measure the speed and direction of ocean surface winds completely over the globe every 36 hours prompted weather and ocean condition forecasting groups and commercial marine interests to establish elaborate data recovery and transfer networks so that they would receive the data in near real time. The Navy's Fleet Numerical Weather Central served as the focal point for this activity. The coverage provided by the sensor was extensive for an active radar, measuring the capillary roughness of stress at the surface of the ocean and empirically relating this quantity to surface layer wind speed. A key feature of the sensor, one tried for the first time in space, was the dual measurements

made of the same surface area with radar aspect angles that vary by 90 degrees. This technique permitted directional measurement of the wind as radar cross section is known to vary as a function of the wind/radar vector angle. Resolving the specific direction requires some processing magic, and techniques to do this job are still in work.

The passive microwave sensor on SEASAT also provides a nondirectional wind speed measurement and fills in the global wind picture in speed ranges that exceed the scatterometers capability. Data taken in a hurricane - Hurricane FICO - during SEASATS lifetime demonstrated this attribute of this broad application sensor. The unique contribution of this sensor was the wide range of microwave frequencies combined in a single feed system and scanning antenna design supporting all weather measurements of sea surface temperature, sea ice extent and age, and contributing atmospheric measurements of water vapor and liquid water content. The atmospheric measurements are important in their own right but also aid in the calibration and use of both altimeter and scatterometer data.

Many think that the radar altimeter was the most sophisticated instrument on SEASAT. Its 3n sec Pulse Width was its most publicized feature, because its 10cm altimetric accuracy is expected to usher in a new era in geodetic and precise topographic measurements. However, another aspect of performance, tracking response and stability, was major in its contribution to improved systems applications. This sensor captured the intense interest of geodesist and physical oceanographer alike and elaborately constructed conversion algorithms were developed and are even now processing data so that scientists can refine and further study the shape of the earth or watch the synoptic state of the ocean as it was monitored orbit by orbit.

MARINE COMMERCE USERS

The SEASAT economic assessment, completed in 1975, identified potential benefits from the use of SEASAT type data operationally in areas such as coast and harbor commerce, and offshore oil and natural gas exploration and development. These benefits are shown in Table 1. In addition, it was concluded that very large potential benefits from the use of SEASAT data could be possible in an area of operations that is now in the planning or

SEASAT-A

INDUSTRY EVALUATION EXPERIMENTS

SEASAT MAJOR BENEFIT AREAS

AREA	PRESENT VALUE OF THE BENEFIT ($ MILLIONS, 1975)
ARCTIC OPERATIONS	96 - 288
COSTAL ZONES	3 - 81
MARINE TRANSPORTATION	215 - 525
OCEAN FISHING	274 -1432
OFFSHORE OIL AND NATURAL GAS	214 - 344

*Benefits Attributable To An Operational SEASAT System, 1985-2000, At 10 Percent Discount Rate, Referenced to 1975.

TABLE 1

GLOBAL COMMERCIAL APPLICATIONS OF SEASAT DATA

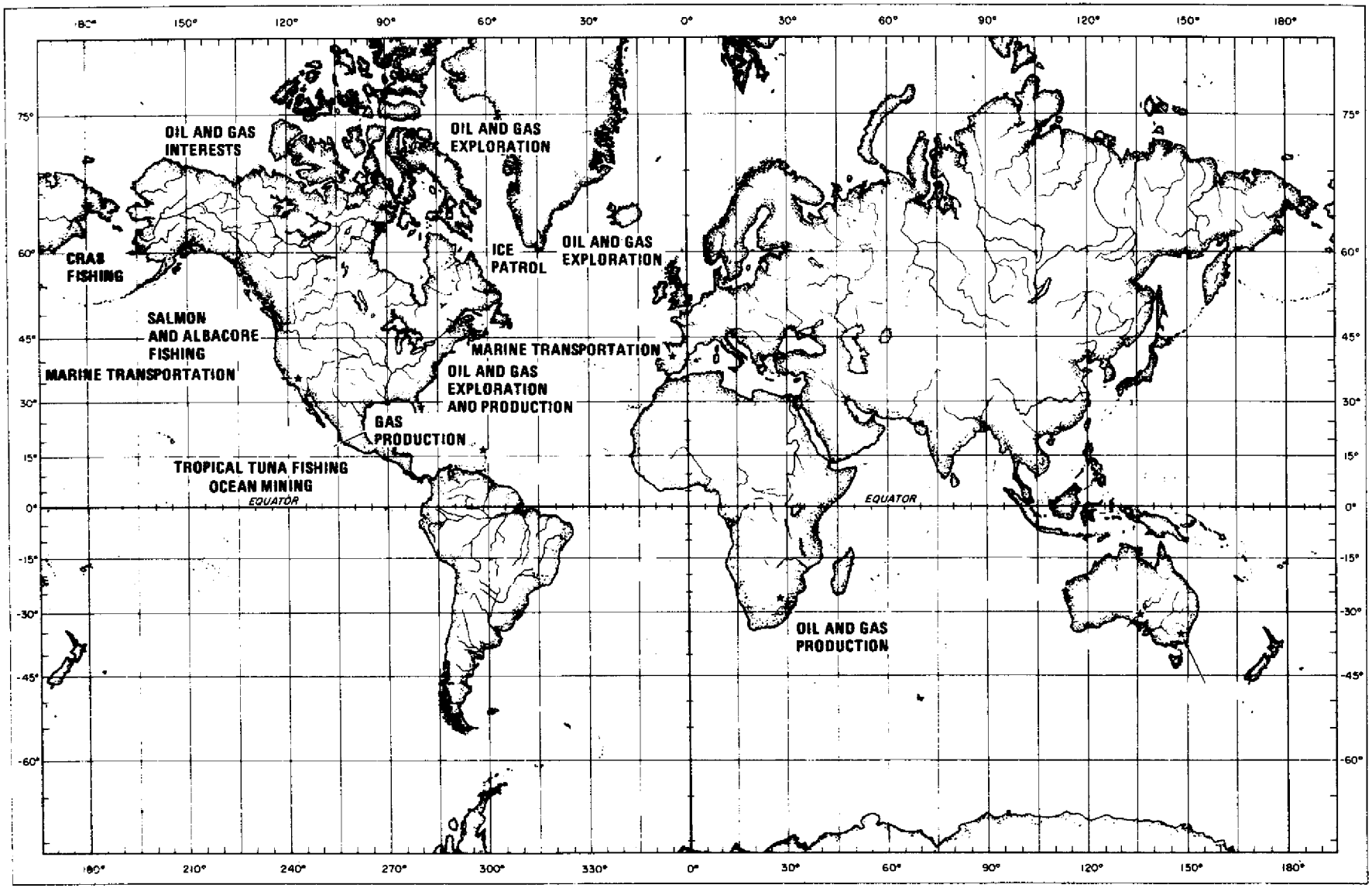


FIGURE 4

conceptual stage, namely, the transportation of oil, natural gas and other resources by surface ship in arctic regions. A further area of large potential benefits that was identified stems from the use of SEASAT data in support of ocean fishing operations. For the purpose of the economic assessment, an operational SEASAT system was considered to begin in 1985, after a SEASAT-A Proof of Concept in 1978 and a SEASAT-B operational demonstration in 1981. The economic benefits shown in the table begin in 1985 and are accrued in the period from 1985 and are accrued in the period from 1985 through 2000. The range of benefits estimated reflected present uncertainties in the future developments of the areas studied, as well as uncertainties in the expected performance of an operational SEASAT system. All benefits were stated in 1975 dollars at a 10 percent rate of discount, referenced to 1975.

The benefit estimates made in the SEASAT economic assessment were largely based upon empirical evidence, and best estimates of the expected impact of operational SEASAT data on operations in the areas of maritime activity which were considered in the assessment. The launch of SEASAT-A in 1978 provided the first opportunity to obtain experimental evidence of the effects of SEASAT data on the economic performance of selected areas of maritime activity through the use of SEASAT-A data in a series of carefully designed experiments. The purpose of using SEASAT-A to begin the process of using synoptic ocean data for the public good was:

1. To provide data to aid in defining operational characteristics of future ocean monitoring systems.

2. To begin the technology transfer process to selected users.

3. To obtain experimental data to help validate economic benefit estimates.

The concept embodied by the industrial evaluation experiments was straightforward. SEASAT-A data was transfered to the Navy Fleet Numerical Weather Central (Monterey, California) for real time processing. NASA supported some additional processing of these FNWC products to meet experiment participants needs, providing the resources necessary to deliver these products to the users "doorstep". The assimilation and operational use of the data products was the responsibility of each participant.

The industrial users were a major ingredient of the SEASAT-A program from the very beginning. Key to the establishment of the program was the fact that the major benefits estimated to accrue from an operational SEASAT system were derived from the commercial ocean community. These benefits, along with the necessary transfer of technology were to be tested during the SEASAT-A mission, and in this early first phase NASA assumed a responsibility to provide support, in a cost-sharing arrangement, to the commercial sector, in order to demonstrate the commercial viability of the SEASAT-A concept.

The industrial users of SEASAT-A data were, in fact, demonstrably different than either the academic, institutional or government agency users. Even first ventures require a commercial user to commit real people and real dollars. These resources can suffer significantly in the event these first ventures are less than successful, as was the case with the trucated SEASAT mission.

A rather broad representation from the commercial ocean community signified the SEASAT industrial evaluation experiments as shown in Table 2. Each selected commercial user was participating on a resource-share basis in the experiments.

The development and implementation schedule for the industrial evaluation experiments had reached a point where installations at Fleet Numerical Weather Central were complete and early data flow pilot runs to commercial users were only days away.

The tragic death of the satellite dealt a nearly mortal blow to the industrial experiments.

Major systems were in place throughout the world to receive SEASAT data and relay it to Monterey California, and unique modifications at the Navy's installation there (Fleet Numerical Weather Central) were beginning to digest the global data they were receiving around the clock. Commercial users are still in place waiting for a successor to appear in the constellation of satellites now circling our globe.

Many users continue as SEASAT experimentors, hoping to achieve some of the "Proof of Concept" goals or shake down their already established systems. But however successful this subtended and limited operation turns out to

ANALYSIS AND EVALUATION OF SEASAT DATA BY THE COMMERCIAL SECTOR

COMMERCIAL SECTOR	ORGANIZATIONS	APPLICATION	AREA OF INTEREST
OFFSHORE OIL AND GAS	1. GULF OIL OF CANADA LTD. CANADIAN MARINE DRILLING LTD. ESSO RESOURCES CANADA LTD.	IMPROVE OIL AND GAS EXPLORATION IN THE ICE-INFESTED WATERS OF THE BEAUFORT SEA	BEAUFORT SEA
	2. TOTAL EASTCAN EXPLORATION LTD.	MONITOR SEA ICE IN THE LABRADOR SEA	LABRADOR SEA
	3. AMERICAN GAS ASSOCIATION	DETECT STORM DEVELOPMENT IN THE GULF OF MEXICO	GULF OF MEXICO
	4. CONTINENTAL OIL CO.	DETECT STORMS AND HURRICANES IN THE NORTHEASTERN ATLANTIC	NORTH SEA, BALTIMORE CANYON
	5. GETTY OIL CO.	DETECT STORMS AND HURRICANES IN THE FOLLOWING LOCATIONS: OFFSHORE WEST AFRICA, U.S. EAST COAT, NORTHWEST AUSTRALIA, CURACAO, ARGENTINA, TUNISIA, NORWAY AND SPAIN	
	6. ALASKA OIL AND GAS ASSOC.	EVALUATE THE UTILITY OF SAR DATA IN OFFSHORE PETROLEUM OPERATIONS IN THE ICE-COVERED AREAS IN THE BERING SEA	BERING SEA
OCEAN MINING	DEEPSEA VENTURES INC. KENNECOTT EXPLORATION INC. LOCKHEED OCEAN LABORATORY	ACCESS SAR DATA FOR OCEAN MINING, DESIGN AND EXPLORATION OPERATIONS	TROPICAL PACIFIC
MARINE FISHERIES	NORTH PACIFIC FISHING VESSEL OWNERS ASSOC. (ALASKA CRAB FISHERY)	ICE OBSERVATIONS IN THE BERING SEA	BERING SEA
	NATIONAL MARINE FISHERIES SERVICE/NOAA – (COORDINATING 20-30 TUNA AND ALBACORE VESSELS)	STUDY OCEAN CONDITIONS (WAVE AND STORM PATTERNS) IN THE PACIFIC TUNA AND SALMON FISHING REGIONS	TROPICAL PACIFIC
	MARINE ADVISORY SERVICE – (COORDINATING 10-15 SALMON VESSELS)		U.S. WEST COAST
MARINE SAFETY	INTERNATIONAL ICE PATROL (USCG)	SURVEY ICEBERGS AND SEA ICE IN THE NORTH ATLANTIC. STUDY DRIFT PROPERTIES OF ICEBERGS	BAFFIN BAY, LABRADOR SEA, NORTH ATLANTIC
MARINE TRANSPORTATION	OCEANROUTES SUN SHIPBUILDING AND DRYDOCK CO.	OPERATIONAL FORECASTING FOR WORLD'S OCEAN	GLOBAL

TABLE 2

be, it leaves a vacuum of many unfullfilled goals.

THE FUTURE

The SEASAT system can be summarized as having a capability that exceeded the sum of its parts. The cooperative nature of the sensors on SEASAT gave it a rare degree of synergism and range of applications. This attribute was a key reason for the promise so apparent to a large and diverse legion of users. Clearly the assertiveness shown by these users as they established reception, processing, dissemination and utilization systems, largely using their own resources, proves this.

The technologies represented by SEASAT work. In depth microscopic analysis of data products will go on for years but one has to only look at the synthetic aperture radar data to get excited by future efforts. The potential of obtaining global wind field data, something the forecasters have to guess into their models now with complex and elaborate extrapolations, is of major value. These and other user needs for microwave all weather observations of the global oceans still exist. The willingness to pay their own way attitude of the commercial users emphasize that the need and support for such a system is stronger now than it was when it helped convert an earlier dream into a real program.

Current Federal Planning has these technologies entering space again in 1985, or later, via such programs as the established Defense Meteorological Satellite Program (BLOCK VI System) and the still in the planning stage National Oceanic Satellite System being considered as a co-operative effort by the National Aeronautics and Space Administration, the U.S. Navy and the National Oceanic and Atmospheric Administration. It's also interesting to note that at present neither program includes a Synthetic Aperture Radar. Although these programs are operational in design and provide improved coverage by using several satellites in orbit at once; one wonders why a seven or eight year wait is necessary. It's not clear, even with the delay, how the real users of the oceans will be served by these systems. User working groups, such as the one that served SEASAT are important to the early constitution and planning of future programs. These groups are not in force at present. If the interests of vital sectors of the user community are not considered during the initial planning stages they stand a good chance of being ignored in the final system.

Last year the concepts now demonstrated by SEASAT were unproved hopes. Now, with the next systems using these technologies way over the horizon, its possible that the promise extended to commercial users of the ocean environment could become a forgotten reality. It's important that these users and government groups sensitive to their needs join forces to prevent this from happening.

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MODIFICATIONS TO SWASH-BEACH PROFILE INTERACTION IN THE PRESENCE OF SEAWALLS, DUNES AND OVERWASH CHANNELS

Donald K. Stauble
Department of Oceanography and Ocean Engineering
Florida Institute of Technology
Melbourne, Florida 32901

ABSTRACT

During storm conditions large breaking waves, high storm tides and strong onshore winds combine to raise the water level and usually allow the swash to penetrate to the backshore. If a barrier is present on the backshore of the beach in the form of a seawall or a dune, the swash is prevented from attaining its normal maximum run-up distance, and is reflected from the barrier. In areas where there are gaps in the foredune or no foredune is present, the storm swash will penetrate landward of the beach crest as overwash, resulting in landward sediment transport and deposition, but little backwash. A laboratory flume experiment was conducted to investigate differences in this interaction of uprush and backwash and sediment transport. As the run-up collides with the vertical wall a plunging type breaker form is created that collapses to form a reflected bore that travels downslope over the thinning backwash. Turbulence associated with the collision causes scour at the base of the wall. Run-up collision with the inclined dune causes the formation of a surging type wave and reflected bore that erodes the bed as it travels downslope. The impact of the uprush with the vertical dune scarp causes the formation of a spilling type wave form with a reflected bore. The bore undercuts the scarp adding significant sediment to the backshore. The overtopping of a beach crest causes a significant amount of uprush to flow downslope landward away from the wave source, transporting sediment landward. The reduced backwash transports little sediment seaward.

