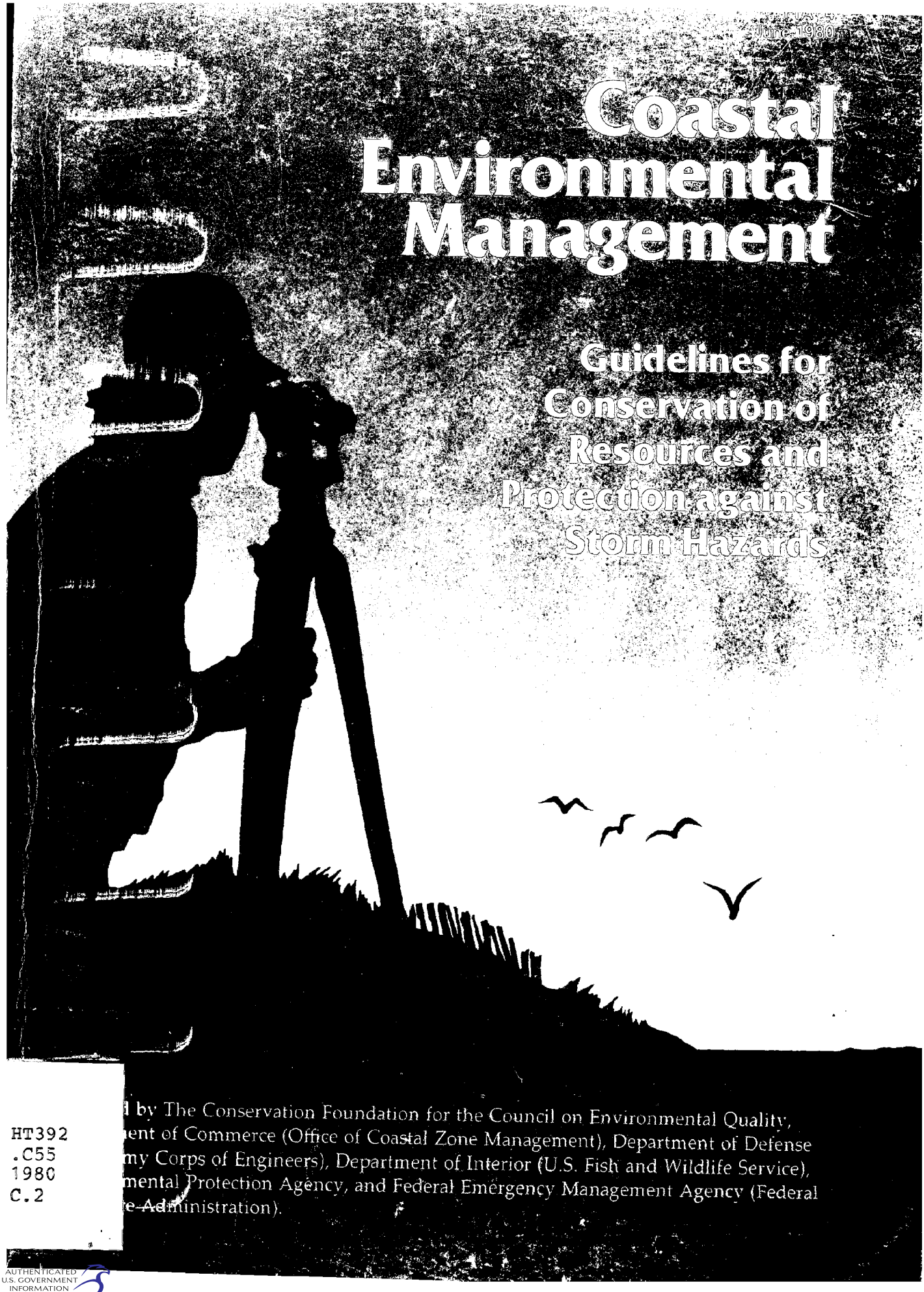
June 1980

Coastal Environmental Management

Guidelines for Conservation of Resources and Protection against Storm Hazards



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Guidelines for Conservation of Resources and Protection against Storm Hazards

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Contents

Introduction

Coastal communities have more than their fair share of environmental management responsibilities. If you are an elected official, zoning officer, tax assessor, county engineer, city attorney, planning director, or concerned citizen who must deal with development in coastal jurisdictions, you face many complicated problems—beach erosion, perhaps, or wetland conservation, saltwater intrusion, estuarine pollution, or, possibly, hurricanes.

For example, as a planner for any of the 68 coastal jurisdictions in California, you must, by State law, protect water quality in estuaries, which will mean devising strategies to control erosion from croplands and housing developments. You will need a special zoning provision, grading ordinance, or performance standards for major land clearing/grading activities in the watershed.

Or, as a conservation commissioner in one of Massachusetts' coastal towns, you are responsible under State law for issuing permits for use of wetlands. You face difficult decisions about which permits to grant, which to deny, what sorts of conditions to impose to minimize disruption.

If you are a county official on the North Carolina coast, attempting to formulate a comprehensive local approach to coastal zone management, you may be overwhelmed by Federal and State regulatory programs.

If you are chairman of the planning commission in a southwest Florida county, you may have to come up with a zoning amendment to make development in the floodplain safer so that your community can be approved for flood insurance by the Federal government.

This book is designed to help you cope with such problems. It offers a comprehensive set of physical management policies for coastal communities and a description of relevant Federal and State programs. Our aim is to help communities create effective programs that conserve resources and, at the same time, protect property and life against natural hazards. The policies are stated in simple terms, and are supported by background materials, implementation suggestions, and references to relevant laws and regulations.

As experienced planners and managers already know, the measures best suited to conserving ecological resources are often the same as those needed to preserve the natural landforms that serve as barriers to storms and flooding. Accordingly, many communities have found that a combined approach to hazards and resource management simplifies the process of zoning and permit reviews and leads to more predictable decisions on what constitutes acceptable development. The recommended policies in this guidebook have been written with this simplification and coordination in mind. For example, in the building code, the same setback requirement that protects beachfront homes from erosion and storm waves could also preserve turtle nesting sites on the backbeach. Similarly, a zoning restriction on development of mangrove swamps could not only conserve an ecologically vital area, but main-

tain a physical defense against storm waves.

The policies proposed will enable communities oriented toward conservation to reach for the highest standards of environmental and hazards protection. At the same time, the policies are designed to help the community with a lesser conservation bent accomplish a moderate level of protection. In giving serious consideration to each recommended policy, you will become aware of the full consequences of your community's actions and will be better able to make informed choices. By familiarizing yourself with the highest goals for resource conservation, you will be most conscious of any environmental losses or storm risks resulting from trade-offs to accommodate residential, commercial, or industrial growth.

Conservation and development are not inevitably at odds. In general, well-planned development will add to the general prosperity of a coastal community, while bad development will sooner or later have a negative effect. The simultaneous achievement of development and resource protection goals may require that communities greatly modify some traditional development patterns. However, with innovative management, many communities can achieve a desirable balance without serious sacrifices to either development or conservation.

There are plenty of examples of poorly controlled development that has had a serious negative effect on the value of our coastal resources. Demands for retirement and vacation housing and other investments in waterfront land have been intense. Developers have encouraged and satisfied these demands and, in so doing, have frequently imposed high capital and servicing costs on coastal communities. These costs are felt by the public in higher taxes. In addition, poorly managed development can be destroyed quickly, at great cost to the community, in floods, severe storms, and hurricanes. Thus, our primary goals, conservation of coastal resources and maintaining nature's systems, can also in the long run save the taxpayer money.

Each community has a unique set of attitudes, social goals, and political styles that will determine the way in which environmental policies are selected and used. How strongly is your community committed to resource conservation and protection against hazards? To what extent will it trade environmental harm for the benefits of economic growth? How much involvement does it desire on the part of State and Federal agencies?

Although your community has considerable freedom to choose the level of development most compatible with its own interests, there is a minimum of protection required by Federal and State regulations. For example, your banks may be unwilling to give mortgages for beachfront homes exposed to erosion and hurricane threat unless the owner has insurance protection against these hazards. The insurance policies are written only by the Federal Emergency Management Agency, which insists, among other requirements, that your community pass an ordinance to prohibit development on sand dunes in high-hazard zones. Some owners of expensive beachfront lots may have the money to build without a loan and may be unwilling to build back from the dune, regardless of the risk. They would oppose the ordinance. Other owners, who need the bank's help and are willing to set their homes back, may support an ordinance.

Local officials must decide whether to pass an ordinance so that the community as a whole will be eligible for insurance. In making their decision, they may consider the environmental benefits of protecting the dunes and beaches, as well as any State dune and beach protection requirements. Used in conjunction with public hearings, conferences among various government departments, or other interchanges, the four recommended policies on dunelands and the five on beach development in this guidebook can help lead to a decision that best reflects the general local interest.

Many shoreline development proposals will evoke conflict, and local officials may find themselves caught in a crossfire between those who want to develop and those who don't. If your community has a strategy based on common goals and prearranged coastal development policies, the officials should find it easier to make decisions that preserve long-term benefits for residents as well as local commercial interests and their special clientele—vaca-

tioners, retirees, recreational boaters, or industry.

Recognizing the difficulty of devising such community strategies, we have attempted to make the policies and management recommendations in this book workable and practicable. In our initial assessment of policies, we worked closely with the American Society of Planning Officials (ASPO, now the American Planning Association), which interviewed planning officials and prepared a summary report of management problems and needs in 18 communities. Many of the planners afterwards gave their time to help evaluate our management policies through many drafts and revisions.

The ASPO report concluded that two major factors influenced local management decisions for coastal areas subject to frequent floods. The first factor was a dramatic or troubling event—for example, large-scale destruction of beachfront property by a storm, or conflict over development of a barrier island. The second factor was conformance to State and Federal requirements—wetlands protection programs, in particular (though wetlands protection was not strongly perceived by most planners as an integral part of management strategy for flood protection). Also frequently mentioned were State coastal management requirements and the National Flood Insurance Program.

We have focused this guidebook on seven **Places of Concern**: coastal uplands, coastal floodlands, saltwater wetlands, banks and bluffs, dunelands, beaches, coastal waters and basins. (See Figure 1.) This arrangement recognizes that many types of coastal landforms in their natural state perform important ecological and hazard-protection services and that each type requires a different approach and different development criteria. The material is in topographical order, from uplands to coastal waters, not in order of importance or program priority. The presentation is standardized for all places so that, with a little familiarity, you can locate any subject —ecological features, hazards, management policies, implementation guidelines—for any of the seven places. The book is a reference work; it is not meant to be read sequentially.

It should be noted that this book is about physical management policies only. Accordingly, it considers sand-dune protection but not hurricane evacuation, management of beach structures but not public access to beaches. We discuss pollution from land runoff and other diffuse (nonpoint) sources because its control relates closely to physical management issues and because effective measures to deal with this kind of pollution are often in the hands of the community officials to whom this book is addressed. On the other hand, we discuss control of water pollution from industrial and municipal treatment plants (point sources) only briefly because this kind of pollution has little relation to storm and flood hazards management.

There is, of course, no single approach that works everywhere. Each community has a unique environmental setting, and needs a unique coastal strategy. The arrangement of policies by place of concern should enable you to select those that match your particular needs and local

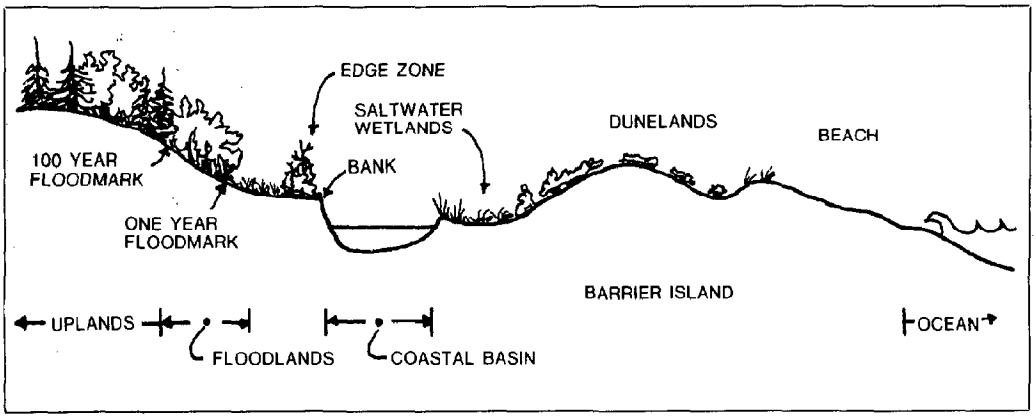


Figure 1. Coastal places of concern

environmental goals. The community with an abundance of wetlands or dunes, for example, will need detailed elements in its strategy to deal with these places.

The policies apply to the entire coastline, including bays, sounds, and tidal rivers, inland to the limit of saltwater influence. Of greatest concern are the places where water and land interact directly —the coastal floodplain, broadly defined, including floodlands (land areas subject to periodic ocean storms), saltwater wetlands, banks and bluffs, dunelands, and beaches. The coastal water basins and the uplands draining directly into them are also discussed. While we focus on seacoasts, many of the principles and policies are appropriate for the Great Lakes.

The guidebook is divided into two major parts. **Part I** addresses principles and policies for ecological and hazards management, and practical ways in which Federal programs and laws affect implementation. **Part II** describes the current regulations and program structure of the Federal agencies with major responsibility for these areas of environmental management.

In discussing **Ecological Features** for each place of concern, we assume that management should aim to enhance the coastal ecosystem's natural carrying capacity—that is, its capacity to provide resource benefits. For example, because of their sheltered position and great biological productivity, saltwater marshes and estuaries provide habitat for more than 80 percent of the commercially valuable fish and shellfish of the Gulf and Atlantic coasts. Human activities that destroy or damage wetlands reduce the capacity of the ecosystem to provide us with some of the necessities of life.

The discussion of natural **Hazards** is based on the premise that protection begins with preservation of coastal landforms that provide natural resistance to wave attack, flooding, and erosion from hurricanes and storms. These landforms differ significantly on our various coasts. On parts of the Atlantic and Gulf coasts, for example, there are barrier islands with special features—dunes, beaches, wetlands—that protect coastal inhabitants and property against moderate storms and absorb some of the more violent energy unleashed in major storms. (In a direct hurricane strike, most barriers, natural or man-made, may offer little protection.) Human activities that remove or degrade protective landforms—for instance, by removing beach sand, bulldozing dunes, or destroying mangrove swamps—diminish the degree of natural protection the coast affords against storm damage.

We recommend six objectives for communities to consider in developing **Management Policies**:

1. *Manage coastal watersheds for least alteration of natural patterns of stormwater runoff.* Coastal watersheds should be protected as much as possible from soil erosion and accelerated runoff. This will reduce flooding of coastal neighborhoods and also protect the quality of biologically productive coastal waters.

2. *Preserve ecologically vital areas, such as dunes, coral reefs, wetlands, and edge-zones (borders of distinctive vegetation between different areas—e.g., between wetlands and floodlands).* Development should be located outside vital areas; further protective measures may also be needed.

3. *Preserve the integrity of coastal geologic protective structures.* These structures include sand dunes, beaches, erodible banks and bluffs. Preserving them can help to conserve ecological resources and offer protection against hazards. Preservation of scenic beauty is another important consideration.

4. *Protect the configuration of coastal water basins against adverse alteration.* Discourage dredging and construction projects that would cause harm to marine life from pollution and loss of habitat, or that would adversely affect currents or tidal flushing in coastal basins through alteration of basin floors or inlets.

5. *Protect coastal waters from pollution.* This entails controlling pollution from shoreland runoff, from industrial and domestic wastes, and from dredging in coastal water basins.

6. *Restore damaged environments.* Private and public means should be used to restore damaged essential elements of the coastal environment.

Our 36 physical management policies together provide a comprehensive program for achieving the objectives outlined above. You may already be implementing some of the policies—such as wetlands preservation. Others may be less familiar,

either because the landforms they affect are of limited occurrence, or because their importance has not been widely understood, or perhaps because they pertain to matters on which local governments have traditionally deferred to State or Federal agencies. All of the policies selected for discussion can, we believe, contribute significantly to conservation of coastal ecological resources and protection of life and property against hazards.

Each section in Part I concludes with a discussion of **Implementation Guidelines**. When a community decides to implement the coastal management policies, it may face difficult administrative and political issues. For example, do you have sufficient expertise and information locally available to administer the program? Where can financial help be found to deal with erosion? State and Federal programs can help to solve some of these problems. You can also use such policies and institutions as zoning and subdivision regulations, land acquisition, public works planning, tax and other financial incentives, technical assistance to land developers and users, and so on. These measures, even if used throughout the community, may need special adaptation for beaches, estuaries, saltwater wetlands, and other environmental features of the coastal area. For example, a construction setback for the beachfront may have to include the concept of progressive shoreline recession—that is, you should include all land that will likely be lost to erosion and sea-level change during the economic life of the new building.

One practical issue facing all coastal communities is the integration of Federal assistance, laws, and regulations with local needs. Local governments, by participating in Federal and State programs, may not only take advantage of assistance but also influence State and Federal decisions and expenditures. Often, your own programs will need to accommodate State and Federal requirements—for example, wetland protection laws. And local planning must also take into account incentive programs, such as the carrot-and-stick National Flood Insurance Program. By understanding how these programs operate, you can participate constructively in them and benefit from their influence.

Part II, the final section of the book, summarizes the Federal programs and regulations that are most relevant to a community's coastal management programs.

This guidebook will achieve its purpose if it helps you to see how protection of the ecological resources of coastal ecosystems may be combined effectively with protection of human life and property against storms, flooding, and shore erosion. Once you are aware of the measures that serve these dual purposes, your community can decide which are economically and environmentally necessary, as well as politically and legally acceptable.

Part I

Coastal Uplands

Coastal Floodlands

Saltwater Wetlands

Banks and Bluffs

Dunelands

Beaches

Coastal Waters
and Basins

Coastal Uplands

1

The land area designated as coastal uplands will differ greatly from one community to the next because of natural variations in topography and soil conditions. For your community's coastal program, the main problem presented by uplands is runoff. As a place of concern, uplands include all watershed terrain that yields substantial stormwater runoff directly to coastal waters via streams, storm drains, or overland flow. The lower boundary of the uplands is the 100-year flood level (see p. 20), below which is the coastal floodplain.

Coastal uplands might be farm fields, woodlands, or suburban neighborhoods. Depending on local circumstances, the uplands might extend anywhere from a few feet back of the water's edge to a mile or more. You may discover that portions of the uplands do not have a significant influence on coastal waters because of distance from the shore or particular topographic or drainage details. Such areas should require no special constraints for the protection of coastal waters.

In the natural state, uplands terrain and hydrologic systems—streams, ponds, wetlands—can hold and can detain large amounts of storm water, acting in effect as a natural sponge that holds water during heavy rains or snows for later, more gradual release. This provides an ecologically compatible rate of runoff flow as well as some protection against flooding for downstream communities.[1] Uplands are also important in protecting coastal waters from storm runoff pollution because their vegetation and soils cleanse the water.

The beneficial functions of the coastal uplands are diminished when the terrain is cleared of vegetation, paved, or altered to accelerate drainage; when surface water bodies and watercourses are filled, detoured, or channelized; or when the natural flow pattern is significantly disrupted so that freshwater flow to the coast occurs in surges. This section of the guidebook calls attention to the need for conservation of soil and of natural hydrologic systems in the uplands (Figure 1).

Figure 1. Planting crops in contour strips reduces the erosion of soil, which can be carried with runoff to coastal water basins. (Photo by U.S. Department of Agriculture, Soil Conservation Service.)

ECOLOGICAL FEATURES

The methodology for identifying watersheds and drawing watershed divides in a coastal area is essentially the same as for any other area, and requires some technical expertise. For effective environmental planning it is desirable to identify the sub-watershed, that is, the smallest functional drainage basin. Some of the flow may drain to channels, some to intermittent drainageways, and some directly to coastal waters (Figure 2).

The capacity of the upland watershed terrain and its hydrologic system to even the flow of runoff water depends on a variety of natural factors—slope, soil type, vegetation, climate, and so forth (Figure 3). So does the capacity to filter the water in transit, physically and chemically, removing sediments, toxic matter, and excess nutrients before releasing it into coastal waters.[2] Whatever the local combination of natural factors may be, the runoff system in its unaltered state is self-sustaining, providing for cleansing of the water, a beneficial flow regime, and a supply of

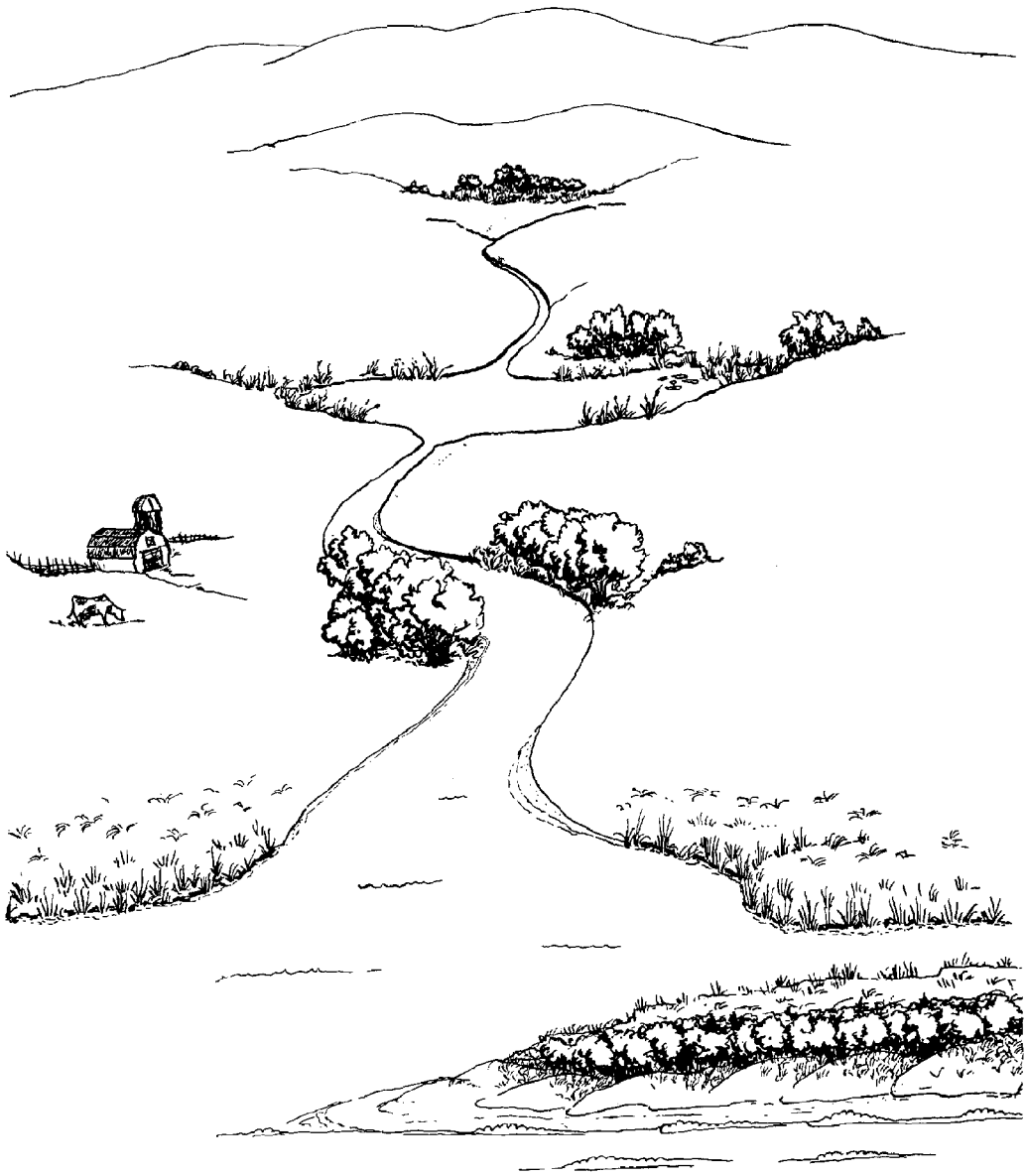


Figure 2. Coastal uplands are linked to a coastal water basin by the water that moves over them and runs through lakes and streams to estuaries. (Drawing by Ruth Ann Hill.)

natural nutrients to coastal waters. These values can best be preserved by maintaining the natural quality, volume, and rate of flow of freshwater discharge from the uplands to coastal water basins. Such preservation will ensure the optimum functioning of coastal ecosystems—the ecological units of coastal waters, their bottoms, and adjacent wetlands and beaches.

The *quality* of the water that runs off the uplands is a function of the amount of sediment, nutrients, minerals, organic matter, and other substances dissolved or suspended in the water. These materials have a strong influence on the coastal ecosystem because they affect such important natural carrying-capacity control factors as plant production, oxygen concentration, and the fallout of sediments. A variety of activities in upland watersheds have the potential to impair seriously the quality of freshwater runoff. Runoff from land surfaces may be contaminated with industrial, agricultural, logging, or household residues. Together, such diffuse sources are termed "nonpoint" sources of pollution, as distinguished from "point" sources, which originate with piped or channeled discharges.

The *volume* of fresh water entering the coastal water basin influences the strength of currents, the pattern of circulation, and the rate of flushing and replenishment of water from the sea. The volume of the fresh water also governs the salinity of water in coastal basins by diluting the water from the sea. A decrease in total runoff volume essentially shrinks the most biologically productive brackish part of a bay, enlarging the area with higher salt content. On the other hand, a large, long-term increase in fresh water can overwhelm a smaller estuary, turning it into a virtual lake.[3]

The seasonal *timing* of the rate of freshwater discharge to the coastal basin governs salinity and circulation; these in turn affect the productivity, stability, and overall natural carrying capacity of the coastal ecosystem. The natural seasonal flow rate is generally optimum for the plants and animals in the ecosystem, because most species are synchronized to this natural rhythm for critical life functions—such as breeding, feeding, and migration for ani-

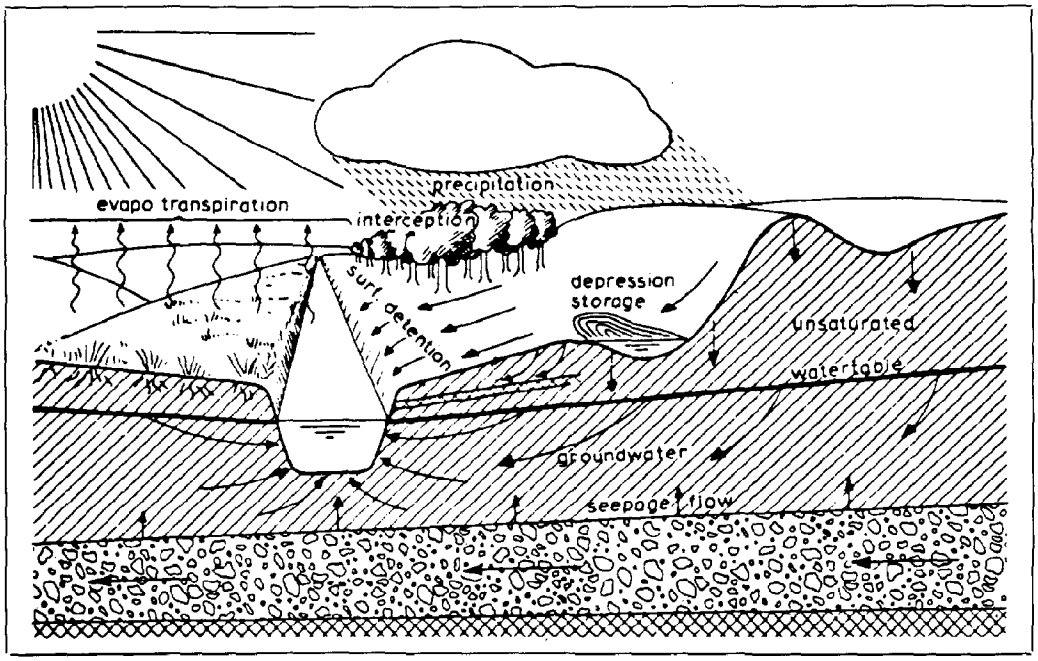


Figure 3. The hydrologic cycle begins with precipitation, which may be intercepted by trees or may fall directly on the land surface. There, it may be detained by soil and vegetation or evaporated or transpired by plants back into the atmosphere. The soil is saturated below the water table and unsaturated above it. Depressions in the land surface—ponds or lakes—store water. (Source: National Science Foundation, "Managing Coastal Lands," *Mosaic*, vol. 4, no. 3 [1973], pp. 26-32.)

mals, photosynthesis, growth, and decay for plants. A significant change in the rate of runoff flow disrupts these functions, which are related to circulation or salinity. Therefore, alteration of the rate of flow of discharge from upland watersheds into coastal water basins is a major potential source of disturbance of coastal ecosystems.

Of particular importance in controlling erosion in the uplands and improving the quality of runoff are the soil and vegetation of edge-zones—borders, banks, or groves at the edge of a water body or watercourse. The edge-zone is an ecotone or ecologic transition area of especially high value which provides unique habitat for many wildlife species.

HAZARDS

Storm-water runoff from the uplands may discharge so rapidly into the coastal water basin that it adds to the water level, already forced up by a sea storm or hurricane. Uplands runoff can thereby cause increased flooding of a community built along the shores of a confined coastal embayment.

Hurricane high-water surges often last from three to five hours, during which seawater flows into bays with such intensity that it may stop or reverse the direction of flow down tidal rivers and through estuaries to the sea. Furthermore, hurricanes are often preceded by many hours of heavy rains, which saturate the soil, cause advance runoff, and raise the water level in rivers and bays before the surge hits. Pre-hurricane rainfalls of five inches or more are common, and far greater rainfalls have been recorded. Ewan, New Jersey, for example, received 24 inches of rain in nine hours in a 1950 pre-hurricane rainfall.[4] In the New England hurricane of September 1938, four days of heavy rainfall in advance of the hurricane saturated the uplands soil and hydrologic system, exacerbating estuarine shoreline flooding.[5] When a storm-induced uplands runoff peak coincides with a natural

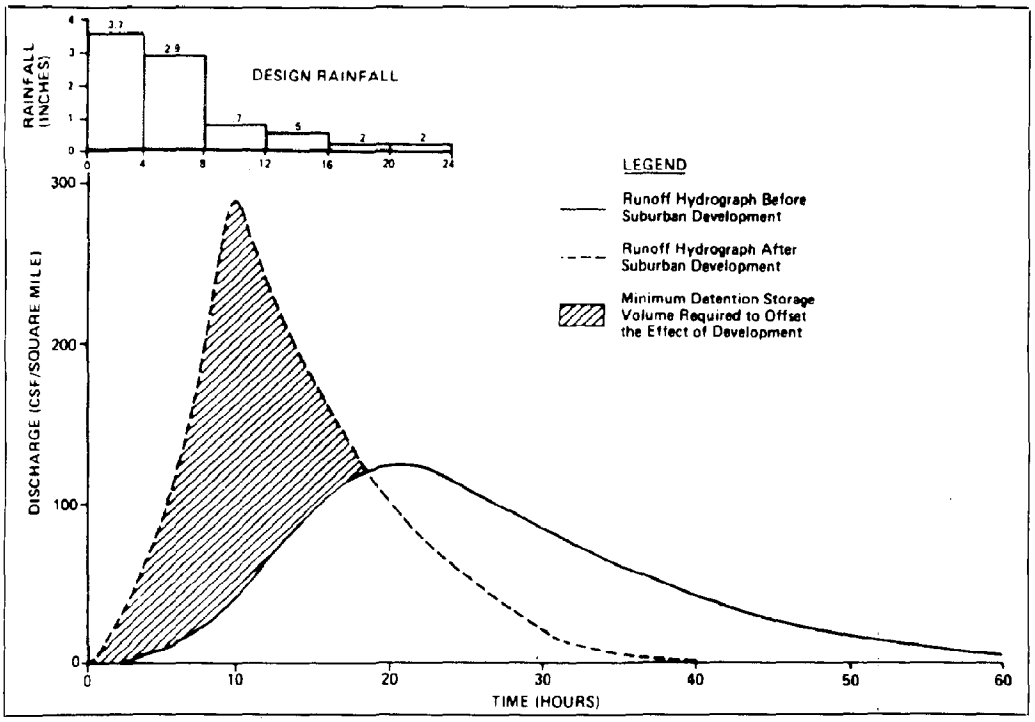


Figure 4. Suburban development with paving and removal of vegetation speeds up and intensifies runoff peaks, as shown by these typical storm hydrographs (Collier County, Florida). The capacity of the uplands terrain to retain rainfall and slow down the rate of runoff to coastal waters should be maintained. (Source: Ronald L. Wycoff and R. David G. Pyne, "Urban Water Management and Coastal Wetland Protection in Collier County, Florida," *Water Resources Bulletin*, vol. II, no. 3 [1975], pp. 455-68.)

Figure 5. The broad riparian floodlands that border the Apalachicola River (Florida) store floodwaters and reduce their velocity, protecting downstream communities from flooding. (Photo by John Clark.)

spring high tide, the damage may be particularly severe.

The capacity of uplands to detain storm waters and lessen potential estuarine flooding depends largely on three elements: the surface of the watershed terrain, the nature of the hydrologic system that stores and delivers runoff to the coast, and the characteristics of the basin that receives the discharge.

Terrain. The natural surface of the uplands normally has a high capacity for retaining storm waters. Urbanization often decreases that capacity, resulting in major increases in the peak volume of runoff and in the speed with which runoff flows to watercourses. Runoff peaks increase when the land is stripped of vegetation, humus, and retentive soils and when the impervious surfaces of human settlements—roofs, roads, sidewalks, and other paved areas —rapidly shed storm water that would otherwise soak into the ground (Figure 4). Storm sewers hasten the runoff process. With more runoff passing quickly downstream and less water percolating through soil into underground reserves, streams alternate between high flows that worsen flooding and low flows that worsen dry periods. Urbanization can raise peak runoff flows to five times the normal amount.[6]

Hydrologic System. The flood-prevention value of any unit of the uplands hydrologic system—bog, pond, marsh, or winding stream—lies in its ability to store storm water temporarily for delayed release to the coastal water basin. In a natural watercourse, high flow volumes in the channel may be reduced by the storage of flood water in numerous river meanders and in broad reaches of riparian floodlands and freshwater wetlands (Figure 5). This effectively lengthens and widens the watercourse, allowing the water to spread sideways instead of piling up higher, which forces it to move faster down the channel. Thus, natural wetlands and long, winding watercourses are prime features of the natural storm-water detention capability of shorelands. The storm-water

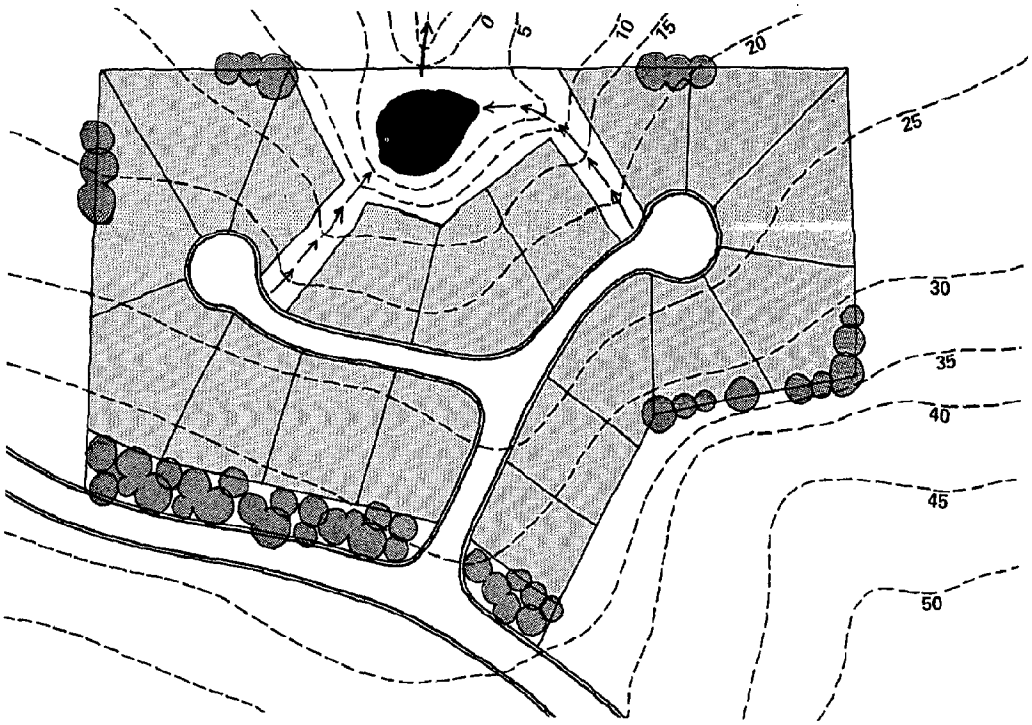


Figure 6. Creative subdivision layouts can use natural factors, such as topography (gradients marked by numbers in this drawing) for environmental protection. Note how drainage flows naturally into a central detention basin (dark area at top of drawing). (Source: Joachim Tourbier, "Water Resources as a Basis for Comprehensive Planning and Development of the Christina River Basin," prepared for the U.S. Department of the Interior [Newark, Del.: University of Delaware, Water Resources Center, 1973].)

retention benefits of the natural hydrologic system may be lost if the system is altered by drainage of freshwater wetlands, construction of levees or dikes, channelization or straightening of streams, or removal of marginal vegetation. Hydrologists emphasize that along natural streambanks, flooding is a routine process and that "flooding is ... seldom catastrophic because wetlands, soil, and vegetation in the stream's floodplain absorb and check the overflow".[7]

Coastal Water Basins. The coastal waters that are most subject to rapid accumulation of storm runoff and to highest floodwater levels are confined coastal basins (embayments, lagoons) that receive direct river inflow and have constricted outlets to the sea. Examples of such places are the shallow bays that lie behind sandy barrier islands along parts of the Atlantic and Gulf coasts. The trapped water may cause severe shore flooding and dangerous backflow that can cut through the sandy barrier strips that enclose the basins. Even among basins such as these the effect varies greatly, depending on such factors as the basin's particular configuration and the inlet size in relation to the watershed area and terrain surface.

MANAGEMENT POLICIES

Your community's program to protect coastal and estuarine resources should recognize the critical role of water flows in integrating the total ecosystem, from the uplands through the estuarine system and into the ocean. It should provide for protection against destructive modification of the upiands watershed terrain, the uplands hydrologic system, and the edge-zone.

In communities with active environmental programs, customary methods of managing watersheds and controlling soil erosion can be applied to the coastal uplands. These include measures to reduce soil erosion, to discourage adverse artificial land drainage, and to protect streams, stream banks, and upland freshwater wetlands. Therefore, inclusion of uplands as a

place of concern in coastal management programs does not add new elements to the active community conservation program. It does call for additional attention to soil erosion controls and for greater emphasis on retention of water in the soil and in the uplands hydrologic system (Figure 6).

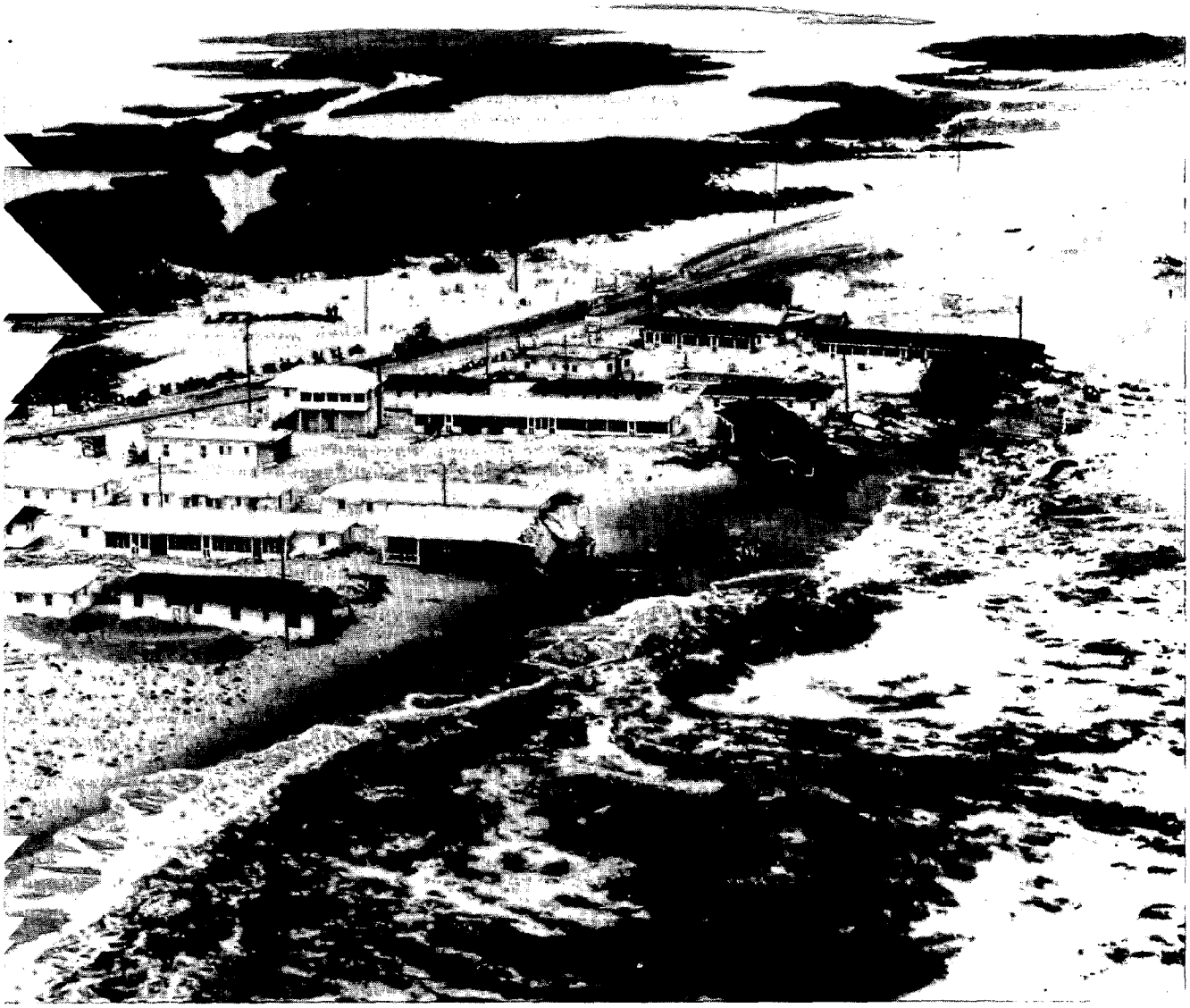
For uplands hydrologic systems, all components should be conserved in as near the natural condition as possible. The components needing protection include: (1) all the drainageways—creeks, streams, swales, sloughs, and other permanent and temporary surface channels; (2) all the marshes, swamps, and other permanent and temporary wetland storage units, including tidal freshwater wetlands; (3) all the ponds and lakes and other stillwater areas that are connected, permanently or intermittently, with the shorelands system; and (4) riparian floodlands that provide floodwater storage during heavy rains.

It is particularly important to preserve the edge-zone of water bodies and watercourses for ecologic benefits and geologic stability. This requires some control of land use adjacent to the water's edge, at least through a construction setback that will preserve an adequate buffer strip of natural soil and vegetation.

As a practical matter, a comprehensive plan for controlling land use throughout the coastal watershed may be difficult to implement. Several units of government may be involved, and, furthermore, a comprehensive plan may evoke resistance from property owners and development interests. The component parts of such an overall management program, however, are mostly traditional and familiar conservation practices—soil erosion control, stream bank setbacks, storm-water detention, freshwater wetland protection.

Community action to manage coastal watersheds may be required in states that are participating in the Federal Coastal Zone Management Program. Some states will require many controls over a broad coastal fringe, while others will require fewer controls within a narrow fringe. For example, California's designated coastal area is broad: "In significant coastal estuarine, habitat, and recreational areas," it extends inland to the first major ridge line paralleling the sea, or five miles from the mean high tide line of the sea, whichever is less. In developed urban areas, the zone generally extends inland less than 1,000 yards. By contrast, Oregon's coastal area is narrow, extending only to the high water mark (uplands management is left to other than coastal zone programs). If your state's designated coastal zone is less than adequate for protecting coastal ecosystems, your community may wish to identify a wider area for management.

Your community's program for managing coastal uplands should include five specific policies recommended in this guidebook. The policies also apply to floodlands, however. Therefore, to avoid repetition, they are identified and described in the following section.



Coastal Floodlands 2

Coastal floodlands are the part of the broader coastal floodplain lying above the yearly reach of the tides. The floodlands are sporadically struck by storm waves and flooded by storm tides. Damage in floodlands may be caused not only by flooding, but by the direct impact of storm waves in "high hazard" areas and by the scouring away of beachfronts in "erosion prone" areas (Figure 1). The most devastating effects are produced by hurricanes, which strike the U.S. Coast about twice a year, with accompanying storm surges that can elevate coastal waters from 10 to 15 feet.

Coastal floodlands attract many users. Flat and accessible to coastal transportation, the floodlands draw industry and commerce. Because of their high amenity values, they are attractive for recreational development and for homesites. Consequently, floodlands are often cleared, graded, filled, and built on without regard to their ecologic and hazard-resistance functions. The result is an increase in danger to life and property from sea storms and hurricanes, land subsidence (as a result of wetland drainage and groundwater "mining"), and loss of edge-zone, the valuable and physically distinct margin that occurs along the water's edge in much of the coastal floodlands.

To protect the hazard-resistant natural features and ecological resources of the floodlands, your community may need construction setbacks, provisions for elevation of structures, and restraints on excavation and groundwater pumping, plus restraints on watercourse modification, soil erosion, and wetland alteration. These considerations are included in the following 10 recommended policies. Numbers 1 through 5 apply to coastal uplands as well. Numbers 6 through 10 apply particularly to coastal floodlands.

Figure 1. Motels at Buxton, N.C., on Cape Hatteras after 1973 storm. The layers of white sand in background were deposited during the storm. Several feet of sand covered the road. (Photo by Paul J. Godfrey, National Park Service Cooperative Research Unit, University of Massachusetts, Amherst.)

1. ***Alteration of Freshwater Wetlands:*** *Discourage draining, filling, excavation, or other alteration of freshwater wetlands.*
2. ***Protection of the Edge-Zone:*** *Protect the edge-zone bordering coastal waters from alteration.*
3. ***Alteration of Watershed Terrain:*** *Discourage clearing, grading, and surfacing that would adversely alter the water retention potential of the watershed terrain.*
4. ***Soil Erosion:*** *Reduce to the minimum erosion and runoff pollution from construction, agriculture, and logging.*
5. ***Alteration of Watercourses:*** *Discourage straightening, deepening, diking, or other adverse alteration of natural channels of the hydrologic system.*
6. ***Land Drainage and Excavation:*** *Avoid land drainage or other excavation that would adversely alter the hydrology of floodlands.*
7. ***Construction in Floodlands:*** *Encourage the use of piling supports or similar techniques to elevate structures built in floodlands.*
8. ***Floodwater Pollution:*** *Prevent pollution from floodwater runoff through proper location and design of facilities where polluting substances are stored.*
9. ***Groundwater Pumping:*** *To prevent subsidence and aquifer contamination, limit the use of groundwater resources.*

Figure 2. The transition area, or edge-zone, that lies at the border between land and water provides especially valuable habitat. (Photo by John Clark.)

10. ***Restoration of Floodlands Environment:*** *Encourage private and community programs for restoration of beneficial floodlands functions.*

ECOLOGICAL FEATURES

The floodlands, topographically, are an extension of the uplands terrain. Except when flooded, they share with the uplands the natural properties of being able to retain runoff waters and remove pollutants. The natural storage-and-release mechanisms of floodlands absorb seasonal rains and slowly release accumulated water into coastal water basins. The terrain and its hydrologic system also filter the water in transit by removing sediments and assimilating excess chemicals. In this way, the floodlands naturally help solve the problems of persistent soil erosion and washoff of fertilizers, biocides, and other toxic substances. Estuaries, the termini for storm runoff from the shorelands (uplands and floodlands), are particularly vulnerable to excess sediments and polluting substances.

Important ecological features are found in the transition area at the lower edge of floodlands, adjacent to wetlands or water bodies (Figure 2). Many species benefit from the geological and botanical features of this transition area, particularly where there are shrub lines or forest hammocks of special habitat value. Animals may use the area for nesting, feeding, resting, and hiding. For example, on Kiawah Island (South Carolina) you can find raccoons, blue herons, pelicans, bald eagles, terns, bears, and foxes using the floodland areas just behind the sand dunes.[1]

The transition area of extremely high ecological value bordering floodlands is often a very narrow and distinct edge-zone (an "ecotone"). The edge-zone is often obvious to the eye—for example, as a band of especially high, close-growing trees or other distinct vegetative assemblages. Certain plants, such as saltbush or beach plum, prosper only in edge-zone areas. Other species, such as wax myrtle or palmetto, which are tolerant of saltspray and of occasional saltwater inundation—and in the subtropics, hardwood hammocks—may also be included in the edge-zone. Edge-zone habitats support a rich variety and density of fauna and provide unique breeding, roosting, and feeding opportunities for many species (Figure 3). The vegetated edge-zone may also help to stabilize the shore, cleanse and regularize

the flow of storm water into the coastal basin, and provide a good visual screen.

Throughout the floodlands above the edge-zone, there may be a variety of sensitive ecological features that need special consideration. In this guidebook, we consider those that are important to the coastal system (for example, streamside wetlands). We do not consider features that have no direct impact on the coast (for example, isolated ponds). Of most concern is the hydrologic system, which collects, conditions, stores, and conveys water to the coastal basins. The functions of all parts of this vital system—bogs, marshes, swamps, connected ponds, streams—need to be preserved intact. In the floodlands and through the edge-zone, the system is non-tidal; just below the annual high-water mark, the lower boundary of the floodlands, the waters are tidal. But sometimes the gradation from fresh non-tidal water, to fresh tidal water, to coastal waters is gradual and nearly imperceptible.

HAZARDS

Coastal flooding is distinctly different from riverine flooding. When a river floods, the runoff and subsequent damage generally follow the river's course. The real damage of coastal flooding, unlike riverine flooding, does not occur in easily identified runoff channels, but over broad areas that alternately flood and drain during hurricanes and intense winter sea storms.

Figure 3. Birds like this osprey are important inhabitants of the edge-zone. (Photo by John Clark.)

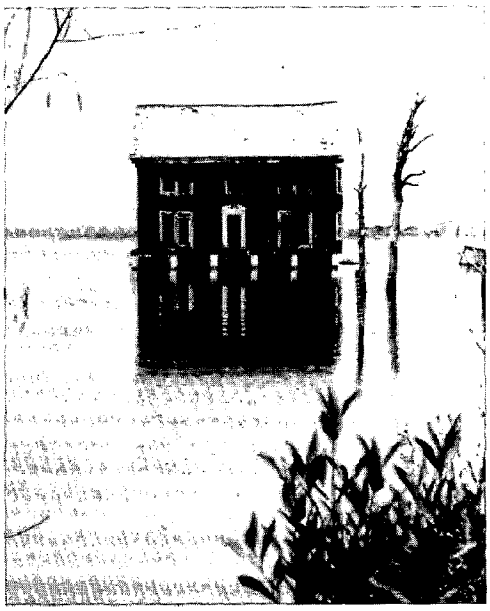


Figure 4. Many homes in Baytown, Texas, are now regularly surrounded by seawater as a result of land subsidence. The Corps of Engineers will vacate the area of residents and create a park. (Photo from U.S. Army Corps of Engineers, Galveston District.)

Mounting flood losses can be expected as residential, commercial, and industrial uses are increasingly located on flood-prone coastal sites. A U.S. Army Corps of Engineers study reported that 75 percent of all loss of life in Florida hurricanes has been due to tidal inundations. Moreover, the study showed that very few Florida coastal communities were located on land high enough to escape partial flooding during a severe hurricane. The study found that a 10-foot storm tide would flood 50 percent of the coastal areas developed on land less than 20 feet above sea level—and in the Florida Keys would flood 90 percent of the land area.[2]

The characteristics of coastal landforms affect the intensity of storm impacts on coastal communities. Three characteristics that have a major effect on the intensity of potential storm hazards are elevation, drainage, and topography.

Elevation. In many coastal areas the land is rising or falling in relation to the sea. Land subsidence—which accounts for an apparent rise in the sea level—is a factor of particular importance in managing floodlands (Figure 4). Rapid subsidence may result from human actions—for exam-

ple, excessive pumping of groundwater. Natural subsidence, by contrast, is a slow process that may be caused by the drying and shrinking of geologic deposits, the decline of water tables, and movement of large geologic deposits. When subsidence is rapid, regardless of the cause, structures built above the floodlands may sink to unsafe elevations.

Drainage. During a storm, any part of the floodlands not reached by the flood can retain water in its soils and hydrologic system, thereby reducing the probable height of the floodwaters (Figure 5). Stream channels and other watercourses can contain floodwaters; so can lakes, ponds, and, particularly, wetlands. The absence of these features leaves only the natural retention capacity of the soils and vegetation of the terrain.

Topography. Topography, or the configuration of the land surface, affects the intensity of storm impacts because the normally dry depressions of floodlands can temporarily retain considerable amounts of floodwaters from both ocean and upland sources. On the other hand, if salt water is held long enough, it can damage soil fertility (by penetration into the earth) or groundwater quality (by penetration into subsurface aquifers).

MANAGEMENT POLICIES

Your overall management objective for coastal floodlands should be to allow for the development desired provided that it is consistent with conservation of coastal ecosystems and protection of life and property from the threat of periodic flooding. You will need to consider the siting, density, design, and construction of residential, commercial, and industrial facilities, and sewage plants. Houses need to be elevated above the forecasted "100-year flood" mark, the elevation expected to be reached by a flood having a 1 percent probability of occurrence in any year; nonresidential structures need to be floodproofed (Table 1). Within the "high hazard" portion of coastal floodlands, where wave forces are severe, additional constraints on design and location of structures are needed.

The policies suggested below will ensure relatively safe and environmentally compatible new development or redevel-

Figure 5. This natural wetlands storage area is permanently set aside to provide flood-retention capability along the Charles River near Millis-Medfield, Mass. (Photo, taken in March 1969 during spring runoff, from U.S. Army Corps of Engineers, New England Division.)

FLOOD PROBABILITY

Event (Annual Probability)	Probability of Occurring at Least Once in		
	10 yrs	25 yrs	50 yrs
10-year (.10)	.65	.93	.99
25-year (.04)	.34	.64	.87
50-year (.02)	.18	.40	.64
100-year (.01)	.10	.22	.39

Table 1. The widely used expression "100-year flood" suggests to some people that a flood is expected to occur once in 100 years. That is misleading. It would be more accurate to state that a flood larger than a defined magnitude (e.g., 12 feet above mean sea level) had a one percent chance of occurrence each year; that is, there is a one percent chance that it will be exceeded. There could be two or more occurrences of that magnitude in a given year. It is important to note that the probability is the same every year regardless of the time of the previous occurrence of an event of that magnitude. (Source of Table: Gilbert F. White, et al., *Natural Hazard Management in Coastal Areas*, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C., 1976.)

opment. To deal adequately with the risks of hurricane and storm flooding in a coastal area, however, your community should include evacuation planning and flood warning systems in its coastal management program (Figure 6).

