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REPORT TO THE CONGRESS

UNITED STATES
GENERAL ACCOUNTING OFFICE

JUN 11 1975



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National Efforts To Preserve The Nation's Beaches And Shorelines-- A Continuing Problem

Corps of Engineers (Civil Functions)
Department of the Army

**BY THE COMPTROLLER GENERAL
OF THE UNITED STATES**

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COMPTROLLER GENERAL OF THE UNITED STATES

WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the continuing national problem
of preserving the Nation's beaches and shorelines.

Our review was made pursuant to the Budget and Account-
ing Act, 1921 (31 U.S.C. 53), and the Accounting and Audit-
ing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director,
Office of Management and Budget, and to the Secretaries of
the Departments of Defense, the Army, Commerce, and the In-
terior.

A handwritten signature in cursive script, reading "Thomas A. Stearns".

Comptroller General
of the United States

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ABBREVIATIONS

CERC	Coastal Engineering Research Center
GAO	General Accounting Office

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

NATIONAL EFFORTS TO PRESERVE
THE NATION'S BEACHES AND
SHORELINES--A CONTINUING
PROBLEM

Corps of Engineers (Civil
Functions)
Department of the Army

D I G E S T

WHY THE REVIEW WAS MADE

The beaches and shorelines of the United States, including those of the Great Lakes, total about 84,000 miles. About 75 percent of the country's population live in States bordering the oceans and the Great Lakes, and 12 of its 13 largest cities are located in the coastal and Great Lakes areas. Since 1946 the Congress has authorized the Corps of Engineers to construct or participate in projects for protecting and preserving the shorelines.

Because of congressional and public concern over the erosion of the Nation's beaches and shorelines, GAO reviewed the beach and shoreline protection activities of the Corps of Engineers at eight of its district offices; of the States of California, Florida, Illinois, Indiana, Michigan, New York, North Carolina, Ohio, and Virginia; and of certain local agencies.

FINDINGS AND CONCLUSIONS

Assessment of shoreline conditions

Damage due to erosion is a major problem on the Nation's coastal and Great Lakes shorelines. The River and Harbor Act of 1968 directed the Corps to obtain information on the erosion problem, determine the best methods of corrective action, provide cost estimates for remedial action, and provide State and local authorities with information and recommendations to assist in the creation and implementation of State and local shoreline erosion control programs. (See p. 8.)

The information was presented in nine regional reports and an overall summary Corps report entitled "Report on the National Shoreline Study." The summary report, issued in August 1971, stated that 20,500 miles, or 24 percent, of the Nation's total shoreline was seriously eroding, of this shoreline, 2,700 miles were classified as

critical and 17,800 miles were classified as under-going noncritical, yet serious erosion. (See p. 8.)

The Corps estimated the total Federal, State, and local cost to construct suitable protection works for the critically eroded areas at about \$1.8 billion, with an additional \$73 million annually for placing sand on the beaches to reduce erosion damage. (See p. 8.)

In comparison, the Corps spent about \$106 million for beach and shoreline protection for fiscal years 1970-74. Only a portion of this was spent in areas where erosion was classified as critical. (See p. 7.)

Although the Corps' study generally complied with its broad objectives, it did not accurately assess the condition of the Nation's beaches and shorelines.

--The criteria for classifying erosion conditions were limited and inadequately defined, and the eight Corps districts GAO visited did not use uniform methodology for making the study.

--Most Corps districts considered the regional and summary reports on shoreline conditions to be of minimal value and used the reports as broad reference documents.

Federal, State, and local agencies were not periodically monitoring shoreline conditions. The eight Corps districts GAO visited had participated in such programs in varying degrees. As a result, shoreline monitoring efforts have been irregular and incomplete. (See pp. 9, 14, and 15.)

In recent years other agencies, such as the Great Lakes Commission, the Great Lakes Basin Commission, the International Joint Commission, and the Federal Regional Councils have pooled their talents and resources in a major effort to identify existing and potential problem areas on the Great Lakes and to develop a regionwide, long-range management plan. (See p. 13.)

Progress in controlling beach and shoreline erosion

Federal progress in controlling beach and shoreline erosion has been slow. At the eight Corps districts GAO visited, about 23 percent of their critically eroded miles of shoreline had been included in shore protection projects. Of a total of 64 projects authorized since 1946, only 20 have been completed. (See p. 18.)

The average time to complete the 20 projects, or project segments, was about 10 years from the date of the local request. For the 44 projects in process, the average time

from the date of the local request to the date of GAO's fieldwork was about 17 years. (See p. 18.)

Delays in scheduling and completing Federal projects have resulted in

- increased construction costs,
- loss of additional shoreline property,
- need for projects to be restudied, and
- need for the construction of temporary measures. (See p. 18.)

GAO's review of State and local agencies' beach and shoreline erosion control activities showed limited project effort at most of the localities and States visited. Although at certain locations considerable Federal, State, and local funds have been spent over extended periods for erosion control projects, many of the projects have not successfully effected long-term improvements to the shoreline, and costly and continuing project efforts have been necessary to combat erosion. (See pp. 21 and 24.)

Problems contributing to delays in project completion

Many factors have been identified as affecting the

completion of authorized projects' such as:

- Inability or reluctance of Federal, State, and local agencies to provide the necessary funds.
- Requirement that public access be provided to beaches developed or improved with Federal funds.
- Inability to agree on the Federal financial participation rate.
- Inability to locate suitable sand and other source materials necessary for beach restoration projects.
- State laws and local requirements which conflict with Federal requirements.
- Changes in environmental conditions which lessen the public's sense of urgency for project implementation. (See pp. 34 to 39.)

In the Great Lakes area and on the ocean shorelines, much of the serious erosion and flooding damage has been to privately owned property. Much of the shoreline in these areas is unprotected and few private property owners suffering erosion damage qualify for Federal assistance. In view of such problems, various legislative proposals for Federal assistance and participation in programs for protecting privately owned property were introduced but not enacted in the 93d Congress. (See pp. 40 to 43.)

Encroachment of development on the shoreline

Encroachment on the shoreline by manmade developments has contributed to beach and shoreline erosion problems in the coastal areas and widespread damage to property in erosion prone areas. (See p. 48.)

The Coastal Zone Management Act of 1972 established a Federal grant program within the Department of Commerce for Federal participation in the development, implementation, and administration of State coastal zone management programs. At the time of GAO's review, progress in carrying out this program had been slow since the act had been only recently enacted. The first appropriation for the act came in fiscal year 1974 in the amount of \$12 million, of which \$7.2 million was applicable to the Federal grant program for the development of State coastal zone management programs. (See p. 48.)

Development of the coastal zone for resort and recreation areas has resulted in many Corps navigation projects for harbor and marina facilities. These projects frequently have contributed to beach erosion problems. (See p. 53.)

When Corps navigation projects cause damage to adjoining shorelines the Federal

Government is financially liable for the prevention and mitigation of property damages. (See pp. 55 and 56.)

GAO asked the districts visited about the contribution of the Corps' Coastal Engineering Research Center in the planning of individual projects. GAO found no indication of Center participation in individual project development. GAO believes that requiring more direct involvement by the Center in the planning and development of individual projects would enhance more effective use of the knowledge gained by the Center's research efforts into beach erosion. (See pp. 44 and 46.)

RECOMMENDATIONS

The Secretary of the Army ²⁰ should require the Corps

--to monitor the condition of the Nation's beaches and shorelines, including the development of uniform criteria and methodology for use in its assessments, with maximum State and local government participation and the use of information developed under Coastal Zone Management Act requirements, (see p. 16) and

--to accelerate the application of its research efforts by more directly involving the Center in individual project planning and development (see p. 47).

AGENCY ACTIONS AND
UNRESOLVED ISSUES

Comments on this report were obtained from the Department of the Army. Sections of the report applicable to the various Federal, State, and local agency activities discussed in the report were made available to such officials who generally agreed with our assessments.

The Department concurred that it would be desirable to monitor the condition of the Nation's beaches and shorelines and to supplement the investigations being made for authorized studies and projects requested for fiscal year 1976, \$150,000 to carry out a program for field collection of coastal engineering data. (See pp. 16 and 17.)

The Department also agreed

that there was a need for more uniform and productive use of the Center's advisory reviews in the project planning area. (See p. 47.)

If the actions to be taken are properly carried out, better project planning and design should result and provide more effective shore protection projects.

MATTERS FOR
CONSIDERATION BY THE
CONGRESS

This report provides the Congress with information on the coastal and the Great Lakes shoreline conditions in the United States, discusses the progress being made, and the problems to be resolved in protecting and preserving the beaches and coastal areas.

CHAPTER 1

INTRODUCTION

The beaches and shorelines of the United States are one of the country's most valuable natural assets. About 75 percent of the country's population live in States bordering the oceans and the Great Lakes, and 12 of its 13 largest cities are located in the coastal zone.

America's coastal zone--the beaches and shorelines--serves as a valuable recreation area as well as a natural defense against the onslaught of the seas. The shore represents a dynamic, fragile, changing environment which natural processes mold and remold.

Wave action changes the beach and shoreline by moving sand onshore, offshore, and along the shore. This sand movement causes alternate erosion and accretion of the shoreline depending on the weather conditions, the seasons, and the direction and violence of the wave attacks on the shore. On a stable beach, over a period of time, little or no net movement of sand occurs unless the natural rhythm is upset. Damage to beaches caused by storms and gradual regression would, in due course, be naturally corrected; however, man has introduced changes both onshore and offshore which have seriously interrupted the natural processes, causing damage to the beach areas.

In addition, changes such as the construction of dams and roads and the urbanization of large land areas have reduced the supply of sand needed to nourish and maintain the shores. Sandy sediments from rivers flowing directly into the ocean are deposited near river mouths forming deltas. Sand in these delta areas is then placed in suspension by wave action and is carried onto the beaches by the littoral drift or currents moving along the shoreline. Man's encroachment on and development of the shoreline for economic and recreational purposes have had serious consequences. Such encroachments have interrupted the supply of sand reaching the ocean and have seriously affected the shore's natural defenses.

With the natural defenses weakened or destroyed, various types of manmade methods of shore protection are employed to reduce erosion damage.



Artificial fill and nourishment-sand is dredged from nearby locations and placed directly on the beach. The beach is then nourished by injection of dredged sand pumped into the littoral current allowing it to accumulate naturally on the beach. Note material being pumped to the beach by pipeline from a dredge located offshore.



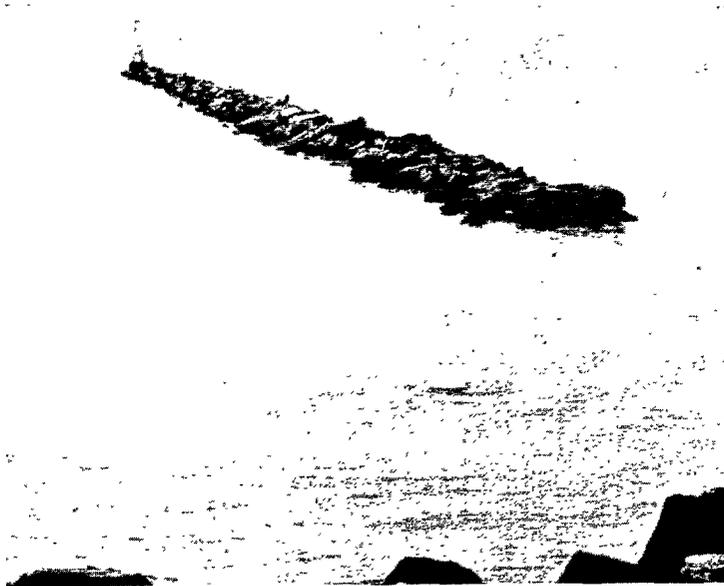
Revetments-blankets of nonerodible material placed on a bank, bluff, or escarpment to prevent erosion. In function, revetments are similar to seawalls except they are more flexible, generally of lighter construction, and less costly.



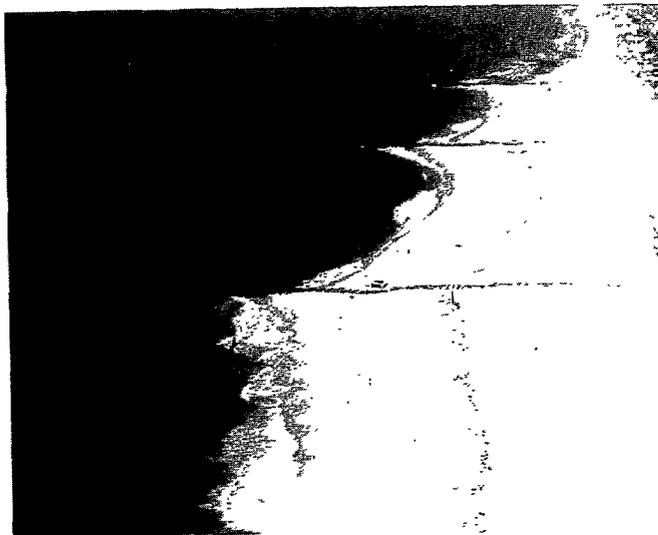
Seawalls--rigid structures constructed parallel to the beach line to withstand and deflect wave energy. Seawalls, by preventing erosion of areas that added sand to the supply in motion in the littoral drift, may accelerate erosion of the fronting beaches and nearby areas.