INTRODUCTION

The purpose of this research is to study the variation from the normal pattern of the swash processes and beach responses when 1) the uprush encounters an obstacle before it reaches its maximum uprush distance, possibly enhancing the backwash's ability to scour and transport sediment and 2) in the absence of an obstruction the uprush penetrates landward of a beach crest and flows downslope away from the surf zone, therefore having little or no backwash.

Field investigation of swash and sediment interaction, during storm conditions, is difficult due to the highly turbulent and irregular impact of water by breaking waves. Direct observation of sediment particle motion is not possible and the ability to maintain data collection devices is limited. To understand the interaction of swash processes with sediment dynamics on the backshore, a laboratory flume study with a movable bed was undertaken. A single swash cycle was isolated and the sediment transport mechanics was observed through the glass wall of the flume.

To study the varying conditions in swash mechanics and the dynamic response of the beach surface to these processes, five different conditions commonly found on the backshore were modeled:

1) As a control, a swash cycle was modeled that allowed for maximum run-up and backwash. This portion of the experiment simulated the normal swash sequence.

2) A vertical wall was placed in such a manner that the uprush was prevented from reaching its maximum distance but struck the wall and was reflected back downslope.

3) A "dune" was constructed of sand on the bed in approximately the same upslope position as that of the vertical wall. The dune profile was constructed to simulate the toe of a natural dune with a slope of thirty-two degrees. The uprush struck this dune face and was also reflected back downslope.

4) The "dune" was modified to present a vertical face to the uprushing bore. This scarp was located in the same position as the impervious vertical wall. Interaction of the uprush with the scarp caused sediment to collapse onto the beach as the reflected backwash moved back downslope.

5) The swash was allowed to overtop the crest of the model beach and flow downslope away from the bore source, simulating overwash of a berm crest. The initial swash depth was the same as in the previous conditions, which resulted in a dimminished backwash flow, with most of the fluid proceeding landward as unidirectional flow.

PREVIOUS INVESTIGATIONS

Few studies have been conducted on the mechanics of scour of swash and backwash impinging on a barrier.

Several investigators have looked into the interaction of waves directly on structures and have found scouring at the base of these structures (1,2). These studies have been centered on the action of waves directly on seawalls or scour in the subaqueous zone. Russel and Inglis (3) found that the beach between high water and the upper limit of swash eroded in the presence of a vertical seawall, first slowly, then at a rapid rate until an equilibrium profile was established at a level below low water or in the subaqueous zone. Sato, et al. (4) as part of a larger study on scour at the foot of coastal structures on the subaerial portion of the model beach, found scour at the base of the vertical wall with little change in the offshore profile.

Beach profile data collected in a related study at Assateague Island National Seashore confirm that storm erosion of the dunes causes scour at the toe of the dune, but the lower foreshore profile elevations are unchanged. Other investigators also report storm wave scour of dunes (5,6,7). Field studies have also shown that swash in the form of overwash can deposit large quantities of sand behind the dune (8,9). The overwash sequence occurs when the super-elevation of mean water level reaches a point where the uprush reaches the crest of the berm. The swash penetration landward of this point will flow downhill away from the ocean. The swash will then spread laterally, decreasing its velocity and depositing the entrained sand.

EXPERIMENTAL DESIGN

To understand the interaction of swash with the bottom sediment during uprush and backwash modification, it is useful to simplify observation by isolating a single incoming bore. A glass wall flume, 13 m long, .75 m wide and 1 m deep was used in this study with a double gated head tank at the lower end of the flume. The head tank dimensions were 1.8 m long, .75 m wide and .42 m high at maximum water depth. Since all breaking waves form into bores regardless of breaker type (10), only the wave in the form of a bore above still water level was used in the study. The bore was formed by rotating the inner head gate forward allowing a fixed volume of water to flow upslope. As the flow changed to backwash the outer head gate was raised vertically, allowing the backwash to flow through the head gate assembly into the floor tank, thus preventing reflection and return flow upslope.

A beach 9.5 meters in length was constructed from the opposite end of the flume to the head gate assembly. The bed was composed of plywood set at a two degree slope to the flat flume floor. Approximately 5 cm of natural beach sand was placed on top of the plywood base.

No groundwater flow was generated on the model beach due to size limitations on the depth of the sand bed (5 cm), but conditions of supersaturation were present due to the impermeable floor. On the natural beach during storm conditions, supersaturation of groundwater is often present. By isolating a single swash cycle, the irregular phasing of the swash during storm conditions was not modeled. This may be an important interaction on natural beaches (11, 12), but could not be incorporated into the experimental design.

As a control, the normal uprush/backwash sequence was modeled to first quantify the normal swash/sediment interaction. Figure 1a shows the experimental setup for the "swash" experiments with the plywood bed and smooth sand covering. The bed was 9.5 m long with a maximum elevation at the far end of the tank of 0.32 m to give a two degree slope. The head tank was filled to a depth of .42 m and the head gate was opened causing the swash bore to flow upslope to its maximum run-up position and then return downslope as backwash into the holding tank.

For the second set of experiments a vertical plywood wall was placed 5.8 m upslope from the head tank on the same bed of sand (Fig. 1b). Using the same head tank depth with the shorter run-up distance caused the swash to reflect off the plywood before it reached its maximum run-up.

In the third set of experiments the vertical wall was replaced with a mound of sand representing a dune face (Fig. 1c). The swash impinged on the .40 m high sand barrier, located in the same position upslope as the vertical wall. Since a scarp was not formed at the toe of the dune during the ten runs, an additional set of ten runs with a scarp cut into the base of the dune, at the same position upslope as was the vertical wall was run (Fig. 1d).

The final set of experiments simulated overwash of a beach crest. The plywood bed was hinged at 5.8 m and the upper beach section was lowered back down to the flume bed, forming a crest (Fig. 1e). A smooth bed of sand was replaced along the entire bed as in the "swash" series. The swash bore now flowed over the

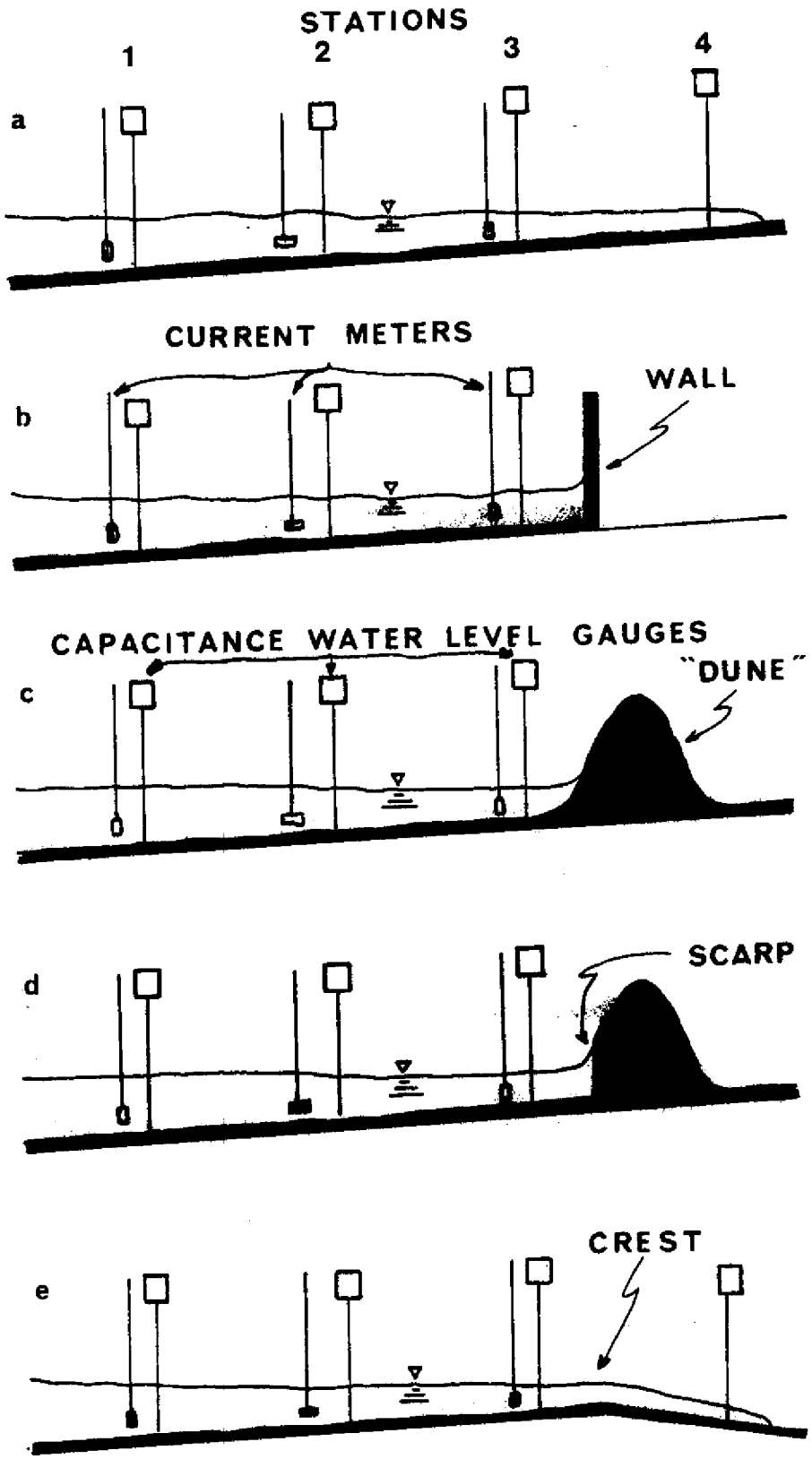

Fig. 1.-Experimental Bed Detail
a. Swash. b. Wall. c. Dune.
d. Dune Scarp. e. Overwash.

crest and into a storage tank at the far end of the flume.

ANALYSIS OF RESULTS

As a wave approaches shore it will pass through water of decreasing depth until a discontinuity forms on the crest causing the wave to break. The mechanisms for breaking are discussed by Miller (13). Shape of the breaking wave has been classified (14) and there appears to be a general agreement that there is a spectrum of major breaker types, ranging from spilling through plunging to surging breakers. However, after the wave has broken, it forms a bore, regardless of the type of breaker. The uprush profile was described as a water mass with a small, steep faced front usually marked with a line of foam, resembling a tidal bore (15). Initially the front of the bore is vertical and overrides standing water. At the shoreline the bore collapses sequentially into the configuration of sheet flow as the swash progresses upslope, with highly turbulent motion (16). A "tongue" occurs at the vertical front face of the uprush bore and was observed to decelerate sharply and be overtaken by a "step" of water behind it. This tongue in a "snowplow" effect removed the top few layers of sediment. As the bore decelerated on its path upslope the mode of sediment transport changed irregularly from one of suspension to saltation to bedload and finally deposition as the depth and velocity decreased to zero. Under conditions that allow for completion of the swash/backwash process, the fluid sinks directly into the sediment, depositing, in the form of a "swash mark", the accumulation of sediment that was in the tongue of the swash.

As the bore reaches its maximum run-up distance, there is a period of decreasing upslope movement. The fluid comes to a momentary halt. The initiation of backwash is accompanied by a rapid drop in depth, as the fluid accelerates downslope. The backwash was found to have different internal flow characteristics from the uprush (16, 17), with a reverse spectrum of transportation mode from bedload through saltation to suspension. The lower backwash obtains high velocities but with shallow depths thus limiting the number of grains in suspension.

The sequence of sediment transport and deposition will be altered, however, if the uprush cycle is

interrupted before it obtains zero velocity and maximum upslope distance. A swash bore that impinges on a barrier while there is sufficient depth, forward velocity and some entrained sediment supplies enough energy to cause scour of the bed downslope from the toe of the barrier.

With the addition of the wall at 3.7 m from the backstake, the uprush was prevented from obtaining maximum run-up. Figure 2 shows the impact of the uprush on the wall, causing the fluid to first rise vertically, then collapse back on itself, in what could be called a plunging breaker form. The force of the impact causes sediment to be placed in suspension at the base of the wall as seen in the photograph. This causes a scour hole at the base of the wall along with much entrainment of air. As the fluid plunges back downslope, much of the suspended material is dropped just downslope of the wall, depositing the upper foreshore ridge. The plunging breaker type wave reformed as a bore that flowed downslope overtop of the thinning backwash. Capacitance gauges and electromagnetic current meters measured dynamics. The velocities in this backwash bore were measured as being higher and the depths were deeper, allowing for more sediment to be entrained and transported downslope, than the typical thinning backwash.

Details of the fluid dynamics are reported elsewhere (18). As the bore reflected off the wall, with its plunging type breaker form, it progressively scoured the area directly in front of the wall and redeposited the sand in a growing ridge like feature on the upper foreshore (Fig. 3).

Removing the vertical wall and replacing it with the dune caused the uprush to collide with a permeable inclined surface. The uprush water mass surged up the dune to a maximum height of 20 cm (Fig. 4). The backwash started in the form of a surging breaker as the fluid mass retreated down the dune face onto the upper foreshore. There the increase mass of water formed a bore that rode over the backwash as it did in the case of the wall. The difference was in the apparent reduced turbulence as the water surged up and down the dune face. There appears to be a less dramatic entrainment of sediment.

A detail of the dune face bed change, drawn from photographs (Fig. 5) shows slight erosion causing the dune face to migrate upslope. This sand eroded from the dune face by the surging type wave form of the uprush bore was deposited on the upper foreshore.

Fig. 2.-Swash Impact on Vertical Plywood Forming Plunging Type Breaker with Sediment Suspension at Base of Wall.

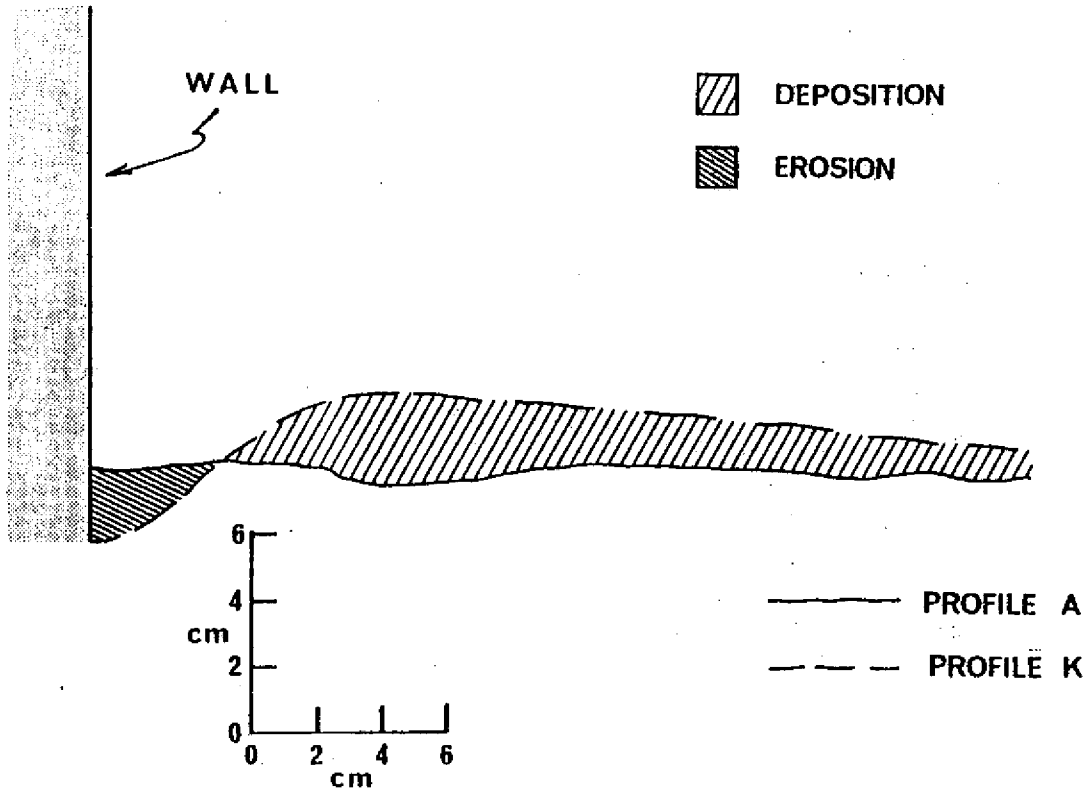

Fig. 3.-Detail of Profile Changes at Base of Wall for Ten Runs.