Recommended Policy 1: Alteration of Freshwater Wetlands.

Discourage draining, filling, excavation, or other alteration of freshwater wetlands.

Freshwater wetlands are, by definition, flooded all year or for a significant part of the year. Water gives wetlands their special character and value. If they are drained and dried out, even partially, that character and value is lost. Once drained for building sites, wetlands may undergo gradual irreversible subsidence, thereby causing sinking and fracturing of foundations, streets, and sewers, and an increase in the potential of flooding during storms.

Draining of wetlands may also have other far-reaching adverse effects, such as lowering the water table or destabilizing runoff flow into estuaries. By reducing the capacity of the hydrologic system to store storm water, draining wetlands also raises the risk of riverine and estuarine flooding.

Figure 6. Before and during a hurricane like Camille, escape roads may become impassable; therefore, advance flood-warning systems and evacuation planning are critical. (Photo courtesy Alvin Samet, National Hurricane Center, Coral Gables, Florida.)

The Corps of Engineers predicts from a study of the Charles River Basin in Massachusetts that if 40 percent of the wetlands in that area were lost, flood levels in the middle and upper river would increase from two to four feet and could cause 12 million dollars in increased damage in one flood.[3]

Your community should, therefore, try to preserve its wetlands, not drain them. In addition, because of the potential adverse consequences of reducing wetland benefits, you should generally avoid filling, excavation, or other surface alteration of freshwater wetlands, whether for dumps, home sites, landscaping, or agriculture. Wetlands should not be used as sites for solid-fill roads, causeways, or other structures that would obstruct water flow. Unavoidable roadways through wetlands or over wetland swales should be elevated on structures, pilings, or columns, rather than placed on fill.

Wetlands can, however, be used for light-duty, pile-supported structures such as boat houses, boat shelters, fences, duck blinds, footbridges, observation decks, and so on. If properly designed, these should have no major detrimental effect on wetland functions.

Although there are important ecological differences between freshwater and saltwater wetlands, management requirements for the two are quite similar. Therefore, the more detailed management recommendations in the Saltwater Wetlands section (pp. 52-64) are largely applicable to freshwater wetlands.

Recommended Policy 2: Protection of the Edge-Zone.

Protect the edge-zone bordering coastal waters from alteration.

There has been a great loss of coastal floodlands edge-zone because of a general lack of appreciation of this zone's ecologic value and its role in resisting storm and erosion hazards. The edge-zone that lies at the lower edge of the floodlands has often been flattened because a homeowner wants to build and landscape right to the water's edge or a farmer wants to open up as much land as possible for planting or grazing. When edge-zones are cleared of vegetation, graded, built on, or otherwise obliterated or seriously altered, the result may be the loss of critical wildlife habitat and natural visual screen and an increased potential for water pollution, bank erosion, and damage from storm surges and waves. It is important to note that structures placed in this lowest, most hazardous, part of the floodlands are extremely vulnerable in moderate to severe floods, particularly when the edge-zone's vegetation is removed.

Because of variations in landform, floodlands may have edge-zones of greater or lesser value; therefore, you have to evaluate each case. The most concentracted ecological values would be expected where the edge-zone is a dense strip of scrub or bush that grades quickly upward to a stand of mixed hardwood trees, which then grades quickly into open field or into a different or less-dense type of forest.

Slope (%)	Slight Erosion [ft (m)]	Moderate Erosion [ft (m)]	Severe Erosion [ft (m)]
0	30 (9)	35 (11)	45 (12)
10	55 (17)	65 (20)	80 (24)
20	80 (24)	95 (29)	115 (35)
30	105 (32)	125 (38)	150 (46)

Table 2. Minimum filter strips for cropland water-quality restoration, recommended to the U.S. Agricultural Research Service for soils with varying erosion problems (arbitrary scale). For example, a 10 percent slope with a slight erosion problem would require a 55-foot filter strip. (Source: Paul Pacobson and Walter Weiss, *Farming Terraced Land*, revised by R.C. Barnes, U.S. Department of Agriculture Leaflet No. 335, Government Printing Office, Washington, D.C., 1973.)

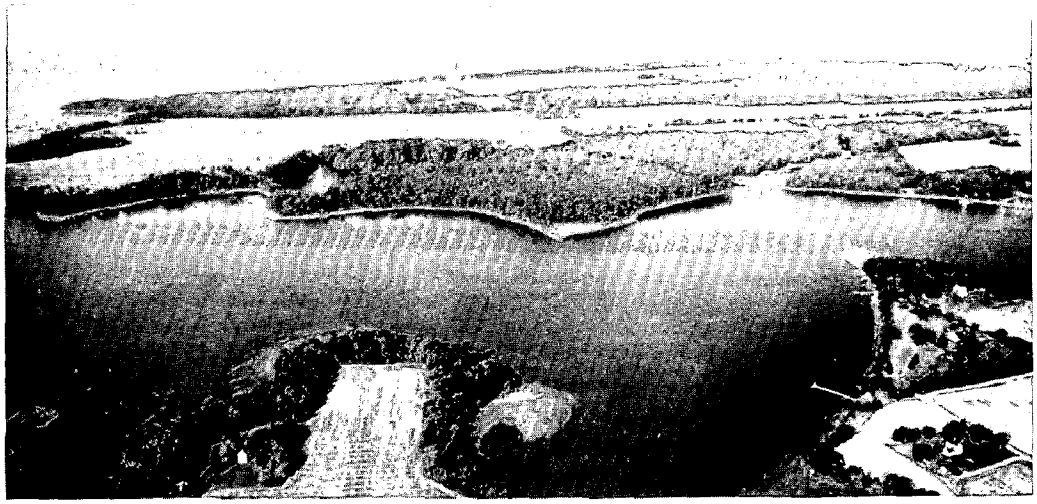


Figure 7. A strip of natural vegetation, or buffer strip, should be required between open fields and water bodies for wildlife habitat and water quality protection. (Photo by John Clark.)

The best way to protect the edge-zone is to set it aside as a "buffer area" or "buffer strip" and prescribe only non-altering uses of it through special performance standards. In addition to conserving critical wildlife habitat and lowering flood hazard and erosion potential, the unaltered buffer strip of natural vegetation and soil just above the wetland or water's edge (i.e., above the one-year flood mark) provides a visual screen and an "anti-pollution" zone, or "filter strip," to intercept runoff and helps to purify water by soil infiltration and vegetative "scrubbing".[4] Where the lower floodland slope is moderately steep or the edge-zone relatively narrow, the natural edge-zone may need to be protected by a wider buffer strip.[5]

For agriculture, the width of a buffer strip should vary according to soil and water-table characteristics, slope, climate, and type of vegetation used. You must also consider the nature of the farm operation—time of harvest, amount of cultivated area, type of crop, amount and type of fertilizer and biocide, tillage techniques, and so forth. Table 2 gives some recommended *minimum* setbacks for agriculture based on water quality requirements. Setbacks should be required along all watercourses and coastal shorelines (Figure 7). A setback distance of 150 feet, in common use for the protection of streams and other water areas, will often be sufficient for soil-erosion control. Additional width will be required to provide for removal of nitrate and other agricultural chemicals. A wide buffer is particularly important in areas where the land surface slopes steeply toward the water.[6] All setbacks should be increased where needed to include values in addition to water quality, such as wildlife habitat.

You can find many uses for buffer strips that are compatible with conservation of edge-zones. Buffers can often be special croplands—for example, close-growing crops (grasses) that have matted root systems and require no fertilizers or pesticides. The area can be set aside as open space or used for certain types of recreation. For example, light-duty structures often are acceptable, if they can fit into the natural landscape and can be accommodated with little clearing, grading, paving, and excavation. You can incorporate such requirements in local zoning or subdivision regulations, though some communities use other techniques, such as special permits with environmental review.

The policies for edge-zone protection in coastal uplands should be identical to those for coastal floodlands. Specifically, setbacks providing for protection of the edge-zone, with additional buffers if necessary, along freshwater wetlands, watercourses, and lakes and ponds of the uplands should be required and follow the guidelines suggested above. It should be noted that edge-zone buffers will often be needed most along shores not protected by wetlands.

Recommended Policy 3: Alteration of Watershed Terrain.

Discourage clearing, grading, and surfacing that would adversely alter the water retention potential of the watershed terrain.

Clearing coastal watersheds of vegetation and covering them with an impervious surface causes major alterations in the quality, volume, and rate of storm-water runoff. The higher the amount of paved surface, the more rapidly the runoff surges into coastal waters. In single-family developments zoned at one dwelling unit per acre, impervious surface can run as high as 15 to 20 percent of the gross land acreage (with five-acre single-family zoning, the average will be 3 to 5 percent).[7]

Conventional techniques can provide most of the protection from runoff needed by coastal-water ecosystems. In site preparation, grades should be designed to direct runoff along natural drainage courses and through natural terrain where the vegetation can cleanse and filter the water. In paving, surfaces should cover a minimal area, and permeable surfaces rather than solid paving should be used insofar as possible to permit water infiltration and reduce the costs of artificial storm drains. Gravel or crushed rock is the simplest form of permeable paving. It is inexpensive, widely used, and usually acceptable for private driveways and other surfacing needs. There are also other suitable paving materials, ranging from lattice concrete blocks to perforated bricks to standard paving bricks with spacing lags.

These surface-management techniques are also valuable in protecting the recharge potential of groundwater resources. Aquifers are naturally recharged by rain percolating through from the land surface or laterally from a lake or stream. Using impervious surfacing, removing vegetation, and draining land in recharge areas will divert waters that otherwise would filter into groundwater aquifers.

Since the needs for terrain management in coastal uplands are identical to those for floodlands, the above suggestions should be implemented uniformly throughout all parts of the coastal watershed under your local jurisdiction.

Activity or Use	Sediment Produced (tons/sq mi/yr)
Construction	48,000
Cropland	4,800
Grassland	240
Forest	24
Disturbed forest (not clear-cut)	24,000
Active surface mines	24,000
Abandoned mines	2,400

Table 3. Sediment produced by major land-use activities. (Source: Midwest Research Institute, Methods for Identifying and Evaluating the Nature and Extent of Non-point Sources of Pollutants, EPA Con. No. 68-01-1839, 1973.)

Recommended Policy 4: Soil Erosion.

Reduce to the minimum erosion and runoff pollution from construction, agriculture, and logging.

As shown in Table 3, construction sites generally pose a higher potential threat of sediment runoff than the sites of other major land activities.[8] Runoff flow from construction sites often carries enough sediments, toxic materials, nutrients, coliform bacteria, and other undesirable matter to pollute coastal waters.

Solutions to soil-erosion problems are well known and widely implemented. Erosion-control techniques can be divided into three functional types: (1) entrapment of eroding sediments with vegetated buffer strips and sediment-detention ponds; (2) diversion of runoff from likely erosion areas through grading, diversion cuts, and grassed waterways (swales); and (3) prevention of soil movement and erosion, including the use of such methods as reseeding, mulching, and placing of special netting over exposed soils.[9]

Vegetated buffer strips and such systems as sediment basins can provide sound erosion control for on-going construction operations by detaining runoff, trapping sediment, and preventing increased turbidities in adjacent water bodies. Your community should implement controls of this sort for all watercourses.

In agriculture, soil erosion can be controlled by technical improvement such as improved soil treatment, tillage methods, and timing of field operations or control

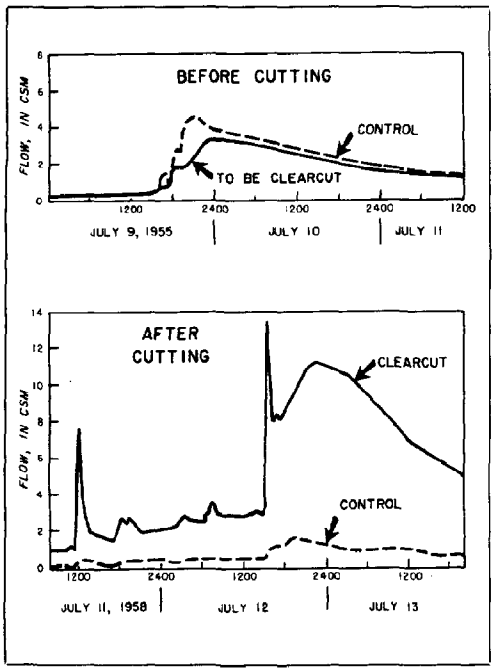


Figure 8. Effects of clear cutting on runoff shown by before (control) and after (clear-cut) storm hydrographs. (Source: K. G. Reinhart, A. R. Eschner, and G. R. Trimble, Jr., *Effects on Streamflow of Four Forest Practices in the Mountains of West Virginia*, U.S. Forest Service Research Paper No. NE-1 [Upper Darby, Pa.: U.S. Department of Agriculture, 1963].)

practices such as terracing, contouring, or water control.[10]

In forest-harvest activities, both clear-cut areas and logging roads cause increased rates of water runoff and soil erosion (Figure 8). In clear-cut areas, terracing, composting, mulching, and fertilizing help species planted for erosion control to prosper and, by aiding the restoration process, reduce sediment output. Logging trails and roads should be properly located and designed and immediately reseeded to speed the restoration process.

Recommended Policy 5: Alteration of Watercourses.

Discourage straightening, deepening, diking, or other adverse alteration of natural channels of the hydrologic system.

Stream channelization—e.g., widening and deepening the stream channel, straightening watercourses to eliminate natural meanders, clearing stream banks, and constructing dikes or bulkheads—may be undertaken to facilitate navigation, to assist in flood control, or to create arable land. Channelization often lowers the water level in streams and in the riparian water table, increases the rate of runoff and of stream flows, and causes an increased potential for flooding by speeding the delivery of storm runoff to coastal water basins. Channelization may also increase bank and bottom erosion and cause a greater sediment load than in an unchannelized stream. Dredge spoil is often deposited on adjacent banks. If this happens, the vegetation is covered and edge-zone habitat eliminated.[11]

Insofar as there may be significant environmental effects, alteration of streams or other watercourses should be discouraged. Where channel deepening appears justified, and there is no practicable alternative, you should conduct a complete assessment of ecological effects, including consideration of estuarine flood hazards and ecological consequences, before approving a project. Preservation of the watercourses and water bodies of the hydrologic system is a general environmental objective, the values of which go far beyond coastal needs.

Recommended Policy 6: Land Drainage and Excavation.

Avoid land drainage or other excavation that would adversely alter the hydrology of floodlands.

Artificial drainage of watersheds may adversely affect coastal ecosystems by accelerating runoff surges to coastal water basins, particularly estuaries, via the drainage canals. Also, the intrusion of salt water upstream in canals during high-water surges may increase the flooding of low-lying areas or contaminate groundwater and human and agricultural water supplies with salt.[12] Drainage of coastal floodland parcels by excavation of drainage ditches and canals that discharge directly (without retention or treatment) to coastal waters generally should be avoided. However, if need be, a developer can design drainage systems to include the necessary protection functions.

For individual parcels, systems should be provided with holding basins that allow sediment to settle and that are of sufficient capacity to hold the discharge during unusually heavy rainstorms. The basic

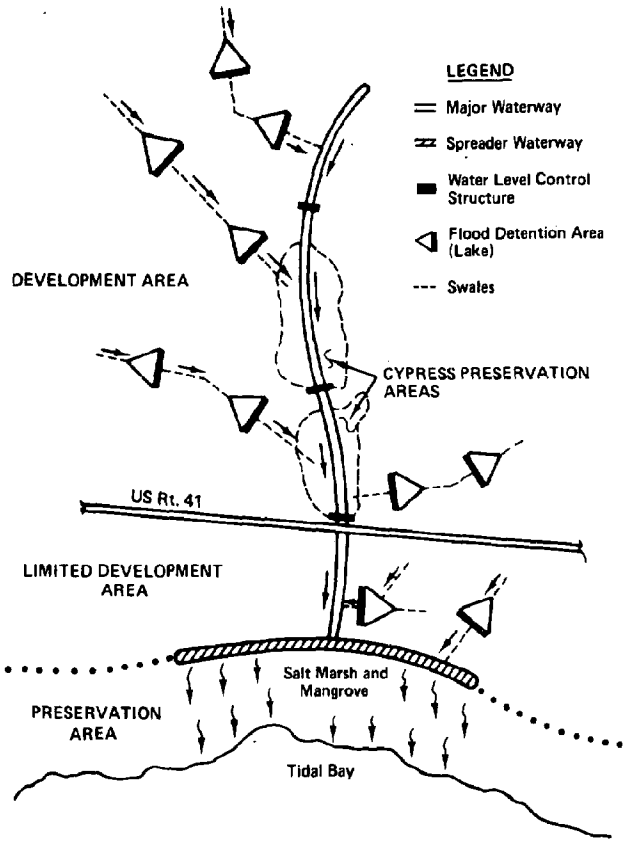


Figure 9. The proposed water management subsystem in this conceptual sketch simulates natural conditions. (Source: Ronald L. Wycoff and R. David G. Pyne, "Urban Water Management and Coastal Wetland Protection in Collier County, Florida," *Water Resources Bulletin*, vol. II, no. 3 [1975], pp. 455-68.)

principle is: new drainage facilities should be designed as far as possible to approximate closely the natural system of water drainage and to maintain the water table at its historic level. Accordingly, artificial drainage facilities should release water from a developed area in a manner approximating the original, natural, local surface-flow regime by the use of either (1) a spreader pond onsite, or structure with equivalent performance, or (2) an adequate natural retention-filtration and flow area, such as a "grassed swale" or vegetated buffer strip (Figure 9).

Drainage canals should generally be discharged into existing natural tributaries rather than into new drainageways cut through floodlands. Canals should have gently sloping sides (preferably not greater than 6:1). They should also be the minimum depth necessary to maintain reasonable flow and to inhibit cattails and other rooted weed growth (four feet), and no deeper than seven or eight feet (Florida specifications). Canals excavated in the floodlands (or uplands) should be stabilized with vegetation before runoff is allowed to be released.[13] They should be designed to maintain natural groundwater levels through the use of high-level weirs or structures or systems with equivalent performance.

Canals excavated for purposes other than drainage—e.g., for boat access or for landfill—will have consequences similar to drainage canals and should be controlled accordingly. Canals built for residential areas are vulnerable to pollution from runoff and septic tanks and may pass the contaminants directly into estuaries, causing problems there with turbidity, nutrient input, dissolved oxygen, and microbial activity (Figure 10).

Artificial lakes dug in low-lying floodlands either as an amenity or to furnish landfill are often troublesome. A frequent problem is that after flooding by storms, these lakes may continue to hold salt water—except what escapes to pollute the water-table aquifer. Lakes too deep may

Figure 10. Canals in residential developments are vulnerable to pollution, which may be passed directly into estuaries. (Photo of Sanibel Island, Florida, by John Clark.)

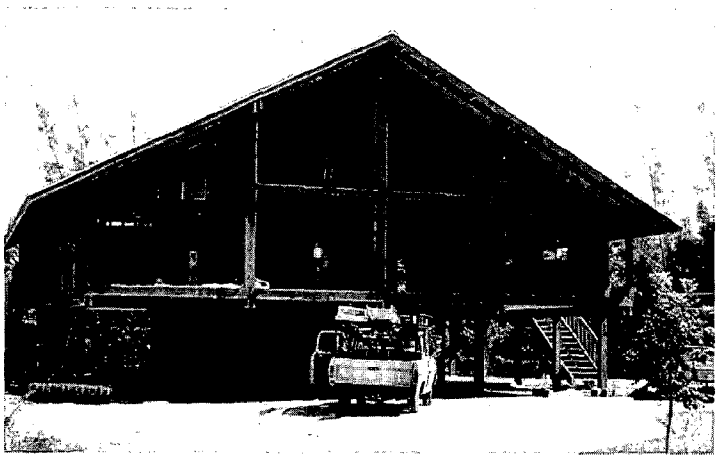


Figure. 11. A house elevated on piles for protection against coastal flooding (Sanibel, Florida). (Photo by John Clark).

become stagnant (lack of internal circulation) and unable to purify themselves naturally. Lakes too shallow tend to choke up with cattails and sediment. The best policy is to avoid such lakes. If you have no alternative, strict performance standards should be applied—lakes should be deep enough (more than four feet) to discourage growth of rooted aquatics and cattails, and shallow enough (less than eight feet) to permit the maintenance of acceptable water quality through wind-induced turnover. A wide buffer strip of natural soil and vegetation around the edge of such lakes is recommended.

Recommended Policy 7: Construction in Floodlands.

Encourage the use of piling supports or similar techniques to elevate structures built in floodlands.

Elevated pilings or post supports, familiar features in many coastal areas, provide protection against flood damage—especially when foundation anchors are installed. The additional cost over grade-level (slab) construction is generally 12 to 14 percent, slightly less than the typical cost of a basement. Dirt fill and slab may cost more than posts or piles once the fill goes over five or six feet.[14] Pile elevation may thus be the best option wherever the required elevation is six feet or more above grade, as well as in high-hazard areas, where anchoring is required and dirt fill is not allowed (Figure 11). The ground level area under the first floor of structures elevated on piles can be used for appliances, utilities, parking cars, storing boats, etc. There is also an aesthetic incentive: in shore locations, elevated structures often have a better view.

Ideally, all structures should be built back from the beach and out of the high-hazard area in a safe place. A 10-foot storm wave pushed by an average winter storm

is said to hit with a force of one ton per square foot. A study by the Galveston District of the U.S. Army Corps of Engineers showed that non-elevated, wood-frame structures were vulnerable for 1,000 to 2,000 feet back from the shore if they were on land lower than 10 feet above mean sea level and that in lower areas structures closer than 500 feet to the shore would be completely destroyed in a severe storm.[15]

Recommended Policy 8: Floodwater Pollution.

Prevent pollution from floodwater runoff through proper location and design of facilities where polluting substances are stored.

Floodwaters wash a variety of materials into coastal basins. These materials may be natural nutrients that are beneficial to aquatic life or harmful pollutants associated with general land runoff or supplies stored at commercial and industrial sites. The effects of harmful substances are particularly severe where the floodlands drain into small embayments or lagoons with restricted rates of flushing.[16] In general, you should assume that the retreat of floodwaters from a developed area in the lower parts of the floodplain (one to 10-year flood levels) has a short-term negative impact on the ecosystem.

One way you can reduce pollution from floodwater runoff is to locate new facilities with pollution potential out of the floodlands, particularly the lower floodlands. Potential pollution sources that already exist—e.g., garbage dumps, chemical warehouses, sewage treatment plants—should be identified as non-conforming uses and relocated to high ground when possible. At the least, these facilities should be floodproofed. Federal pollution regulations require some facilities—e.g., commercial feedlots—to be located above the 25-year flood level or to be floodproofed so that public waters are not contaminated during floods.[17]

Recommended Policy 9: Groundwater Pumping.

To prevent subsidence and aquifer contamination, limit the use of groundwater resources.

Control of groundwater use is urgently needed in many communities to prevent depletion of aquifers and costly subsidence of land or contamination of aquifers. The issue is of particular importance for coastal floodlands, where overpumping of water (or oil) can lead to subsidence of the floodlands and to greater endangerment of life and property (Figure 12). Subsidence of the surface results when land loses the

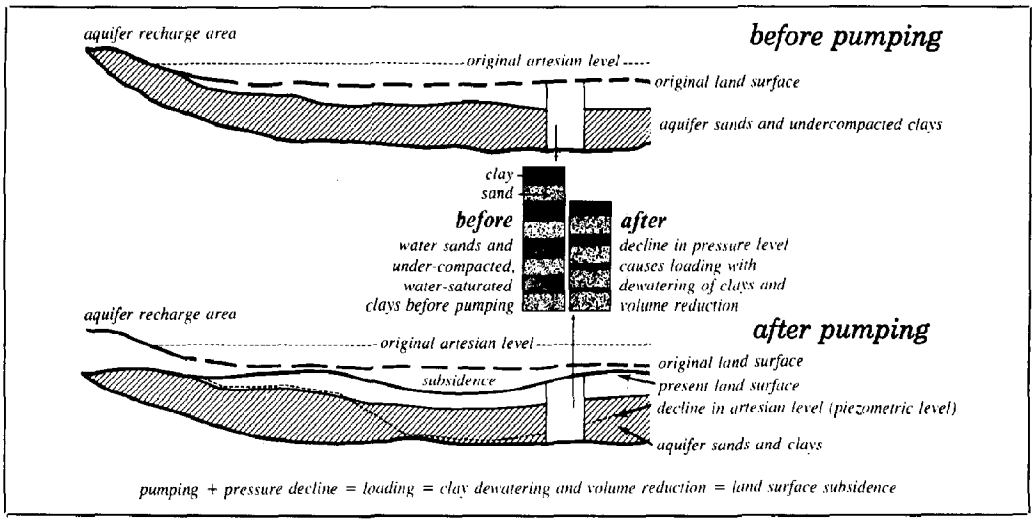


Figure 12. Near Houston, Texas, overpumping of the groundwater aquifer resulted in shrinkage of underground clays, which caused the land to subside from its original elevation (before pumping) to a lower elevation (after pumping). This lowering of the surface greatly increased flooding hazards in much of the area around Houston. (Source: Diagram adapted from Bostwick H. Ketchum, ed., *The Water's Edge: Critical Problems of the Coastal Zone* [Cambridge, Mass.: Massachusetts Institute of Technology Press, 1972].)

Number of hurricane landfalls, 1900-1972	27
Area (square miles) of salt-water flooding, Hurricanes *Carla* and *Beulah*	3,164
Area (square miles) of fresh-water flooding, Hurricane *Beulah*	2,187
Area (square miles) of fresh-water flooding by hurricane rainfall (floodplains), northern part of Coastal Zone only	2,073
Area (square miles) below elevation of 20 feet (MSL): subject to salt-water flooding by tidal surge	5,787
Number of active or potential hurricane washover channels	137
Number of miles of Gulf beach erosion: greater than 10 feet per year (long term)	47
Number of miles of Gulf beach erosion: from 5 to 10 feet per year (long term)	50
Number of miles of Gulf beach erosion: from 0 to 5 feet per year (long term)	104
Number of miles of bay and lagoon shoreline erosion	403
Area (square miles) of land subsidence: greater than 5 feet	227
Area (square miles) of land subsidence: from 1 to 5 feet	1,080
Area (square miles) of land subsidence: from 0.2 to 1 foot	5,422
Number of miles at known active surface faults	96
Number of miles of Gulf shoreline	367
Number of miles of bay-lagoon shoreline	1,100
Area (square miles) of bays and lagoons	2,075
Area (square miles) of land in map area	18,000

Table 4. This table of landform characteristics associated with hurricane vulnerability on the Texas coast shows that over 1,300 square miles of coastal area has subsided more than one foot, thereby increasing the flooding hazard. (Source: Texas Coastal and Marine Council, *Pictorial Atlas of Texas Coastal Hazards*, Austin, Texas, 1977.)

subsurface support provided by groundwater. In heavily industrialized areas around Galveston Bay, Texas, the land has sunk as much as eight feet below sea level and many houses are in jeopardy (Table 4). Subsidence has drastically increased the flooding danger and made the area especially prone to disaster in hurricanes. Dikes have been built and pumps installed to help ward off flooding problems, but such structural protection measures treat only the "symptoms" of unmanaged groundwater pumping—an increase in relative sea level and flooding—and do not solve the problem. The disruption of local public utilities (water, sewer, gas) and regular flooding of roads may be the first signs of subsidence. While only a few coastal communities appear to have been troubled with this type of subsidence so far, others may be in the future.

Uncontrolled pumping can also lead to saltwater contamination of groundwater supplies—a separate, but related problem. The natural head pressures on coastal aquifers normally prevent salt water from intruding into the fresh water, but overpumping may cause intrusion. Groundwater resources of coastal communities are being increasingly jeopardized as aquifers

are pumped for industrial and domestic water use. For example, on Long Island, overpumping for municipal supplies and industrial operations caused the freshwater head to drop as far as 35 feet below sea level, and resulting intrusion of seawater forced Long Island communities to limit water use and eventually to abandon many supply wells.[18] Along California's populated coast there has been significant seawater intrusion in at least 12 localities. Currently, the big users of groundwater in coastal areas are municipal water districts and industry; there is very little demand for groundwater use in irrigation.

To protect groundwater and land resources from seawater intrusion and land subsidence, your community must have sound and comprehensive water management policies. In a total management program, groundwater, surface water, and reused water supplies will be inventoried and used in a coordinated plan of "conjunctive" management. Generally, this type of management is accomplished at the local or regional government level, operating within a framework of powers and duties established by State statutes. The State laws and regulations ought to protect groundwater aquifers from injury and authorize enforcement both by individual property owners who are affected and by public officials and management districts charged with the responsibility of managing groundwater and surface-water resources. U.S. EPA programs under the Federal Safe Drinking Water Act may aid communities concerned with this issue.

Recommended Policy 10: Restoration of Floodlands Environment.

Encourage private and community programs for restoration of beneficial floodlands functions.

Restoration of floodlands for conservation of ecologic resources and for rehabilitation of storm-resistant landforms is required in many coastal communities where uncontrolled drainage, diversion of water systems, and land development projects have led to widespread adverse impacts on watershed drainage systems, which, in turn, has degraded coastal ecosystems. Adverse alterations to water and drainage systems are common, the result of filling in or draining marshes, bogs, and swamps, and/or diversion, obliteration, or channelization of natural drainageways. In some instances, the flow systems of small watersheds no longer retain runoff adequately because of disruptive site grading.

A high priority should be given to remedying such damage through restoration programs that (1) reestablish vegetative cover and renew the hydrologic balance, (2) conserve soil resources by reducing soil erosion and providing soil stability, (3) deter runoff and reduce damage from floods

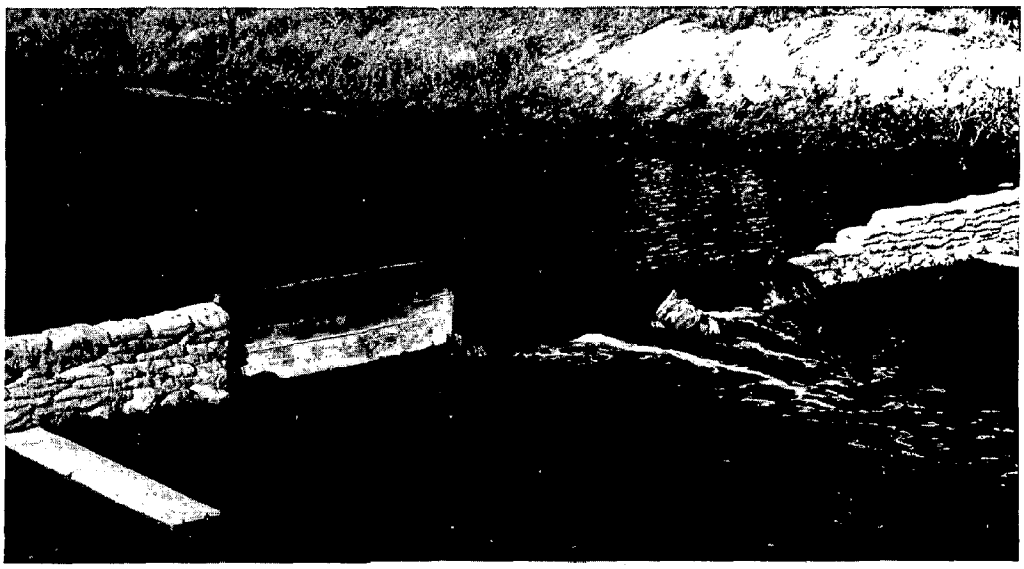


Figure 13. Many types of detention structures are used to correct flow in disrupted streams. (Photo courtesy Bernard Yokel, Rookery Bay Marine Laboratory.)

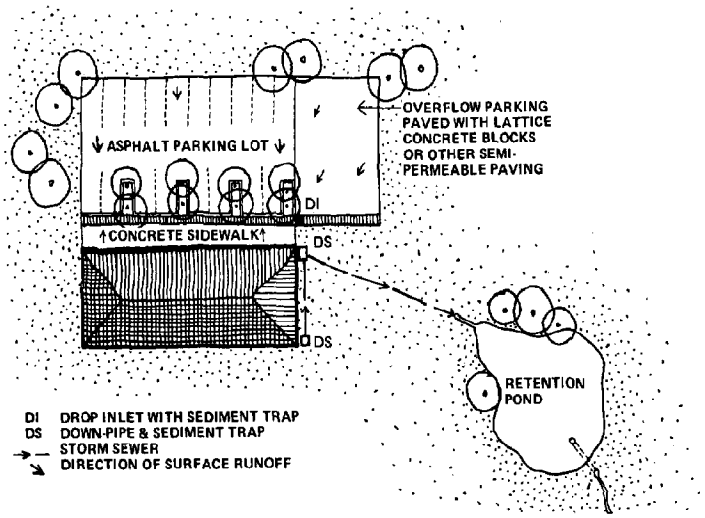


Figure 14. Retention ponds that store runoff for slow release should be designed to simulate the natural system. (Source: Adapted from Joachim Tourbier and Richard Westmacott, *Water Resources Protection Measures in Land Development—A Handbook: Water Resources as a Basis for Comprehensive Planning and Development of the Christina River Basin.* A Prototype Project, Phase II [Newark, Del.: University of Delaware, Water Resources Center, 1974].)

by lowering runoff flow peaks, (4) minimize the sediment carried into streams, and (5) enhance aesthetic considerations and recreational uses.

In general, existing artificial land-drainage facilities should be redesigned to approximate closely the natural system of water drainage and to maintain the water table as close to its historic level as possible. This can be accomplished through partial or complete refilling of canal sections, installing elevated sills or weirs, and restoring the edge configuration to provide an appropriate buffer zone (Figure 13).

Increased flood volume and flood peaks caused by urbanization can be counteracted through artificial detention works so that a natural rate of downstream flow is maintained. For this a thorough knowledge of the hydrology of the drainage basin is required, plus understanding of associated factors such as seasonal precipitation, soils, slopes, vegetation, stream flows, and land-use patterns. A project to maintain or restore the pattern of flow can be designed on the basis of this information. Artificial detention should be equivalent to any natural detention capacity eliminated.

There are many design techniques for returning rainfall to the soil, by collecting water and letting it seep through gravel into the groundwater. Runoff can be held on-site in any combination of the following: gravel-filled channels, gravel-filled seepage pits, runoff retention ponds (Figure 14).

Reservoirs installed on a river can even the flow. Floodwaters can be retained. And in drought periods, reservoirs can release water. You should make sure that the minimum flow to the coastal ecosystem during dry season is that which prevailed under natural conditions.[19]

A damaged or obliterated edge-zone can be repaired rather easily by rebuilding and regrading the soil base and replanting with appropriate species. As to subsided land, because it appears that there is no practicable way to re-elevate it, fill is perhaps your only solution.

IMPLEMENTATION GUIDELINES

If your community decides to pursue the 10 policies just recommended for managing floodlands, it faces a difficult question. How can the policies be translated into action? This section of the guidebook is intended to assist in answering that question for Policies 1 through 8. (Management concerns for Policies 9 and 10 have been addressed in the discussion of those policies.)

The following discussion focuses on two principal kinds of local action: first, modifying local plans, regulations, and programs to respond to the special needs of

floodlands; second, seeking assistance available under Federal programs that affect floodlands. To implement the policies in these ways, you should be prepared to address four principal management needs:

First, **excluding development from key areas within the floodlands,** in accordance with Policies 1 (Alteration of Freshwater Wetlands) and 2 (Protection of the Edge-Zone).

Second, **avoiding adverse alteration of floodlands terrain and natural water systems.** Floodwater retention, a key factor in mitigating the severity of coastal floods, can be significantly influenced by man-made alterations of terrain and watercourses. Alteration of terrain also changes the amount of "diffuse source" water pollution—erosion sediment, fertilizers, pesticides, and the like—that reaches coastal waters. Soil-conservation programs and controls on land clearing, paving, drainage, and channel alteration are among the measures needed to protect against these problems, which are discussed in Policies 3 (Alteration of Watershed Terrain), 4 (Soil Erosion), 5 (Alteration of Watercourses), and 6 (Land Drainage and Excavation).

Third, **establishing standards for new development in floodlands,** in accordance with Policies 7 (Construction in Floodlands) and 8 (Floodwater Pollution). Thousands of American communities already have regulations intended to protect property against future flood hazards. These regulations respond, in part, to the most far-reaching federal initiative affecting floodlands: the National Flood Insurance Program. To implement Policies 7 and 8, however, additional requirements are necessary.

Fourth, **defining the boundaries of floodlands for management purposes.** Since your community will be establishing development standards for floodlands, you will have to define the boundary of that area with some precision.

1. **Excluding development from key areas within the floodlands.**

If avoidance of hazards and ecological protection were the overriding objectives of floodplain management by local governments, you might decide to exclude urban development from the entire floodplain, including the floodlands. In fact, public and private needs make total exclusion impractical in most communities. That is why you need standards for new development.

There are places within the floodplain, however, where excluding development is especially important from the twin perspectives of avoiding hazards and protecting ecological values. Two of these places—freshwater wetlands and the edge-zones bordering wetlands and coastal waters—are located in floodlands. Two of the recommended policies for floodlands (Policies 1 and 2) call for excluding development from wetlands and edge-zones. While achieving ecological objectives, these policies also exclude development from most "high hazard" and "erosion prone" areas in floodlands.

Regulatory techniques that you already use throughout your community are often sufficient to protect the vital areas of floodlands. These areas may be designated in local subdivision regulations as preferred sites for floodwater detention. The edge-zone can be protected in most cases with a simple setback or buffer requirement in zoning, subdivision, or building controls. Requiring notation of flood-hazard or wetland areas on recorded subdivision plats may also be feasible in some situations.[20]

Your efforts to pass or enforce regulations prohibiting development in wetlands (or even in large edge-zone areas) may encounter vigorous objections from affected property owners, who may raise political objections (in essence, that preserving wetlands doesn't justify the resulting private economic loss) or legal ones (that the prohibition exceeds a locality's constitutional or statutory powers). Anticipating such objections, you should consider ways to make the burden of regulation as light as possible, while still achieving the necessary protection, and also devise non-regulatory methods of protecting vital areas.[21]

One way to make prohibitions less burdensome is through special zoning designations such as planned unit development (PUD), transfer of development rights (TDR), or cluster-development provisions. With such designations, you may be able to permit the same (or nearly the same) amount of development that would be permitted if the vital area were not protected. None of the development would be in the vital area, however. Instead, it

would be clustered on the remaining, higher portions of the developer's property. Although such special zoning designations can be extremely useful, they may be unworkable in some situations —for example, where the total quantity of permitted development is excessive.[22]

Public-works programming is a nonregulatory device that can be used to help protect vital areas. If public roads, sewers, and other facilities are permitted in floodlands, they may not only be vulnerable to damage themselves but may also encourage further development nearby. Careful planning can often reduce these risks. The opportunity may be limited, however, when several units of government share responsibility for providing facilities and services in the same area[23] and fail to coordinate their programs. Previous financing arrangements for local public facilities may also limit your community's ability to protect vital areas. In particular, special tax assessments may have given property owners a legitimate expectation of access to sewers and other facilities that they have helped to buy. Nonetheless, public-works considerations should be and generally can be an integral part of local floodplain management.

Local programs of information and education, to create awareness of flood hazards and environmental needs, are another useful device to protect vital areas. Private citizens as well as public officials often benefit from such programs.

Finally, your community should consider acquisition of vital areas. This is a common technique to provide protection without imposing on individuals the financial burdens that sometimes result from regulation. The principal disadvantage of acquisition, of course, is its cost. Even if private donations reduce or eliminate the original purchase cost, acquisition can create continuing costs as a result of lost tax revenues and expenses for maintenance and management. In some cases, the time required for acquisition may also prove to be a significant disadvantage.[24]

Your community should anticipate two problems, in addition to those already mentioned, when it tries to exclude development from edge-zones and wetlands. First, the policies and regulations it adopts will usually not control the actions of State and Federal agencies and of other local governments, although local ordinances are usually respected by Federal agencies. Second, you may find it difficult to define the precise areas from which development is to be excluded.

The following Federal actions may help you overcome these problems:

Federal permits for discharges of dredged or fill material. Freshwater wetlands are protected from harmful discharges of dredged or fill material by Federal regulations. These regulations, established under Section 404 of the Federal Clean Water Act, are administered by the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers. The regulations require a permit before discharge of dredged or fill material into any wetlands, with few exceptions. Permits are issued or denied by the Corps of Engineers. States may, however, after meeting certain U.S. EPA requirements, administer a portion of the Corps permit program. Details of this program, which applies to all wetlands, are discussed in the Saltwater Wetlands section (see p. 67).

Executive Order 11988, "Floodplain Management." The Floodplain Management Executive Order, issued by the President in 1977, requires Federal agencies to "take floodplain management into account ... and require land and water resources use appropriate to the degree of hazard involved" for actions in identified floodplain areas. The Order specifically prohibits any Federal agency from conducting, supporting, or allowing an action in a floodplain unless there is no practicable alternative location or action and, in addition, the Federal agency:

—designs or modifies its action to minimize potential harm; and

—prepares and circulates a notice explaining why the action is proposed to be located in the floodplain (the "A-95" review, discussed below, may be used for this purpose).

The U.S. Water Resources Council oversees an information exchange system based on regulations issued by each Federal agency that conducts or supports activities in floodplains.[25]

The agencies likely to undertake or support substantial projects—other than for flood or erosion protection—that sometimes must be located in floodplains include:

—U.S. EPA, which has a construction grants program assisting new sewage treatment plants;
—U.S. Department of Agriculture, Farmers Home Administration, which assists a variety of public facilities in rural areas;
—U.S. Department of Transportation, Federal aid highway programs;
—U.S. Department of Commerce, Coastal Energy Impact Program and other economic development programs.

Whenever your local government prepares to comment on proposed federally aided actions affecting wetlands or edgezones, it should consider whether the actions comply with the letter and the spirit of this Order.

Executive Order 11990, "Wetlands." At the same time the Floodplains Executive Order was issued, the President issued the Wetlands Executive Order. The Floodplains Order requires that the Wetlands Order be taken into consideration in establishing floodplain review procedures. The Wetlands Order applies to all wetlands and directs "each agency, to the extent permitted by law, [to] avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds

(1) that there is no practicable alternative to such construction, and
(2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use."

In many respects, the Wetlands Order resembles the Floodplains Order. Communities implementing Policies 1 and 2 should note one important difference, however. If construction does become necessary in wetlands, the Wetlands Order requires that the agency take "all practicable measures to minimize harm to wetlands. . . ." Your community should pay particular attention to this requirement when it comments on proposed Federal and federally aided construction that affects wetlands.

A-95 Process. Opportunities to comment on proposed Federal actions often arise under the A-95 process. Most Federal proposed development or assistance actions—grants, loans, construction projects, etc.—must be presented by Federal agencies to regional "clearinghouses," where local governments are given an opportunity to comment. Where there is no regional clearinghouse, the Federal actions are reported to a State clearinghouse.

Instituted as a coordinating mechanism at the order of the Federal Office of Management and Budget, the A-95 process gets its name from the file number for the order—OMB Circular A-95. Each Federal agency must establish its own procedures for reporting actions to the clearinghouses. As a means of communication between different levels of government, the A-95 process works with varying effectiveness, depending on the area of the country and the Federal agency concerned.

Federal agency definition of "wetlands." Localities trying to implement a wetlands protection policy often find it difficult to define the term "wetlands." You may find it appropriate to use the following definition established by the U.S. Army Corps of Engineers and U.S. EPA in 1977:

> Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.[26]

The reference to "normal" circumstances is intended to frustrate attempts to circumvent protection by clearing an area of vegetation or temporarily draining or diking an area shortly before public review.

Adoption of a definition is not, however, the final step in locating wetlands. Problems of delineating boundaries remain. For convenience, these problems are considered later, in the section on Saltwater Wetlands (see p. 70).

Federal assistance for land acquisition. Assistance in land acquisition may be available under numerous Federal programs. For the most part, these programs are directed at lands with specific resources or recreational potential. Many are keyed to State plans or priority lists, e.g., the Land and Water Conservation Fund. Some communities also apply general assistance such as Community Development Block Grants from the Federal Department of Housing and Urban Development (HUD). More complete current information will be found

in the *Catalog of Federal Domestic Assistance.*[27]

2. Avoiding adverse alterations of floodlands terrain and natural water systems.

Several of the policy-implementation guidelines recommended in other parts of this section will help your community to avoid disruptions of floodlands terrain and natural water systems by establishing standards for development or setting up a process to exclude it from edge-zones and wetlands. Beside these development-related plans and regulations, most communities will also need to adopt measures that specifically and directly address disruptions of terrain and water flow. What you will need are:

—Measures to discourage alteration of floodland surface (Policy 3);
—Measures to reduce erosion and runoff pollution from construction, agriculture, and logging (Policy 4);
—Measures to discourage stream channel alteration (Policy 5);
—Measures to control land drainage and artificial water bodies (Policy 6).

Your community can respond to these needs in a variety of ways. For decades, many communities have had grading and land-alteration controls. More recently, many have also established procedures for identifying the environmental impacts of various activities—e.g., environmental impact statements or assessments, environmental site plan review (for new development), community impact reviews, or the like.[28]

Even without formal environmental analysis, communities often become aware of the short-term construction impacts, such as erosion or devegetation of the edge-zone, that are likely to result from new development. Problems of this kind can usually be prevented or reduced by standard construction practices like reseeding or sodding. Conditions requiring these practices can be imposed when your community grants building or site-alteration permission.

You may also prohibit the planting of particular species of trees along flood evacuation routes. Some Florida communities, for example, prohibit the replanting of Australian pines, which pose hazards in coastal floods because of weak root structures.

Local subdivision controls can set standards for drainage and artificial lakes in new residential subdivisions. These controls can also require that subdivision maps provide notice of the flooding and drainage characteristics of particular residential areas.[29]

Promoting soil conservation is far more difficult. Apart from construction, excavation, and other activities that are typically subject to local regulation, it is usually possible to promote soil conservation only through voluntary education and awareness programs. Such programs are well established in many rural counties, and also in some urban areas, where chemical, fertilizer, and sediment problems are common.

In attempting to prevent disruption of floodlands terrain and natural water systems, your community is likely to encounter problems. First, policies of one local government usually have little effect on other governments, including some drainage and flood-control districts responsible for regional stormwater drainage programs. Second, although your community is likely to find numerous State and Federal programs generally oriented toward its goals, the programs overlap and may not easily mesh with your local actions. Obtaining and using the resources available from these programs is sometimes difficult.

In addition to Federal programs mentioned in other parts of this section, the following may help your community to protect floodlands terrain and natural water systems:

Regional Water Quality Planning (208 planning). Section 208 of the Federal Clean Water Act provides funds to States and designated regional agencies to prepare water-quality plans. One of the several objectives of these plans is to provide an outline for future Federal investment in sewage-treatment facilities. Many communities have first encountered section 208, which was enacted in 1972 and is administered by U.S. EPA, while planning or seeking lands for new treatment facilities.

An equally important, but less well understood, objective of "208" planning is control of "nonpoint" sources of pollution.

These include the agricultural and forestry activities mentioned in Policy 4, as well as a number of other problem activities. The 1977 Clean Water Act Amendments reemphasized nonpoint pollution control in the regional water-quality plan.

After 208 plans are completed and approved by U.S. EPA, they are likely to have considerable future influence, particularly on programming of facilities funded in part by U.S. EPA. Your communities may therefore find it wise to cooperate actively in the process of implementing these plans. (For further details, see the discussion of the U.S. EPA in Part II.)

Rural Clean Waters Program. The U.S. Department of Agriculture (USDA) may soon play an important role in implementing section 208 of the Federal Clean Water Act. The 1977 Amendments to the Act authorize $600 million for USDA to help reduce diffuse or "nonpoint" sources of pollution resulting from poor soil-conservation practices. Although this USDA program would not provide funds to localities, it would supplement local efforts by paying rural land users a substantial portion of the costs of land-management practices that protect the water system—for instance, contour farming, or maintaining buffer strips on erosion-prone land. (For further details, see the discussion of the Soil Conservation Service in Part II.)

Federal Flood Control Projects. Flood-protection projects by the U.S. Army Corps of Engineers can sometimes fit in with the implementation of the recommended policies on stream channelization and other alteration of the water system. Different administrative processes are established for small and large projects.

The Corps undertakes small projects in these categories: beach-erosion control, rehabilitation of flood-control works, flood control, navigation, snagging and clearing for flood control, snagging and clearing for navigation. In most cases, the Corps undertakes these projects in response to applications from States, or from local governments after State review.[30] An environmental impact statement is prepared. During project review there are several opportunities for the presentation of local views: at the application stage, the impact-assessment stage, and the regional "A-95" clearinghouse review. In addition, some of these projects require permits from the Corps under Section 404 of the Federal Clean Water Act (see p. 68). The U.S. EPA and the Fish and Wildlife Service have substantial influence on the granting of these permits and may also be able to provide useful information and technical advice to a community seeking to understand the interaction of hazards and ecological factors in the design of small protective works.

Large Corps projects require both a congressional directive to study the need for protection and, if protection is recommended, congressional authorization for the project itself. When specifically authorized by Congress, these projects are exempt from permit requirements of Section 404 of the Federal Clean Water Act if U.S. EPA guidelines are met. This exemption reduces the number of review processes in which localities can make their views known. As a practical matter, you will find the greatest opportunities for presentation of local views during the study process, and at the time of congressional authorization. (For further details see the discussion of the U.S. Army Corps of Engineers in Part II.)

Regulatory Program for dredged and fill material. Federal permit requirements may prove helpful if your community is trying to control the construction of artificial canals. If the canals are to be both navigable and connected to navigable waters, permits are required from the U.S. Army Corps of Engineers. Other canals, notably agricultural drainage canals not connecting to navigable waters, do not require this permit. Nor is the permit required for storm-water detention basins or "real estate lakes." (Corps regulations contain a special provision intended to prevent the construction of navigable channels in the guise of drainage canals or detention basins.[31])

Some localities have established their own standards for the design of canals and basins outside Corps jurisdiction. The Corps and localities often cooperate in advising individuals of applicable Federal, State, and local requirements.

Coastal Zone Management Program. Federally assisted coastal zone management programs have been completed in some coastal States and are nearing completion in others. These programs may be of assis-

tance in dealing with a number of coastal development and conservation issues. To find out what help will be available, your community will need to know:

1. If your State is participating in the national coastal management effort and whether the program has received formal approval from the Governor and the U.S. Secretary of Commerce.
2. The anticipated or existing role of local governments in implementing the program. Some States include local coastal programs as elements of the State program.
3. The boundaries of the State coastal zone, as defined by the program. (Although some of the places described in this manual will be within the coastal zone boundary, others may not be.)
4. The policies established by the program and the means established to implement them.
5. The location or nature of "areas of particular concern" identified by the program, and any provisions established for their management.

The State coastal zone management program may provide: a convenient focal point for identifying other State programs that complement the Federal assistance and management programs discussed here; a means of identifying particular legal constraints and tools that may affect local actions to protect environmental quality and avoid hazards; technical data needed to identify management boundaries within the State's coastal zone (or "coastal management area"); technical or regulatory backup in management decisions for the protection and development of the coast; and control of other governmental actions, particularly Federal agency actions, that may adversely affect local coastal resources.

Two elements of the Federal program are of particular interest:

First, it contains requirements for participation by the public and by local governments. The State must conduct hearings and solicit local agency comment on elements of the State program. In addition to enabling local governments to call for more effective State programs, these hearings and comments may contribute to local awareness of some of the problems and opportunities that will be encountered in trying to implement the policies recommended in this guidebook.

Second, the act requires Federal agency activities significantly affecting the coastal zone to be consistent with approved State coastal zone programs. For example, if the Corps of Engineers proposed to channelize a stream or build a dam that directly affects the coastal zone, the agency must first determine that its project is consistent with the State's coastal zone management program. Where local plans are an element of the State coastal zone management program, your community may also have a significant, though indirect, influence over Federal agency decisions affecting the coastal floodplain. (For further details, see the discussion of the Office of Coastal Zone Management in Part II.)

National Environmental Policy Act, Environmental Impact Statements. Since 1969, the National Environmental Policy Act (NEPA) has required Federal agencies to consider environmental consequences before making decisions. To this end, an environmental impact statement (EIS) must be prepared, first in draft and then in final form, before an agency undertakes actions "significantly affecting" the environment.[32]

Your community is likely to encounter EIS procedures when it seeks Federal financial assistance (for instance, for sewage-treatment facilities construction grants). You ought also to be aware of the opportunity the EIS procedure gives you to influence other Federal actions. The administrative process differs somewhat from agency to agency, each of which writes its own detailed regulations. In every case, however, there must be an opportunity for public agencies and individuals to comment on a draft statement before the final environmental impact statement is prepared. The Council on Environmental Quality has issued regulations governing the procedure, and the Office of Federal Activities in U.S. EPA plays a key role in overseeing it.

The purpose of the EIS review process is to produce well-informed, environmentally sensitive decisions by Federal agencies, through analysis of the likely effects of proposed actions and alternatives. The regulations guiding the NEPA process emphasize coordination and integration of

various Federal requirements for environmental review. EISs should include information necessary to implement the Wetlands and the Floodplains Executive Orders (see pp. 33-34 and 69). The public review required under the orders can be included in public hearings and comment on the EIS. The EIS should also consider whether a proposed Federal action is consistent with other Federal and State requirements, such as those established by the State coastal zone management program or by the Federal Clean Air or Water Acts.

A number of States have adopted "little NEPAs" based on the Federal model. These may provide an additional opportunity to obtain environmental review. A few cities have also set up this kind of process. In most cases, States and cities attempt to follow procedures similar to the Federal ones.

3. Establishing standards for new development in floodlands.

Thousands of American communities have adopted regulations to reduce the likelihood that new structures in floodands will be seriously damaged by future floods. Typically, communities require that new or rebuilt structures within the floodlands be elevated above anticipated flood levels or, for some commercial structures, floodproofed.[33] The requirements may be included in building codes, or zoning or subdivision regulations, or in separate "floodplain regulations," depending on State law and local convenience.[34]

For many coastal localities, particularly those with large areas of floodlands, adopting these regulations is often politically unpopular. Enforcing them may prove more difficult still. Yet the regulations exist, sometimes because local officials have perceived and responded independently to the threat of flood hazard and sometimes because they wish to participate in the National Flood Insurance Program (NFIP), which establishes certain minimum requirements to be adopted by participating communities.[35]

If your community has adopted local regulations in compliance with NFIP regulations, you may believe that nothing more is needed for adequate protection of floodlands. However, to implement Policies 7 and 8, two kinds of standards suggested, but not required, by the NFIP regulations are needed. First, in circumstances where protection of ecological features requires it (e.g., in freshwater wetlands) structures should be elevated on pilings rather than on fill. Second, certain activities that are likely to cause serious pollution if there is a flood (e.g., the production and storage of toxic chemicals) should be excluded from floodlands.

In addition to the NFIP, two other Federal programs are particularly likely to affect the efforts of coastal communities to establish standards for development in floodlands: the Flood Plain Management Services program of the Corps of Engineers and the Coastal Zone Management Program. A description of the NFIP and the Corps program follows; the Coastal Zone Corps program follows; the Coastal Zone Management Program is discussed on pp. 36, 70, 78, and 88.

The National Flood Insurance Program. Established in 1968, the National Flood Insurance Program (NFIP) provides Federal flood insurance to owners of property in participating localities.[36] Some 14,000 localities participate in the program, which is administered by the Federal Emergency Management Agency (FEMA). The agency works with a liaison official in each State government and directly with localities as well.

