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PHYSICAL MANAGEMENT OF COASTAL FLOODPLAINS:

Guidelines for Hazards and Ecosystems Management

DRAFT FINAL MANUAL

prepared by

The Conservation Foundation

for

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The Conservation Foundation
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Washington, D.C. 20036

Sponsored by
the following Federal agencies:

U.S. Army Corps of Engineers
Council on Environmental Quality
U.S. Environmental Protection Agency
Federal Insurance Administration
U.S. Fish and Wildlife Service
Office of Coastal Zone Management

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INTRODUCTION

This manual is for local governments that want to conserve the ecological resources of their coasts and protect human life and property against coastal flooding and shore erosion.

Conservation of ecological resources begins with care and protection of natural systems. A community conservation program can enhance the system's natural "carrying capacity," its capacity to provide resource benefits. The potential of a coastal natural system, or ecosystem, to function effectively and yield the highest values to mankind is dependent on a complex interplay of chemical, geological, physical, and biological factors.

A primary factor that influences ecological carrying capacity, and gives each ecosystem its particular character, is the pattern of watershed drainage and runoff to the coastal basin. Other important factors are the forces of tides and currents and the supplies of critical nutrient constituents of the water, such as dissolved chemicals, dissolved gases, and suspended organic matter. Because these factors are affected by development, carrying capacity can be markedly reduced by poorly planned and uncontrolled land and water uses.

Protection against hazards begins with preservation of coastal landforms that provide natural resistance to wave attack, flooding, and erosion from hurricanes and storms. These landforms vary significantly around the U.S. coast in form, function, and effectiveness. In many areas of the East, Southeast, 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 smaller storms, unaltered natural barriers can prevent considerable damage from waves and floods. If the storm-driven rise of coastal waters is very high, as in a direct hurricane strike, it may overwhelm virtually any defensive barrier, natural or man-made. Human activities that remove or degrade protective landforms--for example, removing beach sand, bulldozing dunes, or destroying mangrove swamps--diminish the natural resistance of the coast and therefore should be controlled.

GOALS

As many localities are already well aware, an action needed to conserve ecological resources is often the same as an action needed to preserve the natural landforms that resist storms and flooding. A unified coastal management strategy, intended to achieve both goals simultaneously, can make local actions more effective and efficient. For example, a single setback requirement in the building code could both preserve turtle nesting sites on tbe backbeach and protect homes from erosion and storm waves. Similarly, a zoning restriction on development of mangrove swamps could both conserve an ecologically vital area and maintain a physical defense against storm waves.

Since each locality has a unique environmental setting, each needs a unique coastal strategy. The community with wetlands or dunes, for example, needs special elements in its strategy to deal with these places. And environmental variations are not the only ones that communities should consider in formulating their strategies. Each community has its unique set of attitudes, social goals, and political styles. How strongly is the community committed to resource conservation and protection against hazards? How much money can the locality spend to formulate and apply a coastal strategy? How much help is the community likely to get from state agencies?

This manual, although it cannot deal with unique local conditions, recommends a general approach to the formulation of local coastal strategies. For all their differences, communities seeking the same general goals often encounter similar needs and opportunities. These common needs and opportunities are the focus of this manual.

A community that decides to establish goals for conservation of ecological resources and protection against coastal hazards will face at least six needs:

1. <u>To manage coastal watersheds for least alteration of natural patterns of stormwater runoff</u>. This requires protecting coastal watersheds from soil erosion and accelerated runoff to stabilize the hydrologic system and to reduce flooding of coastal neighborhoods. It also requires discouraging stream alteration and other adverse alteration of the hydrologic system.

2. To preserve ecologically vital areas, such as dunes, coral reefs, wetlands, and edge-zones. This requires locating development outside vital areas as well as protecting them from alteration.

3. To preserve the integrity of coastal geologic protective structures. Preserving sand dunes, beaches, erodible banks and bluffs, and other geologic structures can have important benefits both for conservation of ecological resources and for protection against hazards.

4. To protect the configuration of coastal water basins against adverse alteration. This requires discouraging dredging and construction projects that would detrimentally alter basin floors or inlets or would adversely affect currents or tidal flushing in coastal basins.

5. To protect coastal waters from pollution. This requires controlling pollution from shoreland runoff, from industrial and domestic wastes, and from dredging in coastal water basins.

6. To restore damaged environments. This requires using private and public means to restore essential elements of the coastal environment that have been damaged.

POLICIES

To aid local government in meeting these needs, this manual recommends 36 policies. The policies are not all embracing. Shoreland areas are considered only insofar as they relate to coastal waters, water basins, and transitional flood-prone and tidal areas. Problems of developing coasts are emphasized, with less attention given to urbanized coasts. The focus is on seacoasts rather than on the Great Lakes. However, the most major coastal environmental issues are covered in sufficient detail in one policy or another to show how the unified management system which the manual advocates can work.

Some of the policies--such as wetland preservation--are already familiar to many coastal localities. Some--such as duneland protection--are less familiar; they relate to landforms of limited occurrence, respond to problems only now being widely recognized as important, or pertain to matters on which local governments have traditionally deferred to state or federal agencies. All of the policies, however, are believed to be worthy of consideration by local governments that want to conserve coastal ecological resources and protect life and property against hazards.

To implement these policies, localities can use an array of familiar techniques: regulations, land acquisition, public works planning, tax and other financial incentives, technical assistance to land developers and users, public education, and so on. Most of the techniques are no different from those available in non-coastal parts of the community. Communities should not assume, however, that measures designed for inland areas are sufficient to implement coastal policies. Most local measures need to be adapted specially for the beaches, estuaries, saltwater wetlands, and other features found only on the coast. For example, a construction setback for the beachfront may have to be adapted to include the concept of recession; that is, the setback will have to be augmented by the projected amount of land to be lost to shore recession where there is serious continuing erosion.

When a community decides to implement the coastal policies, it may face difficult administrative and political issues. For example, is there sufficient expertise available and information at hand to administer the local program? Can the community devise policies and regulations that are both effective and politically acceptable? Also at this point the community must reconcile its coastal resource policies with other policies and goals. How does it protect dunes and provide beachfront recreation space, for example? How does it reduce agricultural runoff without unduly interfering with the lives of farmers? Can it elevate homes and utilities above flood danger levels without an unacceptable increase in housing costs?

Taking advantage of federal and state actions should be a key part of local strategies to implement coastal policies. Thus, along with such traditional measures as regulations and public-works programming, the community will find itself participating in federally mandated planning processes, for example, or commenting on proposed federal permits, or seeking early federal or state attention to a particular local problem. Localities will often find more effective federal and state support in protecting coastal areas than elsewhere. This is true, first, because of long-standing federal and state responsibilities for some coastal areas--navigable waters, for example. It is true also because many recent federal and state actions, such as the National Flood Insurance Program and federal executive orders on floodlands and wetlands, have particular striking impacts on the coasts. State programs vary so greatly that they cannot be covered effectively in a manual of this length. A catalog of major federal programs likely to have significant influence on local management of coastal floodplains appears in Part II of this manual.

PLACES OF CONCERN

Understanding the needs of the coast begins with the recognition that coastal landforms in their natural state perform important ecological and hazard-resistance services to the community. Conservation of each type of landform requires a distinctive approach. For local programs, it is therefore important to identify the important local landforms as distinct places of concern. This same identification is beneficial in coordinating local programs with the many federal actions that affect community efforts to protect the places of concern. Accordingly, this manual is divided into seven sections, each dealing with a particular place of concern. The policies focus most strongly on the floodplain transition area, the zone of change from water to land which includes wetlands, beaches, dunelands, banks and bluffs, and floodlands. In these places of concern, ecological resource conservation and protection against hazards are often the prevalent factors in environmental management.

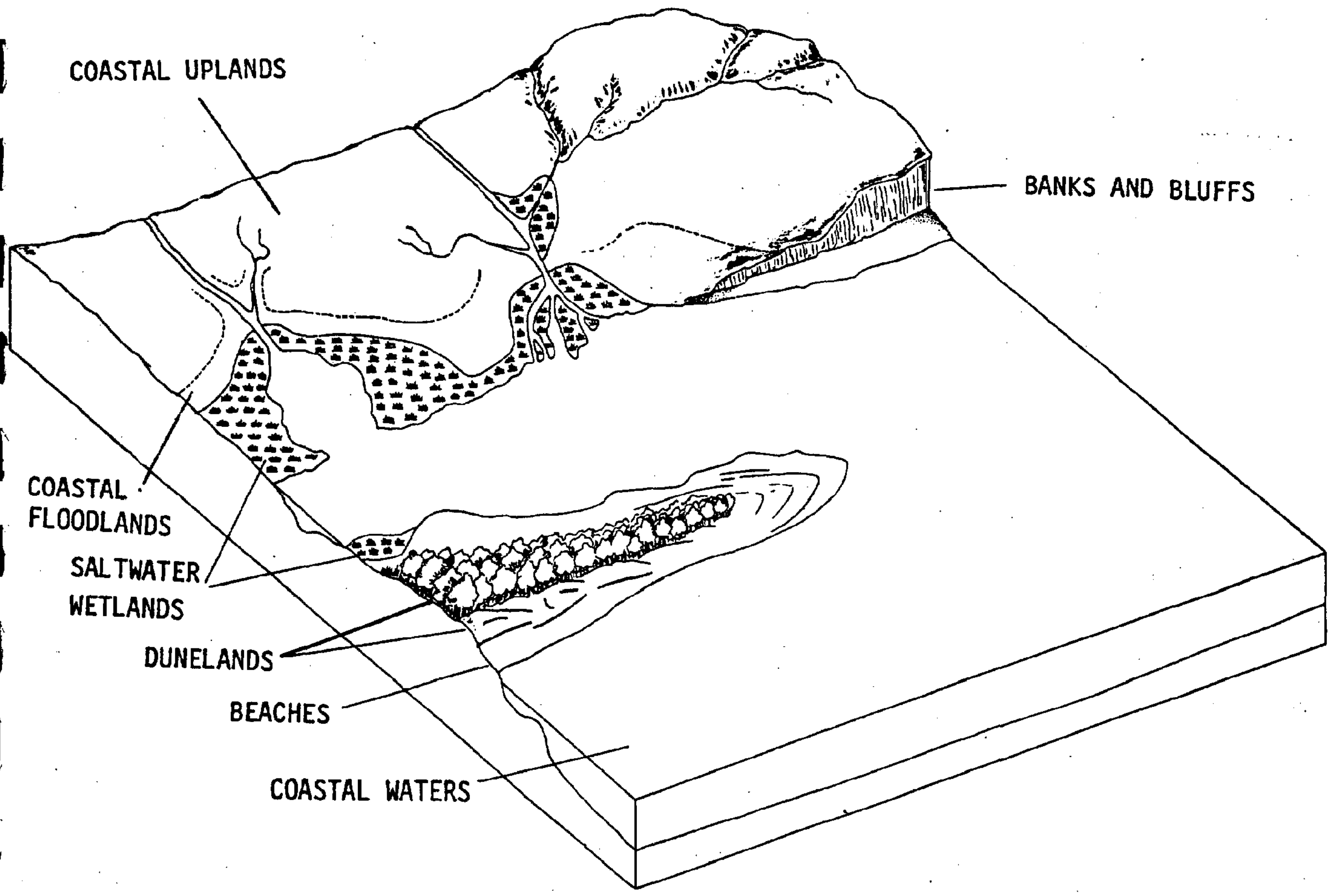
Two other broad areas included in the manual are the coastal uplands and coastal water basins. Both areas are recommended for special attention because they are linked strongly to physical management of the floodplain transition area through the flow of water.

Each place-of-concern section is arranged according to a standard pattern. First, there is a description of the ecological features and the natural hazards common to the place. Second, development policies are recommended and discussed. Third, measures needed to implement the policies are described, including references to federal programs that may aid in implementation. The seven place sections (see Figure 1) are as follows:

Coastal Uplands: The coastal uplands, the slopes directly above the floodplain that drain into coastal waters, are a place of concern because they hold storm water, and regulate its rate of flow and its quality. The flow of water from the land is a primary factor affecting the condition of coastal ecological resources and shore flooding, particularly of estuaries. Uncontrolled clearing, hydrologic alteration, and development activity in the uplands is a potential source of damage to coastal ecosystems and a threat to life and property. The major management needs are soil and water conservation and wetlands and edge-zone protection.

Figure 1

PLACES OF CONCERN FOR COASTAL FLOODPLAIN MANAGEMENT



Coastal Floodlands: The floodlands, the part of the coastal floodplain lying above the normal reach of tide, have all the management needs of uplands and more. Floodlands are sporadically washed by tides or struck with waves of an extent varying from slight to severe. The lowest reaches of the floodlands require the greatest attention. Management needs (in addition to those for uplands) may include construction setbacks, elevation of structures, and controls on excavation, groundwater pumping, and facilities siting (for pollution-prone industry).

Saltwater Wetlands: Saltwater wetlands, which include salt marshes and mangrove swamps, are a vital component of the coastal environment, both for ecological and flood-protection reasons. In addition to providing critical habitats for birds and marine life, the wetlands are a primary source of plant matter for coastal food chains. Wetlands also remove pollutants from the water, slow the surge of floodwaters, break waves, reduce flooding, and stabilize shorelines and prevent erosion. For these reasons, wetlands should be protected and restored to the maximum extent possible.

Banks and Bluffs: Banks and bluffs are areas where geologic instability and water-related erosion contribute to hazardous development conditions. Major management needs are construction setbacks and controls on factors that contribute to erosion and slides--for example, water seepage and face or toe alteration.

Dunelands: The area immediately adjacent to ocean beaches is often a distinctive landform combining sand dunes, beach ridges, flats, or washovers. It has a high potential for storm damage and is a unique natural habitat. Dunes require protection so that they may continue to buffer the force of storm seas and provide capacity to store and yield sand to protect beaches and shorelands. Dunelands furnish turtle and bird nesting areas and valuable habitats for certain wildlife species. Major management needs include setbacks, construction standards, excavation prevention, and traffic control.

Beaches: Besides exerting a strong attraction for recreational use, ocean beaches also play an important role in abating the natural processes of erosion and provide protection from waves and rushing water in major storms. The sand stored in beaches is the key to preservation of the beach. A beach management program is necessary to limit building, prevent excavation, and control beach protection and inlet structures.

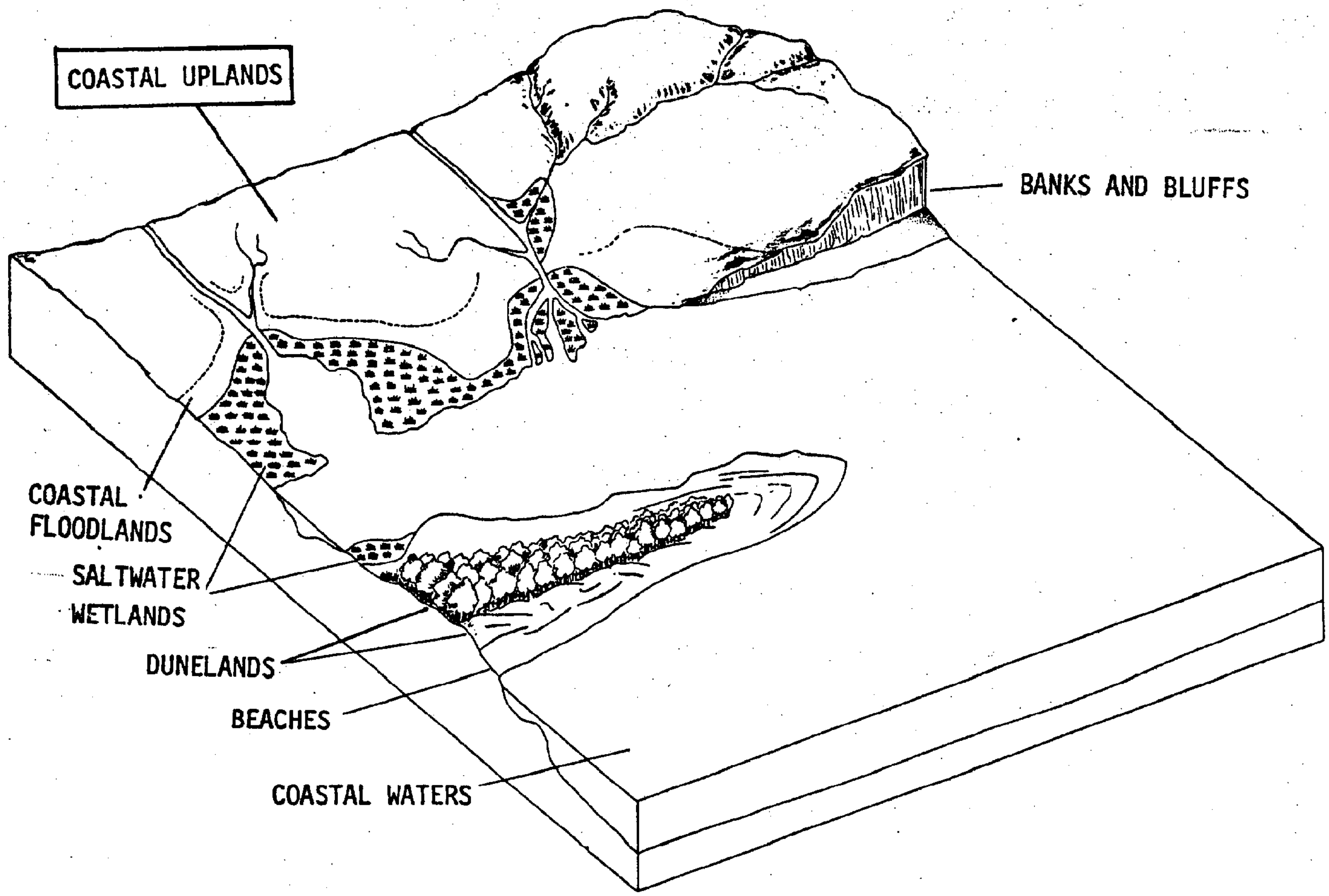
Coastal Waters and Basins: Tidal forces and the characteristics of coastal basin floors strongly influence the carrying capacity of coastal ecosystems. Together they govern the force with which storms strike the coast and height to which floods may rise. Management needs are controls on marine construction, alteration of the basin, and pollution of the waters.

PART I

CONTENTS

COASTAL UPLANDS

PLACES OF CONCERN FOR COASTAL FLOODPLAIN MANAGEMENT



COASTAL UPLANDS

Although the coastal uplands lie above the floodplain, any major alteration in their terrain (land surface), or in streams, ponds, wetlands, and other elements of the uplands hydrologic system, can have a great impact on floodplains and coastal waters, adversely affecting both ecologic and flood-protection values. Therefore uplands--slopes directly above the floodplain that drain into coastal waters--are an important place of concern for coastal-zone management and for this manual (Figure 1).

In their natural condition, the uplands terrain and hydrologic system have a high capacity to detain storm waters--in effect, acting as a natural sponge that holds water during heavy rains or snows for later, more gradual, release. For downstream communities, uplands can thus provide some protection against flooding. Uplands are also important because they protect coastal waters from storm runoff pollution through the water-cleansing function of vegetation and soils and provide an ecologically compatible rate of runoff flow [2].

The beneficial functions of the coastal uplands are diminished when the terrain is cleared of vegetation, covered with pavement, or altered to facilitate drainage. Adverse impacts also occur 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. [Photo] Therefore, there is a need for

NOTE: An improved figure will be prepared for publication.

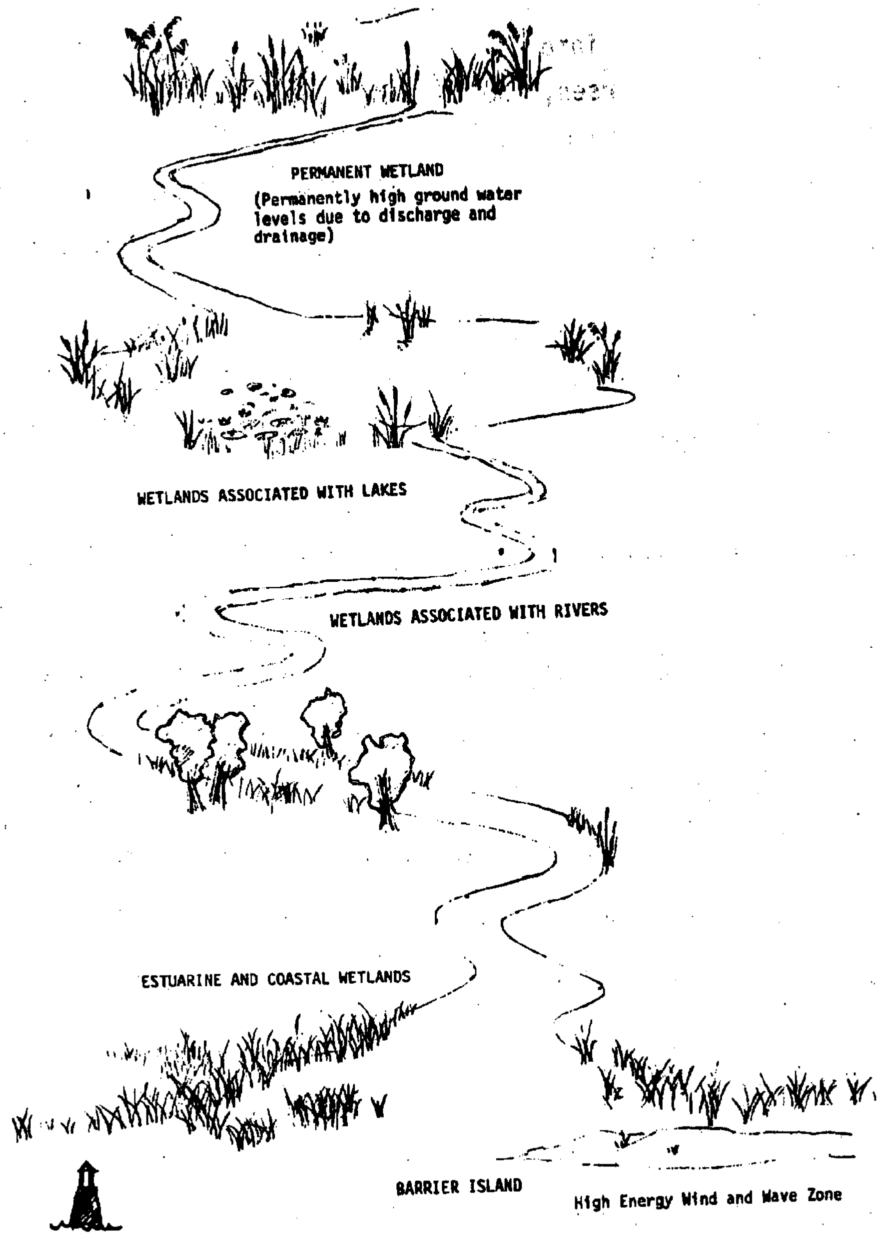


Figure 1. The coastal uplands are linked to coastal water basins by the water that moves over or through them. Stormwater retention in the uplands may deter the flooding of coastal basin floodplains. Quality and quantity of runoff from upland watersheds are primary determinants of coastal ecosystem function and carrying capacity. [1]

PHOTOGRAPH

Land stripped of vegetation showing extreme soil erosion conservation of soil and of natural hydrologic systems in the uplands. It is the purpose of this section to call attention to that need.

ECOLOGICAL FEATURES

The capacity of the upland watershed terrain and its hydrologic system to regularize the discharge of runoff water depends on a variety of natural factors--slope, soil type, vegetation, climate, and so forth (Figure 2). So does the capacity to filter, physically and chemically, the water in transit, removing sediments, toxic matter, and excess nutrients before releasing it into coastal waters [4]. 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 natural nutrients to coastal waters. In brief, these values can be preserved by maintaining the natural quality, volume, and rate of flow of freshwater discharge from the upland to coastal basins. Such preservation will ensure the optimum functioning of coastal ecosystems [2].

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

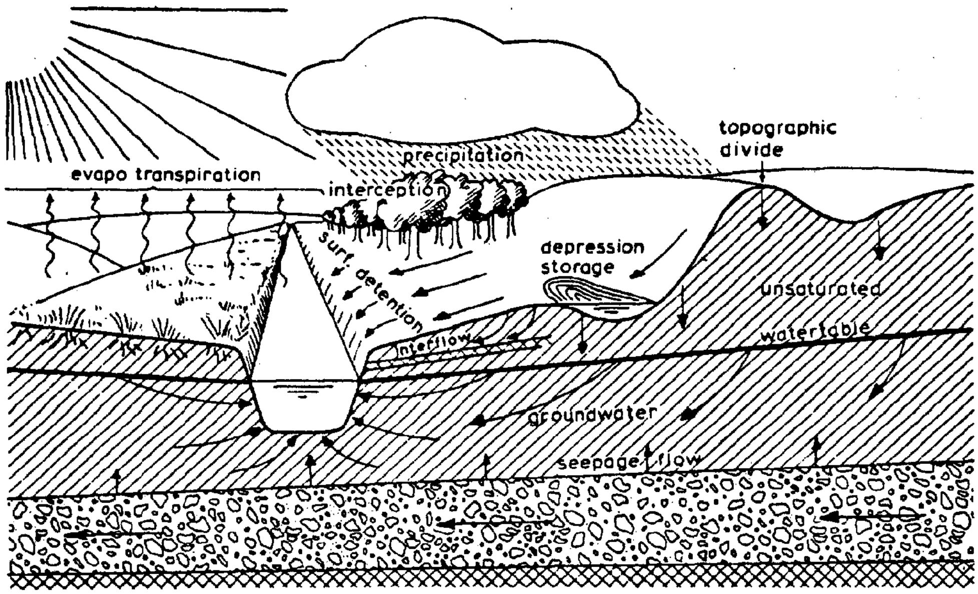


Figure 2. The slope of the land, the soil type and its moisture content, and the type and extent of vegetative cover--all are key hydrologic factors in regulating the quality, volume, and rate of water through the complex watershed system. [3]

contaminated with a variety of industrial, agricultural, logging, or household residues. (Together, such diffuse sources are termed "non-point" sources of pollution [Photo], 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; for example, a decrease in total runoff volume essentially shrinks the most biologically productive brackish part of a bay, while a large, long-term increase in fresh water can overwhelm a smaller estuary, turning it into a virtual lake [2].

The seasonal timing of the rate of freshwater discharge to the coastal basin governs salinity and circulation, which in turn affect the productivity, stability, and the overall natural carrying capacity of the coastal ecosystem. The natural seasonal flow rate is generally optimum for the biota because most species are synchronized to this natural rhythm for critical life functions--breeding, feeding, migration, and so forth. A significant change in the rate of runoff flow has adverse effects by disrupting circulation or salinity-related functions of these species. Therefore, alteration of the rate of the flow of discharge from upland watersheds into coastal water basins is a major potential source of disturbance of coastal ecosystems.

Erosion is impeded and the quality of runoff improved by the soil and vegetation cleansing of the "edge-zone"--a border, bank, or grove at

PHOTOGRAPH

Demonstrating urban runoff

the edge of a water body or watercourse of the uplands hydrologic system. This area is also of especially high ecologic value as an ecotone which provides unique habitat for many wildlife species.

HAZARDS

Stormwater 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 and causes increased flooding of a community built along the shores of a confined estuarine basin. [Photo]

Hurricane high-water surges often last from three to five hours, during which seawater flows into bays and estuaries 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 5 inches or more are common, and far greater rainfalls have been recorded. Ewan, New Jersey, for example, received 24 inches of rain in 9 hours in a 1950 pre-hurricane rainfall [5]. 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 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

PHOTOGRAPH

Showing estuarine flooding in a semi-urban or urban setting 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 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 settlements--roofs, roads, sidewalks, and other paved area--rapidly shed storm water that would otherwise soak into the ground. Storm sewers hasten the runoff process (Figure 3). 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 height [7].

Hydrologic System: The flood-prevention value of any unit of the upland 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. [Photo] 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

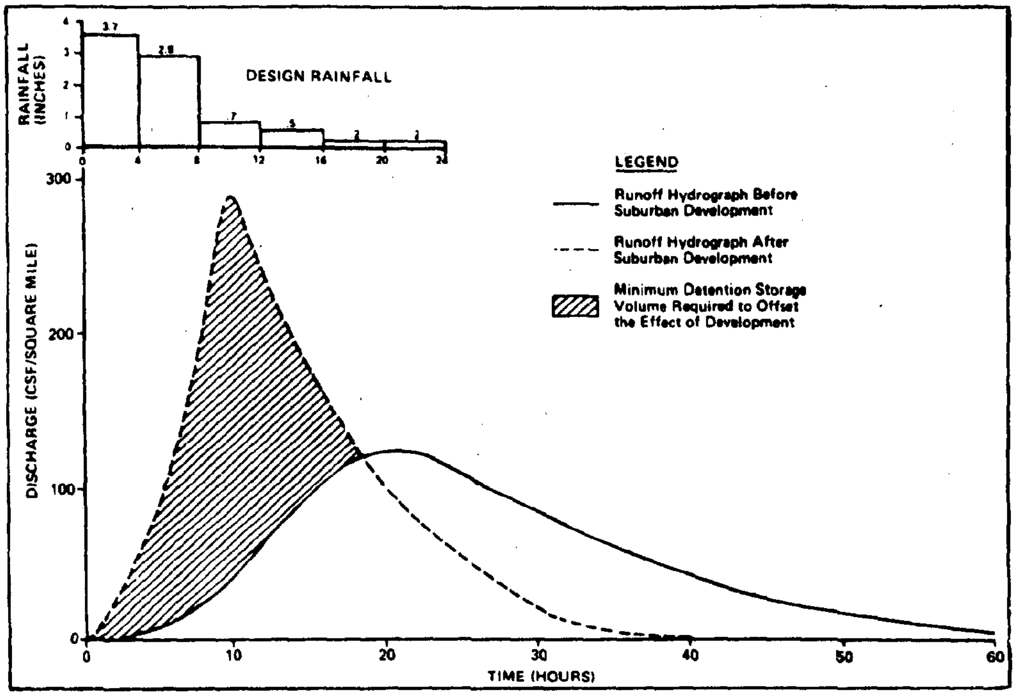


Figure 3. Typical storm runoff hydrographs, before and after development (Collier County, Florida) [6].

PHOTOGRAPH

Showing natural riparian floodlands/wetland situation long, winding watercourses are prime features of the natural stormwater detention capability of shorelands. The stormwater 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: Confined estuarine basins that receive direct river inflow and have constricted outlets to the sea are the most prone to rapid accumulation of storm runoff and to highest floodwater levels. The trapped water may cause severe shore flooding and dangerous backflow that can cut through the sandy barrier strips that enclose many basins. This effect, which varies greatly from basin to basin, depends on many factors, including the basin's particular configuration and the inlet size in relation to the watershed area and terrain surface.

DEVELOPMENT POLICIES

A 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 protect the watershed terrain, the uplands hydrologic system, and the edge-zone from destructive modification.

The essential management needs of coastal uplands can be accomplished by customary methods of hydrologic management and control of soil erosion. These include measures to reduce soil erosion, to discourage land drainage, and to protect streams, stream banks, and upland freshwater wetlands. Inclusion of uplands as a place of concern in coastal management programs does not add new elements to the community conservation program, but rather calls for additional attention to soil erosion controls, and for greater emphasis on retention of water in the soil and in the upland hydrologic system.

Ideally, the terrain should be preserved in its natural condition. Necessary changes, however, can often be compensated with appropriate artificial means.

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 connected bogs, marshes, swamps, and other permanent and temporary wetlands 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) intermittently flooded upland riparian floodlands that provide floodwater storage during heavy rains. [Photo]

It is particularly important to preserve the edge-zone of water bodies and watercourses for ecologic benefits and geologic stability. This will require 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.

PHOTOGRAPH

Of upland riparian floodlands providing floodwater storage during heavy rains

Community goals and management approaches for coastal uplands management are set forth in the policies of the Coastal Floodlands section. Individual policies are not presented in this section because they would be nearly identical to those for floodlands. Therefore, the reader should refer to Floodlands Policies 3, 4, 5, 6, and 8, which apply equally to coastal uplands management:

3. Alteration of Freshwater Wetlands.
4. Alteration of Edge-Zone.
5. Alteration of Watershed Terrain.
6. Soil Erosion.
8. Alteration of Watercourses.

Special considerations that affect the application of these policies to uplands management are noted in the discussions.

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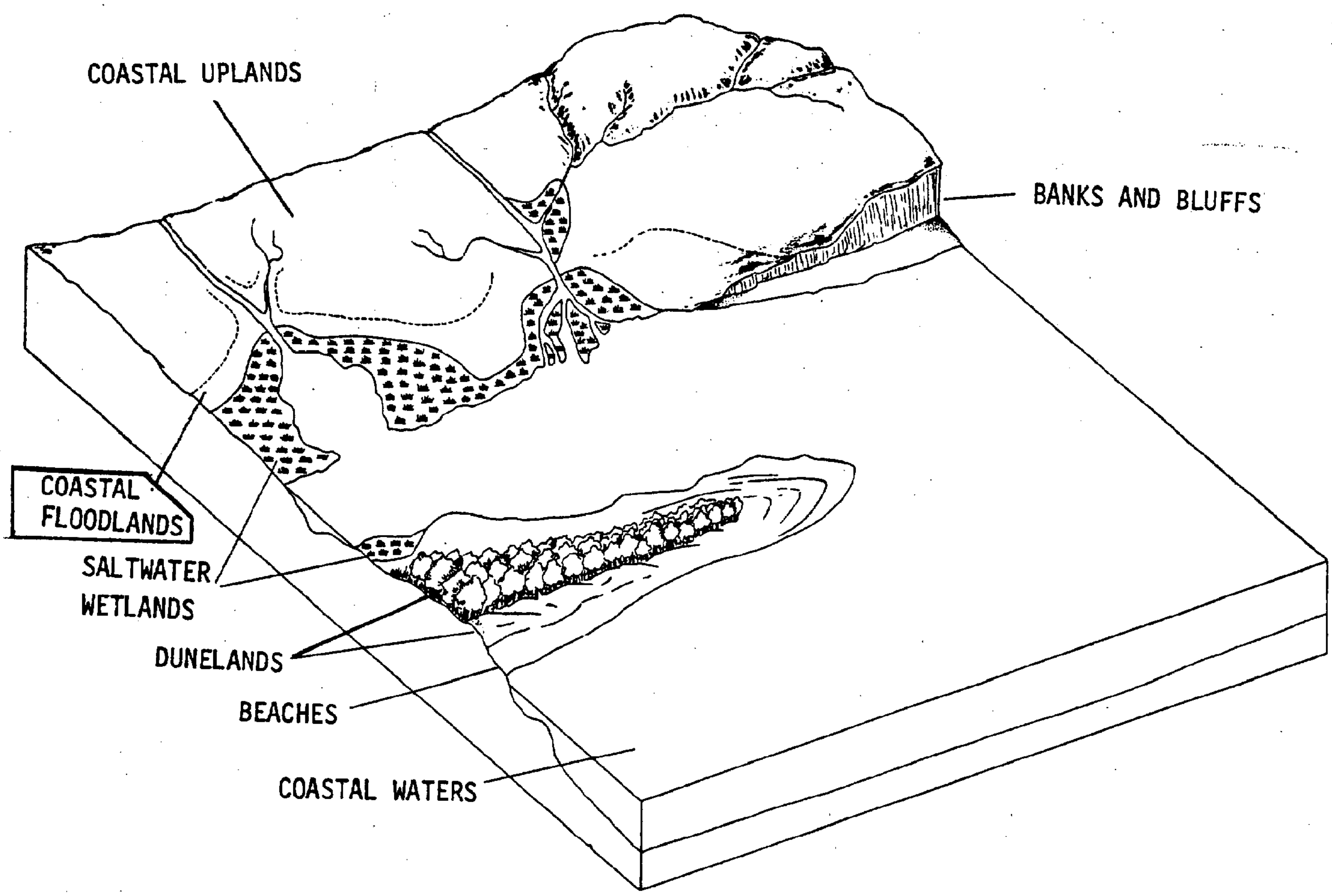
CONTENTS

COASTAL FLOODLANDS

4. Avoiding disruptions of floodlands terrain and natural water systems

   Regional Water Quality Planning (208 planning)
   Rural Clean Waters Program
   Federal Flood Control Projects
   Regulatory Program for dredged and fill material
   Coastal Zone Management Program
   National Environmental Policy Act, Environmental Impact Statements

PLACES OF CONCERN FOR COASTAL FLOODPLAIN MANAGEMENT



COASTAL FLOODLANDS

Coastal floodlands are low-lying coastal areas that are sporadically inundated by storm surges. In addition to flooding, damage in floodlands may be caused by the direct impact of storm waves in coastal "high hazard" areas and by the scouring away of beachfronts in "erosion-prone" areas. The most devastating storms are hurricanes, which strike the U.S. coast about twice a year. Their accompanying storm surges may elevate coastal waters by 10 to 15 feet. [Photo]

Although the risks of occupancy are well known, coastal floodlands are attractive for many uses. Because they are flat and accessible to coastal transportation, they are attractive to industry and commerce. Because of their high amenity values, they are attractive for recreational development and for homesites.