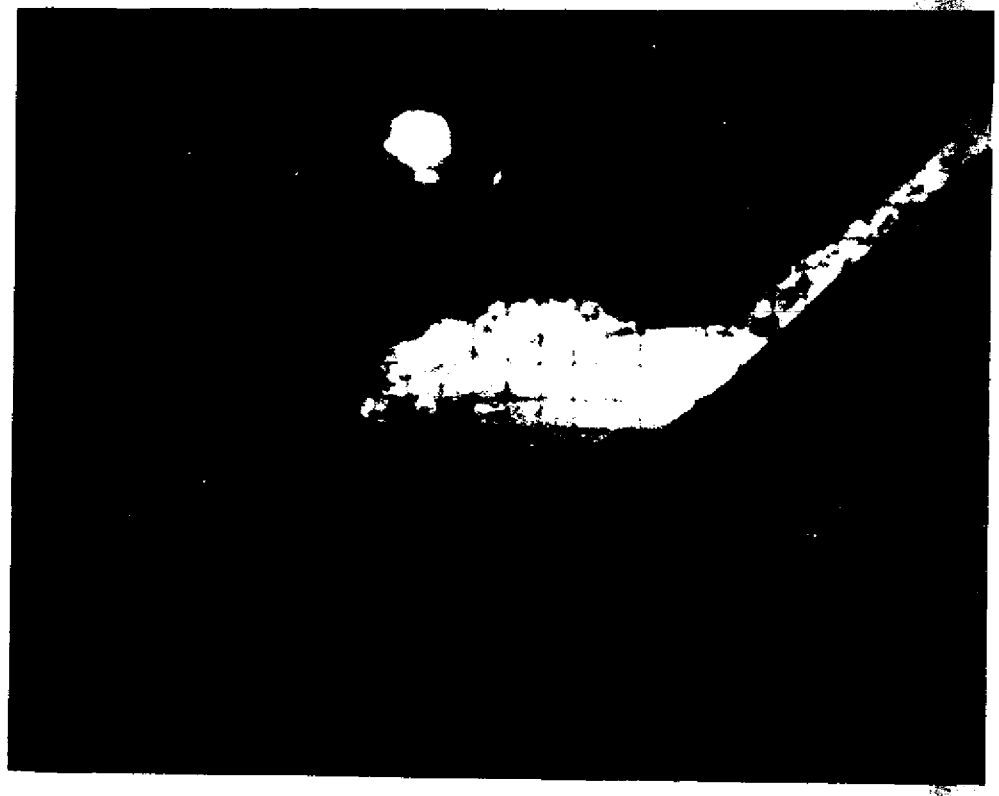

Fig. 4.-Swash Impact on Dune Face Forming Surging Type Breaker with Suspended Sediment Below Crest.

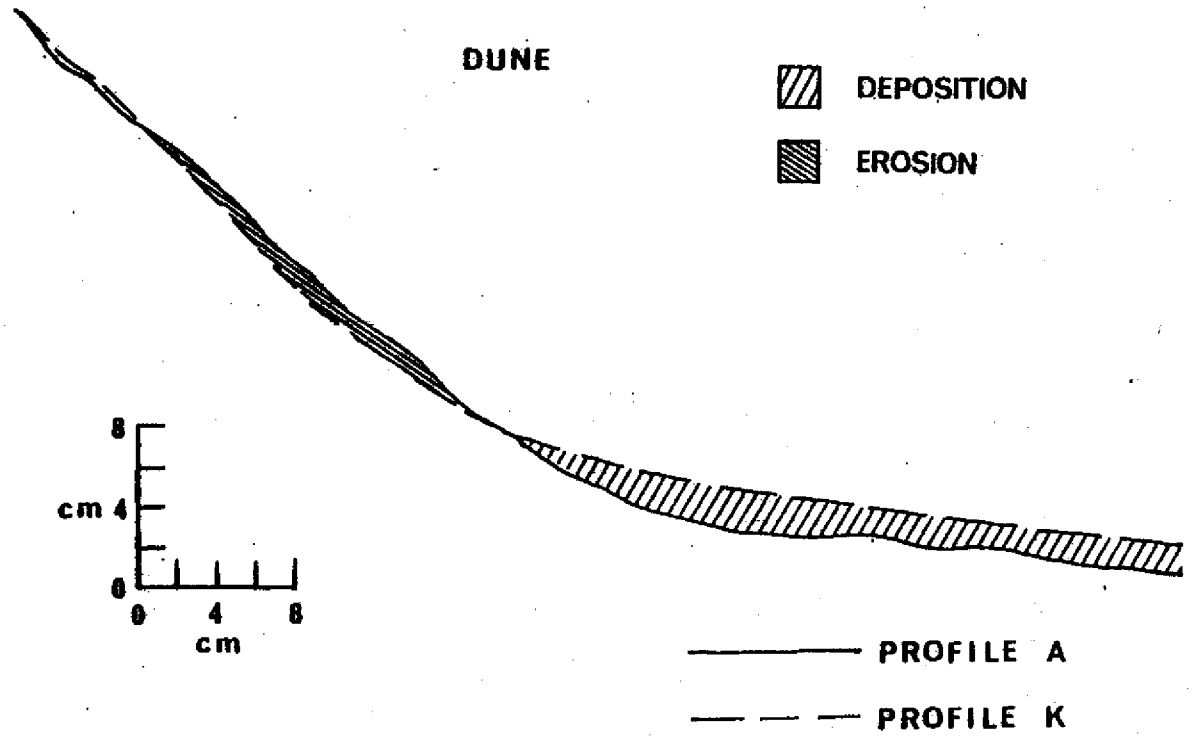

Fig. 5.-Detail of Profile Changes on Dune Face for Ten Runs.

The reflection off a vertical dune scarp did not produce the well defined plunging type wave form, as with the vertical seawall, but rather the surge reformed into a bore in a manner similar to a spilling wave form. The fluid mass caused the scour of the scarp by undercutting, resulting in sections of the vertical sand face collapsing into the turbulence of the surge (Fig. 6). Again this resulted in a bore traveling downslope over the backwash, which lead to scour of the lower foreshore. The addition of relatively large volumes of sand, by collapse of the scarp, added a significant amount of sediment to the upper foreshore, so that the net volume changes were not as dramatic as in the wall experiments. This sand was deposited on the upper foreshore as was the case in the two previous experimental setups. Detailed changes at the scarp (drawn from photographs) show that the vertical wall was reduced to a gradually sloping face after the ten runs (Fig. 7). The dune face profile was changed up to a height of 20 cm by the bore collision as the face migrated upslope.

If the uprush overtops the beach crest as it completes the normal uprush sequence to its maximum distance, the flow will be downslope in a landward direction away from the foreshore. From observations of post storm beach profiles in areas of overwash, an area of deposition resulting from the unidirectional flow of swash was present in the overwash throat. The backwash cycle is weakened considerably as most of the swash mass overtops the crest and flows in the opposite direction. Without the full backwash component to transport sediment back to the lower foreshore, less sediment will be entrained on the backshore and there will be less net erosion by the backwash.

The flow characteristics of the overwash series were most similar to the maximum run-up control series, but exhibited similarities of reflected swash off barriers also. By lowering the backshore, it created a crest which allowed most of the water mass to flow away from the foreshore region. The uprush flowed over the crest and accelerated downslope. At the crest the water depth thinned as the backwash started with water flowing in both directions (Fig. 8). With the loss of fluid to the other side of the crest, the backwash was somewhat reduced in volume. However, the foreshore distance was shorter than in the swash series and about equal to the other series. A bulge of water was observed to form just downslope from the crest as the backwash was

Fig. 6.-Swash Impact on Dune Scarp Forming Spilling Type Breaker with Collapse of Vertical Sediment Wall.

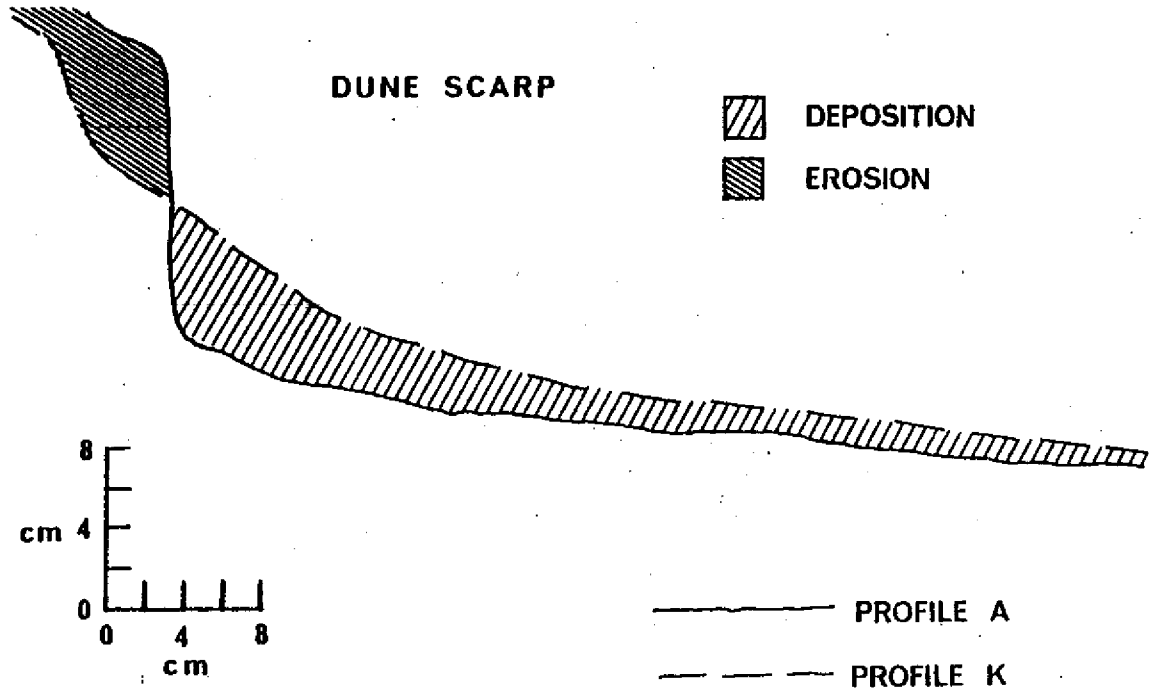

Fig. 7.-Detail of Profile Changes on Dune Scarp for Ten Runs.

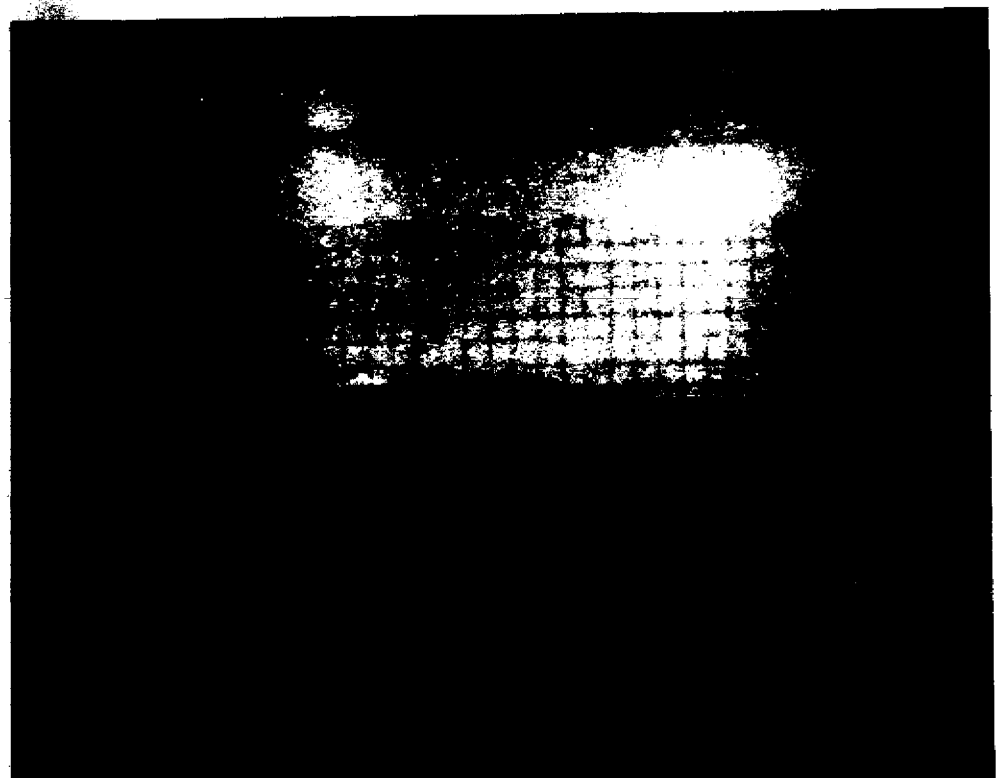

Fig. 8.-Initiation of Backwash Flow at Beach Crest in Overwash Series with Formation of Bulge on Left, Thinning Unidirectional Run-up Flow Toward Storage Tank on Right.

initiated. This bulge of water then flowed back down toward the head tank. The magnitude and duration of the bulge and backwash itself was less than the bore wave form in the wall or dune experiments, being more like the "retrogressive" bore of the swash experiments.

Figure 9 shows the total bed change on both sides of the crest. Past the crest, the flow was unidirectional into a storage tank at the far end of the flume from the head gate. The flow on the foreshore of the crest was still bidirectional, some of which was transported over the crest and the rest was transported downslope. The crest elevation itself was lowered by 3 mm and migrated toward the head tank .3 m.

For comparative purposes, a relative value of total sediment transport was calculated for each experimental group by multiplying the sediment discharge values by the time interval. The lowest relative sediment transport was computed for the overwash series which corresponds to the diminished backwash flow. The backwash flow of the swash series covered a larger distance and was of a longer duration than that of the overwash, which is reflected in the larger transport value. The three series that reflected off barriers and formed the reflected bore had the largest values of relative sediment transport. The dune scarp series had the maximum relative sediment transport value indicative of the input of sediment into the backwash through slumping of the dune scarp. The dune series, where the dune face also served as a source of sediment input into the backwash, had the next largest relative transport. The third largest relative transport value was computed for the wall series where a fixed amount of sediment was scoured from the base of the wall and redistributed by the backwash.

CONCLUSION

It can be concluded from this study, that impact of swash on barriers changes the hydraulic properties of the backwash and its ability to transport sediment. The normal swash, that obtains maximum run-up, exhibits distinctly different backwash flow characteristics and sediment transport properties from those reflecting off barriers. As long as the waves break some distance offshore, allowing for a swash zone, the modified backwash properties will be valid. Waves that break directly on barriers will exhibit different dynamic properties altogether.

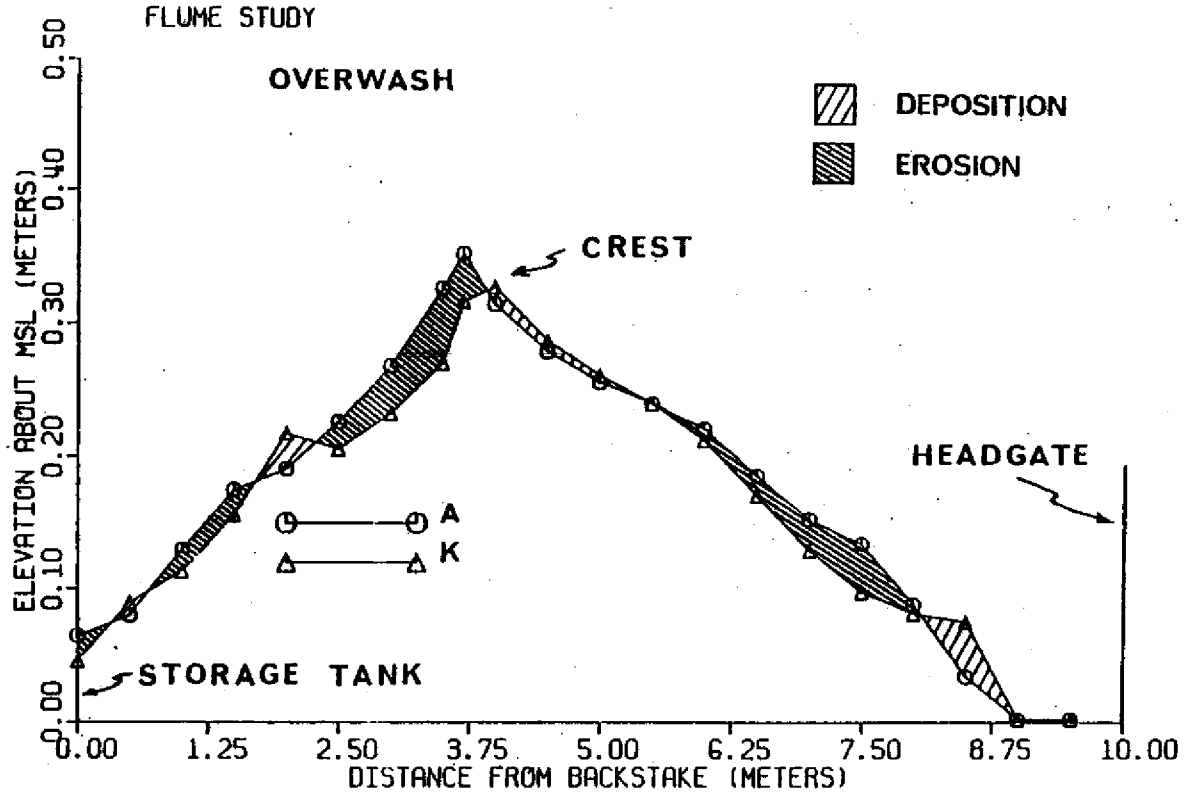

Fig. 9.-Profile Changes for Ten Runs in Overwash Series - Vertical Exaggeration 1:12.5

Flume and field studies revealed that the impact of swash on a vertical wall scours the base and places sediment in suspension while forming a reflected bore. In the flume experiments and the beginning of the field study, deposition of the suspended material was observed on the foreshore. However in a subsequent field study, as the tide level rose and swash impact became more severe, this area was eventually eroded. Natural beaches with a seawall type configuration can expect to experience the most severe erosion of the beach types investigated since there is turbulence and scour with no new sediment entering the system.