At the heart of the program for each participating locality is the Flood Insurance Rate Map (FIRM), which shows the boundaries of flood-hazard areas and anticipated flood levels within them. (Figure 15 illustrates a typical FIRM for a coastal area.)

To limit future flood damage (and thus to keep the cost of insurance and disaster relief within reasonable bounds), localities that want to participate in the program are required to adopt regulations controlling construction within the flood-hazard areas identified on the FIRM. These local regulations must satisfy a number of FEMA requirements. For example, the regulations must require most kinds of new development in the floodlands to be elevated above the anticipated level of the "100-year flood."

At present, many participating communities do not have a FIRM and are therefore unable to enter what is called the "regular" phase of the program. (FEMA

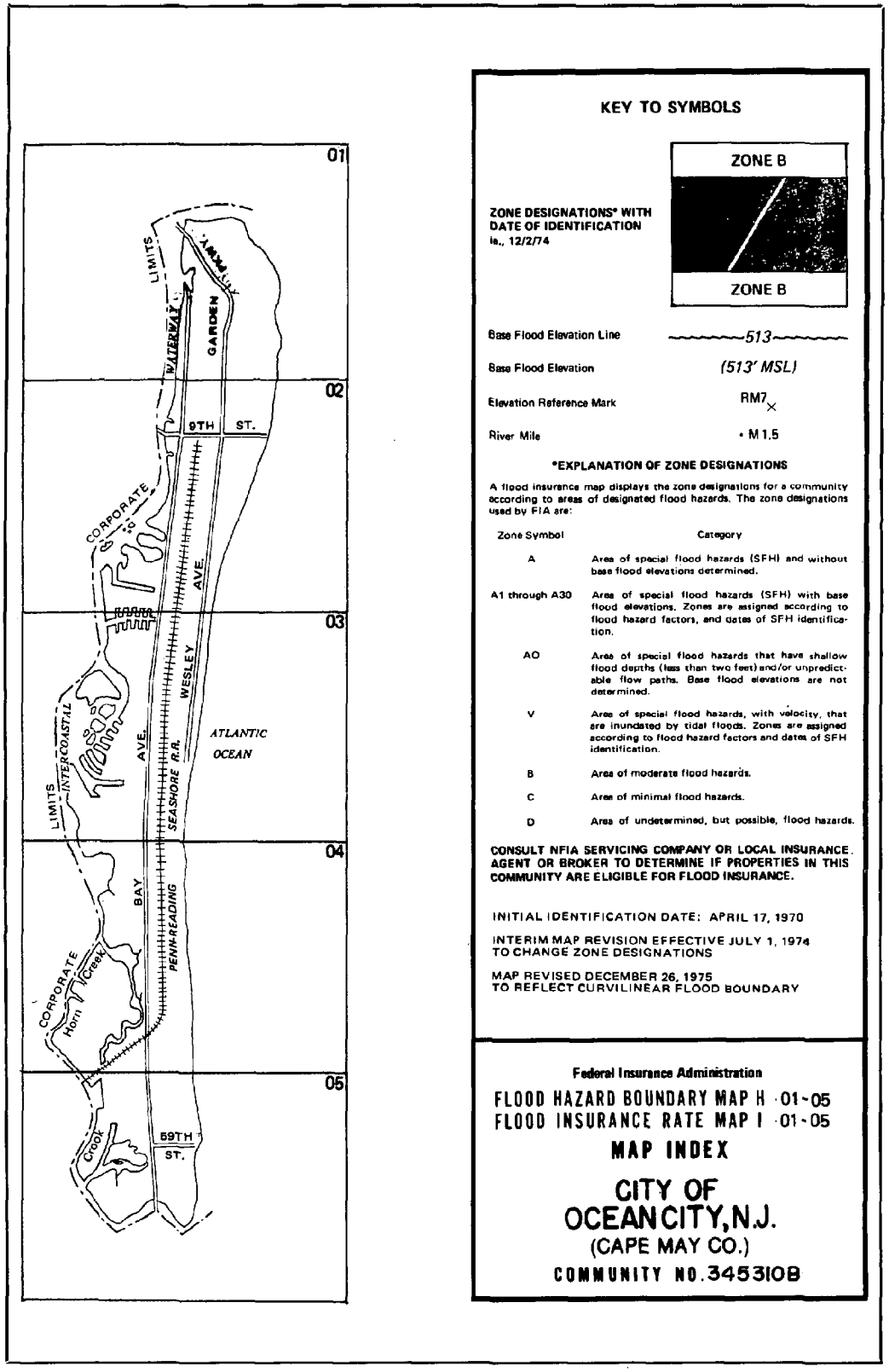
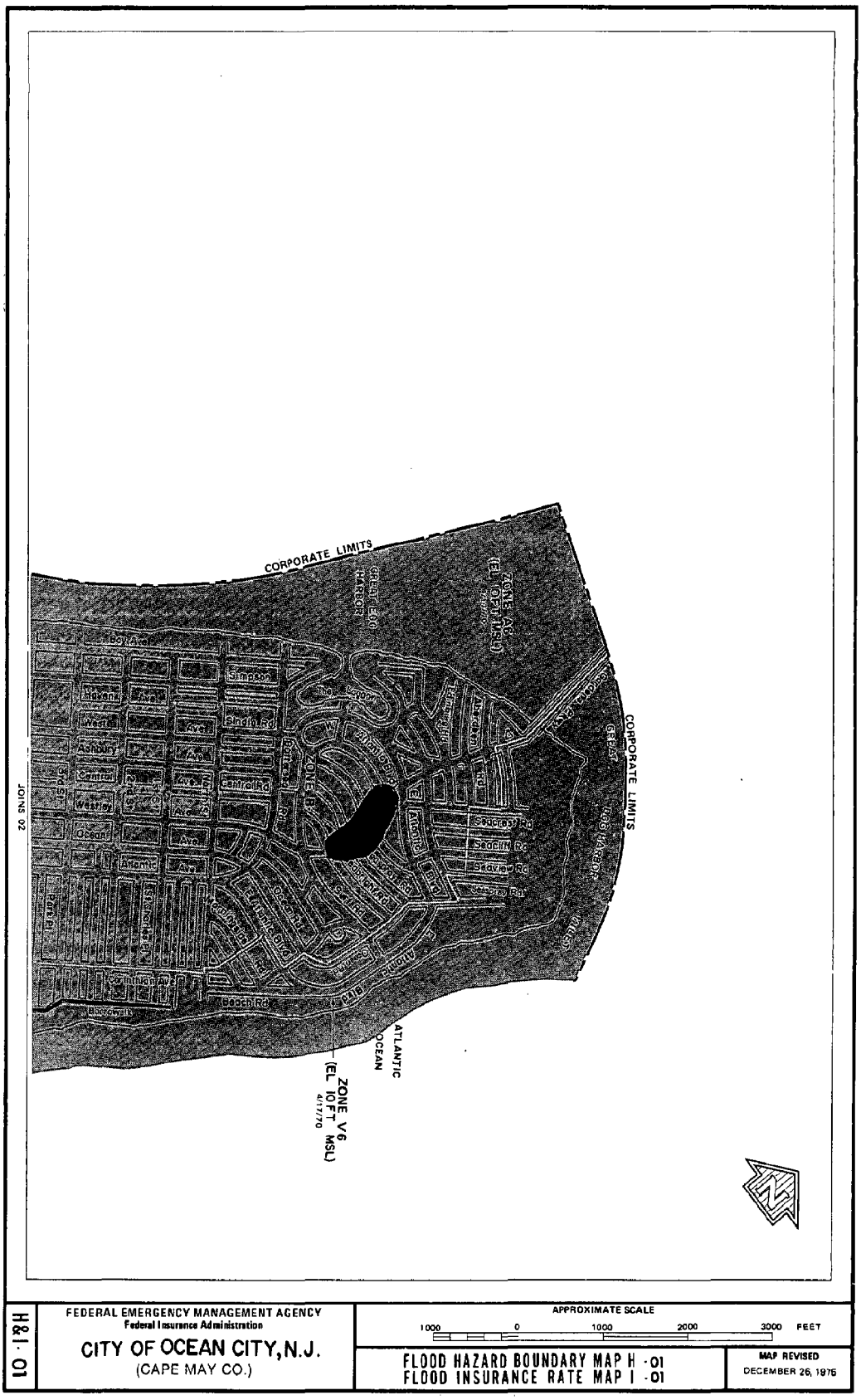


Figure 15. A Flood Insurance Rate Map (FIRM). (Source: Federal Insurance Administration, Federal Emergency Management Agency.)



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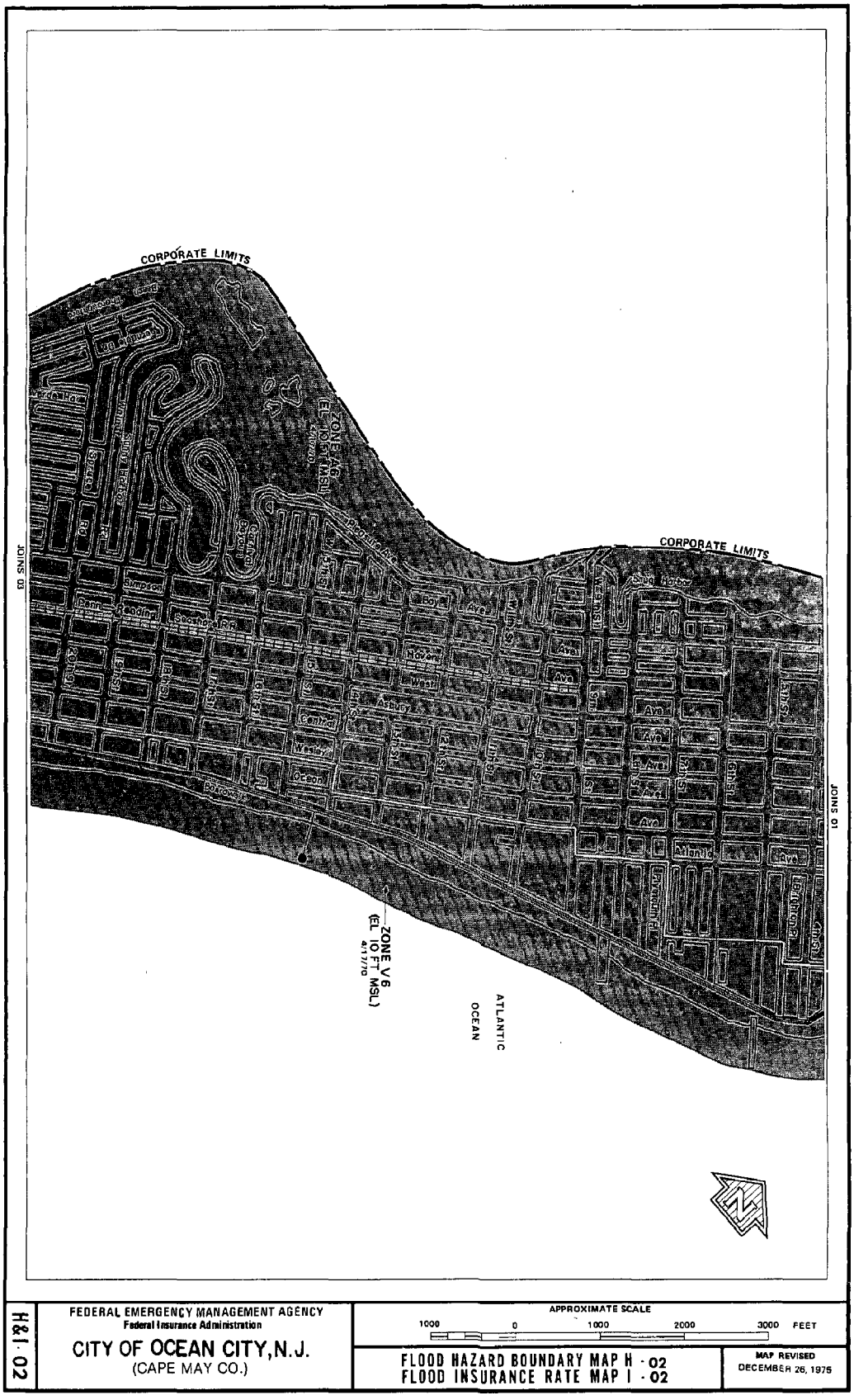

H&I-02

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF OCEAN CITY, N.J.
(CAPE MAY CO.)

APPROXIMATE SCALE
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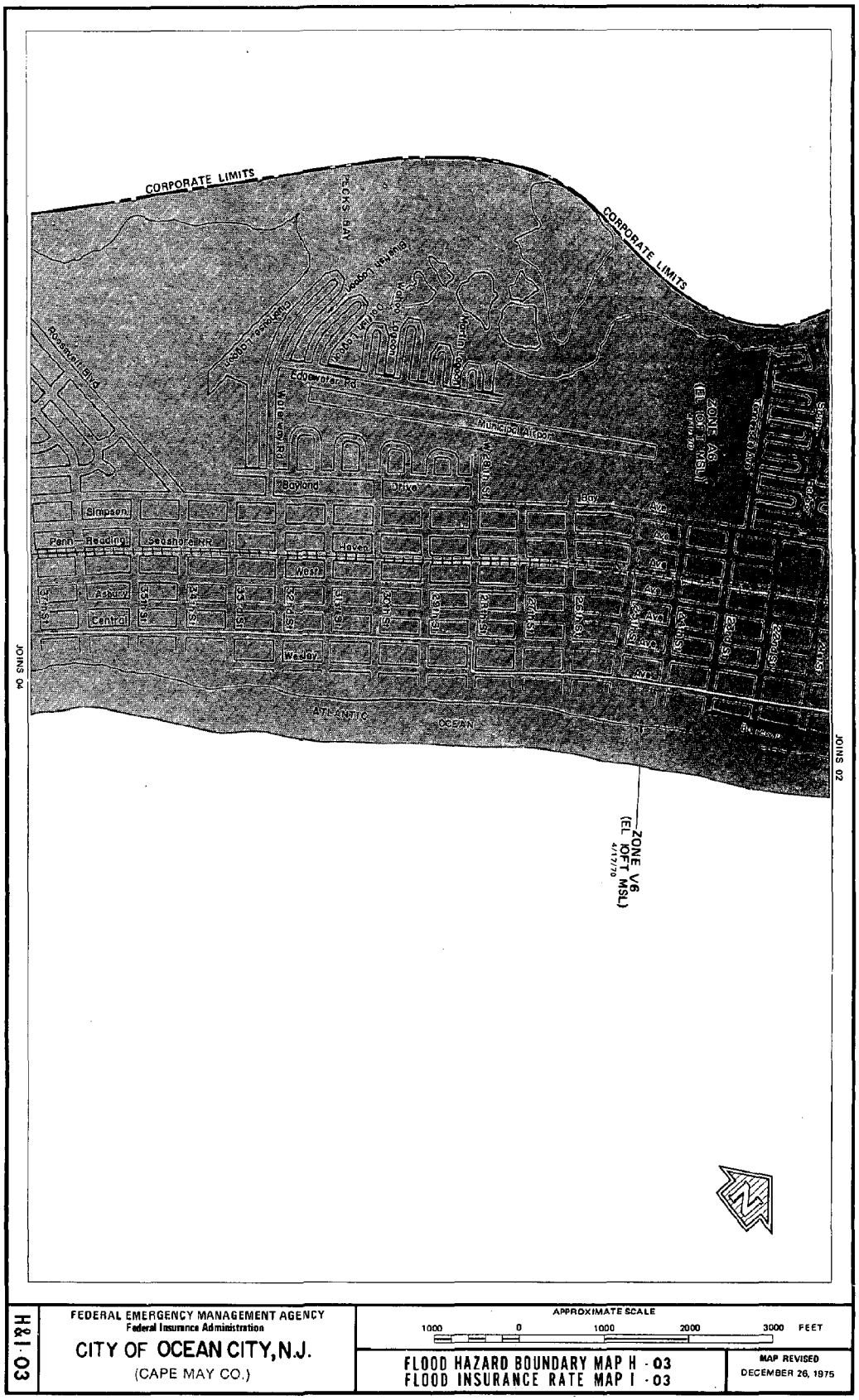
FLOOD HAZARD BOUNDARY MAP H - 02
FLOOD INSURANCE RATE MAP I - 02

MAP REVISED
DECEMBER 26, 1975



H&I-03

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF OCEAN CITY, N.J.
(CAPE MAY CO.)

APPROXIMATE SCALE
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FLOOD HAZARD BOUNDARY MAP H - 03
FLOOD INSURANCE RATE MAP I - 03

MAP REVISED
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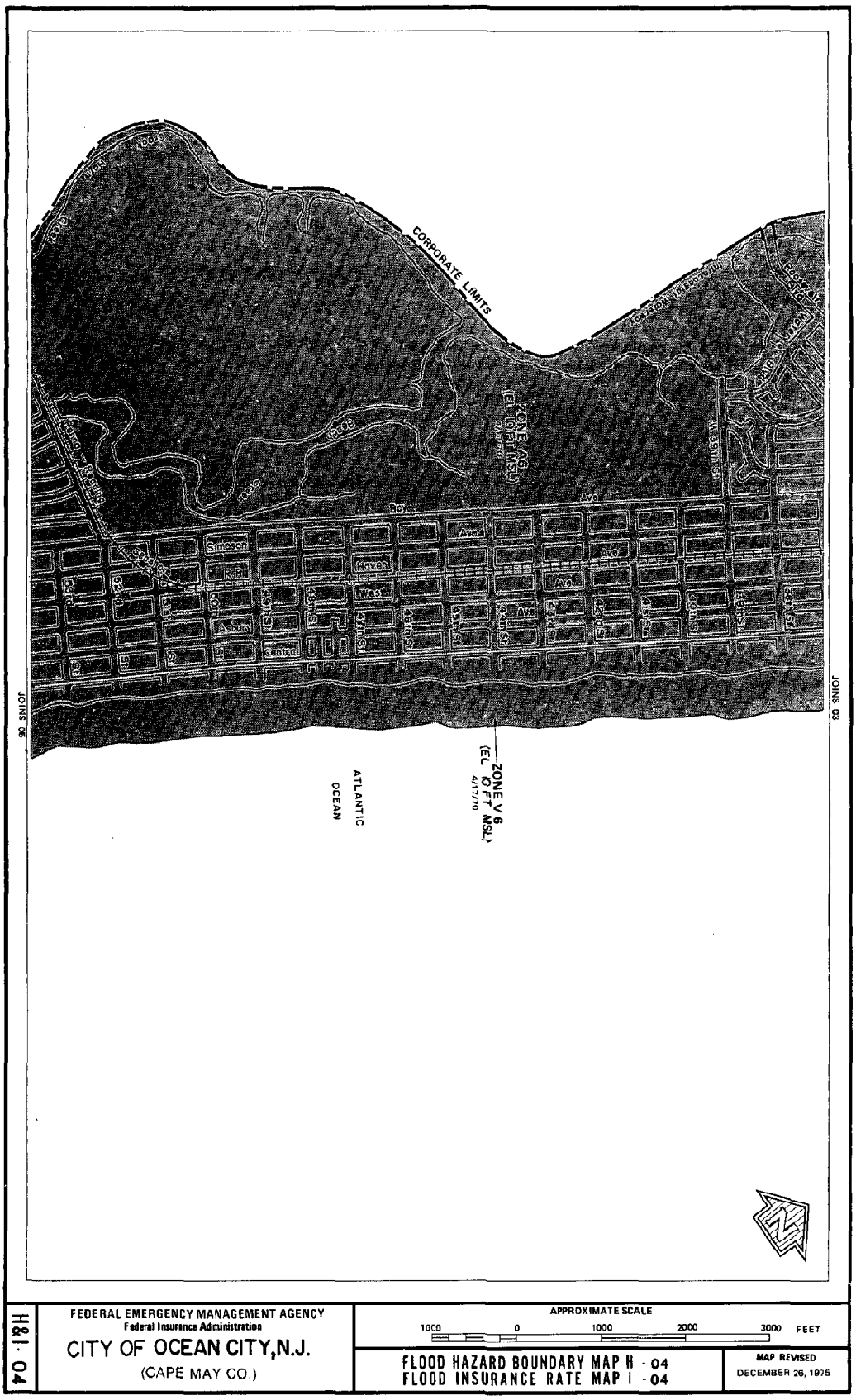
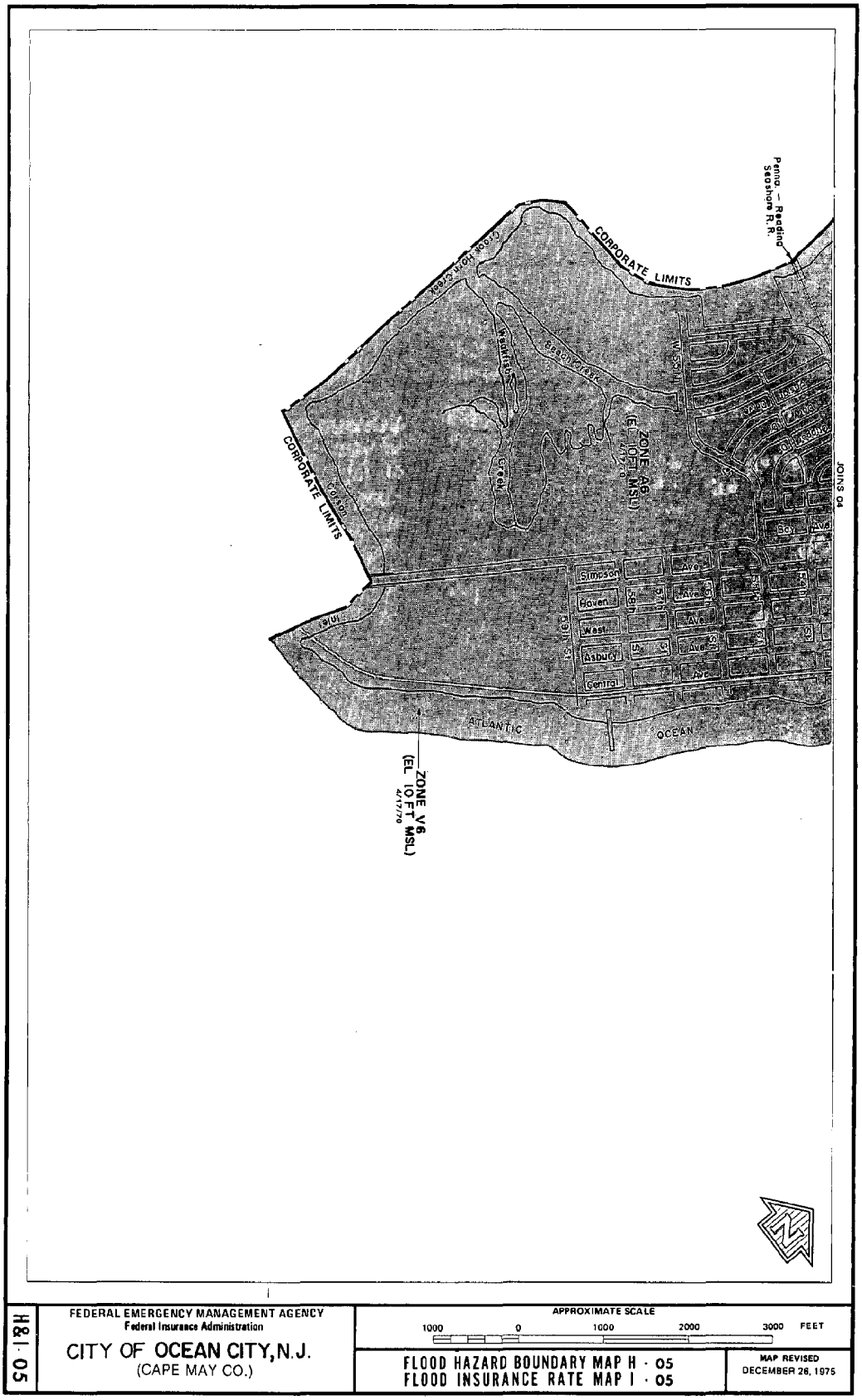


H81-04	FEDERAL EMERGENCY MANAGEMENT AGENCY Federal Insurance Administration CITY OF OCEAN CITY, N.J. (CAPE MAY CO.)	APPROXIMATE SCALE 1000 0 1000 2000 3000 FEET FLOOD HAZARD BOUNDARY MAP H - 04 FLOOD INSURANCE RATE MAP I - 04 MAP REVISED DECEMBER 26, 1975



H81-05	FEDERAL EMERGENCY MANAGEMENT AGENCY Federal Insurance Administration CITY OF OCEAN CITY, N.J. (CAPE MAY CO.)	APPROXIMATE SCALE 1000 0 1000 2000 3000 FEET FLOOD HAZARD BOUNDARY MAP H - 05 FLOOD INSURANCE RATE MAP I - 05 MAP REVISED DECEMBER 26, 1975

expects to complete the last FIRMs in 1983). Instead, communities without FIRMs remain in an "emergency" phase, which relies on less-precise maps (called Flood Hazard Boundary Maps) and imposes looser regulatory requirements on construction in the community. During the emergency phase, a limited amount of subsidized insurance is available to owners of flood-endangered structures. Additional insurance, without Federal subsidies, becomes available when the community enters the regular phase of the program.

Although localities have never been formally required to participate in the NFIP, the effect of Federal law during the period 1973–77 came close to requiring participation. In 1977, congressional action removed specific sanctions that would have established a cut-off date after which most sources of home mortgage financing would be unavailable in nonparticipating communities. Even so, the law still offers powerful incentives for local participation in the NFIP, and thus for adoption of regulations meeting FEMA requirements. If your community chooses not to participate, property owners can no longer buy Federal flood insurance, nor are they eligible for most types of Federal flood disaster relief after future catastrophic floods.

In evaluating the local effects of the NFIP, you should keep in mind the point already touched upon above: the NFIP is a property insurance program and its requirements accordingly focus on providing property protection. As it happens, property protection regulations can sometimes also protect the environment and provide open space and other public benefits. Nevertheless, property protection remains the principal concern of the NFIP requirements; localities implementing the management policies for floodlands will need to take a number of other initiatives. (For additional details, see the discussion of the Federal Emergency Management Agency in Part II.)

Flood Plain Management Services. Since 1960, the U.S. Army Corps of Engineers has conducted a comprehensive Flood Plain Management Services program (FPMS).[37] This program has provided many coastal communities with reports and maps detailing anticipated flood risks and possible responses.

Since 1968, the FPMS program has worked closely with the NFIP. For localities concerned with floodlands management, FPMS personnel in Corps district offices are often able to provide helpful advice on the interpretation and application of technical data. (For additional details, see the discussion of the U.S. Army Corps of Engineers in Part II.)

4. Defining boundaries of floodlands for management purposes.

When a community establishes the boundary of its coastal floodlands, it specifies the areas within which it is concerned about coastal flooding. On one side of the line, in the floodlands, regulations and other measures to respond to flood risks are required. On the other side, above the floodlands, they are not. So drawing the line correctly is important.

Unfortunately, drawing the line is also difficult. A small fringe of shoreland may flood one year and a large area the next, depending on the force of storms. The floodland boundary, therefore, is usually based on yearly probabilities. In effect, you must ask, What areas are likely to be flooded and how often? What is enough to make flood precautions worthwhile?

If your community participates in the National Flood Insurance Program, it must take certain precautions within the "100-year flood" mark, which is the elevation expected to be reached by a flood having a 1 percent probability of occurrence in any year. But that is only one standard. Flooding well above this point does occur. Some communities have experienced 500-year floods or even 1,000-year floods in consecutive years. So your community may decide to take precautions against floods greater than the 100-year flood, particularly when locating hospitals, schools, firehouses, and emergency evacuation structures. The Federal Floodplains Executive Order 11988 requires this approach in Federal decision making. The U.S. Army Corps of Engineers uses a higher mark in its flood projects for urban and urbanizing areas. So does U.S. EPA in reviewing plans for sewage treatment facilities.[38]

After a probability level is selected, there remains the difficulty of determining the precise elevation and boundary of the resulting floodlands (Figure 16). Storm-surge projections over land are difficult to make because the shape and size

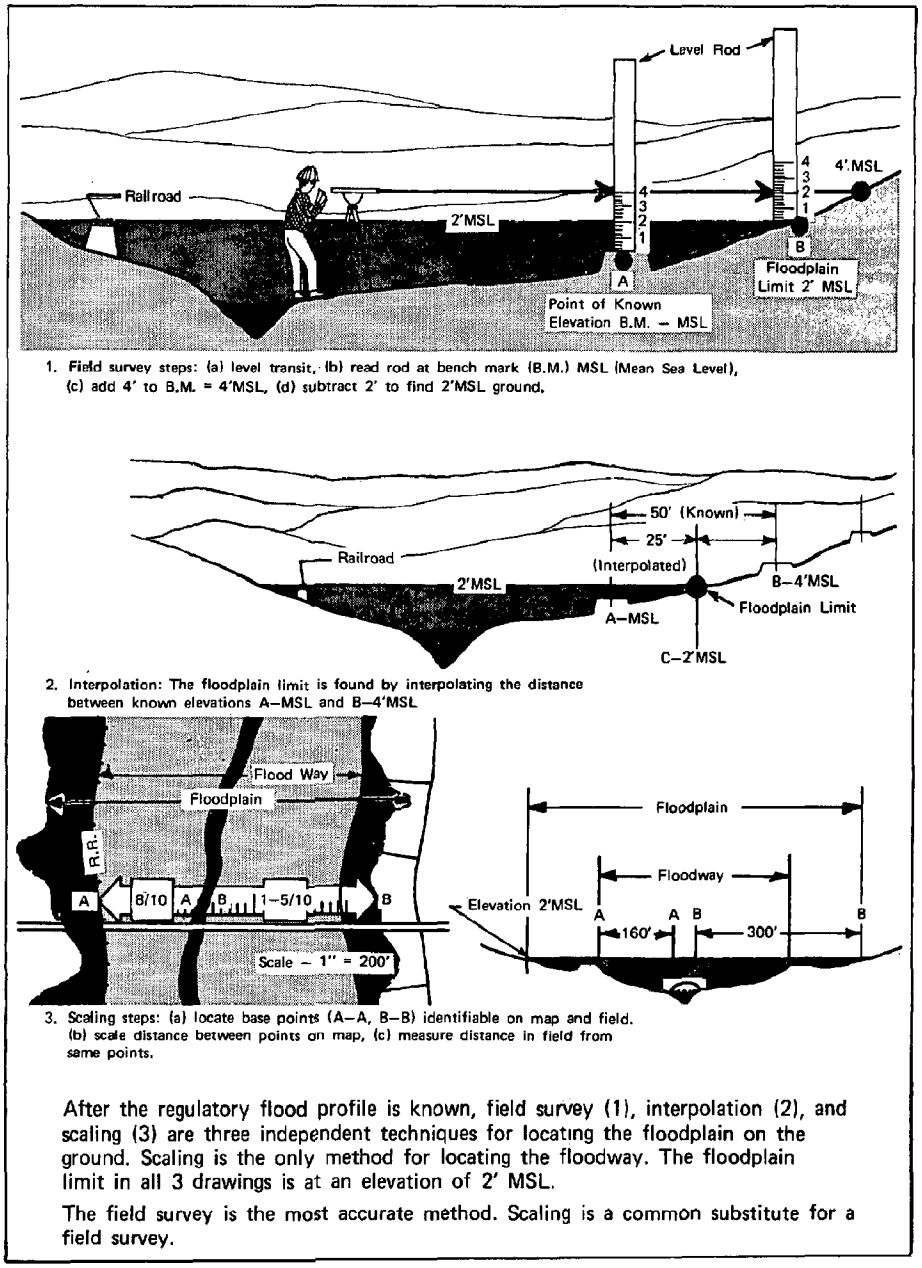


Figure 16. How floodplains and floodway boundaries of tidal rivers are surveyed in the field. (Source: ASPO Planning Advisory Service, *Regulations for Flood Plains*, No. 277, Chicago, Ill., 1972.)

of major landforms in floodlands have a direct relation to flow patterns, water elevation, and total extent of the floodwaters. Alteration of these landforms, including excavations, artificial fills, and structural barriers, can alter flood patterns and flow velocities.[39]

Engineers working with flooding have developed methods of flood prediction that depend in part on experience, but also on complex hydrologic, meteorologic, and topographic calculations, and on other information. These methods have been applied with various refinements to predict

flood hazards for many coastal communities and are presently being standardized by the National Flood Insurance Program to produce more uniform and "true to experience" results in calculating or revising Flood Insurance Rate Maps.

The methods of determining a floodlands boundary still leave a gap between local experience with past floods and the experts' predictions of the future, sometimes producing results that local residents find unrealistic. Even when the methods work well, the resulting boundary is established according to probable future hazard and may, therefore, include areas that have never experienced flooding in the past. When this happens, building standards for elevation and erosion control are often difficult to "sell" to local residents.

Your community should be aware that rough calculations, based largely on experience, *can* identify areas subject to frequent flooding (roughly a 10-year, or 10 percent probability, flood). These areas are likely to be not only "high hazard" (where there is a special danger from waves and rushing water), but also ecologically important (vital wetlands or edge-zones, for example). The correlation between frequent flooding, high hazard potential, and ecological importance is approximate. But there is a close interrelationship among these three in particular parts of the floodplain. Since the frequently flooded areas are likely to include edge-zones and wetlands, mapping of frequently flooded areas can help in efforts to protect edge-zones and wetlands against development. Mapping frequently flooded areas does not, however, provide the information needed for building-elevation standards.

Because of the cost of calculating 100- and 500-year flood elevations and mapping the resulting boundaries, most localities must rely on State and Federal programs that determine flood-hazard boundaries. In particular, you should be aware of the following Federal processes:

The National Flood Insurance Program. Boundary information in the Flood Insurance Rate Map (*not* the Flood Hazard Boundary Map, which some communities are still using) will include two upper boundaries, the 100-year and 500-year predicted floods. The map will also show numbered actuarial risk zones, will differentiate coastal high-hazard areas ("V" zones), and may differentiate erosion-prone areas ("E" zones). In addition, you may find the NFIP data useful in determining elevation levels for frequent floods. (The map also includes the floodway, the riverine analogue of the coastal high-hazard area, which is not considered in this book.)

Community participation in the preparation of the FIRM begins when early visits are made to the site for what are called "time and rate" studies. Your community may wish to outline its policy objectives and needs at that time. When the map is completed, there are also opportunities for technical comment and appeals.

U.S. Army Corps of Engineers. The Corps provides assistance under FPMS in determining boundaries for frequent floods, and boundaries that relate to the Corps' Regulatory Program, which is discussed in the Saltwater Wetlands section (see p. 67). Older studies of coastal flood hazards done by the Corps include references to the Standard Project Flood, a very large flood—about half the maximum possible. This concept is not used in FIRMs of the NFIP, and is derived by a different method from that used to determine the 500-year flood in FIRMs.[40]

U.S. Geological Survey. Frequent-flood boundaries based on physical data—soil characteristics, vegetation, etc.—can often be derived (very roughly) from maps and data of the U.S. Geological Survey.[41] For some areas of the edge-zone, other Federal agencies, such as the U.S. EPA, the Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration can supplement the information from the Survey—for instance, from the National Wetlands Inventory (U.S. Fish and Wildlife Service)[42] or remote sensing experiments (U.S. EPA, research division).[43]

Saltwater Wetlands

3

Saltwater wetlands—marshes and mangrove swamps—are a vital component of the coastal environment. They support waterfowl, nourish marine life, cleanse the waters of the coast, diminish storm flooding, and beautify the shore. These services increase in value as coastal communities grow. The more intensely developed an area, the more crucial is the need for wetland preservation through land-use controls and special regulations (Figure 1).

The wetlands discussed in this section, saltwater wetlands, are both influenced by tides and washed by salty coastal waters (more than 0.5 parts per thousand salt). Saltwater wetlands are most simply defined as places along the shore where vegetation grows that can tolerate saturated salty soil. They extend landward to the yearly limit of normal tidal flooding (Figure 2). (Freshwater wetlands—including the tidally influenced coastal type that occur inland of the saltwater front as well as the regular, nontidal interior types—are considered in the discussion of Floodlands.)

The Federal government and many States regulate wetland use. Your community's coastal management program should protect and restore wetlands to the maximum extent possible, following policies 11 through 16:

11. ***Wetland Surface Alteration:*** *Restrain activities that alter the surface of wetlands, such as excavation, filling, clearing, paving, and grading.*

Figure 1. Wetlands are especially valuable to urbanized areas where they are particularly rare and always subject to development. (Photo of Ballona Wetlands by John Clark).

12. ***Wetland Hydrologic Alteration:*** *Discourage activities that alter the natural water systems of wetlands, such as draining and diking.*
13. ***General Wetland Construction:*** *Require structures to be designed so that they do not degrade wetland functions.*
14. ***Wetland Roadway Crossings:*** *Require roadway crossings through wetlands to be elevated above the wetland surface.*
15. ***Pollutant Discharge into Wetlands:*** *Restrain the discharge of pollutants into wetlands.*
16. ***Restoration of Wetlands:*** *Whenever possible, restore degraded wetlands to function naturally.*

ECOLOGICAL FEATURES

Saltwater wetlands provide an especially valuable habitat for a variety of important coastal species. Waterfowl and shorebirds are well known and highly valued inhabitants of wetlands, as are alligators and muskrats. Less evident but equally important inhabitants are crabs, shrimp, and the tiny juvenile stages of commercial and sport fishes, along with numerous forage species of fish and invertebrates.[1]

The vegetation of saltwater wetlands, particularly red mangroves and cord grass (*Spartina*), also provides the primary productivity that is the base of the aquatic food chain. Using the sun's radiant energy, the plants convert inorganic compounds (nutrients) and carbon dioxide, which are dissolved in water, into leaves and other plant tissue where energy is

Figure 2. The inner limit of saltwater wetlands is often marked by the highest elevation of salt-tolerant wetlands vegetation, indicated above by broken white line. (Photo by M. Fahay.)

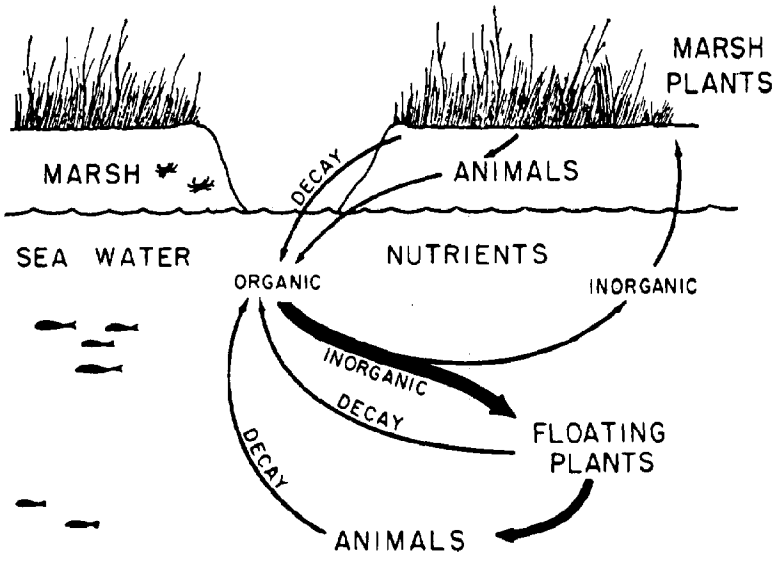


Figure 3. The wetland ecosystem recycles energy through a process that returns inorganic nutrients to the marsh plants. (Source: J.S. Rankin, Jr., "Salt Marshes as a Source of Food," in *Connecticut's Coastal Marshes*, The Connecticut Arboretum, Bulletin No. 12 [New London: Connecticut College, 1961].)

stored. When leaves fall into the water, they are broken down by bacteria and become small particles of "organic detritus." This detritus provides food for shrimps, fiddler crabs, worms, snails, and mussels, which in turn provide nourishment for larger fish, birds, and mammals higher on the coastal food chain (Figure 3).

Wetland vegetation removes silt, toxic chemicals, and excess nutrients from coastal waters. The silt settles out on the marsh surface, while the nutrients and toxic chemicals are removed as water passes through plants. Under optimum conditions a marsh can handle a considerable load of pollutants; for example, a marsh of 1,000 acres may be capable of purifying the nitrogenous wastes (i.e., nitrates in sewage) from a town of 20,000 people.[2]

Ecologically, saltwater wetlands are divided into upper wetlands (those above mean high water) and lower wetlands (below mean high water) (Figure 4). The upper wetlands contain salt-tolerant plants that prosper in soil sporadically flooded by tides. Upper wetlands are usually grass- or rush-vegetated high marshes or meadows, except in tropical regions, where they may be mostly swamps dominated by black and white mangroves. The capability of upper wetlands to receive the flow of runoff and cleanse it of contaminants is of major importance, particularly in areas undergoing heavy development in the uplands and floodlands. Dissolved nutrients from freshwater runoff and spring tide flows are also absorbed and stored temporarily for later release in periodic pulses as either dissolved nutrients or organic detritus or both.

Lower wetlands collect and store dissolved mineral nutrients washed down from the upper wetlands. Here, too, the nutrients are used for plant growth and stored in plant tissues, which in turn decay and are washed as particles into coastal waters, where they provide organic detritus to nourish the food chain of the coastal-water ecosystem. About half the plant tissue created in the grass marshes and mangrove swamps of the lower wetlands is flushed out into coastal waters.[3]

If wetland vegetation were eliminated, the food supply, and thus the carrying capacity of the coastal ecosystem, would be greatly reduced. Research has demonstrated a direct positive relationship between acres of marsh and abundance of fish (judged by the harvest of fish per acre of "fishable" coastal waters edged with marsh). In one typical case—a North Carolina estuary studied by Dr. Richard Wil-

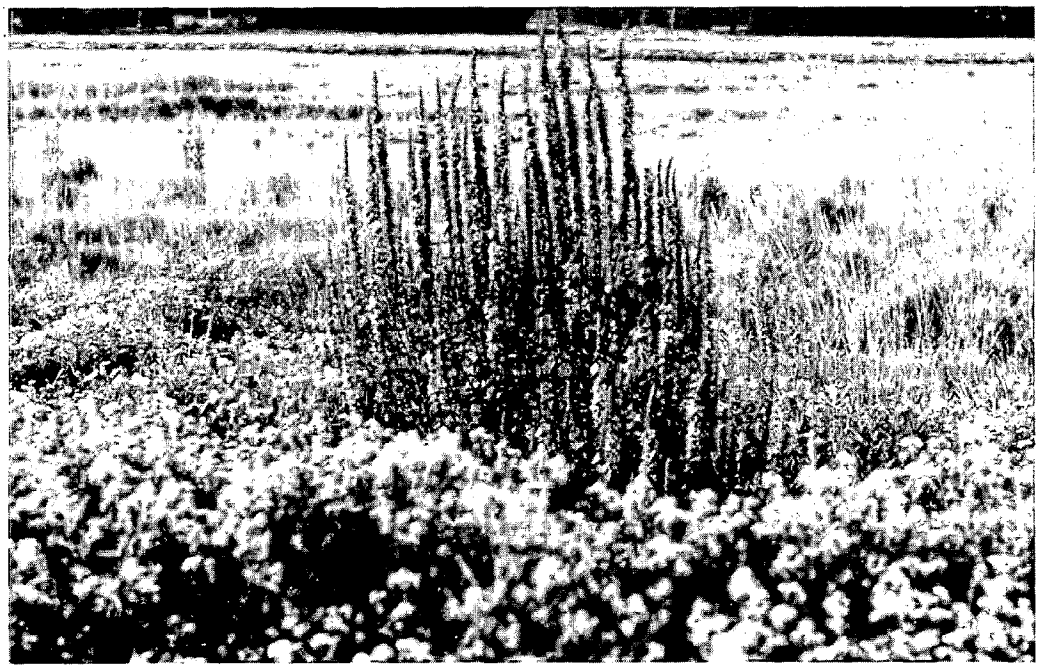


Figure 4. The upper wetlands (foreground) are often clearly distinct from the lower wetlands (background) in saltwater wetlands. (Photo by John Clark.)

liams—the life-support capability of the estuary declined 50 percent after destruction of the associated marsh.[4]

Saltwater wetlands often are not vegetated all the way to the low-tide mark, but become tideflats in their lower reaches. These flats are often rich sources of basic nutrients for the ecosystem and are feeding areas for shore and wading birds when exposed at low tide or for fish and crustaceans when covered at high tide. Moreover, in many estuaries, the flats produce a high yield of clams or bait worms. Recent research has shown that tideflats are an important means of storing energy in the estuarine ecosystem. If the flats and their biota were not present to capture vital dissolved chemical nutrients (such as phosphates, nitrates, nitrites, and ammonia) essential to the food chain, the nutrients would be swept out of the marsh zone with the ebbing tide.[5]

HAZARDS

Saltwater wetlands can help to protect communities from sea storms. Mangrove swamps, paticularly, are credited with the natural capacity to reduce the severity of coastal hazards from waves and flooding.

The red mangroves of the lower wetlands, which are found on the front line of estuarine shores in south Florida, bear the brunt of storm surges and, to an extent yet to be determined, dissipate and reduce the velocity of storm waves. The black mangroves of the upper wetlands, located in the bank behind the red mangroves, probably further reduce the severity of storm surges.

Salt marshes, which are prevalent in the protected waters of most estuaries, also may provide some frictional dissipation of flooding, particularly in the broad stretches of vigorous cordgrass, spikegrass, or black-grass marshes, and especially in minor storms. The band of reed grass (*Phragmites*) or of shrub-like plants such as the saltbush (*Iva*), which often lie in the edge-zone directly behind the marsh, may also assist in checking the storm surge. In addition, the high marshes (upper wetlands) of the smaller, more confined estuaries may have some capacity to absorb floodwaters and to reduce the levels of minor floods.

Wetland vegetation stabilizes estuarine shorelines and prevents erosion. Mangrove trees actually can extend the land's edge by trapping sediments and building seaward (Figure 5). Salt marshes function in a similar manner in many instances.[6]

MANAGEMENT POLICIES

Your community should develop clear guidelines for conserving and using its wetlands and include these in all land-use

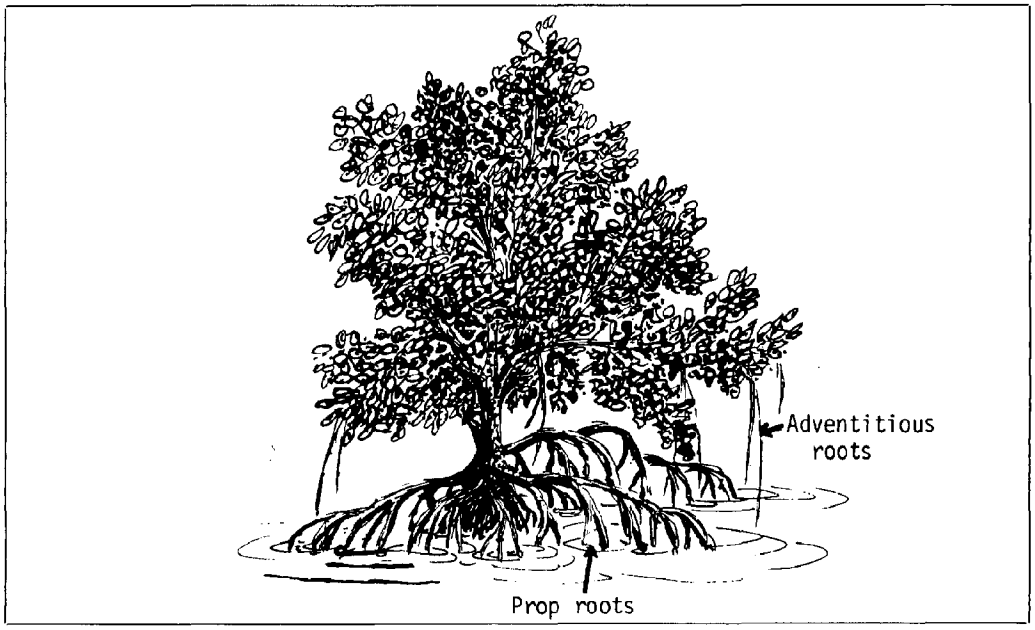


Figure 5. Mangroves can extend the land's edge by trapping sediments in their prop roots, which grow seaward. (Drawing courtesy William Hammond.)

Figure 6. Advanced equipment, operating correctly, can provide trenches for utility lines without causing permanent damage to the marsh. (Photo by Norrel Wallace, U.S. Fish and Wildlife Service.)

plans and review procedures. Decisions to convert wetland areas to real estate—by filling them to create waterfront lots or dredging them to make canals—are often the subject of extensive controversy. A number of other activities also significantly degrade coastal wetlands without eliminating them. These activities include ditching, draining, impounding, diking, or otherwise interfering with normal tidal circulation. Also, pollution from discharges of domestic and industrial wastes may cause serious deterioration of wetland functions.

It should be the goal of your community to ensure that wetlands remain functionally intact; that is, whatever use you make of saltwater wetlands should not alter them in ways that degrade their natural functions. A key requirement is not to allow development that is prohibited by the policies of State or Federal agencies.

Recommended Policy 11: Wetland Surface Alteration.

Restrain activities that alter the surface of wetlands, such as excavation, filling, clearing, paving, and grading.

From the ecological perspective, to keep saltwater wetlands functional, you must preclude virtually any alternation of the wetlands and their natural drainageways. From the hazards-protection perspective, to preserve the capacity of wetlands to dampen the force of storm waves or reduce flood heights, you must give wetlands a high degree of protection from alteration.

Accordingly, as a general rule, all excavation, paving, or surfacing in wetlands

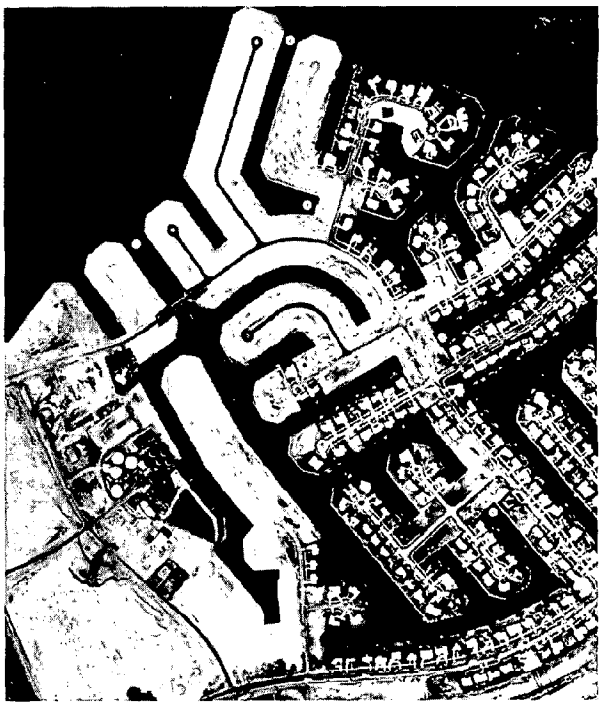


Figure 7. Canal-side lots on long, artificial dead-end canals dug out of the mangrove forest at Marco Island, Collier County, Fla., have caused harmful loss of wetlands and serious degradation of water quality. (Photo from Marco Island Development Corporation.)

should be avoided. Nor should filling or grading be permitted: covering wetlands with soil disrupts their function as completely as excavation or paving does. Removal of natural vegetation through land clearing and grading should also be avoided, since vegetation is a most important element in wetland functions.

This "no-alteration" ideal must be tempered with appreciation that wetlands often ring the shores of coastal communities and that access through them may be necessary for many purposes. Access can often be provided without significant alteration through the use of appropriate development techniques, standards, and restoration work. For example, utility lines can often be successfully installed in a marsh by use of a special trenching machine and by effective refilling and replanting of the disturbed surface. The State of New Jersey, which routinely gives permits for subsurface utility crossings in coastal marshlands (but for little else), has found that trenches can be dug and the surface restored, leaving the marsh functionally intact. Thus, you can usually allow temporary works to install transmission lines (pipelines, electric lines, water lines) that cannot feasibly be rerouted—provided that the wetland soils and surface are restored (Figure 6).

Federal and State agencies can often help localities resolve the complex technical issues that arise when wetland development is proposed. These agencies will have to consider your proposals anyway, before giving Federal or State permits for wetland use. Accordingly, your local decisions should take account of Federal and State policy, which will normally require you to make every effort to avoid wetland alteration. Recently, the U.S. Army Corps of Engineers issued guidelines for the city of Sanibel, Florida, which give specific standards for approval of wetlands development under Section 404 of the Clean Water Act.

Waterfront development that involves dredging wetlands, tideflats, and estuarine bottoms and using the "spoil" to fill and elevate the land is very difficult to reconcile with protection of wetland functions. It causes more ecological disturbance than any other type of coastal residential development. This is particularly true when canals are dredged and the dredge spoil is piled on adjacent wetlands or other low-lying land to gain elevation and to create lots for canal-side homes (Figure 7). The canals often collect storm-runoff pollutants, which foul wetlands and contaminate estuarine waters. Septic tanks installed in filled canal-side lots often leach nitrogen and other substances into

the canal waters so rapidly (often in less than 24 hours) that there is inadequate time for the purifying action of the soil to cleanse the discharge adequately.[7]

One way waterfront development might be handled, in subdivisions where the wetlands are privately owned, is by clustering home sites on dry land above the wetlands in a planned unit development, perhaps with an allowance for greater than normal density on upland property through "transfer of development rights".[8] For example, Collier County, Florida, transferred all the development rights from a mangrove-edged small coastal island to a mainland property of the owner.[9]

If a project has apparent public value but reasonably involves some loss of wetlands, you may consider approval contingent upon "compensatory mitigation," which requires the developer to offer some form of compensation for the losses he occasions—for example, construction of an equal acreage of new wetlands within the same ecosystem, or perhaps restoration of some adjacent damaged wetlands to full function. Acceptance was won for locating an extension of the Nassau Expressway alongside New York's Kennedy International Airport by including the following major wetland mitigation directives: (1) circulation to the wetland system was to be restored by replacing small culverts under existing roadways with larger ones; (2) some existing filled marshes were to be regraded to intertidal level and planted with cordgrass; and (3) a hydrologically isolated marsh section was to be reconnected and refurbished.[10]

Recommended Policy 12: Wetland Hydrologic Alteration.

Discourage activities that alter the natural water systems of wetlands, such as draining and diking.

Saltwater wetlands depend on wet soils and regular flooding. Usually, if they are drained with excavated channels or permanently impounded with levees—for mosquito control, for example—their character is completely changed and their value diminished. Far-reaching hydrologic effects due to artificial drainage include: (1) elimination of surface waters; (2) lowering of the water table; and (3) elimination of periodic flooding. Even relatively minor artificial drainage changes may subvert natural processes and cause wetlands to deteriorate and become disfunctional[11] (Figure 8). Such changes may also increase the vulnerability of human life and property to storms.

Drainage of wetlands and low-lying floodland edge-zones may also create subsidence, a lowering of the land surface due to compaction, drying, and shrinking of

Figure 8. One of the few remaining wetlands in Los Angeles is seriously degraded by ditching, filling, and bulkheading. (Photo by John Clark.)

the surface peats and organic soils. (Localized "spot" subsidence occurs when the weight of a structure is too great a burden for the soil on which it is built.) Subsidence, which is considered to be irreversible, greatly increases the danger of flooding during hurricanes.