Other methods--sand fences, dunes, ridges and vegetation--all of these methods attempt to protect the beach from wind and wave attack that cause erosion.



Breakwaters--stone structures located in the sea interrupt the wave before it reaches the shore. This interruption causes a calm landward of the breakwater which slows the currents along shore and causes sand to impound behind the structures.



Groins--structures constructed perpendicular to the shoreline, across the beach, and into the water. Used individually or in a series, they interrupt the sand moving into the area and serve to widen the beach. Only when large amounts of sand are in transit is this method effective.

Source: Corps of Engineers

Much public and congressional awareness exists about shoreline protection and beach erosion control problems. More than 80 pieces of legislation have been introduced in the 93d Congress about ocean shorelines and the Great Lakes regions.

Before 1930 United States beach and shoreline erosion control projects were concerned with protecting Federal property, including navigation projects. During that period an advisory Board on Sand Movement and Beach Erosion appointed by the Chief of Engineers, Department of the Army, functioned as the principal instrument of the Federal Government in this area. Since that time, Federal interest has broadened considerably.

In the River and Harbor Act of 1930 (33 U.S.C. 426), the Congress created the Beach Erosion Board, under the direction of the Chief of Engineers, to provide technical assistance in conducting studies and reviewing reports of investigations made in the planning of ways to prevent erosion. The Beach Erosion Board was composed of members from both the Corps of Engineers and the State agencies charged with shoreline protection activities. In 1946 and 1956 the Congress provided additional authority to enable the Corps to study beach erosion and to build structures to remedy the problem.

In 1963 the Congress abolished the Beach Erosion Board and established, under the Chief of Engineers, the Coastal Engineering Research Center (CERC). CERC investigates shore processes and wind wave action in coastal waters and develops design criteria for Corps projects. CERC performs these functions for the Board of Engineers for Rivers and Harbors ^{1/} and provides consulting services to Corps district offices and other Federal, State, and local agencies on request.

The Corps said its research program is the basis of its planning and construction programs and, without

^{1/} The Board of Engineers for Rivers and Harbors was created by section 3 of the River and Harbor Act of 1902 (33 U.S.C. 541). One mission of the Board is to examine the reports on surveys ordered by the Congress and to submit recommendations to the Chief of Engineers on proposed projects. The Board consists of a chairman, five division engineers from geographically dispersed areas in the United States, and a resident manager with a staff located at Corps headquarters.

research, the effectiveness of completed projects would be uncertain and costly overdesign or failure would be common. The Corps has also said the effectiveness of the shore protection program can be measured in terms of preservation of natural beaches and recreational areas as well as the protection of life and property.

Most recently, the River and Harbor Act of 1968 (33 U.S.C. 426) charged the Chief of Engineers with the task of minimizing erosion damage by requiring the Corps to study the condition of the Nation's shorelines and to develop suitable means to restore, protect, and manage them effectively.

This study represented a first effort to provide a comprehensive assessment of the country's beach and shoreline erosion problems. The Corps was to survey in detail the condition of 84,000 miles of U.S. coastal and Great Lakes shorelines to determine where considerable erosion had occurred. In August 1971, 3 years after the enactment of this legislation, the Corps issued its report on the National Shoreline Study.

Corps projects for beach and shoreline erosion control are generally cosponsored by State and local agencies and the representatives in the Congress from the respective project areas. The House or Senate Public Works Committee authorizes a survey or study of the proposed project that is performed by the Corps and submitted to the Board of Engineers for Rivers and Harbors. The Corps develops benefit-cost analyses to show the economic feasibility of proposed projects.

The Board of Engineers for Rivers and Harbors has responsibility for the review and analysis of these reports and for the submission of recommendations to the Congress of the feasibility of the projects covered in the reports. Unless estimated benefits exceed economic costs, the projects are seldom recommended for authorization.

PROGRAM FUNDING

The law places limitations on the Corps' financial participation in a project depending on whether it is for beach erosion control or for hurricane and flood protection. The Corps' financial participation in shoreline protection projects where Federal cost share exceeds \$1 million is as follows:

<u>Shoreline ownership</u>	<u>Percent of Federal cost participation</u>
Federally owned shoreline	100
Non-Federal public parks and conservation areas	70
Non-Federal public shoreline	50
Privately owned shoreline with specified public benefits	50x $\frac{\text{Public benefits}}{\text{Total benefits}}$
Privately owned shoreline	-
Public and privately owned shoreline-- projects to lessen damages caused by Federal navigation projects	100
Nonfederally owned shoreline hurricane protection and lands with specified public benefits	70
Hurricane protection	70
Beach erosion	50x $\frac{\text{Public benefits}}{\text{Total benefits}}$

From fiscal year 1970 through fiscal year 1974, Corps-estimated spendings for beach erosion and hurricane and flood protection projects for the coastal and the Great Lakes areas totaled \$106 million, of which \$15 million was for beach erosion projects. The Chief of Engineers, in conjunction with the Secretary of the Army, can also approve Corps participation in authorized projects when the total cost of a project does not exceed \$1 million. In fiscal year 1974 Corps participation in such projects was limited by law to a maximum of \$25 million.

CHAPTER 2

ASSESSMENT OF SHORELINE CONDITIONS

The River and Harbor Act of 1968 directed the Corps to assess erosion on the Nation's coastal and Great Lakes shorelines. The Corps' response entitled "Report on the National Shoreline Study" was issued in August 1971. The study was presented to the Subcommittee on Flood Control-Rivers and Harbors, Senate Committee on Public Works, in June 1972. It consisted of a summary report, nine regional inventory reports, and separate guidelines for shore protection and shore management.

The summary report stated that, at the time of the study, the Nation's shoreline comprised 84,240 miles, of which 47,300 miles were Alaska shoreline. It concluded that 20,500 miles, or 24 percent, of the total shoreline was seriously eroding, of which 2,700 miles were categorized as critical and 17,800 miles were categorized as undergoing noncritical, yet serious erosion. The total Federal, State, and local cost of constructing suitable protection works for the 2,700 miles of critically eroded shoreline was estimated at \$1.8 billion, with an additional \$73 million estimated to be spent annually for beach nourishment. Corps expenditures for beach and shoreline protection from fiscal year 1970 through fiscal year 1974 totaled \$106 million, only a fraction of this estimated total.

The Congress, in authorizing the shoreline study, specified that the Corps was to accomplish the following objectives in its assessments of the shoreline.

1. Determine shoreline areas where "significant" erosion occurs.
2. Identify those areas where corrective action may be justified.
3. Describe the most suitable type of corrective action for those areas having a serious erosion problem.
4. Provide preliminary cost estimates for the necessary remedial action.
5. Recommend priorities for action to stop serious erosion problems.

6. Provide State and local authorities with information and recommendations to create and implement State and local shoreline erosion control programs.
7. Develop and recommend guidelines for land use management in coastal areas.
8. Identify coastal areas where title uncertainties exist.

Each of the above objectives was considered, in various degrees, in each of the regional inventory reports. We found, however, that the reports did not represent an accurate assessment of the Nation's shoreline conditions.

The criteria and methodology used to assess the importance of the erosion problem were not consistent among the various Corps districts. In some cases, when the districts used shoreline data prepared by others, officials were not aware how the data was collected or had no opportunity to review the data assembled and to comment on the study before its completion.

Most districts found the reports to be of minimal value because they were incomplete, outdated, and inaccurate. District officials said they used the reports as broad reference documents. Corps officials said the development of an accurate and complete report on eroding shoreline areas was hindered by time considerations as well as funding limitations.

LACK OF UNIFORM CRITERIA AND METHODOLOGY IN COMPLETING THE NATIONAL SHORELINE STUDY

To develop an accurate assessment of the seriousness of the Nation's shoreline problem, the basic data collected in the various districts should have been based on uniform criteria. Criteria were not adequately defined in the early stages of the study and guidelines clarifying the classification of the shorelines were not issued to the districts until after the fieldwork had been completed. Therefore, findings could not be compared and classified accurately.

About 3 months before the scheduled completion of this report, the Corps provided the districts with the following criteria:

Critical erosion areas--where erosion presents a serious problem and the rate of erosion, together with economic,

industrial, recreational, agricultural, navigational, demographical, ecological, and other relevant factors, indicates that action to halt such erosion may be justified.

Noncritical erosion areas--where erosion is occurring but where action to halt erosion does not appear justified.

Noneroding areas--where the erosion process is not occurring.

The Corps said these assessments were to be made regardless of whether the shoreline was privately or publicly owned. Five months after the survey work was completed the districts were asked to further classify their reported critical erosion areas into the following priorities:

Priority 1--Continued erosion is likely to endanger life or public safety within 5 years.

Priority 2--Continued erosion is likely to endanger property, scarce wildlife habitats, or historical or natural landmarks within 5 years.

Priority 3--Continued erosion is likely to endanger life, public safety, property, scarce wildlife habitats, or historical or natural landmarks within 5 to 15 years.

Priority 4--All other areas undergoing critical erosion.

Corps district offices assigned the above priorities to the critical shoreline areas without additional survey work. We noted that the districts used various approaches in assessing and categorizing shoreline erosion.

The Chicago district defined critical erosion areas as those having high economic or recreational value and a history of rapid land loss or structural damage. In deciding which areas were critical, however, the erosion rate considered to be rapid was not defined and the areas classified as critical varied, depending on the proximity of homes to the beach.

At the Los Angeles district a consulting firm produced the regional inventory report. No field examinations were made of the shoreline and maximum use was made of available information obtained from State and local agencies, including Corps district files. Areas were identified as critical

where judgment indicated that prospective damages, and tangible and intangible benefits that may occur from prospective projects, justified project effort to halt erosion. No standards for measurement were developed.

The Jacksonville district relied on existing survey reports and determined shoreline conditions in Puerto Rico and in the Virgin Islands on the basis of field inspections of selected areas.

The Norfolk district sent questionnaires to the board of supervisors of the various shoreline counties and cities within its area requesting information on the number of miles of critical, noncritical, and noneroding areas within its jurisdiction. No criteria for categorizing erosion accompanied the questionnaires, and the district did not know what criteria the various respondents used in providing the information. The district estimated the level of coastal development over the next 50 years and, with the data received, determined which areas were critical. Although certain eastern shore Virginia barrier islands were isolated and undeveloped, they were classified as undergoing critical erosion since they served to protect mainland areas.

The Wilmington district considered that any area undergoing erosion of two or more feet a year was critical, regardless of land use or development. Of the 539 miles considered critical, 350 miles were along sparsely developed bay and estuarine areas; yet where similar marshlands could not be visually inspected, they were categorized as noncritical, regardless of the extent of erosion.

The Corps, in transmitting the National Shoreline Study to the Congress, noted that the report provided guidelines and "broad conceptual plans" but was not intended to produce project authorizations. The Office of Management and Budget concurred with this evaluation of the study's purpose. The report also stated that the study's reliability was questionable. Corps officials said limited resources and short time frame for completion precluded a more detailed study.

GREAT LAKES BEACH AND SHORELINE CONDITIONS

Shoreline problems on the Great Lakes--Erie, Huron, Michigan, Ontario, and Superior--resulting from erosion and flooding have become more serious and alarming in recent years. (See pp. 41 and 42.) Homes, cottages, recreational beaches, highways, dock areas, and other public and private facilities are eroding or being closed by flooding.

U.S. shorelines on the Great Lakes extend about 3,700 miles, bordering eight states--Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. According to the National Shoreline Study, erosion is occurring on about 1,300 miles, with another 335 miles being flooded. Wind-generated wave action causes most of the lakes' erosion problems. Surface water runoff, underground water seepage, and frost and ice action are contributing causes. Erosion rates vary over a period of years and are influenced by high lake levels and the types and frequency of storms.

Precipitation and lake levels

Rainfall and snowfall in the Great Lakes basin area in recent years have resulted in an average annual precipitation level of about 13 inches above normal. When precipitation in the basin area persists above normal for any extended periods of time, lake levels rise causing more erosion and flooding damage.

The time intervals between successive high-water periods on the lakes are of irregular length. Such periods occurred in the late 1920s, the mid-1940s, and in the early 1950s. In October 1973, the lakes had another period of high lake levels. For calendar years 1971-73, abnormally high lake levels had been established as shown below.

<u>Lake</u>	<u>Great Lakes water levels</u>				
	<u>Maximum</u>	<u>Average</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Erie	572.3	570.4	11	a/17	a/28
Michigan-Huron	581.5	578.7	8	11	20
Ontario	247.2	244.8	-1	6	18
Superior	601.8	600.4	9	8	8

a/ Record monthly lake levels were set for September 1972 through October 1973.