On beaches where there is a well developed dune configuration, impinging swash flow forms a backwash that exhibits similar reflected bore characteristics and net erosion. While the flow has similar enhanced sediment transport properties to a wall, the impact of the fluid on the sloping dune face is less turbulent. The eroding dune face is also a source of sediment to the system and thus lessens the impact of erosion on the foreshore. With a rising tide, swash activity will become more intense on the dune face often causing scour and scarp development. The impact of the swash on the vertical dune scarp configuration causes maximum undercutting of the scarp, leading to a collapse of large amounts of sediment into the backwash flow. Although erosion of the profile occurred in all test cases, it can be concluded that dunes with vertical scarping contribute significant amounts of sediment to the beach-face as they retreat, thus modifying the magnitude of erosion by the reflected swash action.

On beaches where swash flows over the beach crest as overwash, most of the sediment will be transported landward in the unidirectional swash flow. The backwash of fluid not reaching the crest exhibits characteristics of normal backwash but with diminished depth and velocity. Lower sediment transport rates and less bed change can be expected on the foreshore than under normal maximum run-up backwash conditions.

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DAVID AND THE BEACHES

Colonel James W. R. Adams
District Engineer
U.S. Army Corps of Engineers, Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32201

"DAVID AND THE BEACHES"
(Presentation was made in conjunction with the showing of a video tape of the Atlantic shoreline in the aftermath of Hurricane "David")

It is indeed a pleasure for me to be here with you today. Just recently, I had the pleasure of attending this year's annual meeting of your parent organization in Los Angeles. I thoroughly enjoyed my time there.

Down here in Florida, many of you probably missed a few issues of the Washington Post a couple of months ago in which this newspaper devoted considerable space and time to the issue of wasting the taxpayers' money on Florida's beaches and, essentially, their viewpoint was that the tax dollars spent on the nourishment project here in Dade County was a matter of laying the gold on the beach and letting the water wash it back out. Subsequent to that, Time Magazine did an article and while they weren't as hostile as the Washington Post, they somewhat left that same question in people's minds. In all our beach nourishment projects in Florida, we have slightly different purposes. For example, some are designed like the one in Dade County for hurricane protection as well as augmenting the recreational potential of the area. In other places, they are designed for storm protection rather than hurricane protection. And in other places, the primary value is, in fact, the recreation value for the beaches and

for the local communities. Tourism in the State of Florida is a major industry, and it doesn't have to be looked at defensively. It brings revenue into the state that supports a lot of people who are entitled to have that support.

But the questions always remain - just how reliable is this technology? Do we really know what we are doing and is the public truly getting a return on its investment?

With respect to the storms - every time we have a storm, my office is deluged with requests from the press to get an evaluation of whether we have lost more or less sand than we thought from that particular storm. The fact that we really don't operate on a "storm by storm" methodology isn't too relevant. There seems to be a public consciousness, at least among the media, of raising this question of whether we are getting our money's worth - whether they are really getting the protection they think they are buying. And I would say that those of us in the technical community probably have a few questions about that ourselves.

What we attempted to do during David was to manage the whole realm of activities the Corps is involved in - not only disaster operations, but looking at all structures and activities we put the taxpayers' money into in Florida - in trying to get an honest evaluation of the effect of hurricanes. Part of that program was to take a trip up the beaches on the east coast of Florida on the day after David and visually record on video tape what we actually saw. Today, I am going to show you that tape. The issue at hand really is, "are we doing what we have promised?" And I think the answer is going to be - quite clearly - that we are. Now,

what I am going to show you is not one of those cataclysmic types of drama films, but it will show you what the beaches look like right after the storm. As you will see, no major structural damage occurred, but we should also remember that David was a low category hurricane.

We are not going to see every bit of the coastline as we just have about 10 minutes of film. We start out at Virginia Key and work northward up the coast. We find, generally, that the before and after storm conditions where the storm stayed out at sea were unchanged. We had high tide, high water, and wave energy striking the beach at a higher level than normal; but, for all intent and purposes, the various coastal structures and the various parts of the coastline remained essentially unchanged after David. There was no appreciable accretion or loss at Virginia Key. We are now moving up the coast to where we have our Dade County beach project starting at Government Cut. Now, if we'd had a direct hit with a storm, those structures that are unprotected would have absorbed the full force of the wave energy. The fact that the wave energy was not significant major damage did not occur, however, such potential for damage is there. This area coming up is where this project is in the stage of construction.

Going back to the original shoreline, or the pre-project shoreline, you saw how far back the beach actually was. At Bal Harbour, you can see the debris line. You can also see that some sand was pushed up into the vegetation area. If you have the opportunity to visit the beach area behind the hotel, you will have some visual demonstration that the planting - the vegetation they have used - has, in fact, stabilized the sand and and probably prevented some loss from wind erosion.

Up in Broward County, we didn't have the storm coming across the shore. In the areas where the project is not yet underway, you see the waves moving right up to the existing structures - the sea walls - and you can see the potential for property damage if we had had a major storm. At Delray Beach, you can see the debris line short of the sea walls, and you can get some appreciation for the wave energy still there on the day following the storm. Now, there are those who will say that what I am going to tell you is not a significant test because the portion of the beach where the storm moved inland was not a federal project. We can only conjecture that had we had a federal project the damage you are about to see would not have occurred. More important, however, is what happens to unprotected beach if the storm comes ashore. In just a second you will have a visual demonstration of that, because in the Vero Beach area, the storm did, in fact, come ashore. You are now looking at the evidence of the erosion that did take place. These film clips taken from the ground show you some contrast. Severe, significant erosion occurred as well as property damage just because the storm moved ashore. We are confident that erosion damage would not have occurred if we had had a beach project in that area. However, the beach project would not have helped in the prevention of damage to the roof structures.

The fill you see to the left rear was emergency fill put there by local inhabitants right after the storm, but essentially the walk and the parking apron up there were all undercut by erosion. There was a significant loss of beach in this area. As we move north, you might notice that the surf on the day following the storm gets increasingly

higher as you leave the protection of the offshore islands. Consequently, as you move further north, you have more severe conditions that last longer. This area is up near Jensen Beach, Florida. On the Atlantic Beach at Melbourne, a great deal of structural damage to the wooden structures resembles some of the slides you saw this morning. In St. Augustine, there was severe damage along the shoreline. Part of the St. Augustine pier was torn out. That's the one that many of you saw pictured in the newspapers. Erosion has been taking place along this beach. We have an authorized federal project that is in the works. The state just recently commented on it for beach nourishment. It is going to come a little bit too late for David.

Now we are going to look at some before-and-after shots in Duval County. This project was not designed for hurricane protection. There is an 11-foot berm and we think it was overtopped by water elevation of 13 feet, but you can see the soft sand. This is a very nice beach shot. The elevation is 11 feet, and the high water did come over it. In just a second we will see what they did to it. Again, the storm was about 25 miles off the coast when it passed by. After the storm, of course, all the loose sand has been washed away and is pretty well compacted. You can see where all the sea debris was brought up, and right in the center of the screen running right to left, is one of the channels that the water made as the high water came behind the berm and, of course, had to find its way back to sea. That was where the major erosion did occur and it wasn't significant in that it was more a gentle swell normally associated with run off from deep rutted areas.

Back in Miami we had another problem brought about by the storm. The offshore source of sand for Miami Beach contained a high degree of rock, about 5% of the volume. That's been a source of complaint for some time. The contractor removed it from the top foot of the sand, however, the hurricane did move that top foot of sand and displaced it exposing rocks. Now, that brings up two problems for us. First, cleaning up and, second, looking again at the measures we can take so we can get as much of that rock out of the sand as possible before we put it on the beach. One is very costly and the other is a pretty good solution. Using this machine you see on the screen we are able to go down to the depth of about one foot and remove the large rocks and haul them away. We still have a problem offshore, that in the surf zone itself, this machine won't operate. People or bathers going into the water have to contend with the rocks out there. There is a questionable aspect of what we are doing and one that we don't have an economic solution for yet, and that is in how to deal with the rocks that we are getting out of the borrow area. This machine provides a partial answer. There is a lot of coral - in fact, some of these rocks for the rock hunters actually are probably as big a find as some of the shells are for the people that go out and collect shells while we are dredging.

That's a quick look at Dave and the beaches. It's not conclusive what the payback is, and I wouldn't pretend to say that it is. It's an indicator of what the payback is for beach nourishment projects as far as the role they play in protecting the property and the coastline. We feel that severe erosion would have occurred had we had a direct hit with a

hurricane in those places that we had projects. We conjecture that we would have, in fact, prevented major structural damage to those facilities. Aside from the recreational value of putting sand on the beaches, there is a structural and coastal protection component, and storms such as David illustrate that for our consideration. I think it is important, too, though, that we remember, as the costs of fuel oil go up and the cost of dredging increases, there will be continued attention to the economic portion of the nature of beach nourishment, and there aren't any ready answers. I think it is important for us, in view of the public concern over this issue, to keep continually reevaluating this posture, and yet I don't fear that reevaluation process because, for the significant increases of fuel prices to come, the economic return of doing these projects is, in fact, there.

That leads me into a second subject. The two are related. How can we make beach nourishment less expensive? One way is, of course, by using our maintenance projects to put sand on the beach. What I am showing you here is a Corps dredge, the Goethals, which participated in this kind of an activity some time ago. She was tied up to a barge, and from the barge sand was pumped on shore.

Throughout Florida, we have 51 authorized federal navigation projects. These provide almost over a thousand miles of channel which are maintained on an annual basis. Nine of these projects are deep draft harbors. The sand from these projects, as we annually maintain them, can be, in most instances, placed upon the beaches. You probably can't read the figures on the screen, but they are not really that

important other than to say that we have put over 6 million cubic yards of sand on beaches from maintenance dredging projects which represents - compared to the 30 million cubic yards of sand we have put on all of Florida's beaches in the last ten years - approximately one out of every four cubic yards of sand put on the beach comes from a maintenance dredging project. The cost comparison on this is considerable. The increased costs, where increases do occur, or the actual cost to the Corps, in many instances, of taking this material and putting it on the beach rather than dumping out to sea, is about 32¢ a cubic yard. It is going to cost at least $1.91, and some contracts now are up to $2.50 per cubic yard just to do it from scratch for the purpose of beach nourishment. So, there is a compelling economic savings if we can use this maintenance material to put on the beaches.

Well, that brings us to another facet. Now do we go about this? In order to realize the economy of having maintenance dredging spoil - good material for beaches placed on your beach - you first have to have a beach located adjacent to a federal project. Now, that is going to help a lot of folks, and that's going to leave others standing there saying, "OK, so what." Well, the "so what" aspect is that, as we reduce the costs overall to the state and local communities around the state, and we reduce the cost by using maintenance dredging where we can, it does free up monies that are available then for those where we can't address that alternative. It is another way of reallocating the local sponsor's share of the cost and makes more money available to those who can't do this. For those who are benefiting from this, the second feature is that you have to

have in the dredging project material that is suitable to put on the beaches, and that is not always true. There are some places where we have very poor material - primarily silty - that we must dispose of otherwise. And thirdly, the fact that probably is as important as the other two is that, if the cost of putting that material on the beach exceeds the cost of putting it in other disposal areas the local sponsor must pay for that additional cost. He has to pick up the difference. On the federal navigation projects authorized by Congress for maintenance, the Congress does not recognize that as an authorized increased cost to the federal government. We are to dispose of it in those purposes in the most economical manner possible. Congress has, on at lease one occasion that I am familiar with, authorized in the maintenance dredging legislation of putting the material on the beaches at federal cost or on a cost share basis for the whole project. But that is rare, and we can't necessarily count on that. So, we have a unique opportunity in the State of Florida with 51 active, annually maintained projects for maintenance dredging. Putting that material on Florida's beaches is a cheap source of sand, if we can do it. Now, why don't we do it more often? Well, the whys, wheres, and hows on some of that need to be explored. The Department of Natural Resources is our partner in looking at and addressing this issue in Florida. This technology is relatively new. The background is that we didn't get a good start on this because the pipeline dredges which have been doing most of this inlet and channel dredging for us, when they go out in the open waters run into a requirement from the Coast Guard to be certified for operating at sea. Many of the pipeline

dredges in fact can not do that. The Corps, a number of years ago, modified the design of some of our dredges - and our dredges are all ocean-going dredges - so that they would have the direct pump-out capability. This capability permits the dredge to pick up the material, hook up to a barge, and pump sand back on the beaches. The Corps dredges operating out of the Jacksonville District have that capability and are so doing. The split-hull design is another way of looking at putting material, particularly out of some of the shallower areas that we dredge, up on the beaches without pumping it on the beach itself, but coming up on the 10 foot zone, opening a hole, and letting nature through her natural dynamics spread or distribute the sand along the coastline. This aspect has been tested once at St. Augustine, and we are hoping to be able to do more in the future. Working at these things with the Department of Natural Resources we also go into the permitting process that on all maintenance dredging under the Clean Water Act of 1977, the Corps of Engineers must get permits, too. Now for all of you who have been expressing your frustration at the permitting process and many times at me because of our role in giving you permits, let me tell you that we have as tough a time as any of you. As of the first of May, we had requested 14 permits from the State of Florida for maintenance dredging and received two. As of the first of October, we had requested 15 and received six. That essentially eliminated the 1979 fiscal year dredging program in the State of Florida from the maintenance dredging standpoint, and as we carry over almost 20 million dollars into the next fiscal year of work that we did not do because of

permitting problems with the State of Florida, we have a tremendous backlog in this process. So, we have some regulatory problems ourselves in even accomplishing the dredging in the first place let along putting it on your beaches once we do the project. I don't want to leave you in a state of alarm on that, but you have heard Secretary Varn, and I want to say that he has been most cooperative since he has come aboard at DER. We hope - before this month is out - to sign a new memorandum of agreement between the Corps of Engineers and the State of Florida, which will greatly simplify the permitting process as far as the federal government projects are concerned, so that we are not in the position of having DER on maintenance projects asking on behalf of the State of Florida for the money and then turning around and not permitting us to spend it by not giving us the permits when we are ready to do so.

Another point that was brought up this morning that I would like to respond to also was that when we got into looking at putting sand on the beaches, the original rationale for the federal government getting in was not to put sand on the beaches per se, but to recognize the fact that, very often, because of a past policy of navigational priority the groins and jetties that we constructed to protect the harbors and some of the inlets in Florida actually had contributed to the erosion problems adjacent to those projects. Recognizing that the federal government could not afford to assume liability for correcting all of these they did go into a program where they facilitated correction by enabling the districts to put the sand on the beaches as a partial mitigation measure and from that our entire program is developed. The question that I am referring to this

morning is that we have a lot of inlets, and a lot of damage has been done - why not sue the federal government? There are only two inlets in the State of Florida that were created by the federal government. They are Government Cut here in Miami, which was an existing channel that we, in fact improved, and one in St. Augustine where we relocated a new channel adjacent to where an inlet formerly existed. All others were done by local representatives or governments. Therefore, the federal government does not have a liability for those inlets which it did not create, and that's the major reason that you are not getting federal support for the question on mitigation or law suits in those areas. There are many of those that are now federal projects. Congress has recognized that, in the interests of navigation, many of these inlets opened by local sponsors do provide a navigation purpose, and that the federal government, after study, determined there was a benefit to the public for picking these up to be maintained by the Corps on an annual or periodic basis and we have done so. But the original liability then does not transfer to the Corps for picking up subsequent maintenance.