The use of levee and dike structures in wetlands for mosquito control, wildlife management, flood control, or navigation improvement produces both immediate and long-term ecological changes. The relatively recent appreciation of the value of wetlands has necessitated a closer look at the side effects of many previously accepted projects such as impoundments. Some old impoundments will still be acceptable; others will be found too damaging to wetlands.

Your community should, therefore, discourage drainage or impoundment of wetlands in favor of other alternatives. Two effective alternatives now in use for mosquito control are (1) open-marsh water management, a system of strategic ditching to connect still-water areas to the circulation system of the marsh (Figure 9), or (2) diked impoundments with tide gates that are closed only during the seasons of maximum mosquito breeding (Figure 10).

Recommended Policy 13: General Wetland Construction.

Require structures to be designed so that they do not degrade wetland functions.

Although protection of wetlands is generally incompatible with typical residential, commercial, and industrial development, a variety of special-use structures can be built in wetlands provided they are designed in accordance with performance standards to prevent degradation of wetland function.

You can permit light-duty, pile-elevated structures that do not require roadway access or alteration of the site through clearing, filling, grading, paving, and so forth.

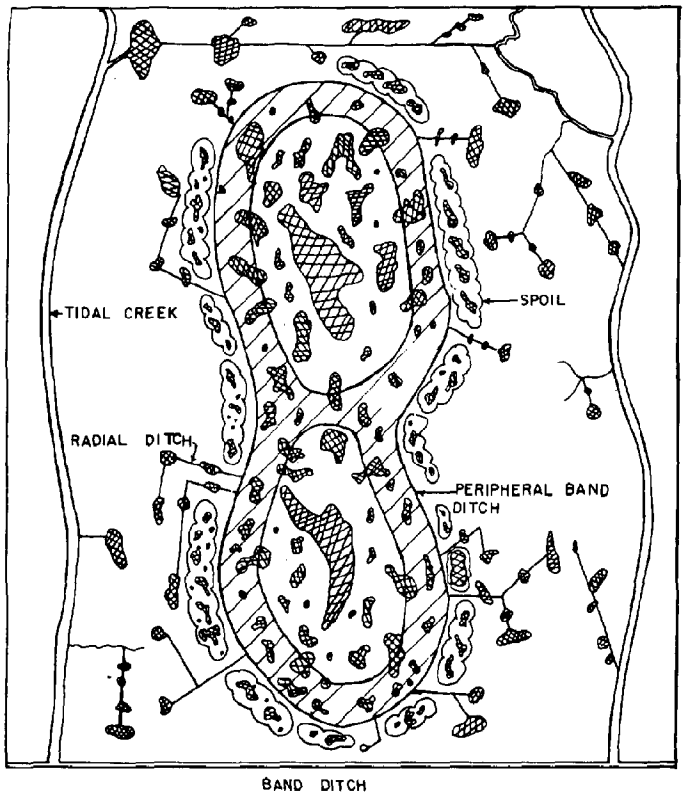


Figure 9. Open-marsh water management plant to eliminate mosquito breeding in many depressions (cross-hatched areas on drawing) by ponding (diagonal lines) and ditching. (Source: F. Ferrigno and D.M. Jobbins, "Open Marsh Water Management," in Proceedings of the 55th Annual Meeting, New Jersey Mosquito Extermination Association.)

Figure 10. Seasonal impoundment on Gumbo Island, Fla. Water management devices: (a) spillway, the low, grassed-over section of dike; (b) culverts with flash boards; (c) culverts with flap-gate; (d) electric pump, served by underwater cable. (Photo courtesy National Aeronautics and Space Administration.)

Appropriate performance standards would ensure that removal of wetland vegetation or interference with surface water and groundwater flow is minimized. Owners of wetlands could be allowed to construct catwalks, piers, boathouses, boat shelters, fences, duck-blinds, footbridges, observation decks, shelters, and other similar structures in conformity with the standards (Figure 11).

Structures built around the edges of wetlands present a different set of problems and solutions. Except in unusual circumstances, bulkheads should be placed landward of the wetlands—i.e., upland of the one-year flood level, which marks the wetlands' upper edge. In addition to damaging wetlands, bulkheads extending into water areas may adversely alter water circulation, increase scouring of the bottom, reduce the surface area of the estuary, and preempt such vital habitat areas as tideflats and shellfish beds (Figure 12). In particular, you should withhold approval of bulkheads built for retention of wetlands fill, since filling the marsh is in any case unacceptable.[12]

In many cases, the shoreline can be protected by grading and planting salt-marsh grasses, mangroves, or other vegetation. This artificial marsh barrier is likely to prove the least expensive method of protection, and it has the added benefit of creating a more biologically productive shoreline. Many owners will also find it more aesthetically appealing than heavy structures (Figure 13).

From the engineering viewpoint, soils of wetland areas present obstacles to development that often can be overcome only by costly construction methods.[13] Either organic muck must be removed by excavation and replaced with fill or deep piles must be driven beneath the rock to provide a solid base for structures.

In sum, you should limit construction in wetlands to light-duty structures not used for permanent occupancy. Where there is already some unavoidable commitment to more intensive use, such as home sites, implementing the Federal flood insurance requirement for elevation of homes above the expected 100-year storm surge level would tend to minimize the damage if the

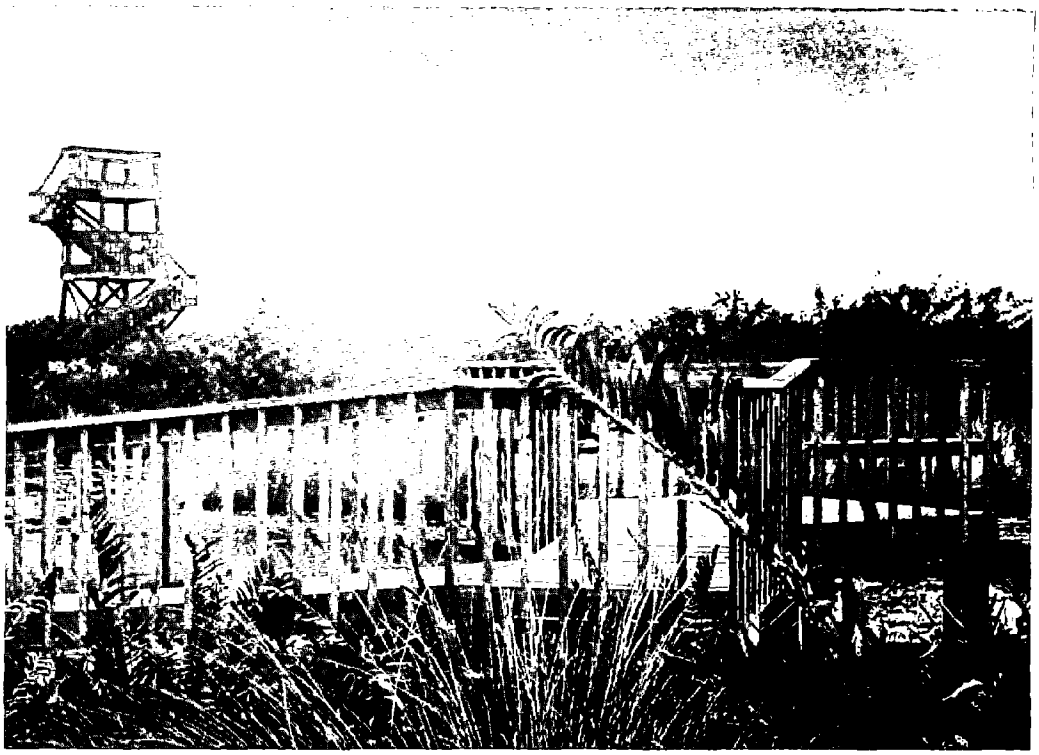


Figure 11. Walkway, observation platform, and tower in the interior wetlands of Sanibel, Florida. (Photo by Richard Workman, Sanibel-Captiva Conservation Foundation.)

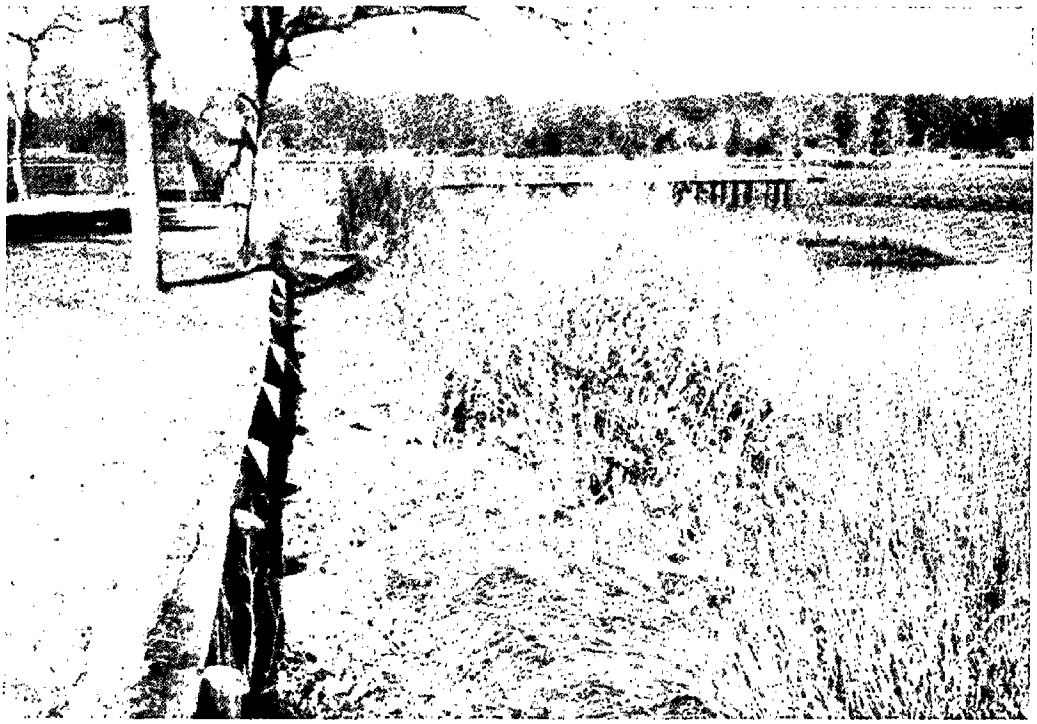


Figure 12. Proper location of bulkheads above the annual flood line and behind marshes and other wetlands will preserve vital habitats while providing protection against erosion and floods. (Photo by Thomas Barnard, Virginia Institute of Marine Science.)

elevation is on piles, without fill (see discussion in Floodlands section). Accompanying constraints on permitted density and performance standards to restrict other excavation, grading, filling, and paving of the wetland site would add more protection (Table 1).

Recommended Policy 14: Wetland Roadway Crossings.

Require roadway crossings through wetlands to be elevated above the wetland surface.

Although there are engineering techniques that can reduce the impacts of road-

A development permit shall be granted for development or site alteration in the Mangrove Forest Zone only if the applicant has demonstrated that the proposed development or site alteration:

Geology

1) will not result in the permanent lowering of the natural elevation of any portion of the parcel proposed for development by excavation, ditching, dredging, digging, filling or other disturbance of sand, silt, soil, sediment, accumulated detritus, or other geologic or biologic component of the mangrove forest except for that activity necessary to:
   a) maintain freshwater levels in the interior wetland;
   b) protect the health, safety and welfare of the City from disease-carrying insects;
   c) manage the mangrove forest as a viable natural community.

Hydrology

2) will not restrict, impede, impound or otherwise interfere with the tidal flow or influence in the mangrove forest, or similarly interfere with drainage in the mangrove forest;

3) provides for the gradual and dispersed drainage of surface runoff such that runoff from within the boundaries of the parcel proposed for development will approximate natural rates, volumes and direction of flow; included shall be a requirement for containment on site of the runoff from a 5 year intensity storm and further, coverage with impermeable surfaces shall be minimized and in any event shall not exceed 1% of the gross area of the parcel proposed for development;

4) will not disturb, break or penetrate the aquiclude or clay layer at the bottom of the freshwater lens, permit saltwater intrusion or otherwise endanger the integrity of the freshwater lens. If in order to comply with the floodproofing regulations of this Plan it is necessary to drive pilings below the level of the aquiclude, such penetration shall be sealed according to the best technology available to avoid saltwater intrusion;

5) will not involve the use of a septic tank or other mechanisms or devices that could result in the discharge of sewage or other waste within the mangrove forest;

6) will not result in the discharge of treated or untreated sewage or other human waste from a boat into the waters of the City of Sanibel.

Vegetation

7) will not involve the necessary removal of any native vegetation which exists as a natural buffer to storm surge, stabilizes soils or provides wildlife habitats, including but not limited to Red mangrove, *Rhizophora mangle*; Black mangrove, *Avicennia germinans*; and White mangrove, *Laguncularia racemosa*;

8) provides for the removal of exotic species of plant which outcompete or otherwise displace native species including the Brazilian pepper or Florida holly, *Schinus terebinthifolius*; the Cajeput or Punk tree, *Melaleuca quinquenervia* within the boundaries of the parcel proposed for development or site alteration;

9) provides that all landscaping will only involve the use of native species of plant or non-competing species of plant.

Wildlife

10) will minimize any interference with the use of the mangrove forest for feeding, foraging, resting, nesting, shelter and breeding by indigenous and migratory birds, shellfish, fish and other indigenous wildlife. Such interference shall include the destruction or diminution of organisms or material upon which wildlife feed.

Table 1. Example of wetlands performance standards from the City of Sanibel (Florida) ordinance governing land use (*Section 3.9.4: Development in the Mangrove Forest Zone*).

way crossings in coastal wetlands, a better solution is to route highways on adjacent uplands. Roadways built on the wetland surface not only obliterate wetland areas, but also may dam water movement, disrupting normal tidal flows or land drainage (Figure 14). Another frequently encountered effect is the creation of "mud waves," undulating out from and parallel to the highway fill. The waves are created by the pressure of the roadbed fill on the soft organic soils beneath. Marshes over 100 yards away from roads have buckled and otherwise been disrupted by mud waves.[14]

The construction of solid-fill causeways and excavation of barge-access channels often create spoil-disposal problems (Figure 15). These problems are likely to be particularly severe when the method of construction is to dig out ("muck" out) deep layers of organic muck and replace them with a solid-fill base. Wetlands are not suitable disposal sites, and acceptable sites are becoming scarce and expensive. The remaining alternatives are to transport spoil either well inland or to the ocean.

Enlightened traffic engineering can often avoid these problems altogether by routing roadways across high ground, and avoiding wetlands. Where there is no feasible or prudent alternative to crossing wetlands, a solution is to elevate the roadbed as a viaduct or column-supported causeway with minimum alteration of the wetlands below. The method to use is end-on construction, in which the supporting piles or columns are driven progressively from equipment based atop the roadbed, and preformed concrete decking is used for the roadway's surface. This procedure should make it unnecessary to operate heavy equipment on the surface of the marsh or to dig canals through the marsh to bring in floating cranes and pile drivers. In many circumstances, crossing the wetlands on elevated structures may be cheaper than routing a roadway around the wetland. The cheapest alternative, however, is not always the best one.

Bridges, too, should be designed so as not to impair the circulation regime and tidal flow of wetlands. The number and size of supports can be minimized by streamlining them, and by building abutments back from the water's edge (Figure 16). Essentially, the cross-sectional area of a watercourse should not be effectively reduced by abutments, support piers, pilings, and so forth. To meet Federal flood-protection regulations, you will have to be sure that the cross-sectional area of a waterway is in no case reduced to less than that which can adequately accommodate the 100-year maximum flood waters.[15]

Spurs and feeder roads that provide ac-

Figure 13. A marsh-grass buffer strip (shown 10 years after planting) controls shore erosion and eliminates the need for bulkheads. (Photo from Interstate Commission on the Potomac River Basin.)

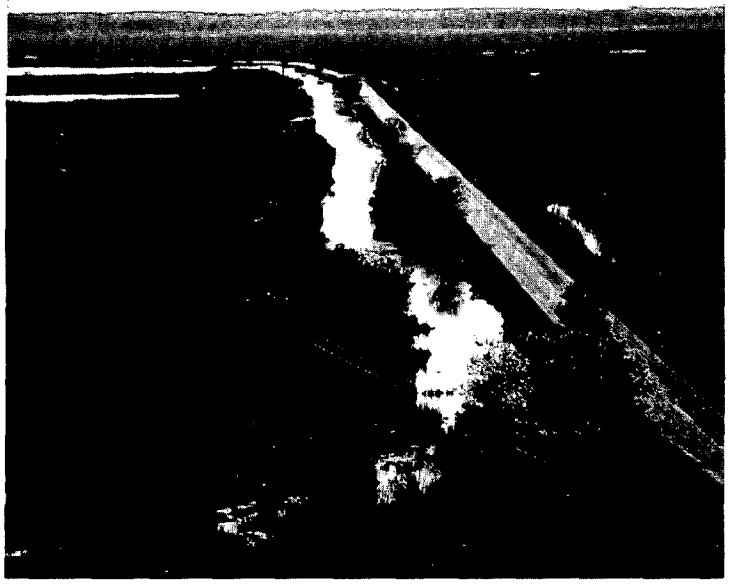


Figure 14. A roadway blocking wetlands circulation. (Photo by M. Fahay.)

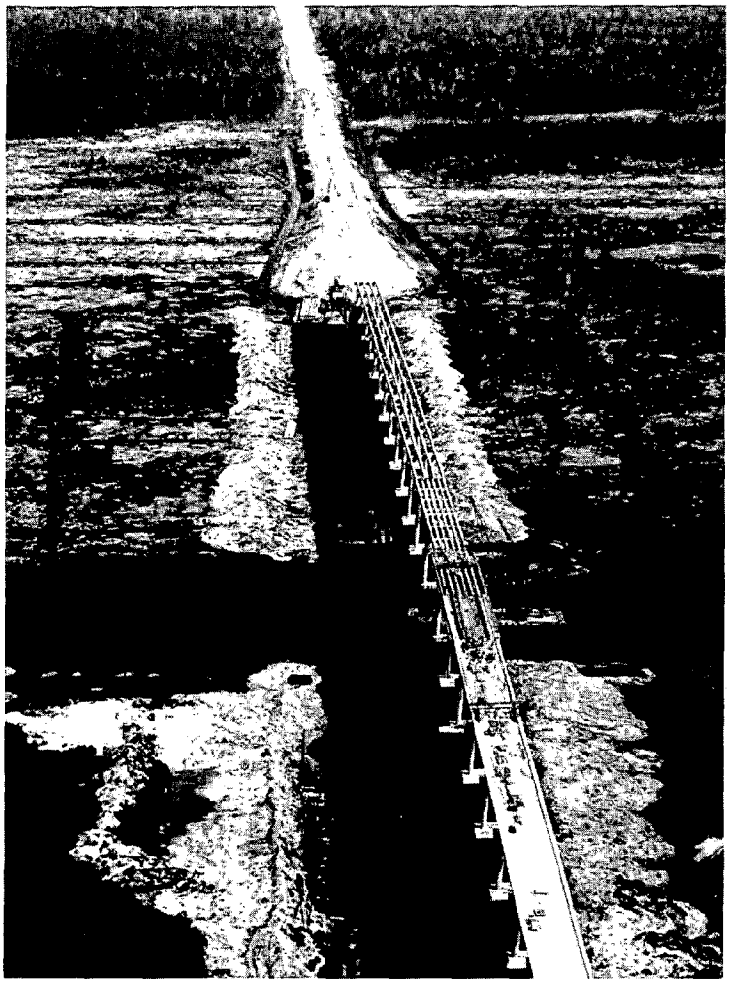


Figure 15. Barge-access channels and spoil mounds preempt wetlands and interfere with natural circulation at New Topsail Beach, N.C. (Photo by M. Fahay.)

Figure 16. Bridge abutments that encroach on watercourses reduce water flow and degrade the coastal ecosystem. (Photo by John Clark.)

cess to the coast from major highways should generally be aligned perpendicular to the coastline. This will minimize the blockage of natural drainage patterns (Figure 17). You should allow only essential service roads to run parallel to the coast, and these should have sufficient water passes and culverts to provide as nearly natural a pattern of runoff and tidal flow as possible.

Recommended Policy 15: Pollutant Discharge into Wetlands.

Restrain the discharge of pollutants into wetlands.

Wetlands can assimilate a reasonable amount of contaminants. But there is a limit. Wetlands must be protected against gross pollution from both land runoff and sources emptying directly into the estuary—in particular, pollution from toxic substances and oil. A polluted marsh is offensive to the senses, a healthy one an aesthetic resource. Excessive nutrient pollution may cause wetlands to breed an abundance of mosquitoes and other pests.[16] Tideflats also may be adversely affected by pollutants—e.g., sulfite waste liquor (from pulp-mill effluent), thermal discharge, and sewage. When polluted, tideflats, like wetlands, may become odorous and unattractive.

Most wetlands can function as a "land treatment" system, absorbing and assimilating storm-runoff pollutants. Experiments have also shown that wetlands have some capacity to assimilate municipal sewage. But there are serious technical difficulties in introducing the right amount of sewage so that the excess nutrients and other pollutants in the water flowing over the wetlands do not overwhelm the capacity of the wetlands and cause health hazards as well as ecological problems. Any pollutants introduced to wetlands should not exceed the calculated receiving capacity of the system, and should not degrade surface water or groundwater below State water-quality standards.[17]

Recent experience suggests that natural wetlands can most practicably serve as a final stage in the sewage treatment process.[18] However, considerable engineering modification—dikes, water-level gates, injection devices, etc.—may be required. The need for controls so increases the cost that in

many cases you may find it less costly to develop a completely artificial treatment system.

Recommended Policy 16: Restoration of Wetlands.

Whenever possible, restore degraded wetlands to function naturally.

There are many opportunities to restore wetlands in conjunction with development projects, both private and public. All project reviews should examine the possibilities. Dikes and levees that damage wetlands can be removed and ditches refilled. Damaged wetlands can often be restored by reworking or supplementing the base soils and by replanting with appropriate species. Often, acceptable soil material will be available from dredge spoils. In protected water bodies—estuaries—where

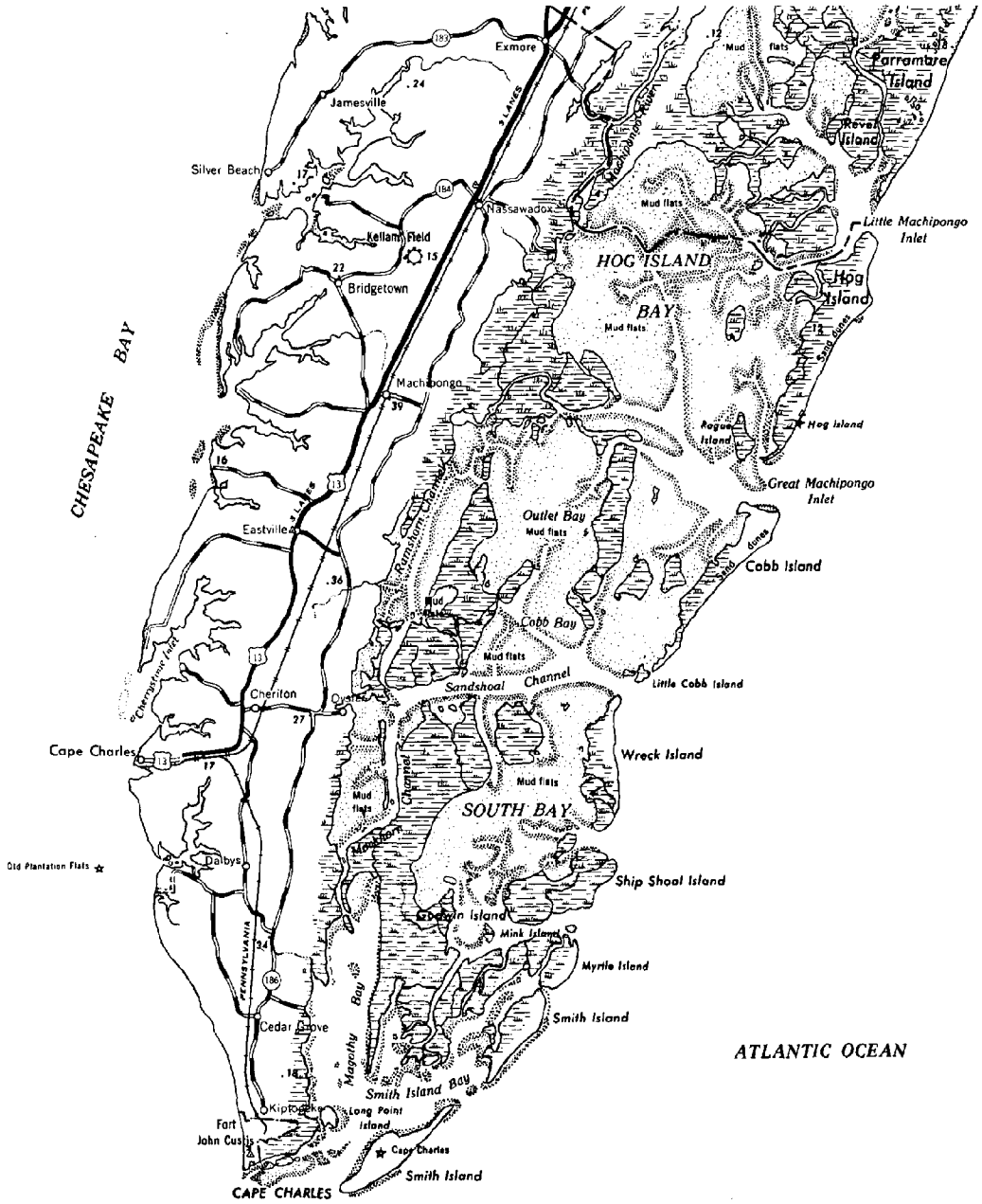


Figure 17. Major roadways should be located inland from wetland shorelands (for example, Route 13), while feeder routes to the shore should run on higher ground between the wetlands, generally parallel to water flows. (Source: U.S. Geological Survey "quad" map.)

wave energy is weak, an artificial salt marsh may be an effective method of shoreline protection, since wave forces can be absorbed and sediments trapped by the planted vegetation (Figure 18). This use of planted marsh strips has been successful in the Chesapeake Bay area.[19] In Florida, mangrove species lend themselves well to shoreline protection in estuaries and may be incorporated into plans for the protection of private waterfront property.[20]

There are professional experts, familiar with wetland replanting techniques, who can help you with the various technical problems you must consider (Table 2). They can also help you to determine the appropriate clean-up techniques for rejuvenating polluted wetlands.

A useful first step is to maintain a list or map of local coastal wetland units that are in need of restoration. Then if you wish to consider a development project in the vicinity, contingent on compensatory mitigation, or if State or Federal funds become available for restoration, you will have the information available to make a proposal. The local offices of the Corps of Engineers, Fish and Wildlife Service, National Marine Fisheries Service, or Environmental Protection Agency can provide valuable assistance on this type of program.

You must be especially careful that restoration as a form of compensatory mitigation is used for its intended purpose—i.e., to compensate for wetland losses incurred by projects for which no practicable alternative exists and that are water dependent, that is, which cannot accomplish their purpose (e.g., housing, recreation, transportation) if located in uplands. Because the compensatory benefits must be evaluated on highly technical grounds, there is a danger that development proponents will gain approval from lay reviewers for compensation plans that are inadequate. To avoid this outcome, you will need technical assistance.

Figure 18. Under certain conditions, marsh grasses can be planted successfully to stabilize sediments and create a salt marsh habitat. (Photo by John Clark.)

Siting Considerations

- Locate new marshes in low energy areas, such as,
  —in the lee of barrier beaches, islands and shoals;
  —in shallow water areas where wave energy is dissipated;
  —within the convex portion of river bends;
  —land extensions and embayments where marsh currently exists;
  —within zones of active deposition;
  —away from areas with long fetch exposure in the direction of prevailing winds;
  —away from major tidal channels and uncontrolled inlets;
  —away from headlands where wave energy is concentrated.

- Take advantage of high water energy areas (e.g., inlets) to obtain coarse grained materials, but only if the inlet will not become hydraulically unbalanced.

- Take advantage of on-going sedimentation processes, such as littoral drift for sand nourishment, to aid in stabilizing new marshes.

Design and Construction Considerations

- Use available coarse grained material to protect exposed surfaces of the new marsh.

- Be aware of possible deflocculation effects when dredged sediments are obtained from highly saline areas and disposed in low saline areas.

- Provide protection against wave erosion by creating a rim of coarse material on the windward face of the marsh. Design criteria of the rim are:
  —elevation above level of normal wave runup,
  —coarse material of substantial width.

- Plan the final grade of the protection rim or dike so that drainage of rain runoff and wave overwash will be towards the interior of the fill.

- Configure the marsh such that exposure to erosion forces is minimized.

- Plan for special action to repair storm damage during the initial period of marsh stabilization.

Table 2. Siting, design, and construction considerations for building artificial wetlands. (Source: Lynn E. Johnson and William V. McGuiness, *Guidelines for Material Placement in Marsh Creation,* CEM Report 4165-519, Center for the Environment and Man, Inc., Hartford, Conn., 1975.)

IMPLEMENTATION GUIDELINES

This subsection provides suggestions on two principal opportunities for local action: first, modifying local plans, regulations, and programs to respond to the special needs of saltwater wetlands; second, seeking assistance available under Federal programs. To implement the six policies in these areas, your community should be prepared to address four principal management needs:

First, **preventing or limiting disruptive activities in saltwater wetlands.** Of the six wetland policies, the first four deal with development-related activities that can disturb wetlands: Policy 11 (Wetland Surface Alteration), Policy 12 (Wetland Hydrologic Alteration), Policy 13 (General Wetland Construction), and Policy 14 (Wetland Roadway Crossings). The policies recommend that you avoid these activities or, in some circumstances, conduct them in ways that minimize unavoidable disturbances. How you can best do this is an important management issue.

Second, **controlling pollution of saltwater wetlands.** From a management standpoint, the measures needed to implement Policy 15 (Pollutant Discharge into Wetlands) are basically the same as those for controlling pollution of coastal waters, as discussed in the Coastal Waters section (see p. 119).

Third, **restoring former wetlands.** Implementation of Policy 16 (Restoration of Wetlands) is sometimes a public expense, sometimes a requirement of private development.

Fourth, **defining the boundaries of saltwater wetlands.** Since your community will be trying to prevent or limit disruptive activities in saltwater wetlands, their boundary will have to be defined with some precision.

1. Preventing or limiting disruptive activities in saltwater wetlands.

A local government setting out to prevent disruptive activities in saltwater wetlands, and to minimize unavoidable disruptions, should anticipate substantial Federal and State influence. With the possible exception of beaches, saltwater wetlands are subject to more far-reaching Federal and State protection than any other place in the floodplain.

Nevertheless, you will need first to consider the array of familiar local tools. These are diverse, including plans, policies, property acquisition, tax incentives, and so on. Two tools—*regulations* and *local public-works programming*—are particularly useful.

Several types of local *regulations* are commonly used to prevent disruption of wetlands:

In many communities, *permit requirements* are established by local zoning or building regulations, or by separate wetland regulations.[21] Some of these regulations prohibit wetland alteration without permits, which may be granted only after consideration of public need for the proposed development, potential pollution and other environmental effects, and private hardships incurred if permission is denied. Alternatively, regulations may allow development in wetlands, subject to strict standards, if preventing development altogether is impracticable. Pile-elevated structures may be allowed, for example, if they occupy only a small percentage of the site and if any destroyed vegetation is replaced.[22]

Subdivision regulations may prohibit extension of new subdivisions into saltwater wetlands, and may require recorded plats to note the special flood hazards and natural characteristics of these areas.[23] The regulations may, in addition, establish special drainage and road-design standards for wetland development.[24] (Under some State laws, these types of controls can only be imposed by special wetland regulations, not by subdivision regulations.[25])

Grading, excavation, and tree-removal regulations are also commonly used.[26]

Septic-tank controls, in addition to their pollution-control effect, can also be an effective tool to control development in wetlands: wetlands are generally not appropriate for septic service without extensive filling and site modification, which in itself is likely to be unacceptable.[27]

A second type of tool, *local public-works programs,* can protect wetlands in at least two ways. First, appropriate constraints can help to assure that your locality's own projects do not disturb wetlands. Second, public-works programs can help guide private development away from wetlands to other locations.

In the absence of essential public facilities, particularly sewers, development of wetlands is difficult. So programming these facilities for other locations helps to direct new development to more suitable sites. Sometimes, however, sewers, water lines, or other public works do have to be built near wetlands. If these facilities are supported by tax assessments against "benefited" property, wetlands property should be excepted from the assessment; preventing development of wetlands is difficult if owners have been forced to pay for development-related benefits.[28]

If your community uses local regulations and public-works programming to protect saltwater wetlands, it may encounter the following problems:

First, it may find that its policies, programs, and regulations do not apply to projects proposed by a State or Federal agency, or by another local government. For example, special drainage districts, which provide drainage and flood protection structures for many low-lying coastal areas, may be beyond control of your local government. And the State highway department may not be bound by local rules when it acquires rights-of-way. Port expansion, too, is sometimes outside the control of local government.[29]

Second, market prices of privately owned wetlands may be reduced, and owners may contend that your locality's regulations exceed its statutory or constitutional authority. In responding to this charge, you may be able to rely on special public rights, sometimes called the "public trust," which apply to saltwater wetlands. Because of these rights, strict regulation of saltwater wetlands appears less likely to exceed legal limits than similar restriction of many other places in the coastal floodplain.[30] Nevertheless, specific legal limits remain uncertain in many situations, and legal challenges may present difficult issues to resolve.

Where wetlands have been subdivided and sold as residential lots, the owner's hardship claims present especially difficult issues. Local regulations adopted to protect wetlands should include provision for case-by-case review to identify such hardship situations and should specify standards for any development permitted to alleviate the hardship. If hardship situations are resulting in excessive development of wetlands, nonregulatory methods (e.g., land acquisition, nonregulatory incentives) may be needed.[31]

Third, where development affecting wetlands cannot easily be avoided, your community may have trouble deciding what sorts of performance standards or other measures are needed, and how much money should be spent to assure proper siting and development. At present, you will find that scientific advice offers only limited help in making these choices, since there is still no scientific consensus on methodology or standards. Your community should, therefore, remain alert to continuing research in this area. Meanwhile, it should anticipate wide differences of opinion among reputable experts.[32]

A community facing limits on its own abilities to protect saltwater wetlands can often obtain important assistance from Federal or State agencies. Federal permit requirements, for example, may relieve your community of the need to make some difficult decisions—or at least let it share the responsibility for these decisions. In other instances, Federal or State agencies can provide invaluable technical assistance. The following Federal programs, and a related State program, should be particularly influential.

Federal Regulations on Dredging and Filling of Wetlands. Most development in saltwater wetlands requires a permit from the U.S. Army Corps of Engineers, with review by the U.S. Environmental Protection Agency (U.S. EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). Regulations issued by the Corps in July 1977 present an integrated picture of the permit program.[33]

Although the Corps has integrated its various permit authorities into a single permitting process, the authority to require permits, and to establish conditions on permitted development, comes from a number of Federal statutes. Two of these are especially important:

First, the *Rivers and Harbors Act of 1899.* This statute requires permits for most development in "navigable waters." The Corps traditionally treated "lower wetlands" as "navigable" and thus subject to the permit requirement. The remaining,

"upper" wetlands were usually exempt. The most common type of permit required by this act is called a "section 10 permit," a reference to section 10 of the 1899 act.

Second, the *Clean Water Act*. Many key elements of this law were enacted as part of the Federal Water Pollution Control Act Amendments of 1972, sometimes called "P.L. 92-500." The 1972 law added to the permit requirements in several ways:

—It directed the Corps to consider water quality in granting or denying permits for discharges of dredged or fill material.

—It required permits for discharges into "waters of the United States." In effect, this extended the areas within which permits are required. In the case of saltwater wetlands, its practical result has been to extend a permit requirement to all parts of the wetlands, "upper" as well as "lower."

—It gave U.S. EPA an important role developing guidelines and in administering the permit program.

These permits required by the Clean Water Act are often called "404" permits, a reference to section 404 of P.L. 92-500. Some important activities do not require these types of Corps permits. "Normal" agricultural and forestry activities, as well as some road-construction projects, are exempt from the permit requirements.

If your community is trying to protect saltwater wetlands, and finds the Corps permit program a potential ally, you can seek Corps help in several ways:

First, informal consultation with Corps officials can be an important source of technical information and will also make them aware of your local problems and concerns. The Corps has 36 well-staffed District offices, and it is usually fairly easy to track down the specific person responsible for processing the permits for any community.

Second, local policy positions are given great weight by the Corps, and local actions on a project can be most influential. Although the Corps is not formally bound by local decisions, your community may be able to influence a Corps decision by denying local zoning, subdivision, or other approvals—or by granting such approvals with conditions that protect the wetlands.

Third, your community can participate in Corps administrative proceedings, asking the Corps to deny Federal permits or to impose protective conditions. In effect, you can ask the Corps to use Federal authority to impose conditions that your community may not have clear legal authority to impose on its own. Also, communities may, in effect, ask the Corps to take or share responsibility for decisions that local officials find politically difficult.

Federal Fish and Wildlife Coordination. Localities will often find the U.S. Fish and Wildlife Service (FWS) playing an important role through environmental assessment and other review procedures that precede Federal projects and U.S. Army Corps of Engineers permits in wetlands and navigable waters. The FWS is a small agency of the Department of the Interior with numerous field offices in different regions staffed with experts in the biological sciences. Perhaps best known for its role in managing wildlife refuges around the country, since 1958 FWS has also played a behind-the-scenes role providing technical evaluation of Corps' and other agencies' engineering proposals for structures or changes in navigable waters and adjacent wetlands.

In evaluating proposed public projects (including some projects proposed by local governments), the FWS often suggests design modifications to benefit fish and wildlife, emphasizing the scientific advocacy role assigned to the FWS by Congress. FWS comments are usually offered in participation procedures open to local government, that is, the environmental assessment process under NEPA (see p. 37) and similar public hearing and review procedures associated with specific programs. If you are concerned with technical questions regarding the impacts on fish and wildlife of proposed Federal actions, you can often find informal counselors among FWS regional or field personnel.

State Dredge and Fill Regulations. Dredging and filling and other uses that can alter saltwater wetlands are regulated by most States. State controls are an important link in the overlapping State, Federal, and local interests in saltwater-wetland management. Unfortunately, the controls vary too widely from State to State to be summarized here. You should determine what type of program is run in your State and

be alert for possible future changes such as the following:

1. The coordination of Federal and State permitting procedures in saltwater wetlands. Successful tests in Florida and the San Francisco Bay Region are pointing the way to integrated application and hearing procedures in other States and regions.
2. The substitution of State for Federal Section 404 authority in certain freshwater wetlands (see p. 33). This may provide help in defining boundaries between saltwater and freshwater wetlands.
3. The implementation of "Section 208" Regional Water Quality Plans of the federal Clean Water Act (see p. 35). These plans and their implementation often require local support for success. With considerable variation in implementation strategy, the "208" program is likely to offer both management opportunities and technical information on local water quality problems.
4. The coordination of State dredge-and-fill regulation with State coastal zone management.

The National Flood Insurance Program. The National Flood Insurance Program (NFIP) can also sometimes help communities to protect their saltwater wetlands. This help becomes available as soon as your community gets a Flood Insurance Rate Map (FIRM)—that is, when your community leaves the "emergency phase" of the NFIP and enters the "regular phase" of the program, which provides specific information on local flood hazards. This information may correlate with wetlands management needs.

Since many saltwater wetlands are subject to frequent or especially dangerous flooding, they may be included within the "coastal high hazard" zones—also known as "V" (for velocity) zones—established by the FIRM.

Inclusion of saltwater wetlands in the "V" zone can help strengthen local protective measures because, if your community wants to enter or stay in the regular phase of NFIP, it must, under Federal regulations, impose the following requirements on future development in "V" zones:

—New structures must be elevated or anchored on pilings or columns.
—New development must be located landward of the reach of mean high tide.
—New utilities and sewers must be floodproofed.
—Man-made alteration of mangrove stands that would increase potential flood damage is prohibited.
—New mobile home subdivisions are prohibited.

Executive Order 11990, "Wetlands." Some of the most disruptive activities in wetlands have been public development projects —sewers, roads, and other facilities. Many of these projects have been conducted or financially assisted by the Federal government.

If your locality is concerned about a federally conducted or assisted project in wetlands, you should be aware of Executive Order 11990, the "Wetlands Executive Order," issued in 1977. The order applies to the following Federal activities in both freshwater and saltwater wetlands:

1. acquiring, managing, and disposing of Federal lands and facilities;
2. undertaking, financing, or assisting construction and improvements;
3. conducting other activities and programs affecting land use, including, but not limited to, water and related land resources planning, regulating, and licensing activities.

The order does not apply to Federal permits issued to private parties for work in wetlands on non-Federal property.

Before a Federal agency can proceed with an activity that would damage wetlands, the order requires the agency to find that:

1. There is no practicable alternative to such construction.
2. The proposed action includes all practicable measures to minimize harm to wetlands as a result of such use.

Public review and comment is required, and usually the environmental impact statement (EIS) procedures of the National Environmental Policy Act will be used to satisfy this requirement (see p. 37). You may also have an opportunity to comment in "A-95" and public-participation procedures of particular grant or expenditure programs (see p. 34).

If your community believes that the Wetlands Executive Order is being ignored, it should make appropriate com-

ments in EIS, A-95, or other procedures, and may have other legal remedies available. But if you feel that the judgment of an agency on practicable alternatives or measures to minimize harm is incorrect, the normal channels of administrative appeal used by that agency will probably be the only means open to you to try to change the decision.

Coastal Zone Management Program. A state coastal zone management (CZM) program developed under the Federal Coastal Zone Management Act of 1972 may also help a community seeking protection of wetlands (see p. 36). A program may, for example, establish State policies and an implementation strategy affecting wetlands.

The legal and technical information necessary for local protective action may be conveniently brought together in the CZM program. In some cases—for instance, in Oregon and California—the implementation strategy may involve local government directly. In others, it may include a State regulatory or assistance program that helps to carry out Policies 11 through 14.

As discussed in more detail in the Floodlands section, many actions of Federal agencies must be "consistent" with the State CZM program once it has received Federal approval. For example, a Corps decision to permit dredging in wetlands would have to be consistent with an approved State CZM program, as well as with Corps regulations.

Coastal Energy Impact Program. If your State and community are receiving grants under this Federal program (a part of the Coastal Zone Management program), you may find that some funds are available to correct destruction of wetlands or otherwise mitigate the results of coastal energy-development activities—past as well as present.[34]

2. Controlling pollution of saltwater wetlands.

See Coastal Waters section (p. 119).

3. Restoring former wetlands.

Restoration of wetlands typically consists of dismantling dikes, tidegates, and drainage canals that interfere with water flows, and rehabilitating the soil base. Communities occasionally undertake restoration projects on their own, but their efforts are limited by costs and uncertainties about benefits. There is, however, growing interest in programs to restore damaged wetlands, particularly in connection with new public-works programs, or large private development projects.

There are three restoration problems that Federal programs may help you to solve:

First, the U.S. Fish and Wildlife Service comments on Federal projects in the floodplain (see p. 68) if they affect wetlands. The Service is required by law to advise on mitigation, including possibilities for restoration of damaged wetlands. Field offices of the Service may be able to provide you with informal assistance in evaluating proposed wetland restoration.

Second, you may lack the information and technical skills necessary to evaluate opportunities for restoration. The State coastal zone management program may, however, be able to provide some assistance, particularly if the State program has identified wetlands as areas for preservation and restoration.

Third, restoration is very expensive. However, when the Federal government pays for projects such as dams and flood-control works, the Fish and Wildlife Coordination Act requires that it pay for mitigation, which may include restoration of damaged wetlands. When wetlands have been damaged as a result of coastal energy activity, the Coastal Energy Impact Program may be a source of funds for restoration.

4. Determining the boundaries of saltwater wetlands.

If your community's policies or regulations treat saltwater wetlands as distinct places of concern, you will need to define the wetlands boundary. There are several possible ways to do this. You could, for example, define the boundary by reference to the tides, or to the salinity of the waters, to soil types, or to vegetation.

In practice, it is usually best to define the boundary of saltwater wetlands by reference to vegetation, since the distinction between salt-tolerant wetland and upland vegetation is easily observed. (Similarly, the vegetative change between adjacent saltwater and freshwater wetlands is distinct.) Often, the upper boundary of saltwater wetlands is identified by a very abrupt change in plant species. For exam-

ple, in many areas, the upper edge of the saltbush, or high-tide bush, clearly marks this boundary.

You are likely to discover, however, that Federal and State governments have already drawn boundaries, for one purpose or another, around saltwater wetlands or through them. Some communities have found it convenient to adopt one of these established boundaries. Before fixing a vegetation-based boundary, therefore, you should know what types of pre-existing boundaries may be available as alternatives. Three types are most common:

First, *a boundary between public and private property* often passes through saltwater wetlands. In all States, this boundary is fixed by reference to the tides, although the particular tidal reference varies from State to State. Thus, the boundary may be "mean high water" or "mean higher high water" or "mean low water." If you use this line as a boundary for saltwater wetlands in your local management program, you are likely to face two limitations. First, the line will probably be more difficult to locate than one based on vegetation (although vegetation may be used to help confirm tidal marks). Second, because the line is likely to pass through the wetlands, it will exclude parts of them from the protection they need. In a locality where neither of these limitations applies—that is, where the property line has already been precisely located and where public property includes all saltwater wetlands as indicated by salt-tolerant vegetation—you will probably find it most convenient to use the property line as your saltwater wetlands boundary.

Second, there may be a *pre-1972 boundary of Federal jurisdiction.* For many years, until 1972, the jurisdiction of the Corps of Engineers over development activities was limited to "navigable waters." During those years, the Corps often had occasion to fix the boundaries of its jurisdiction, particularly in places where someone wanted to build bulkheads or undertake other development. It is possible, though not likely, that a boundary fixed by the Corps during this period will prove helpful to a locality in establishing the boundaries of its saltwater wetlands.

Third, there may be *a post-1972 boundary of Federal jurisdiction.* Since post-1972 Federal jurisdiction is broad enough to include all saltwater wetlands, any such line is likely to be helpful. Because of manpower limitations, however, the Corps usually fixes these lines only on a case-by-case basis, so it is unlikely that such a line will have been fixed for all of your community's saltwater wetlands.

In addition to defining the wetlands boundary, you will need to establish a procedure for drawing the boundary in a specific location. There are two principal choices. You can try to draw boundaries in advance, by surveying, inventorying, and mapping. Alternatively, you can rely on case-by-case identification. Advance determination is the ideal, because it removes uncertainties that can affect both the community and private landowners. Advance determination is expensive, however, and is often impractical because of staff limitations. For these reasons, case-by-case determination is the more common approach.

Banks and Bluffs

4

The banks and bluffs that border many coastal waters are attacked by currents and waves, which may cause slumping and sliding. Water seepage from above may further weaken their stability. Because of this, bank and bluff tops can be hazardous sites for development.

Many wildlife species breed and sometimes live in natural bank and bluff habitats or in the edge-zones immediately behind them.[1] This gives banks and bluffs their ecological value. Because the same measures that help protect against the dangers of erosion and earthslides also preserve ecological values, banks and bluffs offer special opportunities for coastal environmental management.

To protect banks and bluffs and minimize hazards, your community will need to enforce construction setbacks and controls on such factors as water seepage and physical alteration. Beyond this, engineering techniques (structural retention) or natural means (vegetation) can be used to prevent damage and restore already damaged banks and bluffs. In managing these places of concern, you should pursue the following three policies:

17. ***Alteration of Bank- and Bluff-Top Danger Zones:*** *Avoid adverse uses of land adjacent to banks and bluffs.*
18. ***Alteration of the Slope:*** *Discourage activities that physically alter the face or toe of banks and bluffs.*
19. ***Erosion Protection for the Toes of Banks and Bluffs:*** *Encourage the use of natural means of protection or properly designed bulkheads to protect bank and bluff toes from erosion.*

Figure 1. At Malibu, on the California coast, plastic sheeting is used futiley in a last ditch attempt to save the Getty Museum from land slides. (Photo by John Clark.)

ECOLOGICAL FEATURES

Banks and bluffs occur in many formations and sizes. The formation will vary with composition, which can range from clay, sand, or unconsolidated rocks and sand to consolidated rock. Sizes range from the low banks along the shores of Maryland or Texas to the bluffs of the Great Lakes and the high cliffs of the Pacific Northwest. The Great Lakes and Chesapeake Bay states have extremely serious problems with banks that are being undercut by waves, while the Pacific Coast states have serious problems with sliding bluffs and cliffs (Figure 1). As used here, low banks are formations of 1 to 5 feet, high banks are 6 to 20 feet, and bluffs are higher than 20 feet.[2] The exposed surface of the bank or bluff is called a "face." The top is the "crown." The bottom is the "toe." Bank and bluff faces are vegetated only with hardy grasses and shrubs that can withstand constant wind, spray, and slope erosion. This vegetation reinforces slope stability. It also provides habitat for some types of nesting birds and burrowing animals.

Often, the most ecologically valuable part of the bluff or bank system is an upper edge-zone (an ecotone) where the top of the bluff changes abruptly into the inland landscape. When characterized by a strikingly different mix of trees and bushes, the edge-zone provides habitat conditions not found elsewhere on the coast and therefore attracts a special community of birds and wildlife. Bluff or bank tops that merge gradually inland, with a

barely perceptible edge-zone, may be of lesser ecological value.

HAZARDS

Bank and bluff recession is usually caused either by wave action at the toe or groundwater seepage into the face. The sequence of events is: (1) attack by waves and/or groundwater; (2) erosion, with material deposited at the toe; and (3) removal, transportation, and deposition of this material along the shoreline.[3]

Bluffs are protected from normal tides and waves by a beach berm and debris such as piles of logs. But storm surge, storm waves, and tsunamis hitting high on the beach can pull the barriers away, loosening the bluff and exposing it to future hazards until the barriers reform. If waves are large enough, some forms of debris (logs, for instance) can accelerate the erosion process by digging at the bluff face. While erosion of the toe is the most common cause of mass slippage, other causes include the added weight and lubrication of water seeping into the bluff structure or the addition of weight from material deposited along the upper edge of the slope.[4] Banks are eroded by similar, but less violent, processes.

If the bluff is actually the seaward end of a large slide, then the whole slide area behind the crown of the bluff should be considered as potentially unstable. Indeed, this instability is a special concern because not only does the exposed face slide, but the land surface atop the bluff, stretching inland for perhaps a quarter of a mile or more, may also move. Indicators of the slide area include fractures in the earth, slope failure, snapped trees, and leaning trees, fence posts, or power lines, all of which are indicative of recent earth movement.

MANAGEMENT POLICIES

A coastal community must give serious attention to protecting its banks and bluffs with local land-use measures because there is very little in the way of Federal or State intervention. Your community should develop criteria for construction and other uses near the bank or bluff crown and on its face. It should also support general programs of erosion and slide prevention.

Recommended Policy 17: Alteration of Bank- and Bluff-Top Danger Zones.

Avoid adverse uses of land adjacent to bank and bluff tops.

How you use the land immediately behind the crown of a bank and bluff is especially

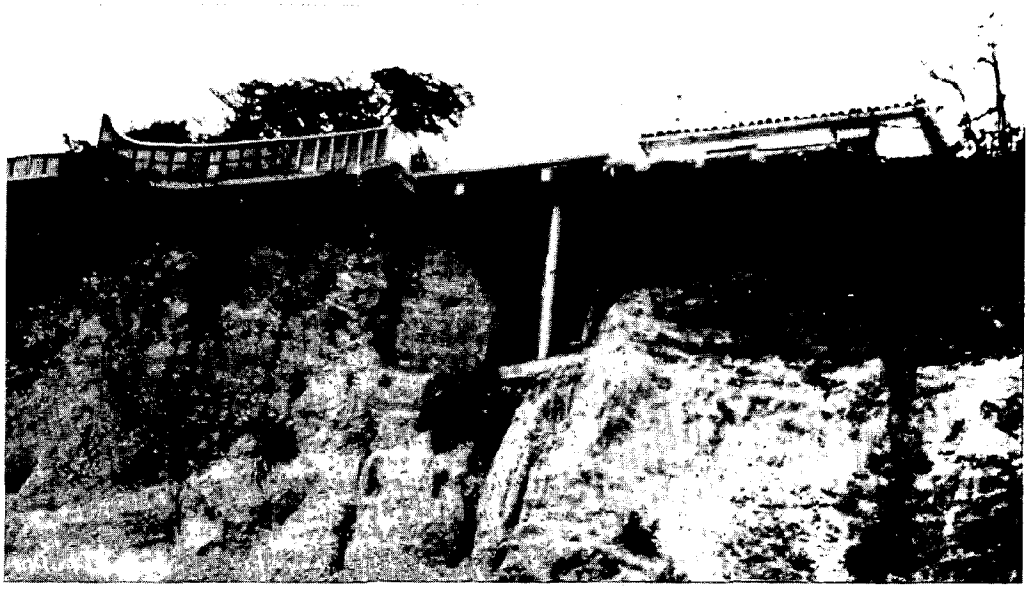


Figure 2. Because of careless development, the cliffs of the California coast cave in regularly, blocking the highway (which runs below bottom of picture) and destroying structures. (Photo by John Clark.)

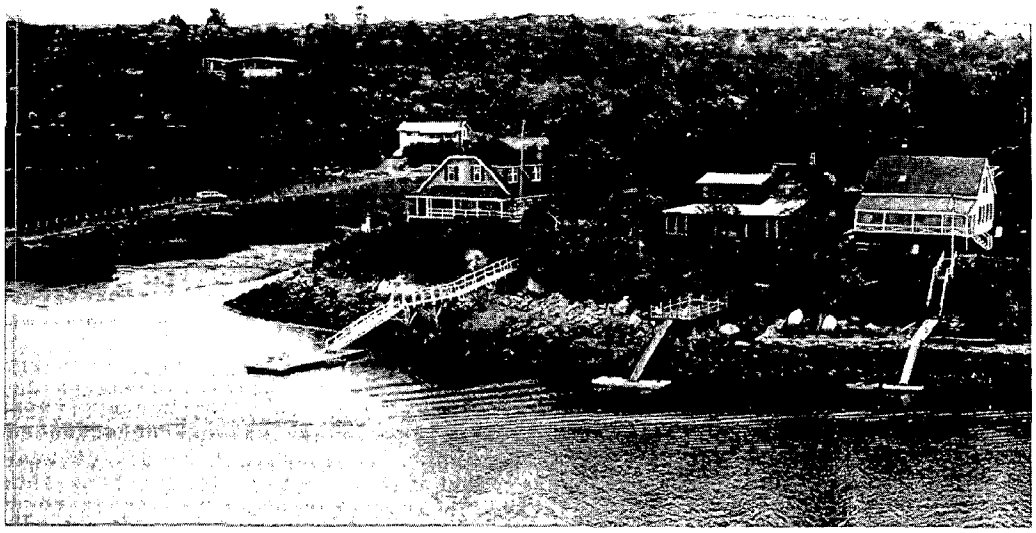


Figure 3. With sufficient knowledge and care, shoreline homes can be safely built behind bluffs or banks. (Photo by M. Fahay.)

important. If you keep this area natural, slope stability generally is fostered. If you allow great alterations by clearing, building, or plowing, the whole bank or bluff may be destabilized.