During periods of high lake levels, the beaches become submerged and a single storm can cause extensive erosion and flood damage. For example in March 1971, at the Sleeping Bear Dunes in Michigan, a combination of high lake levels, wave action, and snow and rain saturation resulted in an overnight loss of 20 acres of land. During the 1951-52 high

lake level period, many reaches of shoreline which had long-term erosion rates of 3 feet or less receded in a single year from 15 to 70 feet. The Corps estimated damages during this period at \$60 million.

The Corps has indicated the potential for damages during the present high lake level period at several times that of the 1951-52 period, although an updated estimate of potential losses has not been made. Storms in Ohio and Michigan in late 1972 and early 1973 have caused property damage exceeding the 1952 estimate of \$60 million.

During the present high lake level period, the Small Business Administration has granted 14,300 disaster loans, totaling about \$52 million, and the Corps has assisted in the construction of emergency flood control works at 139 locations at a cost of about \$25 million.

Studies of the Great Lakes shoreline conditions

In recent years State and Federal agencies have been pooling their talents and resources in a major effort to identify existing and potential problem areas on the lakes and to develop a regionwide, long-range shore management plan.

Two commissions are assisting the States in this effort-- the Great Lakes Commission and the Great Lakes Basin Commission. The International Joint Commission ^{1/} and the Federal Regional Councils have also been studying the various factors which affect the fluctuations of lake levels.

The Great Lakes Commission was established by interstate agreement, ratified by the eight Great Lakes States in the period from 1955 to 1963. The commission is composed of three to five representatives from each State and is financed solely with State funds. Serving in a research and advisory capacity, the group has encouraged and supported various shore protection programs and legislation.

^{1/} Consists of United States and Canadian members and is responsible for investigating all proposals for use, obstruction, or diversion of boundary waters on either side of the international boundary which would affect the natural level or flow of the waters on the other side and for investigating and making recommendations on specific problems along the boundary.

The Great Lakes Basin Commission was established by Presidential Executive order in 1967 at the request of the governors of the eight Great Lakes States. Legislative authority is provided in the Water Resources Planning Act of 1965 (42 U.S.C. 1962). The act requires the Basin Commission to coordinate Federal, State, interstate, local, and nongovernmental planning activities to prepare and keep up to date a comprehensive, coordinated, joint plan and to establish program priorities for the use and development of water and land resources in the Great Lakes area.

The Basin Commission expects to complete its comprehensive plan in fiscal year 1980. The commission's shore-use and erosion study began in 1968. The study was to provide basic inventory data, guidelines, and recommendations to assist in the proper planning and future development of the U.S. shorelands of the Great Lakes. The work group included representatives from each of the eight States, four universities, the Corps, the Department of the Interior, and other Federal agencies.

The work group has mapped the coastline identifying shoreline mileages, shore types and ownership and noted erosion and flooding areas. The sources of these data included aerial photographs, U.S. Geological Survey quadrangle sheets, and various existing reports and publications. No extensive field surveys were made for this study.

During its investigation of further regulation of the Great Lakes levels, the International Joint Commission Board earlier, during the low-water period in 1966 and 1967, (1) conducted field surveys of various Great Lakes shorelines to determine shoreline characteristics and land use, and (2) obtained information on shoreline damages caused by erosion during the 1951-52 high lake level period. The Board also estimated future use of the Great Lakes shoreline under various land-use categories and determined which shoreline categories would be susceptible to damage from erosion because of a lack of natural or manmade protection measures.

SHORELINE MONITORING PROGRAMS

Sand movement causes alternate erosion and accretion of the shoreline depending on weather conditions, the seasons, and the direction and violence of wave attacks on the shore. Efforts to monitor this dynamic environment have been limited. We noted that none of the Federal or State agencies, with the exception of Michigan, have established programs for periodic, comprehensive shoreline monitoring. The Office

of Coastal Zone Management, U.S. Department of Commerce, is authorized to make grants to States for developing and administering programs for the management of their coastal zone resources under the Coastal Zone Management Act of 1972 (16 U.S.C. 1451-1464). The Office expects to make its initial grants for developing program plans in fiscal year 1975. Participating States will be required to inventory coastal resources; however, the Office does not have a specific requirement that State programs include shoreline erosion monitoring provisions on a continuing basis.

The eight Corps districts we visited have participated in shoreline monitoring programs in varying degrees. Monitoring in the Norfolk and Jacksonville districts has only been performed during the preparation of surveys and flights over selected areas after severe storms.

Together with CERC, the Chicago and Detroit districts have analyzed sand movement at specific locations along Lakes Michigan and Huron but have not engaged in periodic, systematic monitoring programs.

A limited program for monitoring changing shoreline conditions was performed by the Los Angeles district in cooperation with the State of California. The program, funded on a 50-50 basis between the State and the Federal Government, was to determine areas of active or potential erosion and evaluate solutions for problem areas. Activities covered by the program included aerial and ground photographs, collecting and analyzing beach and offshore sand samples, conducting shoreline and hydrographic surveys, installing and maintaining wave gages, and conducting research on littoral sand movement, sand bypassing, offshore sand supplies, and the effect of submarine canyons on littoral drift.

The Chicago district, together with CERC and State and local government agencies, has established the Littoral Environment Observation Program. Under this program, daily observations of wind and wave characteristics, beach movement, and littoral current would be made at selected locations.

The Wilmington district also has a monitoring program that includes yearly flights over the coastal areas, comparison of an artificially protected beach with a natural beach, and development of wave action information at various locations on the North Carolina coast.

CONCLUSIONS

Although the National Shoreline Study generally complied with its broad objectives, the study did not result in an accurate assessment of shoreline erosion in the United States. To date, this study remains the only effort made to assess the changing conditions of the Nation's shorelines.

Also, shoreline changes are continuously occurring necessitating a regular monitoring system to provide current information on the condition of the shorelines. Generally, Federal, State, and local agencies are not periodically monitoring shoreline conditions and any such efforts that have been made were irregular and incomplete.

We believe that accurate information is needed to fully assess the erosion problem and to properly plan and manage shore protection projects.

RECOMMENDATIONS TO THE SECRETARY OF THE ARMY

We recommend that the Secretary of the Army require the Corps of Engineers, with the maximum participation of State and local governments, to initiate action to monitor the condition of the Nation's beaches and shorelines, including the development of uniform criteria and methodology for assessing shoreline condition and the classification of the results. We also believe that maximum use of information gathered under the Coastal Zone Management Act be used by the Corps in establishing and conducting its monitoring program.

AGENCY COMMENTS AND GAO EVALUATION

By letter of April 21, 1975 (see app. IV), the Department of the Army generally agreed that it would be desirable to monitor the condition of the Nation's beaches and shorelines. It said that in order to supplement their shoreline investigations and using existing authority, the Corps had requested \$150,000 in fiscal year 1976 to initiate a new program of field collection of coastal engineering data to optimally develop functional and structural coastal project designs, to economically evaluate alternative solutions to coastal problems, and for general planning applications. It estimated the fiscal year 1976-80 program cost at over \$2.5 million.

It also said that the program was being established to provide the base-line data necessary for assessment of the economic and environmental feasibility of specific coastal

projects on a more timely basis. In addition to the Corps' own efforts, the Army said that the new program would involve extensive use and coordination of the efforts of State and local government agencies. It said that the present and the new investigative program should result in a reasonably complete nationwide data base on beach and shoreline condition.

In our opinion, the efforts outlined by the Corps should improve the monitoring of the condition of the Nation's beaches and shorelines and aid in the planning and managing of more effective shore protection projects.

CHAPTER 3

PROGRESS IN CONTROLLING BEACH AND SHORELINE EROSION

FEDERAL INVOLVEMENT IN PROJECTS

Federal progress in controlling beach and shoreline erosion has been slow. At the eight Corps districts we visited-- Buffalo, Chicago, Detroit, Jacksonville, Los Angeles, New York, Norfolk, and Wilmington--a total of 14,562 miles of shoreline was described in the National Shoreline Study. Of this amount about 1,550 miles were considered to be critically eroded.

Since 1946 the Congress has authorized the eight districts to construct or participate in 64 shore protection projects covering 361.4, or 23 percent, of the critically eroded shoreline miles. Appendix I of this report shows that at the time of our fieldwork, the Corps had completed 20 of the 64 authorized projects covering 35.2 miles of critically eroded shoreline.

The time periods needed for the completion of beach and shoreline erosion control projects are generally extensive. For the Corps districts visited, the average time from the date of the local request for Federal assistance to the completion of the project or project segments for the 20 completed projects was about 10 years. For the 44 projects in process, the average time from the date of the local request to the date of our fieldwork was about 17 years. Some of these projects were in the planning stage and had not reached the construction phase. Delays in completing Federal projects have resulted in (1) increased construction costs, (2) loss of additional shoreline property, (3) need for projects to be restudied, and (4) need for construction of temporary protective measures.

Appendix II shows the time required at each of the eight districts to complete Corps beach and shoreline erosion control projects and the time that the incomplete projects have been in process. The factors contributing to delays in Federal projects are mentioned briefly in the following examples; a more detailed discussion begins on pages 34 to 39.

Due to the constantly changing condition of the shoreline and the increasing emphasis on environmental considerations, a complete restudy of delayed projects is often necessary before carrying out a project. We were informed by officials from several districts that many of the Federal projects covered by our review will have to be restudied.

The following examples at Brunswick County, Fort Fisher, and Bodie Island, North Carolina, illustrate the effects of delays in project completion.

Brunswick County

A multipurpose project was authorized by the Congress in November 1966 at a total cost of \$19,250,000 to provide beach erosion control and hurricane protection for 23 miles of shoreline in Brunswick County. By July 1973 the construction cost estimate had increased to \$40,570,000, with a Federal contribution of \$22,035,000.

In February 1975 the Corps requested the State's approval to defer the project indefinitely because of delays in obtaining Federal funding and fulfilling the local cooperation requirement, including funding from three of the five municipalities covered by the project. A lack of Federal funds resulted in the State of North Carolina advancing funds to the Corps in 1969 so that preconstruction planning could be initiated.

The State of North Carolina has also constructed a series of sandbag groins at three Brunswick County beaches in an attempt to minimize erosion and stabilize the area until the authorized Federal project could be constructed.

State officials have said the erosion problem in Brunswick County was so dynamic that without the temporary construction measures, the Corps would have to restudy or resurvey the area before constructing the authorized project.

Fort Fisher

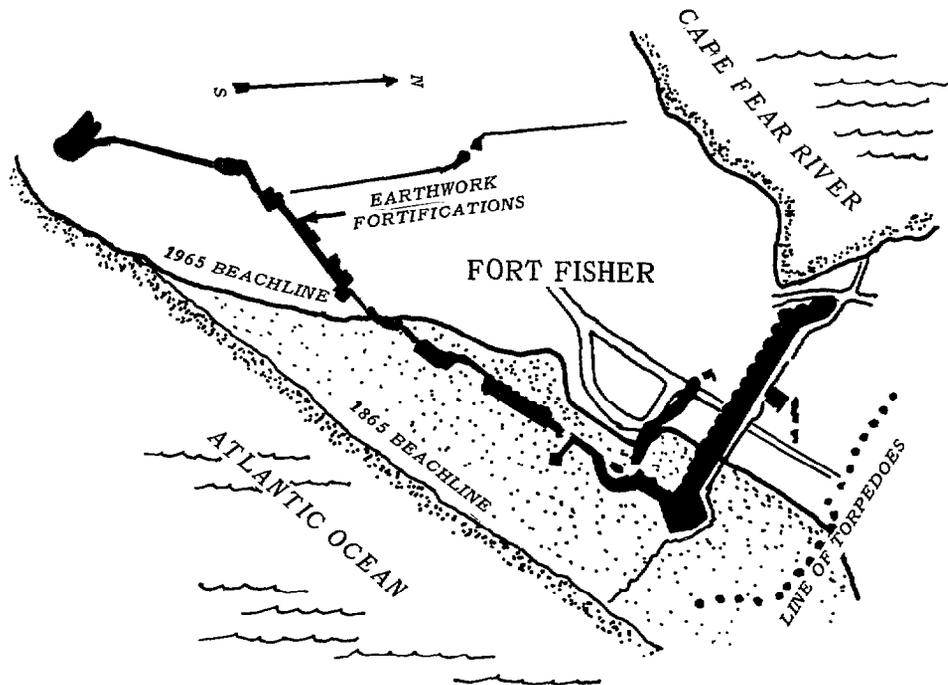
On September 30, 1964, the Senate Committee on Public Works authorized the Corps to study the erosion problem at Fort Fisher to determine whether protection could be provided against the critical erosion that was endangering the historical Fort Fisher State Park. The survey was completed in fiscal year 1971 by the Wilmington district and a project was recommended at a cost of \$2,440,000. A project had not yet been authorized by the Congress at the time of our fieldwork.