Finally, it is important to note that local governments themselves have had a subsidy from the state in the past on putting this material on the beaches. The local sponsor's share of the increased cost has been reimbursed up to 75% by the State of Florida. If the trend is away from doing that, as Secretary Varn indicated during lunch today, these costs then must be borne solely by the local governments and local sponsors, and that may have a dampening effect in the future. Still, the overriding

economical comparison is that where we can do this, and it is a Corps policy to do so, that you can save approximately 70% by doing it with maintenance dredge material compared to having a separate project for it. The second advantage is the savings in time. When we can do it, that is, as opposed to a federal project, we stay out of the annual project-by-project funding process in the Congress, and we can be more responsive to you.

In summary, David has demonstrated the value of storm protection to the beaches. First, it suggests that there is an economic payback to the property and the coastline by having nourishment projects. It does not address the recreation value of the beaches per se. Secondly, we have a technology that we have developed over the past 10 years which is now ready to make itself available to the State by putting vast amounts of material on your beaches from maintenance dredging projects. This year alone we will put from 2 to 4 million cubic yards of material from maintenance dredging on the beaches of Florida. Remember, up to now we have put on a total of 6 million. We are going to almost double the amount that we have done from that source.

This completes my presentation. Do you have any questions?

BARRIER ISLANDS AND BEACHES OF FLORIDA: UNIQUE RESOURCES, PROBLEMS AND PROSPECTS

Dinesh C. Sharma
Environmental Resources Consultant
2750 Rhode Island Avenue
Fort Myers, Florida

BARRIER ISLANDS AND BEACHES OF FLORIDA:

UNIQUE RESOURCES, PROBLEMS AND PROSPECTS

by

Dinesh C. Sharma

ABSTRACT

From Amelia Island in the northeast to Perdido Key in the panhandle, the Florida coast is lined with low-lying barrier islands and beaches. These are highly dynamic and fragile land forms constantly adjusting to sea level changes, ocean waves, tides and winds. They protect the state bays, estuaries and mainland from direct ocean waves and storm attacks and provide habitat for fish, shellfish, wildlife and recreational use. There are 80 barrier island units in Florida--more than any other state in the nation--comprising an area of 467,700 acres with 790 miles of sandy beaches. Incompatible and unsafe urbanization of these islands and beaches is endangering lives and properties, closing public access to the beaches, and adversely affecting the functioning of island and estuarine resources. This paper describes the extent, nature and dynamics of Florida's barrier islands, major problems and issues affecting their use and conservation, and outlines ten recommendations for their wise use and management in the 1980's.

INTRODUCTION

The basic premise of this paper is that barrier islands, beaches and coastal floodplains are highly dynamic, vulnerable and fragile resources and should be treated with the utmost care if we are to minimize losses to lives and property from incompatible urbanization. The management of barrier islands and beaches must have a fundamental goal of conservation, i.e., wise use of the island ecosystems at the highest achievable carrying capacity for human and other uses and enjoyments (Clark, 1977). The first priority in coastal hazard mitigation should be public acquisition of the remaining undeveloped and available barrier islands to meet our recreational and conservation needs and to minimize future losses from hurricane and erosion hazards in these areas. Some barrier island systems can be maintained at a high level of health and productivity while urbanization may be permitted, provided there is effective planning. With effective planning, trade-offs can be accomplished without serious penalties by utilizing innovative growth management programs. However, planning and goal-setting are essential for proper island use and management and island and beach communities should not wait for federal big brothers or state bureaucracies to take the initiative or force the action. Failure to deal with natural hazards on barrier islands and beaches at the local level will lead to enormous losses to lives and property and cause severe economic disruption of the communities. Federal and state governments need to re-evaluate their programs which increase hazards to lives and property and are inconsistent with the sound fiscal and environmental policies and intents of the existing laws.

Environmental Resources Consultant and Southeastern States Coordinator of the Barrier Islands Coalition, 2750 Rhode Island Ave., Fort Myers, Florida 33901.

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BARRIER ISLANDS: A UNIQUE RESOURCE

From Massachusetts to Texas, the United States coast is lined with low-lying barrier islands and barrier spits. These are long, narrow, unconsolidated and highly dynamic land forms. Barrier islands are periodically flooded, overwashed and breached during hurricanes and winter storms. Islands are constantly eroding, accreting, migrating and adjusting in response to short-term and long-term oceanic and atmospheric processes. Barrier islands protect the mainland, bays and estuaries from direct ocean waves and storm attacks by acting as energy barriers and dissipators, therefore, the name "barrier" islands. These islands are the main reason we have productive estuaries and bays where fresh water from the inland river mixes with the salt water from the ocean providing a unique salinity and nutrient balance for a multitude of salt marsh grasses, mangroves, finfish, shellfish and wildlife. In many coastal communites islands' beaches and estuarine fisheries are the main economic base for income and employment. This is especially true in Florida where most of the state's tourists visit the beaches and fishing areas, and where commercial fishing is an important industry (Bell, 1979).

In the continental United States, there are about 300 barrier islands and spits covering an area of 1,658,700 acres. Florida has 80 of these islands--more than any other state--comprising an area of 467,700 acres with 790 miles of sandy beaches (BIWG, 1979). From Amelia Island in the northeast to Perdido Key in the panhandle, Florida's barrier islands range in size from a few acres to 58,000 acres at Shark Point in Monroe County, and from a few miles in length to 39 miles long at Cocoa Beach in Brevard County. However, most of the barrier islands and barrier spits are 1-3,000 acres in size, 5-8 miles long, and less than half-a-mile wide. The status of the barrier islands ranges from highly urbanized Miami Beach to protected St. Vincent Island and from well-planned and managed Sanibel to cluttered Cocoa Beach and Estero Island. Most other islands fall somewhere in between. Meritt Island Wildlife Refuge and Cape Canaveral National Seashore harbor more endangered and threatened species in their habitat than any other wildlife refuge or seashore in the continental United States(National Geographic, 1979) Table 1, shows status of U.S. barrier islands.

BARRIER ISLANDS: ORIGIN

No two barrier island chains are the same; they evolve in different ways and at different rates. The type of barrier islands in a given area reflect complex geological history and atmospheric and oceanic processes. Table 2 summarizes the origin of U.S. barrier islands by various geologic processes.

Along much of the southeast Atlantic and Gulf coasts, including Florida, barrier islands owe their existence to changes in the sea level. The last Pleistocene glacial age, Wisconsin glaciation, began about 35,000 years ago and ended about 15,000 years ago. At the end of the Wisconsin, the sea level was about 135 meters (400 feet) below its present level and the shoreline was 75 to 200 miles seaward of the present shoreline (Emery, 1969; Fairbridge, 1974). As the earth warmed, the ice caps melted and the

sea level rose at the rapid rate of 1 meter per century, until about 4-5,000 years ago (Emery, 1969). Since then, the earth has been warming slowly and the sea level is continuing to rise at the rate of about 12 to 92 centimeters per century on the Atlantic and Gulf coasts, with an average rise of 33 centimeters per century (Hicks, 1973). If the two remaining polar ice caps were to melt altogether, the sea level would rise an additional 70-80 meters and would inundate most of the low-lying coastal areas (Bloom, 1971; Tanner, 1977).

This rise in sea level is one of the major factors in the formation and migration of the barrier islands of Florida. The rising sea level affects the coast in three ways: (a) it pushes the shoreline landward leading to an "apparent" shoreline recession, commonly known as shore erosion. The recession rates are greater on the more gentle slopes and affect the estuarine as well as the oceanic shoreline; (b) the sea level rise combined with periodic storms cause overwash and landward movement of the entire barrier island. Geologists and oceanographers call this phenomenon "island retreat", "island migration" or "island roll-over". Most people call this a disaster or nuisance; and (c) sand is lost from the upper beach to maintain an equilibrium on the offshore bottom profile. Unless sand is replenished from other sources to compensate for the losses, like sand from river deposits or longshore drift, the net result is shoreline erosion.

As the sea level rise slowed down 4-5,000 years ago, waves, currents and winds working together on surplus sands brought by the rivers formed dune ridges and spits parallel to the ancient shorelines. Continued slow rise in sea level and periodic storms caused breakthrough of these ridges and spits, flooding the low mainland behind them, thus forming the lagoons and leaving the ridges and spits isolated as barrier islands. The Gulf coast barrier islands are frequently associated with the estuarine systems such as Charlotte Harbor, Tampa Bay, Apalachicola Bay, Pensacola Bay, etc. Evidence indicates that these estuaries were once river mouths which became inundated by the sea level rise (Riggs, 1977). Sediments for the formation of barrier islands were provided by inland rivers, coastal headlands, and the formerly exposed continental shelf.

Sea level rise is expected to continue in the foreseeable future and coastal citizens, planners, engineers and decision-makers must understand and take it into account for wise use of the barrier islands and beaches so that losses to resources and properties are minimized.

BARRIER ISLANDS: DYNAMIC INTERRELATIONSHIPS

Irrespective of the manner in which a barrier island or a beach is formed, there are certain physical and biological components and interrelationships that are common to the island and between the islands. These components can be grouped into four broad categories (Figure 1).

(1) Sand-sharing System, includes off-shore sand bars, beach, berm and dune, as well as inlet and longshore currents. These are

highly unstable and interrelated components constantly adjusting in response to the oceanic and atmospheric forces. Depending upon the local geologic setting, some barrier islands may have well-developed dune systems while others have none. Beaches and dunes are colonized and stabilized by drought resistant and salt-tolerant pioneer vegetation like beach grasses, sea oats and other species. They are the habitat of many species of sea turtles, rare birds and other wildlife.

(2) Barrier Flats or Uplands consist of areas between the berm or dune and salt marsh and include fresh water wetlands, ponds, sloughs, rivers and shallow aquifers. They have more mature vegetation that may range from a few grasses and shrubs to majestic oak and pine forests. This area provides habitat for many species of wildlife and water supplies for human use. This is the most stable and safe (relatively speaking) area for limited habitation on the barrier islands. Old-timers built their dwellings on these uplands which were closer to the marsh than to the beach.

(3) Salt Marshes on the landward or bay side of the island are subject to constant flooding by daily and seasonal tides. Salt marshes border the waters of the bay, lagoon or estuaries and may consist of various species of marsh grass, mangroves or submerged grasses. Salt marshes and estuaries are the most productive ecosystem on the earth providing food and nurseries to more than 70% of the coastal fish and shellfish and hundreds of wildlife species. (Clark, 1977)

(4) Upland Rivers provide fresh water, nutrient and sediment input to the estuaries and barrier beaches. The rhythmic fluctuations of the river's flow control the salinity balance, nutrient levels and productivity of the estuaries and the health of the barrier beaches. Excessive pollution loads or impoundments on the rivers adversely affect the productivity of the estuarine areas or sand supplies to the beaches.

It is imperative to recognize that all these components are physically, biologically and functionally interlinked in a complex web of relationships. Thoughtless or shortsighted destruction of any one component may adversely affect all other components. In addition, there are close interrelationships among the islands along the coast mainly affected by the longshore currents. Therefore, any barrier island and beach development and conservation must be carefully assessed for its impact on all the components and on the downdrift islands. If we recognize that the barrier islands and beaches are highly unstable and are not the same as the interior mainland, we can begin to use and conserve them while minimizing future hazards and losses to resources, properties and lives.

MAJOR PROBLEMS AND ISSUES

Population Growth

During the last three decades, the population within the narrow coastal zone has been growing three to four times faster than the national average. Florida's population exploded from 2,771,305 in 1950 to 8,717,334 by 1977. This growth has been primarily concentrated in coastal areas. With only 28% of the state's total land area, the coastal zone contains over 78% of the state's population and 12 of the 16 urban Standard Metropolitan Statistical Areas. This population growth is expected to reach 13-14 million by the year 2000 (Florida Statistical Abstract, 1978).

While the positive attributes of the coast, such as sun, surf, beach, blue waters, fishing and carefree living have been oversold, the hazards have been underemphasized. More than 80% of the people moving to the coast are not aware of the hazards of hurricanes and winter storms. (Frank, 1979). Typical grid-pattern subdivisions with 10-20 units per acre, with inappropriate engineering designs, totally unsuited to coastal hazards, have been built. Table 3 shows the growth of population and assessed values of residential and commercial properties on the selected barrier islands in Lee County, Florida and Galveston County, Texas. It should be noted that these property values have not been corrected for inflation. Hurricane Donna struck Lee County in 1960, inflicting $16.5 million in property damages, and hurricane Carla struck Galveston County in 1961, inflicting $29 million in property damages. If similar hurricanes strike these areas again, the losses will be in the hundreds of millions due to the increased number of properties built with inadequate building codes on the barrier islands. These growth figures are just mind boggling!

Hurricane Hazards and Losses

During the last twenty-five years, losses to properties from major hurricanes have been increasing. Table 4 summarizes these losses. Between 1926-1978, Florida suffered $1.45 billion in property damages from hurricanes (Sharma, 1977). During 1979, hurricanes Claudette, David and Frederick hit the U.S. coastline and inflicted heavy damages. Preliminary estimates indicate that the losses could exceed $500 million from David and $1.5 billion from Frederick. Hurricane Frederick destroyed all the residential and commercial structures on Dauphin Island and Ft. Morgan peninsula. These communities met all the requirements of the National Flood Insurance Program (NFIP) and were regular participants under the NFIP. The existing building standards under the NFIP are inadequate to withstand hurricane winds, wave heights, storm surge and scouring (Sharma, 1979a, 1979b). Dauphin Island was overwashed and breached in two places making it into three islands and the causeway from the mainland was destroyed along most of its 6-mile length.

Erosion Hazards

Barrier islands and beaches, by their nature, are highly unstable and constantly changing land forms. Generally, beaches are wider in the summer and narrower in the winter, accreting in one place and eroding in an other. During winter storms or hurricanes, beaches could be severely eroded. Post-

storm recovery is possible but generally it is only partial. In addition to these short-term phenomenon, the long-term sea level rise is causing 1 to 3 feet of natural beach erosion along Florida's coastline. The erosion rates are more intensive near the inlets where it may be 10-70 feet per year (Walton, 1977).

According to the Beach and Inlet Task Force Report (1978), 238 miles of Florida's sandy beaches are facing critical erosion. All of this eroding shoreline is located in urbanized areas of the coast where buildings are poorly designed and improperly located too close to the beach. The Beach and Inlet Task Force Report recommends beach nourishment or other structural solutions to "control" the critical erosion. It has been estimated that typically each mile of restored beach cost $1 million or more initially with a maintenance cost of $25,000 or more per year per mile. The Miami Beach nourishment project will cost in excess of $62 million for 10.5 miles of beach (Adams, 1978). The cost of beach nourishment is likely to increase in the future as labor and material costs increase. We must find non-structural solutions to mitigate erosion hazards and losses.

Beach Access and Hazard Mitigation

Florida has taken a two-pronged approach to provide public access to its beaches and to minimize erosion losses. The state appears to have one of the most extensive programs in the nation for protecting barrier islands and sensitive areas for public recreational uses. Florida has 212,110 acres of its barrier islands protected under two national seashores, eleven national wildlife refuges, nineteen state parks and preserves and several private, local and county parks. However, public beaches near our urban areas are very inadequate, overcrowded and in poor condition. Much more vigorous acquisition efforts are needed to meet the current and future needs.

In order to minimize potential loss to properties from incompatible development and erosion and to protect public access to sandy beaches, the Legislature passed a Coastal Construction Setback Line Law in 1971. All counties, except Dade, Broward and portions of Franklin, have established and adopted the coastal construction control lines (CCCL), seaward of which no construction is permitted unless approved by the County and the State. Table 5 shows the status of the CCCL in Florida. The enforcement of these lines has been a major problem. Between 1972-79, 1,413 applications for variances--mostly to build seaward of the CCCL--were submitted to the state. The state granted 1,050 variances and denied only 7. In many cases some modifications were made by the applicants to meet the state requirements. However, on the whole, the record of enforcement has been poor. Such variances cause loss of public beaches and increase potential hazards to properties from erosion and hurricanes.