Losses of bluffs and high banks to slides are often caused by adding weight to the area behind the crown or by cutting into it. For example, a deposit of fill during highway construction can initiate slippage. When the bank or bluff face slips or caves in, structures built close to the edge are imperiled and valuable property is lost (Figure 2).

Where land is cleared to the edge of the slope for building, landscaping, crop planting, or other purposes, the risk of bank erosion by accelerated infiltration of surface water is increased. The combination of weight and the lubrication of the soil (particularly clays) by water may result in slumping. Septic-tank seepage and storm-water ponds in the edge-zone may also cause problems. To protect existing structures from slippage, the saturation of banks and bluffs can be reduced by diverting water away from the crown areas with drain tiles or similar systems.

As one of its key management objectives, your community should make sure that all new structures are placed behind the vulnerable areas of banks and bluffs. This will minimize the threat to upland property, reduce the need for and cost of bulkheading, and protect the valuable edge-zone habitat. The best policy is to require a setback that provides a wide buffer strip of natural vegetation and soils immediately behind the crown of the bank or bluff. The buffer will both provide for slope stability and protect an ecologically valuable edge-zone. Use of this area should be light, i.e., limited to what is compatible with maximum protection of the bank or bluff slope.

Along shores where there has been a long-term rise in the water level—for example, the Chesapeake Bay and the Great Lakes—erosion and bank recession can be expected to continue to increase in severity. You can address this problem by determining a predictable rate of recession, drawing a future "recession line" (the expected location of the crown 50, 60, or 70 years in the future), and then locating structures far enough behind the line to be safe for their predicted economic lives (Figure 3).

Coastal slides and erosion have long been recognized as problems in siting buildings. For example, in the 1790s George Washington reportedly studied the erosion of the Long Island coast. He ordered that the Montauk Point lighthouse at the eastern tip be built at least 200 feet back from the edge of the cliff so the lighthouse would last 200 years. At the present rate of erosion, it will last just

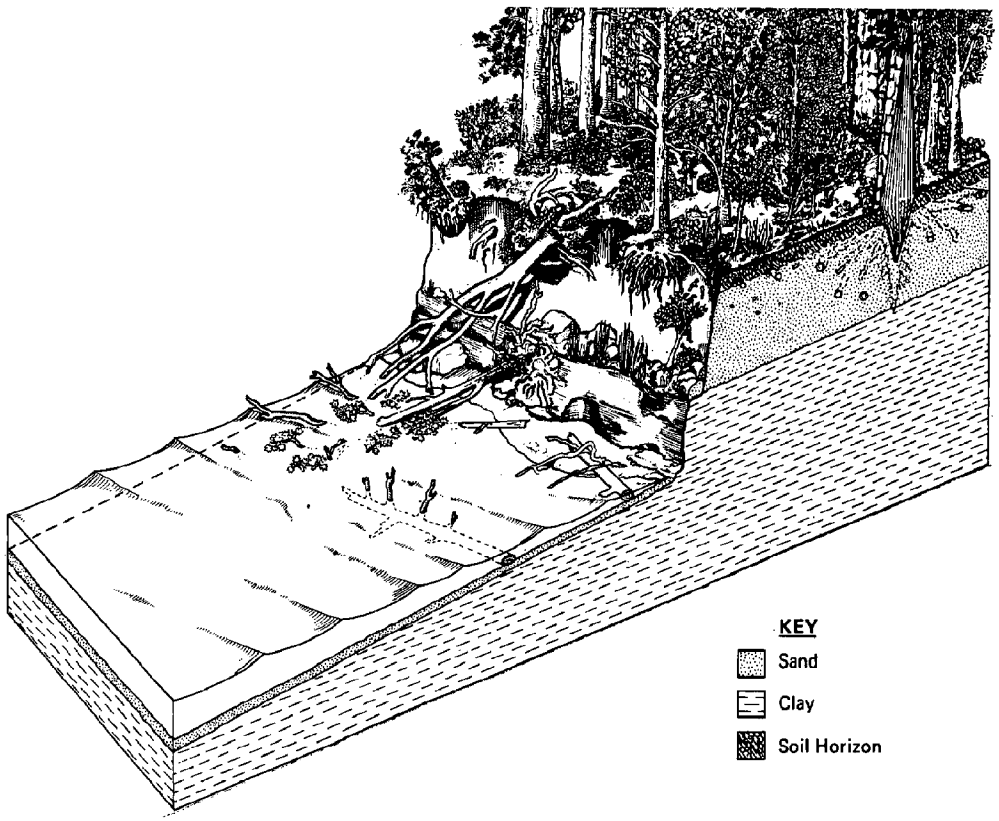


Figure 4. With the sea level rising gradually along the U.S. coastline, erosion of estuary banks is a relentless process. Strong waves undercut the bank, causing earth and trees to slump into the water, where they eventually are carried off by tides and currents. (Source: V.G. Bellis, M.P. O'Connor, and S.R. Riggs, *Estuarine Shoreline Erosion in the Albemarle-Pamlico Sound Region of North Carolina*, Publication No. UNC-SG-75-29 [Raleigh, N.C.: University of North Carolina, Sea Grant Program, 1975].)

about that long; as of 1978, fewer than 40 feet remained between the base of the lighthouse and the edge of the cliff.[5]

Recommended Policy 18: Alteration of the Slope.

Discourage activities that physically alter the face or toe of banks and bluffs.

Disturbing the face or toe of a bluff or bank may cause destabilization, slides, and cave-ins. Removal of the vegetation that helps to stabilize the face, or excavation along the face, increases the chance of slumping. When the bank or bluff slumps, structures are imperiled, adjacent land is lost, the ecological edge-zone is disrupted, sediment is added to the coastal basin, and any marsh fringe that is there may be obliterated. Removing the rubble and debris that accumulates at the toe often results in a greater potential for erosion and subsequent slides.

Your best alternative is to encourage slope conservation practices and to discourage activities that destabilize the slope through removal or unnecessary disturbance of bank or bluff vegetation or physical alteration. Many communities along the Oregon coast have implemented conservation practices in areas that are already inhabited. For example, on the slopes of Tillamook Head, property owners who allow brush and grass to flourish have had little trouble with slippage or destruction of stairs or structures. Even in the very soft terrace sands of Lincoln City, attempts at planting to stabilize slopes have helped ease erosional problems. Extensive planting of grass on unconsolidated sands along the beach at Salishan is also helping to hold steep slopes.[6]

With precautions, owners can install appropriate stairways and other minor fixtures on slopes and use properly designed and located retaining structures. It is the

building of homes or commercial structures on cliffsides or the faces of banks and bluffs that should generally be prohibited.

Recommended Policy 19: Erosion Protection for the Toes of Banks and Bluffs.

Encourage the use of natural means of protection or properly designed bulkheads to protect bank and bluff toes from erosion.

Structural means of protecting against erosion are often used as a remedy where wave action along the shore is strong and the bank or bluff is undercut by the toe (Figure 4). Usually, bulkheads or seawalls built specifically for the purpose are placed at the base of an eroding slope to stop the undercutting and stabilize the slope. A major exception may be made where the beach exists only because of continual depositing of sand and gravel from bank erosion, which is the case, for example, in parts of Puget Sound. Where such "feeder bluffs" exist, you may find that it is better to relocate endangered buildings than to secure the bluff with structures that cut off the supply of sand to the beach. In any event, you should avoid placing bulkheads out in the water and backfilling them to gain land at the expense of wetlands or productive shallow-water habitat (Figure 5).

Riprap (stone work) is often the easiest and least costly technique for toe protection. Its advantages are augmented by its high permeability and other ecological benefits. Groundwater and runoff can move unimpeded through the structure, including both filtercloth and crushed-rock backings used with advanced riprap structures such as revetments.

In many cases, the costs of stabilizing low banks can be reduced by regrading the shoreline and planting salt-marsh

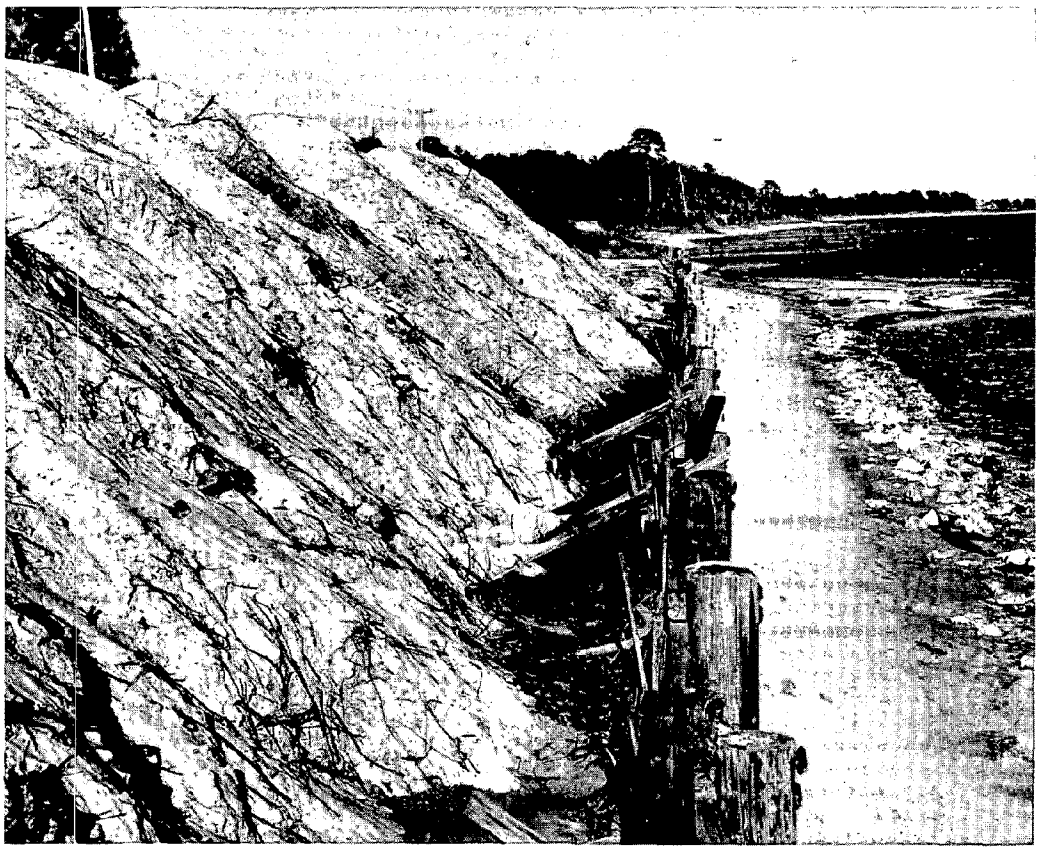


Figure 5. Attempts to extend the land into water bodies with fill and bulkheads should be avoided; there will be continuous maintenance needs and often washouts, with damage to roadways and structures. (Photo from Apalachicola Bay, Florida, by John Clark.)

grasses, mangroves, or other vegetation in the tidal zone and by revegetating the face of the bank. A vegetative retainer may be ecologically and aesthetically preferable to an engineered structure because it creates a more biologically productive shoreline and a more pleasing appearance.

IMPLEMENTATION GUIDELINES

To implement the policies on banks and bluffs, your community will have to address two principal management needs:

First, **establishing a setback from the recession line,** in accordance with Policy 17 (Alteration of Bank- and Bluff-Top Danger Zones).

Second, **establishing standards for protective structures,** in accordance with Policies 18 (Alteration of the Slope) and 19 (Erosion Protection for the Toes of Banks and Bluffs).

1. Establishing a setback from the recession line.

To implement Policy 17, your community must assure that future development is set back, not just from the present edge of banks and bluffs, but from an anticipated future edge—the recession line. If erosion data and analysis are available, the recession line can readily be determined and the setback requirement can then be incorporated in zoning, subdivision, building-code, or other local development controls.

Establishing a setback from the recession line presents four principal problems to communities:

First, to calculate a recession line, you must have extensive data. The location of the line depends on natural processes but it can be affected by protective works and other shorefront alterations. You need a high level of technical expertise to delineate it. Perhaps State agencies can supply the necessary data. Michigan, for example, has calculated a recession line for portions of its Great Lakes shores.[7]

Second, you will need to change the recession line from time to time. A setback established in 1940 or 1950 may no longer be adequate in 1980. The line may have to be repositioned every 5 or 10 years.

Third, your community must decide how long the setback should provide protection. Often, the location of the line is fixed by reference to the "expected life time" of new buildings—perhaps 30, 67, or 100 years.

Fourth, there will often be "nonconforming" buildings (located within currently predicted recession lines). Also, there will often be "unbuildable" lots (no longer large enough to permit construction of a residence). Some communities prohibit construction or reconstruction in such situations. Strict regulation of this sort is likely to raise objections from property owners and may require nonregulatory management approaches, as discussed in the Floodlands section at p. 33. Without strict regulation, however, communities will almost inevitably be asked in the future to provide public funds for expensive shore protection works.

In establishing a setback from the recession line, your community should consider two Federal programs:

The National Flood Insurance Program. In areas defined by the National Flood Insurance Program (NFIP) as erosion zones ("E" zones), Federal regulations require a "setback for all new development . . . to create a safety buffer consisting of a natural vegetative or contour strip." The regulations require the community to limit this setback area to open-space uses and temporary and portable structures. In participating communities, owners of threatened structures in "E" zones may obtain inexpensive insurance against flood-related erosion damage. Setback lines may be more acceptable if it is understood that they are required by Federal regulations which are part of an attractive insurance package. The Federal regulations can thus provide strong support for community efforts to establish setback lines.

In practice, the NFIP has had difficulty defining "flood-related" erosion damage for insurance purposes. Since it is difficult to distinguish "flood-related" erosion, which is covered by the NFIP, from other erosion, which is not, the NFIP is clarifying its eligibility criteria for insurance coverage.

Coastal Zone Management. State coastal zone management programs (see p. 36) are required to identify erosion-prone areas. This may help you with your local regulatory efforts. In Michigan, for example, the State identifies two classes of erosion-prone areas according to the rate of erosion. In

areas where erosion is severe, Michigan provides technical information to facilitate establishment of locally enforced setbacks. In the absence of local cooperation, Michigan law permits the State to enforce minimum standards.

2. Establishing standards for protective structures.

Your community may wish to build, or allow property owners to build, seawalls or other protective structures. Demand for such structures is often intense, even though many are not cost effective (they cost more than the value of the protected property in the long run), and many have side effects that will injure adjacent shoreline areas.

Standards for privately built structures can be incorporated in local building codes. Your community standards should be compatible with the standards of the Corps of Engineers permit program (see p. 67), which evaluates permit applications for structures in navigable waters. The U.S. Fish and Wildlife Service may be able to help you minimize environmental damage caused by such structures (see p. 68).

It is important to remember that these structures are unlikely to provide protection against the greatest storms. In some cases, they will provide light protection against seasonal high waters, but with severe storms and flooding they will wash out.

In setting standards for shoreline protective structures, your community may want to consider the *Small Beach Erosion Control Projects* program of the U.S. Army Corps of Engineers. In addition to the beach erosion control projects that it is authorized to construct on an individual basis by the Congress, the Corps of Engineers has a general authorization to undertake construction of small restoration and protection projects.[8] When periodic beach nourishment is part of the best plan for an area, this practice can be recommended for funding by the Corps. The individual Corps of Engineer District offices are the points of contact for help in these matters. You can also contact them for technical information on shore and streambank erosion and for assistance in dealing with it.[9]

Dunelands 5

Dunelands—the area of dunes, sand ridges, and flats between the beach and higher ground—are a unique natural habitat; they are also highly susceptible to storm damage. At the ocean's edge, land has a quality of impermanence. Some sandy shorelines are continually eroding and receding. Often, however, the damage is more sudden—just one hurricane may carve away an entire lot and all that is on it.

While the risk of building directly on the beach is obvious, the risk of building in the dunelands behind the ocean beach, where buildings are directly in the path of storm-driven waves, may not be apparent. Active dunelands, like beaches, are uncertainly balanced between the erosive forces of storm winds and waves, on one hand, and the restorative powers of tides, winds, and currents, on the other, making dunelands a risky place in which to have a home (Figure 1).

Dunelands need to be protected so that they may continue to buffer the force of storm seas, store and yield sand to protect beaches and shorelands, and furnish turtle and bird nesting areas and valuable habitats for certain wildlife species. Your community's major management needs for dunelands will include setbacks, construction standards, excavation restraints, and traffic control, as recommended in the following four policies:

20. ***Excavation in Dunelands:*** *Prohibit excavation and removal of active dunes and beach ridges.*
21. ***Alteration of Dunes:*** *Prevent disturbance of dunes and dune vegetation by restraining traffic over dunelands.*
22. ***Location of Structures:*** *Build all structures landward of active dunes.*
23. ***Dune Restoration:*** *Encourage private and public projects to restore and stabilize dunes.*

Figure 1. Dunes should survive all but the largest storms. Even with maximum care to trap and hold sand with fencing, these homes at Avon, New Jersey, could be damaged by a hurricane. (Photo by John Clark.)

ECOLOGICAL FEATURES

Dunelands include the active dunes, sand ridges, troughs, and flats lying behind the beach berms that mark the upper limit of the "dry beach." Bounded at their seaward edge by the upper line of the beach at the annual highest tide mark, or a coinciding "vegetation line," the dunelands extend landward as far as the land is subject to active gain or loss of sand because of the sea or sea wind. The duneland area may be quite narrow or may extend many hundreds of feet.

An active dune is one that is mobile, or in the process of visibly gaining or losing sand. The active dune is vegetated mostly with grasses; the stabilized dune, with shrubs and woody vegetation. There are various forms of dunes and sand ridges (flatter, dunelike features). In the most common formation, one or more long dunes or ridges run parallel to the beach (Figure 2). The dune closest to the beach is termed the "foredune," or the "frontal" or "primary" dune; those behind it are called "secondary," "rear," or "back" dunes. Secondary dunes may be active or stabilized. In some places, there is an "erosion scarp" (a formation characteristic of receding beaches) rather than a dune or sand ridge. Duneland areas that do not have pronounced dunes or ridges and are peri-

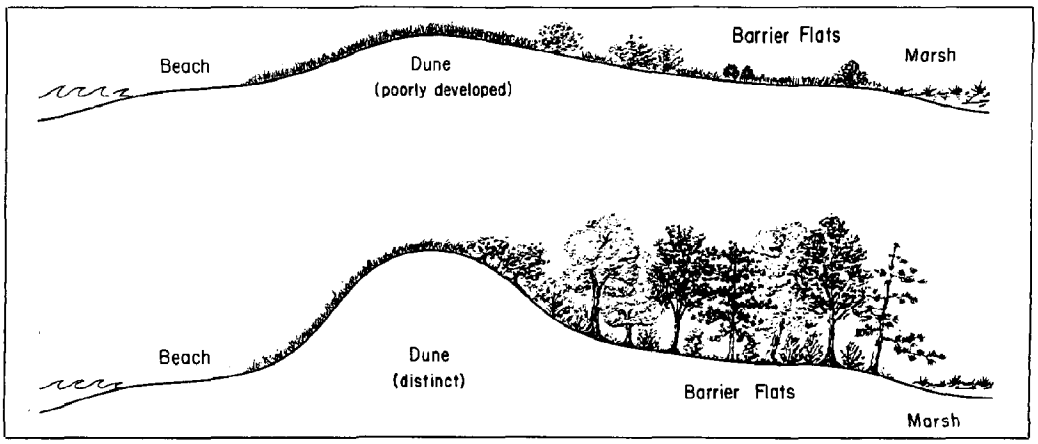


Figure. 2. These cross-sections of a barrier beach illustrate changes in vegetation due to differences in dune structure. The "poorly developed" dune is rebuilding from a storm or is being kept flat by erosion and overwash. (Drawing by Michael Mow from Stephen P. Leatherman, *Barrier Island Handbook* [Amherst, Mass.: University of Massachusetts, Environmental Institute, National Park Service Cooperative Research Unit, 1979].)

odically flooded by the sea and covered with sand are called overwash areas; normally, they lack established plant communities.

A specialized group of hardy plant and animal species occupies the dunelands environment, either temporarily or permanently. Many birds and small animals rest, nest, or feed there. For example, sea turtles nest in the dunelands and back beach, as do least terns and plovers. There are some permanent occupants such as ghostcrabs. Some species of mammals range out onto the dunelands from their primary inland habitats.[1]

The plant species of dunelands are well adapted to the shifting sands of the mobile dune ridges. The foredunes, directly exposed to the full force of the wind, with shifting formations that result from that exposure, have the least vegetation. The backdunes are less exposed and offer a more stable environment for vegetation.

HAZARDS

People are often inclined to build on dunelands to gain a seashore ambience. Occupation of this narrow strip of a hundred or a few hundred feet, however, may exact high costs in property losses and human lives; the enormous sums of private and public money spent to stabilize and safeguard the coast are rewarded too rarely with long-term success. The problem of beach recession is intensified by a relentless rise in sea level along the U.S. coastline (one-half to one foot or more per century), which is slowly pushing the sea onto the land (Table 1).

While dunes and sand ridges provide a useful barrier to storm waves and surges, their primary function in protecting against hazards is to replenish sand that is slowly eroded by waves or instantly torn away by large storms and hurricanes. In this way, dunes foster long-term stability of the shorefront by retarding beach recession. The resilient and mobile character of the dune make it an optimum natural structure for protecting the beach and man-made structures built behind the dunelands.

Dunes offer short-term protection as well. Much of the sand carved from the dunes by storm waves is deposited immediately on the submerged, nearshore portion of the beach. This deposit builds up the lower beach and the bar that lies submerged below the low-water mark. The additional sand helps to break the storm waves, thus dissipating their energy and weakening their attack on the beachfront.

After a storm has passed, the dune is restored with new beach sand carried to it by the wind and secured by dune vegetation. Most dune plants grow rapidly and spread by forming runners or underground root systems. As vegetation increases, the dune becomes more stable and has no significant loss or gain of sand until severe storm waves again carve away the protecting beachfront[2] (Figure 3).

You should treat dunes as fragile resources; they are vulnerable to loss of the

vegetation that binds them together and to erosion of their surface. Construction in dunelands, traffic over them, or removal of their sand-fill invites erosion and storm damage problems.

MANAGEMENT POLICIES

One of your community s management objectives for dunelands should be to keep active dune and overwash areas intact and undisturbed. This means minimizing the disturbances to vegetation and to the duneland's sand system. Public access to the beach, a social-equity issue, is not addressed directly in this guidebook. Physical access, however, must be considered in duneland management. You must have provisions for traversing the dunelands by vehicle or on foot, and this access must be controlled to prevent damage. For example, off-road vehicles should be prohibited from dune systems that are sensitive to vehicle-induced erosion.

A second management objective is to place permanent development well inland of the active part of the dunelands. A construction setback can be adjusted to the particular circumstances, but your community will do best by ensuring that any new development is placed entirely landward of active dune ridges. Wherever a beach is receding because of erosion, it is important to predict the position of shoreline some years ahead and to establish a recession line to govern the setback distances. The setback line should be far enough landward of the predicted recession line to provide for the future location of the beach and dune system.

Recommended Policy 20: Excavation in Dunelands.

Prohibit excavation and removal of active dunes and beach ridges.

Dunes and sand ridges have often been demolished in the course of development, leaving beachfront communities unprotected and leading to depletion of beaches. Dune deposits have even been used as a source of beach fill, although the U.S. Army Corps of Engineers has warned that dune deposits "must be used with caution to avoid exposing the area to flood hazard."[3]

Because the total sand storage capacity of dunelands is a vital component of duneland and beach stability, in most circumstances any significant reduction of the duneland sand stores by grading or excavation should be considered unacceptable, except on rapidly accreting shores. Removal of dune sand from the active duneland system for fill, construction aggregate, or other uses should normally be prohibited (Figure 4).

Northeast Coast	Change in Sea Level (cm/ decade)	(ft/ century)
Portland, Me.	1.62	0.53
Portsmouth, N.H.	1.65	0.54
Boston, Mass.	1.07	0.35
Woods Hole, Mass.	2.68	0.88
New London, Conn.	2.29	0.75
New York City	2.87	0.94
Sandy Hook, N.J.	4.57	1.50
Atlantic City, N.J.	2.83	0.93
Annapolis, Md.	2.87	0.94
Hampton Roads, Va.	3.20	1.05

Southeast and Gulf Coast	Change in Sea Level (cm/ decade)	(ft/ century)
Charleston, S.C.	1.80	0.59
Fort Pulaski, Ga.	1.98	0.65
Fernandina, Fla.	1.25	0.41
Mayport, Fla.	1.55	0.49
Miami Beach, Fla.	1.92	0.63
Key West, Fla	0.73	0.24
Pensacola, Fla.	0.40	0.13
Eugene Is., La.	9.05	2.97
Galveston, Tex.	4.30	1.41

West Coast	Change in Sea Level (cm/ decade)	(ft/ century)
Juneau, Alaska	-13.05	-4.28
Sitka, Alaska	- 2.04	-0.67
Ketchinkan, Alaska	0.30	0.10
Seattle, Wash.	2.59	0.95
Astoria, Ore.	- 0.91	-0.29
Crescent City, Calif.	- 1.34	-0.44
San Francisco, Calif.	1.92	0.63
Los Angeles, Calif.	0.43	0.14
La Jolla, Calif.	1.92	0.63
San Diego, Calif.	1.43	0.47

Table 1. Apparent trends in sea level for the United States. (Source: Modified from S.D. Hectis, "On the Classification and Trends of Long-period Sea Level Series," in *Shore and Beach*, April 20, 1972).

Figure 3. Dune grasses capture sand blown by the wind and bind it with their roots to build sand dunes. (Photo of Ocean Shores, Washington, by John Clark.)

Figure 4. Excavation of sand dunes to obtain fill, level the land surface, or provide a view should be prohibited in most cases to protect the shoreline, structures, and human life during storms and floods. (Photo by John Clark.)

Recommended Policy 21: Alteration of Dunes.

Prevent disturbance of dunes and dune vegetation by restraining traffic over dunelands.

Dunes and beach ridges protect beachfront property and, therefore, your community should preserve them in their best functional condition. This requires protection of the vegetation that binds the dune together. Vegetation that grows on shifting dunes is adapted to withstanding the rigors of wind, sand, and salt, but not human feet, vehicles, or herds of grazing animals. Even slight alterations of dune formations, such as minor erosion or displacement of vegetation, may lead to significant dune loss. Once a frontal dune is worn down by vehicles or foot traffic or by consequent loss of vegetation, it may be eroded by wind or wave action and no longer serve its unique protective role.

You can protect dunes by limiting access to the beach to elevated steps and boardwalks over dunes and sand ridges. Traffic anywhere on the frontal dune system should be prohibited. You can also use control points, where dune damage from vehicular and pedestrian access to the beach is confined and minimized. In instances where damage from livestock has occurred, fences may have to be erected to keep grazing animals off the dunes. In addition, duneland habitats of shore species should be protected by temporary restriction of any entry during critical nesting or breeding seasons.

There is much room for local ingenuity in meeting duneland problems. For example, Howard T. Lee of the Texas Coastal and Marine Council reports: "... regarding pedestrian traffic in dunes, a very elemental reason for such traffic is the need for privacy. The City of Port Aransas has greatly reduced that need on Mustang Island by placing portable toilets at intervals along the beach. It costs a bit of cash, but it does serve a need and seems to be effective."[4]

Recommended Policy 22: Location of Structures.

Build all structures landward of active dunes.

Because dunelands offer the best ocean view and the most convenient beach access, they are often proposed as the site for residential building projects. Buildings will be placed astride a dune, or the dune bulldozed away to make a site level or to provide a better view of the sea. This forecloses the protective values of the dune, not only for the owners of the structure but also for neighboring property owners.

To ensure that structures are properly located, your community should: (1) prohibit homes or other buildings on active dune areas and (2) prohibit alteration of active dunes when a site is being prepared and developed. At the very least, you should have performance standards that do not permit any alteration of dune structure or function. Building on dunes or lowering them will often not be necessary to obtain a view, since structure-elevation requirements imposed as a condition of Federal flood insurance usually result in first floor windows being elevated above the dune top.

Where beaches are receding because of erosion, your community should extend its preservation policy to the dunelands of the future. That is, if the shoreline will recede, say, 150 feet in the next 50 years, the community should plan as though the dunelands are *now* 150 feet inland of their present position. This is done by: (1) predicting a recession line, (2) placing the setback line at an appropriate distance behind it, and (3) requiring all new development and public facilities to be located behind the setback (Figure 5).

A less satisfactory but still useful solution, in cases where parcel configuration does not permit the suggested setback, is to allow buildings to be erected in the area of active dunes but to apply tight performance standards so that design and construction activities will not result in any significant functional alteration of the dunelands.[5] Structures should be elevated above the dunelands on deep anchored piles, and filling and general clearing, grading, and paving of the site should be prohibited (Figure 6).

Recommended Policy 23: Dune Restoration.

Encourage private and public projects to restore and stabilize dunes.

Revegetation programs and simple structures such as snow fences are inexpensive and effective methods by which individual property owners or groups in your community can help to restore dunelands. Replacement dunes should be built above the high-tide line, and on slopes that face the ocean. In some areas, through the use of fencing, dunes four feet high or more may be built

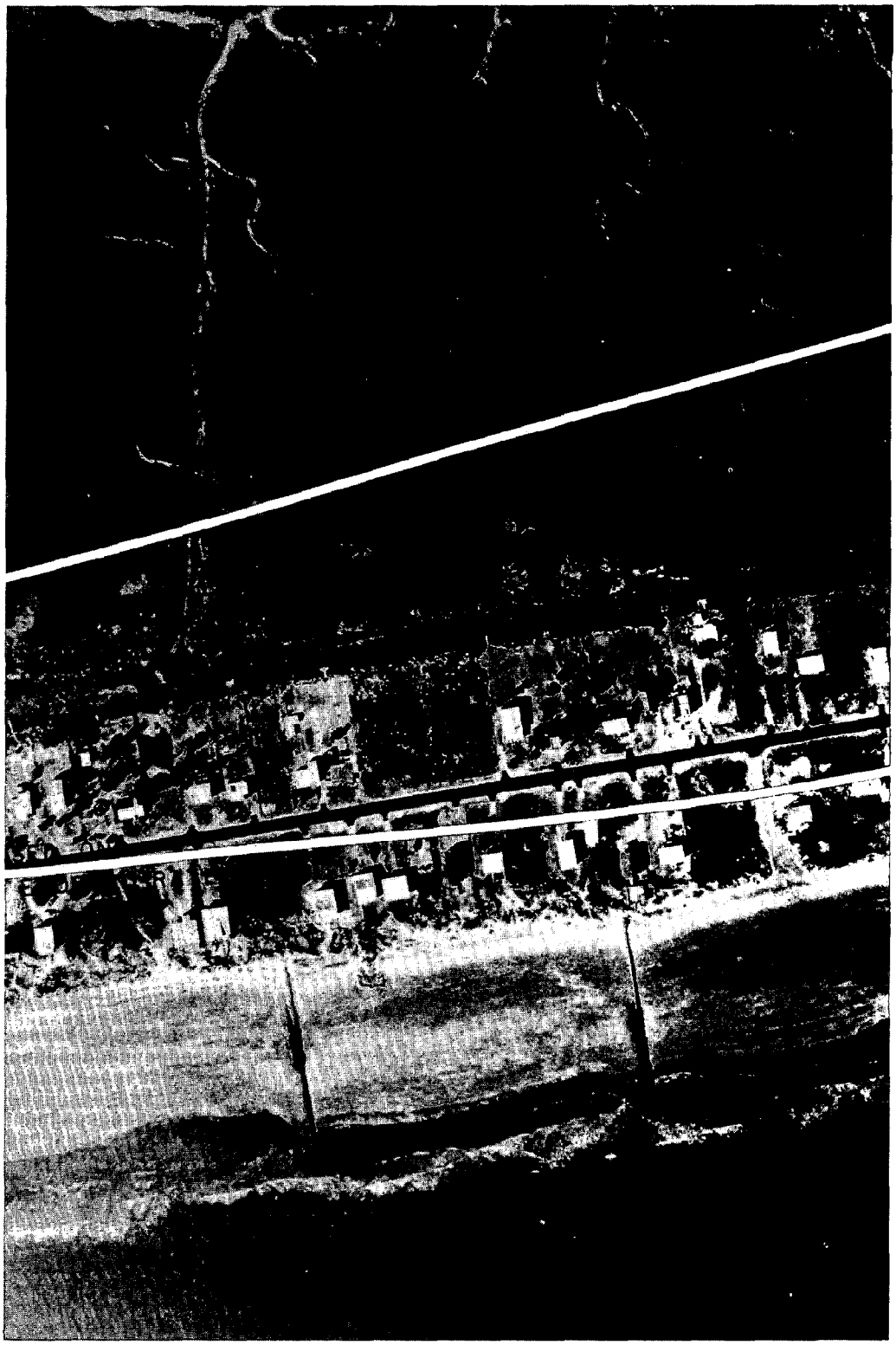


Figure 5. Folly Island, South Carolina, where the sea is predicted to recede within 50 years to a position somewhere between the two recession lines marked on the photograph. Many or all of the homes will be destroyed. The recession line was calculated by the Corps of Engineers. (Source: U.S. Army Corps of Engineers.)

in less than a year, whereas in other places this growth may take several years.[6] You should beware of building dunes too high. Attempts to build dunes to unnatural heights or in unnatural configurations can be counterproductive. Such structures may interfere with rather than facilitate natural geologic processes.[7]

Many community dune restoration projects have proved effective and economical, and have aesthetically enhanced the local beach environment. For example, on Sanibel and Captiva Islands, Florida, three man-made dune lines were successfully planted with sea oats, railroad vine, and sea cucumber. After a year and a half, the plantings established a first-line defense against major flooding and property damage. The dunes withstood heavy storms during the winter of 1978, holding the beach and protecting adjacent property.[8]

IMPLEMENTATION GUIDELINES

Each of the four policies for dunelands presents a different management issue.

First, **controlling excavation in dunelands,** in accordance with Policy 20 (Excavation in Dunelands).

Second, **controlling vehicles and pedestrian traffic on active dunes,** in accordance with Policy 21 (Alteration of Dunes).

Third, **establishing a setback from the recession line,** in accordance with Policy 22 (Location of Structures).

Fourth, **restoring dunelands,** in accordance with Policy 23 (Dune Restoration).

1. Controlling excavation in dunelands.

Your community may control excavation in active dunelands in two principal ways:

—Local zoning and building regulations can require special permits for excavation accompanying construction in dunelands.[9]

—Local regulations can control sand mining that would increase the vulnerability of adjacent properties to hazards.

In seeking to control duneland excavation, your community may encounter two problems:

First, in some coastal areas, identifying active dune areas may be difficult. Some communities are content to protect the first or primary dune; others protect adjacent secondary-dune ridges as well. For accurate definition, you will need technical assistance from a geologist or engineer familiar with beach processes.[10] This help may be available from your State or through the Corps of Engineers.

Second, property owners may argue that strict regulation of sand mining exceeds lo-

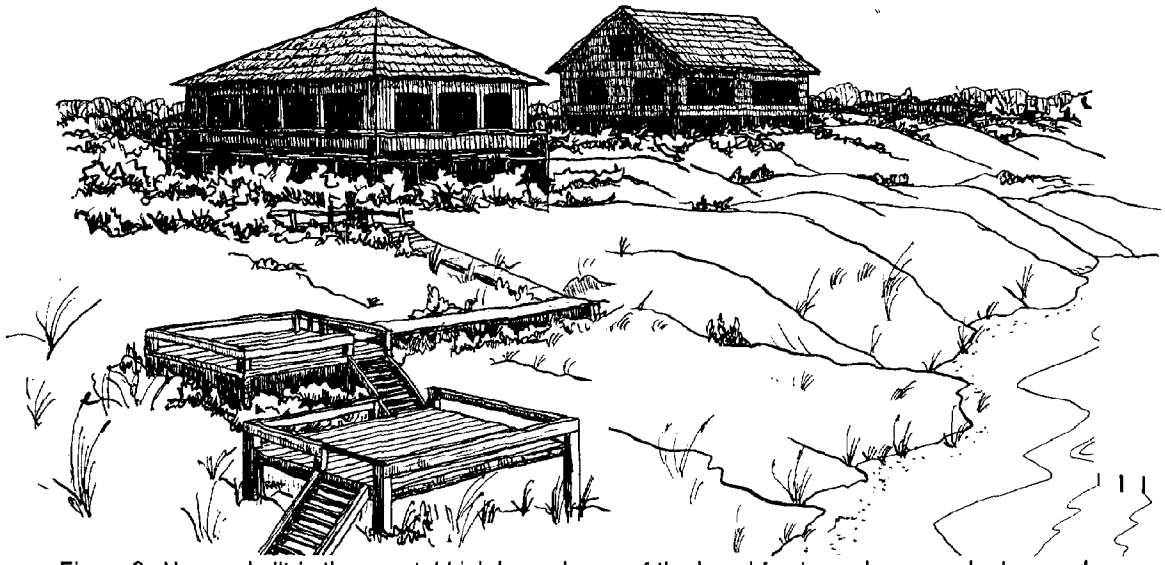


Figure 6. Houses built in the coastal high-hazard area of the beachfront may be severely damaged by wave impact even though they are elevated on pilings to the flat-water level of flooding. (Drawing by Ruth Ann Hill.)

cal statutory or constitutional authority. This is especially likely to be a problem in the absence of good data to identify environmental and hazards-protection needs, and thereon establish the need for strict controls.[11]

Two federally sponsored programs may prove helpful to your community:

National Flood Insurance Program. The National Flood Insurance Program (NFIP) (see p. 38, 47) has established special requirements for high-hazard areas—those areas identified on a Flood Insurance Rate Map (FIRM) as subject to frequent and dangerous flooding. These areas, referred to as "V" zones, often include dunelands because the strong natural forces and exposure to the sea that result in dune creation also make duneland areas likely to bear the brunt of ocean storms and hurricanes.

The NFIP requires that fill (often taken from dunes) not be used to elevate buildings in "V" zones. Your community can meet this requirement with a provision calling for elevation of new structures on pilings. This kind of provision should be applied behind active dune areas and should be coupled with a requirement for revegetation after surface alteration.

Another requirement for "V" zones "prohibit[s] man-made alteration of sand dunes ... which would increase potential flood damage." This requirement can provide important support for communities trying to protect their dunes.

Coastal Zone Management. State coastal zone management (CZM) programs (p. 36) may include policies for dunelands or may identify active duneland areas as "areas of particular concern." If so, special technical assistance or State regulations may be available to support your local efforts to conserve dunelands. In addition, if the State CZM program has been approved by the U.S. Department of Commerce, the activities of Federal agencies must be "consistent" with the program.

2. Controlling vehicles and pedestrian traffic on active dunes.

In its efforts to protect active dunes, your community might deal with pedestrian and vehicle traffic in the following ways:

—Pedestrian access to the beach across active dunes can be limited to wooden walkways or similar structures in either dune-protection or regular development-control regulations. This may be complemented by State regulations prohibiting destruction of dune vegetation such as sea oats or dune grasses.[12]

—Local traffic-control regulations may prohibit vehicle traffic from dunes, limit it to the "wet sand" area of the beach only, and establish speed limits.[13]

—Local policy may assist duneland owners in excluding trespassers, whether on foot or in dune buggies, from private land.

Two types of problems may arise when your community tries to regulate dunelands:

First, it will be necessary to coordinate local policies and regulations with State regulations (and Federal regulations for public lands), which often address one or more aspects of this issue—for example, speed limits on the wet sand beach, or protection of key duneland plant species.

Second, off-the-road vehicles, such as dune buggies, may be difficult to control. Local regulations should provide clear guidance for vehicle users and enforcement authorities. In practice, however, clear rules are often politically difficult to fashion as well as difficult to enforce.

Except for Federal public-lands management, no Federal programs directly address the use of dunelands. A State coastal zone management program may be a helpful non-local source of advice.

3. Establishing a setback from the recession line.

The recession line identifies an area likely to be severely eroded over a given period of time (e.g., 30 years). Where the data and analysis are available to your community, a setback from the recession line is relatively easy to incorporate in local building, zoning, and subdivision controls. This management issue is similar in most respects to establishing a setback for Banks and Bluffs (see p. 78). One special problem in the application of the National Flood Insurance Program (NFIP) requirements may arise because the higher dunes (above the estimated 100-year flood elevation) may be omitted from the Flood Insurance Rate Map (FIRM). On some FIRMs, however, these dunes will be designated as erosion ("E") zones (see p. 47). In any event, all parts of these dunes that are subject to predictable flood-erosion forces, regardless of elevation, should be treated as if they were located in hazardous "V" zones.

You should also recall that all new habitable structures in dunelands should be elevated in accordance with the recommendations for floodlands (see p. 27), preferably on pilings.

4. Restoring dunelands and adjacent beaches.

Even where dunes have been significantly damaged, specific restoration projects are not always needed. If Policies 20 through 23 are implemented, and if existing development does not stand in the way, the natural system itself will restore dunes and beaches.

Sometimes, however, beach and duneland restoration projects are needed, in keeping with Policy 23. Your community may undertake these projects, but that is costly; often you may want to seek other solutions.

The U.S. Army Corps of Engineers is the principal source of Federal assistance to a locality that wants to restore dunelands and beaches. The Corps may nourish beaches or build protective structures. A relevant Corps program is the Small Beach Erosion Control Projects, discussed at page 79. If Corps assistance for restoring a recreational beach is obtained under this program, the beach must be open to the public.

In some places, special Federal or State programs also provide assistance for duneland and beach restoration. The State office of coastal zone management should be able to help you identify these opportunities.

Beaches 6

Beaches serve as the main protective bulwark for property along the shores of oceans and large sounds (Figure 1). Most beaches can absorb heavy surface use, including the vehicle traffic so common in parts of Washington, Texas, and the Carolinas. But beaches are also fragile. If you allow removal of sand, improper building, or blocking of sources of sand replenishment like "feeder bluffs," the beach may be severely damaged or obliterated. Many prime beaches have been (Figure 2). Miami's once wide and beautiful beach has been reduced to fragments. The probable cost for repair is about 60 million tax dollars.

Beach problems are caused by human actions. Normally, if nothing is built on or next to the beach, it will remain as long as the process of natural replenishment continues. It may shift with the seasons, yield sand temporarily to storm erosion, slowly recede landward with rising sea levels, or accrete seaward with natural shifts in the flow of ocean currents, which bring more sand (Figure 3). Mobile and responsive, the beach will remain over the years. But if you try to restrain these natural movements with bulkheads or groin fields so as to hold the beach, you may start an unending chain reaction of problems that can be solved only by the very expensive process of continuously pumping sand from the ocean bottom onto the beach. This remedy is so costly it is not available to most communities.

Since the main threat to the beach is usually from development on land next to it, beach protection requires coordinated management of the beach itself and the land behind it. Your community needs a beach-management program to limit building, prevent excavation, and control beach protection and inlet structures, as covered in the following five recommended management policies:

24. ***Beach Excavation:*** *Avoid removing sand from all parts of the beach system, including the shallow nearshore zone.*
25. ***Location of Structures:*** *Locate all structures inland of the beach.*
26. ***Beach Protection Structures:*** *Maintain natural beach processes by discouraging structures that adversely affect littoral sand transport.*
27. ***Inlet Alterations:*** *Design inlet stabilization projects to protect downstream beaches and to minimize estuarine flooding.*
28. ***Beach System Restoration:*** *Encourage effective restoration of seriously eroded beaches.*

Figure 1. The city of Sanibel, Florida, has enacted a strict set of ordinances to conserve its beaches for recreation and for property protection. (Photo by John Clark.)

Figure 2. The groins and bulkheads of Miami Beach have not stopped erosion: the sand is so depleted on many parts of the beach that there is only water at high tide. A restoration project now underway is costing over $60 million of tax money.

ECOLOGICAL FEATURES

The beach *per se* is the unvegetated face of the shoreline (usually sand) that extends from the upper edge of the beach berm (the lower edge of the dunelands) seaward to the low-water mark (Figure 4). But the beach system as a whole includes the submerged

Figure 3. Barrier beaches in their natural condition remain wide and ample because they respond to storms or sea-level changes by accumulating sand and "rolling" landward. (Photo by John Clark.)

nearshore zone as well. The typical beach system is comprised of the following parts:

Backshore: The dry beach, lying adjacent to and below dunelands (or banks and bluffs) that is washed by waves at least once a year during normal storms and highest tides; it is made up of berms (ridges) and flats formed by wave deposition of sand or gravel on the backshore.

Foreshore: The wet beach, lying adjacent to and below the backshore berms, and extending to the low-water mark.

Bar: An offshore ridge that may emerge at low tides but is submerged at least at high tides and often permanently.

Nearshore Zone: The submerged beach extending seaward as far as the force of waves reaches to the bottom, often the point at which depths reach about 40 to 50 feet.[1]

Ecologically, the beach is a unique environment occupied by animals that have adapted to the constant motion of the sand, gravel, or shell. Many important birds, reptiles, and other animals nest and breed on the berm and open beach, as well as feed and rest there. For example, sea turtles (including such endangered species as loggerhead and green turtles) come ashore during the spring and summer to lay their eggs above the high-water line. Terns and other seabirds frequently lay their eggs on the upper beach.

Beaches provide a unique habitat for burrowing species such as mole crabs, coquina claims, razor clams, and others. There may also be a complex community of crustacean organisms that attract shore birds. The shallow waters of the nearshore zone provide habitat for shellfish of many kinds and a wide variety of forage species, which in turn attract fish and birds that feed on them.

HAZARDS

The ocean beach is too hazardous a place to serve as a building site. In its natural form,

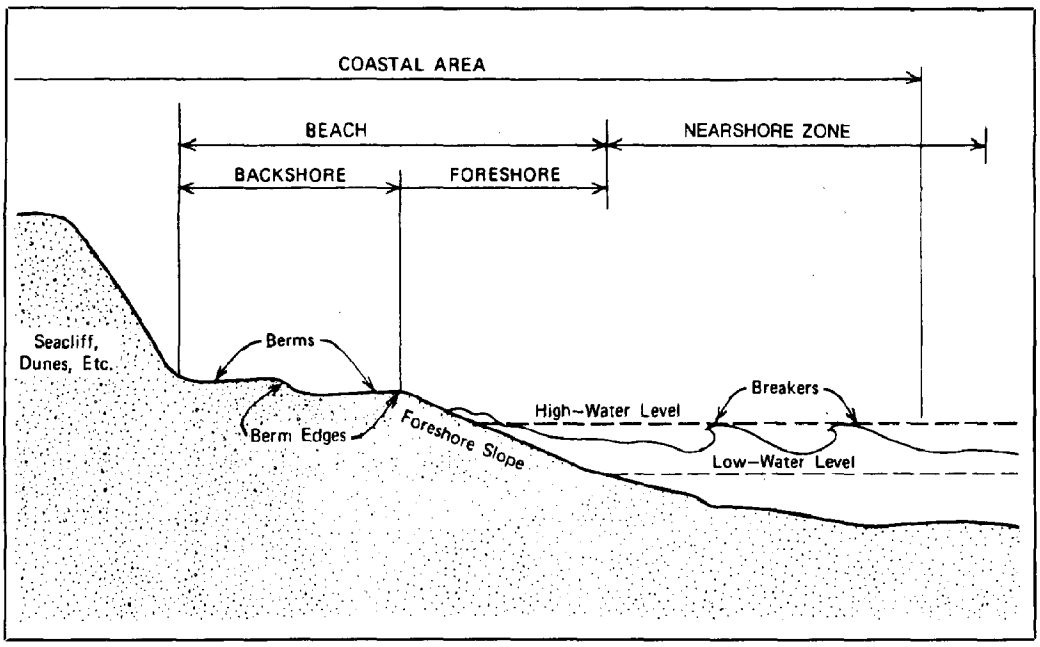


Figure 4. The anatomy of a typical beach front. (Source: U.S. Army Corps of Engineers, *Hawaii Regional Inventory, The National Shoreline Study* [Honolulu: U.S. Army Corps of Engineers Pacific Ocean Division, 1971].)

it exists in a state of dynamic tension, continually shifting in response to waves, winds, and tide and continually adjusting back to equilibrium.

Each part of the beach is capable of receiving, storing, and giving sand, depending on which of several constantly changing forces is dominant at the moment. This keeps the slope or profile intact through balancing the sand reserves held in various storage components in the beach system—dry beach, wet beach, submerged offshore bar, and so forth—and in the duneland area behind the beach. When storm waves carve away a beach, they take sand out of storage. In the optimum natural state, however, there is enough sand storage capacity in the ocean beach berm (or in the dunelands behind it) to replace the sand lost to storms; consequently, the effects are temporary, with the beach gradually building up again (Figure 5). In large sounds (e.g., Puget Sound) with beaches, the situation may differ in that beaches are narrower, dunes are

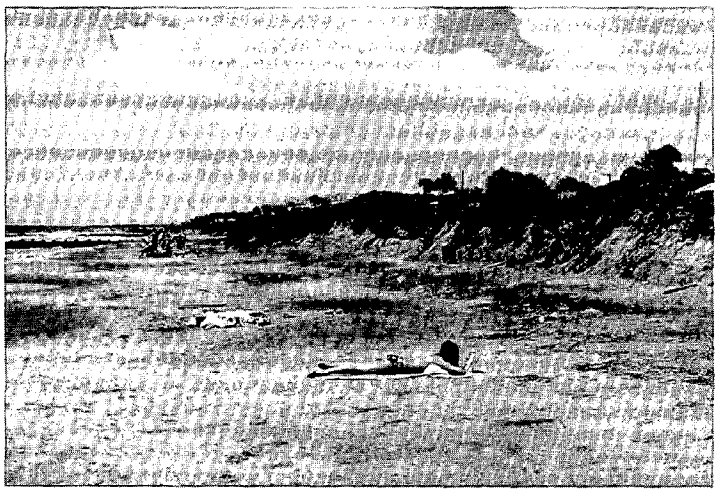


Figure 5. When houses are built sufficiently back from the beach, there is no need for bulkheads and groins; the natural processes work to hold the beachfront intact. (Photo by John Clark.)

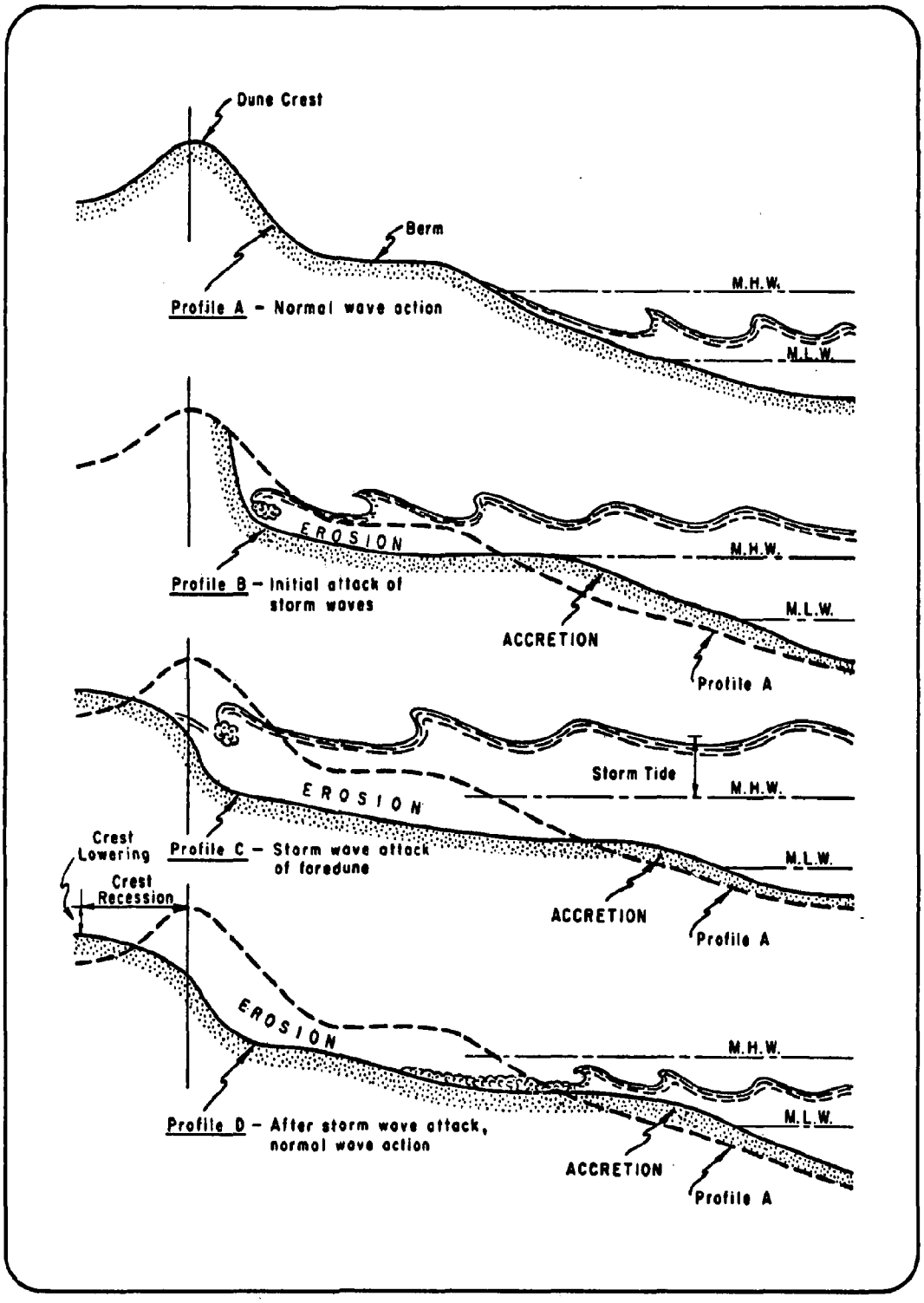


Figure 6. This schematic diagram shows how storm waves attack a beach and dunes. As the dune is attacked by storm waves, eroded material is carried out and deposited offshore, altering the beach's underwater configuration. (Source: U.S. Army Corps of Engineers, "Shore Protection Guidelines," in *National Shoreline Study*, vol. 1 [Washington, D.C.: U.S. Government Printing Office, 1973].)

absent, berms are intermittent, and replenishment comes from "feeder bluffs" and streams.

A beach disturbed by improperly designed bulkheads and groins may have only a small remaining area available to store sand. If sand is shunted to sea because of groins or bulkheads, for example, the reserve sand in storage may be reduced to a level no longer capable of replacing sand losses from severe storms. The beach system becomes unstable, slumps in places, and attempts to reestablish its old equilibrium profile, or "angle of repose." But with less sand, the equilibrium angle of repose can be established only at a position inland of the previous beach profile. When this occurs, erosion cuts away the land.

The natural forces at work are immense. The power of man to hold the beach at a higher than natural angle of repose to protect property is limited. Structural solutions to beach erosion and protection of duneland property from the hazards of sea storms may be expensive and are often temporary or counterproductive. Clearly, the key to the natural protection provided by the beachfront is the sand held in storage and yielded to storm waves to dissipate the force of their attack (Figure 6).

MANAGEMENT POLICIES

The general goal for your community's ocean-beach management program should be to maintain the beach slope (profile or angle of repose) by protecting both the natural processes that supply the beach with sand and the sand-storage capacity of the beach elements. Because groins, jetties, and bulkheads often result in a loss of sand to the beach system as a whole, structures to protect beaches and inlets should be carefully chosen.