The Corps survey reported that the Fort Fisher area has been eroding at a rate of 15 feet each year since 1931. The Corps estimated that without adequate protection, total destruction of the Fort Fisher historical site would occur within 23 years. To date, approximately 630 feet of this Civil War battlefield and earthwork fortification have been lost.

As a temporary measure, the State of North Carolina constructed a limited stone revetment in an attempt to reduce the erosion rate until the Federal project is constructed.

The following map shows the extent of erosion that had taken place at Fort Fisher from 1865 to 1965. By 1965 a large part of the battlefield and earthwork fortifications had already been lost to erosion.

FORT FISHER SHORELINE EROSION--1865 to 1965



Bodie Island

(Source: State of North Carolina)

A multipurpose project was authorized by the Congress in November 1966 at an estimated cost of \$12,080,000 to provide beach erosion control and hurricane protection for 18 miles of shore on Bodie Island. At June 1973 the authorized construction cost estimate was set at \$19,700,000 for this dune and beach project. The project has been delayed due to a lack of local interest and Federal funding and problems in obtaining sand sources.

A severe northeasterly storm in February 1973 caused considerable beach and property damage on Bodie Island. Numerous beach cottages, hotels, and motels were either washed away or toppled by the waves. At certain locations between 30 and 35 feet of beach were lost.

If completed, the hurricane protection feature of this project would result in a 50-foot berm and a 25-foot dune designed to protect shoreline property against this type of storm and to reduce damages along 18 miles of beach area. The picture below shows storm damages to developments along this unprotected shoreline.



Damage at Kitty Hawk section of Bodie Island
after February 1973 storm.

Source: Corps of Engineers

STATE AND LOCAL AGENCY EROSION CONTROL ACTIVITIES

We inquired into State and local agencies' beach and shoreline erosion control project operations. At the local level we noted that the city of Chicago, independent of Federal or State assistance, planned and constructed a structural shore protection system consisting of revetments, seawalls, submerged bulkheads, groins, and beaches on about 22 miles of city-owned lakefront. At other similar locations we noted only limited local government efforts at controlling beach erosion.

We also noted limited project effort underway at the State level for most of the States visited. Each State had, for the most part, limited its participation in the beach erosion effort to providing financial assistance to the

localities involved in Corps projects. Most States require that the general public's benefit must be served before participation is authorized. A review of the efforts of each of the nine States visited, showed varying degrees of interest in the beach erosion problem and attempts by the States in finding solutions. The following are examples of States where some effort has been made at beach erosion control.

California

Since 1946 the State of California's role in shore protection has largely been to cooperate with the Corps in its activities with other local agencies and local governments. California statutes authorized the State to study erosion problems; act as advisor to all agencies of government; and plan, design, and construct protective works when funds are provided by the legislature. It has been the State's policy, however, to only participate in projects when the Federal Government shares part of the cost. The State participates only in those projects designed to protect and restore publicly owned lands. Although not forbidden by State law, the State has not aided private property owners in fighting erosion.

State participation in federally authorized beach erosion projects amounts to one-half of the non-Federal financial contribution. This means that a local jurisdiction could obtain a project where the local jurisdiction pays a 25-percent contribution, the State pays 25 percent, and the Federal Government pays 50 percent of the construction cost. It is estimated that since 1971 the State of California has spent about \$814,000 for shoreline protection. Most of this amount was State contributions to Corps projects.

Compared to the east coast, the west coast has generally been successful "in buying more time" with their erosion programs. Such factors as the influence of the continental shelf, the types and quantities of material transported in the coastal currents, storm frequency, and other acts of nature are chiefly responsible for reducing the impact of erosion in the area.

Florida

The State of Florida and its local governments have constructed and/or sponsored at least 36 erosion control projects since 1963. Corrective measures have included the dredging of inlets and the placement of the sand further down the beach, beach nourishment, groins, revetments, jetties, and breakwaters. The total cost to construct 21 of these projects was estimated at \$3,361,000. Cost data was not available on the remaining 15 projects.

A State review of the 24 State projects approved between October 1964 and June 1970 showed little or no benefits from 12 projects and only temporary benefits from 5 other projects. The State said the remaining seven projects were successful. The State had not reviewed the success of the 12 projects approved since June 1970.

An official responsible for coordinating the State of Florida's erosion control projects said the State's projects are usually completed within 18 to 24 months after they are requested by the local governments.

The official said an average of 1 year is required to study an area, plan corrective measures, authorize a project, and start construction. An average of 4 to 5 months is required for the construction of most projects. These projects involve the same types of protective measures as Corps projects--groins, sloping revetments, jetties, breakwaters, and beach nourishment. (See pp. 34 to 39 for factors contributing to delays in Federal projects.)

Michigan

In 1973 the Michigan legislature appropriated \$370,000 for the construction and evaluation of beach erosion demonstration projects. Ten project areas were selected on the basis of the criteria that the shoreline be public property and in need of structural protection. Of the 18 demonstration projects installed at locations along the Michigan shoreline, 4 were incomplete as of November 1974.

State officials said the State did not plan major expenditures for erosion control projects, but would direct its efforts toward new legislation to (1) set up special assessment districts along the shoreline with the power for raising funds and (2) provide property owners with tax relief for lost land. State law now prohibits the use of State funds for assisting private property owners in combating erosion.

New York

New York State's involvement in shoreline protection began with financial assistance to political subdivisions becoming available in 1946. The State's financial assistance program covers 70 percent of the cost of local projects and a similar percentage of the required non-Federal contribution for Federal projects. Since 1946 it has been estimated that the State and local governments have contributed approximately \$23.2 million to shoreline protective works on at least 122 State- and locally initiated shore protection projects, mostly on Long Island.

About 90 projects have been completed, 5 have been closed or not approved, and 27 projects were underway or their status was unknown.

The State does not participate in beach erosion control projects unless there are widespread public benefits. However, protective works along Long Island's barrier islands have been constructed, including those for the protection of private property, because these islands were vital to the natural protection of the mainland and backshore areas. We were told that requests for projects along the Great Lakes have not been justified since the public benefit for these projects was not widespread.

CONTINUING PROJECT EFFORTS WERE
NECESSARY TO COMBAT EROSION

For various projects where considerable Federal, State, and local funds had been spent over extended periods, continuing efforts were necessary to combat erosion. The following examples illustrate the continuing problems that exist at many locations.

Presque Isle State Park, Pennsylvania

The Corps, together with the State of Pennsylvania, had completed two projects to protect 5 miles of the Lake Erie shoreline at Presque Isle State Park. Beach erosion on this shoreline remains a serious problem. After 17 years and a total cost of \$5.5 million--\$2.4 million Federal share--that was spent on a system of groins, a seawall, and periodic beach sand replenishment, the Corps judged the Presque Isle projects to be a failure for the following reasons:

- The present groin field did not provide satisfactory beach protection.
- Annual sand replenishment necessary to maintain the existing project far exceeded the original estimate and had not been provided.
- The sand fill used in the original project was of too fine a texture to provide a stable beach.

Construction under the first project was started in November 1955 and was completed in August 1956. The second project, a modification of the first, provided Federal assistance for periodic beach nourishment from May 1961 to May 1971. In 1973, because of the criticalness of erosion at the park, the Corps provided \$258,000 in emergency aid in the form of

sand replenishment to save the federally built structures threatened by the high lake levels. At the time of our fieldwork the Corps had under consideration a third project, costing an estimated \$20 million, to restore the beaches by beach nourishment and to protect park property by constructing partial breakwaters. The Congress also had under consideration a project which would provide a maximum of \$3.5 million for beach nourishment over a 5-year period.

Virginia Beach, Virginia

A beach erosion control project covering 3-1/3 miles at Virginia Beach was authorized in September 1954. The project provided for beach sand replenishment and the construction of a system of groins. The beach replenishment placed 1.3 million cubic yards of sand on the beach. The project was completed in July 1953 by local interests, on a reimbursable basis, at a cost of \$705,300, of which the Federal share was \$229,600. The groins, estimated to cost \$1,080,000, had not been constructed because the district office decided that periodic beach nourishment was a more suitable and economic means of maintaining the beach.

Although Virginia Beach assumed responsibility for future beach nourishment, little was done for 8 years. By February 1961 approximately 150,000 cubic yards of the sand placed during the 1953 beach restoration project had been lost.

In March 1962 a storm caused an estimated \$5.7 million of damage to beaches, dunes, bulkheads, and residential and commercial property along the bay and ocean front. Subsequently, \$2,223,000 in Federal emergency funds were spent to restore the beach and dune system and to repair and replace portions of the bulkhead. Corps officials said this effort would provide only temporary protection from future storm damage.

In 1962 the Corps' continued participation in the cost of periodic beach nourishment was authorized for a period of 25 years. The cost estimate for this work was \$4,550,000, with a Federal share of about \$2,270,000. Through fiscal year 1972 the Federal expenditure amounted to \$666,000.

From fiscal year 1964 through fiscal year 1972, an additional 1,395,800 cubic yards of sand were pumped along the beach area. About 65 percent was considered suitable for beach nourishment. At the close of fiscal year 1972, a 357,000-cubic yard sand deficiency existed. This was the lowest sand level at the beach since fiscal year 1964, and it was partially attributable to severe surf conditions during the winter of 1971 and 1972. The city of Virginia Beach

restored the beach with over 300,000 cubic yards of sand. A storm in May 1972 washed away virtually all progress made. In October 1973 we estimated the width of the beach to be between 50 and 75 feet at normal tide and noted that the Corps still considered some of the sand on the beach to be inferior and subject to future severe erosion.

In April 1964 the House Committee on Public Works requested the Corps to study the 38 miles of shoreline at Virginia Beach. The study was completed in September 1970 and recommended a new project which would require an initial 2.5 million cubic yards of sand, with 296,000 yards annually for beach maintenance. This project has been authorized for the general design phase of project development. The estimated construction cost for this project was set at about \$17,010,000, of which the Federal share was estimated at \$11,179,000. The annual beach maintenance cost was estimated at \$338,000, of which the Federal share was estimated to be \$38,000 each year for a period of 25 years. Various officials have stated that without major innovations in erosion control at Virginia Beach, beach nourishment would be required indefinitely.

Cape Hatteras National Seashore, North Carolina

Since the late 1930s the National Park Service, the Corps, and other Federal agencies have spent more than \$21,000,000 on beach erosion control along approximately 75 miles of shoreline at the Cape Hatteras National Seashore. The major objectives have been to save the seashore from beach and dune erosion and to prevent the permanent loss of major parts of the island. The Director of the Park Service said virtually the entire Federal investment had been lost to erosion. Winter storms in 1973 closed the island highway at various points and destroyed several private motels and the Park Service's Coquina Beach, North Carolina, recreation facility. (See photograph on p. 21.)

While beach replenishment was underway in 1972 and 1973, work was interrupted by a series of storms. The Park Service began to realize that its nourishment efforts were not economically justified and in the spring of 1973 began a comprehensive reassessment of its management responsibilities at Cape Hatteras with primary emphasis on its erosion control and dune stabilization program.

In November 1974 the results of this reassessment were presented in an Environmental Assessment which evaluated the following alternatives: (1) let nature take its course and turn the national seashore into a wilderness area; (2) develop

an active resource management program at an annual cost of \$125,000, designate the seashore a natural area, and learn to live with nature; (3) continue present erosion control practices at an estimated cost of \$1 million annually, (4) purchase private property immediately threatened at an estimated 1973 price of \$25 million, or (5) protect the development taking place in the privately owned villages within the seashore at an initial cost of \$40 million to \$56 million and annual maintenance cost of \$3.2 million to \$6.4 million. Public meetings were held in January 1975 to solicit public responses to the assessment, and the Park Service is currently evaluating the various alternatives.

A major consideration in the Park Services' evaluation is the recent scientific studies which indicate that survival of barrier islands such as Assateague Island and Fire Island and areas such as the Indiana Dunes National Seashore is dependent on their ability to adjust to a rising sea level and natural forces impinging on them.

Carolina Beach, North Carolina

A multipurpose project was authorized in October 1962 to provide beach erosion control and hurricane protection for approximately 5 miles of shoreline in the Carolina Beach vicinity. The project provided for berm and dune construction with annual nourishment as needed. Project costs incurred as of April 30, 1973, were \$2,166,574, of which the Federal costs were \$1,386,902.

In April 1965 part of the project was completed by placing about 2.6 million cubic yards of beach fill along 14,000 feet of shoreline at Carolina Beach. Construction of the remaining project segment had been deferred because of lack of local interest.

Rapid erosion occurred along the entire length of beach fill immediately after completing that part of the project. During the first 2 years approximately 43 percent of the total fill material was lost. About 55 percent of this material was lost from the northmost 4,000 feet of the project area.