Floodlands have often been graded, cleared, filled, and built on without regard for their ecologic and hazard-protection functions. The result is to increase the danger to life and property in the floodlands from sea storms and hurricanes, land subsidence (from wetland drainage and groundwater "mining"), and loss of protective edge-zone, a physically distinct margin that occurs along the water's edge in much of the coastal floodlands. Uncontrolled development also reduces the ecological values of floodlands habitats, particularly the special environmental values associated with the edge-zone [1].

PHOTOGRAPH

Showing a hurricane along the Florida coast with the following caption...

The danger to life and property from estuarine flooding is exacerbated by the intensity of development in the coastal zone. Mounting flood losses can be expected when new residential, commercial, and industrial uses are located in coastal floodprone sites. To illustrate the danger of flooding, 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, 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]

ECOLOGICAL FEATURES

As an extension of the uplands terrain, the floodlands share with uplands the natural properties of retention of runoff waters and removal of pollutants. The natural storage-and-release mechanisms of floodlands absorb the heavy seasonal rains and slowly release the accumulated water through a surface water system into coastal water basins. The floodlands terrain and hydrologic system also filter the water in transit by removing sediments and assimilating excess nutrients. In this way, the floodlands naturally help solve the problems of persistent erosion of soil, washoff of fertilizers and biocides applied to the landscape, and toxic substances carried in watershed discharges which otherwise would pollute coastal waters. Estuaries, the termini for storm runoff from the shorelands, are particularly susceptible; they tend to concentrate waterborne pollutants carried off the land.

Important ecological features are found at the border where floodlands meet wetlands and water areas, providing habitats of the highest value to coastal fauna. [Photo] Many species benefit from the geological and botanical features of the lower floodlands, particularly where there may be meadows or forest hammocks of special habitat value. Animals may use the transition habitats for nesting, feeding, resting, and hiding. For example, on Kiawah Island (South Carolina) one can find raccoon, blue heron, pelican, bald eagle, terns, bears, and foxes utilizing the floodland areas just behind the dunes [3].

PHOTOGRAPH

Showing an edge-zone transition habitat

This transition area is often a very narrow and distinct edge-zone of extremely high ecological value (an "ecotone"). The edge-zone lies along the shoreline, just above the lower boundary of the floodlands. The character of the floodland edge-zone is often obvious to the eye--for example, as a band of especially high, close-growing trees or other distinct vegetative assemblages. Specific plant associations, such as saltbush or beach plum, prosper as a dense growth only in edge-zone areas that have appropriate soils and water features. More common species, such as wax myrtle or palmetto, which are tolerant of saltspray and of occasional saltwater inundation, may also be part of the edge community. In the subtropics, hardwood hammocks may be included in the edge-zone. Such habitats support an increased variety and density of fauna and provide unique breeding, roosting, and feeding situations for many species. [Photo] 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 beneficial visual screen.

HAZARDS

Coastal flooding is distinctly different from riverine flooding. In riverine flooding 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 storms.

PHOTOGRAPH

Showing an edge-zone nesting site

The characteristics of coastal land forms affect the intensity of storm impacts on coastal communities. Three characteristics of the coastal floodland that have a major effect on the intensity of potential storm hazards are elevation, drainage, and topography (Figure 1).

Elevation: The floodland surface's elevation above sea level at any specific location governs the height of flooding from a sea storm surge of any given height. In many coastal areas the land is rising or falling in relation to the sea. Land subsidence--which causes the sea level to rise--is a factor of particular importance to management of floodlands. A rapid rate of subsidence may result from human actions--for example, pumping an excess of groundwater. Natural subsidence, by contrast, is a slow process that may be caused by: (1) the drying and shrinking of geologic deposits; (2) the decline of water tables; and (3) movement of large geologic deposits. When subsidence is rapid, regardless of the cause, structures built above the floodlands may sink to unsafe elevations. [Photo]

Drainage: Characteristics of the floodland hydrologic system and terrain affect the intensity of flooding by influencing the storage and release rate of floodwaters. If the retention capability of stream channels and other watercourses that convey floodwaters is large, then the stream channel is more likely to hold back floodwaters. The presence of lakes, ponds, and particularly wetlands, provides for storage of water during flooding to the extent that they have surplus capacity. The absence of these features

FLOOD PROBABILITY

It is desirable, when considering power plant siting or the wisdom of dense residential development, to estimate the likelihood of recurrence of rare events. A device used in the Federal Insurance Administration reports for describing the recurrence interval is delineation of a "100-year flood." This wording suggests to some people that a flood is expected to occur once in 100 years and in that case is misleading. It would be more accurate to state that a flood of defined magnitude had a one per cent (1%) chance of occurrence. In each year there is a one per cent chance that it will occur. There could be two or more occurrences of an event of that magnitude in a given year. It is important to explain that the probability is the same every year regardless of the time of the previous occurrence of an event of that magnitude.

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

*A probability of 1.00 = certainty that an event will occur in a stated period. [4]

Figure 1.

PHOTOGRAPH

Showing land subsidence and consequent flooding leaves only the natural retention capacity of the soils and vegetation of the terrain. For example, during a storm, any part of the floodlands not reached by the flood can retain water in its soils as well as in its hydrologic system and thereby reduce the probable height of the floodwaters. [Photo]

Topography: Topography, or configuration of the land surface, is important because the normally dry depressions of floodlands temporarily retain considerable amounts of floodwater from both ocean and upland sources--such storage may reduce peak flood heights. However, such areas hold salt water long enough for it to damage soil fertility, by penetration into the earth, or groundwater quality, by penetration into subsurface aquifers.

DEVELOPMENT POLICIES

The goal for coastal floodlands management is to utilize the area fully while conserving coastal ecosystems and protecting life and property from the threat of periodic flooding. The constraints necessary for sound management may influence the siting, density, design, and construction of residential, commercial, and industrial facilities, and facilities that treat pollutants. Within the high-hazard portion of coastal floodlands, additional constraints on design and location of structures are required--barriers to drainage may cause floodwaters to reach higher elevations. The hazards are minimized by elevating all structures above the forecasted 100-year flood elevation and controlling future modifications so as not to create new barriers.

PHOTOGRAPH

Freshwater wetlands scene

The policies we suggest will ensure relatively safe and environmentally compatible new development as a community grows and renews itself. But environmental protection and hazard reduction through development standards and location policy are only a part of any program that adequately deals with the risks of hurricane and storm flooding in a coastal area. Evacuation planning and flood warning systems, which are not covered in this guidebook, are essential elements of a local program to ensure the least possible risk to residents from flooding. [Photo]

Management policies 1 through 10, discussed in the following pages, are for community programs in floodlands; policies 3, 4, 5, 6, and 8 apply equally to coastal uplands:

1. Construction in Floodlands: Encourage the use of piling supports or similar elevation techniques for structures built in floodlands.
2. Floodwater Pollution: Prevent pollution of stormwater runoff through proper location of facilities and contingency planning.
3. Alteration of Freshwater Wetlands: Discourage draining, filling, excavation, or other alteration of freshwater wetlands.
4. Alteration of the Edge-Zone: The edge-zone bordering coastal waters should be protected from alteration.
5. Alteration of Watershed Terrain: Discourage clearing, grading, and surfacing that would adversely alter the retention potential of the watershed terrain.

PHOTOGRAPH

Flooding scene

Local evacuation plans are essential for the safety of residents. Federal and state assistance programs are available.

6. Soil Erosion: Reduce erosion and runoff pollution from construction, agriculture, and logging to the minimum.
7. Land Drainage and Excavation: Avoid land drainage or other excavation that would adversely alter the hydrology of floodlands.
8. Alteration of Watercourses: Discourage straightening, deepening, diking, or other adverse alteration of natural channels of the uplands hydrologic system.
9. Groundwater Pumping: Limit the use of groundwater resources so as to prevent subsidence and aquifer contamination.
10. Restoration of Floodlands Environment: Encourage private and community programs for restoration of beneficial flood-lands functions.

Recommended Policy 1: Construction in Floodlands

Encourage the use of piling supports or similar elevation techniques for structures built in floodlands.

Piling supported structures are a familiar feature in many coastal areas and provide proved protection against flood damage, especially when foundation "anchors" or "tie-downs" are installed. The additional cost over that of grade-level construction is estimated at 7 to 10 percent in certain parts of Florida, while the cost for additional dirt fill to reach the regulated height, if this were permitted (it is not allowed in high-hazard areas) could run from 5 to 10 percent [5]. The ground level area under the first floor of elevated structures can be used for parking cars and storing boats; the height of the structure improves the view. [Photo]

Recommended Policy 2: Floodwater Pollution

Prevent pollution of stormwater runoff through proper location of facilities and contingency planning.

Floodwaters wash a variety of materials into coastal basins, ranging from natural nutrients that are beneficial to aquatic life to a number of harmful pollutants associated with general land runoff, or with materials stored at commercial and industrial sites. The effects are particularly severe where floodlands drain into small embayments or lagoons with restricted rates of flushing [1]. In general, one must assume that the retreat of floodwaters from a developed area in the lower parts of the floodplain (1 to 10-year flood levels) has a short-term negative impact on the ecosystem.

One action needed to reduce the pollution potential from floodlands inundation is to locate potential polluting facilities out of the floodlands, particularly the lower part. Potential pollution sources that already exist--e.g., garbage dumps, chemical warehouses--should be identified and eliminated or relocated on high ground at the earliest opportunity. [Photo] At the least, such sources should be floodproofed. Federal pollution law requires some facilities--e.g., commercial feedlots--to be located above the 25-year flood level or to be floodproofed to avoid contamination of public waters during floods [1].

PHOTOGRAPH

Showing pile-elevated residence

PHOTOGRAPH

Showing a large garbage dump

Garbage dumps, chemical warehouses, etc., are potential pollution sources which threaten aquatic environments. Facility siting out of the floodlands reduces the risk of contamination.

These pollution problems should be identified in areawide Section 208 (see p. oo) water quality planning and may be addressed by state water quality programs. The problems are also commonly addressed in local zoning and industrial siting programs.

Recommended Policy 3: Alteration of Freshwater Wetlands

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

Wetlands in the coastal uplands are flooded for all or a significant part of the year. The principal values of freshwater wetlands are lost if they are drained and dried out, even partially. Relatively minor artificial drainage projects may adversely stress natural processes. Once drained for building sites, wetlands may undergo irreversible subsidence for many years, thereby causing sinking and fracturing of foundations, streets, and sewers, and enhancing storm flooding if the land sinks substantially. [Photo]

Moreover, drainage of wetlands may have far-reaching adverse effects, such as lowering the water table and destabilizing runoff flow into estuaries. The consequent reduced storage of storm water in the hydrologic system because of lost wetlands also raises the risk of riparian and estuarine flooding. For example, the Corps of Engineers predicts from a study that if 40 percent of the wetlands in the Charles River Basin (Massachusetts) were lost, flood levels in the middle and upper river would increase from two to four feet and cause $12 million in damage in one flood [6]. [Photo] The

PHOTOGRAPH

East New Orleans, or equivalent, showing foundation cracking, etc.

PHOTOGRAPH

Part of the Charles River watershed wetlands appropriate policy is to discourage drainage of wetlands and floodlands.

Because of the potential adverse consequences, there should also generally be no filling, excavation, or other surface alteration of freshwater wetlands, whether the activity is for dumps, home sites, landscaping, agriculture, or roadways. Without such controls, vegetation would be obliterated, water flow disrupted, soil layers destroyed, pollutable catchments formed, drainage and drying out of wetlands facilitated, with the result that the beneficial functions of the wetlands would be completely disrupted.

There should generally be no solid-fill roads, causeways, or other structures in wetlands that would obstruct water flow. Also, fill for any such structures must normally be obtained by excavation, which is itself damaging. Unavoidable roadways through wetlands or over wetland swales should be elevated on structures, pilings, or columns, rather than placed on fill.

The use of wetlands should accordingly be oriented toward non-altering uses; for example, recreational uses that would be enhanced by the installation of light-duty, pile-supported structures such as boat houses, boat shelters, fences, duck blinds, footbridges, observation decks, and similar non-enclosed recreational and access structures, none of which should be designated for permanent occupancy. If properly controlled, these should not have a major detrimental effect on the functions of upland water systems.

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 provided in the Saltwater Wetlands section are largely applicable to freshwater wetlands.

Recommended Policy 4: Alteration of the Edge-Zone

The edge-zone bordering coastal waters should be protected from alteration.

There has been a high loss of the edge-zone at the lower boundary of coastal floodlands because of a general lack of appreciation of its ecologic value and its role in resisting storm and erosion hazards. This zone, lying along the wetland or open-water boundary, has often been flattened as the result of the water-front homeowner's desire to build and landscape right to the water's edge or the farmer's attempt to open up as much land as possible for planting or grazing. [Photo] When edge-zones are cleared of vegetation, graded, built on, or otherwise obliterated or seriously altered, many values are lost: critical wildlife habitat, natural bank stabilization, runoff purification capability, natural visual screen, and storm surge and wave abatement.

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. Storm danger is increased by removal of the vegetation that tends to reduce the velocity of flow, and slow and lower the height of the storm surge [1].

The major means of protection are to set aside the edge-zone as a natural area or to prescribe only non-altering uses of it through

PHOTOGRAPH

Flattened edge-zone on a coastal homesite.

special performance standards. This optimum approach creates an unaltered buffer strip of natural vegetation and soil just above the water or wetland edge (the 1-year flood mark). In addition to conserving critical wildlife habitat and lowering flood hazard and erosion potential, the buffer may provide a visual screen and an "anti-pollution" zone to intercept runoff and to provide for purification of the water by soil infiltration and vegetative "scrubbing" before it enters any coastal water areas [1].

While some floodlands may have edge-zones of lesser value because of the local landform, the potential should be evaluated in each case. The highest ecological values would be expected where the edge-zone is a relatively narrow strip of scrub and bush that grades quickly upward to a dense stand of mixed hardwood trees, which then grade quickly into open field or into a different or less dense type of forest community. Preservation is particularly practicable where the lower floodland slope is moderately steep and the edge-zone well defined and relatively limited in width. In such situations a buffer strip of 75 to 200 feet might be appropriate [1]. Wider or narrower strips might be needed where the slope is lesser or greater or where the edge-zone has an unusual form.

For agriculture, edge-zone setbacks should be required along all watercourses and coastal shorelines to separate tilled land from water bodies by a vegetated buffer strip. [Photo] Such buffers can often consist of close-growing crops (grasses) that have matted root systems and require no fertilizers or pesticides. The required width

PHOTOGRAPH

Edge-zone buffer strip at boundary between cropland and watercourse of the buffer will vary with soil and water-table characteristics, slope, climate, and type of vegetation in the buffer strip. Width also depends on 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. A setback distance of 150 feet, in common use for the protection of streams and other water areas, would often be sufficient for soil-erosion control. Additional width would be required to provide for removal of nitrate and other agricultural chemicals by soil and vegetation. A wide buffer is particularly important in areas where the land surface slopes steeply from land to water [7]. Table 1 gives some recommended <u>minimum</u> setbacks for agriculture which are based on water quality requirements; the setbacks must be increased where needed to include habitat and other values.

A variety of non-altering uses can be encouraged for floodland edge-zone buffer strips. In addition to certain types of agriculture, recreational use and natural and open-space areas are particularly appropriate. Light-duty structures should be acceptable if they can fit into the natural landscape and require little in the way of clearing, grading, paving, and excavation. These requirements may be incorporated in local zoning or subdivision regulations, though some communities use other techniques, such as special environmental review for development in critical areas.

The needs for edge-zone protection in coastal uplands are identical to those for coastal floodlands. Specifically, setbacks

Table 1. Minimum filter strips for cropland water quality restoration recommended to the U.S. Agricultural Research Service for soils with varying erosion problems. For example, a 10 percent slope with a slight erosion problem would require a 55 foot filter strip [8].

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)

providing for an edge-zone buffer along watercourses, water bodies, and wetlands of the uplands hydrologic system should be required, and the guidelines above should be followed.

Recommended Policy 5: Alteration of Watershed Terrain

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

Clearing coastal watersheds of vegetation and covering them with impervious surfacing causes major alterations in the quality, volume, and rate of stormwater runoff to the estuarine system. The higher the amount of paved surface, the more rapidly the runoff surges into coastal waters (Figure 3). 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 5-acre single-family zoning, the average will be 3 to 5 percent) [9].

The total volume of freshwater runoff may be increased because the water moves to watercourses faster over cleared land. The rate of runoff flow may be altered by land clearing and paving, either by modifying surface runoff patterns or by reducing the capability of the land to store and regularize stormwater runoff. Quality of the runoff is lowered because clearing reduces the ability of watershed land surfaces to hold back runoff for cleansing through soil infiltration and vegetative removal of contaminants. Conventional soil and water conservation techniques will provide most of the protection needed for coastal-water ecosystems. [Photo]

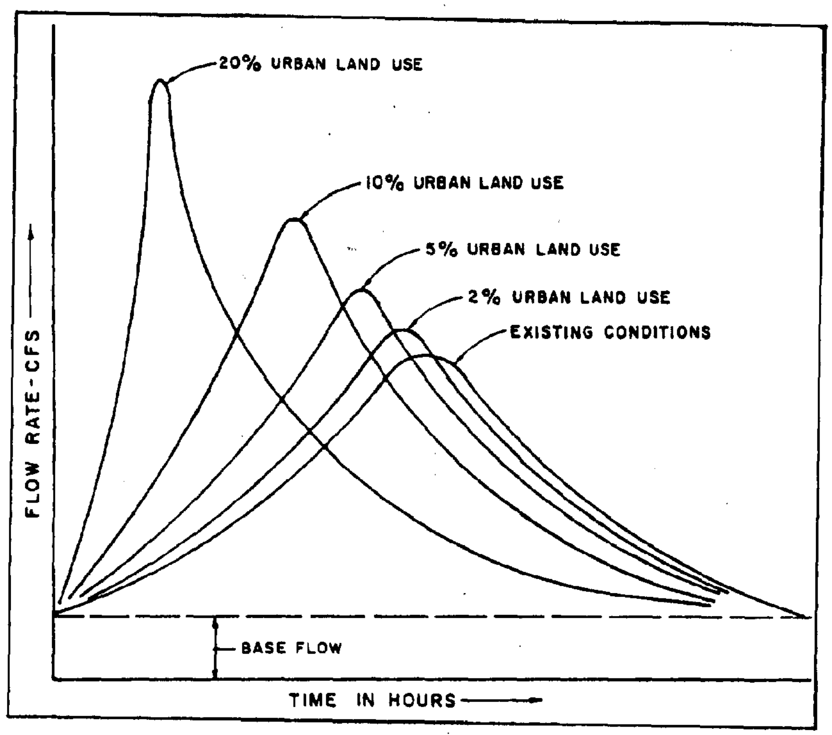


Figure 3. Typical flood hydrographs for various levels of urban land use which correlates with percentage of pavement, roof top and other impervious surfaces [10].

PHOTOGRAPH

Showing soil erosion control--contour strip-cropping

Surface management is also valuable in protecting the recharge potential of groundwater resources. Aquifers are naturally recharged by rain percolating downward from the land surface or laterally from a lake or stream. Impervious surfacing, removal of vegetation, and land drainage in recharge areas divert waters that otherwise would filter into groundwater aquifers.

In site preparation, grades should be designed to direct water flows along natural drainage courses and through natural terrain where the vegetation can cleanse and filter the runoff waters. In paving, surfaces should cover a minimal area to allow rapid and sufficient water infiltration into the soil. Permeable surfaces should be utilized where possible. Gravel, crushed rock, or crushed shell is the simplest form of permeable paving. It is inexpensive, widely used, and 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 corner lags to control spacing. [Photo]

Since the needs for terrain management for coastal uplands are identical to those for floodlands, the above suggestions should be implemented throughout all parts of the coastal watershed under local jurisdiction that make a significant contribution of storm runoff water and associated pollutants to coastal water basins.

Recommended Policy 6: Soil Erosion

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

PHOTOGRAPH

Lattice block driveway

Runoff flow from construction sites often carries sediments, toxic materials, nutrients, coliform bacteria, and other undesirable matter in quantities that pollute coastal waters. Solutions to soil-erosion problems are well developed.

As shown in Table 2 and Figure 4, construction sites generally have a higher potential yield of sediment runoff than the sites of other major land activities [11].

Erosion-control techniques for construction sites 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 [1].

Vegetated buffer strips and artificial systems such as sediment basins can provide sound erosion control for on-going construction operations by detaining runoff and trapping sediment and preventing increased turbidities in adjacent water bodies. Controls of this sort should be planned for all watercourses in order to trap sediment and other pollutants.

In erosion control by diversion or channeling, small parallel diversions or troughs can be cut across long slopes to intercept the downward flow of water. Bench terraces can be constructed across a slope to achieve the same purpose on steeper grades. In certain

Table 2. Sediment produced by major land use activities [11].

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

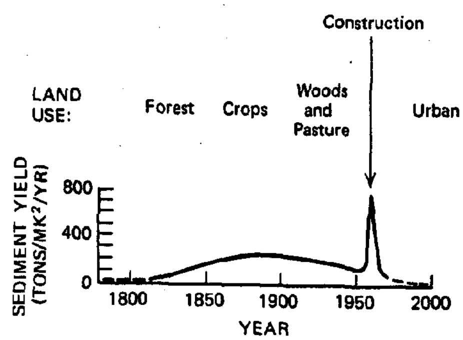


Figure 4. Schematic representation of changes in sediment yield accompanying changes in land use in a fixed area of the Maryland piedmont. (Source: A. Wolman, The Johns Hopkins University, modified).

situations, grassed waterways can be used effectively as drainageways to remove moderate amounts of sediment and to protect against erosion by reducing the velocity of the water at the soil surface. These drainageways can divert water either into sediment basins or into vegetated buffer strips, where any accumulated sediments can be removed [12].

In agriculture, soil erosion can be controlled with agronomical practices that make better use of crop residues or by improved crop systems, seeding methods, soil treatments, tillage methods, and timing of field operations. Generally, farming parallel to the field contours will reduce erosion. However, when slope length and steepness are great, or the area from which runoff originates is very large, such control practices may become ineffective and must then be supported by others, such as terrace systems, diversions, contour barrows, contour strip cropping, or water control [13].

In forest-harvest activities, both clear-cut areas and logging roads cause high rates of water runoff and soil erosion (Figure 5). 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. Skid trails and roads should be properly located and designed and immediately reseeded to speed the restoration process. (Logging roads are usually considered to be the most significant persistent source of soil erosion.) Erosion-control practices established during logging must be continued until the original quality, volume, and rate of flow of runoff water have been restored.

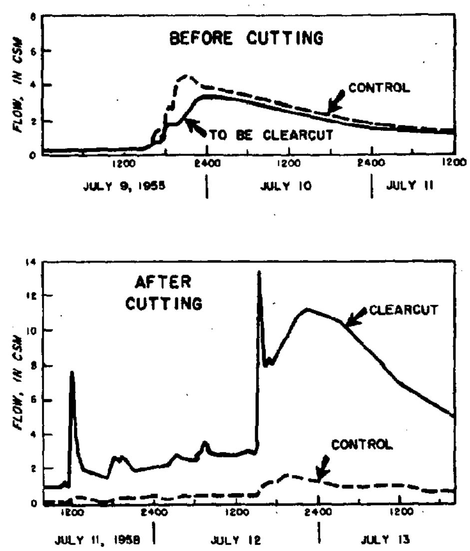


Figure 5. Sample storm hydrographs of clear-cut and control watersheds before and after treatment [14].

Recommended Policy 7: 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 ground-water and human and agricultural water supplies with salt [6]. Therefore, drainage of coastal floodland parcels by excavation of drainage ditches and canals that discharge directly (without retention) to coastal waters generally should be avoided.

When drainage systems can be designed to include the necessary protection functions and remain environmentally compatible, they should be encouraged. For individual parcels, systems should be provided with holding basins that allow sediment to settle out and that are of sufficient capacity to hold the discharge from unusually heavy rainstorms (Figure 6). The basic principle is: new drainage facilities should be designed to approximate closely the natural system of water drainage and to maintain the water table as nearly at its historic level as possible. Accordingly, artificial drainage facilities should release water from a developed area in a manner approximating the natural local surface flow regime by the use of either (1) a spreader pond or performance-equivalent structure onsite, or (2) an adequate natural retention or natural filtration and flow area, such as a "grassed swale" or vegetated buffer strip.

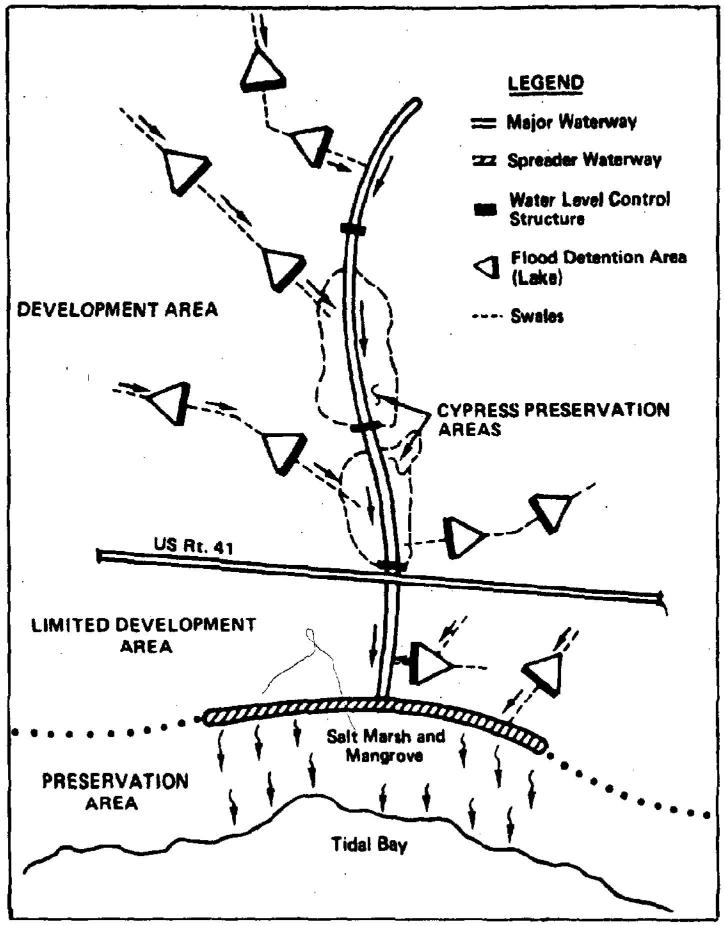


Figure 6. Conceptual sketch of a proposed water management subsystem (Collier County, Florida) [15].

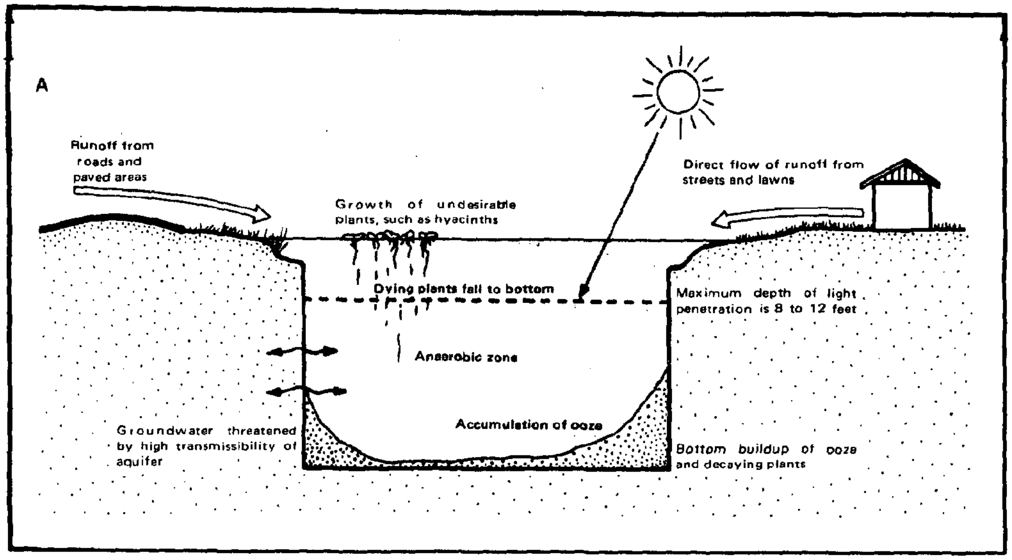
Drainage canals should discharge into the existing natural tributaries of the floodland drainage system; new cuts through floodlands should be avoided. Canals should have gently sloping sides (preferably not greater than 6:1). They should also be the minimum depth necessary to maintain reasonable flow and to inhibit cattails and other rooted weed growth (3 to 4 feet), and no deeper than 7 or 8 feet. Canals excavated in the floodlands (or uplands) should be completely stabilized with vegetation before runoff is allowed to be released [16]. They should be designed to maintain natural groundwater levels through the use of high-level weirs or performance-equivalent structures or systems.

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 by similar rules. Residential canals bring a high potential for pollution from land runoff and septic tanks and pass the contaminants into estuaries, causing problems there with turbidity, nutrient input, dissolved oxygen, and microbial activity. [Photo]

Artificial lakes dug in low-lying floodlands for landfill or amenity purposes are often troublesome. A frequent problem is that after flooding by storms, they are unable to rid themselves of the salt water except that which escapes to pollute the water table aquifer. Lakes too deep become stagnant (lack of internal circulation) and are unable to purify themselves naturally (Figure 7A).

PHOTOGRAPH

Canalside residential development



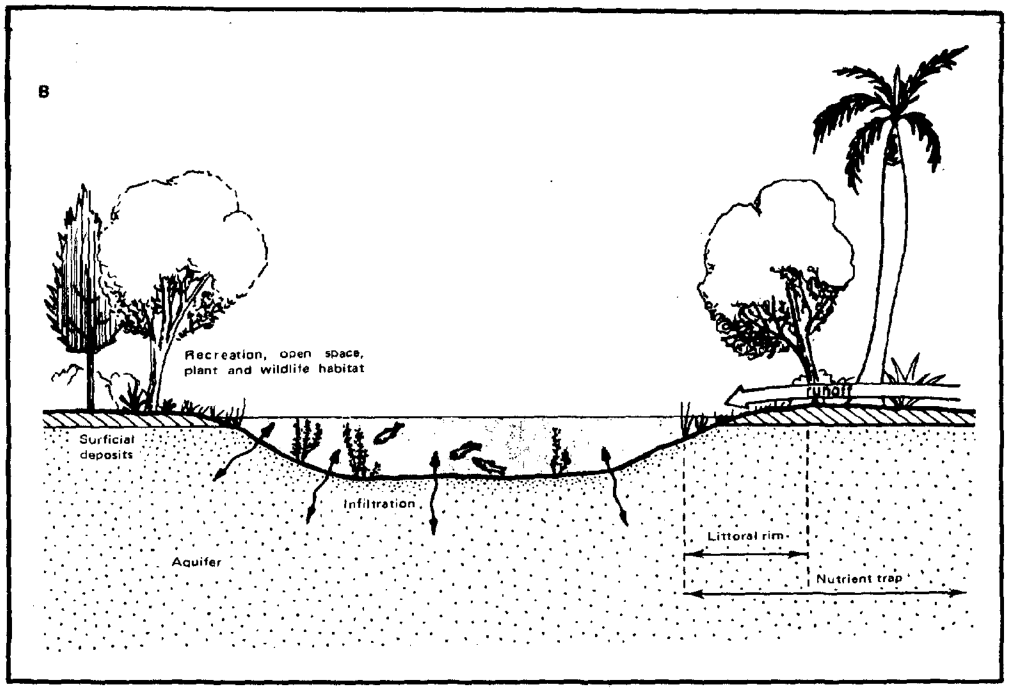


Figure 7. (A) Improperly designed artificial lakes and borrow pits become polluted in a few years; light cannot penetrate to the bottom, resulting in an anaerobic zone of accumulated ooze where oxygen falls to substandard levels. (B) Lakes created by properly designed shallow borrow pits can function as natural systems. Depth is limited so that the optimum amount of light can penetrate to encourage bottom vegetation. [16]

Lakes too shallow tend to choke up with cattails and sediment. The best solution is to avoid such lakes. If there is no alternative, strict performance standards should be applied--lakes should be deep enough (more than 4 feet) to discourage growth of rooted aquatics and cattails, and shallow enough (less than 8 feet) to permit the maintenance of acceptable water quality through wind turnover (Figure 7B). A wide buffer strip of natural soil and vegetation is required around the edge of such lakes.