Disaster Planning and Evacuation

In addition to these hazards and losses, there are serious problems of hurricane evacuation and disaster preparedness. There have been few comprehensive studies conducted to assess the magnitude of the problem in Florida. Most people know very little about the actual behavior and mechanics of hurricanes, tend to under-estimate their devastating effects, and view the odds of one striking their coast as remote and hypothetical (Levy and Smith, 1978).

The Lee County Flood Emergency Evacuation Plan (SWFRPC, 1979) is the only known quantitative study on hurricane-flood evacuation in Florida. The findings and conclusions of this study are alarming. The heavy concentration of population on the barrier islands and in the coastal flood hazard zone, in combination with low topography, inadequate road systems (low elevation, limited lanes, vulnerable bridges), insufficient time to evacuate under the warning system, and lack of coordination between various agencies, would not permit the evacuation of large numbers of people to safer places even if they were willing to evacuate.

In recent years, there has been some discussion of vertical evacuation, i.e. putting people in the safe high-rise buildings during hurricane storms (Miami Federal Executive Board, 1973; Frank, 1979). The concept of vertical evacuation is contrary to the natural dynamics and carrying capacity of the barrier islands resources and hazards. Unless questions of building codes, enforcement of those codes and liability in case of failure are resolved, the vertical evacuation is a pipe dream. We must realize that the barrier islands have certain limitations and if we, as a nation, are to minimize future losses to lives and properties, high density development on the barrier islands is not the solution to our problem. During hurricanes David and Frederick, the evacuation from the barrier islands and beaches was more effective than had been feared by the planners. An intensive public education campaign about the hazards of coastal living and quantitative disaster evacuation planning studies are urgently needed.

Lack of Consistency in Federal, State and Local Programs

Coastal hazard mitigation has not been addressed by local, state and federal government in any comprehensive manner. We continue to build Panama Cities as though they were Kansas Cities. Publicly funded capital improvement projects treat the barrier islands and coastal flood hazard areas the same as if they were located in the interior mainland. The 1963 construction of the Sanibel Causeway, mostly on fill, destroyed scallop beds yielding $1.5-$2 million annually. in Pine Island Sound. If the bridge were built on pilings, allowing free flow and mixing of waters and nutrients, we would still have commercial scallop beds. Our habit of subdividing and building 10-20 units per acre on barrier islands, such as St. George Island, has caused severe pollution problems to the Apalachicola Bay oyster industry. Although a tax-subsidized causeway and water supply was provided to the island, there is no sewer system. Each lot has its own septic system and with permeable sandy soils or wet soils, septic systems do not function well when the carrying capacity is exceeded.

Recognizing the problems of federal inconsistencies, President Jimmy Carter, in his environmental message to Congress on May 23, 1977, stated:

> "....Most of the barrier islands are privately owned. They are targets of intense real estate and development activity. The development of these resources has often been encouraged by federally permitted or subsidized roads, bridges, and sewers, with the result that millions of people have been subjected to the hazards of hurricanes and to property losses from the erosion and

other physical changes that are characteristic to barrier formations. These hazards and abuses have, in turn, invited substantial federal spending for seawalls....and beach restoration projects that perpetuate more settlement and then more federal investment, while causing the continuous loss of valuable and unique resources...."

There are similar problems at the state and local levels where resources are sacrificed and hazards increased in the name of growth and increased tax revenues. For example, since the construction of Sanibel Causeway in 1963, $24-$30 million (1963 price) was lost in revenues from scallop harvesting. In 1979, Sanibel's total budget is $1.735 million of which $934,783 will be provided by local property taxes. The existing bridge is not capable of evacuating the 5-6,000 residents of the island in the event of hurricane warning. In the haste of development, we have lost more than gained and have created more problems than we have solved. With proper planning and consideration, such losses and hazards can be minimized.

RECENT TRENDS AND FUTURE PROSPECTS

Recognizing the values and problems with the development of barrier islands, President Jimmy Carter included a special message on coastal barrier islands in the environmental message to Congress on May 23, 1977 and directed the Secretary of the Interior "to develop an effective plan for protecting the remaining undeveloped islands" from unwise development. The Secretary of the Interior has established an interagency and citizen-represented barrier island work group within the Department. The work group has been working in close cooperation and consultation with various federal agencies and is planning to release a Draft Environmental Impact Statement for public comments in November of 1979. It is very likely that this Draft EIS will recommend significant changes in federal policies and programs for coastal hazard mitigations on the barrier islands and beaches. Specifically, it may impact HUD's National Flood Insurance Program, Federal Emergency Management Agency's post-disaster assistance programs, EPA's water, sewer and solid waste programs, DOT's bridge and road programs, and Corps of Engineers' erosion control and inlet maintenance programs. The Interior's National Seashore and Wildlife Refuge programs may be expanded and strengthened.

In his second environmental message to Congress on August 2, 1979, President Carter again emphasized the problems of the coastal zone and barrier islands' resources and directed the Secretary of Commerce, through the National Oceanic and Atmospheric Administration, to conduct a detailed study of federal programs and their consistencies for protection and development of the coastal resources and high hazard area. The findings and recommendations of this study would be submitted within one year.

Possible adjustments to coastal hazards may range from wholly non-structural to total structural solutions; from strict preservation of the natural resources to uncontrolled and unsafe development; from complete withdrawal of funds from publicly-funded projects to total government apathy and a status quo. Such extremes are unnecessary and undesirable. Strategies which combine public acquisition of undeveloped and available barrier islands and

beaches and land-use planning, zoning and improved building-structural codes on developed or developing areas which permit wise use and safe development would be more acceptable as well as desirable. In the present context, the initial approach to mitigate the coastal high hazards on barrier islands and beaches may include, but should not be limited, to:

(1) Inventory and analysis of the natural and cultural resources and delineation of critically sensitive, unique, hazardous and available areas for earliest possible public acquisition for recreation, preservation and hazard mitigation.

(2) Assessment of risk to life and property for 100-year and 500-year natural events at various population and growth levels; carrying capacity and life cycle fiscal impact analysis of growth in all coastal high hazard areas.

(3) Adoption of appropriate land uses, densities and building setback lines landward of the full primary dunes, berms, mature pioneer vegetation and all freshwater and saltwater wetlands on urbanizing islands and beaches. They must also take into account the natural sea level rise and erosion rates. Multiple setback zones to provide hurricane, flood, erosion, pollution hazard mitigation, and adequate public beach access are preferred over single arbitrarily defined setback lines (Sharma, 1979a).

(4) Dredging and filling of all wetlands and estuaries should be absolutely prohibited, because this nation has already lost more than 40% of its freshwater wetlands and more than 73% of the estuarine areas to destructive human activities (Council on Environmental Quality, 1978; National Estuary Study, 1970).

(5) Establishment of hurricane resistant building codes which incorporate horizontal and vertical impacts of hurricane surge, wave uprush, scour and winds (Figure2). Since we cannot control or modify hurricanes, we must build safer structures, specially suited to the coastal high hazard areas.

(6) Public capital improvement projects such as roads, bridges, water and sewers should recognize the high risk in the coastal hazard areas and federal and state governments should effectively prohibit and discourage direct or indirect expenditures of public funds. Where necessary, all major roads and bridges should be built above 100-year flood levels.

(7) Development of comprehensive hurricane evacuation plans which identify evacuation routes, shelters and coordinating agencies. Lee County's evacuation plan could serve as a model.

(8) Non-structural solutions for erosion control must be used to maximum possible extent. Relocation of public facilities and buildings to safe areas under post-disaster programs and beach nourishment for erosion mitigation are preferred alternatives. However, relocation has not been evaluated by any federal or state agency in a systematic manner, but offers a unique opportunity in the wake of hurricane Frederick.

(9) Provide additional warning to prospective buyers of properties located on barrier islands and hurricane hazard zones that "this property is likely to be flooded or destroyed from hurricane winds, storm surge and scouring". Such a warning can be incorporated in the National Flood Insurance Program's existing floodplain warnings program.

(10) Public information and education programs to improve the general understanding of the nature of barrier islands and coastal high hazard zones and the risks and benefits associated with alternative and wise uses of these resources. Public education programs of the Texas Coastal and Marine Council and the Barrier Islands Coalition provide the prototype for Florida and other states.

Some of the ongoing federal and state programs reflect the recognition of these problems and have already begun to address them. The National Flood Insurance Administration, Office of Coastal Zone Management, Federal Emergency Management Agency and the Department of the Interior's recent actions and programs recognize the dynamic, fragile and vulnerable nature of the island and beach resources (BIWG, 1979). These agencies and others are in the process of improving their programs and policies for hazard mitigation in the coastal barrier islands, beaches and estuarine areas because this nation cannot afford to lose valuable resources and increase losses of lives and properties from incompatible development. Public hazard awareness programs developed in Texas and local island growth management plans developed for Sanibel and Gasparilla Islands are examples of the future directions in hazard mitigation and island planning. Table 6 shows hazard mitigation efforts in several coastal communities.

CONCLUSIONS

During the 1960's and 1970's, scientific research, landmark environmental laws and the environmental impact analysis process have improved our understanding of the physical nature, biological productivity and economic and environmental benefits and hazards of coastal resources and development. Significant progress has been made in developing improved methods of coastal hazard mitigation and planning. Interdisciplinary scientific information, including physical, biological, economic and institutional aspects of coastal hazard mitigation, are available. However, this information is yet to be applied on any significant scale. The decade of the 1980's is likely to witness further research in coastal processes; assessment of risks from hazards; analysis of wind, storm surges and wave heights; application of relocation and non-structural solutions; and simplification and rigorous enforcement of the existing laws, rules and regulations to mitigate hurricane and erosion damages in the coastal floodplains. The success of any program will depend upon increased public education and awareness that the barrier islands and beaches

are not the same as the interior mainlands. Lack of comprehensive policies and programs to address the coastal hazard mitigation in the 1980's will give a new meaning to the term "natural disaster".

ACKNOWLEDGMENT

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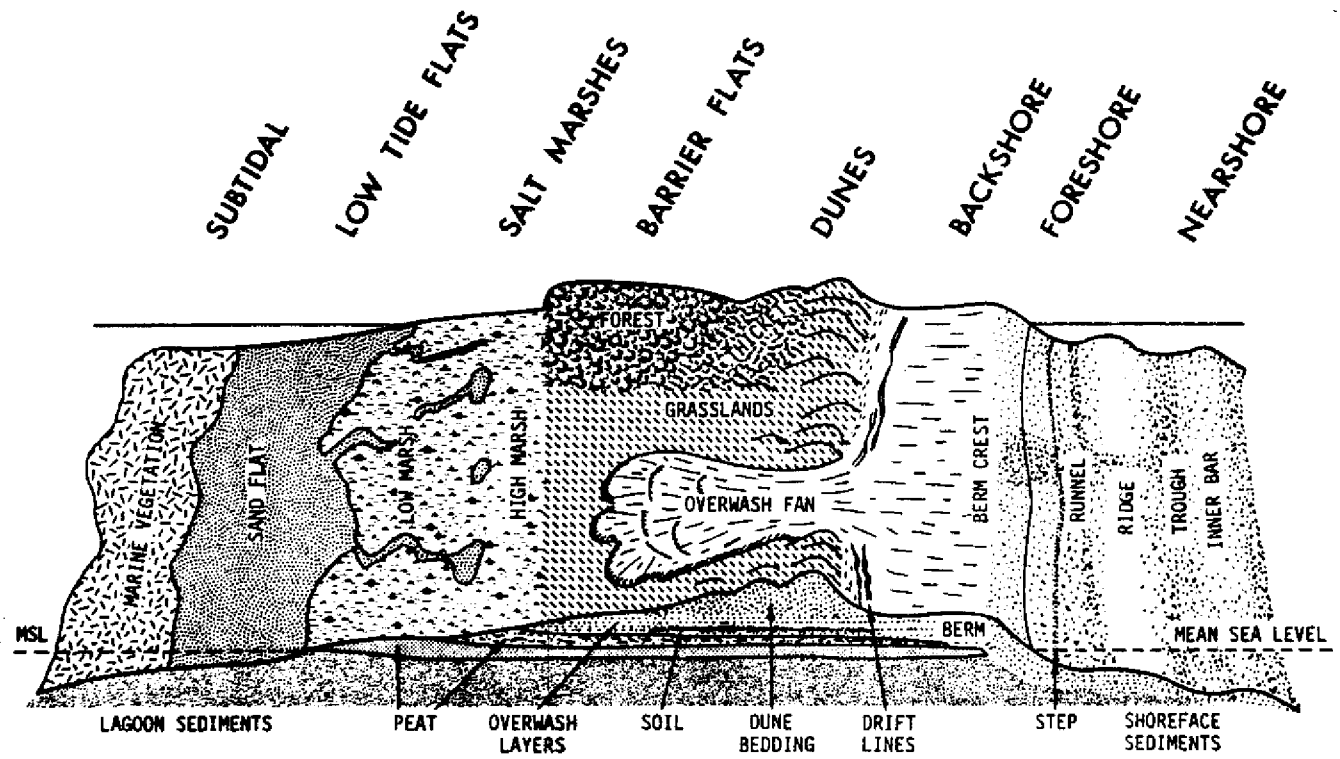

FIGURE 1

BARRIER ISLAND ECOSYSTEMS AND INTERRELATIONSHIPS
(Source: Godfrey in BIWG, 1979)

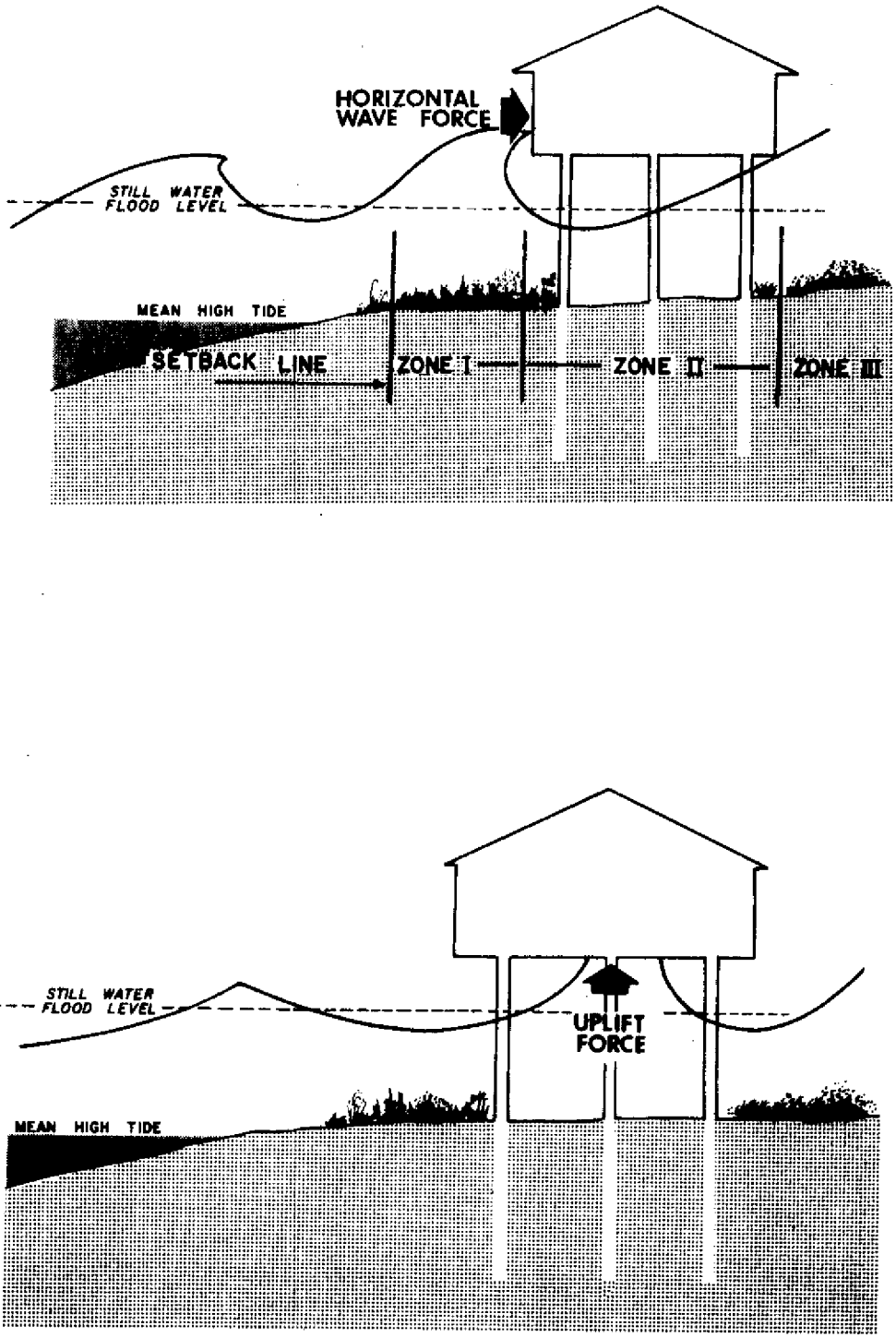

FIGURE 2

BASIC ELEMENTS OF BARRIER ISLAND COASTAL CONSTRUCTION CODES, LEE COUNTY, FLORIDA
(Source: Sharma, 1979a)