In March 1967 an additional 360,000 cubic yards of sand was pumped on the beach and a 405-foot stone groin was constructed near the north end of the project. The following year approximately 56 percent of this beach fill was lost to erosion and the majority of the shoreline returned to its previous condition. In November 1969 a severe overwash occurred at the northern end of Carolina Beach. As a result, \$475,000 in Public Law 99 emergency funds were used to construct a 75-foot-wide artificial berm and a 1,100 foot stone seawall.

Considerable erosion has since occurred north and south of the seawall.

In 1973 an additional \$277,811 in emergency funds were spent to extend the seawall, and additional beach nourishment was scheduled for fiscal year 1974. This work, however, will not be completed because of funding limitations. At the time of our fieldwork, district officials stated they were considering requesting additional emergency funding for beach fill and dune construction.

A pictorial history of erosion problems at Carolina Beach from December 1964 to November 1970 is shown on pages 29 to 32.

Miami Beach, Florida

An extensive groin and seawall system has existed at Miami Beach since around 1930. The majority of the steel and timber groins were constructed between 1927 and 1930 under the Federal Government's Protective Works Program. Since 1930 many additional groins have been constructed north and south of these original groins by private interests. The Corps has concluded that this extensive system has neither preserved nor added sand to the beach area. The Corps plans to cover these groins with beach fill under the Dade County, Florida, erosion control and hurricane protection project.

This latest project for the area was authorized in August 1968 to provide beach erosion control and hurricane protection for 10.5 miles of shoreline in Dade County, including 7.6 miles of shoreline at Miami Beach. The project provides for restoring a 50-foot-wide berm along the entire project area and for constructing a protective dune 20 feet wide along 9.3 miles of the project area. Annual beach nourishment will require about 350,000 cubic yards of beach fill. The estimated construction cost is \$57 million with a Federal share of about \$33 million. The beach nourishment cost is estimated at \$812,000 a year with the Federal share estimated at \$462,000.

The Dade County project has been under consideration for a number of years; however, preconstruction planning has now been scheduled for completion in fiscal year 1975.

The photographs on pages 33 and 34 compare the current shoreline condition at Miami Beach with an artist's conception of the beach area upon completion of the Dade County Project.

**PICTORIAL HISTORY OF EROSION
AT CAROLINA BEACH, NORTH CAROLINA
December 1964 to November 1970**

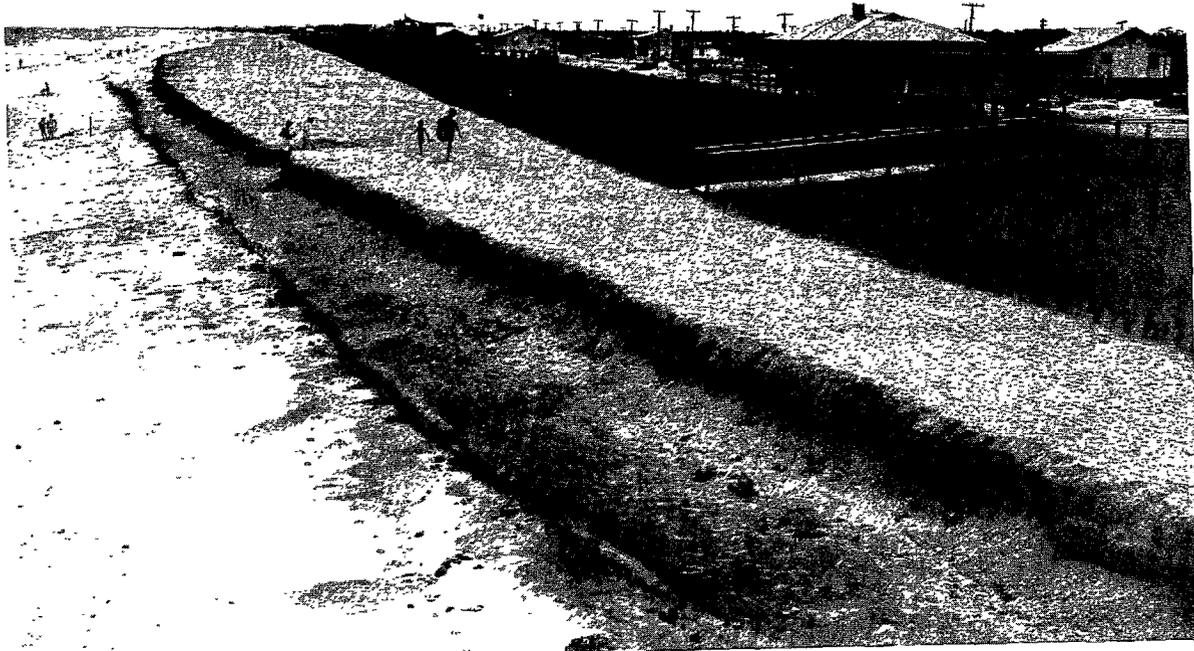


December 16, 1964, before project construction.



April 15, 1965, after completion of sand fill and planting of beach grass.

Source: Corps of Engineers



August 11, 1965, 5 months after construction. Note erosion of beach and rapid growth of beach grass.



June 30, 1966, approximately 16 months after construction. Note extent of erosion of beach, disappearance of grass and earth dike placed by town to prevent flooding of street and sewer system damage.

Source: Corps of Engineers



September 1, 1967, about 29 months after initial construction and 5 months after restoration. Rapid erosion is already underway.



January 15, 1968, about 34 months after initial construction and 9 months after restoration. Note extent of erosion to beach in the 4½ months since last photograph.

Source: Corps of Engineers



March 12, 1969, about 4 years after initial construction and less than two years after restoration, the shoreline has receded to its previous position. Note New Building on shoreline even though serious erosion has taken place.



November 2, 1970, about 5 years 8 months after initial construction and 3½ years after first restoration. Construction of an 1,100-ft. seawall is underway. Sandfill placed for a second restoration and to assist in stone placement was completed on June 20, 1970, and has been virtually eroded away.

Source: Corps of Engineers



Miami Beach, Florida
Current condition

Source: Corps of Engineers



Miami Beach, Florida
Artist's conception of improved beach

Source: Corps of Engineers

FACTORS CONTRIBUTING TO DELAYS
IN PROJECT COMPLETION

Among the factors affecting the completion of authorized projects, the most important is the availability of funds to

Federal, State, and local agencies. Other factors include (1) the reluctance of private property owners to allow public access to the beaches, which is a requirement for Federal participation in beach erosion projects, (2) the inability of Federal, State, and local interests to agree on the Federal financial participation rate, which differs depending on whether the projects are determined as hurricane or flooding protection compared to beach erosion, (3) the inability to locate suitable sand and other source materials, (4) conflict between State laws and local requirements which differ with Federal project development requirements and create obstacles to obtaining cooperation in project development at the local level, and (5) changes in environmental conditions which lessen the public's sense of urgency for project implementation.

Delays in funding

A primary reason delaying the completion of federally authorized erosion control projects is the inability or reluctance of Federal, State, and local governments to provide the necessary funds. For the most part, local governments have shown a lack of interest in providing their share of funds and the necessary cooperation in obtaining the required easements; adequate public access to the beach areas; sufficient parking facilities; and waivers of possible Corps' liability resulting from projects with local funding limitations and a conflict between local, State, and Federal interests.

For example, Corps district officials have informed us that there has been a lack of local cooperation in all 11 incomplete projects in the Jacksonville district. After local cooperation was obtained and local funds were made available for three projects with an estimated total cost of \$54.2 million, the Office of Management and Budget placed the Federal funds authorized for these projects in budgetary reserve.

There has been a similar lack of cooperation in carrying out all five incomplete projects in the Wilmington, North Carolina, district. After local cooperation was obtained for one project with an estimated total cost of \$19.7 million, Federal funds were not requested by the Corps or appropriated by the Congress.

Local interest has been expressed in the project, authorized with an estimated total cost of \$40.5 million, at two of the five Brunswick County beaches in North Carolina. However, funds have not been available to complete the project. Recognizing the problem, the State of North Carolina in 1969 advanced funds to the Corps for preparation of the

design memorandum. In February 1974 the Corps requested the State's approval to classify the project as deferred indefinitely due to a lack of Federal funding and funding from the remaining three municipalities covered by the project.

A lack of funds has delayed the completion of three projects, with an estimated total cost of \$7.4 million, of the seven incomplete projects authorized in the Buffalo district--funds were not requested by the Corps for one project, a second project was not funded by the Congress and was subsequently reclassified as inactive, and funding provided by the Congress for the third project was placed by the Office of Management and Budget in budgetary reserve. Three other projects have been delayed because of a lack of local funding by the participating community.

Two of the six projects in the Chicago district have been delayed due to the reluctance of the local communities to fund the projects, and two additional projects in the district have been delayed because there was no local interest in the projects.

We noted that both projects authorized for the Detroit district had not been initiated because of funding delays experienced by Berrien County, Michigan, and the State of Ohio. We were told that in one case the amount of private property involved made the Federal participating rate low and the financial burden too high for the community, and that in the second case the State of Ohio was considering providing the funds to enable participation in the project.

Reluctance to allow public access

A requirement for Federal participation in beach erosion control projects is that private property owners along the shoreline within the project area must allow public access to the beach. We noted that the reluctance of private property owners to allow the required public access has delayed or prevented the construction of several beach erosion projects.

For example, the Miami beach erosion control project, authorized in August 1968, was opposed by the local hotel owners for a number of years because they refused to allow public access to the beach. The hotel owners viewed the broad, manmade, easily accessible public beach between them and the ocean as impairing their use of the shoreline and as a substantial economic loss of many millions of dollars. They questioned the need for more public beaches, the likelihood of obtaining Federal and State funds, and the financial capability of local governments to fund the added cost of providing the auxiliary public services to a new and wider public

beach. We were advised that in a court case dealing with the condemnation of property needed for the project, the court held that the hotel owners would benefit more from the project than they would lose. Agreements on local cooperation have recently been reached, and preconstruction planning has been scheduled for completion in fiscal year 1975.

Inability to agree on financial participation rate

The inability of Federal, State, and local interests to agree upon the financial participation rate has delayed the completion of some beach erosion control and hurricane protection projects.

This was the case at a multipurpose project to provide beach erosion control and hurricane protection to 83 miles of shoreline on the critically eroded south shore of Long Island from Fire Island Inlet to Montauk Point, New York. The project was to provide basic improvements, such as dune and beach replenishment with groins, for beach stabilization. Authorized in July 1960 and scheduled for completion in June 1968, only a few sections were completed when all construction was halted in November 1970. At issue, in addition to project design and construction sequences, were the applicable cost-sharing ratios.

The State and participating county governments are attempting to obtain a more favorable cost participation ratio from the Federal Government to minimize their financial burden. The State of New York contends that the Fire Island Inlet to Montauk Point project is a single-purpose project, with beach erosion control only incidental to hurricane protection, and wishes to substitute a cost-sharing ratio of 70 percent Federal funds to 30 percent non-Federal funds instead of the 50-50 cost-sharing ratio. The participating county does not want to provide public funds for the protection of private property owners and is not willing to contribute funding in excess of those that would be required by a 70-30 ratio.

The Corps said the beach erosion control aspects were an authorized project and, therefore, the 50-50 cost-sharing ratio should apply. The Corps has also said (1) the project as planned does not achieve the required hurricane protection level and (2) the general-public use of the beaches scheduled for protection is restricted or excluded on over 80 percent of the beaches.

At the time of our fieldwork, a revised completion date had not been determined and the coastal protection needs of the area were being restudied. The impasse has existed for over

4 years and about \$7.7 million has been spent on the project. Since the project's first authorization in 1960, the estimated project costs have increased from \$38.2 million to about \$99 million.

Shortages of sand for beach fill

The inability to locate suitable quantities of sand has delayed beach restoration and nourishment projects at Virginia Beach, Dade County, and Brevard County, Florida. Enormous quantities of sand are needed for these beach nourishment projects, as shown in the following table.

<u>Project</u>	<u>Initial quantity needed</u> (cubic yards)	<u>Annual nourishment quantity needed</u> (cubic yards)
	(000 omitted)	
Virginia Beach	2,500	296
Dade County	15,000	211
Brevard County	1,511	308

Recently the Corps has succeeded in locating offshore sand sources in the Thimble Shoals Shipping Channel in the Chesapeake Bay, which when dredged every 3 years will make an estimated 2-1/2 million tons of sand available for beach nourishment at Virginia Beach. The Corps has also located suitable sand sources 6,000 to 9,000 feet offshore for the Dade County project. At the time of our fieldwork, similar offshore sand sources were also under consideration for use in the Brevard County projects.