Recommended Policy 8: Alteration of Watercourses

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

Stream channelization may incorporate widening and deepening the stream channel, straightening watercourses to eliminate natural meanders, clearing stream banks, and constructing dikes or bulkheads. It 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 of estuarine floodlands 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 may be deposited on adjacent banks, covering the vegetation and eliminating edge-zone habitat [1]. [Photo]

PHOTOGRAPH

Showing effects of stream channelization

Alteration of streams or other watercourses with a known potential for significant adverse environmental effects should accordingly be discouraged. Where channel deepening nevertheless appears justified, and no practicable alternative exists, a complete assessment of ecological effects should be conducted, including estuarine flood hazards and ecological consequences. Similarly, straightening streams, clearing banks, or diking or bulkheading should ordinarily be discouraged and practicable alternatives found.

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. The subject should already be familiar in the enviornmental management programs in most communities.

Recommended Policy 9: Groundwater Pumping

Limit the use of groundwater resources so as to prevent subsidence and aquifer contamination.

Control of groundwater use is urgently needed in many communities to prevent contamination of aquifers and depletion or costly subsidence of land. The issue is of particular importance for coastal floodlands, where overpumping of water (or oil) can lead to subsidence of the floodlands and to further endangerment of life and property. Subsidence of the surface results when the land loses the subsurface support provided by groundwater. In heavily industrialized areas around Galveston Bay, Texas, the land has sunk as much as 8 feet below sea level and houses are flooded by storm tides (Figure 8) [17].

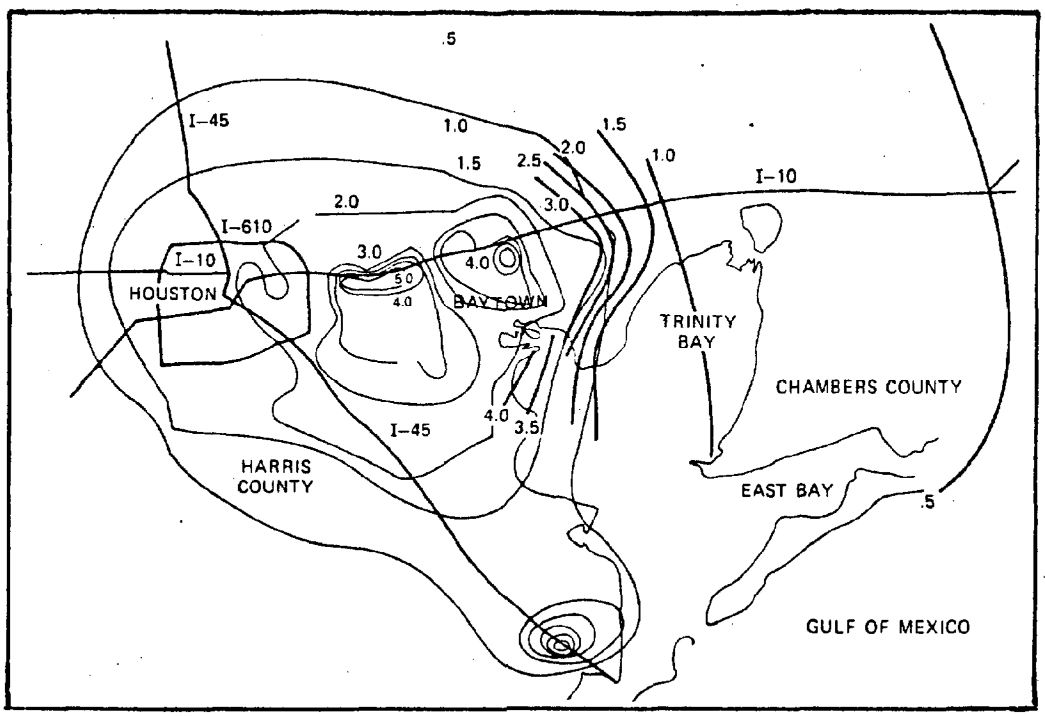


Figure 8. Shorelands in the Houston-Galveston Bay area have sunk as much as 8 feet in the past years; large portions of some communities, such as Baytown, are now under water during normal high tides and heavy rainstorms [17].

This subsidence has drastically increased the flooding danger and made the area especially vulnerable to hurricane disaster. 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--the increase in relative sea level and flooding--and do not solve the problem. [Photo] 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 have been troubled with this type of subsidence so far, many others may be vulnerable.

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 are under growing demand from coastal communities, as aquifers are increasingly pumped for industrial and domestic water use. For example, in 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 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 its use in irrigation.

PHOTOGRAPH

Water must be continually pumped from flooded homesites behind dikes near Baytown, Texas; over pumping of groundwater aquifers caused the land to sink.

The solution to protecting groundwater and land resources from seawater intrusion and land subsidence is sound and comprehensive water management. A total management program provides for groundwater, surface water, and reused water supplies to be inventoried and utilized in a coordinated plan of "conjunctive" management. Generally this type of water 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 should 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.

<u>Recommended Policy 10: Restoration of Floodlands Environment</u>

<u>Encourage private and community programs for restoration of beneficial floodlands functions</u>.

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, have degraded coastal ecosystems. Frequently, water and drainage systems have been adversely altered by filling in or draining marshes, bogs, and swamps, and by diverting, obliterating, or channelizing natural drainageways. In some instances site grading has disrupted the flow systems of small watersheds which then no longer retain runoff adequately.

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 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 done through partial or complete refilling of canal sections, installing elevated sills or weirs, and redesigning the edge configuration. [Photo]

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. The first requirement is a thorough knowledge of the hydrology of the drainage basin involved and of associated factors such as seasonal precipitation, soils, slopes, vegetation, stream flows, and land-use patterns. From analyses of this information one can design the water project according to the specifications required for maintaining or restoring the pattern of flow. Artificial detention should have a capacity equivalent to any natural detention capacity eliminated.

PHOTOGRAPH

Showing salinity weir

Reservoir storage installed on a river reduces the magnitude of peak discharge by spreading the flow over a longer period of time. The provision of upstream flood storage, then, will decrease flood peaks and compensate for the increase caused by urbanization. The need to maintain the flow at some minimum level, even in drought periods, is a familiar concept. Some water-control structures are advocated for the specific purpose of low-flow augmentation. The rule is that the minimum acceptable flow to the coastal ecosystem during dry-season low flows is that which prevailed under natural conditions [2].

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

IMPLEMENTING THE POLICIES FOR FLOODLANDS

Ten policies (Policies 1 through 10) have just been recommended for the management of floodlands. If a community decides to pursue those policies, it faces a difficult question: how can they be translated into action? This section of the manual is intended to assist in answering that question for Policies 1 through 8. (Management concerns for Policies 9 and 10 are relatively brief and have accordingly been addressed in the discussion of those policies.)

As explained in the Introduction (pages oo - oo), the section 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, communities should be prepared to address four principal management needs:

First, establishing standards for new development in floodlands, in accordance with Policies 1 and 2. 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 1 and 2, however, a community needs additional requirements.

Second, excluding development from key areas within the floodlands: edge-zones and freshwater wetlands, in accordance with Policies 3 and 4.

Third, defining the boundaries of floodlands for management purposes. Since the community will be establishing development standards that apply only in floodlands, the boundary of that area will have to be defined with some precision.

Fourth, avoiding adverse alteration of floodlands terrain and natural water systems. Floodwater retention, a key factor in 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 5, 6, 7, and 8.

1. Establishing standards for new development in floodlands

Thousands of American communities have adopted regulations to reduce the likelihood that new structures in floodlands will be seriously damaged by future floods. Typically, communities require that new or rebuilt structures be elevated above anticipated flood levels or, for some commercial structures, floodproofed [19]. 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 [20] [21].

For many coastal localities, particularly those with large areas of floodlands or where whole neighborhoods or communities have been built in flood-prone areas, adopting these regulations is often politically unpopular. Enforcing them may prove more difficult still. Yet the regulations exist, sometimes because local officials themselves perceive the extreme threat of flood hazard and sometimes because of their desire to meet the requirements for participation in the National Flood Insurance Program (NFIP) [22]. For coastal communities participating in the NFIP, federal regulations establish minimum requirements that local regulations must satisfy.

Communities that have adopted local regulations in compliance with NFIP regulations sometimes assume that they have done everything possible to protect their floodlands. To implement Policies 1 and 2, however, a locality needs to establish two kinds of standards in addition to those required by the NFIP regulations. First, it needs to require that structures be elevated, in some circumstances (e.g., freshwater wetlands) on pilings rather than on fill (Policy No. 1). And a locality needs to exclude from floodlands certain activities, such as the production and storage of toxic chemicals, that are likely to cause serious pollution if there is a flood (Policy No. 2). In most communities, these are likely to be only minor additions to local regulations that are principally meant to provide property protection in accordance with NFIP requirements.

Two federal programs are particularly likely to affect local efforts to establish standards for development in floodlands: the NFIP and a related program of the Corps of Engineers. Both are described below.

<u>The National Flood Insurance Program</u>. Established in 1968, the National Flood Insurance Program (NFIP) provides federal flood insurance to owners of property in participating localities [22]. Approximately 14,000 localities now participate in the program, which is administered by the Federal Insurance Administration (FIA). The agency works directly with localities as well as with a liaison official in each state government.

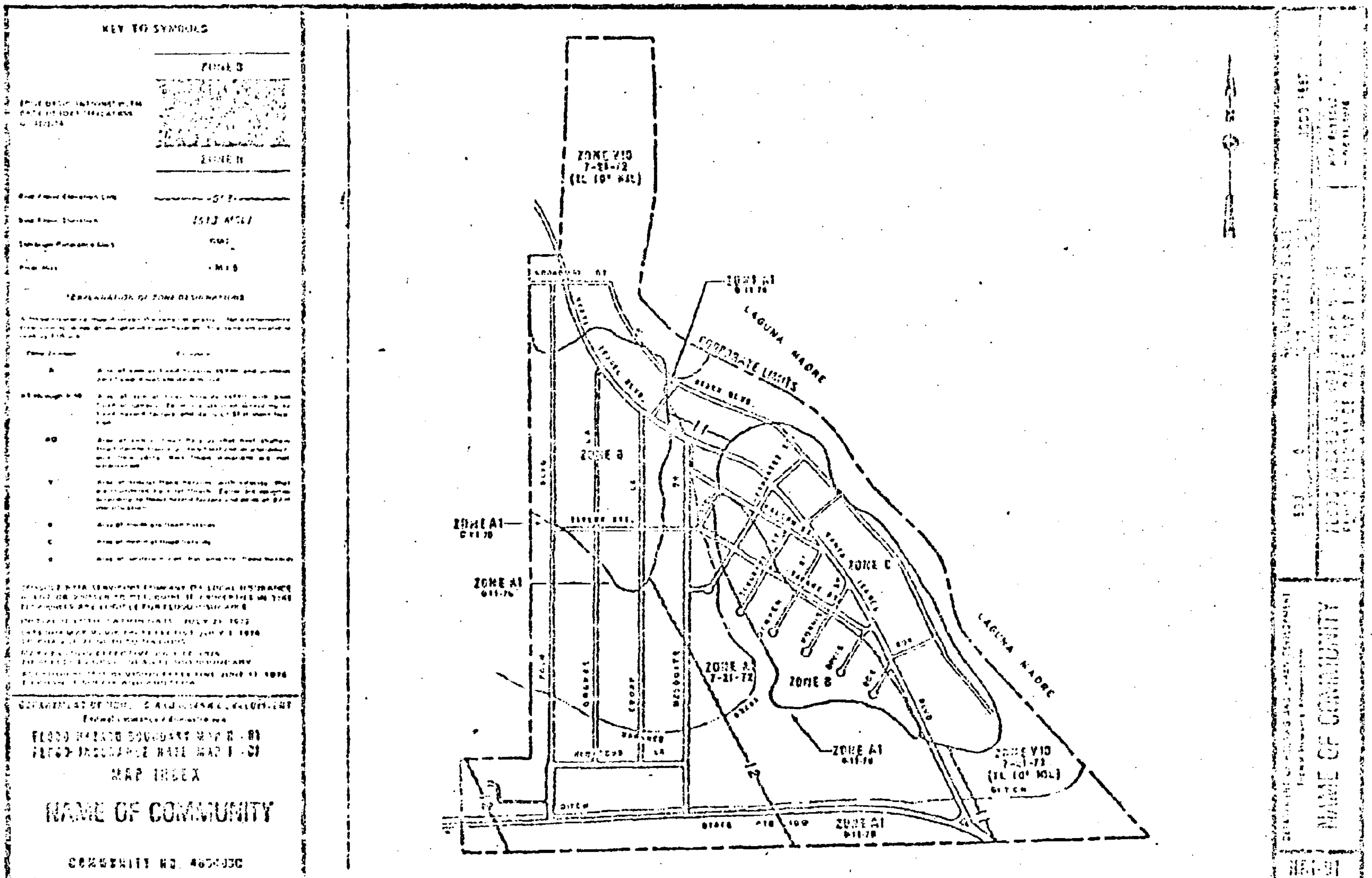
At the heart of the program for each participating locality is the Flood Insurance Rate Map (FIRM), which shows the boundaries of flood-hazard areas and anticipated flood levels within them. Figure 9 illustrates a typical FIRM for a coastal area.

To limit future flood damage (and thus to lower the cost of insurance and disaster relief), 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 FIA requirements. For example, the regulations must require most kinds of new development to be elevated above the anticipated level of the "100-year flood."

At present, many participating communities do not have an FIRM and are therefore unable to enter what is called the "regular" phase of the program. (FIA expects to complete the last FIRMs in 1983). Instead, communities without FIRMs remain in the "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, at unsubsidized rates, 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. Even today, after 1977

Figure 9. Flood Insurance Rate Map (FIRM). [23]



congressional action removing some of the penalties for non-participation, the law establishes powerful incentives for local participation, and thus for adoption of regulations meeting FIA requirements. If communities choose not to participate, property owners within the communities can no longer buy federal flood insurance, nor are they eligible for most types of federal flood disaster relief after future catastrophic floods.

Localities evaluating the local effects of the NFIP should keep in mind that it 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 Development Policies for floodlands will need to take a number of other initiatives. (For additional details, see the discussion of the Federal Insurance Administration in Part 2).

Flood Plain Management Services. Since 1960, the U.S. Army Corps of Engineers has conducted a comprehensive Flood Plain Management Services Program (FPMS) [23]. This program has provided many coastal communities with reports and maps detailing anticipated flood risks and possible responses.

Since 1973, 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 2.)

2. <u>Excluding development from key areas of the floodlands: edge-zones and freshwater wetlands</u>.

If hazards avoidance and ecological protection were the over-riding objectives of local governments, urban development might be excluded from the entire floodplain, including the floodlands. In fact, public and private needs make total exclusion impractical in most communities. That is why communities need standards for new development.

There are places within the floodplain, however, where exclusion of development is especially important from both a hazards-avoidance perspective and an ecological one. Two of these places--freshwater wetlands and the edge-zones bordering wetlands and coastal waters--are located in floodlands. One of the recommended policies for floodlands (Policy No. 3) calls for exclusion of development from wetlands. Another (Policy No. 4) calls for excluding it from edge-zones. In addition to achieving ecological objectives, these policies will result in excluding development from most "high hazard" and "erosion prone" areas in floodlands.

Familiar regulatory techniques are often sufficient to protect the vital areas of floodlands. The edge-zone can be protected in most cases with a simple setback or buffer requirement in the local zoning, subdivision, or building controls. Drainage standards for new developments (often included in local subdivision regulations) can identify these vital areas for floodwater detention. Requiring notation of flood-hazard or wetlands areas on recorded subdivision plats may also be feasible in some situations [21].

Regulations prohibiting the development of wetlands (or even of large edge-zones) may encounter vigorous objections from affected property owners. These owners may raise political objections (in essence, that preserving wetlands doesn't justify the resulting private economic loss) or legal ones (that the prohibition exceeds the locality's constitutional or statutory powers). Anticipating such objections, localities should consider ways to make regulations less onerous and also to devise nonregulatory methods of protecting vital areas [25].

One way to make prohibitions less onerous is through special zoning designations such as planned unit development (PUD), transfer of development rights (TDR), or cluster development provisions. With such designations, a locality may be able to permit the same (or nearly the same) quantity of development that would be permitted in the absence of the vital area. None of the development would be in the vital area, however, but clustered on the remaining, higher portions of the developer's property. Techniques such as these can be extremely useful in some situations, though unworkable in others--for example, where the total quantity of permitted development is excessive because of hazards or ecological needs [26].

In addition to regulations, localities should consider public-works programming as a device to protect vital areas in floodlands. Public roads, sewers, and other facilities in floodlands not only risk damage to the facility but also may encourage further development nearby. Public-works plans and programs 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 floodlands area [27]. In addition, financing arrangements for local public facilities may affect the locality's ability to protect vital areas. In particular, special tax assessments may give property owners a legitimate expectation of access to sewers and other facilities that they have helped to buy.

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

Finally, localities 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 [28].

A 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 adopted by the locality will usually not control the actions of state and federal agencies and of other local governments. Second, it may be difficult to define the precise areas from which the community wishes to exclude development.

The following federal actions may help communities in overcoming 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 pursuant to Section 404 of the federal Clean Water Act, are administered by the U.S. 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 normally granted by the Corps of Engineers. States may, however, with the permission of the U.S. EPA, substitute state permits for discharges into freshwater wetlands that do not adjoin navigable waters. Details of this program are discussed in the Saltwater Wetlands section (see pp. oo - oo).

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 conducting, supporting, or allowing an action in a floodplain unless the action is "the only practicable alternative," and the federal agency:

--designs or modifies its action in order to minimize potential harm; and

--prepares and circulates a notice containing an explanation of why the action is proposed to be located in the floodplain (including "A-95" review), discussed below.

The U.S. Water Resources Council oversees an information exchange and enforcement system based on regulations issued by each federal agency that conducts or supports activities in floodplains [24].

The agencies likely to undertake or support substantial projects that sometimes must be located in floodplains include:

U.S. EPA (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 local governments prepare to comment on proposed federally aided actions affecting wetlands or edge-zones, they should consider whether the actions comply with the letter and the spirit of this Order. (For additional details, see the discussion of the Council on Environmental Quality in Part 2.)

Executive Order 11990, "Wetlands." At the same time the Floodplains Executive Order was issued, the President issued the Wetlands Executive Order. Both are implemented together in many respects. The Floodplains Order requires that the Wetlands Order be taken into consideration in establishing floodplains 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 3 and 4 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...." Communities should pay particular attention to this requirement when they comment on proposed federal and federally aided construction that affects wetlands. (For additional details, see the discussion of the Council on Environmental Quality in Part 2.)

A-95 Process. Opportunities for comment on proposed federal actions often arise under the A-95 process. Most federal proposed development or assistance actions--grants, technical assistance, 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. The A-95 process has been found to work 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." These communities may find it appropriate to use the following definition established by the U.S. Army Corps of Engineers and U.S. EPA in 1977 [29]:

> 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.

(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 page oo).

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. Some communities also apply general assistance such as Community Development Block Grants from the federal Department of Housing and Urban Development to floodlands acquisition. More complete current information will be found in the Catalog of Federal Domestic Assistance [30].

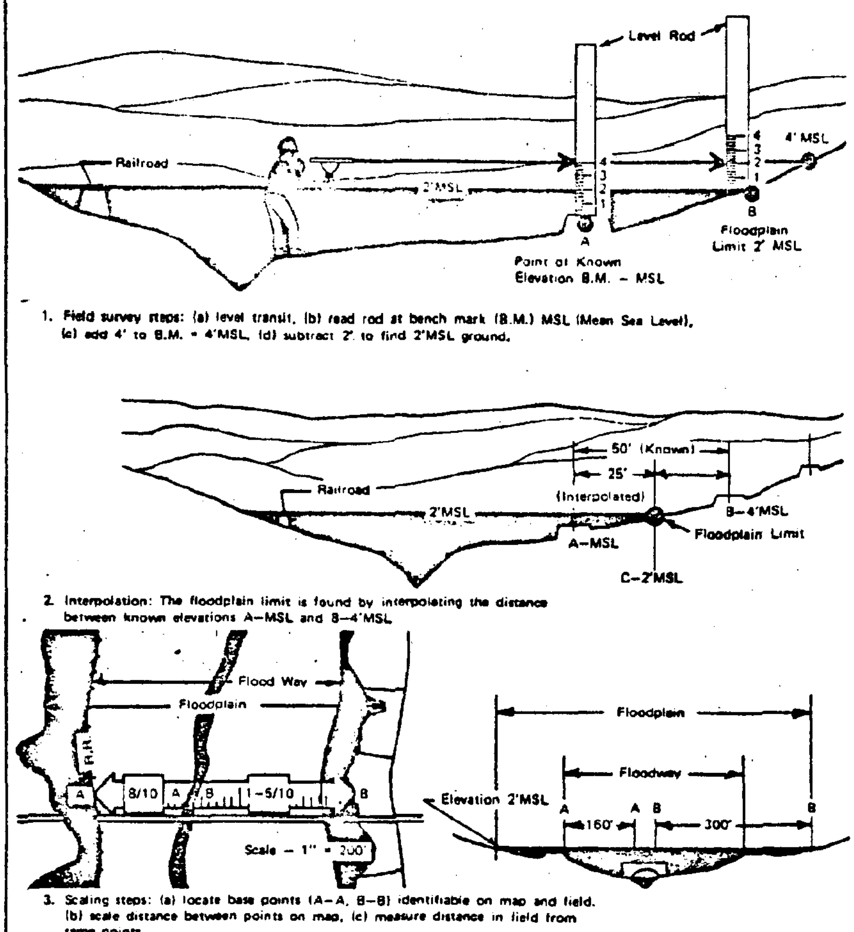
3. Defining boundaries of floodlands

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, the community is asking what areas are likely to be flooded and how often, likely enough to make flood precautions worthwhile.

How big a flood should the community be concerned about? If the community participates in the National Flood Insurance Program, it must at least take some precautions within what is called 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 communities may decide to take precautions against floods greater than the 100-year flood, particularly when locating hospitals, schools, firehouses, and emergency evacuation structures. The U.S. Army Corps of Engineers uses a higher mark in its flood projects. So does U.S. EPA in reviewing plans for sewage treatment facilities [24].

After a probability level is selected, there remains the difficulty of determining the precise elevation and boundary of the resulting floodlands (Figure 10). Storm-surge projections over land are difficult to make because the shape and size 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 [31].



After the regulatory flood profile is known, field survey (1), interpolation (2), and scaling (3) are three independent techniques for locating the floodplain on the ground. Scaling is the only method for locating the floodway. The floodplain limit in all 3 drawings is at an elevation of 2' MSL.

The field survey is the most accurate method. Scaling is a common substitute for a field survey.

Figure 10. How floodplains and floodway boundaries of tidal rivers are surveyed in the field. Adapted from [5].

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.

Communities 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. Moreover, 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 (see Table 3). In particular, localities should be aware of the following federal processes for determining boundaries:

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 many numbered actuarial risk zones, will differentiate coastal high-hazard areas ("V" zones), and may differentiate erosion-prone areas ("E" zones). In addition, the NFIP data can be useful in determining elevation levels for frequent (less than 100-year) 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. A 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.

Table 3. Sources of floodplain information and technical assistance services for determining whether a location is in a floodplain. [24]

Agency*	Floodplain maps and profiles		Technical assistance services
	Riverine	Coastal	
Department of Agriculture: Soil Conservation Service	●	●	●
Department of the Army: Corps of Engineers	●	●	●
Department of Commerce: National Oceanic and Atmospheric Administration	...	●	●
Department of Housing and Urban Development:			
Federal Housing Administration	...	...	●
Federal Insurance Administration	●	●	●
Department of the Interior:			
Geological Survey	●	●	●
Bureau of Land Management	●	●	...
Bureau of Reclamation	●	...	●
Tennessee Valley Authority	●	...	●
Delaware River Basin Commission	●	●	●
Susquehanna River Basin Commission	●	...	●
States	Varies from State to State.		

U.S. Army Corps of Engineers. The Corps may provide limited assistance in determining frequent-flood boundaries, particularly when such boundaries relate to the Corps' "Regulatory Program," which is discussed in the Saltwater Wetlands section (page oo). Older Corps coastal flood-hazard studies will include references that do not appear in the FIRMs of the NFIP, including a reference to the Standard Project Flood, a measure of greatest expected flood. This is derived by a method somewhat different from the methods used to determine FIRMs [32].

U.S. Geological Survey. Frequent-flood boundaries based on physical data--soils characteristics, vegetation, etc.--can often be derived (very roughly) from maps and data of the U.S. Geological Survey [21]. For some areas of the edge-zone, the U.S. EPA and other federal agencies such as the Fish and Wildlife Service can supplement the information from the survey--for instance, from the National Wetlands Inventory (U.S. Fish and Wildlife Service) [32] or remote sensing experiments (U.S. EPA, research division) [33].

4. Avoiding disruptions of floodlands terrain and natural water systems

Several of the policy-implementation measures already recommended will, by establishing standards for development or a process for excluding it from edge-zones and wetlands, help to avoid disruptions of floodlands terrain and natural water systems. The recommended policies, however, call for a number of additional such measures as well, measures that localities do not typically handle by relying on their development-related plans and regulations. What is needed includes:

--Measures to discourage alteration of floodland surface (Policy 5)

--Measures to reduce erosion and runoff pollution from construction, agriculture, and logging (Policy 6)

--Measures to control land drainage and artificial water bodies (Policy 7)

--Measures to discourage stream channel alteration (Policy 8).

Localities can respond to these needs in a variety of ways. For decades, many communities have had grading and land-alteration controls. More recently, many communities 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 [34].

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 the community grants building or site-alteration permission.

Some communities also prohibit the planting of particular species of trees along evacuation routes. For example, the replanting of

Australian pines, which pose hazards in coastal floods because of weak root structures, is prohibited in some Florida communities.

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 [21].

Promoting soil conservation is more difficult. Except for construction, excavation, and other activities typically subject to local regulation, soil conservation can usually only be encouraged through voluntary education and awareness programs. These programs are well established not only in many rural counties but also in some urban areas, where chemical, fertilizer, and sediment problems are also common.

A community attempting to prevent disruption of floodlands terrain and natural water systems is likely to encounter problems. First, local policies normally have little effect on other governments, including some drainage and flood-control districts responsible for regional stormwater drainage programs. Second, although the community is likely to find numerous state and federal programs generally oriented toward its goals, the programs overlap and are not usually focused on action by communities. Obtaining and using the resources available from these programs is sometimes difficult.

The following federal programs may prove helpful to a locality in protecting 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 "non-point" sources of pollution. These include the agricultural and forestry activities mentioned in Policy 6, as well as a number of other problem activities. The 1977 Clean Water Act Amendments reemphasized non-point pollution control in the regional water-quality plan.

Some "208" plans are already completed. The remaining plans now in preparation are scheduled for completion and review by states during 1978. After approval by the U.S. EPA, the plans will be ready for implementation.

Completed 208 plans are likely to have considerable future influence, particularly on programming of facilities funded in part by U.S. EPA. 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 2).

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 "non-point" sources of pollution resulting from poor soil-conservation practices. Although this USDA program would not provide funds to localities, it would supplement local efforts to reduce land-surface alteration and agricultural practices that contribute to non-point-source pollution 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 2.)

Federal Flood Control Projects. Flood-protection projects of the U.S. Army Corps of Engineers can affect implementation of the recommended policies regarding 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 [31]. An environmental impact statement is prepared. The project-review process provides several opportunities for the presentation of local views: at the application stage, the impact-assessment stage, and the regional "A-95" clearinghouse review (see p. oo). In addition, some of these projects require permits under Section 404 of the federal Clean Water Act (see p. oo). 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 reduces the number of review processes in which localities can make their views known. As a practical matter, the greatest opportunities for presentation of local views exist during the study process and prior to congressional authorization. (For further details see the discussion of the U.S. Army Corps of Engineers in Part 2.)

Regulatory Program for dredged and fill material. Federal permit requirements may prove helpful to a community trying to control the construction of artificial canals (see pp. oo - oo). If 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 this permit required for stormwater 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 [29].)

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

--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 boundaries, others may not be.

--The location of any "areas of particular concern" identified in the program document, and any provisions made for their management.

--The policies established by the program and the means established to implement them.

--The anticipated role of local government in implementing the program. Some states include local coastal programs as an element of the state program.

--Whether the program has received formal approval from the governor and the U.S. Department of Commerce.

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 in this guide; a means of identifying particular legal constraints that limit 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 back-up 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 manual.

--Second, the federal program contains what are called federal "consistency" rules. These require federal agencies to respect federally approved state coastal-zone management plans. The state office of coastal-zone management may set up routine procedures to advise and comment on major federal activities in the coastal zone--for instance, the Regulatory Program of the Corps of Engineers, or projects for flood control. Where local plans are an element of the state coastal-zone management program, this may give localities 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 2.)

National Environmental Policy Act, Environmental Impact Statements. Since 1969, the National Environmental Policy Act 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 [35].

Localities are likely to encounter EIS procedures when they seek federal financial assistance (for instance, for sewage treatment facilities construction grants) as well as when they seek 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 environmental impact statement before the final statement is prepared. Both the Council on Environmental Quality and the Office of Federal Activities in U.S. EPA play key roles in setting guidelines and overseeing this procedure.

The EIS review process is the principal means for exchanging the information necessary to enforce the Wetlands and Floodplains Executive Orders (see pp. oo and oo) and for determining whether federal actions are likely to contradict other regulations, including those established by the state coastal-zone management program or by the federal Clean Air or Water Acts.

The courts have played an important role in enforcing the requirement that environmental impact statements be prepared, and that they be complete. Recourse to the courts is now becoming more difficult, however. Courts today often decline to listen to "NEPA arguments" unless an individual or community has made the same points in comments on a draft EIS with no substantial response from the agency preparing the draft statement [36].

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

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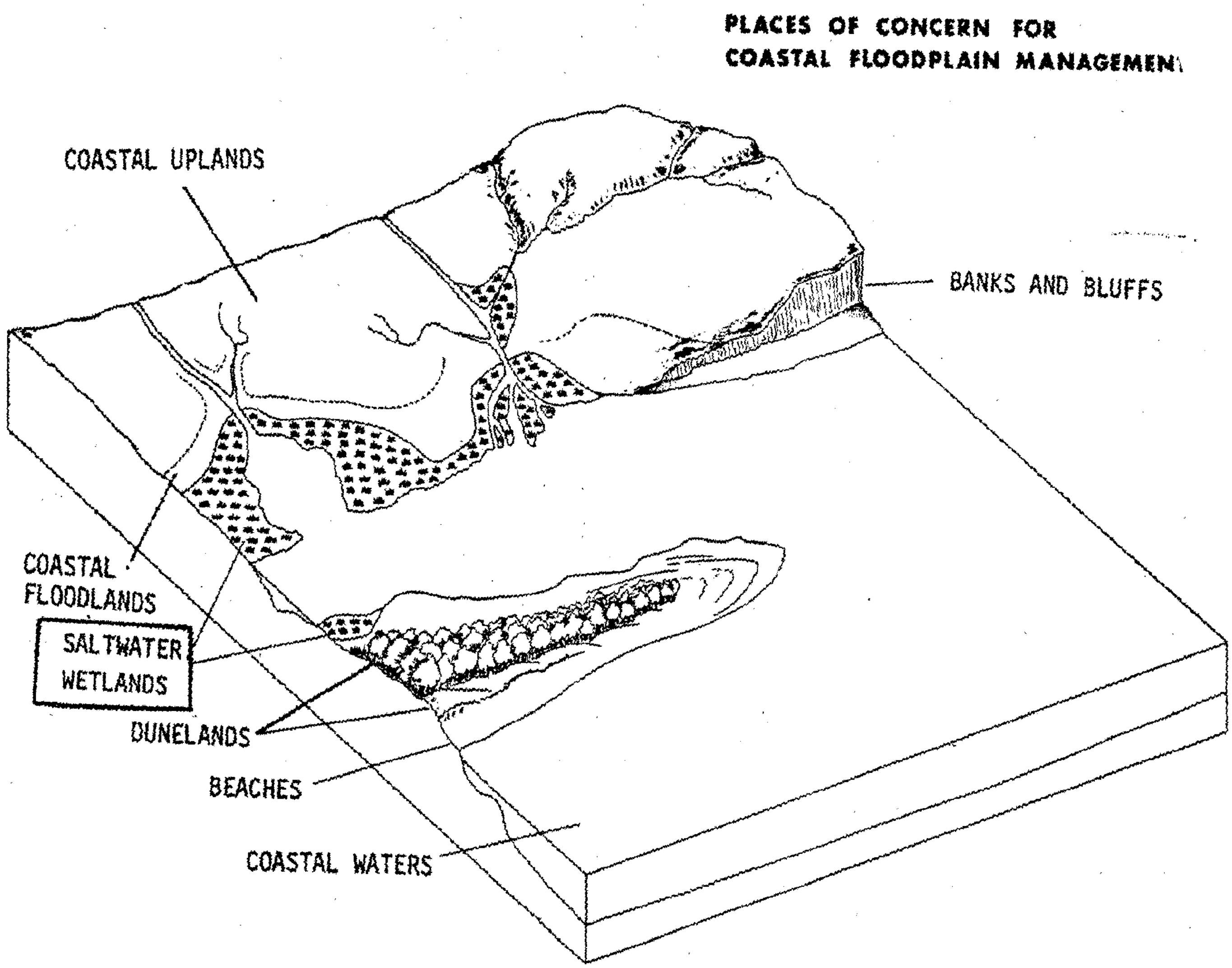
SALTWATER WETLANDS


PLACES OF CONCERN FOR
COASTAL FLOODPLAIN MANAGEMENT
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SALTWATER WETLANDS

Saltwater wetlands and their adjacent tideflats are widely recognized as an environmental resource of high value, serving in many ways as a vital component not only of the ecosystem but of the surrounding human community as well. They support waterfowl, nourish marine life, cleanse the waters, diminish storm flooding, and beautify the shore. The services they provide to society increase in value as coastal communities grow. The more intensely developed an area is, the more crucial the resource and amelioration role of wetlands and the more urgent the need for their preservation through land-use controls and special regulations. [Photo]

The wetlands discussed here, saltwater wetlands, are those that are both influenced by the tides and washed by coastal waters (salty waters, more than 0.5 parts per thousand salt). Saltwater wetlands include coastal marshes and mangrove swamps. Freshwater wetlands--both the tidally influenced coastal type that occur inland of the saltwater front and the non-tidal interior type--are considered elsewhere in this manual. However, management requirements for the various types of wetlands are quite similar, despite important ecological differences.