TABLE 1

STATUS OF THE BARRIER ISLANDS OF THE UNITED STATES

State	Number of Islands	Total Acres	Fed. Mgmnt- # of Acres	State Mgmnt.	Other Public Mgmnt.	Private Mgmnt.	# of Acres Developed 1950	# of Acres Developed Present	# of Acres Protected	# of Acres Undeveloped/ Unprotected
Alabama	5	28200	-	1200	100	26900	-	5200	1300	21700
Connecticut	14	2362	-	1417	215	730	264	678	1398	286
Delaware	2	10100	1000	2000	100	7000	1507	2900	3100	4100
Florida	80	467710	212110	32900	7575	215125	32423	103405	233735	130570
Georgia	15	165600	36100	44800	3100	81600	5161	8700	71000	85900
Louisiana	18	41120	7600	1600	500	31420	1651	3980	9650	27490
Maine	9	2640	60	710	110	1760	593	1640	760	240
Maryland	2	14300	9900	700	200	3500	820	2400	10500	1400
Massachusetts	27	37600	12875	2550	5025	17150	4519	8390	19580	9630
Mississippi	5	9500	6200	-	-	3300	-	200	6100	3200
New Hampshire	2	1100	-	200	200	700	467	700	100	300
New Jersey	10	48000	3800	3500	3500	37200	17746	22700	9600	15700
New York	15	30310	2650	4400	5270	17990	8140	11700	12260	6350
North Carolina	23	146400	45400	12100	100	88800	5862	23700	57100	65600
Rhode Island	6	3660	-	550	300	2810	773	1360	850	1450
South Carolina	35	144150	11125	27350	100	105575	1654	20525	38725	84900
Texas	16	383500	72600	39700	3000	268200	9246	22850	120200	240450
Virginia	11	68900	17350	1400	10	50140	-	1350	28660	38890
TOTALS	295	1605152	438770	177077	29405	959900	90826	242378	624618	738156

Source: A Plan for Protecting the Barrier Islands (1979).

TABLE 2

ORIGIN OF BARRIER ISLANDS AND SPITS

Major Theories	Major Processes	Examples
Erosion of Glacial Deposits and the Subsequent Formation of Elongated Spits as a Result of Littoral Currents	Glacial deposits erode and elongated spits result from littoral currents. As a spit lengthens across either open water or along the front of an indented mainland region, the spit may become quite narrow. If it is breached by an inlet, then an island will form.	Monomoy, MA Fire Island, NY Northeastern Coast
	Spits may also end up with both ends attached to the mainland. Such barriers are called bay barriers.	Martha's Vineyard, MA Nantucket, MA Rhode Island shoreline
Drowned Beach Theory	The sea level rises along the mainland coast causing dune ridges to form. As a sea level continues to rise, it breaks through the dune ridge, floods the mainland area behind it, and creates a lagoon.	Southeastern and Gulf Coast Miami Beach, FL Cape Canaveral, FL
Coastal Plain Remnants	Pleistocene uplands cut off from the mainland by the submergence of low areas and isolated form these islands. Often they have modern or Holocene barrier beaches.	Cumberland, GA Sapelo Island, GA
Barrier Islands formed by Rivers	Created from riverine sediments deposited at the mouths of major rivers that deposit large amounts of sediment in the ocean. The waves erode the deltaic deposits, especially as sea level rises, creating spits and islands.	Cape Romain Area Mississippi Delta Area Southeastern Coast Sanibel Island, FL St. Vincent Island, FL
	Are also found at large river mouths that do not have river deltas but where the ocean is quite deep.	Small's Point, ME Popham Beach, ME Reid State Park, ME
Chenier-like Barriers	Often related to the various stages of sea level change and storm floods. They have long narrow, almost parallel beach ridges deposited on the marshes when storm surges push materials from the shoreline back across the marsh leaving a deposit on the marsh surface. Sand may blow in on top of these ridges and create higher features called dune ridges. Sea recedes leaving a series of beaches that will be submerged again when the sea rises.	St. Phillip's Island, SC

Source: Modified after Paul Godfrey, In A Plan for Protecting the Barrier Islands (1979).

TABLE 3

INCREASE IN ASSESSED PROPERTY VALUES

ON SELECTED BARRIER ISLANDS

SINCE LAST MAJOR HURRICANE STRUCK THESE COUNTIES

Barrier Island Population	Assessed Property Values		Percent Increase
	At Time of Hurricane	Current	
Lee County, Florida	1960 (1)	1978 (2)	
County Population: (DONNA)	54,539	180,700	331
Captiva Island	$ 2,191,290	39,991,320	1,825
Estero Island (Ft. Myers Beach)	17,868,700	184,144,570	1,030
Gasparilla Island (Boca Grande)	4,698,690	37,246,980	793
Sanibel Island	4,870,750	148,735,580	5,107
Galveston County, Texas	1961 (3)	1977 (3)	
County Population: (CARLA)	140,364	197,759	41
Galveston Island City	131,675,741	820,445,768	623
Galveston County	240,825,990	1,102,194,139	477

Sources: (1) Compiled by Dinesh C. Sharma from the Lee County Tax Assessment Record for 1960.

(2) Mr. Jack Board, Deputy Property Appraiser, Lee County, Ft. Myers, Florida. Letter dated August 2, 1979.

(3) Mrs. Estella Aldape, Asst. Tax Assessor and Collector, City of Galveston, Texas. Personal Communication September 5, 1978.

TABLE 4

DAMAGES AND DEATHS FROM MAJOR HURRICANES IN THE UNITED STATES: 1954 - 1978

NAME OF HURRICANE	TIME MONTH - YEAR	DAMAGES (MILLIONS)	DEATHS (NUMBER)	REGION OF LOSSES
CAROL	SEP 54	$456	60	NORTHEAST
HAZEL	OCT 54	232	94	SOUTHEAST
DIANE	AUG 55	832	180	NORTHEAST
AUDREY	JUN 56	150	556	SOUTHEAST
DONNA	SEP 60	360	13	SOUTHEAST
CARLA	SEP 61	431	46	SOUTHCENTRAL
THE GREAT ATLANTIC STORM	MAR 62	245	33	NORTHEAST
BETSY	SEP 65	1,420	81	SOUTHEAST
BEULAH	SEP 67	169	44	SOUTHCENTRAL
CAMILLE	AUG 69	1,421	256	SOUTHCENTRAL
CELIA	JUL 70	440	13	SOUTHCENTRAL
AGNES	JUN 72	3,000 (EST)	122	NORTHEAST
CARMEN	SEP 74	107	5	SOUTHCENTRAL
ELOISE	SEP 75	229	0	SOUTHEAST
BLIZZARD OF 78	FEB 78	1,087	29	NORTHEAST

DINESH C. SHARMA - RNC

SOURCES:
1. DACY AND KUNREUTHER (1969), THE ECONOMICS OF NATURAL DISASTERS, YEARS 1954 - 1965
2. U.S. ARMY CORPS OF ENGINEERS, HURRICANE REPORTS, 1966 - 1978
3. PLATTE, R. AND McMILLAN, G. (1978), THE COASTAL FLOODING IN MASSACHUSETTS DURING FEBRUARY 1978

TABLE 5

THE STATUS OF IMPLEMENTATION OF THE

CCCL IN FLORIDA, JULY 1979

Year	Counties with Established CCCL	Miles of Coastline	Fiscal Year	Number of Variances by Fiscal Year		
				Reviewed	Granted	Denied
			1970-72	31	12	0
1972	Martin	22				
	St. Lucie	+22				
			1972-73	45	27	0
1973	Flagler	18				
	Volusia	+46				
			1973-74	86	62	0
1974	St. Johns	41				
	Collier	28				
	Bay	28				
	Franklin (partial)	+30				
			1974-75	88	69	0
1975	Brevard	40				
	Walton	25				
	Gulf	30				
	Indian River	+22				
			1975-76	131	71	1
1976	Duval	13				
	Escambia/Santa Rosa	41				
	Nassau	13				
	Okaloosa	+ 6				
			1976-77	260	185	1
1977	Charlotte	14				
	Manatee	14				
	Lee	+44				
			1977-78	175	170	1
1978	Sarasota	35				
			1978-79	243	205	4
1979	Palm Beach	45				
	Pinellas	35				
	Okaloosa	4				
Subtotal		619				
Counties Pending CCCL						
	Franklin (partial)	17				
	Broward	24				
	Dade	+21				
25 Total Counties		681		1444	1062	7

Sources: (1) S. M. Rogers, Jr., Personal Communication and letter dated January 10, 1978. Bureau of Beaches and Shoes, DNR, Tallahassee.
(2) R. White, Personal Communication, September 3, 1979. Bureau of Beaches and Shores, DNR, Tallahassee.

Many applications not granted within the Fiscal Year are considered in the next Fiscal. The remaining applications are either withdrawn by the applicant or resubmitted after modifications mandated by the DNR.

TABLE 6

COASTAL HAZARD MITIGATION IN COUNTY AND LOCAL BARRIER ISLAND PLANS

	COMPREHENSIVE PLAN	PROTECTION OF CRITICAL RESOURCES	CARRYING CAPACITY ANALYSIS	FISCAL IMPACT ANALYSIS	BEACH & DUNE EROSION MITIGATION	HURRICANE - PROOF BUILDING CODES	HURRICANE EVACUATION
FLORIDA							
Brevard County	Y	P	-	-	Y	P	-
*Collier County	Y	Y	-	P	Y	-	-
Gasparilla Island	Y	Y	Y	Y	Y	Y	Y
*Sanibel Island	Y	Y	Y	Y	Y	Y	Y
Lee County	-	-	P	-	Y	Y	Y
*Longboat Key	Y	P	P	P	Y	Y	P
Perdido Key	Y	Y	P	P	Y	P	P
GEORGIA							
St. Simon & Sea Islands	P	Y	-	-	Y	-	-
*Jykll Island (State)	P	P	-	P	-	-	-
Little Cumberland Island (Private)	-	Y	Y	-	Y	Y	-
TEXAS							
Galveston Island	P	P	P	-	Y	P	P
SOUTH CAROLINA							
St. Phillips Island	Y	Y	Y	Y	Y	-	-
*Kiawah Island (Private)	Y	Y	Y	Y	Y	Y	-

Explanations: Y - Yes
P - Partial
* - Adopted and Implemented

NATIONAL FLOOD INSURANCE PROGRAM

Richard W. Krimm
Acting Assistant Administrator
Office of Program Analysis and Studies
Federal Insurance Administration

I would like to thank Mr. Stan Tait for extending the invitation to address you this morning on the National Flood Insurance Program. The flood insurance program, as you know, was created by Congress to accomplish one primary objective -- to reduce the losses of life and property resulting from floods. It is fitting then that we consider at this conference the direction and initiatives of the National Flood Insurance Program. For this program cannot protect man in coastal areas without also considering the preservation of natural beaches as an integral part of our effort.

Conversely, as more construction occurs in coastal areas and more and more people are placed in harm's way, more irrevocable damage is being done to our Nation's beaches, estuaries, and barrier islands. It is a colossal irony that the delicate and intricate environment of coastal areas, which has been the most lucrative for development and growth, is also the most hazardous. In short, a frequent scenario of coastal development over the past fifty (50) years has been one of man blundering into the fragile coastal environment with dim perception of the risk, disrupting the ecosystems of beaches and barrier islands, only to expose people to extreme hazard.

In this connection, the worst natural disasters in our Nation's history have been related to coastal storms. In 1900, 6,000 people lost their lives during a hurricane at Galveston. Then, in Florida, in 1928, 2,000 lost their lives as a hurricane tore unchecked from Palm Beach to Lake Okeechobee. Celia, Betsy, Camille, Agnes -- the painful litany of more recent major hurricanes is familiar to most Americans, yet unless people and their communities better safeguard the coastal environment, we can expect in our lifetime a natural tragedy of unparalleled devastation.

Aside from the sheer forces of nature at work in coastal areas, there are several other reasons why the hazard there is so extreme. First of all, in the last two decades, the growth rate for our coastal areas has outstripped the national rate by nearly four times. In short, more people are now exposed to coastal hazards than ever before. A related factor is the dim perception of risk: Many of those who have recently moved to coastal communities have never witnessed a major hurricane -- a chilling echo of the Galveston hurricane at the turn of the Century where people actually made it a point to travel to the shoreline to watch the gigantic waves boiling off-shore. Actually many have confused the relatively mild hurricane activity since 1970 with major events. As a result, many have been lulled into complacency about coastal hazards. This in turn has resulted in disinterest about evacuation plans and, at times, open resistance to environmental concerns as well as the flood insurance program's standards designed to reduce the hazard to new coastal property.

For years, the scientists, the scholars, a handful of unnoticed forward-looking communities have been wilderness prophets with their warning that the vulnerable and dynamic coastal environment is also the most dangerous for man. Now that warning is appearing more frequently in the press. For instance, on June 9, the New York Times quoted Stan Riggs, a geologist with Eastern

Carolina University, as saying, "Building anything on the seaward edge of a barrier island is like building sand castles. What is here today may will be gone tomorrow, or at least within the next five years." That theme was treated as well in a feature article titled "Gone with the Wind" that appeared in the July 29 issue of the Washington Post. Fred Powledge, the author, describes the overdue "killer hurricane" in this way, "such a storm almost certainly will destroy and maim human life and millions upon millions in property. But the grisliness and destruction are inevitable. The big storm is out there somewhere, lurking almost as a human would, keeping its path and its toll close secrets until the last moment, a moment when it may be too late for anyone to do anything but run away as fast as they are able to." Powledge summarizes the interplay between development and environmental and human hazards in this way:

> "For we know that much of the development on the shore is a destructive act. It invites the destruction of its own self by the normal forces of nature. But even worse, because it interrupts other normal forces of nature, it promotes the destruction of the rest of the shoreline as well."

No one would suggest that any one program could erase the environmental damage already caused by several decades of imprudent coastal development or that any one high-exposure effort could remove the risk for the growing numbers of people that have settled along our shores during the past fifty years. The best that the Nation can expect is a reversal of a self-destructive cycle. Existing programs must be reshaped to ensure that Federal funds will no longer be used to stimulate coastal development. Public education is also needed to make people aware that an enormous price in environmental damage and human lives eventually must be paid for the brief gratification of coastal occupancy. We must make people aware that there are no endless summers at the shore, that in time certain inevitable weather patterns over the Atlantic will incite 20 foot waves and our brief salad days will come to a sobering end. We must make people realize that the footprints that man leaves on the beach are not without consequence and will not be easily erased. Finally, public policy makers and coastal property owners must begin to heed the dire warnings that certain coastal emergency programs will not be able to evacuate many endangered coastal residents at the time of the next major hurricane unless dramatic changes are made.

For our part, the National Flood Insurance Program must also undergo some serious soul searching. We must examine our current policies to determine how effectively we have been serving the mission of reducing the exposure of people to hazards along the coast. Many interested coastal observers maintain that the availability of low cost, subsidized flood insurance has actually stimulated growth along the coasts. Others maintain that the program has not gone far enough in guiding new construction away from coastal areas and that we have been a counterforce to prudent coastal management.