Conflict between Federal requirements, State laws, and private interests

We were advised that under existing North Carolina and Florida property laws, private property lines extend to the mean high-water mark. Property lines will thus vary, depending on the position of the high-water mark. Federally sponsored erosion control projects, however, require that property lines be permanently established at a fixed mean high-water mark. As a result, all land accreted after implementation of an authorized beach replenishment project belongs to the State. Private property owners in Brevard County opposed an authorized project that would create a 1,000-foot-wide beach fronting their property. Property owners feared that should

the beach widen by accretion, they would lose direct access to the beach by the construction of a highway between their property and the oceanfront.

Additionally, section 221 of the Flood Control Act of 1970 (42 U.S.C. 1962 d-5b) requires local sponsors of Federal erosion control projects to commit their share of the required funding before starting the construction of the project. On September 16, 1971, the attorney general of North Carolina ruled that to commit unappropriated funds for these projects, it would first be necessary to submit the request for funds to a vote of the people. State and local governments in Florida have also been reluctant to commit funds which would have to be appropriated at some future date.

Changes in environmental conditions

Changing environmental conditions along the ocean and the Great Lakes shorelines influence the willingness of communities to provide local cooperation in the Corps' beach erosion projects. Many projects were authorized when the lake levels were high, but, by the time the projects were ready to be constructed, lake levels dropped so that they were less of a threat to the shoreline. As a result, the interest of the community to provide local cooperation lessened with the decreased threat.

For example, in January 1952, when lake levels were high, the Corps completed a study which resulted in the authorization in September 1954 of a beach erosion control project to construct two steel sheet pile groins at Lake Bluff, Illinois. At that time the cost was estimated at \$34,000. After the project's authorization, lake levels receded and the city lost interest in the project. In the early 1970s lake levels were up and the city expressed renewed interest in the project. A contract was entered into between the city of Lake Bluff and the Corps in December 1972. In 1974 the cost of constructing the two groins was estimated at \$224,000. At the time of our fieldwork, the construction contract had not been signed.

Another condition which can affect project completion is water pollution. This was one of the reasons delaying the completion of the \$3 million project in the Buffalo district to construct breakwaters to protect the beach at Fort Niagara. The pollution necessitated the closing of the public beach that the project was to protect and maintain.

PROBLEMS INVOLVED IN PROTECTING PRIVATE PROPERTY

Private property accounts for about 70 percent, or 25,800 miles, of the U.S. shoreline, excluding Alaska. According to the National Shoreline Study, critical erosion is occurring on about 1,800 miles of private property. This represents about 70 percent of the U.S. shoreline undergoing critical erosion.

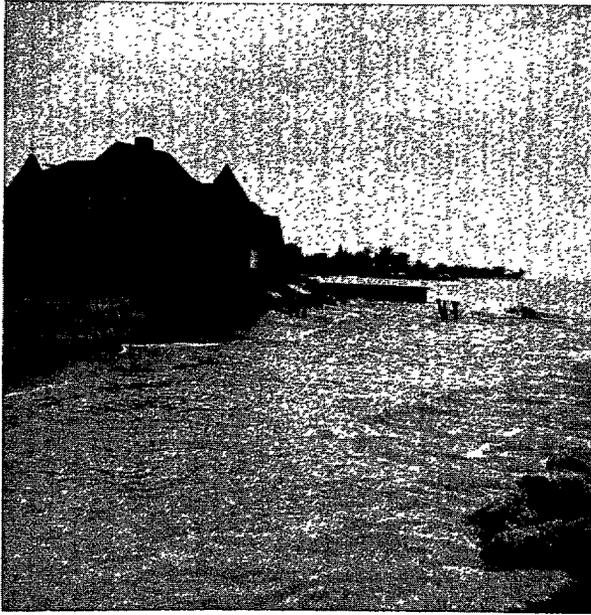
One of the areas where a large part of the U.S. shoreline is privately owned and undergoing critical erosion is on the Great Lakes. About 82 percent, or about 3,030 miles, of the lakes' shoreline is privately owned. According to the Shoreline Study, about 70 percent of the critically eroding areas on the Great Lakes, or about 150 miles, are privately owned residential property. Much of the shoreline in residential areas is unprotected. Very serious damage to private property has occurred in these areas, including the complete destruction of private homes. The following photographs illustrate the extent of damages caused to the shoreline and to private residences by flooding and erosion.

The construction of seawalls and groins or other structures in the affected areas could lessen damages to private property along developed shorelines in high-risk areas. However, their cost to install and maintain would be beyond the financial means of many residents.

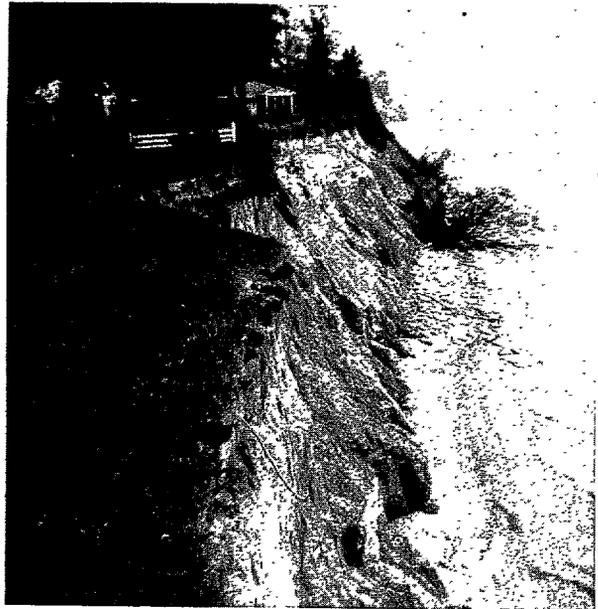
LIMITS ON SOLUTIONS FOR PRIVATE PROPERTY OWNERS

Few private property owners on the coastal and Great Lakes shorelines suffering erosion damage qualify for Federal financial assistance. Generally the Federal Government's responsibility for shoreline erosion protection is limited to publicly owned land areas or areas to which the general public is granted access. Limited Federal cost sharing is also available to protect private property if a project is required to complete a protective measure for other publicly owned lands or results in substantial public benefits. Federal funds can also be used to protect private property if a project is undertaken to correct erosion caused by the construction of Federal navigation works.

In December 1973 the Flood Disaster Protection Act of 1973 (42 U.S.C. 4002) increased the limits of coverage and the amount of insurance authorized on privately owned property under the National Flood Insurance Program. Under the program, designated flood-prone communities are required to



Flooding endangering private residence in Winthrop Harbor, Illinois (September 1973).



Eroding bluff cutting away backyard of private residence in South Haven, Michigan (September 1973).



Damage to a private residence at Indiana Dunes National Shoreline, Indiana.



Two timber pile seawalls were constructed to protect the eroding bluff. Both seawalls have failed and water is reaching the base of the bluff. A large area of the hillside has been undermined and the sod and trees are on the slope just above the water.

adopt local land-use control measures before property owners in the community can qualify for the subsidized insurance. The act provides for insurance protection against damage and loss resulting from erosion and the undermining of the shoreline by waves or currents which exceed anticipated cyclical levels. The act does not require private property owners to provide public access to their beaches before participation.

The Congress has recognized the problem of damage due to erosion of privately owned property on U.S. shorelines and the limited solutions to this problem. As a result, several bills were introduced in the 93d Congress, such as S. 1161, H.R. 2456, and H.R. 3311. H.R. 3311 would have amended the River and Harbor Act of August 13, 1946 (33 U.S.C. 426, e though h), to provide for Federal participation in the cost of protecting privately owned property from erosion. None of these bills were enacted into law.

Other legislation introduced in the 93d Congress would have provided the following:

- Federal assistance to protect shorelines against erosion on an emergency basis for the benefit of private, as well as public, properties (H.R. 5888, H.R. 6368, and H.R. 6670).
- Federal disaster assistance for reconstruction and rehabilitation of public and private areas affected by extraordinary shoreline erosion damage (S. 1267, H.R. 5889, and H.R. 6013).
- Federal reimbursement to responsible non-Federal public entities for undertaking repair of shore damages attributable to Federal navigation works (H.R. 5890, H.R. 6672, and H.R. 6015).
- Federal assistance to States adjacent to the Great Lakes in acquiring shoreland, including privately held shoreland areas which need to be protected because of unique recreational value (S. 2759).
- Federal assistance to landowners in the Great Lakes Basin area to assist them in changing their cropping systems and land uses to control erosion on farms, ranches, and other lands (H.R. 6537).

None of this legislation was enacted.

PROJECT DEVELOPMENT AND RESEARCH EFFORTS

CERC's mission is to conduct laboratory and field research and development in the coastal engineering area and to publish the findings. It also provides consulting services to district and other Corps offices as well as to Federal and State groups upon request. CERC's role as it relates to beach erosion projects is to provide the project review function for the Board of Engineers for Rivers and Harbors. We found, however, that CERC does not have a clearly defined role in the planning and development of individual projects and that the review process takes place after the district office has surveyed and planned the project in detail.

At the districts visited, we inquired as to CERC's contribution in the planning of individual projects. Although the results of CERC's research were made available to the district offices in the form of technical manuals and reports, and CERC, upon request, was to provide consulting services in the planning of projects, we found no indication of CERC participation in individual project development. Officials at the CERC headquarters and district levels were also not able to specify which projects CERC assisted and the types of assistance CERC provided. One reason the Corps cited for the lack of success of beach restoration projects at Presque Isle (see pp. 24 and 25) was the use of sand which was not heavy enough to withstand the wave action on these beaches. With greater CERC involvement in the planning and design of these projects, this problem might have been avoided.

Regarding further contributions to project development by the Corps' research effort, we noted that the Shoreline Erosion Control Demonstration Act of 1974 provides for Corps development of new prototype methods for erosion control. Over a 5-year period, \$8 million has been authorized for development of engineering and vegetative protective measures at about 16 demonstration locations under the direction of the Chief of Engineers through a Shoreline Erosion Advisory Panel. It is anticipated that CERC, as well as private agencies, will be involved in these projects.

In our discussions with CERC officials regarding CERC's contributions in project development, it was agreed that a need still exists for more CERC involvement in the area. Such additional contribution by CERC should result in improved project effectiveness.

PROBLEMS IN CONTROLLING THE WATER LEVELS OF THE GREAT LAKES

Excesses or deficiencies in precipitation cause variations in the lake levels. Excess waters from one lake are discharged through connecting channels into the next lake downstream in the system. When the inflow to any one lake exceeds outflow, its level rises; conversely, when the inflow is less than outflow, the level falls.

Both low- and high-water levels can cause extensive damage to public, commercial, and private interests. However, the requirements of these interests are varied and might be in direct conflict with each other. Generally, navigation and power interests are enhanced by high lake levels; shore property interests are benefited by low lake levels. The fluctuations between the extreme low and extreme high monthly water levels vary from lake to lake.

Regulating water levels is one method which has been considered for reducing shoreline erosion and flooding damage. To achieve control of the water flow, manmade regulatory works would be required at the outlets of each of the lakes, except for Lakes Michigan and Huron which would require regulatory works located at the head of the St. Claire River. The levels of Lakes Superior and Ontario are regulated. The levels of Lakes Michigan, Erie, and Huron are unregulated.

The Corps completed a report on the feasibility of regulating these three lakes in 1965. At that time it was estimated that initial costs for locks and channels for regulating Lakes Michigan and Huron were estimated at from \$726 million to \$1.6 billion and for Lake Erie at \$188 million.

In October 1964 the Governments of the United States and Canada requested the International Joint Commission to determine whether further regulation of the Great Lakes levels would be practicable and in the public interest for the purposes of improvements in flood control, domestic water supply and sanitation, navigation, water for power and industry, agriculture, fish and wildlife, recreation, and other public purposes.

The International Joint Commission established the International Great Lakes Levels Board in December 1964 to undertake this investigation. In a report released to the International Joint Commission in February 1974, the Board generally concluded that further regulation of lake levels was not economically feasible. The report acknowledged, however, that two preliminary plans for the continued regulation of Lakes

Superior, Erie, and Ontario showed a favorable benefit-cost ratio and would result in a slight modification of these lake levels.

The Board suggested further investigation, on the basis of the 1900-73 period, the above-normal precipitation, and the resulting above-normal lake levels of 1973 and 1974, which exceeded any average levels during the 1900-67 selected study period. The Board's report emphasized that the most promising measures for minimizing future flooding and erosion damage was strict land-use zoning and structural setback requirements, which limit how close to the shoreline buildings can be constructed. The report stated that if such measures were not instituted and enforced, future development would continue to follow the general lake levels, that construction would continue as near the water line as possible, and that total shoreline damage would continue to increase.

In July 1972 a Great Lakes Basin Commission report commented on the feasibility of regulating lake levels. The report stated that, while further lake regulation would result in some reduction of erosion damage to shore property, it was not economically feasible to maintain lake levels at a constant elevation, even under regulated conditions.