ECOLOGICAL FEATURES

Saltwater wetlands provide a specially valuable habitat for a variety of coastal species that are of great importance to mankind,

PHOTOGRAPH

Showing wetland and adjacent developed community either for food or other direct uses or because they support the aquatic food chain. Waterfowl and shorebirds are well-known inhabitants of wetlands, as are alligators, nutria, and muskrats. Less well-known, but very important, inhabitants are crabs, shrimp, and the tiny young stages of commercial and sport fishes, along with numerous forage species of fish and invertebrates.

Wetland vegetation removes toxic chemicals, silt, and excess nutrients from coastal waters. For example, a marsh of 1,000 acres may be capable of purifying the nitrogenous wastes from a town of 20,000 people [1].

The vegetation, particularly red mangroves and cord grass (Spartina) also provides "primary productivity," that is, the first link in the aquatic food chain. Using the sun's radiant energy the plants play the key role in converting inorganic compounds (nutrients) and carbon dioxide dissolved in water into the stored energy of plant tissue. When leaves and other tissues of wetlands vegetation fall into the water, they are broken down by bacteria and become small particles of "organic detritus," the food of shrimp, fiddler crabs, worms, snails, and mussels, which in turn become the base of the coastal food chain, providing nourishment for larger fish, birds, and mammals (Figure 1).

Ecologically, saltwater wetlands are divided into upper wetlands (those above mean high water) and lower wetlands (below mean high water). [Photo] The upper wetlands are vegetated with salt-tolerant plants that prosper in sporadically flooded wet soils.

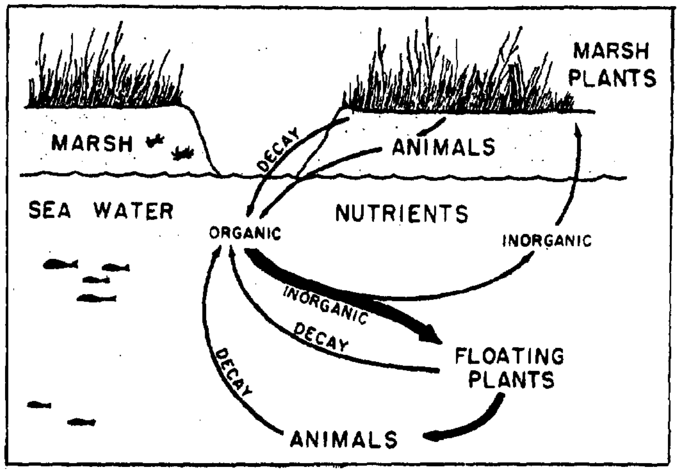


Figure 1. The marsh-estuarine nutrient exchange system is a continuous recycling process [2].

PHOTOGRAPH

Showing the boundary between upper and lower wetlands.

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 upper wetlands often serve to receive the flow of land runoff water and to cleanse it of contaminants--a role of major importance, particularly for areas undergoing heavy development in the shorelands. They also take up beneficial dissolved nutrients from freshwater runoff and spring tide flows and store the nutrients temporarily for later release in periodic pulses as either dissolved nutrients or organic detritus or both. The dissolved nutrients support the phytoplankton (algae) and other important plants of the estuarine food chain, while the detritus supports the small animal life [1].

Lower wetlands serve as the vehicle for collecting and storing the dissolved mineral nutrients washed down from the upper wetlands and from the coastal uplands and floodlands. As in upper wetlands, the nutrients are used for plant growth, stored as plant tissue, and ultimately transported into coastal waters to 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 wetlands vegetation were eliminated, carrying capacity of the ecosystem (in terms of food supply) would be greatly reduced--it was reduced about 50 percent in one typical case (a North Carolina estuary). Research has demonstrated a direct positive relation between abundance of fish and acres of marsh (judged by the harvest of fish per acre of "fishable" coastal waters edged with marsh) [4].

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

HAZARDS

Saltwater wetlands serve to protect communities from sea storms. Both mangrove swamps and salt marshes are credited with naturally reducing the severity of coastal wave and flooding hazards.

Red mangroves (lower wetlands), which are 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. Black mangroves (upper wetlands), located in the band behind the red mangroves, probably function to further reduce the severity of storm surges. [Photo]

PHOTOGRAPH

Showing exposed tidal wetland flats with shorebirds feeding

PHOTOGRAPH

Showing the mitigation of storm impact by mangroves

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

Wetland vegetation quite definitely serves to stabilize estuarine shorelines and prevent erosion. Mangrove trees not only hold present shorelines, but actually can extend the land's edge by trapping sediments and building seaward (Figure 2). Salt marshes may function in a similar way [1].

DEVELOPMENT POLICIES

Physical removal or obliteration through dredging and filling has been cited frequently for the loss of wetlands and the important ecological and hazards-protection purposes that these wetlands serve. There are, however, a number of other disturbances that significantly degrade coastal marshes and mangrove forests without directly altering their surface or their soils (Figure 3)--for example, 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 wetlands functions.

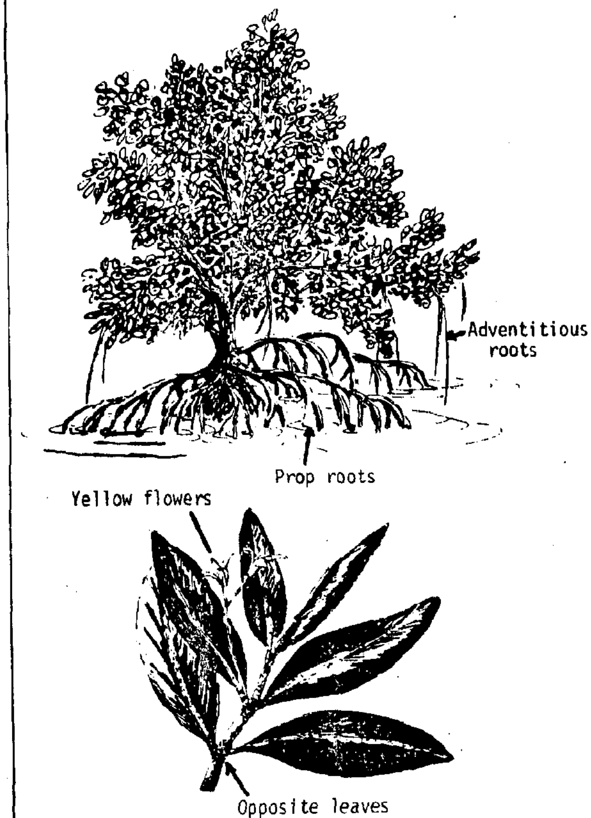
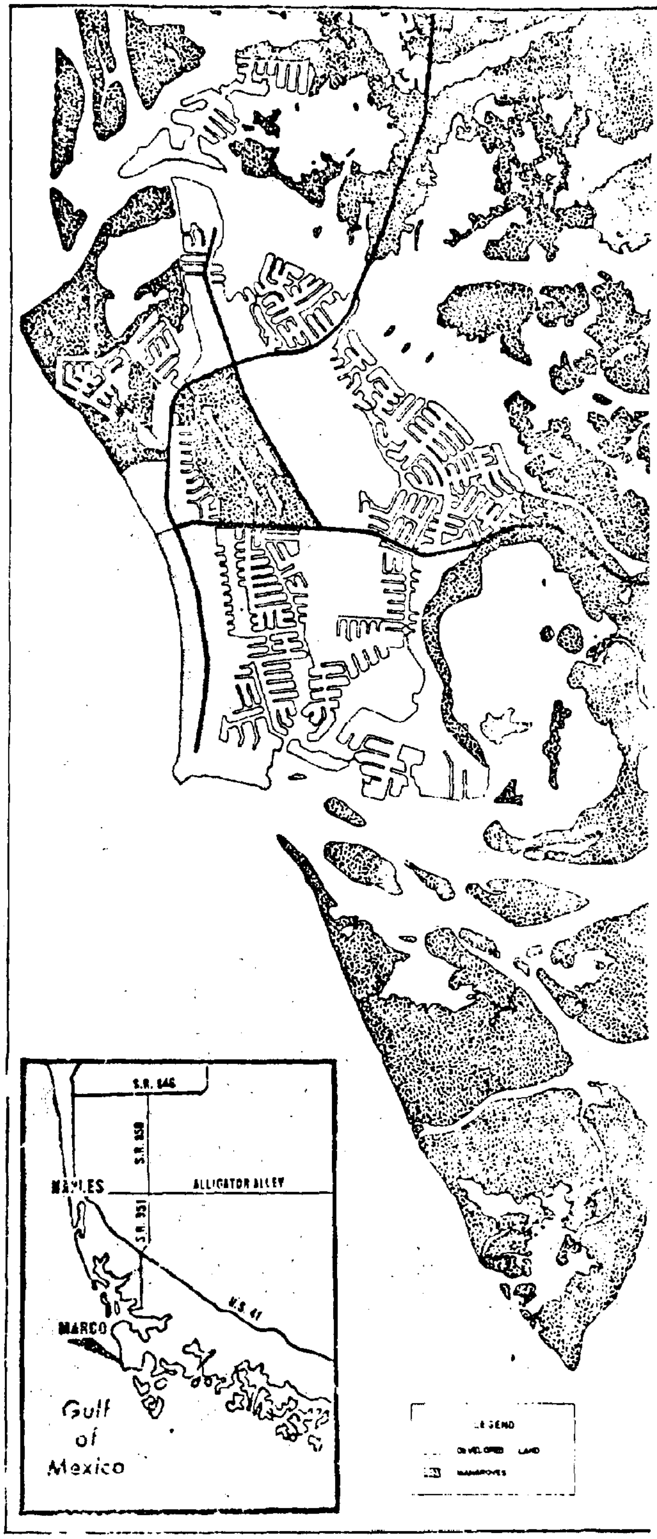


Figure 2. Among the roles attributed to mangrove communities by various workers are: land building and stabilization, filtering of suspended material, assimilation of dissolved material, assimilation of dissolved nutrients, storm wave attenuation, aquatic and terrestrial wildlife habitat, and contribution to estuarine food chains.... As primary colonizers of emergent oyster bars, red mangroves frequently create islets which gradually grow in size by a process of accretion of silts around the numerous prop-roots. Similarly, in quiet backwater areas, the prop-roots of red mangroves and the pneumatophores of black mangroves trap sediments and gradually elevate or extend land surfaces. (Drawing courtesy of William Hammond) [6, 7].



One hundred miles west of Miami, on the mangrove-rimmed shores of southwest Florida, one of the state's most persistent land use dilemmas--the loss of its valuable coastal wetlands--is coming into sharp and sudden focus.

The Miami-based Deltona Corporation is seeking federal approval for a major expansion of its resort and residential community on Marco Island.

And in a state where the piecemeal conversion of wetlands into homesites has been a time-honored tradition, the Marco Island project would be one of the biggest pieces yet.

It calls for the transformation of nearly 3,000 acres of mangroves, bay bottom and tidal creeks--dredging and filling on a scale capable of providing real estate for an estimated 14,000 people.

Critics call it an unprecedented act of destruction--possibly the largest single commitment of estuarine resources ever made in Florida.

But supporters say that the expansion of Marco Island will also mean jobs, more tax revenue and a major step toward completion of a community planning effort that began more than 11 years ago.

The Miami Herald
July 3, 1975

Figure 3. Configuration of Marco Island (58% developed) [Courtesy of Deltona, Inc.]

It should be the public policy of each coastal community to ensure that wetlands remain functionally intact; that is, whatever use is made of saltwater wetlands should not alter them in ways that will degrade their natural function.

To this end, management policies 11 through 16 are recommended and discussed below:

11. Wetlands Surface Alteration: Avoid activities that alter the surface condition of wetlands, such as excavation, filling, clearing, paving, and grading.
12. Wetlands Hydrologic Alteration: Discourage activities that alter the natural water systems of wetlands, such as draining and diking.
13. Wetlands Construction: Structures that degrade wetlands functions should not be built in wetlands.
14. Wetlands Roadway Crossing: Roadway crossings through wetlands should be avoided.
15. Wetlands Pollutant Discharge: Discharge of pollutants into wetlands should be limited.
16. Restoration of Wetlands: Degraded wetlands should be restored to their natural functional condition.

Recommended Policy 11: Wetlands Surface Alteration

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

From the ecological perspective, the characteristics of salt-water wetlands and their natural drainageways are such that, to keep the wetlands functional, virtually any alteration of the surface must be precluded. From the hazards-protection perspective, wetlands that dampen the force of storm waves or that reduce flood heights should also be provided a high degree of protection from alteration.

Accordingly, as a general rule, all excavation in wetlands should be avoided, as should paving or surfacing. Nor should filling or grading of wetlands be permitted, because soil covers the wetlands and 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 of wetlands function. An exception might be made, however, to permit control and removal of noxious exotic plants.

Waterfront development that involves dredging wetlands, tideflats, and estuarine bottoms and using the "spoil" to fill and elevate the land 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 low lands to gain elevation and to create lots for canal-side homes. [Photo] 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 [1].

PHOTOGRAPH

Canal-side home sites built up from dredged marsh spoil

The "no-alteration" ideal must be tempered with appreciation that wetlands often ring the shores of a community 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 installed successfully in a marsh by use of a special trenching machine and by effective refilling and replanting of the disturbed surface; therefore, it should usually be acceptable to allow for 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. [Photo] Methods for constructing acceptable accessways to piers and other waterside facilities are described in Development Policy 13.

<u>Recommended Policy 12: Wetlands Hydrologic Alteration</u>

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

Saltwater wetlands are dependent for their viability on wet soils and regular flooding. If such areas are drained with excavated channels, or their waters permanently impounded with levees, their character is usually completely changed and their value diminished. [Photo]

Far-reaching hydrologic effects due to artificial drainage include: (1) elimination of surface waters; (2) lowering of the water table; (3) elimination of periodic flooding. These effects

PHOTOGRAPH

Special sidecast trenching machine for placing utility lines in wetlands

PHOTOGRAPH

Drained (or diked) degraded wetland

disrupt the important biological function of wetlands and, to a degree, may increase the vulnerability of human life and property to storms. Even relatively minor artificial drainage changes may subvert natural processes and cause wetlands to deteriorate to a non-functional state [1].

Drainage of wetlands and low-lying floodland edge-zones may also create subsidence, that is, a lowering of the land surface due to compaction, drying, and shrinking of the surface peats and organic soils. (Localized "spot" subsidence occurs when the weight of a structure is too great for the bearing strength of the soil on which it is built.) Subsidence, which is considered to be irreversible, greatly increases the danger of flooding during hurricanes. [Photo]

The use of levee and dike structures for mosquito control, flood control, or navigation improvement produces immediate and long-term changes. These include total loss of wetlands under and along diked embankments and the degradation or even the destruction of the swamps or marshes within the diked area. A significant reduction in the size of the wetland reduces its capacity to store floodwaters and to provide ecological benefits.

Conventional drainage or diking of wetlands should, therefore, be discouraged in favor of other alternatives. For example, two options can be used for mosquito control: (1) open-marsh water management (strategic ditching to connect still-water areas to the circulation system of the marsh (Figure 4); (2) diked impoundments with tide gates that are closed only during critical seasons for mosquito

PHOTOGRAPH

Development where subsidence has occurred is exposed to increased flood damage

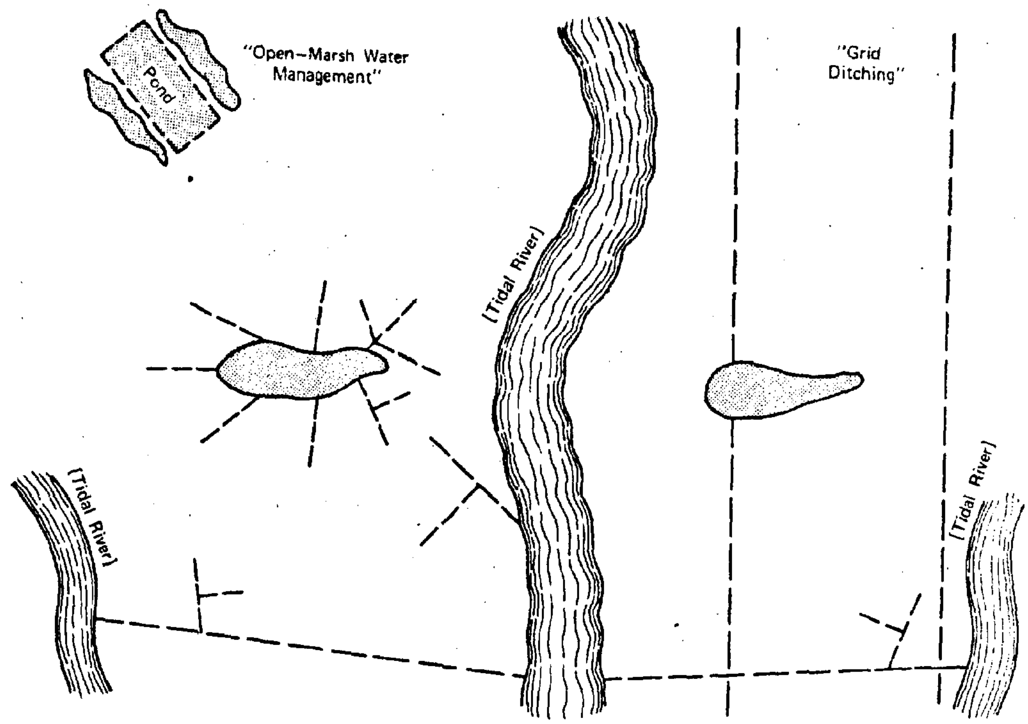


Figure 4. A comparison of two management techniques for mosquito control--the efficient open marsh water management system (left side) and the outdated grid ditching system (right side)--on portions of a hypothetical marsh. (Source: Adapted from a drawing by Fred Ferrigno, New Jersey Division of Fish, Game and Shell Fisheries.)

breeding. Subsidence problems caused by drying the wetlands or overloading the soil might be solved by concentrating development or farming on higher land.

Recommended Policy 13: Wetlands Construction

Structures that degrade wetlands functions should not be built in wetlands.

Wetlands are generally unsuitable for residential, commercial, and industrial development because of the resulting ecological damage, loss of hazards protection, and practical engineering reasons.

From the engineering viewpoint, soils of wetland areas present difficulties to development that can be resolved only by costly construction methods [1]. Unsuitable soils (organic muck) must be removed by excavation or deep piles or columns must be used to provide a solid base for structures.

If construction in wetlands is restricted to light-duty, pile-elevated structures--such as piers and catwalks--that do not require roadway access or alteration of the site through clearing, filling, grading, paving, and so forth, the likelihood of significant obliteration of wetlands or of interference with surface water and groundwater flow is minimized. Such construction constraints will permit wetlands owners to construct catwalks, piers, boathouses, boat shelters, fences, duck-blinds, footbridges, observation decks, shelters, and other similar structures. [Photo]

Except in unusual circumstances, flood- and erosion-protection bulkheads should be placed upland of the 1-year flood level--which

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MEMORANDUM

TO: Reviewers of PHYSICAL MANAGEMENT OF COASTAL FLOODPLAINS

FROM: John Clark J.C.

Enclosed is the Draft Final Manual prepared by the Conservation Foundation under contract number EQ7AC004 (CEQ) for your review. This, the final phase of work, completes preparation of the manual except for consideration of comments by all sponsoring agencies as coordinated by CEQ and preparation of final text and manuscript art for publication.

A number of details are brought to your attention concerning the draft:

1. We suggest that the manual be liberally illustrated with black and white photography, as indicated on track sheets.

2. Technical figures (charts and graphs) are an important part of the manual; they are indicated by facsimile sheets in the draft. For the final manuscript, many of the figures will be redrawn or specially drafted for the manual.

3. References and figures, now numbered separately by section, will be sequentially numbered in the manual as published.

4. Index side tabs as used in our Task 1 report will be incorporated in the manual for each place of concern.

5. The routine front matter (foreword, acknowledgements, etc.) is omitted following standard practice; it will, of course, be supplied with the final manuscript.

6. Optional additions include a glossary and recommended additional readings. Your opinion on the need for these is welcomed.

It should be understood that the manual is intended as a reference book, more than a reader. Accordingly, we have prepared each place section to stand alone as far as possible. This creates some unavoidable duplication between sections, and in some instances, between policy subsections.

We hope that you will agree that the manual is particularly timely in that it looks at national programs from the point of view of local governments and tries to help them understand and utilize these programs and the partnership with Federal agencies to their fullest advantage.

Further, collaboration of six Federal agencies in producing the manual should be a welcome sign to coastal communities of close agency cooperation.

According to the wishes of Ms. Gillman of CEQ there will be a meeting of Federal Representatives and Conservation Foundation staff at the CEQ library on June 26 at 9.30 a.m. for a discussion of the draft manual and revisions for publication. If you have questions or would like to discuss specific points prior to the meeting, please contact either John Clark, (202-797-4360) or John Banta, (202-797-4337). Since this is the final session we stress the importance of receiving your comments.

JC/los
June 9, 1978

PHOTOGRAPH

Recreation structure elevated over wetlands (White Cedar Swamp, Cape Cod) marks the upper edge of coastal wetlands. The adverse impact on wetlands is greatest when the outer periphery of a coastal marsh is bulkheaded and then filled with dredge spoil [1]. In addition to damaging wetlands, bulkheads that extend into water areas often 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.

In many cases, shore protection can be accomplished by grading the shoreline and planting salt-marsh grasses, mangroves, or other vegetation. This artificial marsh barrier is preferable to heavy structures and should prove to be the least expensive method of protection. It has the added benefit of creating a more biologically productive shoreline, as well as one that to many owners has higher natural aesthetic appeal.

In summary, the optimum goal is to discourage excavation and fill in saltwater wetlands and to restrict construction there to light-duty structures not used for permanent occupancy. Where there is some unavoidable commitment to heavier use, such as home sites, the federal requirement for elevation of homes above the expected 100-year storm surge level would tend to minimize the damage, particularly if accompanied by constraints on permitted density and on excavation, grading, filling, and paving of the wetlands site.

Recommended Policy 14: Wetlands Roadway Crossing

Roadway crossings through wetlands should be avoided.

In addition to obliterating wetland areas, roadways built on the wetlands surface disrupt normal water-circulation patterns, either tidal flows or land drainage, insofar as the roadways act as dams to water movement. [Photo] A third effect, frequently encountered, 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 (surcharge) on the soft organic soils beneath. Marshes over 100 yards away from roads have buckled and otherwise been disrupted by mud waves [8].

A fourth serious effect of surface roadways is spoil disposal. The construction of solid-fill causeways (and the excavation of barge-access canals) often creates spoil disposal problems, particularly when the method of construction is to dig out ("muck" out) existing deep layers of organic muck and replace them with a solid-fill base. Wetlands are not suitable disposal sites, and acceptable sites that are easily accessible are becoming scarce and expensive. The remaining alternatives are to transport spoil either well inland or to the ocean.

The best way to avoid these problems is to route roadways across high ground and avoid wetlands altogether. This can often be accomplished by enlightened traffic engineering.

A solution for the situation where crossing wetlands is mandatory is to elevate the roadbed as a viaduct or column-supported causeway with minimum alteration of the wetlands below. The recommended method is end-on construction, whereby the supporting piles or columns are driven progressively from equipment based atop the

PHOTOGRAPH

Showing roadway blocking wetlands circulation structure, and preformed concrete decking is used for the roadway surface (Figure 5). By this means it should be 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, a wetlands crossing on elevated structures may be cheaper than routing a roadway around the wetland.

Bridge structures should be designed so as not to impair the circulation regime and tidal flow of wetlands. This can be done by minimizing the number and size of support members and streamlining their form and by building abutments back from the water edge. [Photo] Most simply, 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, the cross-sectional area of a waterway should in no case be reduced to less than that which can adequately pass the 100-year maximum flood waters; that is, the bridge should not raise the flood waters more than 1 foot above the natural flood level [1].

Spurs and feeder roads that provide access to the coast from major highways should generally be aligned perpendicularly to the coastline to minimize interference with natural water circulation patterns (Figure 6). Unless placed on elevated pilings, roadways in the lower floodplain should be located parallel to land drainage flow and tidewater movement. Only essential service roads should be allowed 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.

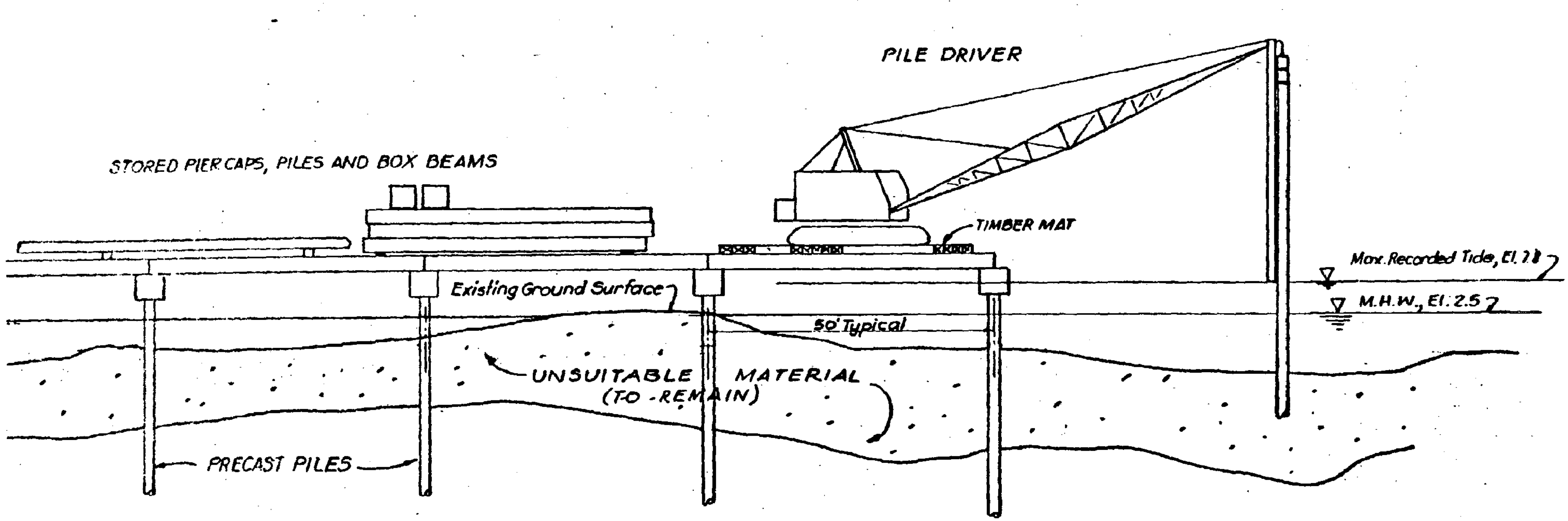

Figure 5. Construction of a pre-cast concrete viaduct through wetlands. [9]

PHOTOGRAPH

Bridge with minimum supports in water so as not to impede circulation and flow

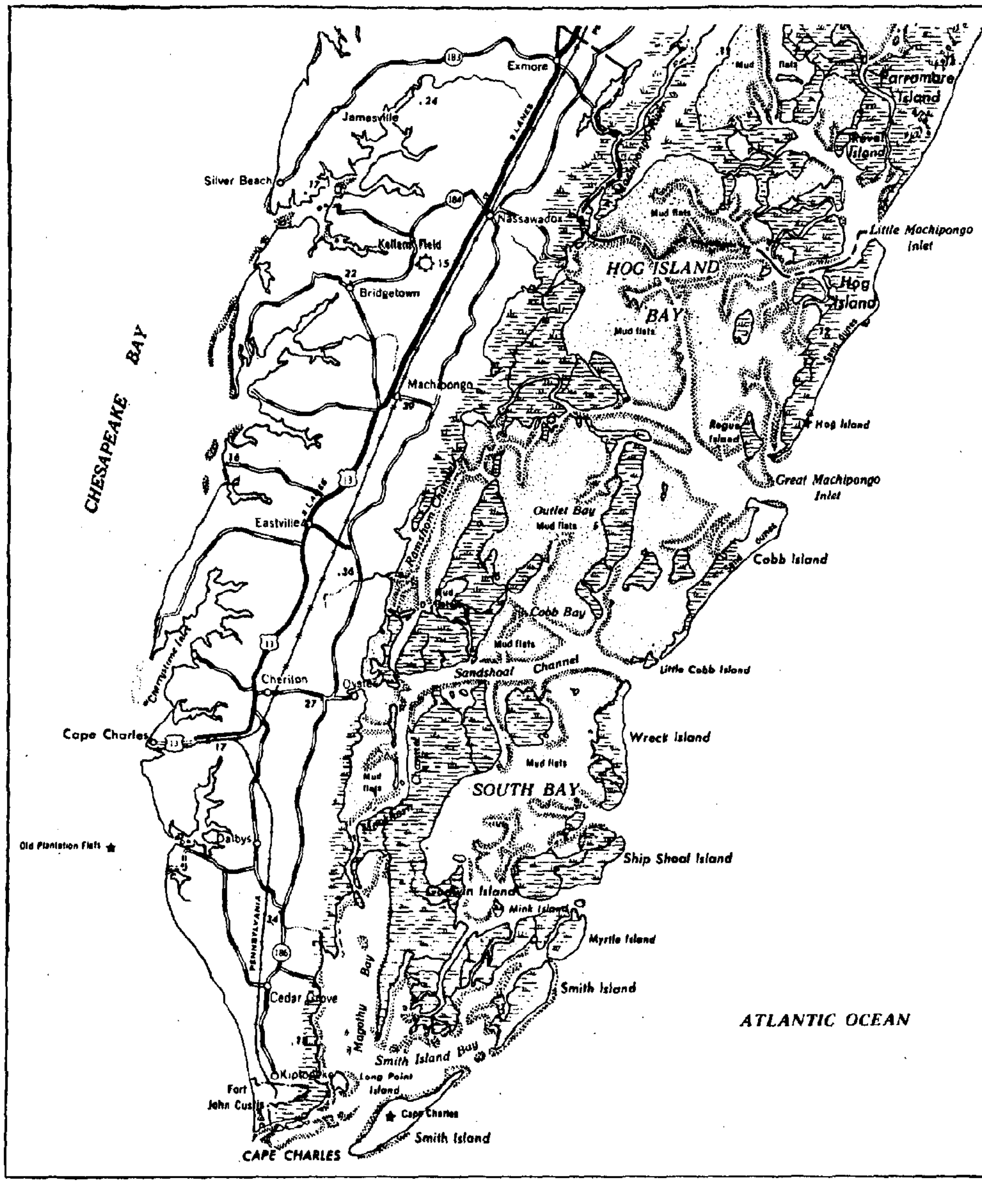

Figure 6. Major roadways should be located away from wetland shorelands while feeder routes to the shore should lie parallel to water flows (Northhampton County, Virginia). [10]

Recommended Policy 15: Wetlands Pollutant Discharge

Discharge of pollutants into wetlands should be limited.

Although they can assimilate a reasonable amount of contaminants, wetlands do have a limit, and so must be protected from some kinds of gross pollution from both land runoff and estuarine sources--in particular, from toxic substances and oil. A polluted marsh is offensive to the senses, whereas a healthy one is an aesthetic resource. Also, nutrient pollution may cause wetlands to breed an abundance of mosquitoes and other pests [1]. Tideflats may also be adversely affected by pollutants such as sulfite waste liquor (from pulp-mill effluent), thermal discharge, and sewage. When polluted, tideflats may become odorous and unattractive.

Most wetlands have some capacity to absorb and assimilate storm runoff pollutants, thereby functioning as a "land treatment" system. Also, experiments have shown that wetlands have the capacity to assimilate municipal sewage. But there are serious technical difficulties in introducing the effluent so that it does not pollute the water flowing over the wetlands, causing hazards to human health and ecological problems. Any such pollutants should not exceed the calculated receiving capacity of the system, and should not degrade surface water or groundwater below state water-quality standards.

Recommended Policy 16: Restoration of Wetlands

Degraded wetlands should be restored to their natural functional condition.

Dikes and levees that damage the 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 may be available from dredge spoils. Wetland replanting techniques are available, feasible, and can be provided by appropriate professional experts (Table 1). Also, polluted wetlands can be rejuvenated by appropriate cleanup techniques.

In many cases, eroded shores and banks can be stabilized by grading the shoreline and planting salt-marsh grasses, mangroves, or other vegetation. [Photo] In protected water bodies where erosion rates and wave action are low, an artificial marsh may be an effective method of shoreline protection, since wave forces are absorbed and sediments are trapped by the planted vegetation. Such use of planted marsh strips has been successful in the Middle Atlantic area [1]. In Florida, mangrove species lend themselves well to shoreline protection and may be incorporated into plans for the protection of private waterfront property [11].

IMPLEMENTING THE POLICIES FOR SALTWATER WETLANDS

Six policies (Policies 11 through 16) have just been recommended for the management of floodlands. This section of the manual is intended to assist communities in translating those policies into action.

The section focuses on two principal kinds of local action: first, modifying local plans, regulations, and programs, to respond to

Table 10. Siting, Design and Construction Considerations for Wetlands Restoration. [10]

Siting Considerations	Design and Construction Considerations
o 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. o 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. o Take advantage of on-going sedimentation processes, such as littoral drift for sand nourishment, to aid in stabilizing new marshes.	o Use available coarse grained material to protect exposed surfaces of the new marsh. o Be aware of possible deflocculation effects when dredged sediments are obtained from highly saline areas and disposed in low saline areas. o 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. o 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. o Configure the marsh such that exposure to erosion forces is minimized. o Plan for special action to repair storm damage during the initial period of marsh stabilization.

PHOTOGRAPH

Marsh grass planted along shore banks for erosion/
stabilization

the special needs of saltwater wetlands; second, seeking assistance available under federal programs. To implement the six policies in these ways, communities should be prepared to address four principal management needs:

First, preventing or limiting disruptive activities in saltwater wetlands. Of the six recommended policies, the first four (Policies 11 through 14) deal with development-related activities that can disturb wetlands. The policies call for avoiding these activities or, in some circumstances, for conducting them in ways that minimize unavoidable disturbances. How best to do this is an important management issue.

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

Third, controlling pollution of saltwater wetlands. From a management standpoint, the measures needed to implement Policy 15 are basically the same as those for controlling pollution of coastal waters, as discussed in the Coastal Waters section (page oo).

Fourth, restoring former wetlands. Restoration (Policy 16) is sometimes a public expense, sometimes a requirement of private development.

This section deals with these issues.

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 protection than any other place in the floodplain.

Nevertheless, the locality will need first to consider the array of familiar local tools. The tools are diverse, including plans, policies, property acquisition, tax incentives, and others. Two tools--regulations and local public-works programming--are often 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 wetlands regulations [12]. Some of these regulations prohibit wetlands 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 permit development in wetlands, but subject to strict standards if preventing development altogether is impracticable. Pile-elevated structures may be permitted, for example, if they occupy only a small percentage of the site and if any destroyed vegetation is replaced [13]. [Photo]

PHOTOGRAPH

Showing residence elevated over wetlands

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 [12]. The regulations may, in addition, establish special drainage and road-design standards for wetlands development [14]. (Under some state laws, these types of controls can only be imposed by special wetlands regulations, not by subdivision regulations [12,15].)