Special attention must be given to the problems of receding beaches, often caused partially by human activity and partially by the natural trend of a rising sea level (Figure 7), which amounts to one foot per century for some beachfronts.[2] As the sea level rises, the shoreline is forced inland because there is little to anchor it permanently in place.

To preserve the attributes of your community's beaches, you will have to undertake a careful and comprehensive examination of conservation needs, natural processes, building practices, and corrective engineering proposals that affect the whole beach system. These considerations will require technical expertise in beach processes and beachfront engineering.

Recommended Policy 24: Beach Excavation. Avoid removing sand from all parts of the beach system, including the shallow nearshore zone.

A major management objective is to maintain the beach slope intact by not disturbing sand reserves held in the beachfront and the adjacent, submerged, nearshore zone. Taking sand from any part of the beach—dry

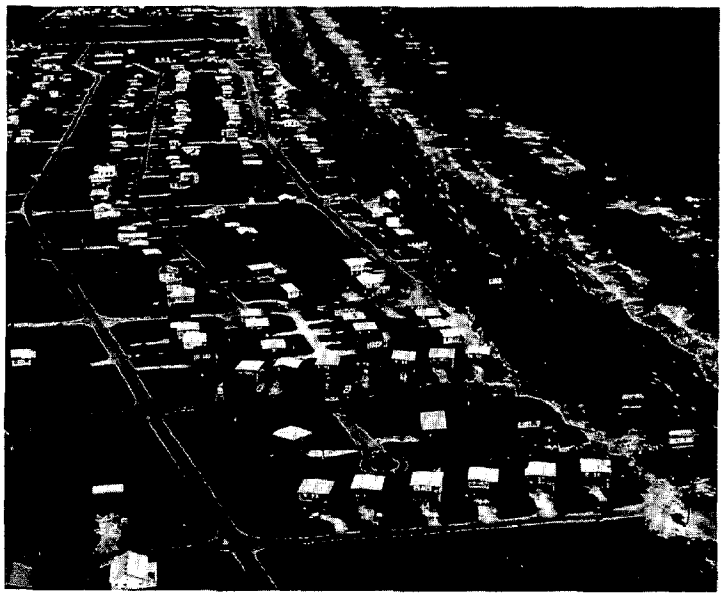


Figure 7. Severe beach erosion is threatening homes at Surfside, Texas, near Freeport. Beach property, previously located some distance from the Gulf of Mexico, now is in the surf. The Galveston District, Corps of Engineers, is engaged in a study of controls for erosion. (Photo from U.S. Army Corps of Engineers, Galveston District.)

beach, wet beach, bar, or nearshore zone—can lead to severe erosion and recession of the beachfront. Therefore, beach conservation should start with the premise that any removal of sand is adverse, whether for construction fill, concrete aggregate, or any other purpose.

Many communities and States recognize the serious consequences of removal of sand from the beach *per se*, but do not understand the effects of dredging sand immediately seaward of the beach. When sand is mined from the nearshore zone of the beach system, a submerged depression is created. Nature's response is to replace the lost material via wave and current transport. This takes sand from the beach, eroding its structure and depleting its stores. The result may be a perpetual cycle of dredging sand offshore and placing it on the beach, while the new supplies are carried back into the sea to fill in the depressions caused by the mining.

For these reasons, large-scale excavation of sand from any part of the beach system, whether above or below water, should be prohibited. This means from the backshore of the beach seaward as far out as wave energy penetrates to the bottom, which could be as far as a mile or more offshore (often to depths of 40 to 50 feet).

Recommended Policy 25: Location of Structures.

Locate all structures inland of the beach.

With rare exceptions, no residential, commercial, or industrial structures should be built on beaches, including the whole backshore to the annual high-water mark. Buildings should be placed well back of the future beach recession line. Continued severe beach recession is certain and predictable along much of the U.S. coast (Figure 8). It is unwise to allow development of property that will certainly be lost to the sea, especially when the security of development so often creates lot-owner demands for protective works, which may further imperil the whole beach system. Therefore, your community should be certain that structures are located behind a setback line that accommodates the predicted long-term (50 to 70 years) recession rate of the ocean beach (see Dunelands section for details).

Public rights are another compelling reason to bar building on beaches. The beach up to the mean high-water line (mean higher high water for the Pacific coast) in most States is in public domain; therefore, owners of adjacent land do not have the right to use this part of the beach exclusively for private purposes. In some states, public rights are extended to the berms and other parts of the "dry beach" above mean high water. For example, by legislative action, Texas has declared that the public may have access to the beach all the way to the beginning of permanent vegetation (above the toe of the first dune).

Some local governments provide a similar beach setback. Whatcom County, Washington, for example, requires in all subdivision and site-development plans that a minimum of 30 feet of land above mean high water (or mean higher high water) be set aside for community recreation and open space.[3] Whatcom County Planner Roger

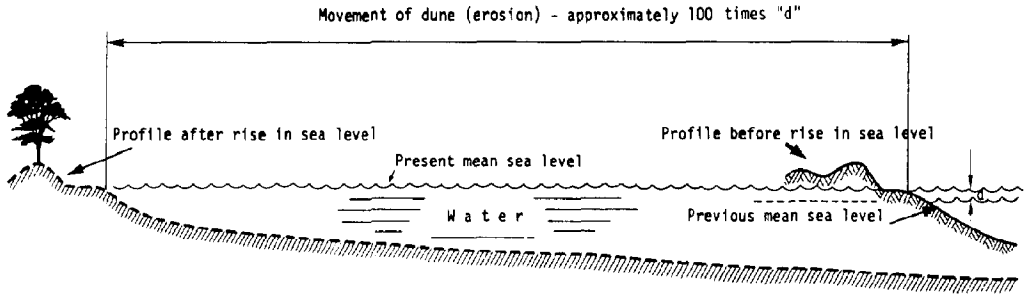


Figure 8. The diagram shows the recession of a beachfront (Bogue Banks, N.C.) in response to a relative rise in sea level for a beach with a slope of 1 percent. The beach recedes a distance of 100 times the increase in sea level (d). For example, if relative sea level rose one-half foot, the beachfront would recede 50 feet. (Source: Orrin H. Pilkey, Jr., Orrin H. Pilkey, Sr., and Robb Turner, *How to Live with an Island: A Handbook to Bogue Banks, North Carolina* [Raleigh: North Carolina Department of Natural and Economic Resources, 1975].)

Figure 9. A tsunami suddenly striking a developed part of the California coast, such as these Malibu homes, could cause severe property damage and loss of lives. (Photo by Jack McDowell.)

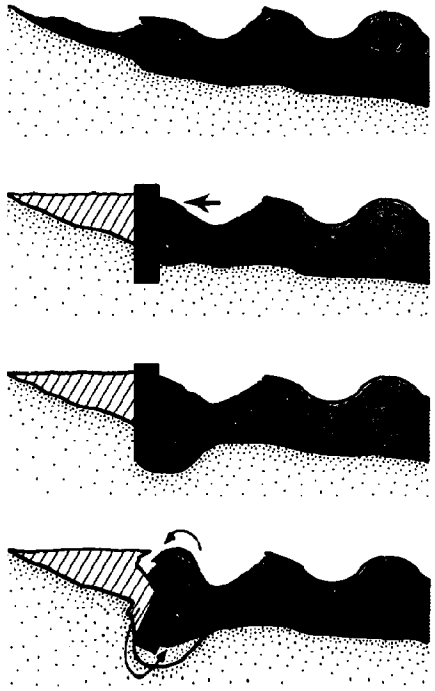


Figure 10. A naturally sloping beach dissipates wave energy. Seawalls or building foundations, however, reflect the energy almost completely, creating a scouring action near the toe of the wall and causing the undermining and eventual collapse of the structures. (Drawing by Albert R. Veri.)

Almshaar believes that many other communities would find this beneficial, but warns that the setback should be more in most cases.

Recommended Policy 26: Beach Protection Structures.

Maintain natural beach processes by discouraging structures that adversely affect littoral sand transport.

When dunelands or bluff tops are occupied, roads built, and investment capital committed along a beachfront, it may seem necessary to retard the natural recession of the shore with groins (linear rock or concrete structures built perpendicular to the beach) and bulkheads. If improperly designed, however, these structures may be short-lived and may create or intensify long-term problems.[4] By providing a false sense of security, they may set the stage for a larger-scale disaster than would occur without them (Figure 9).

Groins, sewalls, and other approaches to shore protection sometimes have complex and unanticipated secondary effects. A row of parallel groins may force sand to move further offshore with the littoral drift, from one groin tip to another, instead of moving along close to the beach. Bulkheads tend to accelerate beach loss because they reflect the force of waves downward and back into the sand, which causes the beach to be scoured away.[5]

Thus, improperly designed structures intended to stabilize the beach may actually reduce the reserve of sand to a level no longer capable of replenishing losses caused by severe storms. In such cases, storm waves may remove enough beach to erode under and around the structures, causing the beach line to move inland as the berm regains its equilibrium slope (Figure 10). Shorefront structures may also prevent the wind from carrying beach sand up onto the dunelands. If the sand supply is thus cut off, frontal dunes may gradually deteriorate. You should, therefore, generally discourage the construction of shore-protection structures

Figure 11. The small groin shown at the very tip of Gasparilla Island (Florida) has been successful in collecting sand and preventing the island from eroding further. A short distance away the beach has receded 700 feet in 30 years, possibly because of dredging the inlet and disposing of the sand offshore in the ocean. (Photo by John Clark.)

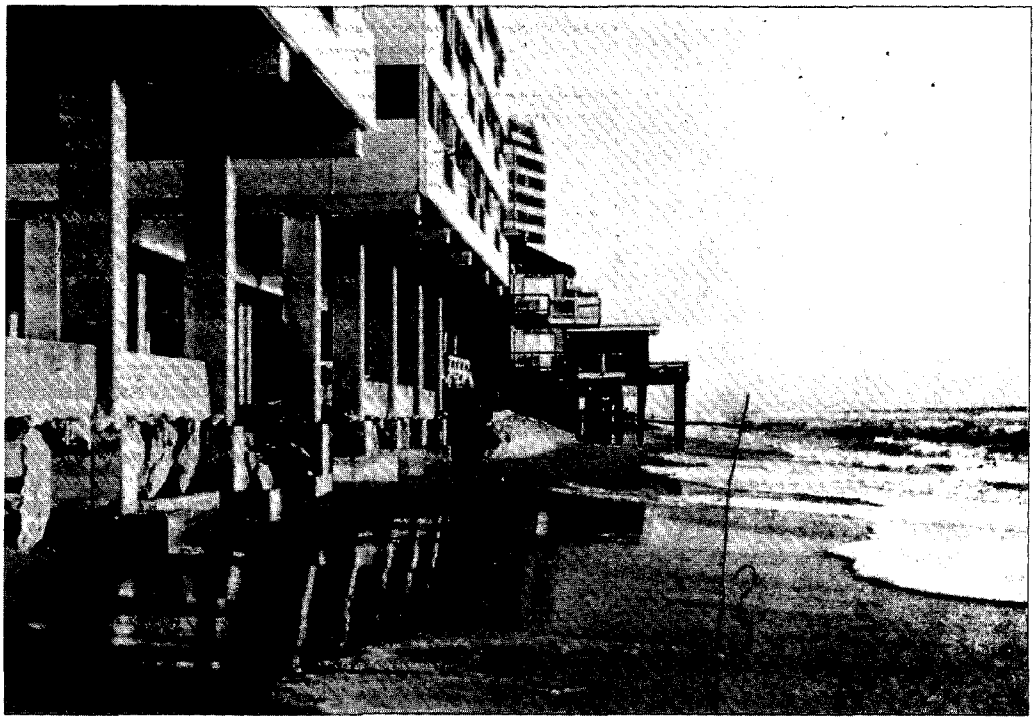


Figure 12. At Ocean City, Maryland, condominiums are still built on the beach, even though existing structures are being undermined by winter waves. (Photo by Steven Leatherman.)

in favor of setbacks and other nonstructural remedies.

Sometimes, beachfront development has already progressed so far that it is too late for nonstructural remedies alone. Some commendable engineering structures have been devised to supplement natural processes, and to reduce further damage, where development is quite intense (Figure 11). But there are many examples of failure of the structural approach. Miami's beach has been all but eliminated by the extensive seawalls and groin fields that accompanied urban encroachment. The beachfronts of Captiva, Gasparilla, Treasure Island, and other barrier islands on Florida's west coast are in precarious condition. Ocean City, Maryland, is fighting a losing battle against the sea (Figure 12) with bulldozers attempting to restore the backshore by using foreshore sand after each winter storm (Figure 13).

Unfortunately, extensive areas of the coast are already occupied and must somehow be maintained safely until setbacks and other protective land-use plans can be implemented. Policy 28 addresses this problem.

Recommended Policy 27: Inlet Alterations. Design inlet stabilization projects to protect downstream beaches and minimize estuarine flooding.

Inlets affect the stability of adjacent beaches by interrupting littoral drift—lateral movement of sand with shore currents—and by trapping the passing sand. When inlet channels are artifically deepened by dredging, the sand moving along the coast may be deposited in the dredged channel. It is clear that both inlet deepening and inlet stabilitzation projects affect the sand supply moving along the beach with littoral drift; either can lead to a major imbalance of sand along the beach system.

Where moving sand must cross an inlet, the total amount of sand in motion in both directions is important. Jetties, structures that stabilize the location of the channel and shield vessels from waves, affect sand movement at inlets. A deepened inlet might result in eroded, narrower beaches on the downdrift side of the jetty because the sand that normally would pass the inlet is detained. Some of this sand is impounded at the updrift jetty, while additional sand is either lost into deep water at the inlet's seaward end, where it forms offshore bars, or is deposited in bars inside the estuary. The term "net littoral drift" refers to the difference between the volume of sand moving in one direction along a beach and that moving in the opposite direction (caused by shifts in the direction of attacking waves).

An example of sand movement across an inlet is available for Corson Inlet, on the New Jersey coast:

Southward-moving sand	600,000 cu. yd/year
Northward-moving sand	450,000 cu. yd/year
Net littoral drift	150,000 cu. yd/year

The total sand moving across the inlet, 1,050,000 cubic yards per year, is the amount that could be lost to beaches north and south of the inlet if sand building up in the inlet were dredged and removed. Losses in

Figure 13. Ocean City, Maryland, uses bulldozers to push beach sand against failing foundations and bulkheads each winter in a futile attempt to correct the mistake of building too close to the ocean; a hurricane striking here will cause extraordinary damage. (United Press International Photo.)

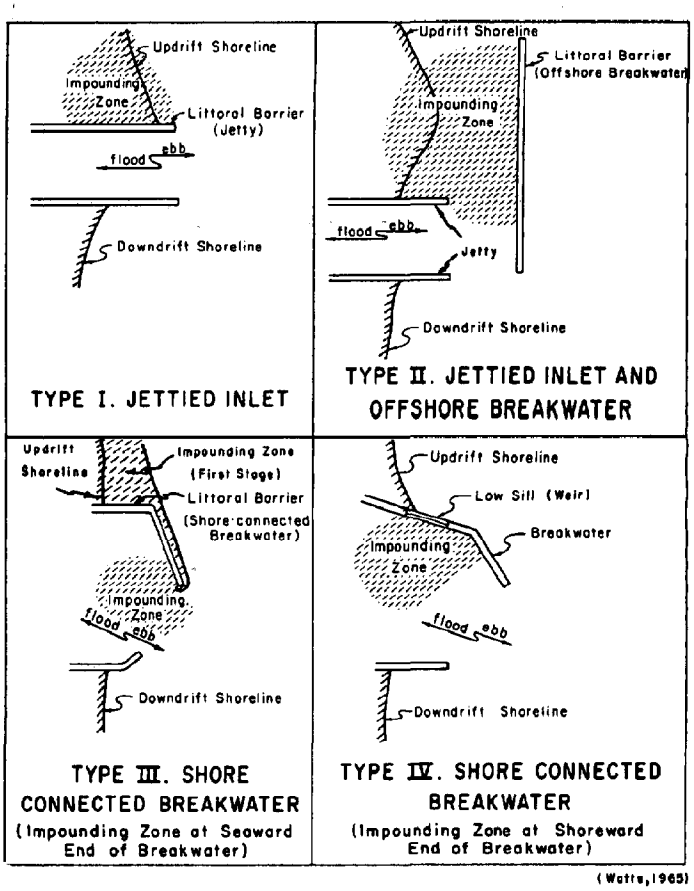


Figure 14. Inlet stabilization and dredging projects typically cause problems for beaches downdrift of the inlet, because the jetties and sand dredging stop the natural flow of sand past the inlet. The U.S. Army Corps of Engineers is experimenting with various bypass structures with which to solve this problem by impounding the sand at the updrift jetty for transfer by pump or dump truck to the beach below the downdrift jetty. (Source: U.S. Army Corps of Engineers, *Shore Protection Manual* [Vicksburg, Miss.: U.S. Army Coastal Engineering Research Center, 1973].)

these amounts could spell disaster to the beaches north and south of the inlet.[6] This problem can be partially solved by providing artificial sand "bypass systems" which impound the moving sand in special basins for pumping across to the downstream side of the inlet, as illustrated in Figure 14.

The dimensions of inlets, which control the water flow in and out of bays, are another element of critical importance. For example, if the inlet is narrowed, the extent of hurricane-surge penetration into the bay may be reduced. At the same time, however, the flow of storm waters out of the bay will be impeded, thereby increasing floodwater elevations in bayfront communities. If your community decides to stabilize, deepen, or otherwise artificially interfere with natural processes in inlets, you should make sure the project design includes the correct balance to minimize surge entry and maximize release of storm waters accumulating in bays and other estuarine basins. This requires practitioners with special competence in coastal engineering. Local jurisdictions usually do not have such competence available to them. If that is the case in your community, you should contact the U.S. Army Corps of Engineers, the appropriate State agency, or private consultants for engineering evaluation. In any event, complex and expensive projects of this type are usually carried out by the U.S. Army Corps of Engineers.

Recommended Policy 28: Beach System Restoration.

Encourage effective restoration of seriously eroded beaches.

Many coastal communities clearly need beach-restoration programs. Sand replenishment, or artificial beach nourishment, is the main hope for restoration of most badly eroded beaches, with structures playing a secondary role. Rebuilding beaches artificially, by replacing lost sand, permits the natural process to continue. Beach nourishment provides (1) a beach suitable for recreational purposes, (2) an effective check on erosion in the problem area, (3) a supply of

sand to adjacent beaches, and (4) a practicable, if expensive, answer to beach erosion where large quantities of sand are available. However, beach nourishment usually does not *permanently* restore the beach. This kind of technique provides only a temporary solution, often at great expense, and additional replenishment may be required at regular intervals. If it does not produce the desired result, beach nourishment may easily be discontinued.

Sources of sand for beach fill are often scarce. In light of present knowledge, any removal of sand from the beach system itself will threaten the beach profile because of the reduction of storage—whether the sand is taken from dunes, the beach *per se*, or from the longshore bar or nearshore zone. Therefore, you should not try to solve an erosion problem in one part of the beach system by using sand from some other part of the same system. Since dunes, adjacent beaches, nearshore areas, and estuaries are generally considered off limits for sand removal, there are two appropriate sources of supply for beach nourishment: (1) the open ocean or broad non-estuarine bays beyond a depth of about 40 feet[7] or (2) areas around inlets or other places of accretion, where the supply is constantly replenished by natural forces (particularly suitable in conjunction with navigation dredging).

Often, strategically placed and properly designed groins will be required to hold the sand pumped onto the beach (Figures 15 and 16). Such groins will not have the same adverse impact of groins placed on a natural beach insofar as the sand pumped onto the beach is sufficient to prevent "downstream" sand starvation.

Another partial, but more permanent, approach to restoration is the removal of improperly designed barriers such as bulkheads, groins, and other structures that deplete the sand supplies. You can replace those structures, if necessary, with a beach-nourishment project.

Whatever approach is taken, very few communities can afford to engage in large restoration projects on their own. Groins may cost $500,000 each; seawalls, $200 to $500 a foot. In 1975 prices, the cost of sand used for beach nourishment ranged from about $1.50 to $2.00 a cubic yard—for sand pumped by a dredge over a short distance—to as much as $5.00 a cubic yard if the sand is hauled by truck.[8] State and Federal funds and expertise will normally be required. If Federal money is used, your community will have to use its own resources to provide parking lots and points of access to the beach (in many cases at intervals of one-half mile).

IMPLEMENTATION GUIDELINES

Although beaches are physically different from banks and bluffs and dunelands, the management needs are nearly identical. Each of the management needs that your community must address to implement Policies 24 through 28 has been discussed in the sections on Banks and Bluffs and Dunelands:

First, **controlling excavation,** in accordance with Policy 24 (Beach Excavation) is discussed at page 87.

Second, **establishing a setback from the recession line,** in accordance with Policy 25 (Location of Structures), is discussed at page 78.

Third, **establishing standards for protective structures,** in accordance with Policies 26 (Beach Protection Structures) and 27 (Inlet Alteration), is discussed at page 79.

Fourth, **restoring beaches,** in accordance with Policy 28 (Beach System Restoration) is discussed at page 89.

Following are several problems, and responses to them, that you may also encounter when implementing the recommended policies for beaches:

First, there may be little understanding of how difficult and expensive it is to control the natural forces that alter beaches. As a result, people often want to continue building in hazardous adjoining areas. Also, they often demand expensive protective works that ultimately prove futile because of relentless changes in sea levels. Your community can respond to this problem in a number of ways. It can decline to build protective works on public beaches. (The National Park Service is now declining to do so in some oceanfront areas.) Or, if your community does build such works (or arranges for Federal agencies to help build them), it can make sure that the economic and environmental costs of the works are taken into account by officials and citizens.

Second, because most beaches are publicly owned, major beach-protection projects are likely to be formally proposed by government rather than by private property owners. Thus, coordination with other public

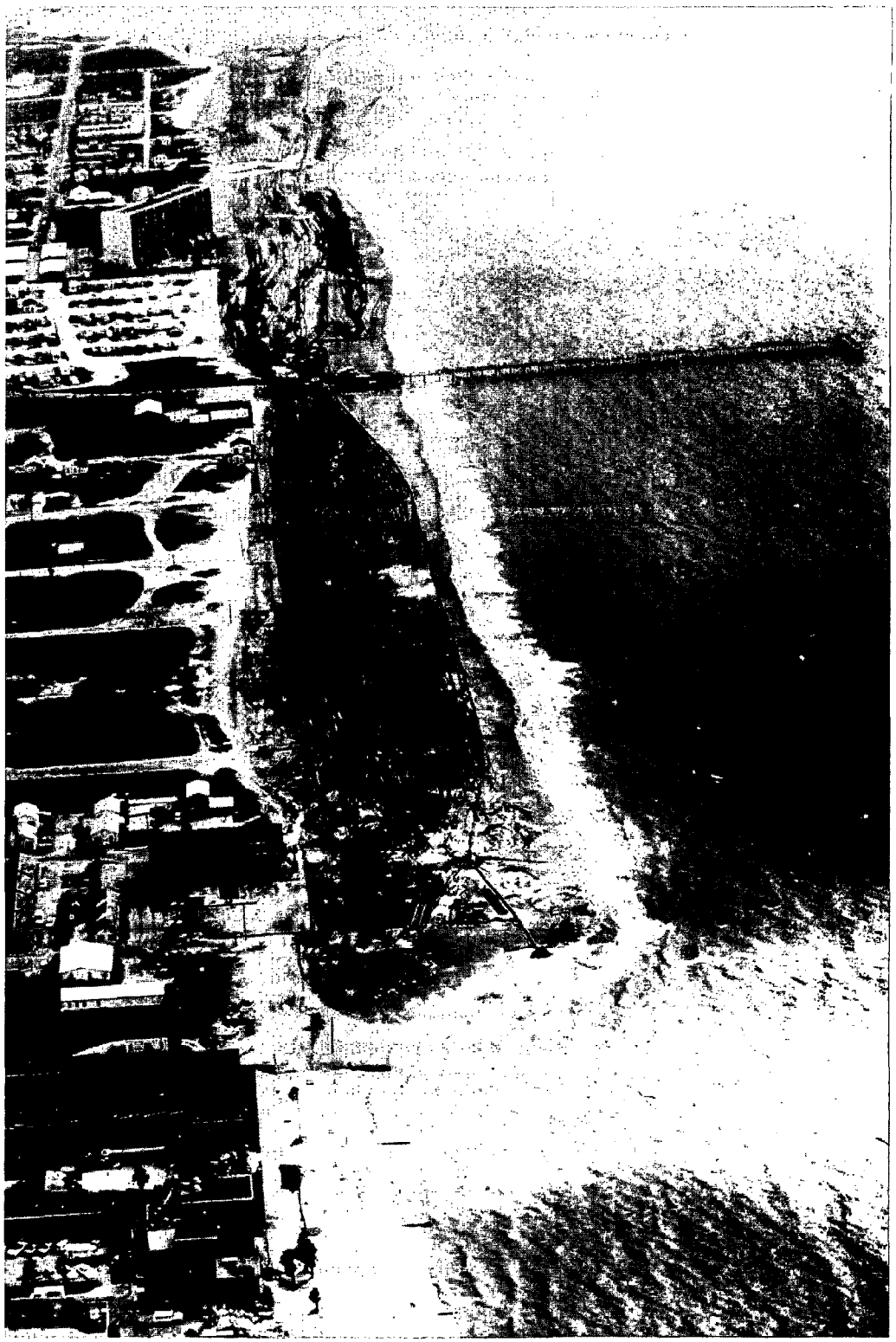
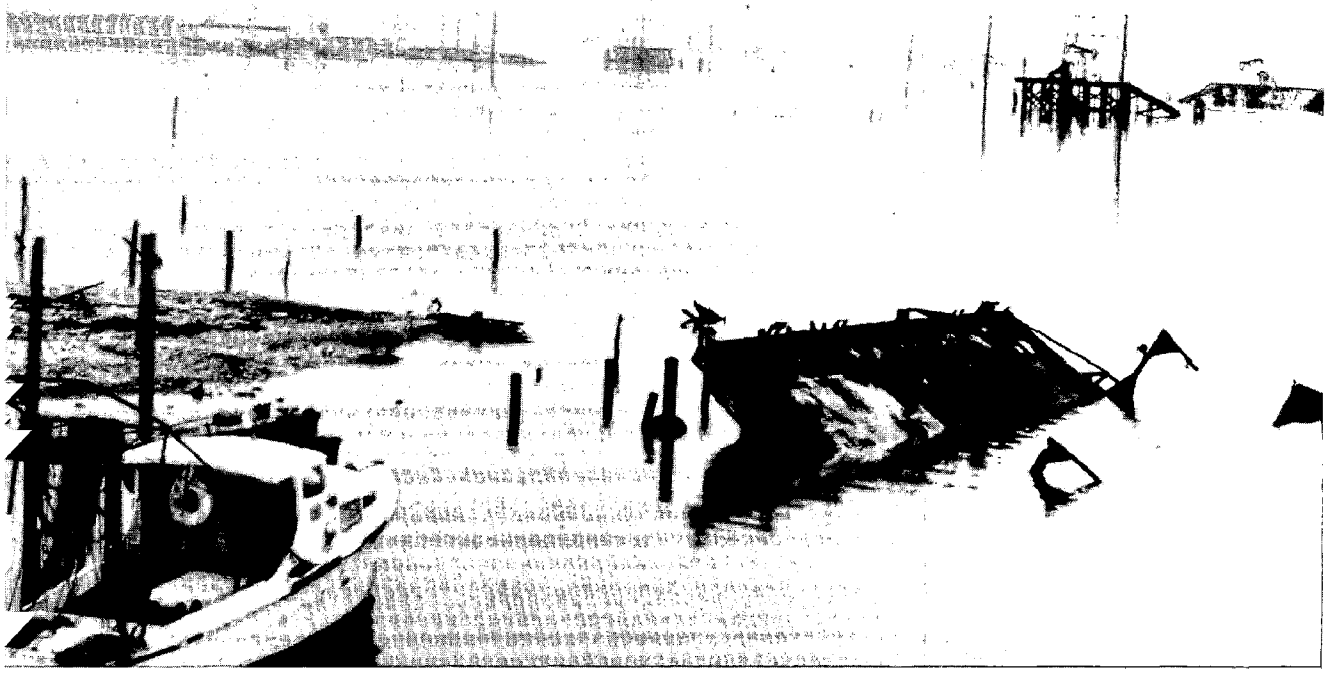


Figure 15. The North Beach at Corpus Christi, Texas, in the summer of 1977, during the dredging and spreading operation of a beach restoration project by the Galveston District, Corps of Engineers. Sand for the base was dredged from Corpus Christi Bay, with cover sand trucked in. (Photo from U.S. Army Corps of Engineers, Galveston District.)

Figure 16. The North Beach at Corpus Christi following beach restoration. The new beach is 1.25 miles long and 300 feet wide. (Photo from U.S. Army Corps of Engineers, Galveston District.)

programs, including coordination of local policies with State and Federal agency activities, is especially important in beach management. Coordination can be achieved in a number of ways, depending on the particular State or Federal activity affecting your community. The Federal environmental impact assessment process (see p. 37) provides opportunities to comment on proposed Federal activities and on important regulatory actions by agencies such as the U.S. Army Corps of Engineers. The "A-95" review process (see p. 34) provides another forum for most local governments to make similar comments. State coastal zone programs (see p. 36) can be an important means of coordinating local and State/Federal policies for beaches. Finally, the procedures of many Federal programs allow local comments. Under some Federal programs, a State official serves as a conduit for such comments, and you will often find it beneficial to work closely with that official.

Third, your community may have difficulty in obtaining the expertise necessary for intelligent analysis of Federal, State, and private proposals for beach protection, inlet alteration, and other beach modifications. The Corps of Engineers or your State department of navigation can sometimes help to explain various alternatives, although these agencies are sometimes proponents of particular projects. The U.S. Fish and Wildlife Service may be able to interpret the impacts of different proposed alternatives on natural systems, particularly where proposals require Corps of Engineers permits or are undertaken by the Corps itself. A State coastal zone management program may also be of assistance by providing policies and standards by which to analyze or formulate proposals for beach protection.



Coastal Waters and Basins 7

The shallow waters and estuaries that fringe the U.S. coast are vulnerable to pollution and to physical disturbance (Figure 1). In an affirmative program of conservation to protect these waters, your community will have to consider the shoreland watershed adjacent to the coastal water basin. The flow of water from the land is a primary factor controlling the condition of coastal ecosystems.

The policies of this section emphasize the conservation of estuaries—protected sounds, bays, lagoons, and tidal rivers—rather than the open sea, because estuaries are richer in resources and more vulnerable to damage from pollution and other environmental disturbance. The dense settlements so often located on estuarine shores produce high volumes of waste and cause extreme alteration of natural systems.

To conserve marine resources, while providing opportunities for swimming and boating, your community will find it necessary to control marine construction, discharge of pollutants, and dredging and other alteration of the basin floor. The following policies are designed to facilitate these management objectives:

29. ***Disposal of Effluents:*** *Require the highest levels of waste treatment for industrial and municipal effluents released into estuarine and nearshore coastal waters.*
30. ***Siting of Heavy Industry:*** *Locate industrial facilities inland if they have a high potential for disturbance of coastal ecosystems.*

Figure 1. Shallow estuaries along the coast are especially vulnerable to the effects of development of all kinds, particularly pollution-prone development such as oil drilling. (Photo by John Clark.)

31. ***Diffuse Sources of Pollution:*** *Require the highest standards for control of stormwater runoff and other diffuse sources of pollution.*
32. ***Structures in Coastal Waters:*** *Avoid in coastal waters the use of structures that would adversely impede coastal water circulation.*
33. ***Sites for Removal and Deposit of Dredged Material:*** *Select locations for removal and deposit of dredged material to avoid adverse effects on basin floors and critical areas such as grass beds.*
34. ***Dredging Performance:*** *Require seasonal, locational, and operational controls on coastal dredging projects.*
35. ***Channel Location and Design:*** *Select routes and designs for navigation channels that minimize adverse effects on basin floors.*
36. ***Coastal Basin Restoration:*** *Encourage the restoration of polluted coastal waters and basin floors.*

ECOLOGICAL FEATURES

The term *estuary* has a variety of definitions, but as used here estuary (Figure 2) means an enclosed coastal water body that has a measurable quantity of salt (greater than 0.5 parts per thousand salinity, the threshold of human taste) and a free connection to the sea. "Enclosed" is used in a relative sense and includes all "protected" coastal water bodies, ranging from open bays with wide mouths to nearly landlocked salt ponds with narrow water passages to the sea. Estuaries serve as mixing basins where ocean water is diluted with fresh water from streams and with runoff from adjacent watersheds.

Where it is important to distinguish between estuarine basins and indented nearshore oceanic basins, you can use the following rule of thumb: An enclosed coastal water body, or estuary, is one that has a shoreline length greater than three times the width of its outlet to the sea. Some deep, wide sounds that have nearly oceanic conditions may fall into an in-between category.

Estuaries are the richest of all coastal waters. They not only produce an abundance of fish and shellfish but also serve special needs of the migratory nearshore and oceanic species that require shallow protected habitat for breeding or as sanctuary for their young (Figure 3).

Second only to the estuary in environmental concern is the nearshore zone, the band of shallow waters adjacent to the ocean shore. Inshore, it is bounded by the beach; offshore, it extends seaward as far as the force of waves reaches to the bottom, normally where water depth reaches 40 to 50 feet.

Life in coastal waters is supported by a food cycle—or food chain—beginning with plants such as mangroves, marsh grasses, floating micro-plants (collectively called phytoplankton), and algae of the basin floors. This chain provides food for the animal life. Of particular importance is wetlands detritus, small floating particles of plant matter from decomposing cordgrass or mangrove leaves or other plant tissues. Detritus is consumed by a wide variety of shrimp and other small estuarine life forms which in turn serve as forage for birds and fish.[1]

All aquatic plants are nourished by nutrient minerals dissolved in the water, particularly compounds of nitrogen and phosphorous, which are supplied from within the ecosystem through a continuous internal recycling process. However, nutrients continuously trickle out of the system and are replaced by minerals from land runoff and other sources.

Sunlight is the basic force driving the ecosystem. It is the fundamental source of energy for the aquatic plants. It must be able to penetrate coastal waters so as to foster the growth of both the rooted plants, such as sea grasses, and the suspended algae (or phytoplankton). Increased turbidity, from the addition of suspended matter to the water, reduces light penetration and depresses plant growth. Estuarine waters are

Figure 2. Estuaries such as this mangrove lagoon behind Sanibel Island, Florida, are shallow water bodies protected from ocean waves. In an estuary, salt water and fresh water mix, greatly enhancing the estuary's productivity for seafood. (Photo by John Clark.)

normally more turbid than ocean waters, more laden with silt and more rich in suspended life.[2]

Of the various gases that are found dissolved in coastal waters, oxygen is of the most obvious importance to the fauna. Coastal waters need a high oxygen concentration to provide for optimum ecosystem function and highest carrying capacity.

The entire dynamic balance of the estuary revolves around and is strongly dependent on water circulation. Vertical and horizontal water circulation transports nutrients, propels plankton, supports and spreads "seed" stages (planktonic larvae of fish and shellfish), flushes away the wastes of animal and plant life, cleanses the system of pollutants, controls salinity, shifts sediments, mixes water, and performs other useful work. The specific pattern of water movement found in the estuarine portion of any coastal system is a result of the combined influences of runoff volume, tidal action, wind, and, to a lesser extent, external oceanic forces.[3]

Salinity, or salt content, of the water is a

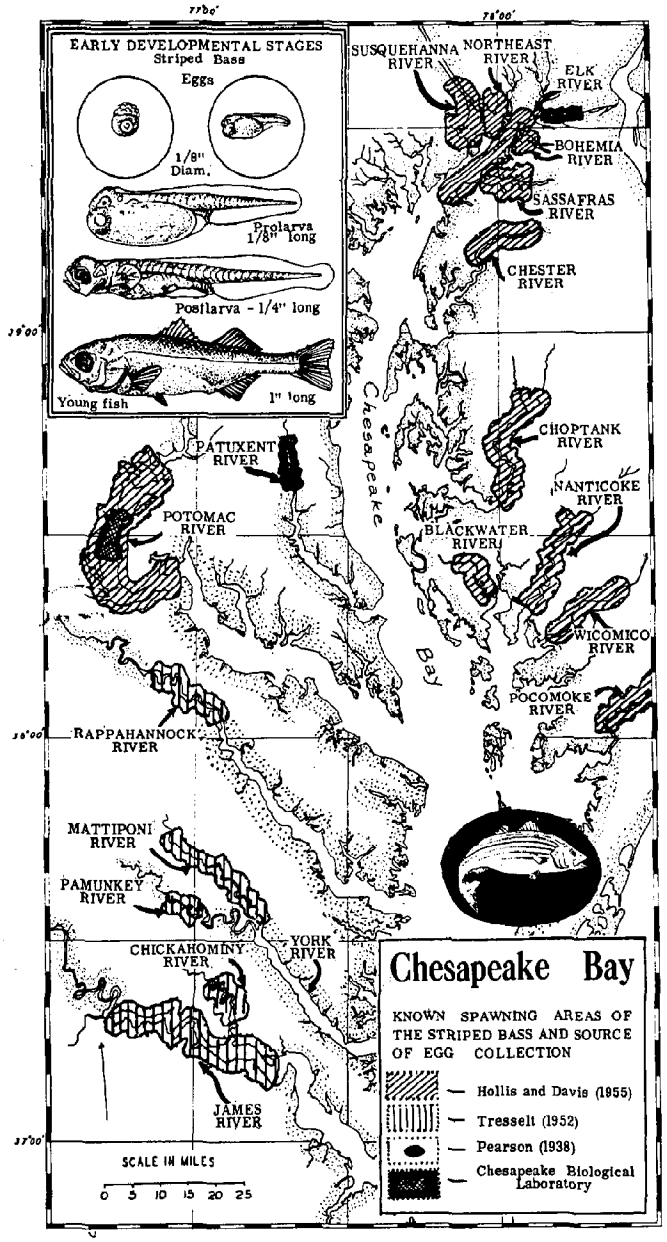


Figure 3. The Chesapeake Bay riverine spawning areas are a prodigious producer of Atlantic Striped Bass, a saltwater angler's favorite species. (Source: R.J. Mansueti, "Effects of Civilization on Striped Bass and Other Estuarine Biota in Chesapeake Bay and Tributaries," in *Proceedings*, Gulf and Caribbean Fisheries Institute, 14th Annual Session, Miami, Florida, 1961.)

critical factor for estuarine species. Generally, there is a gradient in salinity that starts with a high concentration in the ocean, decreases inward through the estuary, and drops to near zero at some distance up estuarine tributaries. Some coastal species tolerate a wide range of salinity, whereas others require a narrow range to live and reproduce successfully. Some species require different salinities at different phases of their life cycles, conforming to regular seasonal rhythms in the amount of land runoff.

The floors of coastal basins are important. They provide the basic form and structure of the basins, and govern the flow of water through them, as well as harbor the richest habitat areas of coastal waters—clam beds, coral reefs, submerged grass beds, and so forth. Estuarine floors are usually biologically richer and more vulnerable to adverse impacts than are nearshore ocean floors.

Many commercially or recreationally valuable species depend on the basin floor for habitat, and forage about within the bottom sediments for their food.[4] The community of life of the basin floor is also a major element in ecosystem stability. The bottom species are highly diverse—including worms, lobsters, clams, oysters, shrimps, and fish.

Ecologically healthy estuaries have clean and firm bottoms and undisturbed habitats with a high resource carrying capacity. The system's capacity is reduced when functioning grass beds, shellfish beds, coral reefs, and other vital areas of the basin floor are seriously altered or degraded. Carrying capacity also suffers when sediments accumulate on the bottom of the basin, causing shoaling and lowered water quality. Disruption of tidal currents, or other circulation forces that seriously reduce flushing, may allow a buildup of pollution, cause salinity changes adverse to the biota, or result in increased silt fallout. Similarly, any significant alteration of water circulation may adversely influence the pattern of distribution of life in the marine basin, and the movement of floating planktonic life.

HAZARDS

The danger to life and property from estuarine flooding is exacerbated by the intensity of development in the coastal zone. Mounting losses due to floods can be expected when new residential, commercial, and industrial construction is located in the floodplains of bays and other estuaries. Not only are more people and property exposed, but there is a reduction of the coastal environment's natural resistance to floods. Lowering dunes, eliminating wetlands, and stripping watersheds accelerates runoff to the coastal basins.[5]

The greatest threat of flooding is posed by hurricanes, which frequently cause surges of seawater eight feet or more above the normal high-water level. Such enormous surges of seawater are produced by the combined effects of a hurricane's low atmospheric pressure and high winds, the shape of the coast, and the slope of the ocean bottom near shore.[6] An extreme example of what can happen is Hurricane Camille, which in 1969 virtually destroyed Pass Christian, Mississippi, with a record surge of 24 feet above normal sea level. In 1975 Hurricane Eloise raised water levels more than 15 feet along 60 miles of coast in the Florida Panhandle (Figure 4).

In estuaries, inundation from a rising water level, rather than direct wave action, is the principal threat. The flood waters come principally from seawater driven through the estuarine mouth, or inlet, by the force of the hurricane. As mentioned in the discussion of Beaches, the form of an inlet is a key factor in protection against hazards. Inlet channels, if they are narrow, slow the surging water entering estuarine basins but also hold back the outward flow of rainwater and storm runoff that fill the basins.

The normally heavy rains that accompany hurricanes and sea storms not only fall into the estuary itself but also often produce heavy storm-water runoff that flows into the estuary from adjacent uplands. These two sources—rain and runoff—added to the ocean surge level may, during the later part of a storm, elevate bay waters higher than the ocean waters outside. The result can be extreme flooding of shore communities as well as possible breaks through barrier islands from bay water rushing seaward after the hurricane peak passes.

The flooding of estuarine shores diminishes according to the basin's capacity to receive and store both storm-water discharge from the shorelands and storm surges from the ocean. This capacity is related to the depth, width, and shape of the basin. Under normal conditions, estuarine configuration changes slowly. Suspended sediment from

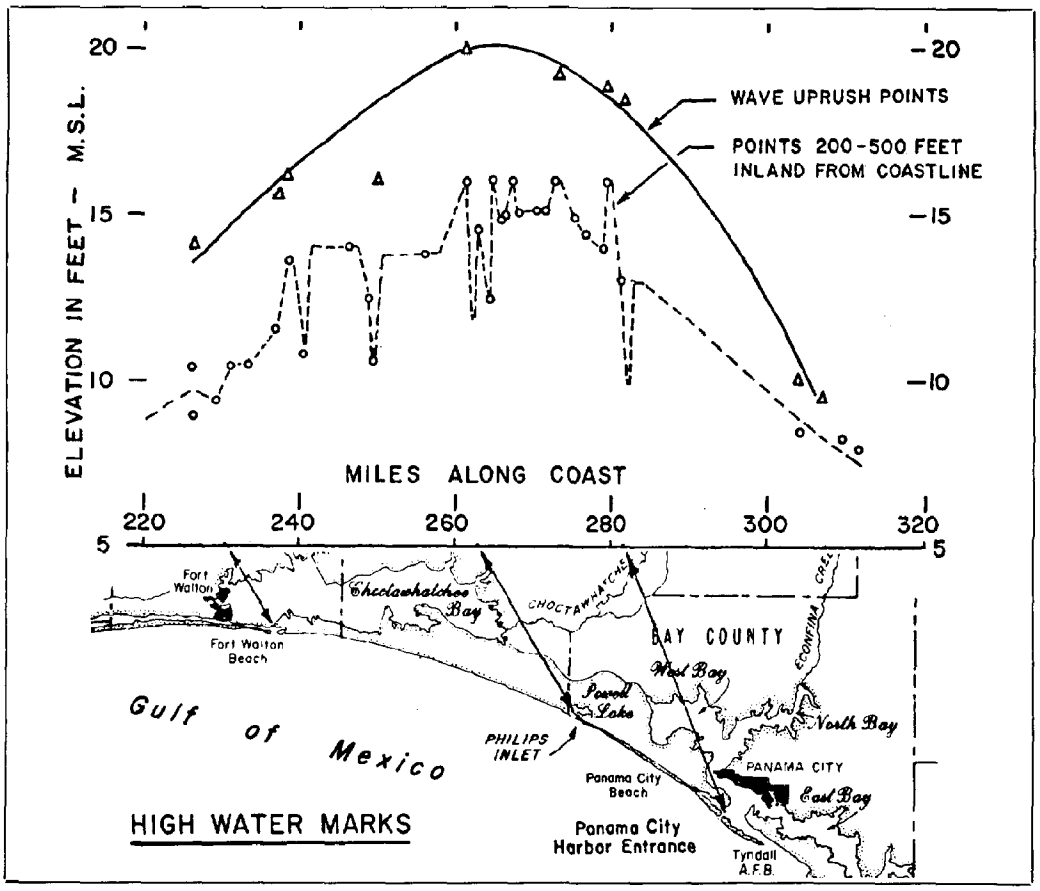


Figure 4. Hurricane Eloise high water marks, Panama City (Florida) beaches. (Source: Walter W. Burdin, "Surge Effects from Hurricane Eloise," *Shore and Beach*, vol. 45, no. 2 [April 1977], pp. 3-8.)

upland areas and the sea is deposited in the basin. Waves and currents may alter bottom configurations, as sediments are scoured off the basin floor in open areas to accumulate in sheltered areas. Biological activity also affects the structure of the basin floor through the growth of reefs or the colonization of the bottom by shellfish or marine grasses. Development in the basins or on adjacent wetlands subjects this natural process to rapid and severe changes.

MANAGEMENT POLICIES

Ecologically, development activity anywhere in coastal areas—floodlands, banks and bluffs, dunelands, beaches, or water basins—can be a potential source of damage to the coastal waters ecosystem.

One of the important objectives of your community's coastal management activities should be to prevent pollution of coastal waters. Aside from outright fish kills and other dramatic effects, pollution causes a pervasive and continuous degradation, evidenced by the gradual disappearance of fish or shellfish or a general decline in the carrying capacity of the system. The most likely sources of pollution are chemicals or organic waste.[7] These contaminants create a hostile environment that drives away fish, prevents shellfish from reproducing, or undermines the food chain.

A second management objective for your community should be to maintain the natural characteristics of basin configuration, circulation, and tidal flushing to achieve maximum resistance to hazards and maintain the optimum carrying capacity of the ecosystem. Activities that alter the configuration or composition of the basin floor create disturbances that often have far-reaching effects. The major adverse effects stem mainly from dredging, which is undertaken to create and maintain canals, navigation channels, turning basins, harbors, and marinas, as well as

to lay pipeline or to obtain material for fill or construction.

A third management objective is to maintain the natural pattern of land drainage into coastal waters. When portions of the coastal watershed system are altered or short-circuited, the natural flow pattern is disrupted and estuaries may be overburdened by surges of fresh water. This not only disturbs the ecosystem, but increases flood hazards. The most confined estuaries (particularly lagoons) need a maximum of protective controls: buffer strips above wetlands; control of sewage and storm-drainage effluents; safeguards against runoff of soils, fertilizers, and biocides from the coastal uplands; restrictions on industrial siting; and so forth.

Because they are navigable waters, coastal waters and basin floors are managed mostly by Federal and State authorities. Nevertheless, because the resources to be protected and the hazards to be minimized are of particular interest to the people that live in the surrounding area, your community and other local governments may need to influence decisions on projects that affect coastal waters.

Recommended Policy 29: Disposal of Effluents.

Require the highest levels of waste treatment for industrial and municipal effluents released into estuarine and nearshore coastal waters.

Industrial sources of pollution are mainly "point source" effluents discharged from pipes or canals. Some municipal waste products frequently discharged into coastal waters are also toxic to marine organisms. Toxic materials may have a short catastrophic impact or a more subtle chronic interference with growth and reproduction processes. The lower limits of water quality are known for many species. Below those levels, mobile animals either vacate an area or survive in reduced health and abundance. Migratory fish are particularly affected by chemical contamination of water and typically abandon coastal areas with "bad" water.[8]

The salts of heavy metals—such as lead, mercury, copper—are relatively soluble and stable in solution, and consequently will persist for extended lengths of time. Many of these salts are highly toxic to the aquatic biota, and since many marine organisms have the ability to accumulate and concentrate these substances within their cell structure, the presence of metals from industrial-waste discharge, even in small concentrations, can have deleterious effects.[9]

While the addition of large quantities of heat from industrial cooling water constitutes a form of pollution that can put stress on the ecosystem, a more important effect of cooling-water systems that require a large intake of water from estuaries is the entrainment of fish and shellfish larvae with the intake water followed by mass mortality in passage through the plant.[10] Another problem is that plants use chemical biocides to clean out their cooling water systems and discharge of the biocide in estuaries can be seriously damaging. Therefore, your community should try to ensure that power plants with large intake needs (called a "once-through" cooling system) or that discharge large quantities of toxic substances are not located on estuarine shores (Figure 5).

One of the major constituents of municipal sewage and many industrial wastes is decomposable organic material, primarily carbohydrates from sewage plants and paper manufacturing, proteins from animal matter, and miscellaneous fats and oils. These decomposable organics are not necessarily detrimental by themselves but exert a secondary effect by reducing dissolved oxygen in the water. The lower the concentration of dissolved oxygen, the lower the carrying capacity of the system.[11] Marine animals may be killed by a sudden drop in the water's concentration of oxygen, but the usual effect is to reduce their health or, if they are mobile, to drive them away as the waste spreads through the water. Disposal of sludge from sewage plants into coastal waters may create additional oxygen problems, often serious enough to disable an ecosystem. In addition to the depletion of dissolved oxygen, municipal waste discharges may introduce pathogenic organisms, settleable materials, heavy metals, and inorganic nutrients.[12]

Although industrial wastes have heavily damaged estuarine and nearshore ecosystems in the past, recent Federal water pollution control legislation administered by the U.S. Environmental Protection Agency (EPA) holds promise of preventing or greatly reducing damage in the future. Many municipal waste discharges contain significant amounts of industrial wastes,

which may add to the variability and complexity of the wastes discharged. Technology exists to provide thorough treatment for nearly every kind of municipal and industrial waste, and there is no technical reason for your community to allow treatment insufficient either to protect the environment from damage or to permit optimum ecosystem function. Potential effluent dischargers unwilling to meet these standards may be required, through zoning or other controls, to locate away from the coast.

Recommended Policy 30: Siting of Heavy Industry.

Locate industrial facilities inland if they have a high potential for disturbance of coastal ecosystems.

The carrying capacity of the coastal ecosystem is limited by water quality. The effect of any pollutant depends on where it goes, how concentrated it is at the point of discharge, how rapidly it is assimilated or flushed out of the environment, and whether it can be dissolved in the water column or is chemically fixed to sediments. All of these conditions depend on water movement and circulation patterns, which, in turn, are governed by the relationship of tide and river flow to estuarine shape and size.[13]

In many bays, embayments, lagoons, and tidal rivers, circulation is sluggish and pollutants may build up to a level that can cause damage, even with efficient treatment of effluents. An ever-present threat to the estuarine ecosystem is the chance of a catastrophic oil spill or release of other hazardous materials. The large volumes of petroleum and chemical products transported through the estuarine zone by ships, barges, pipelines, and railroads present a continuing potential for accidental bulk spills of oil or chemicals.[14] Industries with high waste output, such as power plants with large estuarine water intakes, chemical plants with irremediable toxic discharges, and oil-transfer terminals, should not be located on estuarine water bodies unless there is no practicable alternative—that is, the private and public costs of protection of ecological resources from pollution would be exorbitant (Figure 6).

In some coastal areas that have undergone intensive development, only a few locations ideally suited for industrial use in relation to waste discharge still remain. Your community can identify, inventory, and reserve these prime locations as important industrial resources. Many such sites in growing metropolitan areas have been and continue to be taken over by housing and commercial establishments, which are not really depen-

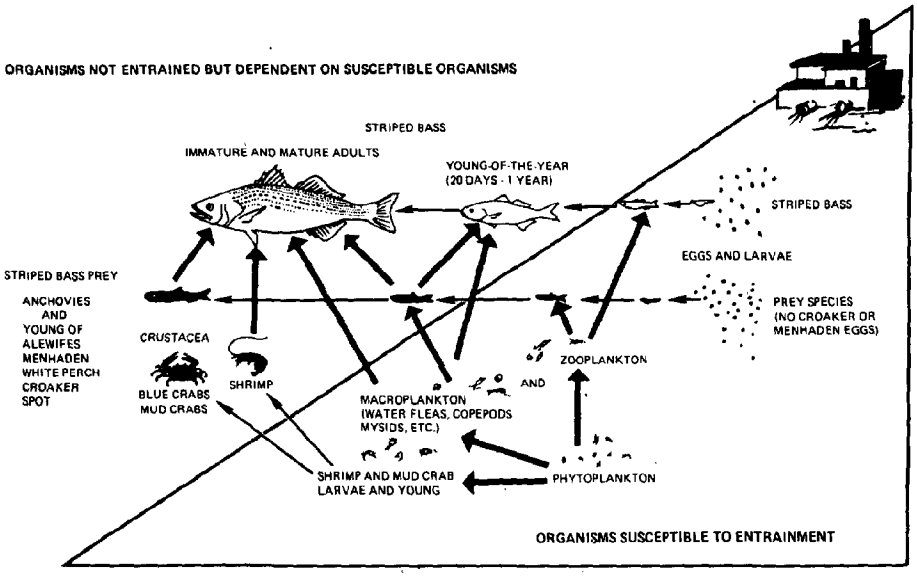


Figure 5. Small fish and planktonic forms are subject to high mortality when swept into power plants with the flow of cooling water. (Source: State of Maryland, *Record of the Maryland Power Plant Siting Act*, Vol. 1.)

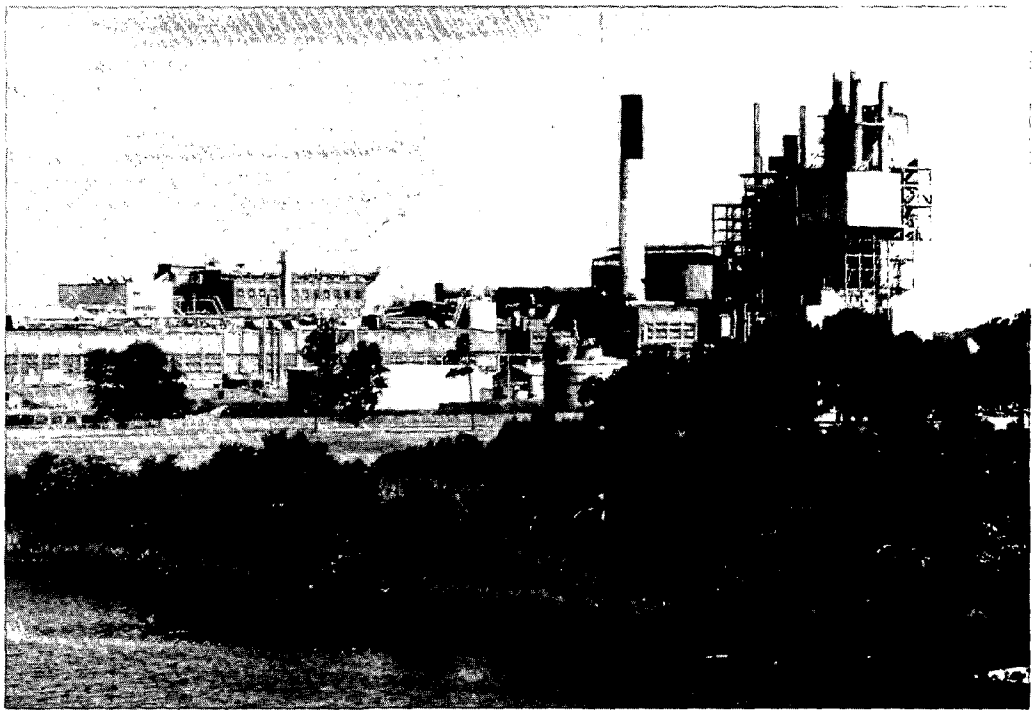


Figure 6. Modifying older industrial plants, such as this paper mill in South Carolina, to protect estuaries from pollution is often difficult because the plants were built near the water expressly to make disposal of wastes easy. (Photo by John Clark.)

dent on waterfronts. To ensure that prime sites with the lowest pollution potential are available when needed for industrial use, you may have to apply special land-use controls, restricting the development of these sites to waterfront-dependent industry.