CONCLUSIONS

We believe that progress in controlling erosion on the Nation's shoreline and coastal areas has been slow. Also, in many cases where substantial and costly erosion control projects had been completed, they did not prove to be permanent solutions and continuing and costly project efforts were necessary to combat erosion. At present, no structural solution has been devised which will insure the permanent preservation of the Nation's shoreline and coastal areas. We believe that even though the results of CERC's research were made available to the district offices in the form of technical manuals and reports and CERC's consulting services, minimal use of these services has been made in individual project planning. We believe that with greater CERC input in project planning and design, optimum use of the application of CERC research can be made, and that the technical problems, such as those experienced at Presque Isle and in the construction of the coastal inlet at Carolina Beach, might be avoided.

The serious erosion and flooding condition caused by the current high lake levels, on the Great Lakes shorelines has resulted in considerable losses of public and private property. Both the Great Lakes Basin Commission and the

International Joint Commission have concluded that a comprehensive system of further lake regulation to reduce property damages is not economically feasible at the present time. However, consideration is currently being given to modifying existing structures at Lake Superior which would provide limited additional regulation.

In addition, most of the shoreline on the Great Lakes is privately held and such property cannot be included within the scope of Federal projects under the current criteria for Federal financial participation. Because of such problems various legislative proposals for Federal assistance and participation in programs for protecting privately owned property have been introduced in the Congress.

RECOMMENDATIONS TO
THE SECRETARY OF THE ARMY

The extensive and continuing development of the Nation's coastal areas and the Great Lakes shoreline highlights the necessity for the Corps' developing viable project solutions to prevent or lessen beach erosion and flooding damage. Therefore, we recommend that the Secretary require more direct involvement on the part of CERC in individual project planning and development to enhance more effective use of the knowledge gained by CERC's research efforts into beach erosion.

AGENCY COMMENTS AND GAO EVALUATION

By letter of April 21, 1975 (see app. IV), the Department of the Army agreed that CERC has the responsibility to consult with and assist Corps field and headquarters level personnel in their individual planning efforts, and that there might be a need for more uniform and productive use of CERC's advisory reviews in this area. It said, however, that CERC should not be assigned individual project planning responsibilities which would duplicate those of other Corps personnel.

In our opinion, the additional emphasis to be provided by CERC into the project planning effort should intensify the planning now being done by Corps field and headquarters office staffs. We also agree that CERC's efforts should not duplicate existing planning work.

CHAPTER 4

ENCROACHMENT OF DEVELOPMENT ON THE SHORELINE

In recent years the Nation's coastal areas and the Great Lakes shoreline have experienced increased economic development and population growth. This has contributed to a severe erosion problem and widespread damage to property in erosion-prone areas.

The Congress, recognizing that State and local programs for planning and regulating land and water use were often inadequate, enacted the Coastal Zone Management Act of 1972. This act provided for the establishment of national policies for the management of the land and water resources of the Nation's coastal zone. To carry out these policies a Federal grant program was started within the Department of Commerce for Federal participation in the development, implementation, and administration of State coastal zone management programs.

The act provides that the State programs establish objectives, policies, and standards to guide public and private uses of lands and waters in the coastal areas. At the time of our review, progress in carrying out this program had been slow since the act had been recently enacted.

The Department of Commerce had established a group within the National Oceanic and Atmospheric Administration to administer the program. The initial appropriation of \$12 million for fiscal year 1974, of which \$7.2 million was applicable to the Federal grant program, was being used to aid the States in developing their coastal zone plans.

Delays in funding and increasing pressure for the development of the shoreline has made the objective of controlled use of the coastal zone more difficult to achieve. For example, by the year 2020, the population of the Great Lakes area is estimated to increase from the present 29 million to about 53 million. As the construction of suburban residences, vacation homes, and hotel and tourist accommodations increases in the coastal areas, controls over the development of the shoreline will become increasingly more important.

DEVELOPMENT RECOGNIZED AS A
CAUSE OF EROSION PROBLEM

Development along the shoreline begins with the destruction of a natural dune system. When the dunes are removed to make way for construction, a major sand supply for replenishment of the beaches is lost. The erection of buildings is the next step in a series of related factors contributing to accelerated erosion. Once the buildings are constructed, they are often defenseless against extensive storm damage and flooding unless protective measures are taken. Seawalls and bulkheads are widely used methods of protecting against these hazards. Although these walls protect property behind them, they often accelerate erosion on the ocean side. During storms when the ocean lashes against these hard surfaces a large amount of wave energy is concentrated on the base of the structure where it meets the beach. This energy forces large quantities of sand away from the wall and out to sea, thereby increasing the erosion rate.

A 1972 draft report of the Great Lakes Basin Commission (see p. 14) points out that development of not only the shoreline but also the upper shoreland areas will continue and that indiscriminate development will accelerate erosion and the permanent loss of resource value. The report states that time is an important factor and that if meaningful measures controlling future land use are to be taken, it will do little good to adopt them after further development takes place. At the close of calendar year 1970, about 40 percent of the Great Lakes shoreline had already been developed.

Examples of how development has contributed to the erosion problem at two major recreational areas follow.

Miami Beach

Miami Beach is considered one of the most luxurious and densely developed resort areas in the world. To protect the costly string of hotels, motels, and other tourist accommodations built along the beach, about 7-1/2 miles of seawalls were constructed. (See photograph on p. 33.) The city of Miami Beach erected some of these walls as early as 1927.

In 1967 the Corps surveyed the erosion problem at Miami Beach and concluded that the seawalls had adequately protected the upland property but that the direct wave

action against the seawalls caused accelerated erosion of the beach. During our visit we observed that the ocean was lashing against the seawall, and that virtually no beach existed to the seaward side of the seawall.

In 1968 the Congress authorized a beach replenishment program for the area with the latest estimated construction cost of \$57 million to place about 15 million cubic yards of sand on the oceanside of the seawall. Recently adequate public access was assured and the Corps is proceeding with finalizing preconstruction planning. (See p. 34.)

Virginia Beach

The primary resort area of Virginia Beach is a 3-1/2 mile stretch along the Atlantic Ocean. Many of the hotels, motels, and other buildings in this area do not have foundations which provide adequate protection from coastal flood waters. These structures are susceptible to flood damage because their first-floor levels are below the projected flood level. To protect the upland development at Virginia Beach, local interests constructed a concrete bulkhead and promenade in 1927.

A Corps survey completed in 1970 recommended improvements to the existing bulkhead, including its extension to protect recently constructed oceanfront development. The Corps said greater emphasis must be placed on dune preservation and controlled development at Virginia Beach. The Corps concluded that well-managed development would result in saving lives and property in the future. A committee composed of members from the Corps, the city of Virginia Beach, and the Virginia Beach Erosion Commission concluded in a 1972 report that the removal of the dune ridge and the hardening of the oceanfront by bulkheads and the boardwalk were contributing factors to the beach erosion problem.

At the time of our review, the city of Virginia Beach and the State of Virginia had not established a coastal zone management program as recommended by the Corps.

Even though the erosion problem continues to persist, the city continues to grant permits for constructing high-rise motels and condominiums. At the time of our visit, a number of high-rise condominiums and motels were under construction on oceanfront and bayfront areas of Virginia Beach. Although emphasis has been placed on better designs for new construction, there are few controls or restrictions on shoreline development.

Through fiscal year 1972 the Federal Government had contributed about \$3,100,000 to beach erosion at Virginia Beach; however, no permanent solution has been reached and a serious erosion problem will continue to exist. (See pp. 25 and 26.)

EXISTING AND PROPOSED STATE LIMITATIONS ON COASTAL DEVELOPMENT

As mentioned earlier the State governments have taken little action to establish coastal zone management programs. Of the nine States that we visited, only four States--California, Florida, Michigan, and North Carolina--have enacted State coastal zone management programs, although the Florida program will not be fully implemented until 1975.

California

An initiative known as Proposition 20, the "Coastal Zone Conservation Act," was approved by the voters of California on November 7, 1972. The act provides for a means of controlling the present and future use of the California coastline.

Specifically, the act created the State Coastal Zone Conservation Commission and six regional commissions whose duties include:

- Establishing a long-range plan for submission to the State legislature by December 1, 1975, for the preservation, restoration, and enhancement of the coastline environment and ecology.
- Controlling coastal development activities on the shoreline up to 1,000 yards above the high-tide line and seaward to the extent of existing State jurisdiction.

To carry out these activities, the State appropriated \$5 million for use in calendar years 1973-76.

Florida

In 1970 the State of Florida established a construction setback line of 50 feet from the mean high-water line. By 1971 the State realized that 50 feet was not adequate, and legislation was enacted for the State Department of Natural Resources to establish variable setback lines. The setback

lines are to be developed for 25 coastal counties having sandy beaches. All setback requirements are expected to be completed by early 1975.

The setback lines are to be developed after considering ground elevations in relation to historical storm and hurricane tides; predicted maximum wave uprush; beach and offshore ground contours; the vegetation line; erosion trends, the dune or bluff line, if any exists; and any existing upland development.

Michigan

Michigan is active in promoting shoreline management on the Great Lakes. The U.S. Water Resources Council has been providing funds for use in the State's water resources management programs since 1967; in recent years the State has received about \$74,000 annually. In 1970 the State legislature passed the Shorelands Protection and Management Act. This act directed that the State Water Resources Commission establish rules to regulate the uses and development of shoreline high-risk and environmental areas.

The State has studied the shoreline on an annual basis since 1971. It has completed a shoreline plan and has drafted rules to carry out the plan and the 1970 act. In accordance with the act, the State is obtaining erosion rates for use in establishing building setbacks from the shoreline. It has notified all local agencies having zoning authority for shoreline high-risk and environmental areas so that these authorities can regulate the development of such shoreland areas by zoning. We were told that if these local agencies did not establish the necessary setback lines by July 1975, the State had the option to enact the necessary zoning regulations.

North Carolina

In April 1974 the State of North Carolina enacted legislation to regulate the development of the coastal area. A 15-member commission was established to examine the coastline of the State and to designate areas of environmental concern, including dunes, wet lands, estuarine zones, and marshlands, important to the preservation of the environment. It is expected to take from 18 to 24 months to complete this classification process. A permit program has also been enacted which requires commission approval on the development of any area greater than 60,000 square feet within an area of environmental concern, although setback lines were not to be established.

EFFECT OF NAVIGATION PROJECTS ON BEACH EROSION

With increased development of the coastal zone as resort and recreation areas, access to the ocean and additional harbor and marina facilities became essential. To provide these additional navigation facilities, Federal, State, and local agencies have sponsored projects for the construction of coastal inlets and related navigational structures. At the time of our fieldwork, there were about 730 Corps-sponsored navigation projects, the majority of which were in coastal areas and could have had an impact on erosion.

Corps officials have stated that in areas of considerable littoral drift, harbors and inlets generally contribute to beach erosion. When this occurs, sand accretes to one side of the navigation project and erodes on the opposite side. Sand can also accrete in the project channels, which, in turn, may require periodic dredging to maintain a satisfactory water depth. When the channels are dredged, sand may be available for beach replenishment.

The following examples illustrate navigation projects which have had an adverse effect on beach erosion. Each project has contributed greatly to erosion of neighboring beaches.

Carolina Beach Inlet, North Carolina

Local interests requested permission from the Corps to dredge a channel through the barrier beach to connect the Atlantic Ocean and the Atlantic Intracoastal Waterway at Carolina Beach. Corps officials recognized the potential beach erosion that could result and advised local interests not to construct the inlet. Because of strong local interest, however, the Corps gave permission to construct the inlet, and it was completed in September 1952.

Immediately after development of the inlet, severe erosion occurred on the southward beaches. During the 17-year period, 1952-69, Carolina Beach Inlet entrapped over 4 million cubic yards of littoral material.

In a 1970 study of the Carolina Beach erosion problem, the Corps said the most direct and economical means of correcting the problem was to close the Carolina Beach Inlet. The closing of the inlet, however, would be incompatible with a congressionally authorized navigation study to determine the advisability of modifying the existing inlet. The study is scheduled for completion in fiscal year 1976.

If maintenance of the Carolina Beach Inlet is found to be in the public interest, the Corps is considering an alternate beach stabilization plan. This plan involves the mechanical bypassing of material entrapped within the inlet to the north end of Carolina Beach. A decision on the erosion problem at Carolina Beach will not be made until after the completion of the navigation study.

Rudee Inlet, Virginia

Rudee Inlet was opened at the south end of Virginia Beach in June 1952. The inlet was improved with jetties and related bulkheads a year later. Soon after the jetties were completed, rapid erosion occurred on the beach immediately north of the inlet. A study by the Institute of Oceanography, Old Dominion University, said that the barrier effect of the stabilized inlet caused the rapid erosion. A fixed dredging plant was installed at the inlet in 1954 to bypass sand to the northern beach. The plant operated with limited success until it was destroyed by a storm in March 1962.

In July 1967 Rudee Inlet was again improved to provide additional harbor facilities for the Virginia Beach resort area. Improvements consisted of extending the north jetty, constructing a new south jetty, and dredging a sand trap within the inlet. A floating dredge was used to transfer trapped sand to replenish the northward beach. Because of inadequate equipment and changing environmental conditions, the dredging operation has not provided an adequate sand supply for the northward beach, and the beach continues to erode.