Grading, excavation, and tree-removal regulations are also commonly used [13].

Septic-tank controls, in addition to their pollution-control effect (see p. oo), 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 [12].

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 the 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-realted benefits [16].

A community using local regulations and public-works programming to protect saltwater wetlands may encounter the following problems:

First, the locality 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 the local government. [Photo] 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 [15].

Second, market prices of privately owned wetlands may be reduced, and owners may contend that a locality's regulations exceed its statutory or constitutional authority. In responding to this charge, communities 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 [17]. Nevertheless, specific legal limits remain

PHOTOGRAPH

Showing local drainage district project

uncertain in many situations, and legal challenges may present difficult issues for localities 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 hardship situations such as these and should specify standards for any development permitted to alleviate the hardship. If hardship situations are resulting in excessive development of wetlands, regulatory methods (e.g., land acquisition, nonregulatory incentives) may be needed to protect wetlands [12].

Third, where development affecting wetlands cannot easily be avoided, localities 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. Scientific advice presently offers only limited help in making these choices, since there is still no scientific consensus on methodology or standards. Communities should remain alert to continuing research in this area. Meanwhile, they should anticipate wide differences of opinion among reputable experts [12].

A community facing limits on its own abilities to protect salt-water wetlands can often obtain important assistance from federal or state agencies. Federal permit requirements, for example, may relieve localities of the need to make some difficult decisions--or may at least enable local officials to share 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 [18]. Major provisions are summarized in Tables 2 to 4.

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

Table 2. General Regulatory Policies of the Corps of Engineers [19].

- Public Interest Review. A process weighing conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production, and, in general, the needs and welfare of the people. Four criteria are applied to any proposal covered by the program:

    -- the relative public and private need

    -- the desirability of using appropriate alternative locations and methods

    -- the extent and permanence of the beneficial and/or detrimental effects on public and private uses to which the area is suited

    -- the probable impact of the single proposal in relation to the cumulative effect of existing and anticipated work or structures in the area

- Effect on wetlands. Particular emphasis is given to cumulative effects on wetlands. The Fish and Wildlife Service plays a special role in reviews of particular wetland areas along with NMFS, NOAA, EPA and the SCS.

- Fish and Wildlife. The Fisn and Wildlife Coordination Act defines the Fish and Wildlife Service advisory role under this program. Applicants are advised that they will be urged to modify proposals to eliminate or mitigate consequences identified by the Service.

- Water Quality. The Environmental Protection Agency authorities set a number of conditions which must be certified by EPA before the Corps will approve an application under this program.

- Historic, Scenic and Recreational Sites. A number of authorities require special consideration of specific resources in these categories.

- Effect on Limits of the Territorial Sea. This consideration relates to baseline measurements that determine respective state, federal and foreign interests in the seas and seabed.

- Interference with Adjacent Properties or Water Resource Projects. This consideration relates primarily to up and downstream effects of protective work, and other nuisance effects of work on other public and private rights.

- Activities Affecting Coastal Zones. Approved State Coastal Zone Management Programs may include a procedure for advice and comment on Corps permits.

- Activities in Marine Sanctuaries. Certification by the Secretary of Commerce is required before permit approval in Marine Sanctuary areas.

- Effect on Floodplains. Pursuant to Executive Order 11988, May 24, 1977, the Corps must consider impacts on flood losses and safety of individuals and the natural and beneficial values of floodplains in reviewing permits under this program.

Table 3. Jurisdiction and Policies for Permits for Structures or Work in or Affecting Navigable Waters of the United States [19].

Jurisdiction

- Permits are required for all structures or work in or affecting navigable waters of the United States (Category 1) or on the Outer Continental Shelf.

Policies

- A national permit is authorized for:
  - -- aids to navigation placed by the USCG
  - -- structures in artificial canals associated with primarily residential development, where the connection of the canal to a navigable water of the United States has been previously authorized
  - -- the repair or rehabilitation of a previously authorized structure where the structure is presently serviceable and repairs conform to the previously authorized plans, for uses specified in the previous authorization
  - -- marine harvesting devices that do not interfere with navigation
  - -- staff gauges, water recording and testing devices and the like that do not interfere with navigation
  - -- survey activities including core sampling
  - -- structures or work completed prior to 18 December 1968 or in water bodies where the District Engineer has not asserted jurisdiction, provided there is no interference with navigation
- General permits may be issued for clearly defined categories of structures or work. After a general permit is issued, individual activities or work within the permit category will not require individual processing unless the District Engineer finds this is necessary on a case-by-case basis. General permit conditions and selection criteria are defined in part in the Corps regulations.
- Structures or work by private parties required by related Federal dredging or other work or structures, may be considered in planning for the Federal work and, to the maximum extent feasible, authorized in coordination with the Federal work or structure.
- Authorization for dredging a channel, slip, or other such navigation project will authorize maintenance dredging, subject to revalidation at regular intervals.
- Applications by riparian owners for structures for small boats will be favored when consistent with navigation, in the absence of an overriding public interest.
- Applications for aids to navigation are coordinated with the USCG.
- Applications for structures and artificial islands on the OCS are evaluated solely for impact on navigation and national security; total environmental impact is evaluated in the U.S. Department of the Interior leasing process.
- Canals and similar artificial waterways require a permit if they constitute a navigable water of the United States or if they are connected to a navigable water of the United States in a way that affects its course, condition or capacity.

Table 4. Jurisdiction and Policies for Permits for Discharges of Dredged or Fill Materials into Waters of the United States [19].

Jurisdiction

- o Permits are required for the discharge of dredged or fill materials into waters of the United States (Categories 1-4).

Policies

A national permit[a] is authorized for:

- o Discharges prior to the effective dates of phasing (see text), some subject to general conditions.

A national permit[a] subject to specific conditions is authorized for:

- o A discharge into Category 4 waters (isolated lakes, wetlands, intermittent streams, etc.), except isolated lakes of over 10 acres.

A national permit[a] subject to specific conditions is authorized for:

- o Specific categories of discharges:

  -- utility line crossing bedding or backfill;

  -- bank stabilization less than 500 feet in length;

  -- minor road crossings;

  -- fill incidental to the construction of bridge structures (not approaches);

  -- repair or replacement of previously authorized, currently serviceable fill.

- o Permits are reviewed by EPA prior to issuance in a "coordination" process to respect the joint authority of the Corps and EPA for this aspect of the permitting program.

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[a]Individual permits may be required within the discretion of the District Engineer.

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 in the revision and administration of 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 these permit requirements.

Communities trying to protect saltwater wetlands that find the Corps permit program a potent ally, can seek Corps help in several ways:

First, informal consultation with Corps officials can be an important source of technical information and can make Corps officials aware of 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 these 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, a 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, the community can participate in Corps administrative proceedings, asking the Corps to deny federal permits or to impose protective conditions. In effect, the Corps may be asked to use federal authority to impose conditions that the 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 Service often suggests design modifications to benefit fish and wildlife, emphasizing the scientific advocacy role assigned to the FWS by Congress. These comments are usually offered in the same participation procedures open to local government, that is, the environmental assessment process under NEPA (see p. oo) and similar public hearing and review procedures associated with specific programs. Localities concerned with technical questions regarding fish and wildlife impacts of proposed federal actions 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-wetlands management, though they vary too widely from state to state to be summarized here. Communities should determine what type of program is run in their 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 expected to point the way to integrated application and hearing procedures.

2. The substitution of state for federal Section 404 authority in freshwater wetlands not adjacent to navigable waters (see p. oo). 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. oo). These plans can include "best management practices"--guidelines and standards for pipelines and light structures likely to be located in saltwater wetlands, for example. The best management practices may be used to set standards in Section 404 permit proceedings.

4. The coordination of state dredge-and-fill regulation with state coastal-zone management, which may give opportunities for local participation, or, more likely, opportunities for building awareness of the policy objectives served by the CZM program.

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 a community gets a Flood Insurance Rate Map (FIRM) (Figure 7). To put it another way, it becomes available when a community leaves the "emergency phase" of the NFIP and enters the "regular phase" of the program.

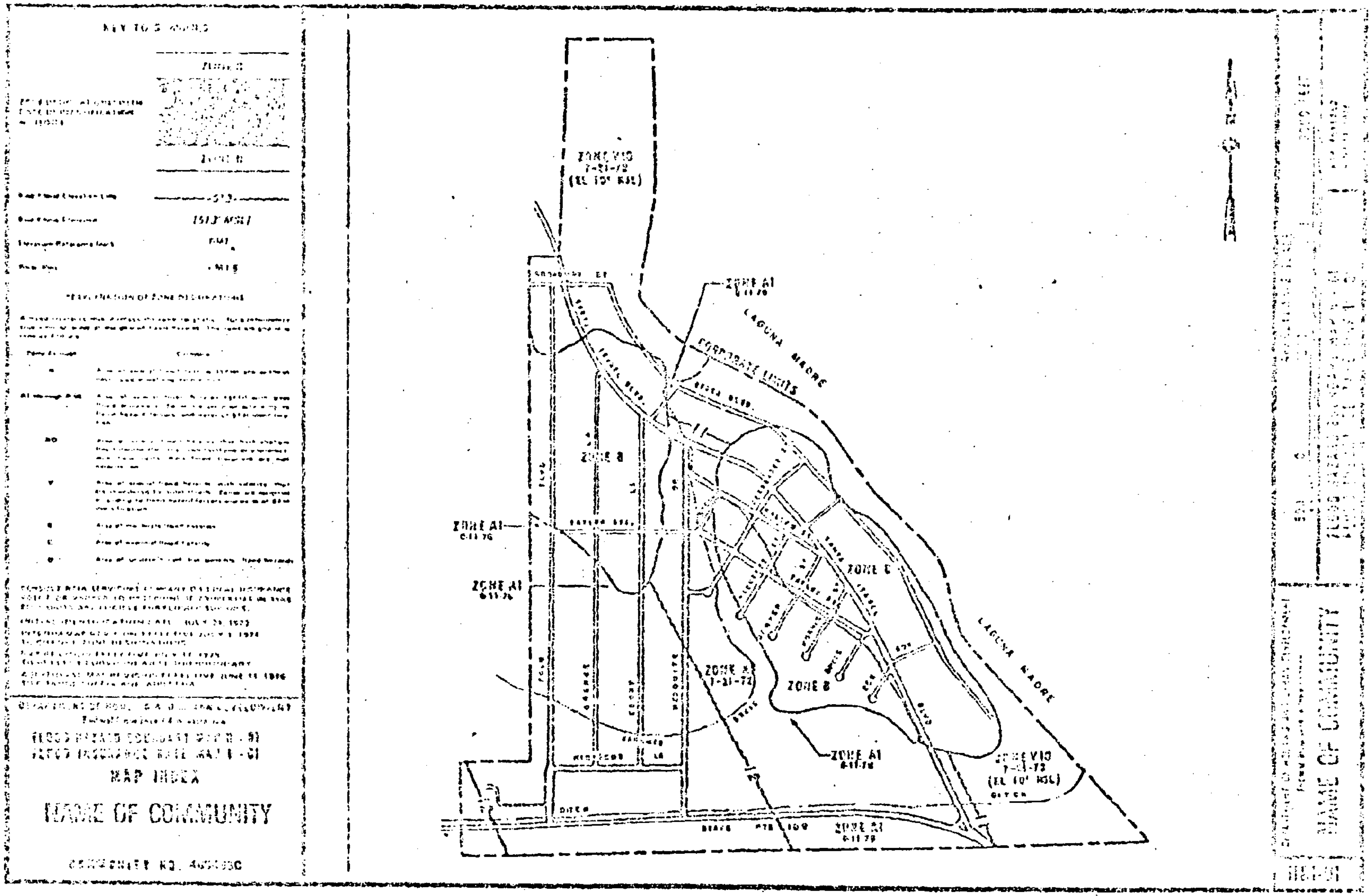

Figure 7. FIRM map for Community X. [20]

Many saltwater wetlands are subject to frequent or especially dangerous flooding and are therefore 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 communities that want to stay in the NFIP 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. [Photo]

A locality concerned about a federally conducted or assisted project in wetlands should be aware of Executive Order 11990, the "Wetlands Executive Order," issued in 1977. The order applies to the

PHOTOGRAPH

Showing public service facility in wetland following federal activities in both fresh- and saltwater wetlands:

(1) acquiring, managing, and disposing of federal lands and facilities

(2) providing federally undertaken, financed, or assisted construction and improvements

(3) conducting federal 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. oo). A locality may also have an opportunity to comment in "A-95" and public-participation procedures of particular grant or expenditure programs (see p. oo).

A community believing that the Wetlands Executive Order is being ignored should make appropriate comments in EIS, A-95, or other procedures, and may have other legal remedies available. But if it feels that the judgement of an agency on practicable alternatives or measures to minimize harm is incorrect, there is unlikely to be any way to change the decision except through the normal channels of administrative appeal used by that agency.

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

Both 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.

Many actions of federal agencies must be "consistent" with the state CZM program if it has received federal as well as state approval. For example, a Corps decision to permit dredging in wetlands would have to be consistent with the approved CZM program as well as with Corps regulations. State agencies may comment on proposed federal actions to ensure that the state policies are followed.

Coastal Energy Impact Program. If the state and communities are receiving grants under this program, a locality may find that some funds are available to correct wetlands destruction resulting from coastal energy-development activities [20].

2. Determining the Boundaries of Saltwater Wetlands

If a locality's policies or regulations treat saltwater wetlands differently from other places, the locality will need to define the wetlands boundary. There are several possible ways to do this. The locality 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 example, in many areas, the upper edge of the saltbush, or high-tide bush, clearly marks this boundary. [Photo]

Localities 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, localities should know what types of pre-existing boundaries may be available as alternatives. Three types are most common:

PHOTOGRAPH

Showing vegetative characteristics of upper edge of wetland. [The upper boundary of a wetland is often readily determined by a vegetative transition.]

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." Using this line as a boundary for saltwater wetlands in a local management program is likely to have two limitations. First, the line is likely to be more difficult to locate than one based on vegetation (although vegetation can help to 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--the locality will probably find it most convenient to use the property line as its 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 a locality's saltwater wetlands.

In addition to defining the wetlands boundary, the locality will need to establish a procedure for drawing the boundary in a specific location. There are two principal choices. The locality can try to draw boundaries in advance, by surveying, inventorying, and mapping. Alternatively, it 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.

3. Controlling pollution of saltwater wetlands.

See Coastal Waters section (pages oo - oo).

4. Restoring former wetlands.

Restoration of wetlands typically consists of dismantling dikes, tidegates, and drainage canals that interfere with water flows and of rehabilitating the soil base. Communities occasionally undertake restoration projects on their own, but their efforts are limited by coasts 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 assist in solving:

First, local governments have no direct control over federal permit issuance and federal projects in the floodplain. If these affect wetlands, however, the U.S. Fish and Wildlife Service comments on them (see page oo). 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 informal assistance to localities evaluating proposed wetlands restoration.

Second, localities 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.

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BANKS AND BLUFFS

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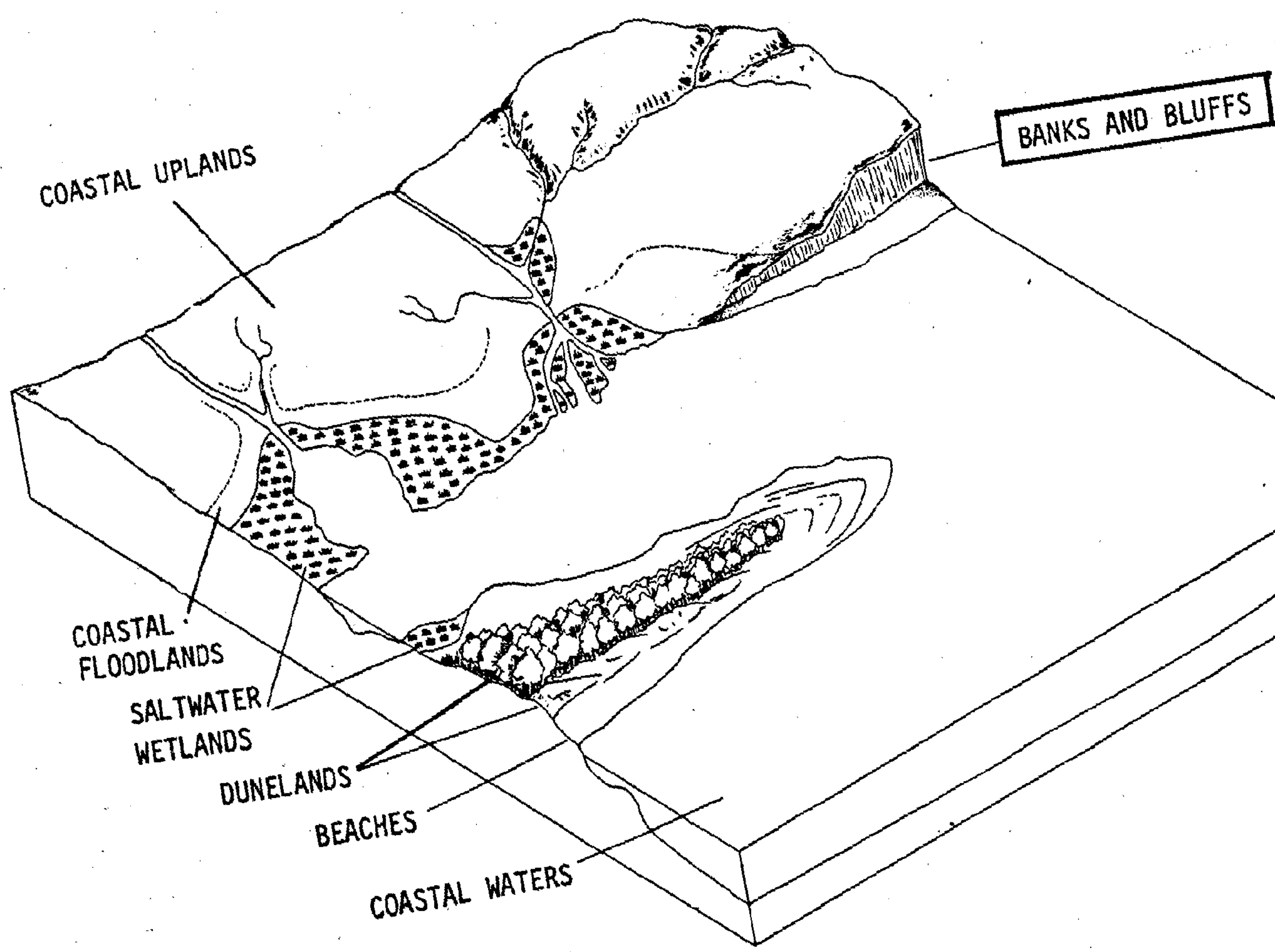

BANKS AND BLUFFS

Coastal banks and bluffs present a special problem for management because so often they are unstable. From the safety standpoint, they may be potentially hazardous building sites. Bluffs and banks are vulnerable to currents, waves, and storm surge, which cause erosion and structural failure. Poor drainage and slide-prone soils may also contribute to instability. Ecologically, many wildlife species benefit in breeding or other critical life functions from natural bank and bluff habitats or from the edge-zones immediately behind them [1]. [Photo]

Bluffs and banks occur in many formations and sizes. Formations vary from clay, sand, or unconsolidated rocks and sand to consolidated soft rock, such as sandstone. Sizes range from the low banks of Maryland or Texas bayshores to the high bluffs of the Great Lakes and the Pacific Northwest. As used here, low banks are formations of 1 to 5 feet, high banks 6 to 20 feet, and bluffs higher than 20 feet [2]. The exposed cross section or profile of the bank or bluff is called a "face." The top is the "crown." The bottom is the "toe."

ECOLOGICAL FEATURES

Bluff and bank faces provide habitat for some types of nesting birds and burrowing animals. Vegetation along the face is limited to hardy grasses and shrubs that can withstand constant wind, spray, and slope erosion. This vegetation reinforces slope stability.

PHOTOGRAPH

Bluff faces provide habitat for certain nesting birds.

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 merges 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 into the shorelands, with a barely perceptible edge-zone, may be of lesser ecological value. [Photo]

HAZARDS

The primary processes responsible for bank and bluff recession are usually related to either wave action at the toe or groundwater seepage into the face. The sequence of events in the recession process are: (1) physical 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 [1].

Bluffs are resistant to persistent erosion, since they 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

PHOTOGRAPH

Showing the upper edge-zone which has a special assemblage of vegetation and provides a unique habitat for wildlife.

along the upper edge of the slope [3]. Banks are eroded by similar, but less violent, processes. [Photo]

If the bluff is, in fact, the seaward end of a large slide, then the whole slide area back of the crown of the bluff should be considered potentially unstable. 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. [Photo]

Coastal slides and erosion have long been recognized as problems. For example, it is said that in the 1790s George Washington studied the erosion of the Long Island coast and 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 about that long; as of 1978, there was less than 40 feet left between the base of the lighthouse and the edge of the cliff [4].

DEVELOPMENT POLICIES

Serious attention should be given to management of banks and bluffs in coastal areas. Erosion, slumping, and caving of these slopes may decrease property values, destroy structures, and adversely affect coastal waters [1]. Approaches to bank and bluff protection are addressed in recommended policies 17, 18, and 19:

PHOTOGRAPH

Showing bluffs eroded above average high tide level.

PHOTOGRAPH

Showing slide-area indicators.

17. <u>Alteration of Bank and Bluff Tops</u>: Avoid adverse uses of land adjacent to banks and bluffs.

18. <u>Alteration of the Slope</u>: Discourage activities that physically alter the face or toe of banks and bluffs.

19. <u>Erosion Protection for the Toes of Banks and Bluffs</u>: Encourage the use of natural means of protection or properly designed bulkheads to protect bank and bluff toes from erosion.

<u>Recommended Policy 17: Alteration of Bank and Bluff Tops</u>

<u>Avoid adverse uses of land adjacent to banks and bluffs.</u>

The use of land immediately back of bank and bluff crowns is critical to slope stability. If this edge-zone is kept natural, stability is fostered. Where the edge-zone is greatly altered by clearing, building, or plowing, the bank or bluff may be destabilized.

Losses of high banks and bluffs are often caused by adding weight to the crown area or cutting into it. The deposit of fill, such as might accompany 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. [Photo]

Where land is cleared to the edge of the slope for building, landscaping, crop planting, or other purposes, bank erosion may be enhanced by accelerated infiltration of surface water. The combination of weight and the lubrication of the soil (particularly clays) by water may result in slumping (Figure 1). Other sources, such as septic tank seepage, can increase the potential for loss. Ponding of

PHOTOGRAPH

Showing damaged or imperiled structures built too close to the bank edge.

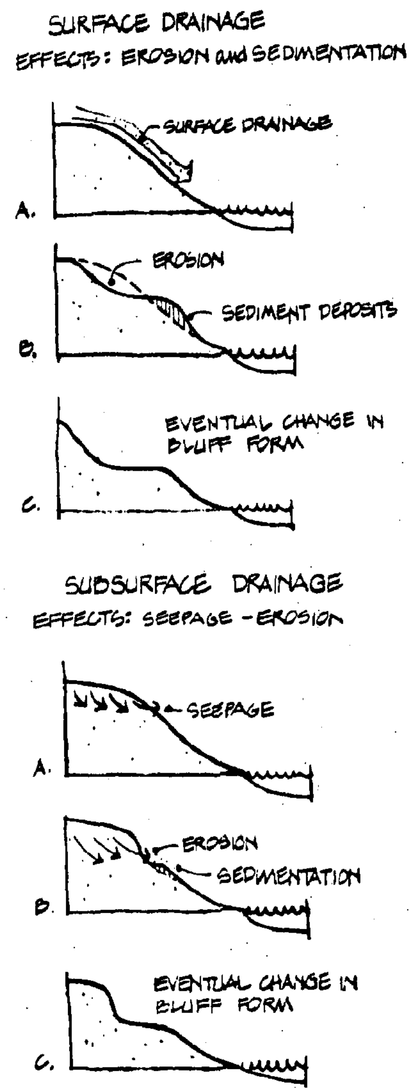

Figure 1. Surface runoff and seepage contribute to erosion. Surface water is brought to the bank or bluff by natural channels, drains and storm sewers. The water is usually released near the bluff crest, resulting in steep falls which cause erosion. Subsurface water that seeps from the bank or bluff face also erodes and weakens the soil [5].

storm water in the edge-zone may also cause problems. To protect existing structures from slippage, water saturation of banks and bluffs can partially be reduced by diverting water away from the crown areas through the use of drain tiles or similar systems.

The management goal should be to place new structures behind the vulnerable part, protecting bluffs and banks from destabilizing influences so as to minimize the threat to upland property, reduce the need for and cost of bulkheading, and protect the valuable edge-zone habitat. The optimum policy is to require a setback that provides a wide buffer strip of natural vegetation and soils along the edge of the adjacent lands immediately behind the crown of the bank or bluff. The buffer strip area should be limited to light-duty uses compatible with maximum protection of the bank or bluff slope.

Along shores with long-term rising water levels--for example, the Chesapeake Bay and the Great Lakes--erosion and bank recession is expected to increase in severity. This problem can best be addressed after a predictable rate of recession has been determined. From this rate, a recession line can be drawn and structures located far enough behind it to be safe for their predicted economic life. [Photo]

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. When vegetation that helps to stabilize the face is removed, or excavation is done along the

PHOTOGRAPH

Showing severe erosion of bank edges in the Chesapeake Bay (or Texas) face, the chance of slumping may be increased. [Photo] When the bank or bluff slumps, adjacent land is lost, structures are imperiled, sediment is added to the coastal basin, and marsh or other vital areas may be degraded or obliterated. Removal of the accumulating rubble and debris from the toe usually results in a greater potential for slides.

The best policy is to discourage activities that adversely alter the faces of banks and bluffs and those that involve removal or unnecessary disturbance of bank or bluff vegetation. It is particularly important to protect the toe from alteration. These strictures should not prevent owners from installing stairways, other minor fixtures, or properly designed bulkheads. But building of homes or commercial structures on cliffsides or over banks and bluffs usually should 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 2). Bulkheads or seawalls built specifically for the purpose and placed at the base of an eroding slope to stop the undercutting effect and to stabilize the slope are usually acceptable. However, bulkheads placed out in the

PHOTOGRAPH showing grass and low brush planted on slopes holding sand in place and helping to prevent rain and runoff from eroding property. For example, on the inhabited 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 on the hillside. Even in very soft terrace sands of Lincoln City, the few attempts at planting to stabilize slopes have helped ease local erosional problems. Extensive planting of grass on unconsolidated sands along the beach at Salishan is helping to hold steep slopes. [3]

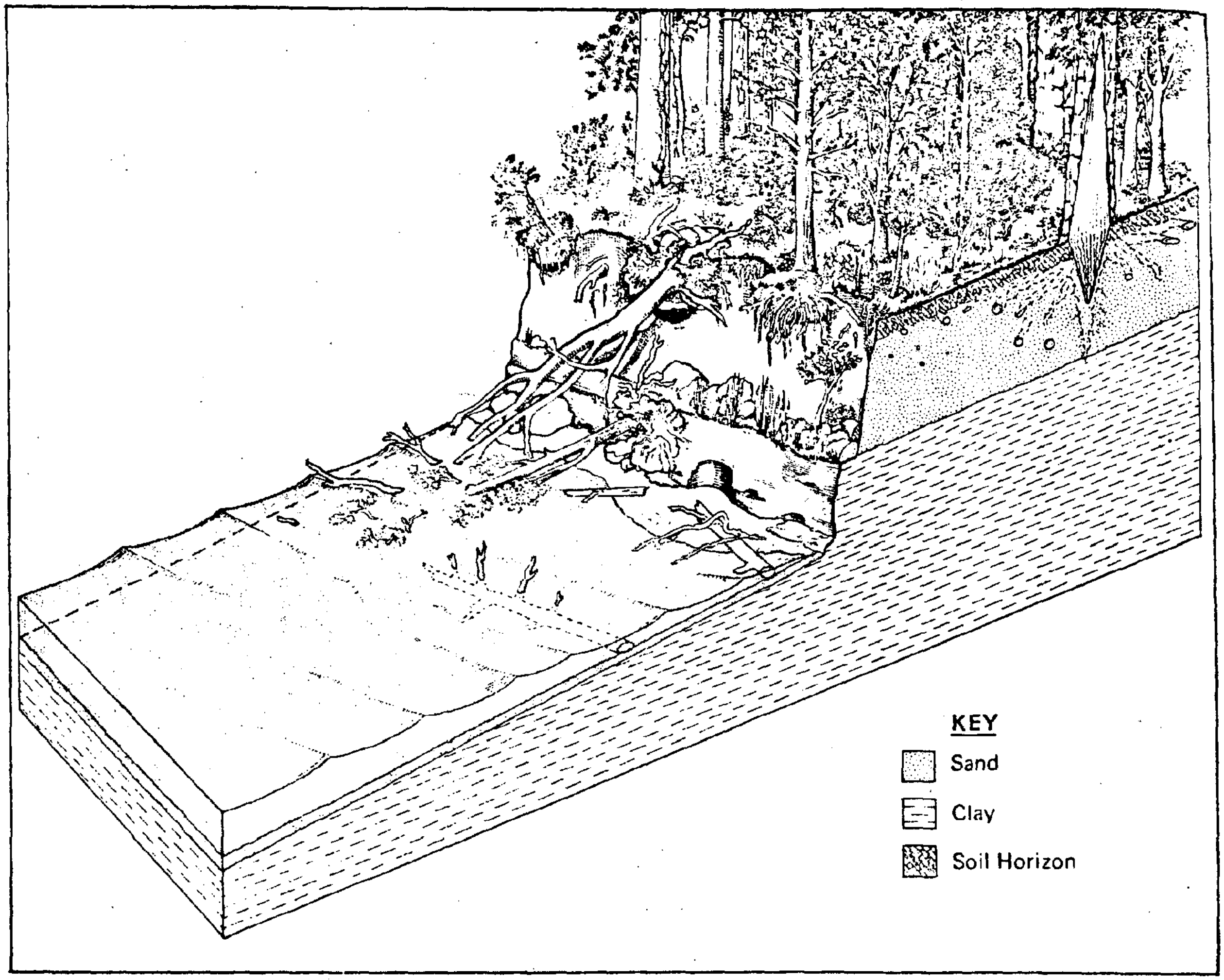

Figure 2. Storm waves undercut the high bank causing slump blocks, along with their vegetative cover, to slide onto the beach. Here the slump blocks are reduced by further wave action, leaving behind accumulations of fallen timber [2].

water and backfilled to gain land at the expense of wetlands or productive shallow water habitat should be discouraged. [Photo]

Riprap (large stones) is often the easiest and least costly technique for protection. Those advantages are augmented by the high permeability of riprap and its other ecological benefits. Ground-water and runoff can move unimpeded through both the filter-cloth and the crushed-rock backings required for riprap structures.

In many cases, the costs of stabilizing low banks can be reduced by grading the shoreline and planting salt-marsh grasses, mangroves, or other vegetation in the tidal zone and by revegetating the face of the bank. This artificial marsh barrier is also ecologically preferable to engineered structures because it creates a more biologically productive shoreline with a natural appearance. [Photo]

IMPLEMENTING THE POLICIES FOR BANKS AND BLUFFS

Three policies (Policies 17, 18, and 19) have just been recommended for the management of banks and bluffs. This section of the manual is intended to assist communities in implementing those policies. Successful implementation of the policies requires communities to address two principal management needs:

First, establishing a setback from the recession line (Policy 17).

Second, establishing standards for protective structures (Policies 18 and 19).

PHOTOGRAPH

Showing a structure for stabilizing the base of an eroding bank.

PHOTOGRAPH

Showing an artificial marsh barrier used to stabilize the tidal edge of low banks.

1. Establishing a setback from the recession line.

To implement Policy 17, a 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. Where erosion data and analysis are available to localities, 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, calculating a recession line requires extensive data. Location of the line depends on natural processes but can be affected by protective works and other shorefront alterations. A high level of technical expertise is necessary to delineate the recession line. (See Figure 3) Some state agencies may be able to supply the necessary data to communities. Michigan, for example, has calculated a recession line for portions of the state's Great Lakes shores [7].

Second, a recession line needs to be changed from time to time. A setback established in 1940 or 1950 may no longer be adequate in 1970 or 1980. The line may have to be repositioned every 5 or 10 years.

Third, the community must decide how far into the future the setback is intended to provide protection. Often, the location

CALIFORNIA COASTAL BLUFF CONSTRAINTS

Regulate Bluff and Cliff Developments for Geologic Safety. Bluff and cliff developments shall be permitted if design and setback are adequate to assure stability and structural integrity for the expected economic lifespan of the development and if the development (including storm runoff, foot traffic, grading, irrigation, and septic tanks) will neither create nor contribute significantly to erosional problems or geologic instability of the site or surrounding area.

a. Expert to Evaluate Site Stability. The demonstration of stability shall include a report prepared by a registered geologist, a professional engineer specializing in soils engineering, and/or a certified engineering geologist acting within their areas of expertise, based on an on-site evaluation. The report shall consider (1) historic cliff erosion, (2) cliff geometry, (3) geologic conditions, including soil and rock characteristics, (4) landslides, (5) wave and tidal action, (6) ground and surface water conditions and variations, (7) potential effects of earthquakes, (8) the effects of the proposed development including landscaping and drainage measures, and (9) any other factors that may affect slope stability....

b. Area of Stability Demonstration. As a general rule, the area of demonstration shall include the base, face, and top of all bluffs and cliffs (of 10 feet in height or greater measured from the toe of the cliff face) extending inland to a line formed by a 20-degree angle from the horizontal plane at the base of the cliff or bluff (a 2.75:1 slope) or 50 feet from the top edge of the cliff, whichever is greater. However, the coastal agency may designate a lesser area of demonstration in specific areas of known geologic evaluation and historic evidence) or where adequate protective works already exist, and may designate a greater area of demonstration and/or an area of absolute development exclusion in areas of known high instability. [6 --California Coastal Plan]

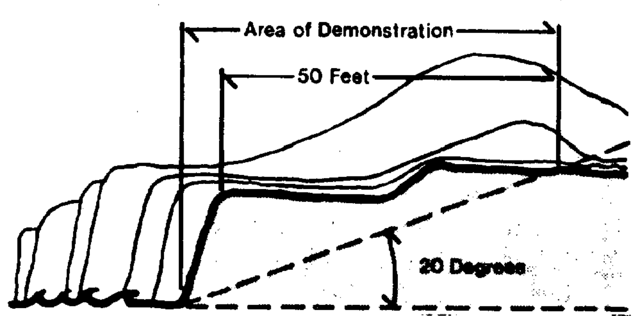

Figure 3.