Recommended Policy 31: Diffuse Sources of Pollution.

Require the highest standards for control of storm-water runoff and other diffuse sources of pollution.

Sources of diffuse (or nonpoint) pollution that principally affect coastal areas are septic tanks, dumps, landfills, concentrations of boats, and, particularly, storm-water runoff from adjacent watersheds. These sources, working either separately or together, may cause serious eutrophication or toxicity where the pollutants concentrate in confined estuarine water bodies. Clearly, your community should locate dumps, sanitary landfills, septic tanks, and similar sources away from watercourses, and, to the extent possible, out of floodplains, to prevent leaching of pollutants into coastal waters. Also, you will have to enforce standards to prevent pollution from boat and marine wastes.

Land-alteration activities, principally those associated with site preparation for development and for cropland, as well as controls on shoreline and water-basin alterations, are among the most important causes of nonpoint source pollution. Specific constraints should be imposed on project location, design, and drainage engineering throughout the coastal watershed (see Coastal Uplands and Floodlands sections for details). Poorly designed urban storm-water systems may have quite adverse effects on coastal waters, especially estuaries.

If your community is extensively developed, it may have large-scale, storm-water sewer systems that collect runoff and pipe it directly into coastal waters. This not only introduces high loads of pollutants (if not treated) but causes accelerated discharge to the coast. Where this discharge augments the ocean storm surge in estuaries, the additional elevation of water may increase flooding. The flow of runoff in storm sewers may be stopped or reversed by storm surges from the ocean and the torrential rains that typically accompany hurricanes or heavy winter storms. Consequently, with runoff obstructed, low-lying areas may flood even more, with damage to shops, homes, and

Figure 7. Piers built on pilings, unlike those built on solid fill, permit circulation of water in estuaries to continue with the least interference. (Photo of Apalachicola Bay, Florida, by John Clark.)

other structures that might otherwise be above the peak surge height of the storm or hurricane.

For protection of coastal waters, the best storm-water system is one that most nearly simulates the natural system, that is, one that has features to detain storm runoff and to provide the maximum of soil filtration for natural purification of pollutants. Ideally, your community should preserve and enhance the use of existing natural drainageways—creeks, sloughs, swales, and so forth—to the maximum (see Floodlands section for details). While this approach is not feasible in urban centers, it is quite possible in developing areas along much of the coast. For example, St. Mary's County, Maryland, encourages the use of natural drainage swales for all new subdivisions along the Patuxent River and requires artificial grassed (sodded) swales for all connector drains.

Recommended Policy 32: Structures in Coastal Waters.

Avoid in coastal waters the use of structures that would adversely impede water circulation.

If your community is placing structures in estuarine basins, the structures should be designed so as not to interfere significantly with water flows. In particular, this applies to piers, docks, wharves, bridge abutments, and dredge spoil mounds. Restricting flows can block the rapid outflow of storm waters that accumulate in estuaries, thus increasing the risk of floods. Solid-fill piers, docks, causeways, and other structures may adversely alter tidal circulation by restricting the flow to narrow watercourses, thus creating eddies and turbulent backwaters, which increase the deposit of sediment. Therefore, to the extent possible, encourage the use of elevated, pile-supported structures, which allow freer flow of tidal currents (Figure 7).

Reducing the capacity of the estuary to contain runoff waters during storms by filling around its edges may also be dangerous. Bulkheading shorelines to extend the land, for example, reduces the water surface, may increase potential flooding hazards, and deprives beaches of the sand and gravel originating from "feeder bluffs." Surges of storm water flowing rapidly from coastal watersheds and tributaries before and during the "landfall" of a hurricane may cause water to rise higher in a bay than in the ocean. If the bay surface is shrunk by bulkheading, there will be less capacity to hold runoff, thereby

increasing the potential inundation of floodlands.[15]

It has become increasingly evident in recent years that "nonstructural" floodplain management, rather than the use of flood-control structures, is the better approach to preventing losses from floods. Because many homes now situated in coastal areas are subject to flood damage, however, proposals are still made for areawide engineering solutions, such as sealing off a whole bay system by a tide gate at the inlet or building extensive artificial barrier-dune structures. These structural solutions are expensive, may cause ecological damage by blocking circulation, and can foster a false sense of security, which promotes the occupancy of hazardous shore areas. In developing its coasts, your community should reserve frequently flooded areas for uses that do not expose life and property to risk—open space, wildlife habitat, shelter belts, buffer strips, nonresidential recreational structures, and scientifically controlled silviculture.

Recommended Policy 33: Sites for Removal and Deposit of Dredged Material.

Select locations for removal and deposit of dredged material to avoid adverse effects on basin floors and critical areas such as grass beds.

In the years before the Federal agencies involved in construction became conscious of ecological necessities, spoil—the term commonly used for sediments and other material excavated by dredges—often caused serious loss of estuarine resources. It was often deposited on vital bottom habitats such as grass beds or shellfish beds. Large-scale spoil banks or landfill deposits in water basins restricted water flow and tidal exchange, causing particular damage where one portion of an estuary was isolated from another by long, uninterrupted spoil banks. Circulation was blocked, stagnation set in, and large portions of the estuarine area were degraded, and sometimes eliminated, as productive units of a coastal ecosystem.[16] These problems have been greatly reduced in recent years by activities of the U.S. Army Corps of Engineers, the Fish and Wildlife Service, National Marine Fisheries Service, and the U.S. Environmental Protection Agency.

Your local government can assist Federal agencies by monitoring private dredging projects and advising on Federal works. In doing so, you should remember that when dredging occurs in coastal water basins, care must be taken not to damage, directly or indirectly, vital habitat areas such as grass beds, shellfish beds, coral reefs, and productive basin-floor habitats. Adequate protection often requires a surrounding buffer strip of several hundred feet (or thousands, in some cases) from which dredging should be excluded. Therefore, an important part of your community planning should be to identify all vital habitat areas so that all interests will be advised of protected locations and required safeguards. Community programs for ecological resource conservation should set particularly high standards to protect ecologically vital areas, which are essential to the survival and well-being of certain valuable species or to maintenance of the system's ecological carrying capacity.

To protect beaches from erosion, dredge removal of sand for beach fill, construction fill, or aggregate should be limited to offshore areas beyond the limits of the active beach system. (See Beach section for details.) This will prevent destabilization of the beach. In most cases, sand should not be removed from estuaries because the potential for ecologic disruption of the estuary is too high. In any case, the grain size of sand from estuaries is usually too small to be useful in restraining ocean currents and waves, which is a requirement of beach fill.

When the spoil removed in a dredging operation is coarse and clean—that is, it consists of sand or gravel without much clay, mud, or organic matter—it may be used for many beneficial purposes. But to be fully acceptable, the spoil should not contain toxic pollutants, it should not be deposited in ridges that significantly impede water flow, nor should it cover vital habitat areas or productive benthic habitats. Generally, you should make certain that spoil is deposited in confined disposal sites, taken to a safe ocean site for disposal, or put in nonsensitive upland areas. The disposal site should be large enough, initially, so that it can last for the life of the project.

Millions of cubic yards of spoil are produced each year in dredging new navigation channels and maintaining existing ones. Although some spoil is polluted, or useless muck, some is clean and suitable for creative engineering projects, such as creation of artificial islands to increase breeding habitats for birds and to expand wetlands

along the island fringe. If properly located and designed, these islands may increase ecosystem carrying capacity. However, they must be planned with the utmost care.

Clean spoil from channel dredging can also be deposited as estuarine breakwaters to protect marina sites. Properly designed, the breakwaters will allow adequate circulation around the marina area and create useful habitats as additional benefits.

The following criteria are suggested for the design of spoil islands: (1) avoid all existing vital areas, including grass beds, shellfish beds, and wetlands; (2) use coarse sand or other material not susceptible to rapid erosion (fine, organic sediments or polluted spoil should not be used); (3) locate the spoil island in a protected area away from heavily used boat channels to minimize erosion from boat wash; (4) vegetate the island with both upland plants and marsh grasses as soon as possible; and (5) shape the island so as to facilitate water movements—for example, make it elliptical in shape and parallel to water flows.

Dredge spoil deposits are often proposed for mitigation, that is, as compensation for some damage done elsewhere in a project—say, as a marsh fill. Mitigation proposals must be carefully studied, however. If they are an excuse for deliberate degradation of natural marsh or bird habitat, they should be viewed skeptically and questioned thoroughly. It has not yet been proved that a man-made marsh ever attains the durability and productivity of a natural one. Restoration or upgrading a previously degraded system by building islands or marshes may be possible, but improving on a natural area by such construction is normally not possible.

Recommended Policy 34: Dredging Performance.

Require seasonal, locational, and operational controls on coastal dredging projects.

The season when dredges are allowed to operate, and their mode of operation, should be controlled to reduce the spillover of silt and of foul, dredged materials into biologically productive areas. Each of the two major types of dredges—mechanical and hydraulic—has a different locus for pollution problems (Figure 8).

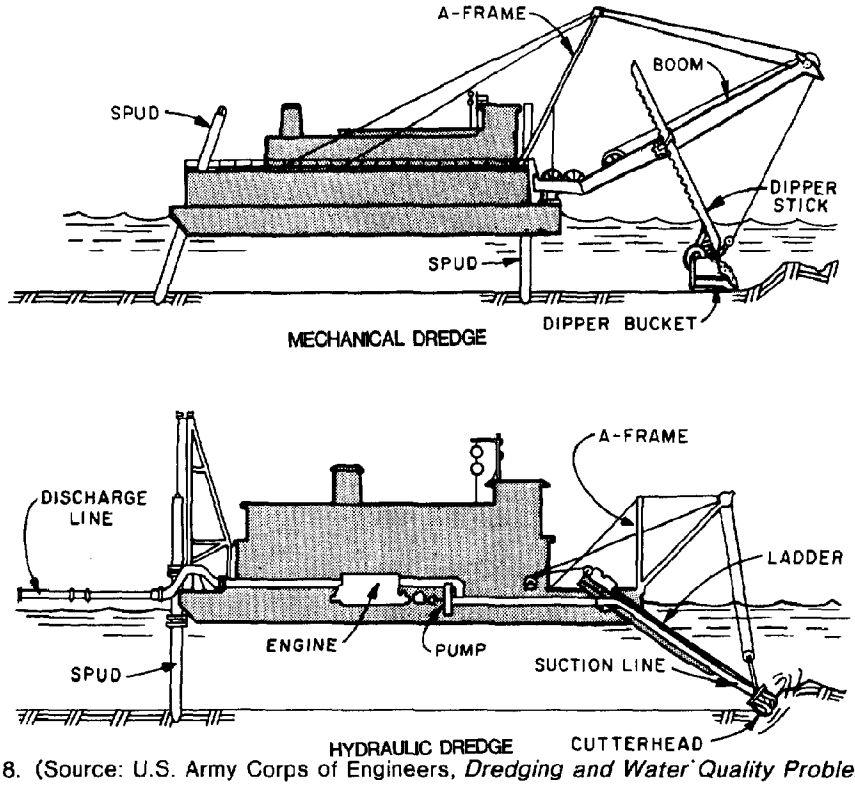


Figure 8. (Source: U.S. Army Corps of Engineers, *Dredging and Water Quality Problems in the Great Lakes: Summary Report* [Buffalo, N.Y.: U.S. Army Corps of Engineers Buffalo District, 1969].)

Mechanical dredges cause the greatest disturbance at the point where dredging occurs. To contain turbid water near the dredge site, preventive "silt curtains" or "diapers" may be suspended in an arc around the dredge to prevent the silt and chemicals released from escaping. While it makes sense to use such devices, they cannot be taken as a panacea because they only work well in shallow still waters (1 knot current or less) near shore.[17]

Hydraulic dredging, on the other hand, creates problems at the end of the delivery pipe, where the spoil is discharged as a slurry (80 percent water) and must be confined behind dikes while the silt settles out. Although these conditions are temporary, lasting for the period of dredging and a few days after its completion, the sum of environmental impacts created during entire work periods is often of sufficient magnitude as to require that steps be taken to eliminate or control their extent. If the dredged material is clean sand, precautions may be unnecessary.

Depressions or "deep holes" dredged in the bottom may affect the mixing and flushing of estuarine waters, eventually causing adverse changes in temperature, salinity, or dissolved oxygen and sediment accumulations. The stagnant waters in artificially deepened areas act as sediment traps: the affected area becomes unproductive, bad quality water may spread to neighboring areas, and debris and anaerobic sediments are flushed out during storms.[18]

Dredging typically has more adverse consequences at one time of year than another. Therefore, the schedule of dredging operations should avoid biologically critical periods. Dredging operations should be suspended near known spawning and nursery areas during periods when the young of a species are passing through critical stages of development. Dredging should also be suspended along migration routes during known periods of migration of such species as salmon or striped bass.

Recommended Policy 35: Channel Location and Design.

Select routes and designs for navigation channels that minimize adverse effects on basin floors.

In the past, many activities associated with navigation in estuarine basins have significantly altered the basin floor, thereby disturbing the natural pattern of water flows. These activities have included: changing flow through inlets and passes by

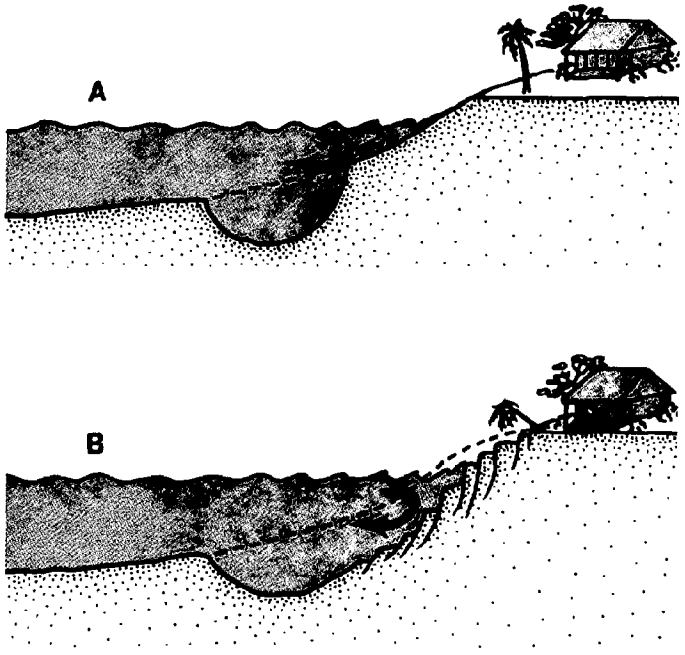


Figure 9. Channel cuts located too close to the shoreline can cause (A) slumping and (B) erosion of the shore. (Source: Adapted from John Clark, *Coastal Ecosystems: Ecological Considerations for Management of the Coastal Zone* [Washington, D.C.: The Conservation Foundation, 1974].)

constricting them with bulkheads or deepening them by dredging; impeding water flow in the estuary with "spoil banks" of disposed dredged material; and diverting water flow by channel dredging. Major deepening of harbor inlets and channels across bays and up tidal rivers has often significantly altered water-circulation patterns, causing complex ecological effects throughout the basin and accelerating the flow of storm surge into the estuary. Far more care is now taken by Federal and State reviewers to avoid adverse impacts and to reject unnecessary or damaging projects.

In considering the probable impact of a channel project, you must recognize that, in addition to the cost of the initial work, there are continuing costs for periodic maintenance dredging. Projects that are essential to the public, and for which there are no alternative solutions, should be designed with care and built under stringent environmental controls. To reduce the side effects, you must start with appropriate choices of location and design of the work: suitable alignment of the channel, minimum dimensions, judicious choice of methods to be used in construction (e.g., choice of dredge type), use of appropriate performance controls on dredges, proper disposal of spoil, selection of an appropriate time of year for construction, and so forth.[19]

The adverse environmental impacts associated with many navigational dredging projects can be reduced greatly by minimizing the length, width, and depth of the channels. Excessively wide channels may lead to unnecessary loss of adjacent vital habitat areas, such as shellfish or grass beds. In general, a navigation channel needs to be no wider than approximately three or four times the width of the largest vessel for which it is designed. Similarly, operable channels do not need to be deeper than about four feet beneath the deepest draft vessel at low water, provided that traffic moves at moderate speeds so as not to stir up the bottom where fine sediment has accumulated. In many cases, you can add to this depth an additional foot or so to accommodate siltation or slumping and to reduce the frequency of maintenance dredging.

Projects that would cause accelerated shore erosion should be avoided or modified in such a way as to eliminate the erosion-inducing effects. For example, you will have to make sure that dredging is avoided close to the shore in shallow-water areas where it may cause severe recession of the shoreline (Figure 9). Recession occurs when the bank or beach is destabilized by channel slumping and by direct erosion. The presence of a channel may increase the frequency and speed of boat passage and thus the intensity of erosion of the shoreline from boat wakes. In addition, the deepening of the shoreline will cause higher wave impact, decreasing the dissipation effect that shallower water bottoms have on incoming waves. The solutions are: (1) use natural channels to the extent possible, and (2) carefully choose artificial channel routes. Also, to avoid excessive slumping of the adjacent bottom into the channel and repeated maintenance dredging, channel sides should be dredged out to a final stable slope or "angle of repose" during the initial operation, the exact cut depending on local geohydrological conditions.[20]

One of the most obvious adverse effects of channel dredging is the direct removal of vital habitat areas such as grass beds, shellfish beds, coral reefs, and other productive marine habitats. Therefore, an important part of planning includes the advance identification of all vital habitat areas. To a large extent, vital-area disturbance can be avoided by limiting dredging to existing natural estuarine channels (Figure 10).

Of all the forms of estuarine life affected by dredging, oysters are perhaps the most immediately vulnerable because they are sedentary creatures. The oyster chooses its home for life when it is a tiny larva, one-third inch long. Oyster larvae hatch from floating eggs in early summer to drift about with the current until they find on the bottom a suitable firm object to which they can attach themselves for the rest of their lives. A deposit of silt from dredging one-tenth inch thick on shell or rocks is enough to discourage young oysters from attaching themselves. And once they have found a clean solid surface for attachment, they have no chance at all to escape a dredge or a suffocating blanket of silt. The Chesapeake oyster industry has suffered more damage than any other from these effects: in 1880, 72 million pounds of oysters were harvested from Chesapeake Bay; by 1920, the yield had dropped to 31 million, and recently it has dropped to around 8 million. It should be noted, however, that this loss cannot be blamed entirely on siltation.[21]

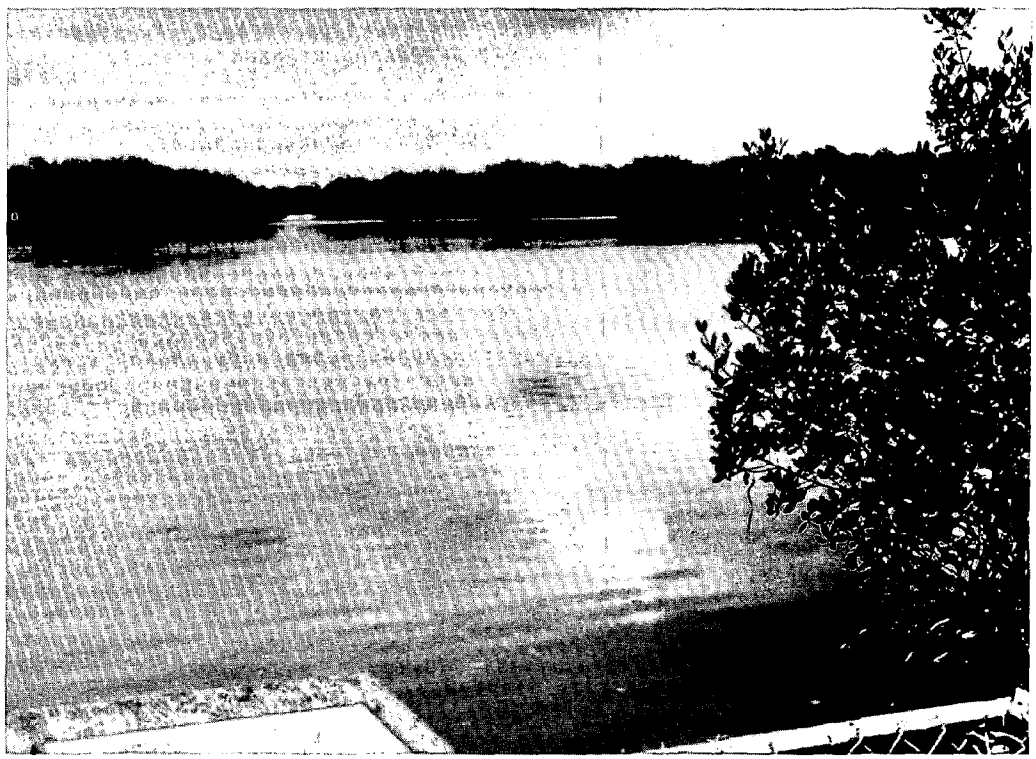


Figure 10. The natural beauty and ecological richness of estuarine habitats is conserved by avoiding needless dredging projects. (Photo by John Clark.)

If your community is one where navigation dredging is an important concern, you may want to provide specific standards on dredging. This can be done with aid from the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, or another source of technical assistance. The following are examples of community standards developed by the Nassau-Suffolk Regional Planning Council (Long Island, New York):

- Designate the maintenance width of *navigation channels* serving boat ramps at approximately 50 ft., marinas and other recreational facilities at up to 100 ft., and major commercial facilities at up to 200 ft., unless wind, current, or other unique local conditions necessitate the greater separation of boating traffic.
- Locate new *navigation channels* so as to provide *at least a 500 ft buffer* zone between boating traffic and sensitive natural areas (e.g., wetlands, wildlife sanctuaries), rapidly eroding shorelines, or bathing beaches, unless smaller buffer zones can be shown to be unavoidable and/or appropriate.
- Limit slopes on *navigation channel* sides, based on slumping characteristics, up to a maximum slope of 1 on 3. Adjust channel locations and widths, if possible, to minimize slumping of adjacent lands or mud flats.[22]

Recommended Policy 36: Coastal Basin Restoration.

Encourage the restoration of polluted coastal waters and basin floors.

The water quality of coastal basins can be restored in part by controlling the sources of pollution. However, in many coastal basins there are extensive existing accumulations of polluted silt, sometimes many feet thick. Much of the silt in estuaries is caused by upland soil erosion from poor farming practices. In other areas, urban runoff has caused eutrophication and the buildup of organic ooze on the bottom. There are various opportunities and methods for removing this silt or mitigating its effect. The major obstacle is high cost.

Corrective dredging, the principal approach, is expensive and difficult to implement; however, the ecological benefit to public waters and natural resources, as well as aesthetics within a community, may override the consideration of expense. Your community should inventory its coastal basins to identify those areas seriously degraded by sediment and should get in

touch with appropriate agencies for possible financial assistance in cleanup projects.

One example of the timely implementation of a strategic plan is the restoration of Tillamook Bay, Oregon:

> *What are the opportunities to restore a dying estuarine ecosystem through selective dredging or current manipulation? Practically no attention has been given to opportunities to restore an estuary that has been damaged. In Oregon, renovation and revitalization have been proposed for such estuaries as Tillamook, Nestucca, and Siletz Bays. A 1972 project by the U.S. Army Corps of Engineers in Tillamook Bay, which cleared the channels of the Wilson and Trask Rivers, may have successfully pioneered the concept of renovation. Large scale efforts are now needed.*[23]

The 1973 project was undertaken after massive flooding, which qualified the local area for federal disaster relief funds. Because it has prepared a plan ahead of time, the community was able to obtain available funds and direct them on short notice to solving an environmental problem identified far in advance.

While many coastal ecosystems remain seriously degraded by blockage of water flow, there are other encouraging examples of systems that have been vastly improved by restoration of circulation. For example, Great South Bay and Moriches Bay on Long Island were greatly disturbed by organic pollution until the reopening of Moriches Inlet enhanced circulation. Similarly, Escambia Bay, Florida, was heavily polluted and almost destroyed ecologically until a railroad bridge that blocked circulation was rebuilt to allow water to flow under it more freely.

IMPLEMENTATION GUIDELINES

Although local plans, regulations, and programs can be of some use in implementing the eight policies on coastal waters, greater opportunities for local action appear to lie in seeking assistance available under Federal and State programs. Your community should be prepared to address three principal management issues:

First, **controlling discharges of pollutants** into coastal waters, in accordance with Policies 29 (Disposal of Effluents), 30 (Siting of Heavy Industry), and 31 (Diffuse Sources of Pollution).

Second, **controlling alteration of basin floors**, in accordance with Policies 32 (Structures in Coastal Waters), 33 (Sites for Removal and Deposit of Dredged Material), 34 (Dredging Performance), 35 (Channel Location and Design), and 36 (Coastal Basin Restoration).

Third, **removing pollutants from basin floors**, in accordance with Policy 36 (Coastal Basin Restoration).

1. Controlling discharges of pollutants.

Although Federal and State governments bear principal responsibilities for controlling point-source discharges of pollutants, your community can also contribute to pollution control—for example, by working on regional plans to reduce diffuse ("nonpoint") sources of pollution, discussed in the sections on Floodlands and Saltwater Wetlands. You can control the location of new pollutant sources, through land-use plans and regulations, and you can establish and operate systems for municipal wastewater collection and treatment.

If new treatment facilities are needed, you will likely work closely with state water-quality agencies and U.S. EPA, which pays most of the cost of most new municipal wastewater treatment facilities in the United States. In some other situations, however, the community trying to control pollutant discharges from existing sources is likely to find itself principally playing the role of watchdog, calling local problems to the attention of Federal and State officials.

In their watchdog role, communities will rely mainly on provisions of the federal Clean Water Act and related state laws. Two provisions of the Clean Water Act have already been discussed: Section 208, which deals with regional water quality planning (see p. 35), and Section 404, which controls discharges of dredged or fill material into wetlands and other waters (see p. 68). Other principal provisions are described in Part II of this manual. Some special opportunities for local action may also arise under the following provisions of the Clean Water Act:

National Pollutant Discharge Elimination System (NPDES). Most point sources of pollutants require an NPDES permit, which is issued by U.S. EPA or, with its approval, by State agencies. Complex conditions are often included in the permits. Communities with sufficient expertise will sometimes find it beneficial to review conditions carefully

during the comment period prior to permit issuance.

Oil and Hazardous Substances. The Clean Water Act sets fines and penalties for oil spills and discharges of other hazardous substances. In addition, it authorizes the Coast Guard or EPA to clean up spills and charge the polluter for the work.

Your community can help protect local waters by notifying the Coast Guard of suspected oil spills. While spills of toxic chemicals may be more difficult to identify, they, too, may have a great impact on coastal fisheries.

Vessel Sewage. Setting standards for "onboard marine sanitation devices" (toilets) is a responsibility of the U.S. Coast Guard. Once Coast Guard regulations are issued, the Clean Water Act bars alternative state or local controls.

A community experiencing problems with vessel sewage should consult with the Coast Guard, which has considerable discretion in setting standards. One provision permits the Coast Guard to designate waters where discharges are prohibited because of local pollution problems, or to protect drinking-water supplies. Application of this provision may be influenced by your community, since the prohibition can be enforced only if adequate alternative facilities are locally available. This provision can be an effective method for dealing with diffuse pollution from vessels, in accordance with Policy 31.

Public Participation. Your community should remain alert to changes in the Clean Water Act. One way to stay aware of these changes is through the public-participation procedure emphasized in the Act. In the construction grants program for new sewage-treatment facilities, there may be special public hearings or other procedures intended to involve local residents in the decision process. In the Section 208 planning process, the law requires participation of local government officials. Citizen-suit procedures also provide local officials and other local residents access to the courts to present evidence of violations of the law.

2. Controlling alteration of basin floors.

Most localities make little effort to control dredging, filling, and building offshore structures, any of which can alter basin floors. Typically, your community would defer to Federal and State judgements on these matters.

Increasingly, however, localities are becoming aware of the impact that these activities have on water circulation, erosion, and water pollution. Accordingly, some are trying to influence Federal and State judgements.

The applicable Federal controls, administered primarily by the U.S. Army Corps of Engineers, have already been discussed in the Saltwater Wetlands section (see p. 67). That discussion also describes ways that a local government can influence Federal decisions. If your community seeks to do so, it may encounter the following problems:

First, evaluating the environmental consequences of dredging, filling, and offshore structures requires extensive data and special expertise. For some critical estuarine areas, the Corps has even constructed complex models of the basin floor to simulate natural forces and evaluate the long-term consequences of channel alterations. Typically, therefore, if your community wishes to influence Federal decisions, it will have to seek technical advice. This may be available from State navigation, coastal management, and fisheries agencies as well as from the Corps, U.S. National Marine Fisheries Services, and the EPA 404 coordinators.

Second, your community will have to choose the means by which it wants to influence Federal and State decisions. After a community has taken formal action prior to a Federal agency decision, it needs to inform Federal decision makers of its position. Some Federal procedures—for instance, those of the Corps—give great weight to official local plans and policies. One technique for putting local views before Federal officials is public participation, using procedures like the environmental impact statement process (see p. 37). The A-95 process of formal State and local comment on certain Federal agency grant and assistance proposals is a second avenue open to some localities. Your community should also seek out the official or agency in State government that is designated in Federal regulations for comment or review in a particular proceeding. In controversial situations, Federal agencies often turn to those State sources for further advice and interpretation. For instance, the regulations of the Corps identify the governor as the "official" spokesman when there is disagreement

among State agencies in a permit proceeding for the dredge and fill regulatory program. If the State has an approved coastal management program, that, too, serves as a means for Federal agencies and the State, perhaps including local governments, to notify one another of planned activities.

3. **Removing pollutants from basin floors.**

Local governments will occasionally have an opportunity to participate in projects for removal of pollutants from basin floors, as described in the discussion of Policy 36 (see p. 118).

Part II

This section of the guidebook summarizes the Federal programs and regulations that are most relevant to coastal environmental management in your community. The discussions are arranged by agency:

Department of Agriculture, Soil Conservation Service
Department of Commerce, National Marine Fisheries Service
Department of Commerce, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management
Department of Commerce, National Oceanic and Atmospheric Administration (Coastal Hazards Initiative)
Department of Defense, U.S. Army Corps of Engineers
Department of the Interior, U.S. Fish and Wildlife Service
Environmental Protection Agency
Federal Emergency Management Agency
Water Resources Council

Department of Agriculture, Soil Conservation Service*

RESOURCE CONSERVATION AND DEVELOPMENT PROGRAM (RC&D)

Speeding up resource programs in multiple-county areas as a base for economic development and environmental protection is the aim of resource conservation and development (RC&D) areas authorized by the Food and Agriculture Act of 1962 (Public Law 703, 87th Cong.). The Soil Conservation Service (SCS) is responsible for helping local sponsors of these rural-urban areas and for helping to coordinate the assistance of other Federal and State agencies in meeting sponsor objectives.

Each RC&D area has its own unique goals, but most aim to:

1. Develop land and water resources for agricultural, municipal, or industrial use and for recreation and wildlife.
2. Provide soil and water resource information for a variety of land and water uses including farming, ranching, recreation, housing, industry, and transportation.
3. Provide conservation measures for watershed protection and flood prevention.
4. Accelerate the soil survey where it complements RC&D measures.
5. Reduce pollution of air and water.
6. Speed up conservation work on public land and on individual farms, ranches, and other private holdings.

Further information on RC&D: Contact your local conservation district or local Soil Conservation Service representative. The SCS office is listed in telephone directories under U.S. Government, Agriculture, Soil Conservation Service. Assistance is available without regard to race, creed, color, sex, or national origin.

RIVER BASIN INVESTIGATIONS

SCS directs Department of Agriculture water resource activities that require cooperation with other agencies and with State governments. Public Law 566 provides broad authority for cooperation between USDA and State governments and other Federal agencies in river basin planning, surveys, and investigations.

SCS helps survey river basins at the request of cooperating State or Federal agencies. Surveys help in coordinating upstream watershed projects, for which SCS has responsibility, with measures taken downstream to solve problems of water resource use and development. Surveys identify water and land resource problems, analyze the economic base and environmental setting of the area, and suggest alternative ways to solve problems and to improve the local economy and environment.

Cooperative river basin surveys and investigations, although authorized by Public Law 566, are not directed specifically toward developing watershed projects. They provide a basis for coordinating resource conservation and development and are helpful in guiding upstream watershed activities. The Forest Service and Economics, Statistics and Cooperatives Service also participate in these studies.

* This description has been supplied by the Soil Conservation Service.

Technical Description: Program regulations in 7 CFR 621 and in the internal SCS Directives System. Consult the list of SCS State Conservationists for names, addresses, and telephone numbers for further information.

FLOOD PLAIN MANAGEMENT ASSISTANCE PROGRAM

State and local governments need technical data and assistance in identifying flood hazards and preparing programs for flood plain management. Despite substantial efforts to control flooding, the nation's flood losses are continually increasing, partly because of unwise use of flood plains.

SCS assists State and local governments by carrying out flood hazard evaluations, inventory of natural and beneficial values, and public participation in flood plain areas. Other optional study features include local flood plain management options, floodway determinations, and study followup. The studies are requested by local communities and coordinated by the responsible State agencies. A report is prepared that delineates floodprone areas. The report provides State and local planners with a basis for planning and regulating use of flood plains.

Technical Description: Program regulations are contained in 7 CFR 621 and in internal SCS Directives System. For further information, consult the Conservation District, whose address and telephone number can be found in your telephone directory. Additional information may also be obtained from SCS State Conservationists.

WATERSHED ACTIVITIES

Rural and urban residents in hundreds of communities have learned that by working together through watershed projects they can help solve their land use and water problems. With Federal help they can reduce erosion, siltation, and flooding; supply water for growing domestic and industrial needs; provide for recreation; recharge ground-water reservoirs; provide for water quality management; and meet water conservation needs.

Watershed projects under Public Law 566, enacted in 1954, establish soil and water conservation measures on private and public land and construct dams and other water control structures on upstream tributaries to insure effective water management. Watershed projects are based on local initiative and responsibility; State review and approval of local proposals and opportunity for State financial and other assistance; and Federal technical and financial assistance.

State agencies and qualified local organizations can sponsor a watershed project. These include soil and water conservation districts; municipalities; counties; watershed, flood control, conservancy, drainage, and irrigation districts; and associations of water users or similar organizations not operated for profit.

SCS administers the watershed program for the Department of Agriculture. It also administers watershed work, authorized by the Flood Control Act of 1944 (Public Law 534), in 11 major watersheds comprising about 30 million acres.

A watershed project under Public Law 566 is limited to an area no larger than 250,000 acres. Such a project can be multipurpose.

The Federal government gives technical help in planning and installing the project measures, pays the full cost of building flood control measures, and shares the cost of other measures. It lends to sponsoring organizations to finance their share of the cost up to a maximum of $5 million per project for a maximum of 50 years at a reasonable interest rate. It also advances funds to develop water supply for future municipal or industrial use amounting to a maximum of 30 percent of the cost of a multiple-purpose reservoir and defers payment for a maximum of 10 years without interest.

Major obligations of local sponsors include acquiring land, easements, and rights-of-way; awarding contracts for construction on private land or electing to delegate contracting to SCS; sharing the construction cost of measures if appropriate; and operating and maintaining the project when completed.

RURAL CLEAN WATER PROGRAM (RCWP)

The Rural Clean Water Program (RCWP) is a voluntary program authorized in 1977 by Congress to apply best management practices (BMP's) on privately owned rural land in selected areas. Landowners in eli-

gible project areas may enter into 5-10 year contracts until September 30, 1988, to receive cost share and technical assistance to apply these practices to help control water pollution.

Areas eligible for RCWP projects: Each State has developed 208 Water Quality Management (WQM) plans that identify rural areas within the States that are contributing to water pollution. From these areas, the Governor selects potential RCWP projects. With the assistance of a State Rural Clean Water Coordinating Committee (SRCWCC) and following public meetings, the Governor decides in which order these applications will be developed. The Governor recommends an administering agency for the potential RCWP projects and authorizes RCWP applications to be completed.

Funding: The National Rural Clean Water Coordinating Committee (NRCWCC) will review all RCWP applications for the purpose of recommending those projects to be funded each fiscal year. Project approval will be contingent upon funds appropriated for the RCWP each fiscal year. The Clean Water Act authorized $200 million for FY 1979 and $400 million for FY 1980. The administration included $75 million in the FY 1980 budget for RCWP.

Technical Documents: The National Rural Clean Water Program Manual is in eight parts. Part 500 contains the program objective, description, and general program administration; Part 501 provides guidance for the development, review, and approval of an RCWP application; Part 502 contains guidance for project operation after an area has been approved as an RCWP project—administration of grant agreements by the administering agencies, preparation, administration, and application of practices in the RCWP water quality plans and contracts is included in this part; Part 503 contains guidance about financial management, including the accounting system and use of grant funds by administering agencies; Part 504 gives the requirements for reporting, monitoring, and evaluating RCWP accomplishments; Part 505 is made up of exhibits of agreements, reports, and forms; Part 506 is the appendix, which includes a glossary of terms, and other reference material; Part 507 is a topical index.

Department of Commerce, National Marine Fisheries Service*

THE COMMERCIAL FISHERIES RESEARCH AND DEVELOPMENT ACT OF 1964 (PUBLIC LAW 88-309 AS AMENDED)

Authorizes the Secretary of Commerce to cooperate with the 50 States, the Commonwealth of Puerto Rico, and the Governments of the Virgin Islands, Guam, and American Samoa, and the Trust Territory of the Pacific Islands in carrying out research and development of the Nation's commercial fisheries. Projects eligible for funding include research, development, construction, and coordination. Cost-sharing projects are funded up to 75 percent level of Federal participation, whereas projects to alleviate resource disaster and for establishment of new commercial fisheries may be financed with 100 percent Federal funds. This Act has been extended by Public Laws 92-590 and 95-53 for an additional 7 years or to June 30, 1980.

THE ANADROMOUS FISH ACT OF 1965 (PUBLIC LAW 89-304 AS AMENDED)

Authorizes the Secretary of Commerce to enter into cooperative agreements with States and other non-Federal interests for the conservation, development, and enhancement of the anadromous fishery resources of the Nation and the fish in the

* This description was supplied by the National Marine Fisheries Service.

Great Lakes that ascend streams to spawn and the control of the sea lamprey. The program is administered at the Federal level jointly by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. Federal funds up to 50 percent may be used to finance project costs. State fishery agencies, colleges, universities, private companies, and other non-Federal interests in 31 States bordering the oceans and the Great Lakes may participate under the Act. All projects must be coordinated with the State fishery agency concerned.

Department of Commerce, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management *

COASTAL ZONE MANAGEMENT PROGRAM

The preservation, protection, development, and, where possible, the restoration and enhancement of this nation's coastal resources, is the goal Congress intended when the Coastal Zone Management Act (CZMA) was passed in 1972.

To achieve this, Congress required that States wishing to participate in the national program would have to develop management programs that would:

1. Identify and evaluate those coastal resources recognized in the Act as requiring management or protection.
2. Reexamine existing policies or develop new policies to manage these resources. These policies must be specific, comprehensive and enforceable.
3. Determine specific uses and special geographic areas that are to be subject to the management program, based on the nature of identified coastal concerns.
4. Identify inland and seaward areas subject to the management program.
5. Provide for the consideration of the national interest in the planning for and siting of facilities that meet more than local requirements.
6. Include sufficient legal authority and organizational arrangements to implement the program and to ensure conformance to it. In arriving at these elements of the management program, States are obliged to follow an open process which involves providing information to and considering the interests of the general public, special interest groups, local governments, and regional, State, interstate, and Federal agencies.
7. Provide a planning process for energy facilities likely to be located in, or which may significantly affect, the coastal zone, including, but not limited to, a process anticipating and managing the impacts from such facilities.
8. Contain a procedure for assessing public beaches and other public areas, including State owned lands, tidelands and bottom lands, which require access or protection, and a description of appropriate types of access and protection.
9. Describe a method for assessing the effects of shoreline erosion and evaluating techniques for mitigat-

*This description has been supplied by the National Oceanic and Atmospheric Administration, Office of Coastal Zone Management.

ing, controlling, or restoring areas adversely affected by erosion.

The results of applying the policies and procedures of an approved State coastal management program would be four-fold, as indicated by the findings and policies of Sections 302 and 303 of the CZMA:

- Increased protection of valuable, natural coastal resources;
- Better management of development in coastal areas in order to avoid or mitigate losses to life and property, and to give priority to water-dependent uses;
- Enhanced access to and enjoyment of the amenities of the coastal zone; and
- Better coordination of governmental activities at all levels in order to make government more responsible to the public, and more efficient and effective in its delivery of services.

The coordination of governmental activities is enhanced by the Federal Consistency provision of Section 307 of the Act. After a State's program is approved by the Secretary of Commerce, Federal activities in that State's coastal zone must be performed in a manner consistent with that State's program. Early contact and coordination between State and Federal agencies are strongly encouraged by this provision and the Federal Consistency regulations.

The CZMA authorizes up to 80 percent grants for operation of coastal management programs, and authorizes grants for cooperative interstate planning related to coastal management, grants for research and technical assistance in support of coastal management programs, and 50 percent grants for acquisition of lands to establish estuarine sanctuaries, to provide public access to the coast and to preserve islands or other important coastal resources.

Technical Documents

305/306 Regs: Final CZM program development and approval regulations were published in the Federal Register, March 28, 1979. The regulations, which took effect April 30, 1979, were mailed to State CZM program managers under a cover memorandum which highlights major revisions. Of particular interest is the procedure for amendments to State CZM programs (Subpart I, 923.80-85). Under the final regulations, adoption of local coastal programs will be considered as part of routine implementation rather than amendments to the programs unless the local plan might result in a significant change in boundaries, uses subject to management, criteria or procedures for designating or managing critical areas, or consideration of the national interest in the planning or siting of energy facilities. [15 CFR 923, CZMP: Development and Approval Provisions]

307 Regs: Final regulations for Federal Consistency were modified and published in the Federal Register on June 25, 1979. [15 CFR 930, Consistency for Department of the Interior OCS Prelease Sale Activities and for other Federal Activities Directly Affecting the Coastal Zone]

ESTUARINE SANCTUARY PROGRAM

The national concern for estuaries was embodied in the Coastal Zone Management Act of 1972, which was amended in 1976. The Estuarine Sanctuary Program was established to make 50 percent matching grants to coastal States for the purposes of acquiring, developing, or operating estuarine areas to be set aside "to serve as natural field laboratories in which to study and gather data on the natural and human processes occurring within the estuaries of the coastal zone." To protect representative estuarine systems, the goal of the national program will be to establish a system of estuarine sanctuaries from the eleven biogeographic regions within the Nation's coasts.

The basic goal is to preserve as much of each protected estuary's watershed as possible—thereby protecting the entire ecosystem within this sanctuary—so that both information can be gained which will aid in future management decisions concerning the coastal zone, and natural learning centers will be provided for educational institutions and members of the public. Secondary benefits include: the preservation of habitats for estuarine dependent flora and fauna, including endangered species; and low intensity recreation, as long as that activity does not detract from the major purposes outlined above.

The estuarine sanctuary process is administratively broken down into three phases: preacquisition, acquisition, and operations. The preacquisition grant may be used for land appraisals, refinement of boundaries, and for the development of management plans and/or programs for research and education. The acquisition grant is to cover the actual and related costs of land acquisition. Finally, operation grants are for those costs necessary for monitoring the sanctuary, protecting the health of its ecosystem, and for the establishment and maintenance of an educational program.

Technical Documents: The sanctuaries are acquired and managed by the individual coastal States within the policies of the Estuarine Sanctuary Guidelines [15 CFR 921, Estuarine Sanctuary Guidelines]. These guidelines also include detailed descriptions of the eleven biogeographic regions into which the Nation's estuaries have been divided.

MARINE SANCTUARY PROGRAM

Title III of the Marine Protection, Research and Sanctuaries Act of 1972 authorizes the Secretary of Commerce, with Presidential approval, to designate ocean waters as marine sanctuaries for the purpose of preserving or restoring their conservation, recreational, ecological, or esthetic values. Marine sanctuaries may be designated as far seaward as the outer edge of the Continental Shelf and in coastal waters where the tide ebbs and flows, or in the Great Lakes and their connecting waters. Marine sanctuaries are built around the existence of distinctive marine resources whose protection and beneficial use requires comprehensive, geographically-oriented planning and management.

As of January 1980, two sanctuaries had been designated:

1. The Monitor Marine Sanctuary. This sanctuary serves to protect the wreck of the Civil War Ironclad, the *U.S.S. MONITOR*. It was designated in January of 1975 and is an area one mile in diameter southeast of Cape Hatteras, North Carolina.
2. Key Largo Coral Reef Marine Sanctuary. This sanctuary, designated in December of 1975, provides protective management of a 100 square mile coral reef area south of Miami.

The procedures for considering an area are designed to determine the desirability of and public interest in the designation of a sanctuary, and initiation of the process does not presuppose that a sanctuary will be designated. Provisions are made for public input and comment throughout the designation process. The nomination procedure and types of the sanctuaries which may be recommended are described in the marine sanctuary regulations.

The first step in reviewing a nomination or recommendation is the determination of feasibility. The public and Federal and State agencies will be involved early in this process by means of requests for information and comment, consultations, and public workshops. Announcement of the workshops will be given through press releases and Federal Register notices. When a workshop has been scheduled for a nomination/recommendation, the site is considered an active candidate for designation.

If a particular site is determined to be feasible for further study, NOAA will begin preparation of a draft environmental impact statement (DEIS) assessing the impact of the proposed designation and regulations. Notices of feasibility and intent to prepare the DEIS will be given in the Federal Register and in press releases. Consultation with interested and affected groups will continue through DEIS preparation.

When the DEIS is completed, notice of its availability and the full text of the proposed designation document and regulations will be published in the Federal Register.

At least 30 days after notice has appeared in the Federal Register, a formal public hearing will be held in the affected coastal area. The public hearing provides a forum in which all interested parties can present their views on the adequacy of the DEIS, the proposed regulations, and desirability of creating a sanctuary. Written comments on the regulations and the DEIS are accepted for 60 days from the date of the notice. After the close of the comment period, a final environmental statement is prepared and the public has the opportunity to comment again.

Finally, Presidential approval is required before the Secretary of Commerce designates a sanctuary.

The governor of the affected State may veto a marine sanctuary in state waters within 60 days of designation.

There are seven active candidates for marine sanctuary status: The Flower Garden Banks in the Gulf of Mexico, the waters around the northern Channel Islands and Santa Barbara Island, Monterey Bay, the waters around Point Reyes and the Farallon Islands of the California coast, Looe Key in Florida, Gray's Reef off the coast of Georgia, and a site at St. Thomas, Virgin Islands. [Tech. Doc: 15 CFR 922, Title III, Marine Protection, Research and Sanctuary Act of 1972]

COASTAL ENERGY IMPACT PROGRAM

The Coastal Energy Impact Program (CEIP) directs the Federal government to assume some of the responsibility when energy development projects, undertaken to meet the Nation's energy needs, strain existing facilities and cause financial stress to nearby communities. The program was enacted by Congress in 1976 and is administered by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) through its Office of Coastal Zone Management.

The program is intended to help communities and their local government officials cope with the burden caused by such development activities by providing them with grants and loans. With Coastal Energy Impact Program funds, communities may plan for the need for more schools or more roads, for example, and apply for financing for these public facilities and services. The program also is designed to prevent or keep to a minimum any damage or loss to the coastal zone environment with its natural and recreational resources.

Coastal communities receive CEIP funds through their respective States by proposing projects for funding to the single State agency designated to coordinate the CEIP program. These State agencies, using an intrastate allocation process, review and forward local funding applications to the Federal Office of Coastal Zone Management for final approval.

Several types of grants or loans are now available. These include Outer Continental Shelf (OCS) Formula Grants, Environmental and Recreational Loss Grants, Planning Grants, and OCS Participation Grants. Credit Assistance, ranging from direct loans to bond guarantees to repayment assistance, is also available under the CEIP.

Types of CEIP Assistance

OCS Formula Grants for public facilities and services can pay up to 100 percent of the costs of planning for and development of new or improved public services and facilities required as a result of Outer Continental Shelf (OCS) oil and gas activity. Public facilities and services include police and fire protection activities and equipment, schools, water supply, roads, docks, navigation aids, waste collection and treatment, parks and recreation, and health care. Previously funded projects include hospital construction, road improvements, a hurricane protection system, and oil spill prevention programs.

Environmental and Recreational Loss Grants are awarded to help prevent, reduce, or ameliorate unavoidable losses to environmental and recreational resources from coastal activity in a State's defined coastal zone. OCS exploration or production, coal and liquefied natural gas terminals, deepwater ports, and associated support installations are examples of coastal energy facilities. Regulations define "unavoidable" losses as those which cannot be traced to any identifiable party or otherwise not preventable because of facility siting needs. Environmental and recreational resources include air and water quality, important animal habitats, wetlands, beaches, parks, or public access to these areas. Environmental and recreational grants paid for a freshwater siphon to reduce the damage to a freshwater marsh caused by saltwater intrusion resulting from coastal energy activity, an oyster bed reseeding project, and a freshwater intake to prevent drinking water loss due to energy development, among other projects.

Planning grants assist local governments to plan the economic, social, or

environmental consequences of new or expanded energy facilities such as power plants, refineries, and nuclear fuel processing plants as well as OCS and other coastal dependent energy activities affecting the coastal zone. CEIP funds pay for as much as 80 percent of the costs (requiring 20 percent matching funds from the grantee) of these planning activities. Funds from this grant category helped finance a harbors study, an outdoor recreation master plan, and an OCS lease sale impacts study.

Credit assistance is available to finance new or improved facilities in communities experiencing unplanned and unbudgeted demands upon their public services and facilities from coastal energy activity. The assistance is either direct loan or a loan guarantee.

Direct loans are available from the Coastal Energy Impact fund and can be made for periods of up to 30 years. Loan interest rates range from a low of 5 percent on certain environmental and recreational projects to a rate equaling that of comparable U.S. Treasury Securities. The interest rate varies according to project need, applicant's financial condition, and State statutory interest rate ceilings on municipal obligations.

Bond guarantees for principal and interest also are available from the Coastal Energy Impact Fund. The interest paid on such obligations, however, is to be included in the gross income of the bondholder to comply with Chapter One of the Internal Revenue Code of 1954. An interest subsidy sufficient to lower the interest rate to that available on direct loans may be paid to the borrower.

Repayment assistance is a special and unique feature of the CEIP. Under this provision a borrower may receive special assistance if revenues securing the loan or guaranteed bond prove insufficient to repay the debt because the expected employment or population increases did not materialize. The forms of this assistance may include: modification of loan terms (including interest rate reduction and principal postponement), refinancing and supplemental loans, and grants to meet the debt service on the loan.

OCS participation grants are available for the first time, FY 1980, to help states participate in the Federal policy, operational and management decisions relating to the development of OCS oil and gas resources. Specifically, these grants are for state participation in the formulation of the OCS leasing program, reviewing OCS DEIS/FEIS documents and formulating recommendations concerning exploration, development and production plans.

Applying for CEIP Assistance

Who Can Apply: Local governments with general jurisdiction over coastal land accommodating or adjacent to energy development activity may receive CEIP assistance through their State governments. Local governments seeking this assistance should direct their inquiries to the State agency designated to handle CEIP matters. These agencies will supply grant applications and relevant State and Federal regulations and advise on the proper way to make an application.

Reminders: Applicants should be sure that proposed CEIP projects show the relationship of the project to an identifiable coastal energy activity. Project need must result as a consequence of coastal energy activity, and the proposal must show how the project meets this need. It is particularly important to distinguish between projects proposed as a result of general coastal energy development and those required by OCS development as this bears directly on the amount and type of funding available to these projects.

All applications are subject to NEPA and the requirements of the Office of Management and Budget Circular A-95 requiring public comments.

CEIP funded construction project applications must contain Environmental Impact Assessment data as prescribed in CEIP guidelines available from your State CEIP agency, all necessary State and Federal permits, and a Preliminary Engineering Report in accordance with CEIP guidelines.

Technical Documents: The new Regulations can be located in the May 21, 1979, and January 21, 1980, issue of the Federal Register.

FOR FURTHER INFORMATION ON OCZM

United States Department of Commerce
National Oceanic and Atmospheric Administration
Office of Coastal Zone Management
3300 Whitehaven Street, N.W.
Washington, D.C. 20235

State Programs Office

North Atlantic Region
(Maine, New Hampshire, Connecticut, Massachusetts, New York, New Jersey, Rhode Island)

South Atlantic Region
(Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia)

Gulf/Islands Region
(Florida, Alabama, Mississippi, Louisiana, Texas, Virgin Islands, Puerto Rico)

Pacific Region
(California, Bay Conservation Development Commission, Oregon, Washington, Alaska, Hawaii, North Mariana Islands, Guam, American Samoa)

Great Lakes Region
(Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, Pennsylvania)

Department of Commerce, National Oceanic and Atmospheric Administration (Coastal Hazards Initiative)*

COASTAL HAZARDS INITIATIVE

The potential for a catastrophic disaster as the result of a hurricane and associated storm surge is growing. This threat increases even though there have been significant improvements in recent years in our capabilities to monitor, predict, and warn of hurricanes. In fact, it is easy to visualize the kind of situation, wherein two or three times the number of lives lost at Galveston in 1900 (6,000) would be lost, even with a very accurate forecast. This seeming paradox of better warnings but greater risks results directly from the fact that many rapidly growing population centers in the coastal zone do not have adequate means of evacuation when threatened by a severe hurricane.

Developers have capitalized on the lure of sunshine, surf, and sand to build housing for new residents at a dizzying pace. In many locations, the community planners have not made adequate provision for emergency protective action in connection with natural disasters. Bridges, ferries, and exposed coastal highways that allow adequate transportation during normal times, may become clogged choke points during an attempted quick evacuation to avoid the threat of a hurricane. Rising tides and floods from intense hurricane rainfall can disrupt such lines of transportation many hours in advance of hurricane landfall. People depending on them as evacuation routes are then trapped to become potential victims of the storm surge and high winds. And the problems become worse if the normal population

*This description has been supplied by the National Oceanic and Atmospheric Administration.

is swollen by vacationers (typically the case during the hurricane season) or if the evacuation orders are issued at night. Until the hurricane hazards are given proper attention in long-term planning and coastal land use management programs, this threat of catastrophic loss of life and property will continue to grow.