St. Lucia Inlet, Florida

St. Lucia Inlet, a manmade inlet, was opened near Stuart, Florida, in 1892. Since that time, Jupiter Island, south of the inlet, has had severe beach erosion problems. A study by the University of Florida reported that Jupiter Island lost 350 acres of land between 1892 and 1898 and 380 acres between 1929 and 1946. In addition, a Corps study in 1968 reported that the 16 miles of shoreline immediately south of St. Lucia Inlet had receded an average 6 feet annually between 1892 and 1964.

A board member of CERC said Jupiter Island is the worst eroding area in Florida. He said St. Lucia Inlet has entrapped over 8 million cubic yards of sand since it was opened and was the major cause of erosion in the area.

In addition, local officials of Jupiter Island have said the cause of Jupiter Island's erosion problem is clearly the St. Lucia Inlet, which intercepts the normal and natural flow of sand to feed the Jupiter Island beach. According to Corps District officials, the inlet channel and jetty constitutes a littoral drift barrier, and a need exists for sand transfer across the inlet.

In May 1973 the Congress asked the Corps to study the erosion problem on Jupiter Island to determine methods of controlling the severe erosion. At April 1975 the problem was being studied.

RESPONSIBILITY FOR DAMAGE TO THE SHORELINE CAUSED BY NAVIGATION PROJECTS

Under the River and Harbor Act of 1968 (33 U.S.C. 426i), the Corps is authorized to investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works. Where the Corps' navigation works cause damage to adjoining shoreline, there is Federal liability to pay the full cost of installing, operating, and maintaining such projects.

For all regular erosion control projects, the Federal cost share is limited to 70 percent for public property and 50 percent for private land with public access. Most owners of private property do not receive Federal aid because they refuse to allow public access.

The potential effect of the act is threefold. First, it makes the Corps responsible for damages caused by Federal navigation structures. Second, the benefits of the mitigation will accrue to private property owners for the most part. Third, construction of erosion control projects adjacent to the navigational structures will directly relieve part of the critical erosion along the national shoreline.

Although the full impact of the act has been negligible to date, the Corps has been receiving numerous requests for studies. Nationwide, 2 projects have been authorized and 35 preliminary (reconnaissance) studies have been undertaken. Seventy-seven percent of these studies cover areas along the Great Lakes shoreline.

Recent work at five of the district offices we visited provides some insight into the potential effect of the act on the Corps and on the problem of erosion. A total of

27 Corps preliminary studies have been authorized in the Buffalo, Chicago, Detroit, Jacksonville, and Wilmington districts. Twenty-one of these surveys have been completed, and it has been positively concluded that 14 navigation projects are a major cause of erosion.

CONCLUSIONS

Development of the Nation's coastal and Great Lakes shoreline areas greatly contributes to property losses in erosion-prone areas. Although the recently enacted Coastal Zone Management Act provides for States to establish policies for the management of the land and water resources of the Nation's coastal zone, the States' progress in carrying out its provisions has been slow. Unregulated development of the coastal areas continues. In addition, the construction and operation of federally sponsored navigation projects continues to adversely affect the Nation's shoreline and coastal areas.

CHAPTER 5

SCOPE OF REVIEW

Our review of the beach erosion and shoreline protection activities in the United States was conducted at the Corps headquarters office and eight selected district offices-- Buffalo, Chicago, Detroit, Jacksonville, Los Angeles, New York, Norfolk, and Wilmington.

We interviewed officials of CERC and of the National Oceanic and Atmospheric Administration, Department of Commerce.

Also, we obtained information and met with representatives of various commissions, universities, and State and local governments in California, Florida, Illinois, Indiana, Michigan, New York, North Carolina, Ohio, and Virginia that were directly involved with activities discussed in this report. A listing of review locations is provided in appendix III.

We selected for inclusion in the report the information which we believed best described the progress that had been made and the problems being encountered in protecting the Nation's shorelines.

CORPS BEACH AND SHORELINE EROSION PROJECTS

COVERING CRITICALLY ERODED SHORELINES

District office	Shoreline miles (note a)		Projects authorized		Critical miles covered by projects			
	<u>Total</u>	<u>Critical</u>	<u>Total</u>	<u>Completed</u>	<u>Authorized Miles</u>	<u>Percent</u>	<u>Completed Miles</u>	<u>Percent</u>
Buffalo	619	46.7	9	2	8.5	18.2	5.0	10.7
Chicago	626	49.5	8	2	.8	1.6	-	-
Detroit	1,585	99.1	2	-	.1	.1	-	-
Jacksonville	5,957	171.0	15	4	97.0	56.7	6.6	3.9
Los Angeles	436	55.0	10	6	26.8	48.7	4.5	8.2
Norfolk	993	258.0	2	2	3.6	1.4	3.6	1.4
New York	685	332.0	10	1	106.0	31.9	6.0	1.8
Wilmington	<u>3,661</u>	<u>539.0</u>	<u>8</u>	<u>3</u>	<u>118.6</u>	<u>22.0</u>	<u>9.5</u>	<u>1.8</u>
Total	<u>14,562</u>	<u>1,550.3</u>	<u>64</u>	<u>20</u>	<u>361.4</u>	<u>23.3</u>	<u>35.2</u>	<u>2.3</u>

a/ Includes shoreline miles directly attributed to district responsibility. For study purposes, mileages also included areas located in other districts. (See ch. 3.)

CORPS BEACH AND SHORELINE EROSION PROJECTSDELAYS IN PROJECT COMPLETION

<u>District</u>	<u>Number of completed projects</u>	<u>Average time to complete project from date of local request</u>	<u>Number of incomplete projects</u>	<u>Average time from date of local request to date of our fieldwork</u>
Buffalo	2	11 yrs. 5 mos.	7	21 yrs. 4 mos.
Chicago	2	12 yrs. 5 mos.	6	25 yrs. 6 mos.
Detroit	-		2	18 yrs. 4 mos.
Jacksonville	4	8 yrs. 7 mos.	11	14 yrs. 5 mos.
Los Angeles	6	a/7 yrs. 7 mos.	4	16 yrs. 4 mos.
New York	1	12 yrs. 2 mos.	9	12 yrs. 1 mo.
Norfolk	2	5 yrs.	-	
Wilmington	<u>3</u>	<u>13 yrs. 10 mos.</u>	<u>5</u>	<u>17 yrs. 1 mo.</u>
	<u>20</u>	<u>9 yrs. 8 mos.</u>	<u>44</u>	<u>17 yrs. 2 mos.</u>

a/ This average is based on four of the six projects. The dates of the local requests were not available for two projects.

GAO REVIEW LOCATIONS

FEDERAL:

U.S. Department of the Army	
Corps of Engineers	
--Office of Chief of Engineers	Washington, D.C.
--Division Office	Chicago, Ill.
--District Offices	Buffalo, N.Y.
	Detroit, Mich.
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National Oceanic and Atmospheric Administration	
--Headquarters	Washington, D.C.

Department of the Interior	
National Park Service	
--Headquarters	Washington, D.C.

STATES:

The Resources Agency of California	Sacramento, Calif.
Florida Department of Natural Resources	Tallahassee, Fla.
Illinois Department of Business and Economic Development	Springfield, Ill.
Indiana Department of Natural Resources	Indianapolis, Ind.
Michigan Department of Natural Resources	Lansing, Mich.
New York State Department of Environmental Conservation	Albany, N.Y.
North Carolina Department of Natural and Economic Resources	Raleigh, N.C.
Ohio Department of Natural Resources	Columbus, Ohio
Department of Conservation and Economic Development	Richmond, Va.

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Great Lakes Basin Commission

Great Lakes Commission

International Joint Commis-
sion

Virginia Beach Erosion

Commission

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Ann Arbor, Mich.

Chicago, Ill.

Virginia Beach, Va.



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY

WASHINGTON, D.C. 20310

21 APR 1975

Mr. Henry Eschwege
Director, Resources and Economic
Development Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

Representatives of our respective offices held a very helpful meeting on 2 April 1975 to discuss [See GAO note] the draft report "National Efforts to Preserve the Nation's Beaches and Shorelines - A Continuing Problem" (OSD Case #3967). Apparently, there had been some misunderstanding about the recommendation for the Corps to periodically monitor the Nation's beaches and shorelines.

Enclosed as a follow-up to the meeting is an Information Paper which describes the Corps' new program for collecting coastal engineering data and further defines the responsibility of the Coastal Engineering Research Center.

We appreciate the opportunity to provide this additional information.

Sincerely,

Charles R. Ford
Deputy Assistant Secretary of the Army
(Civil Works)

GAO note: Material has been deleted because it refers to comments received in a letter dated February 28, 1975, which has been superseded.



INFORMATION PAPER

'National Efforts to Preserve the Nation's Beaches and Shorelines -
A continuing Problem'' (OSD Case No. 3967)

The field offices of the Corps of Engineers investigate shorelines when needed to meet the requirements of authorized studies and projects. If sufficient studies are accomplished over the years, considerable data will be collected, much like in a monitoring program.

To supplement their shoreline investigations and using existing authority, the Corps has requested \$150,000 in Fiscal Year 1976 to initiate a new program of field collection of coastal engineering data to optimally develop functional and structural coastal project designs, to economically evaluate alternative solutions to coastal problems, and for general planning applications. The estimated Fiscal Year 1976-80 program cost is over \$2.5 million. Long-term statistical data on physical environmental parameters, such as wave climate, the location and quantity of sand resources, and erosion/accretion rates along the shoreline and backshore areas are necessary for beach erosion control, hurricane/storm protection, and coastal navigation studies, as well as for broad overall coastal zone planning.

This program is being established to provide on a more timely basis the base-line data necessary for adequate assessment of the economic and environmental feasibility of specific coastal projects. Data will be collected by field offices of the Corps at representative coastal sites where erosion and accretion rates indicate that specific site studies may be requested by the Congress.

In addition to the Corps' own effort, the new program will involve extensive use and coordination of the efforts of State and local government agencies, private organizations, and other Federal agencies in the critical areas of acquiring wave-gage data; visually

observing surf and nearshore currents; profiling longterm, seasonal and storm-induced beach, dune, and nearshore changes; cataloging available coastal aerial photography; and quantifying offshore sand resources for potential beach nourishment requirements.

The present investigative program and the new program should eventually result in a reasonably complete nationwide data base. To expand the program any more would require a substantial increase in funding over that which has been budgeted.

The Coastal Engineering Research Center (CERC) has in its mission a limited monitoring program: "... determination of probable effects of ... works on adjacent shores, ..." Specifically, CERC plans and performs laboratory, field, and theoretical studies in support of the CERC research mission, with emphasis on sediment motion as it is related to beach erosion and shoaling in coastal waterways. Also, CERC is responsible for developing, compiling, and analyzing laboratory and field data, including data which are photographic and remotely sensed, on the behavior of coastal works. CERC has the responsibility to consult with and assist Corps field and headquarters level personnel in their individual planning efforts, and there may be a need for more uniform and productive use of CERC's advisory reviews in this area. However, in our view, CERC should not be assigned individual project planning responsibilities which would duplicate the responsibilities of other Corps personnel.

PRINCIPAL MANAGEMENT OFFICIALS
RESPONSIBLE FOR THE ACTIVITIES
DISCUSSED IN THIS REPORT

	<u>Tenure of office</u>	
	<u>From</u>	<u>To</u>
<u>DEPARTMENT OF DEFENSE</u>		
SECRETARY OF DEFENSE:		
James Schlesinger	June 1973	Present
William P. Clements, Jr. (acting)	May 1973	June 1973
Elliot L. Richardson	Jan. 1973	Apr. 1973
Melvin Laird	Jan. 1969	Jan. 1973
Clark M. Clifford	Mar. 1968	Jan. 1969
Robert S. McNamara	Jan. 1961	Feb. 1968
<u>DEPARTMENT OF THE ARMY</u>		
SECRETARY OF THE ARMY:		
Howard H. Calloway	May 1973	Present
Robert F. Froehlke	July 1971	May 1973
Stanley R. Resor	July 1965	June 1971
Stephen Ailes	Jan. 1964	July 1965
Cyrus R. Vance	July 1962	Jan. 1964
Elvis J. Stahr, Jr.	Jan. 1961	June 1962
Wilber M. Brucker	July 1955	Jan. 1961
CHIEF OF ENGINEERS:		
Lt. Gen. William C. Gribble, Jr.	Aug. 1973	Present
Lt. Gen. Frederick J. Clarke	Aug. 1969	July 1973
Lt. Gen. William F. Cassidy	July 1965	Aug. 1969
Lt. Gen. Walter K. Wilson, Jr.	May 1961	June 1965
Lt. Gen. Emerson C. Itschner	Oct. 1956	May 1961

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