For several years this has been a concern to supporters and officials of the flood insurance program. For instance, Crane Miller in the November 1975 issue of Environmental Comment reported on his investigation of three coastal communities in Rhode Island where the evidence suggested that flood insurance was actually stimulating coastal development -- a result at crosspurposes with the Congressional intent for the program. This view was tempered somewhat in a subsequent study by Miller who found that communities were allowing new structures along the coast but were exercising hazard reduction by elevating them above the 100-year flood level as the program requires. Nonetheless, the concern persists that flood insurance can be misused in coastal areas to stimulate imprudent growth. In this connection, the Department of Interior at the President's direction is completing a series of recommendations on how the Federal government should limit its subsidies, grants, etc., that promote growth on the barrier islands. To the extent of our statutory authority we will follow those recommendations. At present, however, we are doing three things that will help correct the misuse of federally-subsidized flood insurance in coastal areas. First, at the Federal Insurance Administrator's direction, we are placing the highest priority on conducting detailed flood insurance rate studies in coastal areas. These studies are the real payoff for individual communities in the program. After flood elevations are determined from these surveys, the coastal community must require that new construction be built at or above those levels in order to remain eligible for flood insurance. Restrictions on fill and mobile homes are also required in coastal high hazard areas -- determined from our surveys to be subject to high velocity waters that would occur during hurricanes. Also as required by law, once the elevations are set in a community, then the subsidy for insurance is no longer available for new construction. All new construction must then pay actuarial insurance rates that reflect the degree of a building's exposure to risk. Hence, after the completion of our studies, one will have to pay dearly for building imprudently along the coast -- that is if his community will even permit him to build below standard. In short, there are many tangible benefits for communities and the taxpayers in our completing flood insurance rate studies for coastal areas as quickly as possible. By 1981, all coastal communities with development potential will have been studied or will be under study at that point. The second initiative in coastal areas we are taking to better serve the program's mission of hazard reduction involves a different way of viewing our study effort for inland minimally flood-prone communities. By statute, we must study in detail the Nation's critically flood-prone communities by 1983. During the first ten years of the program's operation, the concept of a "critically flood-prone community" became synonymous with any community having a 100-year flood plain. Hence, 20,000 such communities nationwide were slated for study regardless of the size of their flood plain or of the number of flood-prone structures, or the amount of growth potential in such areas. We now believe after consulting with Congress that the intent of the law was never to invest taxpayers' money -- and the detailed surveys cost on the average of $40,000 a piece -- in flood-prone areas where people and property would not be exposed to harm. We now believe we can reduce

our study effort by at least 3,000 such communities. The resources we would have otherwise invested in studies for these marginally hazardous areas can be used for technical assistance in critically flood-prone communities such as Collier County, Lee County, Palm Beach, Miami, etc. The technical assistance effort we envision for coastal areas will include concrete advice on guiding new construction out of harm's way, on addressing coastal environmental problems, and on developing evacuation plans. That last effort will be facilitated by our consolidation with the Defense Civil Preparedness Agency under the Federal Emergency Management Agency -- an agency inspired by mutual State and Federal concerns for a streamlined delivery of Federal disaster and hazard reduction programs.

Finally, as you are probably aware, the Federal Insurance Administration has had under contract Tetra Tech a nationally renowned coastal engineering firm for the purpose of perfecting that firm's methodology for calculating wave heights. That effort will continue until we can fully integrate wave height determinations in our engineering surveys so that elevation requirements for coastal communities will reflect the hazard of tidal surge. In the interim, we are developing a new rating procedure to be in place by 1980 for coastal high hazard areas. Insurance agents in writing flood insurance policies there will be advised to call a central rating facility where a calculation of the risk for new properties with respect to wave heights will be made. The rate itself will act as an incentive to build not only above the 100-year flood level but also above the additional wave height level as well. Currently insured new construction will be "grandfathered in," i.e., given the benefit of the earlier, less rigorous rate property owners had previously been paying.

This policy will ensure that lenders and property buyers fully consider the true price that has to be paid for new coastal occupancy.

These initiatives, in time, will help guide imprudent new construction away from the fragile yet perilous environment of our coasts and barrier islands. I am confident that these initiatives will advance our shared objectives to reverse the self-destructive trend of spoiling our beaches with unsafe new construction.

I will be pleased to answer now any questions you may have on the National Flood Insurance Program.

PRESIDENT'S REPORT:
THE STATE OF BEACH PRESERVATION IN FLORIDA

Arthur V. Strock, P.E.
President of Arthur V. Strock & Associates, Inc.
and
President of the Florida Shore & Beach Preservation Association
829 Southeast Ninth Street
Deerfield Beach, Florida

AN IDEA WHOSE TIME HAS COME

Twenty-three years ago, a few enlightened and foresighted people organized the F.S.B.P.A. Those few, joined over these past twenty-three years by other equally concerned persons, have brought the Florida Shore & Beach Preservation Association to the formidable position it now enjoys as probably the most viable organization dedicated to the preservation of shores and beaches, and all of that pulling for you and for Florida.

IN THE BEGINNING

In Genesis 1:9-10 God said, "let the waters under the heaven be gathered together unto one place, and let the dry land appear": and it was so, and God called the dry land earth; and the gathering called He seas; and God saw that it was good.

Ever since that time there has been erosion. Only in relatively recent times have we recognized that our task is to preserve that which has been given to us. Therein, in simple terms is our very purpose, our goal and justification for existence---preserve that which has been entrusted to our care.

HURRICANES DAVID AND FREDERICK

This is the fifteenth year without a major hurricane in South Florida. Other parts of the state have not been as fortunate. We did get a taste this year, however, with a wind called David. David created a great deal of property damage in Vero Beach and parts north. Then there was Frederick. Frederick skirted South Florida, then did his thing in Florida in the Panhandle with 100 MPH winds. There were higher winds, of course, near the center in the vicinity of Mobile, Alabama. We have been addressing the phenomenon known as hurricanes. Yet, after the hurricane season closes November 1st, we can expect numerous storms that will adversely affect our beaches. Not as violent perhaps as hurricanes, but many times just as damaging (sometimes even more so) and they will continue from November through March. The precautions taken against damage from the fury of the storm vary from nothing for winter storms to masking tape or a half-hearted effort of nailing a couple of boards cross fashion across the window to an elaborate storm paneling system for hurricanes.

BANDAID VS. F.S.B.P.A.

In the past, the efforts expended for beach protection can be likened unto storm protection for other property: A bandaid, some masking tape, a nail, here a groin, there a little rock, some sand.

The F.S.B.P.A. has provided the stepping stones directing us away from the first aid approach, this bandaid syndrome. The F.S.B.P.A. has fostered, supported and encouraged the study and research necessary for a more thorough understanding of causes of erosion and a better evaluation of corrective measures. You as individuals, and working in concert with one another through the F.S.B.P.A., have and are providing the leadership to get action on funding and on much needed legislation.

F.S.B.P.A.

We in Florida and the F.S.B.P.A. have much to be proud of. Florida is well ahead of any state in the country in the battle against beach erosion. In Florida, we no longer have to settle for beaches of little recreational value. We no longer have to tolerate coastal destruction and property damage due to storms. We are not fully there yet, but the strides made are mammoth, thanks to the F.S.B.P.A.

F.S.B.P.A. VS. PEOPLE

In examining the role of the F.S.B.P.A. in this progress, first and foremost we find people. Probably the single greatest strength of the F.S.B.P.A. is people---joined together under the umbrella of the F.S.B.P.A. People like Bill Carlton, Director of the Bureau of Beaches and Shores, Eldon Mariott, City Manager of Delray Beach, Fred Maley, City Manager of Bal Harbor, Ken Thompson, City Manager of Sarasota, Stan Tait, Executive Director of the F.S.B.P.A., Paul Stahlin, Bob Nalven, Herb Kahlert, Jim Purpura, Per Bruun and the list goes on, reading like a "Who's Who". These are peole who are willing to stand up and be counted when the going gets tough. Each of these outstanding people, together with countless others, have their own daily job to do. Each has his own special beach erosion problems and yet gives unselfishly of himself to add his knowledge, his guidance and his support to assist you in this common cause.

FUNDING

The enormity of this financial commitment for beach restoration is, at times, staggering. It is through the action of the F.S.B.P.A. at local, state and federal levels that financing such a project has become possible; especially at state level where, as volunteers and by invitation, the F.S.B.P.A. undergirded budget requests and testified as to funding requirements. The F.S.B.P.A. promoted the legislation which increased state funding from 25 percent to 75 percent of the non-federal share of the cost of beach restoration. Financing is not now the restraint that it once was and beach

restoration is now possible for virtually any ocean-front community.

State financing for erosion control has increased from a modest $35,000 in 1963 to $70,000 in 1964 prior to the formulated program as we know it now. The identifiable program of state financing of erosion control was initiated in the fiscal year 1966-67 with a contribution amounting to $497,711.00. In 1972-73, state funding topped the million dollar mark and in 1978-79, the recently completed fiscal year state appropriation for erosion control amounted to $8,735,714.00, the highest for any year to date. The state contribution for beach erosion control in the fiscal years 1979-80 and 1980-81 is expected to total almost $13,000,000.00.

Erosion control facilities in the form of structures and/or beach restoration have been constructed at similar rates. Beach projects have increased from .5 mile in 1963-64 to 1.7 miles in 1966-67 to almost 30 miles in 1978-79. Areas covered are as broad as the F.S.B.P.A. membership; from Jacksonville south along the east coast to Miami Beach and up along the west coast to and along the Panhandle. Due in great part to the persistence exercised through the F.S.B.P.A., the State of Florida now has the largest on-going program of beach restoration in the history of mankind.

PROPERTY PROTECTION - RECREATION

In terms of property protected, the value would be countless millions. In terms of recreational beaches restored, this also would be in the millions of dollars in value even though figures would pale beside the true cost to the tourist economy if we let our fragile coastline of beaches become a Maginot Line of seawalls and rocks.

COASTAL CONSTRUCTION CONTROL LINE

The first legislation enabling establishment of the coastal construction line was drafted by an F.S.B.P.A. committee. The line was modified into the "coastal construction control line". Seaward of the coastal construction control line, structures are erected which are engineered to withstand hurricane-force storms and minimize impact on the natural beach system.

Another piece of extremely important legislation passed which aids in the beach restoration effort was the passage of the Erosion Control Line legislation. The F.S.B.P.A. drafted the initial ECL legislation for the State of Florida. What the ECL does is it clearly delineates the line between private and public ownership of the property and the beach. Seaward of the ECL, the property

is considered to be public domain. As long as there is beach access within one-quarter mile of the beach, federal funding is available for all beach restoration done seaward of the ECL. Thus, this legislation has opened the door to federal funding for many beach projects in Florida that otherwise would not qualify.

LOOKING FORWARD

As one sage put it, "there is no history, only prologue". If we are wise stewards, this history will guide us in the steps the F.S.B.P.A. must now take. You have allowed me to serve this year as president and it has been a memorable experience. The single most important thing I can do as president is prepare you to meet the challenges ahead. Those challenges include the following:

1. Membership

This organization could not accomplish what it has, nor will it effectively continue in the future, without a broad membership base. The goal for 1980: Every coastwise county, every Florida coastline community, every Florida Registered Engineer active in coastal work and every citizen concerned with the shoreline must add their strength to the F.S.B.P.A.

2. Funding

Through continued efforts, sometimes against seemingly impossible odds, funding has reached levels that allow a major project to be completed. The F.S.B.P.A. vigilance must be maintained in order to avoid budgetary crippling of the beach program. We must sustain the present level of beach improvement which includes $13,000,000.00 of state funding covering 27 erosion control projects.

3. Environmental Concerns

The F.S.B.P.A. must push forward and be the leader in integrating the various environmental concerns into the beach preservation effort. We must insist that the area from the offshore bottom affecting the beach and being affected by our actions to and including the dune and vegetation thereon be considered an inseparable part of every program. We, ourselves, must do that, it must not be left to others.

4. State Staffing

Much furor has been raised recently about the Department of Natural Resources and the Bureau of Beaches and Shores. The

furor can be likened to a new coach critiquing Saturday's game; most anyone can call the defense after the offense is known. The challenge to the F.S.B.P.A. is to be knowledgeable of the needs---avoid adding staff on the simple assumption that more bodies accomplish more work. The F.S.B.P.A. should strongly support (a) optimizing use of present staff; (b) discourage staff excursions into areas that offer little in return to the program; and (c) where justified, strongly and vigorously support staff increases in qualified technical categories.

5. Research

There is a great deal that is not known about coastal dynamics. As a result, there are many unanswered questions about the "best" approach for promoting our shoreline. The F.S.B.P.A. must support increased and improved research in pertinent areas of coastal phenomena applicable to solution of problems in Florida. There are many answers needed from goal-oriented research, for example:

(a) Development of a more accurate application of design forces associated with coastal construction.

(b) Sediment transport is still elusive; longshore, on-shore-offshore and offshore limits should be investigated.

(c) Optimization of sand transfer across inlets, minimizing the interruption of natural transport along our coasts.

These and other anwers are needed to provide cost effective beach protection.

6. Inlets

As previously mentioned, one area of vital concern is inlets. At last count, Florida has approximately 70 inlets, some natural and some man-made. Of that total, 35 are maintained by dredging to provide navigation to inland waterways. Although inlets are a major cause of erosion, there is no official policy existing at the state level on the inlet problem. We must recommend and support an inlet management program to maintain navigable inlets, while at the same time reducing the effect of the inlets on beach erosion.

Florida is the fastest growing major state in the nation with a population of almost nine million people. Indications are that we will continue to be the fastest growing state, adding almost three million more people to our population in the next

decade. By the year 2000, it is expected that our population will be in the neighborhood of 14 million people. The demand for beaches will increase with the population. These facts lead to the next three recommendations for future efforts of the F.S.B.P.A.

7. Barrier Islands

Florida is lined by barrier islands on both the east and west coasts. Like much of Florida, growth and development of the barrier islands has been rapid and has occurred without adequate understanding of the impact of development on the islands. There is much work to be done in the study of the effects of development on the fragile barrier islands. The F.S.B.P.A. should support research of this nature.

8. Public Beach Access

As a part of our systematic planning for the future of the State of Florida, we must confront the problem of public access to the beaches. Accompanying the tremendous growth in population will be an equally tremendous demand for access to the beach. The beach access problem is a two-edged sword. On one hand, we wish to provide as much access to the general population as possible to the beach, while on the other hand protecting and guaranteeing the rights of the private property owner on the beach and protecting the beach itself from over use. The F.S.B.P.A. must be a supporter of efforts to obtain access lanes to the beach for use by the public, efforts to protect the riparian property owner rights and protect the beach from over use. We believe that, with careful planning, it is possible to achieve all goals.

9. Acquisition of Public Recreational Areas

The F.S.B.P.A. must continue to support the increase of local, state and federal efforts in the purchase of coastal properties for use as public recreational areas. Florida's phenomenal growth rate is particularly intense in the coastal regions. The division of Parks and Recreation has done a commendable job in the acquisition of beach-front property for use as recreational area. Since 1973, the Division has purchased 23 miles of beach or 6,400 acres of property for 80 million dollars. We, as members of the F.S.B.P.A., must encourage the beach purchasing program to continue and hopefully accelerate before property values become prohibitive.

10. Coastal Permitting

Finally, I would like to recommend that the F.S.B.P.A. support the assumption of coastal permitting responsibilities by local government with oversight by the Department of Natural Resources. This concept was sponsored by the F.S.B.P.A. in a 1978 law and should receive our support in the future. Local government can keep a closer eye on coastal construction in their jurisdictions than can the D.N.R. in Tallahassee. Local government can respond more readily to violations. The D.N.R. would still retain an overseeing position to insure that local permitting follows state guidelines. This plan would effectively provide a double check on shoreline development.

In conclusion, our efforts to date have been fruitful. The F.S.B.P.A. has made great strides in the area of beach preservation and restoration. Present and future plans call for the restoration of over 50 miles of beach at a cost of $100,000,000.00, much of which will be funded by federal and state government. Although a relatively new program, efforts have been completed or are underway on sand dune construction and revegetation projects on both coasts of Florida. The F.S.B.P.A. has been a major force in the initiation of legislation which has been designed to reduce the contributors to beach erosion problems. Such legislation, as that which provides for the CCCL and the ECL, increased funding for erosion control projects and have served to open the door to successful combat of the erosion problem. The potential for the future is great. The efforts of the F.S.B.P.A. must increase to achieve that potential. Efforts must increase in the areas of continued beach restoration, improving coastal construction permitting, improving research and increasing beach accesses.

In addition, we must provide more information as an organization to the communities along the coastline of Florida so that they are aware of the options open to them in the control of their erosion problems. We are on the verge of turning the tide against beach erosion in Florida; but, to achieve that goal, we must increase our efforts. I believe the F.S.B.P.A. will meet and exceed our goals.