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 communiites prohibit construction or reconstruction in such situations. Strict regulation of this sort is likely to raise objections from property owners and may require non-regulatory management approaches, as discussed in the Floodlands section at p. oo. In the absence of strict regulation, however, communities should anticipate future demands on public funds to establish shore-protection works. The economic stakes involved can be enormous.

In establishing a setback from the recession line, a 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. Moreover, owners of threatened structures in "E" zones may obtain inexpensive insurance against flood-related erosion damage. The federal regulations, plus the availability of insurance may make it easier for communities to establish a setback line.

In practice, the NFIP has had difficulty defining "flood-related" erosion damage for insurance purposes, particularly in the Great Lakes. In many cases, 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, and special studies are expected to help communities that wish to establish setback requirements.

Coastal-Zone Management. State coastal-zone management programs (see p. oo) are required to identify erosion-prone areas. This may help local regulatory efforts. In Michigan, for instance, 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

A 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 (costing 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. Community standards should be compatible with the standards of the Corps of Engineers permit program (see p. oo), which controls the design and placement of structures in navigable waters. The U.S. Fish and Wildlife Service may be able to help communities minimize environmental damage caused by such structures (see p. oo).

Communities should be aware 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 will wash out with severe storms and flooding.

In setting standards for shoreline protective structures, a community may want to consider the following program of the U.S. Army Corps of Engineers:

Small Beach Erosion Control Projects. The U.S. Army Corps of Engineers provides advice and, in some cases, designs and constructs projects to control shore erosion that threatens existing buildings. For instance, the Corps provides expert guidance on low-cost means of protecting buildings around the Great Lakes from bank and bluff erosion [8]. Communities may wish to direct residents to District Engineers' offices for advice on this matter.

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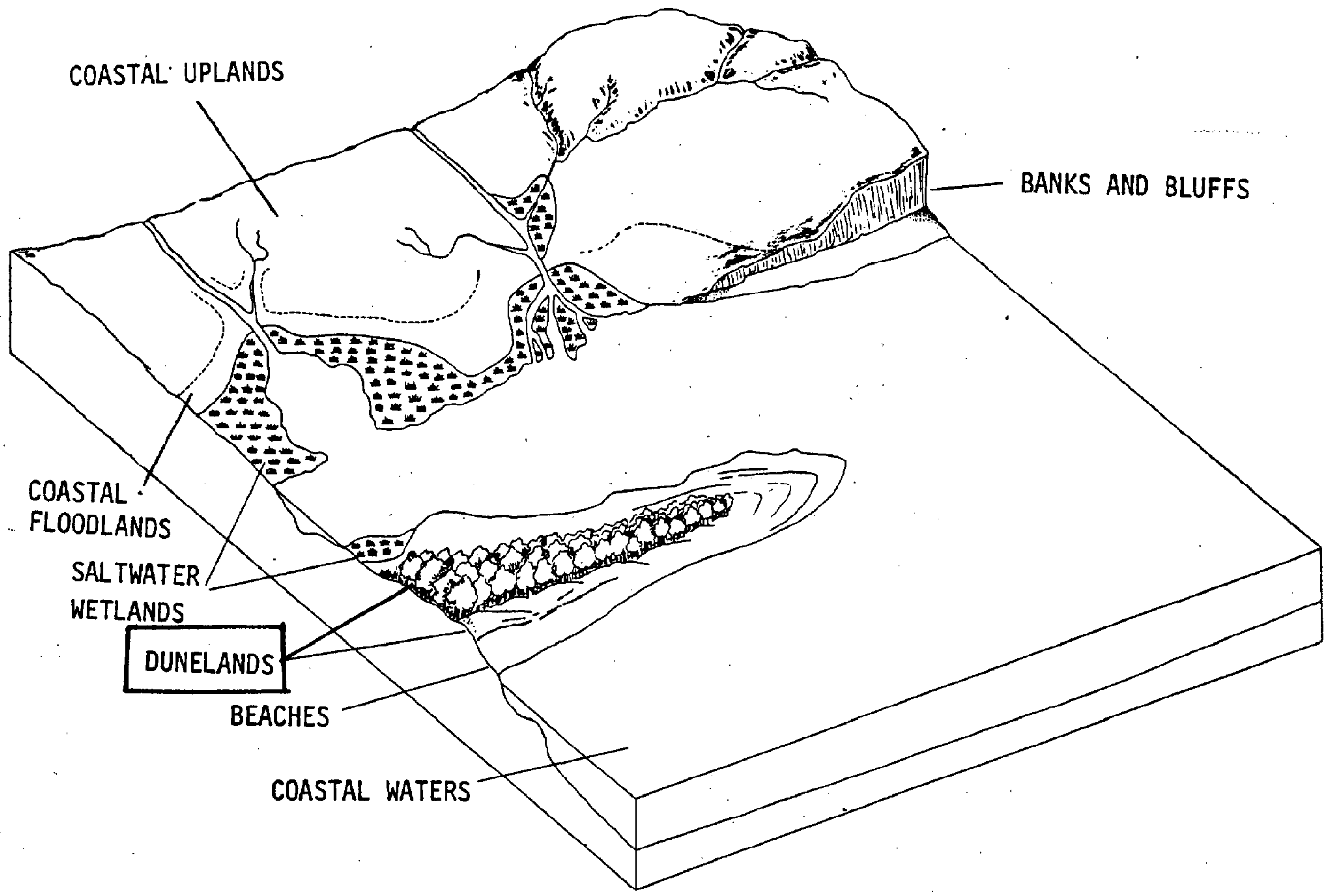
CONTENTS

DUNELANDS

PLACES OF CONCERN FOR COASTAL FLOODPLAIN MANAGEMENT



DUNELANDS

At the ocean's edge, land has a quality of impermanence. Beachfront property may be here today and gone tomorrow. It often takes just one hurricane to carve away an entire lot and all that is on it. That is why dunelands--the area of dunes, sand ridges, and flats between the beach and higher ground--belong more to the sea and to the beach than to the land. This is particularly clear where sandy shorelines are eroding and receding.

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, is not so obvious. Active dunelands, like beaches, are caught in the balance 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 to maintain habitation. [Photo]

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 conflict with community needs for public access and recreation, beach stability, hurricane protection, provision of public services, resource conservation, and fiscal control. The costs in property losses and human lives have been high along the duneland coast, and the enormous sums of private and public money spent to stabilize and safeguard the coast are rewarded too

PHOTOGRAPH

Showing before and after storm effects on dune system.

rarely with long-term success. Moreover, the problem is intensified by a relentless rise in sea level along the U.S. coastline (1/2 to 1 foot or more per century), which is slowly pushing the sea onto the land. [Photo]

The primary subject of this section is the need to conserve dunes for protection of seashores and shore property. During heavy sea storms or catastrophic hurricanes, dunes and sand ridges provide both a barrier to waves and a reservoir of sand to replenish storm losses.

The dunelands include all the active dunes, sand ridges, troughs, and flats of sandy beachfront areas 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 seawind. 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 vegetation on the active dune is mostly grasses, and on the stabilized dune, shrubs and woody vegetation. Dunes and sand ridges (flatter, dunelike features) come in a variety of forms. The most common formation is one or more long dunes or ridges parallel to the beach (Figure 1). In some places, there is an "erosion scarp" (a formation characteristic of receding beaches) rather than a dune or sand ridge. Duneland areas

PHOTOGRAPH

Showing badly eroded beach due to sea level rise.

[NOTE: An improved figure will be prepared for publication.]

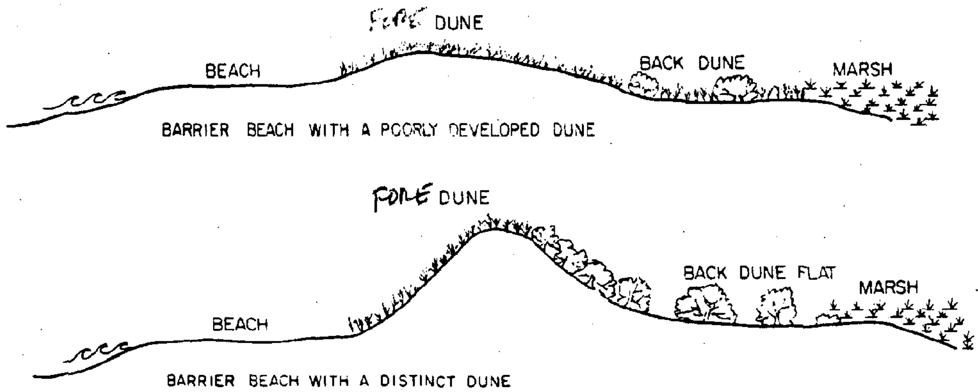


Figure 1. Cross sections of typical Rhode Island duneland formations showing: the beach, undeveloped and developed dunes, the back dune, and sand flats. Developed dunes are usually densely vegetated by shrubs and small trees on the pond side. The primary dune vegetation is American beach grass. The dune 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. [1]

without pronounced dunes or ridges that are periodically flooded by the sea and covered with sand are called overwash areas; they lack normally established plant communities.

ECOLOGICAL FEATURES

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. Sea turtles nest in the dunelands and back beach, as do least terns and plovers. Permanent occupants include ghostcrabs. Some species of mammals range out onto the dunelands from their primary transitional and forest habitats [2]. [Photo]

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 the wind blowing, have the least vegetation. The backdunes are less exposed and offer a more stable environment for vegetation.

HAZARDS

The primary function served by dunes and sand ridges in protecting against hazards is to provide a storage area for sand to replace that 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 resulting from severe storms. Dunes also buffer the direct force of storm surge and waves, the resilient and mobile character of the dune making it an excellent structure to absorb wave and water energy.

PHOTOGRAPH

Dunelands provide wildlife habitat for a number of birds and mammals

Dunes offer short-term protection as well. Much of the sand carved from 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 in on 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 [3]. [Photo]

Dunes should be treated 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 for fill invites erosion and storm-damage problems.

DEVELOPMENT POLICIES

Dune conservation is important. One management goal should be to keep active dune and overwash areas undisturbed because of the great benefits they provide for protection of life and property and for animal habitats. This means minimizing the disturbances to vegetation and to the duneland's sand system; for example, offroad vehicles should be prohibited from dune systems that are sensitive to vehicle-induced erosion. The critical sand system of dunelands

PHOTOGRAPH

Showing how dune grasses hold sand and enable dunes to grow can be disturbed directly by altering dune ridges or indirectly by removing or blocking the beach sand destined for the dune via wind transport.

A second management goal is to place permanent development well inland of the active part of the dunelands. This can be accomplished by a setback gauged for the particular circumstances. A setback line should be entirely landward of any active dune ridges. Moreover, it is important to establish a recession line to govern the setback distances wherever a beach is receding from erosive forces. The setback line should be far enough landward to allow for predictable recession of the beach and dune system.

Access to the beach involves traversing the dunelands and must be considered in planning and in managing development. Not only must access to the public beach be permitted, it must be controlled to prevent nuisance and damage to the fragile dunelands from beach traffic. Public access, however, is a social-equity issue and is not addressed directly in this book.

Major community program needs for duneland protection are outlined in Development Policies 20 through 23:

20. Excavation in Dunelands: Excavation and removal of active dunes and beach ridges should be prohibited.
21. Alteration of Dunes: Avoid disturbance of dunes and dune vegetation by controlling traffic over dunelands.
22. Location of Structures: All structures should be built landward of active dunes.

23. Dune Restoration: Private and public projects to restore and stabilize dunes should be encouraged.

Recommended Policy 20: Excavation in Dunelands

Excavation and removal of active dunes and beach ridges should be prohibited.

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 Corps of Engineers has warned that dune deposits "must be used with caution to avoid exposing the area to flood hazard" [4].

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 excavation should be considered unacceptable. Removal of dune sand for fill, construction aggregate, or other uses should normally be prohibited.

Recommended Policy 21: Alteration of Dunes

Avoid disturbance of dunes and dune vegetation by controlling traffic over dunelands.

Dunes and beach ridges protect beachfront property and therefore should be preserved in their best functional condition. This requires protection of the vegetation that binds the dune together. Vegetation growing on shifting dunes is adapted to withstanding the rigors of wind, sand, and salt but not human feet, vehicles, or grazing animals. Even slight alterations of dune formations, such as minor erosion or displacement of vegetation, may lead to significant disruption. 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 protection role.

Dunes that would be adversely affected by vehicular or foot traffic should be protected by controlling access. Access to the beach should be limited to elevated steps and boardwalks over dunes and sand ridges. Traffic anywhere on the frontal dune system should be prohibited. Vehicular and pedestrian access to the beach should be provided at points where crossing dunes is unnecessary.

In instances where damage from livestock has occurred, fences should be erected to keep grazing animals off the dunes. In addition, the duneland habitats of shore species should be protected by temporary restriction of vehicle or foot traffic during critical nesting or breeding seasons.

Recommended Policy 22: Location of Structures

All structures should be built landward of active dunes.

Offering the best ocean view and the most convenient beach access, dunelands are often proposed as the site for residential building projects. The buildings may be placed astride the dune, or the dune may be bulldozed away to make a level site or, often, to provide a view for structures built behind the dune. The protective values of the dune are thus foreclosed, not only for the owners of the structure but also for neighboring property owners--both those situated landward, who then become exposed, and those down the beach, who depend on dunes for storage of sand to replenish that lost to storms.

The optimum solution to proper location of structures is to: (1) prohibit the siting of homes or other buildings on active dune areas and (2) prohibit alteration of active dunes in preparing and developing a site. Building on dunes or lowering them should not be necessary to obtain a view, since structure elevation requirements imposed as a condition of federal storm insurance (sometimes up to 12 feet) usually result in first floor windows above the dune top.

Where beaches are receding because of erosion, the preservation policy should be extended to the dunelands of the future. That is, if the shoreline will recede, say, 250 feet in the next 50 years, the community should plan as though the dunelands are <u>now</u> 250 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. [Photo]

A fall-back solution for use 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 as to ensure that design and construction activities will not result in any significant functional alteration of the dunelands [5]. The principal means of accomplishing this goal is to require structures to be elevated above the dunelands on deep

PHOTOGRAPH

Showing receding beach zones, where the dunelands area may predictably become the surf zone within a lifetime.

anchored piles and to prohibit filling and general clearing, grading, and paving of the site (Figure 2).

Recommended Policy 23: Dune Restoration

Private and public projects to restore and stabilize dunes should be encouraged.

Revegetation programs and simple structures such as snow fences are inexpensive and effective restoration methods. By such means, individual property owners or community groups can build and rehabilitate sand dunes. 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 4 feet high or more may be built in less than a year, whereas in other places this growth may take several years [7]. It should be noted, however, that 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 [8].

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 manmade 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 [9]. [Photo]

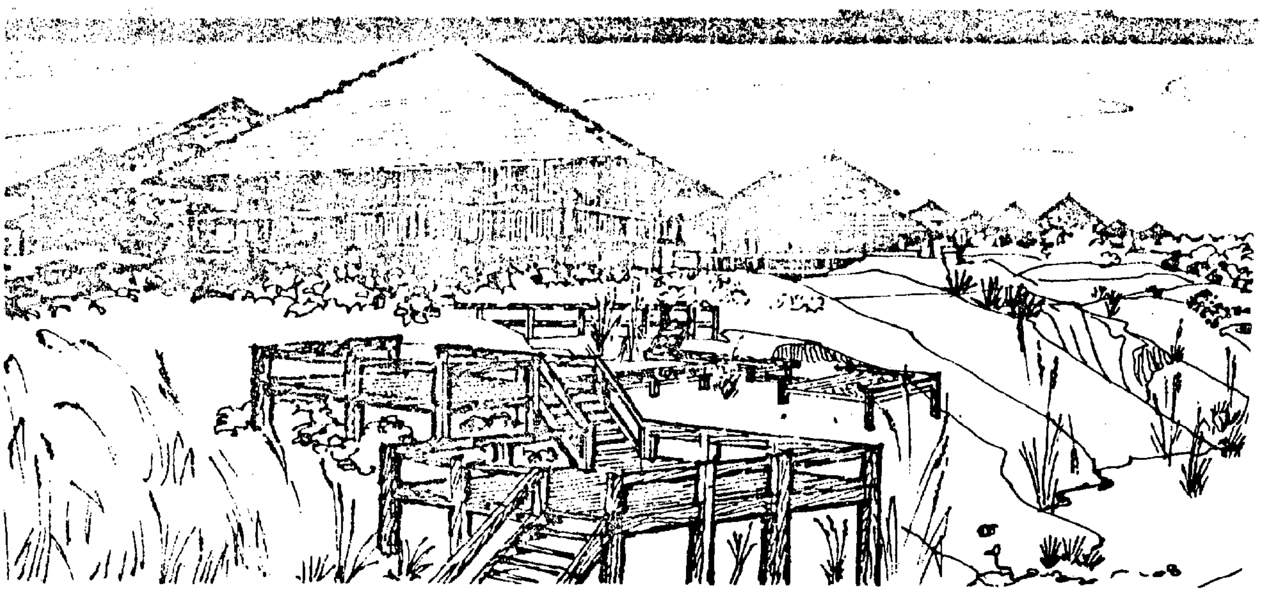


Figure 2. Concept sketch for non-alteration approach to building location and design where parcel configuration does not permit a full setback. [6]

PHOTOGRAPH

Showing successful dune restoration project on Captiva Island.

IMPLEMENTING THE POLICIES FOR DUNELANDS

Four policies (Policies 20 through 23) have just been recommended for the management of dunelands. This section of the manual is intended to assist communities in translating these policies into action. Each of the policies presents a management issue:

First, <u>controlling excavation in dunelands</u> (Policy 20).

Second, <u>controlling vehicles and pedestrian traffic on active dunes</u> (Policy 21).

Third, <u>establishing a setback from the recession line</u> (Policy 22).

Fourth, <u>restoring dunelands</u> (Policy 23).

1. <u>Controlling excavation in dunelands</u>

A 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 [10].

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

A community seeking to control duneland excavation is likely to 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 and sometimes also adjacent secondary-dune ridges. For accurate definition, however, technical assistance from a geologist or engineer familiar with beach processes will be needed [3]. Technical help may be available through the state or Corps of Engineers.

Second, property owners may argue that strict regulation of sand mining exceeds local 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, thereby establishing the need for strict controls [11].

Two federally sponsored programs may prove helpful to a community that seeks to control dunelands excavation:

National Flood Insurance Program. The National Flood Insurance Program (NFIP) (see p. oo) has established special requirements for high-hazard areas--those identified on a Flood Insurance Rate Map (FIRM) as areas 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 dunelands areas likely to bear the brunt of ocean storms and hurricanes (Figure 3).

The NFIP requires that fill (often taken from dunes) not be used for building elevation in "V" zones. A locality can meet this requirement with a provision calling for elevation of new structures on pilings. To meet recommended Policy 20, this kind of provision

[NOTE: An improved figure will be prepared for publication.]

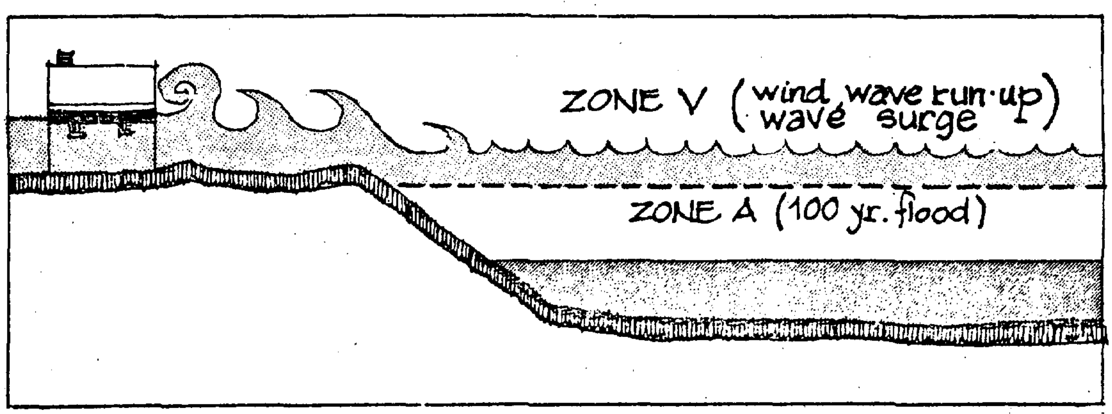


Figure 3. Hazard zones in coastal areas [12].

should be applied behind active dune areas and should be coupled with a requirement for revegetation after surface alteration (see p. oo).

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. oo) 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 local efforts to control 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

Local efforts to protect active dunes may deal with pedestrian and vehicle traffic in the following way:

--Pedestrian access to the beach across active dunes can be limited to wooden walkways or similar structures in either a dune-protection or a locality's regular development-control regulations. This may be complemented by state regulations protecting dune vegetation such as sea oats or dune grasses [13].

--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 [14]. [Photo]

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

A community regulating dunelands may encounter two types of problems:

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 dunelands 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 being difficult to enforce.

Except for federal public-lands management, no federal programs directly address dunelands use. A state coastal-zone management program may be a helpful non-local source of advice (see p. oo).

3. <u>Establishing a setback from the recession line</u>

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 local communities, a setback from the

PHOTOGRAPH

Showing car traffic on beaches restricted to the "wet sand" area.

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. oo). 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. oo). In any event, all parts of those that are subject to predictable flood-erosion forces, regardless of elevation, should be treated by communities as if they were located in velocity ("V") zones because of erosion hazards.

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

4. <u>Restoring dunelands and adjacent beaches</u>.

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 will restore dunes and beaches.

Sometimes, however, beach and duneland restoration projects are needed, in keeping with Policy 23. Localities may undertake these projects themselves, but that is costly, so often other solutions are sought.

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. Relevant Corps programs include Small Beach Erosion Control Projects, discussed at page oo. To obtain Corps assistance under these programs, localities must usually provide public access to restored areas.

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 a locality identify these opportunities.

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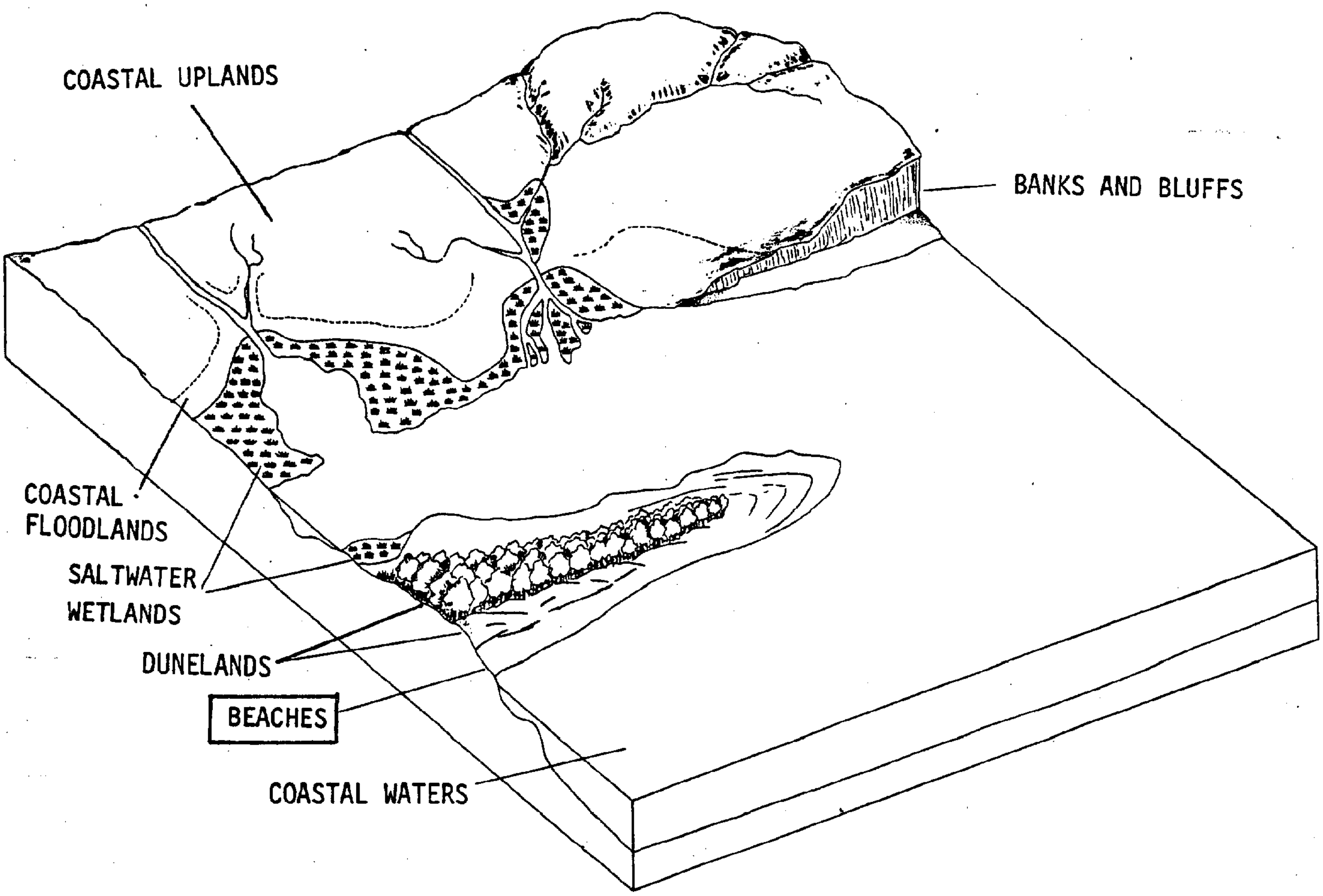
CONTENTS

BEACHES

PLACES OF CONCERN FOR COASTAL FLOODPLAIN MANAGEMENT



BEACHES

Ocean beaches are one of the nation's great recreational resources. They are also the main protective bulwark for property along sandy ocean shores. Beaches can absorb heavy surface use, including the vehicle traffic so common in Washington, Texas, and the Carolinas--but they are also fragile. They can be obliterated by removal of sand or improper building. Many of America's prime beaches have been lost through ignorance or arrogance. [Photo] For example, Miami's once wide and beautiful beach is reduced to fragments, and Miami Beach resorts are on the decline. The probable cost for repair is about $60 million of tax money.

Beach problems are caused by human actions. Normally, if nothing is built on or next to the beach, it will remain. It may shift with the seasons, yield sand temporarily to storm erosion (Figure 1), slowly recede landward with rising sea levels, or accrete seaward with natural shifts in the flow of ocean currents, which bring more sand. Mobile and responsive, the beach will remain over the years. But if we try to restrain these natural movements with bulkheads or groin fields so as to hold the beach, we 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

PHOTOGRAPH

Showing beach erosion because of improper stabilization approach.

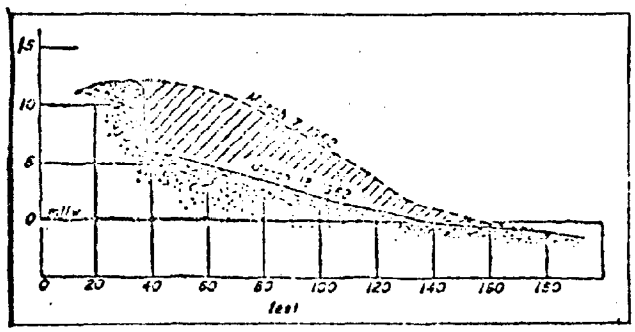


Figure 1. Typical erosion pattern of Delaware beaches during the storm of March 1962. Many miles of beach receded 60 to 75 feet. [1]

development on the land next to it, beach protection requires coordinated management of the beach itself (which is discussed in this section) and the land behind it (covered in the sections on Dunelands and Banks and Bluffs).

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. But the beach system as a whole includes the nearshore zone as well. The typical beach system is comprised of all the following parts (see Figure 2) [2]:

Backshore: The dry beach, lying adjacent to and below dunelands (or bluffs) that is washed by waves only during storms and exceptionally high tides; it is made up of berms, which are ridges 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 is submerged at highest tides, sometimes 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.

ECOLOGICAL FEATURES

Ecologically, the beach is a unique environment occupied by animals that have adapted to the constant motion of the sand. Many

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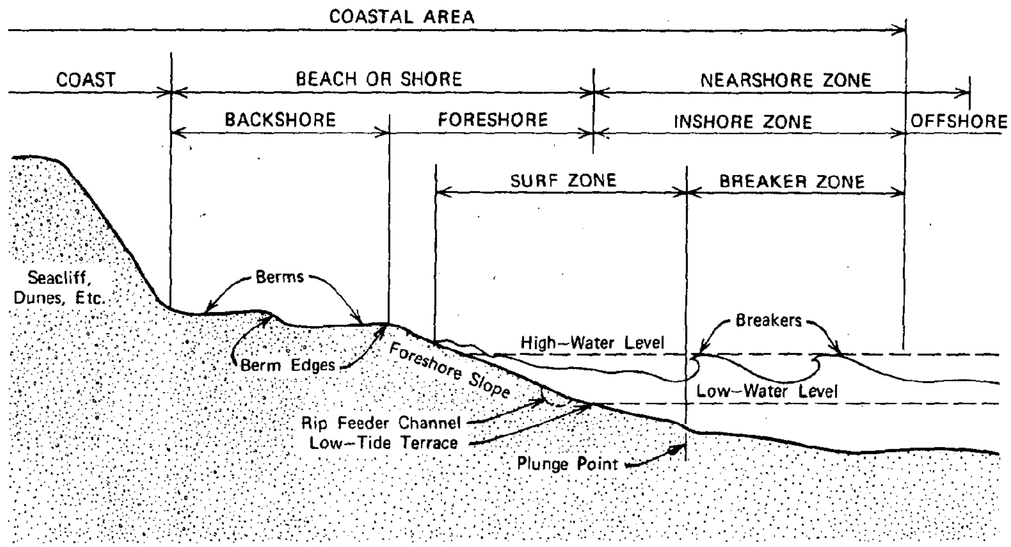

Figure 2. The anatomy of a typical beachfront [2]

important birds, reptiles, and other animals use the berm and open beach for nesting and breeding, as well as for feeding and resting. For example, sea turtles (including endangered species such 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. [Photo]

Beaches provide unique habitat for burrowing species such as mole crabs, coquina clams, razor clams, and others. There may also be a complex community of crustacean organisms to 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 fishes 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, 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 function 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--as well as in the duneland area behind the beach. When storm waves carve away a beach, they are taking sand

PHOTOGRAPH

Showing terns and other seabirds with eggs on upper beach area out of storage. In the optimum natural state, however, there is enough sand storage capacity in the 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. [Photo]

A beach disturbed by improper bulkheads and groins may have only a small remaining area available to store sand to protect the shore during storms. If sand is shunted to sea because of groins or the shore is bulkheaded, 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, the beach cuts back into 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.

PHOTOGRAPH

(Two panels) showing winter and summer beaches

DEVELOPMENT POLICIES

The general goal for beach management is 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 (Figure 3), structures to protect beaches and inlets should be carefully chosen so as to avoid a general loss of beach.

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 (Table 1). As the sea level rises, the shoreline is forced inland because there is little to anchor it permanently in place.

This section is aimed at the community seeking to preserve the natural attributes of its remaining beaches, while reasonably accommodating the alterations necessary for protective engineering, whether for beachfront homesites or inlet channels for boats. Accomplishing this requires a careful and comprehensive examination of goals and development objectives that affect the whole beach system and of the availability of technical expertise in beach processes and beachfront engineering. Local physical management objectives for beaches will depend on the extent of present beach protection structures and the degree of adjacent development. Community actions to meet these needs are discussed in Development Policies 24 through 28:

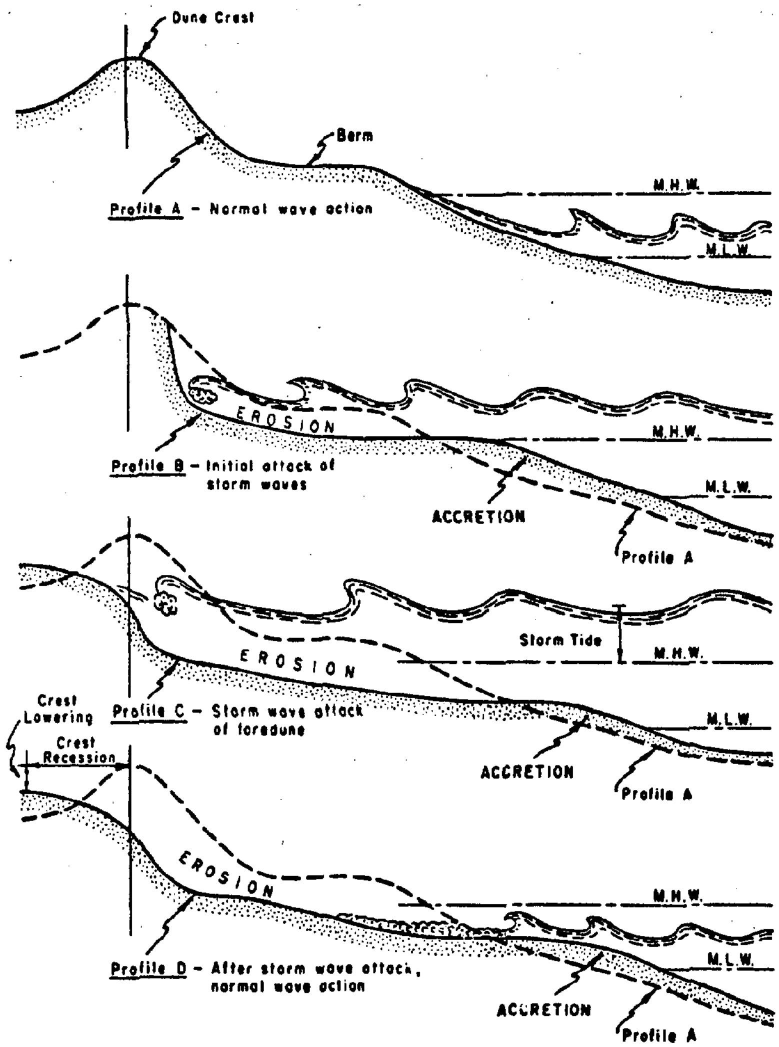

Figure 3. Schematic diagram of storm wave attack on beach and dune [3]. As the dune is attacked by storm waves, eroded material is carried out and deposited offshore where it alters the beach's underwater configuration. Accumulating sand decreases the offshore beach slope (makes it more nearly horizontal), thereby presenting a broader bottom surface to storm wave action. This surface absorbs or dissipates through friction an increasingly large amount of destructive wave energy which would otherwise be focused on the shoreline behind the barrier [4].