The Initiative's Goal: To Reduce the Loss of Life and Property from Hazards in Coastal Areas

- Avoid/minimize development in high risk areas.
- Where development in high risk areas exists or is increasing, develop comprehensive emergency evacuation plans to minimize risk to life and property.
- Establish requirements for disclosure of more precise description of risk areas.
- Seek establishment of more appropriate building standards.
- Establish and clarify responsibilities and authorities.
- Establish and maintain coordinated system of cooperation and communication between all parties and participants concerned and involved.

General Objectives and Discussion

This effort builds upon the basic technical competence of the National Weather Service; the National Ocean Survey, and the Environmental Data Information Service; the financial assistance (to State and local government) and coastal management framework of the Office of Coastal Zone Management program; and the financial assistance to technically competent universities and technical assistance of the Marine Advisory Service of the Sea Grant Program.

The intent is to focus this combination of NOAA technical and financial assistance in a way which effectively supports the priority activities of the Federal Emergency Management Agency, and State and local government activities in cooperation with other Federal agencies and hazards mitigation organizations.

The initial emphasis is on the protection of life and property from the impact of hurricanes and related storm surge in coastal areas. The effort will be expanded to consider other natural hazards in the coastal areas of the country later.

Factors responsible for the magnitude of the threat can be summarized as follows:

- overdevelopment or development in the wrong place (lack of adequate land use controls);
- inadequate "risk" information (lack of localized storm surge forecast capability);
- inadequate evacuation routes/maps/plans (due in part to failure to perceive the magnitude of the threat);
- lack of public awareness (lack of information and relevant experience—80 percent of the present coastal population has not experienced a major hurricane);
- lack of authoritative and effective communications with the public (inadequate intergovernmental planning/coordination).

The NOAA Initiative: Key Aspects

- Risk Assessment Program (to insure a clearer understanding of the risks):
  - —compilation of meteorological/oceanographic data (frequency, intensity, nature, location);
  - —development and application of localized storm surge models;
  - —identification of priority coastal areas for which detailed risk assessment will be developed;
  - —preparation and dissemination of risk assessment information and products.
- Storm evacuation maps and planning (emphasis on high risk areas):
  - —provide technical mapping data, information, and assistance;
  - —provide model plans and approaches at various levels of government and for different geographic areas.
- Expanded public awareness (hazard risk awareness and evacuation and other planning measures to protect life and property):
  - —site specific public service announcements for high risk areas;
  - —reformatting existing products to make them more useful or meaningful;

—expansion of education and information programs.

- CZM Coastal Hazards Assistance Program (increase coastal hazards emphasis in State Coastal Zone Management programs and support the development of State and local government capability in dealing with Federal agencies and others).
- Emphasize coastal hazards in State CZM programs.
- Increase NOAA technical assistance to States:
  —coastal and evacuation mapping;
  —accelerated storm surge modelling;
  —localized risk assessment information.
- Encourage and facilitate cooperation and coordination at Federal and State levels.
- Support development of State capability:
  —to develop state policies and program;
  —to coordinate administration of State programs;
  —to interact with FEMA and other Federal agencies.
- Sea Grant research and technical assistance support:
  —increase the level of activity at Sea Grant institutions concerning coastal hazards and facilitate the identification of priority projects and exchange of research results.
- Post disaster survey activities:
  —photo missions with NOAA aircraft;
  —installation of water level measuring equipment.
- Cooperation with other agencies:
  —facilitate where possible, through CZM, Sea Grant and other NOAA programs full coordination and cooperation between all levels of government toward common program goals to minimize loss of life and property damage due to coastal hazards.

Department of Defense, U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers has major responsibilities for protection and management of the coastal zone. It is involved in virtually all construction projects in navigable waters and adjacent wetlands. In some cases, it undertakes projects for hazard protection or shoreline restoration. For construction or development in or adjacent to navigable waters, and having an impact on them, it sets conditions in special permits required by Federal law.

The Corps operates at three decision-making levels: the Office of the Chief of Engineers, in Washington, D.C.; 11 U.S. Army Engineer Divisions; and 36 Districts which serve as the field offices of the Corps. Boundaries of the Divisions and Districts are based on natural systems, using watersheds and river basins. On an experimental basis, some Districts have adjusted boundaries for permit issuance to State lines to simplify coordination with similar State permit requirements.

Localities are most likely to work with the District Engineer or his staff when requesting advice or assistance from the Corps (in New England and Honolulu a Division office serves this role). The District Engineer makes final decisions on most questions.

Among the responsibilities of the District Engineers' offices are:

—to prepare and submit analyses of water-resource needs and development studies pursuant to specific congressional resolutions;
—to perform engineering studies and design facilities;
—to construct dams, dikes, jetties,

groins, etc., if found feasible and so authorized by Congress;
—to operate and maintain water-resources projects for navigable waters of the United States;
—to acquire, manage, and dispose of some types of Federal land.

FLOOD PLAIN MANAGEMENT SERVICES PROGRAM (FPMS)

The 1960 Flood Control Act required the Corps to provide information, technical planning assistance, and guidance to States, localities, and private citizens to help them determine the potential magnitude and extent of flood hazards and implement wise floodplain management plans. The program through which this is done is known as the Corps' Flood Plain Management Services (FPMS). On a contract basis, the FPMS now also undertake studies on behalf of the Federal Emergency Management Agency (FEMA). FPMS will provide additional planning assistance to communities participating in the NFIP if they request it.

Usually the District Office of the Corps will have staff assigned to FPMS to provide technical assistance. Communities can check current requirements of this program by consulting Section 12.104 of the Catalog of Federal Domestic Assistance; additional information is available from District Engineers' offices.

FLOOD AND EROSION CONTROL PROGRAMS

When Congress authorizes it to do so, the Corps builds structures to protect against hazards and has legislative direction to restore areas damaged by floods and erosion. These programs began with the Flood Control Act of 1936, subsequently amended and expanded to encompass several types of coastal construction and restoration (in addition to the FPMS planning assistance).

Key activities initiated through the District Engineer under continuing authorities, i.e., not requiring specific congressional authorization, are:

—Aquatic Plant Control
—(Small) Beach Erosion Control Projects
—(Small) Flood Control, Coastal Protection Works for Public Shores, Rehabilitation
—Emergency Coastal Protective Works
—Protection of Essential Public Works
—Snagging and Clearing for Flood Control
—(Small) Navigation Projects

Actions culminating in large construction projects are usually initiated by local interests working with Representatives in Congress who present proposals to congressional committees. The Corps may be asked to investigate and furnish recommendations. Once approved and funded large and small projects normally require State or local support of 30 to 50 percent of project costs. Under recent cost sharing proposals by the President, the local share would be fixed at 20 percent for all flood-related items.

Current information on small project assistance is available in the *Federal Catalog of Domestic Assistance*, Sections 12.100-12.110 and in publications available from District Engineers' offices.

REGULATORY PROGRAM

The Corps also grants permits for various types of activities in the waters of the United States. At various times, beginning in the 19th century, the Corps of Engineers has been given regulatory authorities, mainly to protect navigable waters. Two laws remain important as the principal sources for Corps permit authority: the Rivers and Harbors Act of 1899, and additions to the Clean Water Act in the Federal Water Pollution Control Act Amendments of 1972.

These two laws, and other laws bearing on Corps permits like the National Environmental Policy Act of 1969 (NEPA), and the 1966 Historic Preservation Act, are integrated, interpreted, and implemented in regulations issued as the "Regulatory Program," July 19, 1977. This ended a somewhat confusing period of lawsuits and revisions that followed NEPA and the 1972 changes in the Clean Water Act. Subsequent 1977 Amendments to the Clean Water Act have confirmed the Corps' program, while clarifying some exemptions from the permit requirement, and allowing State assumption of permitting responsibilities for

limited geographic areas of non-navigable waters.

The most common permits issued by the Corps are called Section 404 (or "404") permits, after Section 404 of the Water Pollution Control Act Amendments of 1972, and Section 10 permits, after Section 10 of the 1899 Rivers and Harbors Act.

Though as a practical matter, applications for these permits are identical, and require similar information, there are important differences between the two provisions of law. Section 404 applies to a larger area, "the waters of the United States." Section 10 applies to "navigable waters" without the expansive additional definition provided for Section 404. The result is an area of non-tidal and freshwater wetlands where the "404" requirements alone apply, and another area of navigable waters and adjacent tidal wetlands where both Section 404 and Section 10 apply.

A second difference betwen the 1899 and 1972 laws lies in the activities covered by the permit. "404" permits set conditions for, or prohibit, discharge of dredge and fill material into waters and wetlands, for instance; Section 10 prohibits structures without a Federal permit.

A third difference lies in the roles assigned by the law to other Federal agencies. Though the Corps is responsible for implementing the "404" permit program, the U.S. EPA is given a key concurrent role. It must set overall guidelines for the implementation of the program, may consult on individual permits, and could veto permit issuance if it felt that its guidelines were being ignored by the Corps. The uneasy alliance that this pairing established in 1972 has been smoothed, reflected in the carefully drafted 1977 Regulations that outline all of the different interests in the process and in EPA's current preparations for review of State permit programs that may qualify under 1977 Amendments to the Clean Water Act as substitutes for the Corps program in non-navigable waters and their adjacent wetlands.

The Corps' dredge and fill program works in coordination with State and local programs. For example, to dispose of dredge and fill materials in Virginia, two State permits may be necessary. State law requires certificates of compliance from the State Water Control Board for any discharge in State waters. For discharge in wetlands, a permit is required from the local wetlands board if there is one, or the Virginia Marine Resources Commission (VMRC). A State coordination procedure meshes these requirements together. The Corps will defer to negative decision at the State level, though Federal law requires an independent judgment before granting a permit. In Florida, joint application procedures are being tested to see if they simplify this coordination process.

The permit decisions are highly decentralized. The 11 Division Engineers and 36 District Engineers have substantial autonomy in the permit process. Applications are processed by the District Engineer. If an application is noncontroversial and meets Corps standards, the District Engineer may issue a permit. The majority of applications fall into this category.

Objections from States via the governor, from other Federal agencies, or from the public may cause the Division Engineer to review the application. The Division Engineer directs the District to grant or deny a permit. In 1975 only 100 of 15,000 permit decisions were made by the Division Engineer.

Two elements influence the time required for a decision: the level at which the permit decision is made the Corps standards required for issuance. Conditions may be attached to a permit.

Two elements influence the time required for a decision: one is the level at which the permit decision is made; the other is the Corps own standards required for issuance. Conditions may be attached to a permit.

Department of the Interior, U.S. Fish and Wildlife Service*

THE ENDANGERED SPECIES ACT OF 1973

The Endangered Species Act of 1973, as amended, gives the Secretaries of the Interior and Commerce, who act through the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), broad powers to protect and conserve all forms of wildlife which may be in jeopardy. Within the Fish and Wildlife Service, the Endangered Species Program has been carefully formulated to meet this task.

Section 7 of the Act requires all Federal agencies to consult with FWS or NMFS when any of their actions, or activities funded, authorized, or approved by them will affect endangered species. In cases where irresolvable conflicts arise following consultation, an elaborate review process is now provided through which Federal agencies may be exempted from compliance with Section 7.

If the Service finds that jeopardy to a species will result from a federally authorized activity and that Federal agencies cannot accept any of the reasonable and prudent alternatives offered by the Service, then the involved Federal agency, the Governor of the State in which the action was to occur, or the permit or license applicant may apply to the Secretary for an exception.

Technical Documents. All proposed and final listings, delistings, or reclassifications are drafted by FWS or NMFS and published in the Federal Register, a daily publication devoted to Federal regulatory activities. Also, the substance of proposed listing actions is published in affected area newspapers, and is made available for publication in pertinent scientific journals. Regulations implementing the act appear in the Code of Federal Regulations-50, Part 17. The most recent complete list of protected species was published in the Federal Register, January 17, 1979 pp. 3636-3654. New regulations implementing Section 4 of the Act were finalized, in compliance with the Endangered Species Act amendment of 1978 in the February 27, 1980 Federal Register, pp. 13010-13026. New Section 7 regulations are nearing publication; the interagency cooperation regulations published January 4, 1978 Federal Register, pp. 870-876, are being used until new regulations are published.

For further information contact: Office of Endangered Species, U.S. Fish and Wildlife, Main Interior Building, Washington, D.C. 20240.

FISHERY RESOURCES PROGRAM

The activities of the Fishery Resources Program are performed in three related program areas—coastal anadromous fisheries, inland fisheries and reservoirs, and the Great Lakes fisheries. The first and third are relevant to this manual.

Coastal Anadromous Fisheries

Many important commercial fish species are anadromous: the adults migrate from the sea upstream to spawn in fresh water. Often, these anadromous fish species such as Atlantic salmon and chinook salmon encounter great difficulties during migration, such as dams and other barriers, polluted streams, and low water levels.

Measures to protect these fish during migration, spawning, and early growth are important to maintain the resource and ensure continued benefits to the public. Fishery resources activities of management assistance, production, and research are integrated to help solve some of these problems.

A good example of this integration is the salmon fishery of the Columbia River System. Fisheries assistance is provided for protection and management of the

*This description has been supplied by the U.S. Fish and Wildlife Service.

fishery, researchers are identifying migrating fish with biochemical/genetic identifiers, computer modeling is used to estimate the contribution of separate salmon populations to the mixed stock fishery, and an extensive hatchery production program contributes to enhancement of the salmon population of the Columbia River System.

Great Lakes Fisheries

Historically, the Great Lakes provided some of the country's best commercial and recreational fishing. Overfishing, pollution problems, and predation by the sea lamprey have decimated lake trout populations and other resident fish species. The Great Lakes Fishery Commission, created to restore and improve the sport and commercial fisheries of the Great Lakes, contracts with the U.S. Fish and Wildlife Service for sea lamprey control. Control measures consist of monitoring adult and larval lamprey populations, and chemical treatment of the larval stage. Research is investigating chemicals to reduce lamprey populations through artificially sterilized adult lampreys which are released into the lake to compete with normal lampreys for mates. Research is also being conducted on population status, environmental factors causing negative impact on the fishery, and general fish-life histories. Fish production is devoted to restoring populations of lake trout, sauger, and other recreational and commercial fish species and providing information on diseases affecting these species. Lamprey control efforts have been very successful. In 1977, natural lake trout reproduction was observed in Lake Michigan for the first time since the program began. The total economic impact of the Great Lakes commercial fishery is approximately $160 million. Total economic impact of the recreational fishery approaches $1 billion.

For further information contact: Associate Director—Fisheries Resources, U.S. Fish and Wildlife Service, Main Interior Building, Washington, D.C. 20240.

THE BIOLOGICAL SERVICES PROGRAM

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues which impact fish and wildlife resources and their supporting ecosystems. The mission of the Program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decision makers in the identification and resolution of problems associated with major land and water use changes.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decision-making process to prevent or minimize the impact of development on fish and wildlife. Biological Services research activities and technical assistance services are based on an analysis of the issues, the decision makers involved and their information needs, and an evaluation of the state-of-the-art to identify information gaps and determine priorities. This is a strategy to assure that the products produced and disseminated will be timely and useful. Among the environmental issues being addressed by the program are coastal and estuarine modifications, riverine and riparian protection, and conduct of a National Wetlands Inventory.

ENVIRONMENTAL CONTAMINANT EVALUATION PROGRAM

The program provides ecologically sound and scientifically useful information to minimize the adverse toxicological and ecological impacts of environmental contaminants on fish and wildlife and their habitats. Evaluation of the environmental effects of chemicals is a Federal responsibility, since the effects far outreach the boundaries of any State or region. The Fish and Wildlife Service is the Federal organization responsible for conser-

vation and management of wild species, and so has a particular responsibility for research on environmental chemicals. In 1974, the Service signed a memorandum of agreement with the Environmental Protection Agency (EPA) to establish their areas of expertise, avoid duplication of effort, and assure mutual support and information exchange. The agreement established the leadership role of the Fish and Wildlife Service in evaluating the effects of pollutants on wildlife, but agreed to a sharing of responsibilities for research on fish and other aquatic life, with the Service to be particularly concerned with the effects of pollutants on conservation management, and recreational use of fish and fish food organisms. Information exchange has been good in both fish and wildlife areas. In 1977, a second agreement was signed which defined the roles of the two agencies in water quality research.

Despite the substantial information base available, knowledge of effects of contaminants on fish and wildlife is far from adequate. A fundamental problem is the enormous number of contaminants that are widespread in the environment and the vast array of species that may be at risk. Urban, industrial, agricultural, and energy-related activities continue to introduce a myriad of contaminants into the environment. The rapid growth of the chemical industry in the past few decades has been accompanied by a corresponding increase in the quantity of hazardous substances that are processed, transported, and ultimately disposed. Each year approximately 1,000 new chemicals will find their way into the market place and subsequently into the environment through use and disposal.

Monitoring

The Service participates in EPA's National Pesticide Monitoring Program by monitoring levels of environmental contaminants in fish and wildlife. The primary purpose is to ascertain on a Nationwide basis the levels and trends of selected contaminants in the bodies of freshwater fish, and certain bird species over a period of time. Monitoring residues in birds was initiated in 1965, and in 1967 for fish.

The monitoring program provides a sensitive indication for the spatial distribution and trends in contaminants. Three monitoring networks are maintained: (1) freshwater fish, (2) starlings (bird species representative of the terrestrial environment), and (3) mallard and black ducks (bird species representative of the wetland environment). All samples are analyzed for organochlorine pesticides (e.g., DDT and dieldrin) and related compounds (e.g., PCB's). Many of these are complex compounds that require sophisticated analytical equipment and methodology for detection and quantification. Fish samples are also analyzed for metals (e.g., mercury, lead, cadmium, and arsenic).

Field Operation

The primary purpose is to locate, identify, and correct sources of environmental contamination through field appraisals and investigations of fish and wildlife losses. The program provides immediate response to sudden changes in pollutant levels in the environment. Specifically, the program (1) provides review of proposals for pesticide usage on Service lands, (2) coordinates training of Service pesticide applicators, (3) provides technical assistance on pesticide use and potential effects of pollutants on key fish and wildlife communities, (4) responds to fish and wildlife die-offs related to environmental contaminants, and (5) responds to spills of oil and other hazardous substances when fish and wildlife might be affected. A direct benefit is early recognition of detrimental environmental changes, which results from rapid assessment of contaminant problems in the environment. The appropriate use of pesticides and other potential contaminants minimizes the detrimental impact on the fish and wildlife resource.

Research

Combined field and laboratory research provides an evaluation of the effects of environmental contaminants on fish, wildlife, and their habitat. The multidisciplinary research focuses efforts of ecologists, physiologists, toxicologists, behaviorists, chemists, and statisticians on identifying and evaluating potentially harmful environmental contaminants, and identifying populations, species,

habitats, or ecosystems that might be adversely affected. Behavioral, reproductive, or other chronic effects may lead to changes in the size, age structure, or spatial distribution of fish and wildlife populations.

Carefully coordinated studies are conducted to assess status of animal populations in the field before, during, and after pollution exposure of short or long duration; to measure exposures of animals to agents suspected of causing any effects observed; and to test the effects of the same agents on animals under controlled laboratory conditions.

The results are published in major scientific journals as well as disseminated to resource managers at both the Federal and State level in a form which can be used by them to make informed management decisions.

LAND AND WATER RESOURCE DEVELOPMENT PLANNING PROGRAM (LWRDP)

This program, largely operational in nature, carries out the mandated and discretionary review and consultation with other agencies. Through this program, the Service, using the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) and other legislation, acts in an advisory or consultative capacity by conducting surveys and investigations, and by providing planning assistance and recommending conservation measures to Federal, other government, and private resource planning and management organizations.

This input is often specific to water and related land resource development projects and comprehensive studies of the Nation's river basins. Service reports, based on results of reviews and consultation, are incorporated in requests for authorization transmitted to Congress by the Federal development agencies. In the case of federally permitted or licensed water resource projects, the reports of Service investigations are transmitted in the form of recommendations for issuance, modification of the proposed work to make it more compatible with fish and wildlife values, or denial of a Federal permit or license.

Specifically, the LWRDP program does the following:

a. Provides consultation, field evaluation, and planning assistance for proposed water and related land projects to be constructed by Federal agencies, assisted with Federal funds, or constructed by non-Federal entities under a Federal license or permit.
b. Provides ecological input to field level planning related to specific river basin studies.
c. Is responsible for insuring that actions initiated by the Service comply with requirements of the National Environmental Policy Act.
d. Coordinates review of other agencies' environmental impact statements in areas where the Service has been designated by the Council on Environmental Quality Guidelines.
e. Develops methodologies to be used in the pursuit of the activities of the program, such as the Habitat Evaluation Procedures, general guidelines for permits, and information brochures of methods to preserve fish and wildlife resources in concert with development.

The program is administered by six regional offices and an Alaska Area Office.

FURTHER INFORMATION

For further information on FWS projects, contact:

Region I
U.S. Fish and Wildlife Service, Lloyd 500 Building, Suite 1692, 500 N.E. Multnomah Street, Portland, Oregon 97232
Region II
U.S. Fish and Wildlife Service, 500 Gold Avenue, S.W., P.O. Box 1306, Albuquerque, New Mexico 87103
Region III
U.S. Fish and Wildlife Service, Federal Building, Fort Snelling, Twin Cities, Minnesota 55111
Region IV
U.S. Fish and Wildlife Service, Richard B. Russell Federal Building, 75 Spring St., S.W., Suite 1276, Atlanta, Georgia 30303
Region V
U.S. Fish and Wildlife Service, One Gateway Center, Suite 700, Newton Corner, Massachusetts 02158

Region VI
U.S. Fish and Wildlife Service, P.O. Box 25486, 134 Union Boulevard, Lakewood, Colorado 80228

Alaska Area Office
U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99503

Environmental Protection Agency *

THE CLEAN WATER ACT

SECTION 404—DREDGE OR FILL PERMIT PROGRAM

The purpose of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the waters of the United States. These waters are valuable for navigation, commerce, recreation, habitat, and breeding and spawning areas for many species of fish and wildlife, and as a source of water and food for much of the nation's population. Wetlands form a particularly sensitive and important segment of these ecosystems. [p. 2, ¶ 4]

Section 404 of the Clean Water Act regulates the discharge of dredged or fill materials in wetlands or aquatic ecosystems that may destroy or modify habitat, increase suspended sediment loads and bottom sedimentation, and alter hydrological regimes. The Section 404 program requires that such adverse impact be evaluated before discharging dredged or fill material into waters of the United States. The program is administered by both the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (COE), which has the primary responsibility for the permit program. EPA is authorized to oversee transfer of specified parts of the program to interested States with eligible State-level programs. [p. 2, ¶ 1]

The Section 404 (b) (1) Guidelines. The Section 404 environmental guidelines are intended to be the basis of decision making under Section 404. Established by EPA in conjunction with COE, they were issued in interim final form, 40 CRF Part 230, in 40 FR 41291 (Sept. 5, 1975). The guidelines are currently undergoing substantial review, and should be proposed in revised form in the near future. [p. 12, ¶ 1 & 2]

The guidelines govern the determination of the environmental effects of discharging dredged and fill material into waters of the United States, for (1) analysis of State and COE permit applications, (2) Federal project environmental impact statements, and (3) activities conducted under best management practices must conform to the guidelines. The guidelines require consideration of adverse environmental impacts of a proposed discharge, as well as alternatives to the project.

Relations with Other Programs

The Section 404 program may affect, and be affected by, a variety of other programs. These include the Fish and Wildlife Coordination Act, the National Environmental Policy Act, the Endangered Species Act, the Wild and Scenic Rivers Act, the Migratory Bird Conservation Act, and a number of others. Two programs in particular are significantly enmeshed with Section 404. These are Sections 9 and 10 of the Rivers and Harbors Act of 1899 and Section 208 of the Clean Water Act. Section 9 and 10 of the Rivers and Harbors Act require a COE permit to construct any dam or dike or other structures or perform other work in a navigable water of the United States. Section 208 of the Clean Water Act provides an alternative to the Section 404 program in a State having approved Section 404 permit program and a Statewide approved Section 208 (b) (4) program dealing with the discharge of dredged or fill material; no Section 404 permit will be required for any activity for which there is no

* This description has been supplied by the Environmental Protection Agency.

approved best management practice. [p. 12, ¶ 3]

The Corps of Engineers' Program. The COE administers several permit programs, among them Section 404. COE authority under Section 404 extends to discharges of dredge or fill material in the waters of the United States, or only in navigable waters and their adjacent wetlands.

The COE generally issues individual permits under Section 404 evaluated on a case by case basis in compliance with the guidelines. General permits may be issued by both the COE and the states for certain types of activities in specific, relatively small geographic areas within their jurisdiction. The activities must cause only minimum environmental harm, both individually and cumulatively. The permit must terminate within 5 years and may be modified or revoked earlier should the adverse environmental impacts become greater. The COE may also issue nationwide permits either for discharges into smaller, minor waters or for certain types of activities. [p. 18, ¶ 1 & 2]

Technical Documents: For more detailed information on the COE section 404 regulatory program, see 33 CRF Parts 320-329, especially parts 320, 323, 325, 327 42 FR 37121 (July 19, 1977), the U.S. Army Corps of Engineers Permit Program, A Guide for Applicants (EP1145-2-1, November 1977), or contact the District Engineer in your area.

State Programs Under Section 404

General Requirements: The 1977 Amendments established a system whereby the State could assume a significant part of the Dredge or Fill Program. The object was to return responsibility for certain decisions affecting land use to the States and to limit duplication of effort. The State programs are essentially to mirror the Federal program and must comply with Section 404 guidelines. EPA's role both in approving State programs and overseeing decisions made under them emphasizes the importance Congress placed on maintaining Federal standards and insuring that water quality and wetlands be protected. EPA's responsibility in the transfer of Dredge and Fill programs to the States is an integrated system of ministerial and substantive duties. [p. 17, ¶ 1]

The statute itself sets requirements for State authority, Federal review criteria and time schedules, and State program withdrawal procedures.

Technical Documents: EPA regulations may be found in the Proposed Consolidated Permit Regulations, 40 CFR Parts 122A, 123E, and 124, published in 44 FR 34243 (June 14, 1979).

Program Transfer to the States: The requirements a State must satisfy to have its program approved and the procedures EPA must follow in approving State programs are contained in both the Clean Water Act and the regulations. For more detailed information refer directly to the regulations or contact Frances Peterson, Aquatic Protection Branch (WH-585), 401 M Street, S.W., Washington, D.C. 20460 (202-422-3400).

SECTION 208 CONSTRUCTION GRANTS FOR TREATMENT FACILITIES

Under the program, EPA is authorized to make grants of $18 billion to the States for construction of new municipal treatment facilities. The Federal funding share for these projects is 75 percent. The rest of the cost is divided among State and local governments and industrial users who hook up to a municipal sewage system. Municipalities are also eligible for grants for demonstration projects that utilize new methods for treating sewage, for developing joint systems for treatment of municipal and industrial waste discharges and for perfecting new water purification techniques. [Public Awareness Publications]

SAFE DRINKING WATER ACT

The 1974 Safe Drinking Water Act was designed to assure that water supply systems serving the public meet minimum national standards for protection of public health.

The Act gives EPA responsibility for setting minimum national drinking water regulations for all public water systems throughout the United States. The States are to play the lead role in enforcing these regulations. If a State is negligent in administering the law, however, EPA may take action. The

Agency also may act to prevent or halt drinking water contamination posing an "imminent and substantial" health hazard if State and local authorities fail to respond.

If public water systems cannot reasonably meet the regulations, provision is made for States to grant variances and exemptions but these must not pose unreasonable risk to public health and a schedule must be established for compliance.

The Act also provides for regulating the underground injection of fluid to prevent the endangerment of underground sources of drinking water. This is accomplished by means of regulatory programs similar to that governing public water systems. Primary responsibility falls to the States where underground source protection programs have been established. If a State has failed to assume this responsibility within two years after enactment, EPA will prescribe a control program for that State.

The Act specifies that regulations will not be established that will interfere with oil or natural gas production unless such regulations are considered endangered by such injection. [Public Awareness Publications]

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT, AS AMENDED (P.L. 92-532)

The purpose of Title I of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA) is to regulate transportation for ocean dumping and to prevent or strictly limit the ocean dumping of any material which would unreasonably affect human health, welfare, or amenities, or the marine environment, ecological system, or economic potentialities. To implement this purpose and to control dumping in ocean waters, Title I of the Act establishes a permit system and assigns its administration to the Environmental Protection Agency (EPA) and the Corps of Engineers (COE).

Transportation from the United States of any radiological, chemical, or biological warfare agent or high-level radioactive wastes for dumping in ocean waters, the territorial seas, or the contiguous zone is prohibited. Transportation of other materials (except dredged material) for the purpose of dumping is prohibited except when authorized under a permit issued by the Administrator of EPA. Based upon criteria outlined in section 102 of the Act, the Administrator is required to establish and apply criteria for reviewing and evaluating permit applications. Such permits may be issued after determining that the dumping involved will not unreasonably degrade or endanger human health or the marine environment. Before a permit is issued, EPA must also give notice and opportunity for a public hearing.

In addition, the Administrator is authorized to designate areas where dumping may be prohibited. EPA has the authority to revoke or modify permits, to assess civil penalties for violation of permit conditions, and to initiate criminal action against persons who knowingly violate the Act.

Title II requires the National Oceanic and Atmospheric Administration (NOAA) to conduct a comprehensive program of research and monitoring regarding the effects of the dumping of materal into ocean waters. Title III gives NOAA the authority to establish marine sanctuaries.

During 1977 the MPRSA was amended to require that ocean dumping of sewage sludge will cease as soon as possible and in any event no later than by December 31, 1981. For the purposes of this amendment, the term "sewage sludge" is defined to mean "any solid or liquid waste generated by a municipal wastewater treatment plant the ocean dumping of which may unreasonably degrade or endanger human health, welfare, amenities, or the marine environment, ecological systems, or economic potentialities." Thus, the 1981 phase out date required by interim permits under the EPA ocean dumping regulations is now a statutory date to terminate dumping of sewage sludge as defined.

Wastes from a municipal wastewater treatment plant which meet the EPA environmental impact criteria for ocean dumping are not precluded by the amendment. However, at this time such wastes are not treated to the extent that they would no longer be classified as sewage sludge as defined in the amendment. Therefore, this amendment will

bring about the termination of all ocean dumping of sludges under interim permits from municipal wastewater treatment plant discharges by the end of 1981.

III. NONSTRUCTURAL ALTERNATIVES FOR FLOODLOSS REDUCTION

The Council is also active in responding to the President's Water Policy Initiatives relating to use of nonstructural approaches to flood-loss reduction. Under its direction, consultants to the Council prepared the following four reports in 1979:

- —Nonstructural Floodplain Management Study: Overview
- —Options to Improve Federal Nonstructural Response to Floods
- —Floodplain Acquisition: Issues and Options in Strengthening Federal Policy
- —Improved Formulation and Evaluation of Nonstructural Elements for Water Resources Plans in Flood Hazard Areas

Recommendations arising from these reports are undergoing review by affected agencies, the White House, and the Office of Management and Budget.

IV. EXECUTIVE ORDER 11988

The Council was assigned three major responsibilities under Executive Order 11988. The first was to prepare guidelines to aid Federal agencies in the preparation of their procedures to implement the Order. Floodplain Management Guidelines for Implementing E.O. 11988 were prepared in February of 1978 (43 FR 6030). The second was to provide technical assistance to the agencies along with CEQ and FEMA, in the preparation of implementing procedures. This ongoing activity has involved eighty agencies and subagency units to date. The third was to evaluate periodically agency procedures and their effectiveness. The first such evaluation is described in I, above, under Task F.

V. PRINCIPLES AND STANDARDS

The Council has established "Principles and Standards for Planning Water and Related Land Resources" (P&S). Many of the activities guided by the P&S have floodplain management implications. President Carter, in July 1978, directed the Council to modify the P&S to include a primarily nonstructural plan as one alternative whenever structural project or program alternatives are considered. This modification was complete through final rulemaking in December of 1979.

Federal Emergency Management Agency *

An Executive Order signed by President Carter July 20, 1979, formally completed establishment of the Federal Emergency Management Agency, creating for the first time an independent government agency responsible for all national emergency preparedness, mitigation, and disaster response programs.

The Presidential action consolidated five agencies and six additional disaster-related responsibilities into one structure, FEMA, reporting to the President and Congress.

The five agencies transferred to the combined unit—FEMA—their previous affiliation, and administrative responsibilities are:

- —Federal Disaster Assistance Administration (FDAA) from the Department of Housing and Urban Devel-

*This description has been supplied by the Federal Emergency Management Agency.

opment (HUD), which coordinated and funded Federal natural disaster relief operations.
—Federal Insurance Administration (FIA) from HUD, which managed flood insurance and hazard mitigation programs.
—Federal Preparedness Agency (FPA) from General Services Administration, a coordinator of civil plans for national emergencies.
—Defense Civil Preparedness Agency (DCPA) from Department of Defense, responsible for the civil defense program and planning, guidance, and financial assistance to State and local governments for attack and, as a secondary mission, natural disaster preparedness.
—United States Fire Administration (USFA) from the Department of Commerce, which administers Federal fire prevention programs in coordination with State and local governments.

FEMA's Major Objectives Are:

—To provide a single point of contact for State and local governments.
—To enhance the dual use of emergency preparedness and response resources at all levels of government by taking advantage of related matters in planning and response to activities for peacetime and attack emergencies.
—To provide greater effectiveness in hazard mitigation, preparedness, planning, relief operations, and recovery assistance.

Additionally, other closely related functions merged into FEMA are:

—Community preparedness programs for weather emergencies administered by the National Weather Service in the Department of Commerce.
—And three programs in the Office of Science and Technology in the Executive Office of the President: Earthquake Hazard Reduction; Dam Safety Coordination; and the Federal Emergency Broadcast System oversight responsibility.

Also, FEMA has two emergency functions not previously assigned to any specified Federal agency:

—Coordination of emergency warning and
—Federal response to consequences of terrorist incidents.

FEMA operations are being administered through 10 offices in the Federal Regional cities.

The National Flood Insurance Program (NFIP)

The NFIP is administered by the Federal Insurance Administration (FIA). FIA's prime objective is to support the State and local efforts at making the NFIP work in their community. To accomplish this objective, FIA provides the community with up-to-date floodplain mapping and assists the community with utilizing this information.

Some of FEMA's Services Are:

—County level seminars for building inspectors and other municipal officials.
—Planning assistance for developing local regulations to meet the program's floodplain management requirements.
—Engineering assistance with questions about the siting of structures in flood hazard areas.
—Assistance in evaluating possible flood hazard mapping errors and in initiating the required changes.

Another responsibility is to see that the program's Standard Flood Insurance Policy is properly promoted and written. The EDS Federal Corporation is under contract with the SFIP to assist with these marketing-related responsibilities.

NFIP Publications

An update on some of the brochures and manuals published by the NFIP:

—Questions and Answers
—How to Read Flood Hazard Boundary Maps
—How to Read a Flood Insurance Rate Map
—Coastal Flood Hazards and the National Flood Insurance Program
—Elevated Residential Structures
—Manual for the Construction of Residential Basements in Non-coastal Flood Environments
—Statutory Land Use Control Enabling Authority in the Fifty States

—Guide for Ordinance Development (Community Assistance Series No. 1)
—Coordination During Flood Insurance Studies (Community Assistance Series No. 2)
—Entering the Regular Program (Community Assistance Series No. 3)

Study on the Purchase of Floodprone Structures

A study has been undertaken to examine alternative methods of implementing Section 1362 of the National Flood Insurance Act. Section 1362 authorizes the program to purchase severely damaged floodprone structures. The study is almost completed; FEMA will be taking action on Section 1362 in the near future.

Water Resources Council*

The U.S. Water Resources Council is performing several significant functions in the area of floodplain management. These include coordination, policymaking, and research activities.

I. UNIFIED NATIONAL PROGRAM FOR FLOODPLAIN MANAGEMENT

Early in 1980, President Carter transmitted the Council's Unified National Program for Floodplain Management to Congress. The United Program established a conceptual framework for floodplain management at the Federal, State, and local levels. It identifies strategies and tools for flood-loss reduction and floodplain values protection. Included in it are recommendations for each level of government. Among these recommendations, the Council is called on to establish a Floodplain Management Task Force. This group has initiated its activities by assigning several tasks to work groups. Six tasks are currently being addressed:

Task A. Preparation of a general guide for local public officials and the interested public on floodplain management issues, strategies to address them, and sources of assistance.

Task B. Preparation of Volume 3 of the Council's Regulation of Flood Hazard Areas to update volumes 1 and 2, published in 1971 and 1972. The new volume will build on the earlier ones and incorporate improvements in the state of the art in the regulatory approach.

Task C. Preparation of a summary and analysis of agency research in floodplains and wetlands.

Task D. Preparation of an analysis and comparison of wetlands evaluation procedures in use or under development with recommendations for achieving greater consistency and better use of such procedures.

Task E. Preparation of a handbook to guide local acquisition of floodplain and wetland areas.

Task F. Performance of the first WRC evaluation of the effectiveness of Federal agency procedures for implementing Executive Order 11988, as required by Section 5 of the Order.

II. COORDINATED WETLANDS/FLOODPLAIN MANAGEMENT

The Council has also been active in coordinating wetlands protection and floodplain management activities. There exists both a physical and functional overlap between most floodplains and wetlands; both are subject to increasing

*This description has been supplied by the Water Resources Council.

development pressure; and management techniques are often similar. In recognition of these points, the Council held seminars early in 1979 to identify "common denominator" issues and possible mechanisms for better coordinating ongoing efforts and reducing conflict. The work under Tasks C, D and E above is an outgrowth of the seminars, along with a report entitled "Emerging Issues in Wetlands/Floodplain Management."

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PROGRESS REPORT, AMENDED TO APRIL 1, 1980
IMPLEMENTATION OF EXECUTIVE ORDER 11988
FLOODPLAIN MANAGEMENT

Prepared by Frank H. Thomas
Chairman, Floodplain Management Task Force
United States Water Resources Council

Background

It was the expectation of the agencies with consultation responsibility under the Order—WRC, CEQ and FEMA—that several major factors would have by this time significantly increased Federal floodplain management efforts under E.O. 11988. First, the Order's implementation date, May 24, 1978, is well over a year past. Second, recognizing this, the President specifically directed the agencies to expedite their implementation of the Order in a July 12, 1978 memo. Two additional progress reports were required in order to monitor progress. Third, the results of the first of these progress reports, due November 30, 1978, showed a clearly unsatisfactory effort on the part of the agencies. Cecil Andrus, Chairman of the Council, notified the agency heads in May of their status and in most cases had to request a firm schedule for completion of final regulations and procedures.

Unfortunately, the expected upgrading of the Federal effort has not occurred. Agency progress is still far from adequate. Since the January 15, 1979 WRC Status Report when there were five agencies out of 32 with final implementating procedures, the number has now only risen to 16.

Status of Implementation Procedures

Executive Order 11988 applies to all proposed actions by all Federal agencies with the sole exception of the emergency activities specified in Section 9 of the Order. The term "agency" as used here refers to 13 cabinet level organizations within the Federal Government, and 19 independent agencies. The term "Subagency units," refers to individual program areas within the agencies that are anticipated to be preparing more detailed procedures of their own. For those agencies carrying out actions of a nature essentially without direct or indirect effects on a floodplain, (e.g., labor mediation and securities regulation), the publication of extensive implementation procedures may not be appropriate. To focus attention on those agencies whose activities more frequently affect floodplains, a survey was made of agency activities as described in the 1978-79 Government Organization Manual.

Consequently, 32 agencies and 50 of their subunits have been identified (Appendix B) as the focus of this effort to evaluate progress under the Presidential directive of July 12, 1978. The status of each of these as of January 1, 1980, is discussed in this report. However, as information and experience warrant, agencies and subagency units may be added to or deleted from this list.

Among the 32 agencies, 13 cabinet level departments and administrative units have been identified (Table 1). In the consultation process these units have been encouraged to first issue agency-wide procedures indicating general policy, substantive and mechanical requirements, designation of responsibility, and identification of subagency

units expected subsequently to issue more detailed implementation procedures. Similar broad procedures and specific subagency procedures may be appropriate for a few of the 19 independent agencies identified in this report. To date, of the 32 agencies, 20 have published implementing procedures including 16 final procedures. Of these 32 agencies, 20 have submitted the May 30 status report required by the President's Memorandum of July 12, 1978.

TABLE 1

Type of Procedures	Expected	Published		Unpublished	No Progress Evident
		Preliminary	Final		
Agency	32	4	16	2	10
Subagency Units	50	13	15	1	21

At the subagency level, 50 units were identified. Of these, 29 have prepared implementing procedures including 15 in final form. In addition, most of the subagencies are drafting regional and field level documents such as management directives, handbook inserts, manuals, etc. Three of these units submitted the May 30 reports independently, while several others were spoken for in the agency reports.

Analysis of Progress to Date

We are now over a year and a half past the due date for agency implementing procedures that is set in E.O. 11988 at Section 2(d). As summarized in Table 1, about one half of the procedures expected from the agencies are in final form. For the subagency units, about one quarter of the total expected are in final form.

In response to Secretary Andrus' May letter calling for firm implementation schedules from the agencies, some commitments were made to propose or promulgate final procedures between June and December of 1979. Nineteen commitments were made, six for agency and 13 for subagency units. One agency and six subagencies have yet to meet their commitments (refer to Appendix B). If each of these commitments is fulfilled, the total of agencies with published procedures will be 22 and the total for subagencies will be 35.

It should be noted that the data compiled here on the status of agency procedures gives no firm indication of the effectiveness of the Order's implementation at the field level. Few procedures have been in effect for very long, and the provision of adequate guidance to agency field staff is only in its initial stages. Only four of the twenty-one agencies submitting the May 30 report made reference to the effectiveness of their implementation efforts. In summary, they reported modest results and emphasized the need to await the administration of final procedures to gather useful data.

Despite the status report's lack of detail on implementation, there is evidence that the Order is having an impact across the Nation. Both the Water Resources Council and the Federal Emergency Management Agency* receive inquiries daily about the applicability of the Order to specific field situations. In some of these situations, the Executive Order has clearly resulted in desirable modification of a proposed action.

Impact of the Order on Agency Activities

The May 30 written status reports were received from 23 agencies and subunits. These reports concerned themselves primarily with descriptions of progress in developing implementing procedures, manuals, handbooks, etc. Only 4 agencies commented on the

*The President's Executive Order 12148 of July 20, 1979, established the Federal Emergency Management Agency (FEMA) as co-consultant on agency E.O. 11988 procedures along with WRC and CEQ. This role was previously performed by the Federal Insurance Administration which is now a part of FEMA.

impact of the Executive Order on their programs, not a sufficient number to permit meaningful evaluation.

The status reports also included 4 agencies which indicated the Executive Order did not apply to their program activities. These agencies stated either that E.O. 11988 does not apply to their activities, or that by the nature of the activities they carry out, any effort that they might make to implement the Order would not achieve its intent. One of these agencies, however, noted that it is continuing its review of the applicability of the Order (refer to Appendix B).

From our experience to date, it appears that the potential for the objectives of E.O. 11988 to be achieved can be expected to vary based on the type of Federal program under consideration. The greatest long term potential would appear to be in technical assistance and water and land use planning programs. These include the Coastal Zone Management Program and EPA 208 and HUD 701 planning programs, as well as the technical asistance programs of SCS and the Corps, and the National Flood Insurance Program. Such programs, through integration of the Order's concepts of floodplain avoidance and impact mitigation into land and water planning efforts, can provide the best vehicles for laying the groundwork for sound floodplain management.

The greatest short term potential for achieving the Order's objectives may be expected from the day-to-day application of the Order's provisions through direct Federal construction and land management programs. These include programs implemented by the Corps of Engineers, GSA, the Forest Service, BLM and others. In these programs, the Order's implementation is quite straightforward, and results are more immediate and measurable over the short run.

It appears that the potential for achieving the Order's objectives is somewhat less among the grant and loan and regulatory and licensing programs such as those administered by EDA, EPA, FERC, the Coast Guard and others. In these programs, the Federal agencies provide the wherewithal for others to perform actions affecting the floodplain, e.g., State or local governments or private developers. In the grant and loan programs, especially, the Federal Government does not have full control over every aspect of considering a proposed floodplain action. This effort is compensated for to some degree, and thus, the potential for achieving the Order's objectives is greater among agencies providing grants and loans for disaster relief and recovery, such as SBA and FEMA. In post flood situations, there is an unusually high receptivity to the initiation of sound floodplain management efforts. While the Federal regulatory programs have the power to revoke licenses or permits and to demand restitution of disrupted floodplain areas, they frequently lack the resources for effective monitoring.

The potential for Federal agency efforts to achieve the Order's objectives is least strong in the Federal instrumentalities, e.g., FDIC, FSLIC, etc. However, even among these agencies which have the least direct involvement in actions having the potential to affect the floodplain, opoportunities to achieve the Order's intent exist. For example, although the Federal agencies that guarantee, regulate, approve or insure financial transactions related to floodplain locations have a very indirect connection with persons carrying out actions impacting floodplains, they can aid in achieving the Order's intent through the transmittal of information about the nature of the risk to potential floodplain developers and occupants.

It is to be anticipated that there will be similarities and continuity between the procedures developed by different agencies performing the same type of functions. The public notice, floodplain avoidance, and impact identification and mitigation provisions of the Order will logically be addressed in a basically similar manner by agencies performing the same types of activities. This is already becoming evident from the procedures of agencies involved in property acquisition, management and disposal,

construction of structures and facilities, granting of licenses and permits, provision of grants and loans, land use planning, etc. It is these similarities, in fact, that will provide WRC with a comparative framework to perform the first comprehensive evaluation of the effectiveness of the Federal effort to implement E.O. 11988. This evaluation is being initiated by WRC pursuant to the provisions of Section 5 of the Order.

Appendix A

Implementation of Executive Order 11988, Floodplain Management

May 24, 1977	Executive Order 11988 issued by the President
Nov. 20-21, 1977	CEQ meeting with designated agency contact to discuss the Order
Feb. 10, 1978	Guidelines for Implementing E.O. 11988 publishd by WRC
March 6-9, 1978	WRC/CEQ/FIA Workshops for Agency contacts
March 1978 - to date	WRC/CEQ/FIA consultation and comment on agency draft procedures
March 21, 1978	CEQ Memo to Agency Heads discussing implementation and offering guidance
May 24, 1978	Publication of Draft Procedure in *Federal Register* by only five agencies
June 6, 1978	President's Water Policy Reform Message calls for expedited implementation
July 12, 1978	Presidential Memorandum to Agency Heads directing agencies to expedite implementation and submit progress reports by November 30, 1978 and May 30, 1978.
Nov. 15, 1978	Draft regulation for consultation and comments submitted by 32 agencies, including 23 published in the *Federal Register*
January 15, 1979	Progress Report based on consultation and status reports submitted by agencies indicates the following: — 31 Federal agencies have largest amount of program activity affecting floodplains — Of 13 cabinet level agencies, one has published final procedures and seven have published draft or interim procedures — Of 18 independent agencies, four have published procedures and five have published draft or interim procedures — Of 44 subdepartmental units, 10 have published draft or interim procedures and five have submitted unpublished drafts for consultation.
April 19 - June 7, 1979	WRC/CEQ/FIA conducted comprehensive field staff training on the Order in 10 major cities nationwide. The sessions were attended by 360 staff from over 35 Federal agencies.

May 8 and 11, 1979	Secretary Andrus, Chairman of the Water Resources Council, informed the agency heads of the unsatisfactory rate of progress in implementing the Order and requested a firm schedule for issuing final procedures.
January 1, 1980	Progress report based on consultation and May 30, 1979 status reports submitted by agencies indicates the following: — 32 Federal agencies have largest amount of program activities affecting floodplains; — Of 13 Cabinet level agencies, seven have published final procedures, three have published proposed procedures, and two have informal drafts; — Of 19 independent agencies, nine have published final or interim procedures, and one has published proposed procedures. — Of 50 subagency units, 15 have published final procedures, 13 have published proposed or interim procedures, and one has an informal draft.
January 1, 1980	First formal evaluation of the effectiveness of agency procedures initiated by WRC pursuant to Section 5 of E.O. 11988. A Work Group of the Council's Floodplain Management Task Force is performing the evaluation which is to be completed in September 1980.

Appendix B

STATUS OF FEDERAL AGENCY PROCEDURES FOR E.O. 11988, FLOODPLAIN MANAGEMENT (AMENDED TO APRIL 1, 1980)

Agency and Subunit	Status of Procedures
Department of Agriculture	FINAL — Internal memo, October 30, 1978
Soil Conservation Service	FINAL — *Federal Register*, July 30, 1979
Rural Electrification Administration	PROPOSED — *Federal Register*, Aug. 29, 1978 (September, 1979)*
Economics, Statistics and Cooperative Service	PROPOSED — *Federal Register*, June 9, 1978
Farmers Home Administration	PROPOSED — *Federal Register*, Sept. 14, 1978
Forest Service	PROPOSED — *Federal Register*, May 4, 1979
Science and Education Administration	PROPOSED — *Federal Register*, June 9, 1978

*Date agency committed itself to publish proposed or final rules in *Federal Register* according to its May 30 Progress Report.

Agency	Status of Procedures
Agricultural Stabilization and Conservation Service	PROPOSED — *Federal Register*, March 14, 1978
Department of Commerce	FINAL — *Federal Register*, May 23, 1979
Economic Development Admnistration	FINAL — *Federal Register*, August 31, 1979
National Oceanic and Atmospheric Administration	INFORMAL DRAFT — December 1979 (August 1979)*
Department of Defense	
(Military Construction)	FINAL — *Federal Register*, March 6, 1978
Air Force	FINAL — Design Manual, Dec. 22, 1978
Army	INTERNAL DIRECTIVE — May 22, 1978
Navy	FINAL — Design Manual, August, 1979
(Civil Works) Corps of Engineers	FINAL — *Federal Register*, May 15, 1979
(Regulatory Programs) Corps of Engineers	FINAL — *Federal Register*, July 19, 1977
Department of Energy	FINAL — *Federal Register*, March 7, 1979
Federal Energy Regulatory Commission	PROPOSED — *Federal Register*, August 23, 1979
Department of Health, Education and Welfare	PROPOSED — *Federal Register*, March 6, 1980
Education Division	NONE
Public Health Service	NONE
Department of Housing and Urban Development	PROPOSED — *Federal Register*, Aug. 9, 1979
Community Planning and Development	NONE
Housing	NONE
Neighborhood, Voluntary Associations and Consumer Protection	NONE
New Community Development Corporation	NONE
Department of the Interior	FINAL — *Federal Register*, June 20, 1979
Fish and Wildlife Service	FINAL — *Federal Register*, Nov. 20, 1979
Heritage Conservation and Recreation Service	FINAL — *Federal Register*, June 21, 1979

Agency	Status of Procedures
National Park Service	PROPOSED — *Federal Register*, March 14, 1980 (July, 1979)*
Bureau of Land Management	FINAL — *Federal Register*, March 15, 1979
Water and Power Resource Service	FINAL — *Federal Register*, July 17, 1979
Bureau of Indian Affairs	PROPOSED — *Federal Register*, Oct. 1, 1979*
Office of Surface Mining	NONE
Bureau of Mines	NONE
Geological Survey	NONE
Department of Justice	PROPOSED — *Federal Register*, August 2, 1979
Bureau of Prisons	NONE
Law Enforcement Assistance Administration	NONE
Immigration and Naturalization Service	NONE
Department of Labor	INFORMAL DRAFT — June 1979
Department of State (provided by)	
Bureau of Oceans and International Environmental and Scientific Affairs	INFORMAL DRAFT — September, 1978
Department of Transportation	FINAL — *Federal Register*, April 26, 1979
Federal Aviation Administration	**
Federal Highway Administration	FINAL — *Federal Register*, Nov. 26, 1979
Federal Railroad Administration	**
Urban Mass Transit Administration	**
Saint Lawrence Seaway Development Corporation	**
U.S. Coast Guard	**
Department of Treasury	FINAL — *Federal Register*, May 24, 1978
Environmental Protection Agency	FINAL — *Federal Register*,Jan. 5, 1979
Office of Air Quality Planning and Standards	NONE
Office of Drinking Water	NONE (October 1979)*
Office of Enforcement	FINAL — *Federal Register*, June 7, 1979
Office of Environmental Review	PROPOSED — *Federal Register*, June 18, 1979

* Date agency committed itself to publish proposed or final rules in *Federal Register* according to its May 30 Progress Report.

** A DOT Memorandum of October 1, 1979 points out that these subagency units have adopted the DOT-wide directive as their own.

Agency	Status of Procedures
Office of Solid Waste Management	**
State Plans	FINAL — *Federal Register*, July 31, 1979
Disposal Facilities	PROPOSED — *Federal Register*, Feb. 6, 1978 (June 1979)*
Hazardous Waste Permits	PROPOSED — *Federal Register*, Dec. 18, 1978 (December 1979)*
Office of Water Planning and Standards	FINAL — *Federal Register*, May 23, 1979
Office of Water Program Operations	FINAL — Handbook, January 1979
Independent Agencies	
Advisory Council on Historic Preservation	NONE
Action	NONE
Community Services Administration	NONE (July 1979)*
Farm Credit Administration	NONE***
Federal Communication Commission	FINAL — *Federal Register*, Nov. 15, 1977
Federal Deposit Insurance Corporation	NONE***
Federal Emergency Management Agency	INTERIM — *Federal Register*, Dec. 27, 1979
Office of Plans and Preparedness	NONE
Office of Disaster Response and Recovery	PROPOSED — *Federal Register*, June 13, 1979
Federal Insurance Administration	NONE
Federal Home Loan Bank Board	NONE***
General Services Administration	FINAL — *Federal Register*, August 1, 1979
International Boundary Water Commission	FINAL — *Federal Register*, Dec. 29, 1978
National Aeronautics and Space Administration	FINAL — *Federal Register*, Jan. 4, 1979
National Capitol Planning Commission	NONE
National Credit Union Administration	NONE***
Nuclear Regulatory Commission	PROPOSED — *Federal Register*, Oct. 6, 1978
Small Business Administration	INTERIM — *Federal Register*, Oct. 28, 1978
Tennessee Valley Authority	FINAL — *Federal Register*, August 3, 1979
U.S. Postal Service	FINAL — PS Bulletin, August 14, 1978

* Date agency committed itself to publishing proposed rule in the *Federal Register* according to its May 30 Progress Report.

** The Office of Solid Waste Management will be reflecting the Order's requirements in the three sets of referenced procedures.

*** In their May 30, 1979 progress reports, these agencies stated either that E.O. 11988 does not apply to their activities, or that by the nature of the activities they carry out, any effort that they might make to implement the Order would not achieve its intents. The National Credit Union Administration, however, noted that it is continuing its review of the applicability of the Order.

Agency	Status of Procedures
Veterans Administration	FINAL — *Federal Register*, Aug. 22, 1978
Water Resources Council	*
NEPA Procedures	Council of Members Approval — Nov. 13, 1979
Title I — Principles and Standards	Council of Members Approval — Nov. 13, 1979
— Floodplain Management Guidelines	FINAL — *Federal Register*, Feb. 10, 1978
Title II	INFORMAL DRAFT
Title III	INTERNAL MEMO — October 1977

*The Water Resources Council is reflecting the Order's requirements in the referenced procedures.

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