Table 1. Apparent trends in sea level for the United States. [Modified from 5]

Northeast Coast	Change in Sea Level (cm/decade)	Change in Sea Level (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)	Change in Sea Level (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)	Change in Sea Level (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

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 prohibiting structures that adversely affect littoral sand transport.

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

28. Beach System Restoration: Encourage effective restoration of seriously eroded beaches.

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 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. [Photo]

The serious consequences of removal of sand from the beach *per se* is understood in many states and communities, but the effects of

PHOTOGRAPH

Showing beach loss following excavation of sand.

dredging sand immediately seaward of the beach is not. 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. This kind of erosion may occur in some instances even if the mining takes place in depths of 30 to 50 feet.

For these reasons, large-scale excavation of sand should not be permitted from any part of the beach system, whether above or below water. Implementing a restriction on sand excavation is quite feasible as part of a comprehensive beach-protection program.

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. Buildings should be placed well back of the future beach line. Continued severe beach recession is certain and predictable along much of the U.S. coast (Figure 4). It is unwise to allow development of property that will certainly be lost to the sea, especially when the security of the structures built so often creates demands for protective works, which imperil the whole beach. The solution is to locate structures behind a

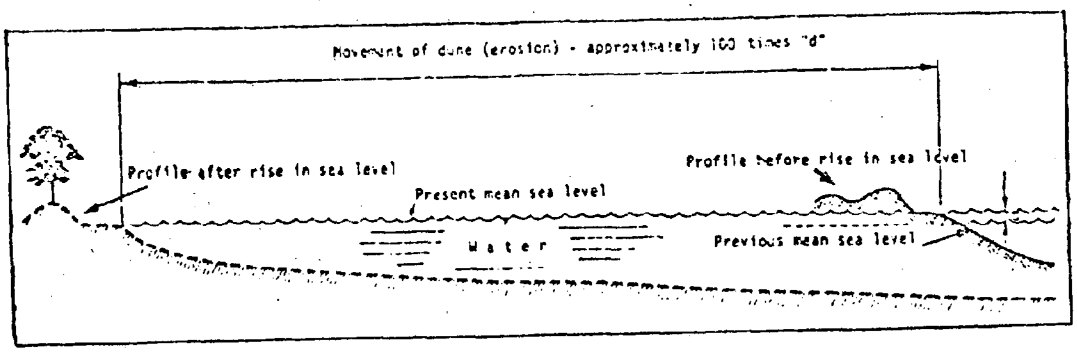

Figure 4. Recession of beachfront in response to a relative rise in sea level for a beach with a slope of 1 percent (Bogue Banks, North Carolina). The beach recedes a distance of 100 times the increase in sea level. For example, if relative sea level rose one-half foot the beachfront would recede 50 feet. [6]

setback line that accommodates the predicted long-term (50 to 70 years) recession rate of the ocean beach (see Dunelands section for details).

Recommended Policy 26: Beach Protection Structures

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

When sandy shores are occupied, roads built, and investment capital committed, it may seem desirable to retard the natural recession of the shore with seawalls and groins (linear rock or concrete structures built perpendicular to the beach). If improperly designed, however, these structures may be short-lived and may create or intensify long-term problems [7]. By providing a false sense of security, they may set the stage for a larger-scale disaster than would occur without them. [Photo]

Groins, seawalls, and other approaches to shore protection sometimes have complex and unanticipated secondary effects. A row of parallel groins may tend to 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 [8].

Thus, when improperly designed structures are used to stabilize the beach, the reserve of sand may be reduced to a level no longer

PHOTOGRAPH

Showing property losses exacerbated by structures which provided a false sense of security.

capable of replenishing losses caused by severe storms. In such cases, storm waves may remove enough beach to erode under and around the structures, allowing the beach line to move inland as the berm regains its equilibrium slope (Figure 5). 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. The solution to these problems is to discourage the construction of all but the most essential shore protection structures in favor of setbacks and other nonstructural remedies.

There are fewer examples of structures improving beach conditions than of those contributing to destabilization of beaches. [Photo] As mentioned agove, Miami's beach has been all but eliminated by 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 future and losing battle against the sea with bulldozers attempting to restore the backshore by using foreshore sand after each winter storm. [Photo]

Although it might be simplest to let nature take its course, extensive areas of the coast are already occupied and must somehow be maintained safely until setbacks and other protection land-use plans can be implemented. [Photo] The recommended approach is beach replenishment, in which sand is pumped onto the beach from nearby inlet channel dredging or from far enough offshore so that the beach

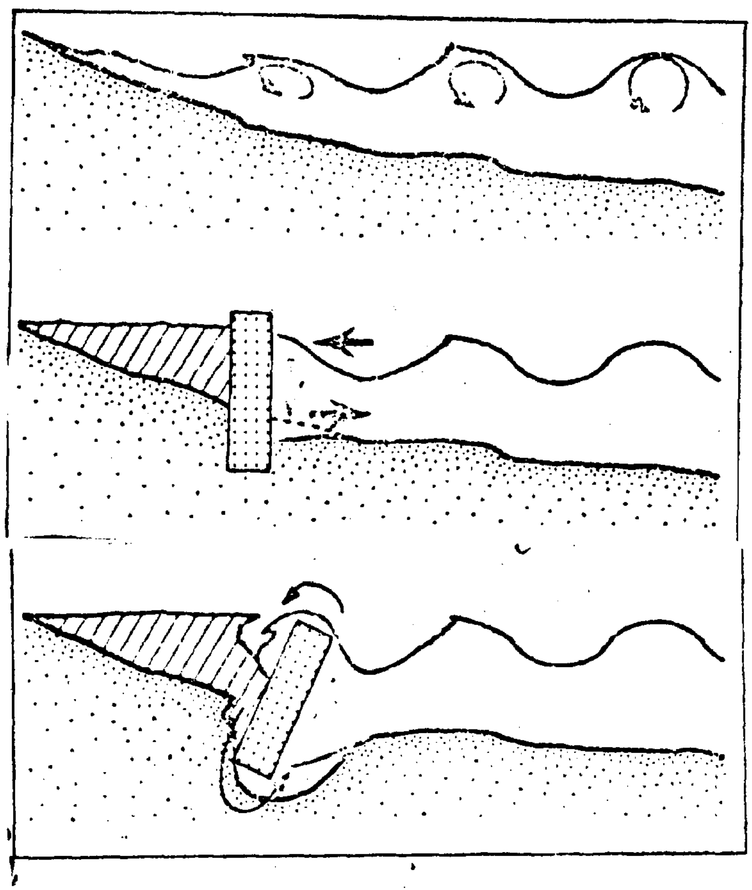

Figure 5. A naturally sloping beach dissipates wave energy, but a seawall or building foundation wall reflects the energy almost completely, creating a scouring action near the toe of the wall and causing the undermining and eventual collapse of the structure [8].

PHOTOGRAPH

(Aerial) Showing the south end of Gasparilla--with a good jetty and some bad structures

PHOTOGRAPH

Ocean City beachfront (April 26, 1978)

PHOTOGRAPH

Showing a protected beachfront that is connected to development is not destabilized. Often groins will be required to hold the sand pumped on the beach. Sand to replenish the beach should not be dredged from estuaries because of the ecological disruption that typically results. Such work should be commenced only after thorough study of the problems and preparation of a comprehensive beach plan that uses structural techniques (groins, seawalls) only when non-structural solutions (setbacks, excavation restrictions) are exhausted.

<u>Recommended Policy 27: Inlet Alterations</u>

<u>Design inlet stabilization projects to protect downstream beaches and minimize estuarine flooding</u>.

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 artificially deepened by dredging, the sand moving along the coast may subsequently be deposited in the dredged channel. It is clear that both inlet deepening and inlet stabilization projects affect the sand supply moving along the beach and that either can lead to a major imbalance of sand along the beach system (Figure 6).

Jetties are structures that control sand movement at inlets, stabilize the location of the channel, and shield vessels from waves. A possible result of a deepened inlet is eroded, narrower beaches on the downdrift side of the jetty because the sand that normally would pass the inlet is detained unless there is an artificial bypass system [3]. [Photo] Some of this sand is impounded at the updrift

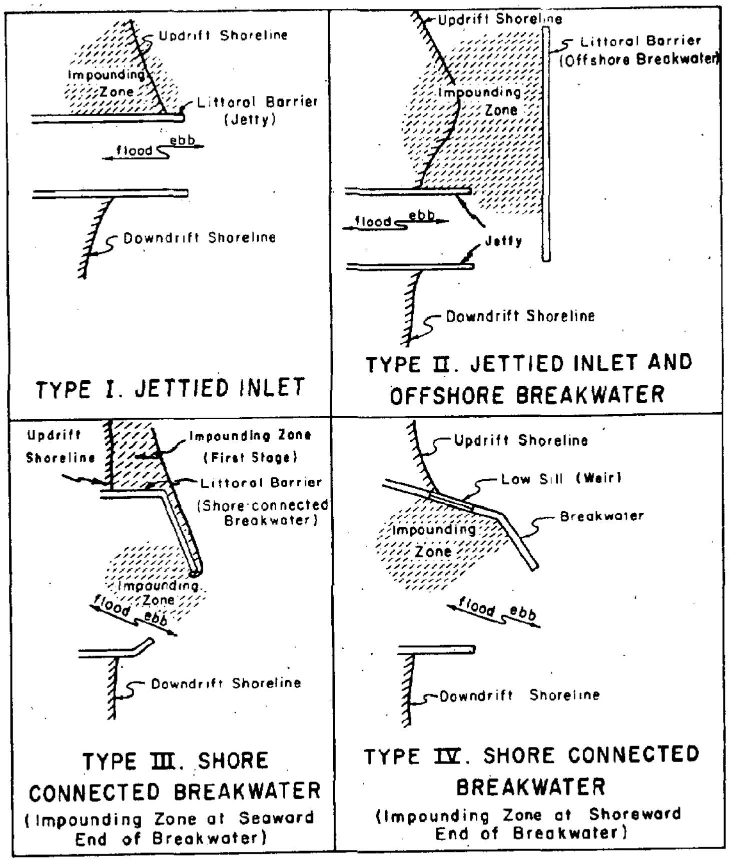

Figure 6. Types of littoral barriers where sand transfer (bypass) systems have been employed [7]. The term "net littoral drift" refers to the difference between the volume of sand moving in one direction along a beach and that moving in the opposite direction (caused by shifts in the direction of attack of the waves). On the Santa Barbara coast, net littoral drift is about 300,000 cubic yards a year. Where the moving sand must cross an inlet, the total amount of sand in motion in both directions is important. Figures for Corson Inlet, an unimproved inlet on the New Jersey coast, are:

Southward-moving sand	600,000 cu. yd/year
Northward-moving sand	450,000 cu. yd/year
Total sand moving	1,050,000 cu. yd/year
Net sand moving south	150,000 cu. yd/year

The total sand moving across the inlet is 1,050,000 cubic yards per year, which represents the amount of sand that could be lost to the beach at that point if dredged and removed--instead of bypassed. Such a loss could spell disaster for the beaches both north and south of the inlet [9].

PHOTOGRAPH

Showing a working sand bypass system

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 dimensions of inlets, which control the flow in and out of bays, are of critical importance. For example, narrowing the inlet may reduce the extent of hurricane-surge penetration into the bay, but it may also impede the flow of storm waters out of the bay, thereby increasing floodwater elevations in bayfront communities.

A partial solution to the sand transfer problem is to provide artificial sand "bypass systems" when inlets are dredged and jetties installed. A solution to the flow problem is to control inlet dimensions for optimum release of storm waters accumulating in bays and other estuarine basins. Such projects should be designed only by practitioners with special competence in coastal engineering. Since local jurisdictions usually do not have such competence available to them, they must rely on the U.S. Corps of Engineers, the appropriate state agency, or private consultants, for engineering evaluation.

Recommended Policy 28: Beach System Restoration

Encourage effective restoration of seriously eroded beaches.

Beach restoration is a present and critical need for many coastal communities. Sand replenishment, or artificial beach nourishment, is the main hope for restoration of most badly eroded beaches, with structures playing a secondary role. [Photo]

PHOTOGRAPH

Sand replenishment for beach restoration

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 if large quantities of sand are available. However, in beach nourishment the beach is not permanently restored. It is only temporarily replenished, 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 is known to 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 submerged bottoms. Therefore, an erosion problem in one part of the beach system should not be solved by bringing 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 [10], 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).

Another partial, but more permanent approach to restoration is to remove barriers such as bulkheads, groins, and other structures that deplete the sand supplies and replace those structures, if necessary, with better-designed protective works.

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. The cost of sand used for beach nourishment can range 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 (1975 prices) [4]. State and federal funds and expertise will normally be required. If federal money is used, the community with its own resources will have to provide parking lots and ways of access to the beach (in many cases at intervals of 1/2 mile).

IMPLEMENTING THE POLICIES FOR BEACHES

Five policies (Policies 24 through 28) have just been recommended for the management of beaches. This section of the manual is intended to assist communities in translating those policies into action.

Although beaches are physically different from banks and bluffs and dunelands, management needs are nearly identical. This is why each of the management needs that must be addressed to implement Policies 24 through 28 has already been discussed in the sections on Banks and Bluffs and Dunelands:

First, controlling excavation (Policy 24) discussed at page oo.

Second, establishing a setback from the recession line (Policy 25) discussed at pages oo and oo.

Third, establishing standards for protective structures (Policies 26 and 27) discussed at page oo.

Fourth, restoring beaches (Policy 28) discussed at page oo).

Following are several problems, and responses to them, that a community 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 areas adjoining beaches. Also, they often demand expensive protective works that prove ultimately futile because of relentless changes in sea levels. Local governments can respond to this problem in a number of ways. For example, a locality can decline to build protective works on public beaches. (The National Park Service is now doing this in some oceanfront areas.) Or, if a locality does build such works (or arrange for federal agencies to help build them), it can assure that the economic and environmental cost of the works are taken into account by officials and citizens.

Second, because beaches are publicly owned, major beach protection projects are likely to be proposed by state or federal agencies rather than by private property owners. Thus, coordination with other public 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 a localtiy. The federal environmental-impact assessment process (see page oo) provides opportunities for local governments to comment on proposed federal activities and on important regulatory actions by agencies such as the U.S. Army Corps of Engineers (see page oo). The "A-95" review process (see page oo) provides another forum for most local governments to make similar comments. State coastal-zone programs (see page oo) also provide important means of coordinating local and state/federal policies for this area of the coastal zone. 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 localities often find it beneficial to work closely with that official.

Third, communities 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 a 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.

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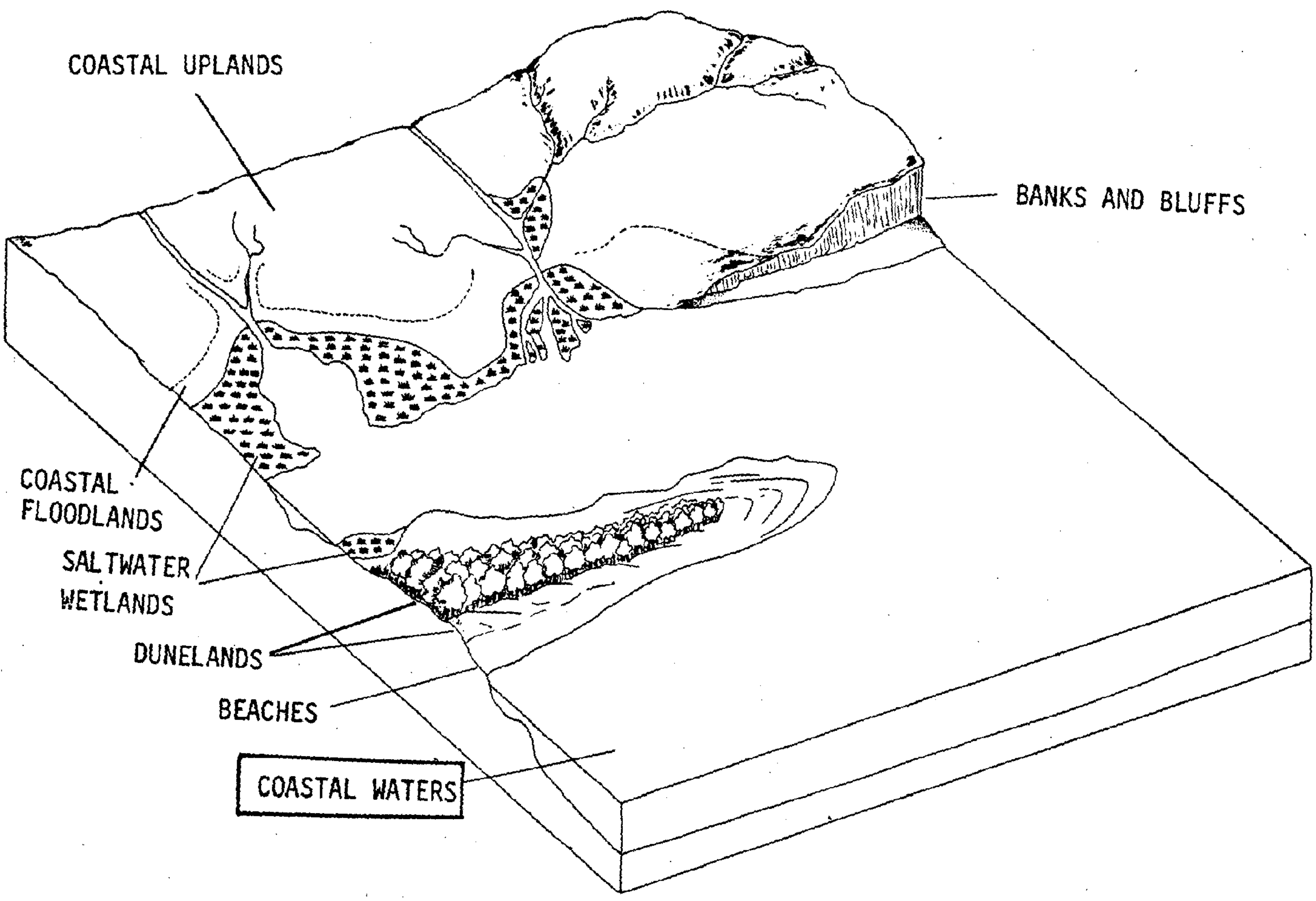
CONTENTS

COASTAL WATERS AND BASINS

PLACES OF CONCERN FOR
COASTAL FLOODPLAIN MANAGEMENT



COASTAL WATERS AND BASINS

The band of shallow water that fringes the U.S. coast is vulnerable to pollution and to physical alteration. With uncontrolled development or other careless use, man can deplete the resources of coastal waters and intensify the impact of storm waves on seaside communities.

The subjects of this section are coastal waters and the basins that contain the waters. Coastal waters are defined as "those waters adjacent to the shorelines which contain a measurable quantity or percentage of seawater" [1] and which extend seaward to the outer limit of U.S. jurisdiction. Basinfloors are the bottoms of the coastal water basins, extending from the depths up to the mean low-water mark.

The main focus of the section is on estuaries--protected sounds, bays, lagoons, and tidal rivers--rather than open seas because estuaries are richer in resources and more vulnerable to damage from pollution and other environmental disturbance generated by coastal towns and cities. The dense settlements so often located on estuarine shores produce high volumes of waste and cause extreme alteration of natural systems. They are also particularly vulnerable to storm damage because so many people and structures are exposed to danger.

Estuary has a variety of definitions, but as used here it is an enclosed coastal water body with a measurable quantity of salt in its waters and a free connection to the sea (measurable means greater than 0.5 parts per thousand salinity, the threshold of human taste). Enclosed is used here in a relative sense and includes all "protected" coastal water bodies, ranging from very open bays with wide mouths to nearly landlocked salt ponds with very narrow water passages to the sea. Where it is important to distinguish between estuarine basins and indented nearshore basins (shallow waters adjacent to ocean beaches), the following rule of thumb may be used: an enclosed coastal water body, or estuary, is one that has a shoreline length in excess of three times the width of its outlet to the sea.

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

ECOLOGICAL FEATURES

Life in coastal waters is supported by a food cycle, or food chain, which begins with plants such as mangroves, marsh grasses, floating microplants (collectively called phytoplankton), and algae of the basin floors. Much of the animal life is nourished by wetlands detritus--that is, small floating particles of plant matter (from decomposing mangrove leaves, for example). Detritus is consumed by a wide variety of small estuarine life forms which in turn serve as forage for birds and predatory 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, which in turn support the basic food chain that nourishes all life. Sunlight 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 normally more turbid than ocean waters, more laden with silt and more rich in suspended life [1].

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

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

PHOTOGRAPH

Show shellfish and fish kill off Atlantic coast, 1976, due to low BOD.

of pollutants, controls salinity, shifts sediments, mixes water, and performs other useful work (Figure 1). 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 [1].

Salinity, or salt content, of the water is a critical factor. 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 [1].

Whereas life in the deep ocean waters is sparsely scattered, except in a few areas of abundance, life on and over the continental shelf is generally more profuse, particularly in the nearshore sector adjacent to the coast. The richest of all coastal waters, the estuaries, serve special needs of the nearshore and oceanic species that require shallow protected habitat for breeding or sanctuary for their young (Figure 2).

The floors of coastal basins are an important aquatic resource. 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

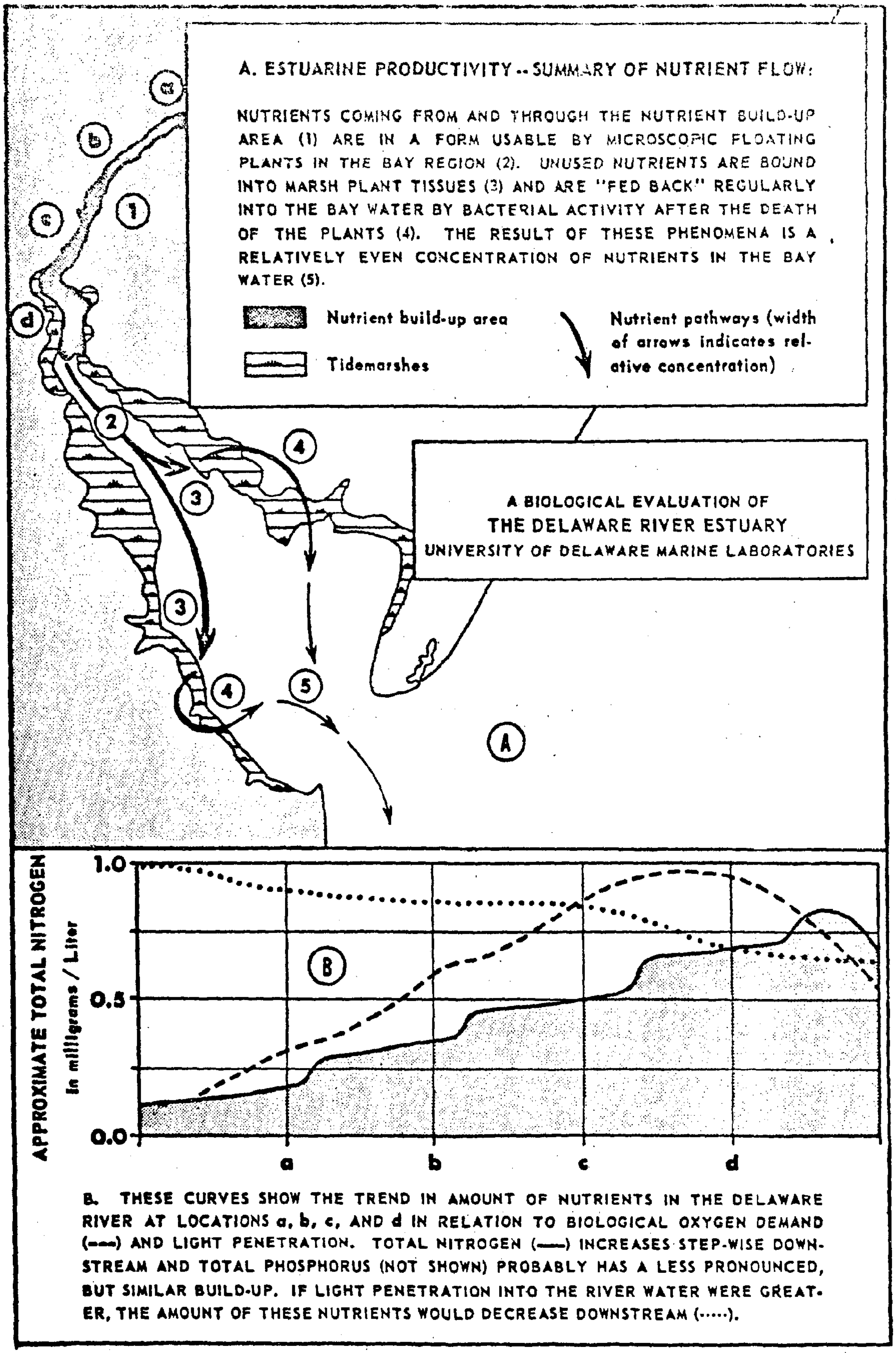


Figure 1. Subsystems in the Delaware Estuary system. The dark area is the oligohaline ecosystem (0.5 - 3.0 parts per thousand salinity). [2]

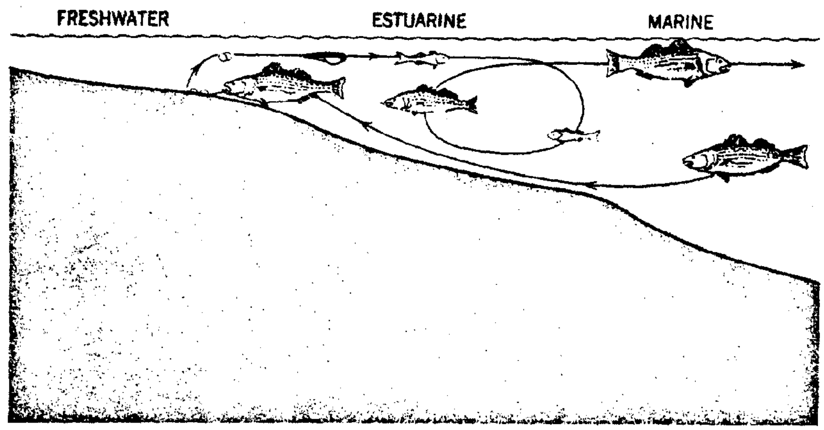


Figure 2. Life cycle of the striped bass shows extensive estuarine involvement [3].

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 [1]. This community of life of the basin floor is important, not only for its yield of fish and shellfish species but also because it is a major element in ecosystem stability and a source of forage. 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. The overall resource carrying capacity of the system is reduced when functioning grass beds, shellfish beds, coral reefs, and other vital areas of the basin floor are seriously altered or degraded. [Photo] 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

PHOTOGRAPH

Typical grass bed habitat (underwater)

Submerged marine grass beds are easily depleted, being especially vulnerable to pollution of all types, including heat discharged from power plants and the turbidity induced by them. Turbidity from silt and eutrophication screens out light and prevents growth of grass. Fine sediment (mud) often creates an unstable bottom condition in which the grasses cannot anchor their roots. Boat traffic over grass flats may compound the problem by stirring up the sediments or ripping up the plants and roots. [1]

exacerbated by the intensity of development in the coastal zone, which frequently augments potential hazards by reducing the coastal environment's natural resistance to floods--for example, by lowering dunes, eliminating wetlands, and accelerating runoff in the coastal basins [1]. 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.

The greatest threat of flooding is posed by hurricanes, which frequently cause surges of seawater eight feet or more above normal. An extreme example is hurricane Camille, which in 1969 virtually destroyed Pass Christian, Mississippi, with a record surge of 24 feet above normal sea 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 [4] (Figure 3).

In estuaries, inundation from rising water level, rather than wave action, is the principal threat. The effects of storm runoff can be reduced by appropriate controls and may, therefore, be especially important for management programs. The normally heavy rains that accompany hurricanes and sea storms and raise estuarine water levels also often produce heavy stormwater runoff from adjacent shorelands. These two sources added to the ocean surge level may elevate estuarine waters even higher than ocean waters and cause extreme flooding of shore communities as well as possible breaks through barrier islands from bay water rushing seaward when the hurricane passes. [Photo]

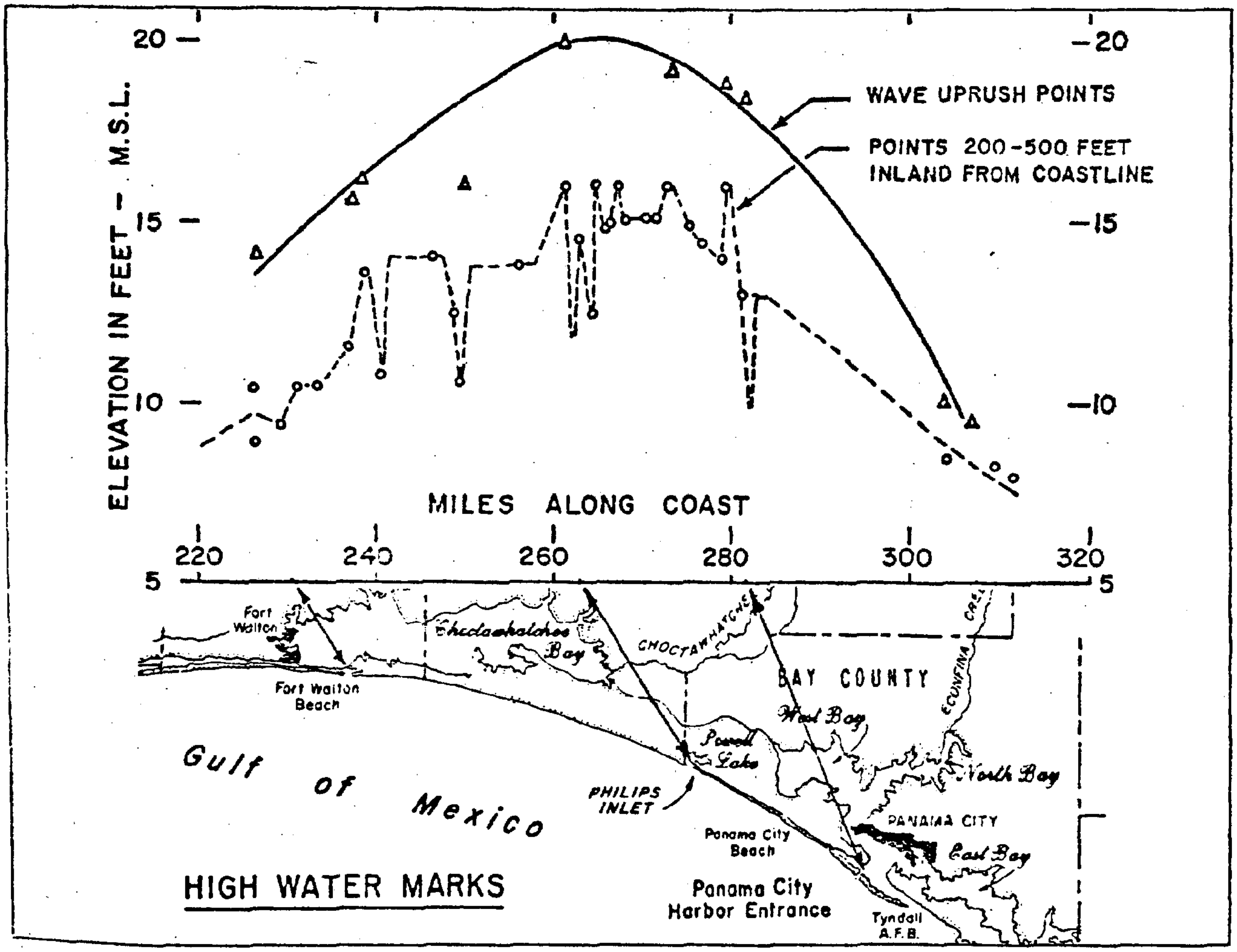


Figure 3. Hurricane Eloise high water marks, Panama City Beaches [5].

PHOTOGRAPH

Showing a barrier island broken through by baywater surge

Basin floors take the force out of surges from hurricanes and sea storms. As big waves approach the coast, they are slowed first by the shallowing bottom of the nearshore basin and then by the sandbar that usually lies just off the beach. Inlet channels, if they are narrow, slow the surging water entering estuarine basins and also hold back the outward flow of rainwater and storm runoff that fill the basin. The form of an inlet is a key factor in the coastal ecosystem and in protection against hazards because the flooding of estuarine shores diminishes according to the basin's capacity to receive and store both stormwater discharge from the shorelands and storm surges from the ocean.

Under normal conditions, estuarine basin floors change slowly, as suspended sediment from upland areas is transported and deposited in the basin. In shallow areas, both waves and currents may temporarily or permanently alter bottom configurations, as sediments are scoured off the basin floor in unprotected 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.

Activities that alter the configuration or composition of the basin floor create disturbances that often have far-reaching effects. The major adverse effects--changes in water circulation, shoreline profile, loss of productive benthic communities, and increased water pollution--stem mainly from dredging. Dredging is done 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.

DEVELOPMENT POLICIES

An important management goal for coastal waters is prevention of pollution. More serious than fish kills and other dramatic effects of pollution is the pervasive and continuous degradation evidenced by a mysterious disappearance of fish or shellfish or a general decline in the carrying capacity of the system. The sources of this pollution will likely be chemical pollutants or organic waste loads [1]. These contaminants cause a hostile environment which repulses fish, prevents shellfish from reproducing, or undermines the whole food chain. A second management goal for coastal waters is to maintain the natural characteristics of circulation, tidal flushing, and water quality to achieve maximum resistance to hazards and optimum carrying capacity of the ecosystem. A third goal is to maintain the natural pattern of land drainage into coastal waters as intact as possible (see Floodlands Section).

Any alteration that reduces water movement in an estuary with existing poor circulation and rate of flushing has a high potential for serious adverse effects. 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.
[Photo]

PHOTOGRAPH

Showing soil conservation in the coastal uplands.

Adverse effects on basin floors can be avoided for the most part through careful planning and attention to the natural processes at work in coastal ecosystems and to the probable impacts of dredging activities. It is important to search for alternative solutions that eliminate the need for channels. Feasibility considerations must recognize the need for periodic maintenance dredging after completion of the initial work of a channel project. Those 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. Reducing the side effects--mitigation--starts with appropriate choices of location and design of the work, including: suitable alignment of the channel, minimum dimensions, judicious choice of methods to be used on 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.

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 people in adjacent communities, local governments may wish to influence decisions on projects that affect these environments.

Policies 29 to 36 emphasize estuaries and, to a lesser extent, the nearshore waters of the open coast.

29. Disposal of Effluents: Require the highest levels of waste treatment for industrial and municipal effluents released into coastal waters.

30. Siting of Heavy Industry: Industrial facilities with a high potential for disturbance of coastal ecosystems should not be located on estuarine shores.

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

33. Sites for Removal of Dredged Material: Select locations for removal and deposit of dredged material to avoid adverse effects on basin floors.

34. Dredging Performance: Require strict controls on the operation of dredges.

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.

Recommended Policy 29: Disposal of Effluents

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

Industrial sources of pollution are mainly "point sources," collected and discharged from pipes or canals. Among waste products frequently discharged into coastal waters are some directly toxic to marine organisms. Toxic materials may have a short catastrophic impact [Photo] or a more subtle chronic interference with growth and reproduction processes. For many species, the lower limits of water quality, below which mobile animals either vacate an area or survive in reduced health and abundance, are known. Migratory fish are primarily dependent on chemotaxis and therefore are particularly affected by chemical contamination of water. Typically, they abandon coastal areas with "bad" water [1].

The salts of heavy metals 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 substances within their cell structure, the presence of metals from industrial-waste discharge, even in small concentrations, can have deleterious effects [6].

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 large cooling-water systems is the entrainment of fish and shellfish larvae into the intake withdrawal, followed by mass mortality in passage through the plant [7].

One of the major constituents of municipal sewage and many industrial wastes is decomposable organic material--primarily,

PHOTOGRAPH

Showing estuarine fish kill.

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 (Figure 4). The lower the concentration of dissolved oxygen, the lower the carrying capacity of the system [6]. 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.

In addition to the depletion of dissolved oxygen, municipal waste discharges may introduce pathogenic organisms, settleable materials, and inorganic nutrients [6]. Many municipal waste discharges contain significant amounts of industrial wastes, which may add to the variability and complexity of the wastes discharged.

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. Technology exists to provide thorough treatment for nearly every kind of municipal and industrial waste, and there is no technical reason to provide treatment insufficient to protect the environment from damage and permit optimum ecosystem function. Potential effluent dischargers unwilling to meet the highest standards should be required to locate away from the coast.

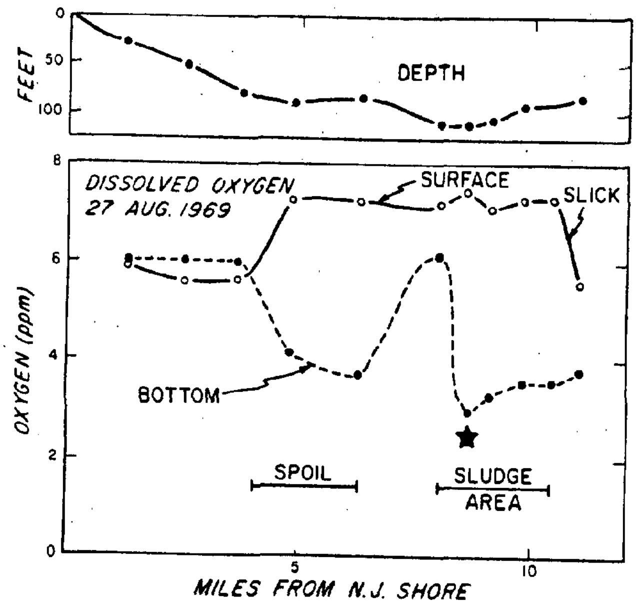


Figure 4. Many square miles of the ocean bottom off Sandy Hook, New Jersey, are so blighted with pollution from New York City sludge and harbor dredge spoil dumping that the dissolved oxygen level sinks below the absolute minimum threshhold for the support of marine life in deposition areas. [8]

Recommended Policy 30: Siting of Heavy Industry

Industrial facilities with a high potential for disturbance of coastal ecosystems should not be located on estuarine shores.

The carrying capacity of the coastal ecosystem is governed by water quality. The effect of any pollutant depends on where it goes, how strong it is at 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 are in turn governed by the relationship of tide and riverflow to estuarine shape and size [6]. In many bays, embayments, lagoons, and tidal rivers circulation is sluggish and pollutants may build up to damaging amounts even with efficient treatment of effluents. Industries with high waste output--e.g., power plants with open-cycle cooling, chemical plants with irremedial toxic discharges, and oil transfer terminals--should not be located on such water bodies. One ever-present threat to the estuarine ecosystem is the chance of a catastrophic oil spill or the release of other hazardous materials. [Photo] 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.

In some coastal areas that have undergone intensive development, only a few locations ideally suited for industrial use in relation

PHOTOGRAPH

Showing oil spill effects.

to waste discharge still remain. These prime locations can be identified, inventoried, and reserved as important industrial resources. Many such sites in growing metropolitan areas, such as the San Francisco Bay region, have been and continue to be taken over by housing and commercial establishments, which are not really dependent on waterfronts. To ensure that prime industrial shorelands with the lowest pollution potential are available when needed for industrial use, special land-use controls may have to be applied, restricting the development of these areas to waterfront-dependent industry. [Photo]

Recommended Policy 31: Diffuse Sources of Pollution

Require the highest standards for control of stormwater runoff and other diffuse sources of pollution.

Sources of diffuse (or non-point) pollution that principally affect coastal areas are septic tanks, dumps, landfills, concentrations of boats, and, particularly, stormwater runoff. These sources, working either separately or together, may cause serious eutrophication or toxicity where the pollutants concentrate in confined estuarine water bodies. It is clear that dumps, sanitary landfills, septic tanks, and similar sources should be located back from watercourses, and, to the extent possible, out of floodplains, to prevent leaching of pollutants into coastal waters. Also, standards to prevent pollution from boat and marine wastes should be enforced.

Regarding land runoff, the effects on coastal waters, expecially estuaries, of poorly designed urban stormwater systems may be quite

PHOTOGRAPH

Showing planned industrial development along waterfront.

adverse. When portions of the coastal watershed system are altered or short-circuited by uncontrolled stormwater drainage, the natural flow pattern is disrupted and freshwater flow into the estuaries occurs in surges. The resulting surges overburden estuaries with fresh water, at the same time depriving land areas of water and increasing flooding hazards in downstream coastal water basins. Thoughtful control of runoff, therefore, should be practiced in coastal communities.

In extensively developed areas, large-scale stormwater sewer systems often 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 augments the ocean storm surge in estuaries, the additional elevation of water may cause worsened flooding.

The flow in storm sewers may be stopped or reversed by storm surges from the ocean and the typical torrential rains that accompany hurricanes or heavy winter storms. Consequently, with runoff obstructed, low-lying areas may flood even higher, damaging shops, homes, and other structures that might otherwise be above the peak surge height of the storm or hurricane.

For protection of coastal waters, the best stormwater 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 infiltration for natural purification. The ideal would be to preserve and utilize existing natural drainageways--creeks, sloughs, swales, and so forth. For management, the appropriate goal is the following: the system of land runoff discharge in coastal watersheds should be retained in a form as near to the natural pattern as possible.

Recommended Policy 32: Structures in Coastal Waters

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

Structures that interfere with water circulation in the estuary may cause severe problems. The structures that may particularly interfere with water flow include piers, docks, wharves, bridge abutments, and mounds of dredge spoil. Reducing the capacity of the estuary to contain runoff waters during storms by filling around its edges may also be potentially dangerous. Restricting flow may block the rapid outflow of storm waters accumulating in estuaries, thus increasing flood risk. Solid-fill piers, docks, causeways, and other structures may adversely alter tidal circulation by restricting flow to narrow channels, thus creating eddies and turbulent backwaters, which increase localized sedimentation. On the other hand, elevated, pile-supported structures allow freer flow of tidal currents. [Photo]

Bulkheading of shorelines to extend the land reduces the water surface and may increase potential flooding hazards. Surges of storm water flowing rapidly from the shorelands before and during the "landfall" of the hurricane may cause water to rise higher in an affected bay than in the ocean outside. If the bay surface is shrunk

PHOTOGRAPH

Showing a typical pile-supported structure.

by bulkheading, there will be less capacity to hold runoff, thereby increasing the potential inundation of floodlands [1].

It has become increasingly evident in recent years that prevention of flood losses may often be better accomplished through "nonstructural" floodplain management than through construction of flood-control structures. Because many homes already in coastal areas are subject to flood damage, areawide engineering solutions may still be proposed, such as sealing off whole bay systems or building artificial barrier-dune structures. Such structural solutions are not enthusiastically supported nowadays because of their expense, their potential for ecological damage through blocking circulation, and the false sense of security they afford, which encourages the occupancy of hazardous shore areas. In developing coasts it is a better solution to reserve areas that are flooded frequently 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 of Dredge Material

Select locations for removal and deposit of dredged material to avoid adverse effects on basin floors.

When dredging 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 other productive basin floor habitats. [Photo] Adequate protection often requires a surrounding buffer strip of several hundred (or thousand, in some cases) feet, from which

PHOTOGRAPH

Showing coral reef before and after damage

Suspended sediments, which reduce light penetration, inhibit coral growth. Sediment settling on corals may kill them within a few days if the blanket is thick enough. The planktonic larvae of corals and many other reef invertebrates cannot settle and colonize soft shifting sediments. Dredging and coastal land filling associated with harbors, marinas, ship channels, etc., and sand removal for construction and beach replenishment have injured or destroyed hundreds of reef communities. Sewage is probably the second worst form of pollution stress on reef communities (through accelerated effects of eutrophication and oxygen in tropic ecosystems and overgrowth of algae, which can smother corals). Another stress due to bad land management--accelerated runoff of fresh water--has sometimes lowered coastal salinities to the point where shallow reef communities have been completely killed within a few hours. Thermal effluent from power plants has killed corals and associated organisms in Florida, Hawaii, the Virgin Islands, Guam and elsewhere.[9]

dredging should be excluded to prevent damaging fallout of sediments or other pollutants. Therefore, an important part of planning should include identifying all vital habitat areas so that all interests will be advised of locations and required safeguards.

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--entirely outside of the nearshore zone is preferable. In most cases, sand should not be removed from estuaries because the potential for ecologic disruption is too high and because the grain size is often too small to withstand ocean currents and waves, which is a requirement of beach fill. This will prevent destabilization of the beach by removal of sand which upsets the equilibrium existing between the beach and nearshore sand reserves (Figure 10).

The deposit of spoil on the basin floor may cause serious adverse ecological effects if inadequately controlled. Spoil, the common term for the sediments and other material excavated by dredges, is mostly a byproduct of dredging in navigation channels. Its disposal often creates extremely difficult problems economically and environmentally. Clearly, extensive damage to fish and wildlife resources occurs when dredge spoil is deposited on vital bottom habitats such as grass beds or shellfish beds. In addition, large-scale spoil banks or landfill deposits in water basins can act as a dam, restricting water flow and tidal exchange. This is especially damaging if one portion of an estuary is isolated from another by long, uninterrupted spoil banks

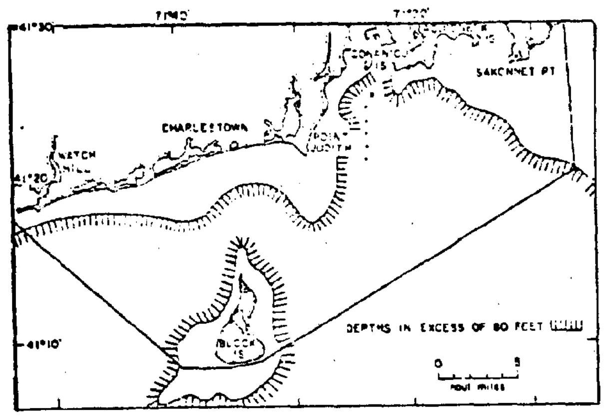


Figure 10. A chart showing an area of Rhode Island coast where sand mining is not recommended in depths less than 80 feet (the area shoreward of the hatched line). [10]

whereby circulation is blocked, stagnation sets in, and large portions of estuarine areas are degraded, sometimes eliminated, as productive units of a coastal ecosystem [11].

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--direct disposal of dredge spoil onto the bottom may be acceptable, provided that the spoils do not contain toxic pollutants, are not deposited in ridges that significantly impede water flow, and do not cover vital habitat areas or productive benthic habitats. Otherwise, spoil should be 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, to last for the life of the project.

Recommended Policy 34: Dredging Performance

Require strict controls on the operation of dredges.

Uncontrolled removal of sediment during dredging may disperse quantities of polluting silt and debris throughout the water. Many kinds of pollutants, including heavy metals and pesticides, adsorbed onto the sediments, may be resuspended during dredging, thus increasing the probability that plants and animals will be exposed to them. The silt suspension may also increase nutrient release, leading to algae blooms. Deposition of sediment--either silt fallout or spoil disposal--may also have major adverse effects on estuarine water basins. It can change the configuration of the basin and severely degrade the carrying capacity of large areas of estuarine floors. Furthermore, with loose materials on the bottom, continuing resuspension by tide and currents causes increased turbidity.

Depressions or "deep holes" dredged in the bottom may affect the mixing and flushing of estuarine waters, eventually causing changes in water temperature, salinity, dissolved oxygen, sediment accumulations, and carrying capacity. 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 [12].

The mode of operation of dredges should be controlled to reduce the spillover of any foul dredged materials into biologically productive areas (Figure 11). To contain turbid water near the dredge site, preventative "silt curtains" or "diapers" may be utilized. While it makes sense to require the use of such devices, one cannot depend upon them as a panacea because they only work well in still waters (1 knot current or less) [1] (Figure 12).

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

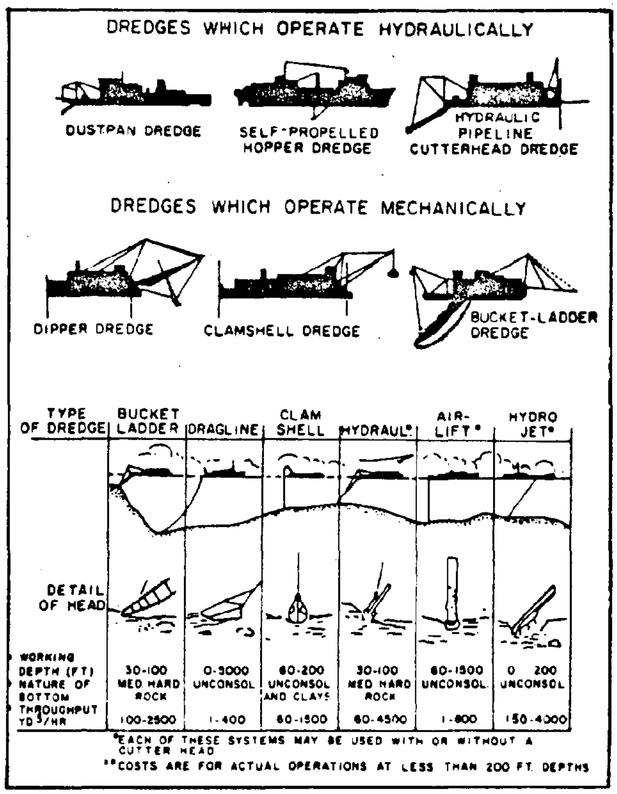


Figure 11. Basic dredge types and methods of marine ore exploitation. [13]

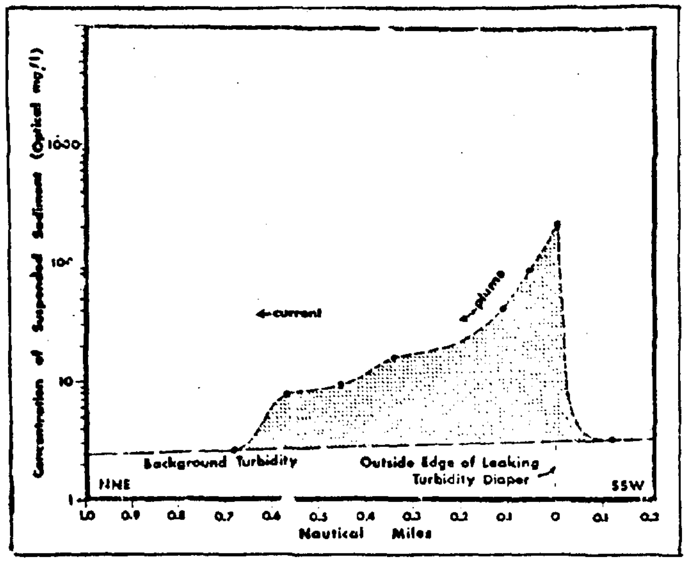


Figure 12. Concentration of suspended sediment in the plume versus distance from the dredge showing a turbidity plume extending 0.7 nautical miles past a silt curtain or "diaper". [14]

Recommended Policy 35: Channel Location and Design

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

A number of activities in estuarine basins have the potential to disturb the natural pattern of water circulation significantly by altering the basin floor. These activities include: changing flow through inlets and passes by 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. Interruption of water circulation is one of the most serious of the various effects from alteration of basin floors. Major deepening of harbor inlets and channels across bays and up tidal rivers can significantly alter water-circulation patterns, causing complex ecological effects throughout the basin and facilitating the flow of storm surge waters in and out of the estuary.

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 4 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, it is not unusual to add to this depth an additional foot or so to accommodate siltation or slumping and to reduce the frequency of maintenance dredging.

One of the most obvious 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. [Photo] To a large extent, this can be avoided by limiting dredging to existing natural estuarine channels. Therefore, an important part of planning includes the identification of all vital habitat areas.

Projects that would cause accelerated shore erosion should be avoided or conditioned in such a way as to eliminate the erosion-inducing effects. For example, a major requirement is to ensure that dredging is avoided close to the shore in shallow-water areas where it may cause severe recession of the shoreline (Figure 13). 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 of natural channels to the extent possible, and (2) careful choice of 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

PHOTOGRAPH

Showing oyster bed underwater

OYSTER VULNERABILITY

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, 1/3 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 attach themselves for the rest of their lives. A deposit of 1/20 inch of silt on shell or rocks from dredging is enough to make attachment impossible for young oysters. 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: in 1880, 72 million pounds of oysters were harvested from Chesapeake Bay; by 1920 the yield had dropped to 31 million, and recently to around 8 million. This loss cannot be blamed entirely on siltation, of course. [1]

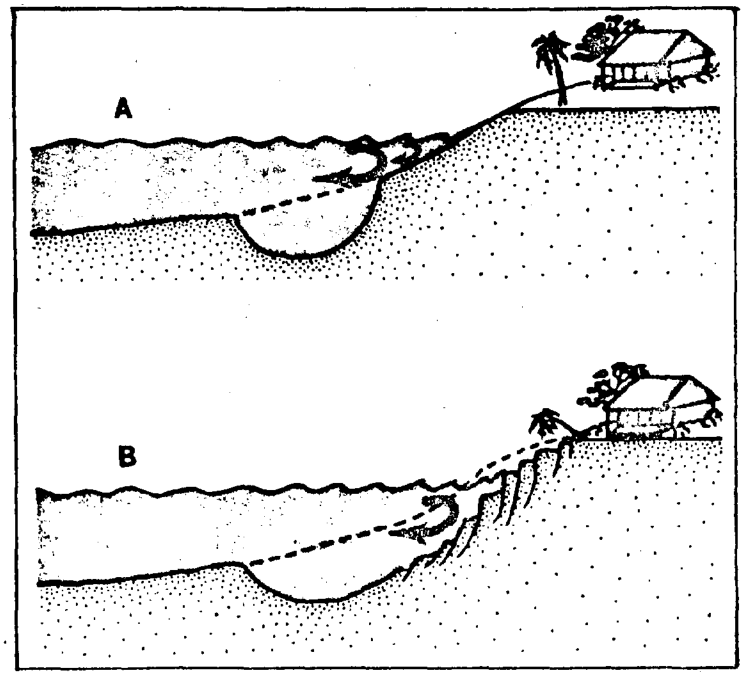


Figure 13. Channel cuts located too close to the shoreline (A) can cause slumping and erosion of the shore (B). [15]

operation, the exact cut depending on local geohydrological conditions [5].

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 accumulations of polluted silt. Much of the silt in certain estuaries is from poor farming practices which have caused soil erosion that filled stream beds and covered wetlands and grass beds. 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 otherwise correcting this situation which should be explored. 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 the community, may override that expense. Communities should inventory their coastal basins to identify those areas seriously degraded by sediment and should contact appropriate agencies for possible financial assistance for cleanup projects.

One example of the opportunistic implementation of a plan prepared in advance is the restoration of Tillamook Bay, Oregon. The background is explained in the following account [16]:

> Planning presumes the availability of a bank of hard data on biological stocks, historical uses, physical characteristics, etc.... Facts are not available ... in some areas ... but we can't wait. Make the necessary decisions on the basis of the best information--even if incomplete. Recognize that changes in the plan may be necessary when new data become available.
>
> 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.

The 1973 project was undertaken after massive flooding, which qualified the local area for federal disaster relief funds. By having the plan prepared ahead of time, the community was able to obtain and direct funds available on short notice to solve 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 heavily impacted by organic pollution until the reopening of Moriches Inlet enhanced circulation. Similarly, Escambia Bay, Florida, was heavily polluted and virtually destroyed ecologically until a railroad bridge that blocked circulation was rebuilt to allow water to flow under it more freely.

Millions of cubic yards of spoil are produced each year in dredging new channels and maintaining existing ones. Although some spoil is polluted or is useless muck, some is clean and suitable for use in creative engineering projects. The most valuable opportunities appear to lie in the creation of artificial islands to increase breeding habitats for birds and to expand wetlands along the island fringe. If properly located and designed, such islands may increase ecosystem carrying capacity.

An example of the creative disposal of dredge spoil is a "multiple use" application whereby clean spoil from channel dredging is deposited as estuarine breakwaters to protect marina sites. Properly designed, such islands 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.
5. Shape the island so as to facilitate water movements--for example, make it elliptical in shape and parallel to water flows.

Dredge spoil islands permanently alter the natural system and must be planned with the utmost care. If the mitigation proposal is an excuse for deliberate degradation of other natural marsh or bird habitats, it should be viewed most skeptically. It has not yet been proved that a man-made marsh ever attains the durability and productivity of a natural one.

IMPLEMENTING THE POLICIES FOR COASTAL WATERS AND BASINS

Eight policies (Policies 29 through 36) have just been recommended for the management of coastal waters and basins. This section of the manual is intended to assist communities in translating these policies into action.

Although local plans, regulations, and programs can be of some use in implementing the policies, greater opportunities for local action appear to lie in seeking assistance available under federal and state programs. Communities should be prepared to address three principal management issues:

First, controlling discharges of pollutants into coastal waters (Policies 29, 30, and 31).

Second, controlling alteration of basin floors (Policies 32 through 36).

Third, removing pollutants from basin floors (Policy 36).

1. Controlling discharges of pollutants

Although federal and state governments bear principal responsibilities for controlling point-source discharges of pollutants, localities can also contribute to pollution control--for example, by working to reduce diffuse ("non-point") sources of pollution, as already discussed in the sections on Floodlands and Saltwater Wetlands. A locality can influence the location of new pollutant sources, by adopting plans and regulations, and it can establish and operate systems for municipal wastewater collection and treatment.

If new treatment facilities are needed, the community is likely to 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 most other situations, however, the locality trying to control pollutant discharges 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, localities 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. oo), and Section 404, which controls discharges of dredged or fill material into wetlands and other waters (see p. oo). Other principal provisions are described in Part 2 of this manual, pp. oo - oo. Some special opportunities for local action may 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 to clean up spills and charge the polluter for the work.

Communities seeking to control pollutant discharges 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, such spills may also have a great impact on coastal fisheries.

Vessel Sewage. Setting standards for "on-board marine sanitation devices" (toilets on vessels) 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 local action, 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. A 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 Clean Water 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, localities 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 localities 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. oo). That discussion also describes ways that a local government can influence federal decisions.

Communities seeking to do so 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 similate natural forces and evaluate the long-term consequences of channel alterations. Typically, therefore, localities wishing to influence federal decisions need to seek technical advice. This may be available from state navigation and fisheries agencies as well as from the Corps and the U.S. National Marine Fisheries Service.

Second, a community will have to choose the means it intends to use 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. oo). 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. Localities 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 that source 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.

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 (page oo).

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PART II

CONTENTS

FEDERAL PROGRAMS

FEDERAL PROGRAMS

In Part I of this manual, we discussed ways in which federal programs could contribute to a balanced local approach to the physical management of the coastal floodplain. Here we take a second look at federal programs to provide two kinds of information that local governments need:

First, references to the laws, regulations, and interagency agreements that govern each important applicable federal program. These define program objectives and establish outer limits on agency discretion.

Second, organization of the administering federal agencies as it affects their accessibility to local governments. The best opportunity for local access to a particular federal program may lie through a state agency, for example, or through a federal regional office, or through the central office in Washington.

Many different laws and presidential directives are reflected in the federal programs discussed in Part I of this manual. In this Part, we will concentrate on nine:

Coastal Zone Management Act of 1972

National Flood Insurance Act of 1968

Flood Disaster Protection Act of 1973

Flood Control Acts

Clean Water Act

Fish and Wildlife Coordination Act

National Environmental Policy Act

Executive Order 11988, Floodplain Management

Executive Order 11990, Protection of Wetlands

These laws and directives serve differing purposes relating to the physical management of coastal floodplains, as indicated in Table 1. Each may contribute to implementing one or more of the Recommended Policies of Part I of this manual.

The following discussion is organized around the department or agency responsible for executing a program. The programs are scattered in eight federal agencies:

1. Council on Environmental Quality (Office of the President)
2. Federal Insurance Administration (Department of Housing and Urban Development)
3. National Marine Fisheries Service (Department of Commerce)
4. Office of Coastal Zone Management (Department of Commerce)
5. Soil Conservation Service (Department of Agriculture)
6. U.S. Army Corps of Engineers (Department of Defense)
7. U.S. Environmental Protection Agency
8. U.S. Fish and Wildlife Service (Department of the Interior)

Table 1. Stated Goals of Federal Authorities Bearing on Physical Management of the Coastal Floodplain

Coastal Water Act[1]

- -- Restore and maintain chemical, physical, and biological integrity of the nation's waters. (Sec. 101(a))
- -- Eliminate discharge of pollutants into navigable waters by 1985. (Sec. 101 (a)(1)
- -- Protect and propagate fish, shellfish, and wildlife and provide recreation in and on the water (wherever attainable) by July 1, 1983. (Sec. 101 (a)(2)
- -- Adequately control sources of pollutants in each state through areawide waste treatment management planning. (Sec. 101(a)(5))
- -- Prohibit discharge of toxic pollutants in toxic amounts. (Sec. 101(a)(3))

National Flood Insurance Act of 1968 and Federal Disaster Protection Act of 1973[2]

- -- Ensure availability of flood insurance for residents of flood-prone areas through the means of a federal subsidy.
- -- Achieve local land use and control measures designed to guide the rational use of the floodplain as a condition for the availability of federally subsidized flood insurance.
- -- Substitute insurance to eventually replace federal disaster relief for flood occurrences, so that property owners will contribute to their own protection and be more fully indemnified (without having to repay a federal disaster loan) when flood loss occurs.

Coastal Zone Management Act of 1972[3]

- -- Preserve, protect, develop, and where possible restore or enhance, the resources of the nation's coastal zone, including those coastal waters and the adjacent shorelands that are strongly influenced by each other, for this and succeeding generations. (Sec. 303(2))
- -- Encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and aesthetic values as well as needs for economic development. (Sec. 303(b))
- -- Encourage all federal agencies engaged in programs affecting the coastal zone to cooperate and participate with state and local governments and regional agencies in this effort. (Sec. 303(c))
- -- Encourage the participation of the public, of federal, state, and local governments and of regional agencies in the development of coastal zone management programs. (Sec. 303(d))

/Continued

Table 1 - Continued

Fish and Wildlife Coordination Act[4]

-- Provide that wildlife conservation receives equal consideration and is coordinated with other features of water-resource development programs through the effectual and harmonious planning development, maintenance, and coordination of wildlife conservation and rehabilitation. (Sec. 661)

Executive Order 11988, Floodplain Management[5]

-- Avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and avoid direct or indirect support of floodplain development whenever there is a practicable alternative (for federal activities).

Flood Acontrol Act [6]

-- Preserve and protect established and potential uses of the Nation's rivers; aid to the consideration of projects on a basis of comprehensive and coordinated development; and limit the authorization and construction of navigation works unless they substantively benefit navigation and can be operated consistently with appropriate and economic use of the rivers by others.

Executive Order 11990, Protection of Wetlands[7]

-- Avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and avoid direct or indirect support of new construction in wetlands whenever there is a practicable alternative (in federal programs).

Wetlands Policy: U.S. Environmental Protection Agency[8]

-- Preserve the wetland ecosystems and protect them from destruction through waste water or nonpoint source discharges by treatment or control, or the development and construction of waste water treatment facilities, or by other physical, chemical or biological means.

Preservation of the Nation's Wetlands: Department of Transportation[9]

-- Assure protection and preservation of wetlands to the fullest extent practicable during planning, construction, and operation of federal transportation facilities, and federally assisted state and local transportation projects.

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1. 33 U.S.C. 1151
2. 42 U.S.C. 4001-4128
3. 16 U.S.C. 1451-1464
4. 16 U.S.C. 661-666
5. Executive Order 11988
6. 33 U.S.C. 701
7. Executive Order 11990
8. 38 Fed. Reg. 84 (1973)
9. D.O.T. Order 5660.1

1. Council on Environmental Quality (Office of the President)

The President's Council on Environmental Quality (CEQ) was created by the National Environmental Policy Act of 1969. CEQ has a small staff located entirely in Washington. The agency advises the President on environmental policy, oversees the Environmental Impact Statement process, and plays a catalytic role in environmental policy formulation. Outside Washington, it is probably best known for its studies and other publications, including an annual report, Environmental Quality.

CEQ played a key role in drafting the two executive orders discussed in this manual. Executive Order 11988, "Floodplain Management" requires federal agencies to revise their procedures for considering the impact that their actions may have on potential hazards from flooding. Where a practicable alternative exists, agencies should avoid activity in the floodplain. The Water Resources Council now has the responsibility for coordinating the responses by different agencies. This order is also discussed in Part I at page oo.

Executive Order 11990, "Wetlands" is a second presidential policy applying to all federal agencies. It reinforces Section 404 of the federal Clean Water Act with specific policies for federal construction projects. Again, other agencies are responsible for implementation, principally the Water Resources Council. The Wetlands Executive Order is discussed further at pages oo and oo.

2. Federal Insurance Administration (Department of Housing and Urban Development.

The Federal Insurance Administration (FIA) is a division of the Department of Housing and Urban Development. Most of its professional staff is based in Washington, D.C. The FIA oversees several federal insurance programs. Most coastal communities will have corresponded with this agency as a result of the National Flood Insurance Program.

National Flood Insurance Program. The National Flood Insurance Program (NFIP), authorized by the National Flood Insurance Act of 1968 and the Disaster Protection Act of 1973 (as amended), is managed by FIA. The FIA management structure has 10 small regional staffs reporting directly to the Federal Insurance Administrator in Washington.

While the regional offices of the FIA will often be the source of correspondence with communities, questions about technical studies may well be referred to Washington. Reviews of local ordinances for community eligibility in the Program and monitoring of local compliance are the direct responsibility of staff in Washington. Insurance policy sales and claims reimbursement for flood insurance are also being increasingly brought under the control of FIA in Washington, although at present, they are contracted out to a private corporation, EDS Federal Systems, as fiscal agent for FIA.

The NFIP has four primary objectives:

-- to provide flood insurance at reasonable rates for potential property losses caused by flood, mudslides, or flood-related erosion

-- to promote wise floodplain management practices in areas prone to floods and mudslides

-- to reduce federal disaster-assistance costs

-- to avoid direct or indirect federal support of floodplain development when there is a practicable alternative.

It offers federally subsidized flood insurance to property owners in participating communities with identified flood, mudslide, or flood-related erosion hazards. Its basic regulations were issued October 26, 1976, and have been revised to take into account the shift to EDS Federal Systems for insurance sales and claims reimbursement (November 1977); and 1977 amendments to the Federal Disaster Protection Act of 1973 (January, 1978).

Under present law and regulations, communities must enter the program within one year after their flood-hazard areas are formally identified. Local homeowners are ineligible for federal flood insurance or disaster relief if their community misses this deadline. In communities that join the Program and continue to meet its guidelines, owners of property already developed when the community entered the program receive heavily subsidized insurance at less than 20 percent of commercial rates.

There are two levels of community participation in the NFIP: the Emergency Program phase and the Regular Program phase. Typically, a community enters the emergency phase before the Regular Program.

In the emergency phase, the community must review permit applications to determine whether proposed development sites will be reasonably safe from flooding, and then require that appropriate management measures be implemented. Federally assisted mortgage financing is unavailable unless the review procedure is followed. The FIA provides a map roughly outlining flood hazards, called the Flood Hazard Boundary Map (FHBM). A locality may also rely on other local state or federal data if it provides more accurate information. No more than half of the Program's total flood insurance coverage is available under the emergency phase.

After a community qualifies under the emergency phase, the FIA undertakes detailed elevation and hydrologic studies (at no cost to the community) to determine the level of the 100-year flood (the flood that has a 1 percent chance of being equalled or exceeded in any given year). After a review and appeal period, a Flood Insurance Rate Map (FIRM) is published. The map delineates a community's special flood hazard areas and classifies the mapped area into a series of flood hazard zones, with appropriate actuarial insurance rates. The NFIP is discussed in Part I at pages oo., oo, oo, and oo.

3. <u>The Office of Coastal Zone Management (National Oceanic and Atmospheric Administration, Department of Commerce.)</u>

The Office of Coastal Zone Management (OCZM) is small and is located in Washington, D.C. Its interests are limited to coastal and oceans policy and management. It works primarily with state governments. For a locality seeking access to its expertise or resources, the state office of coastal zone management will be the best initial point of contact.

OCZM is concerned with the following three programs relevant to this manual.

Coastal Zone Management Program. The Coastal Zone Management (CZM) program implements the Coastal Zone Management Act of 1972, as amended. Because of restrictions imposed by the Office of Management and Budget the program received funds for its first grants to states only in 1974.

States receive two types of grants from the Office of Coastal Zone Management (1) grants to develop a management program for the coastal zone; and (2) grants to implement the program. Federal regulations set conditions for these grants, defining the outlines of both the planning and implementation program, that is, the subjects to be addressed, and, in some cases, suggested means of implementation.

State grants are administered for five regions, each of which has a Regional Manager based in the Washington office of OCZM. The federal regulations are in three sections, "Coastal Zone Management Program Development Grants", "Coastal Zone Management Program Approval Regulations", and "Federal Consistency with Approved Coastal Management Programs," found in the Code of Federal Regulations, Title 15, Parts 923, 926, and 930.

Program development grants, called Section 305 grants, are intended to assist in:

-- identifying the boundaries of the coastal zone.

-- defining permissible uses for lands and waters that have a direct impact on the coastal waters.

-- inventorying and designating areas of particular concern (sometimes called "APCs").

-- identifying means by which the state plans to control land and water uses.

-- setting guidelines on priorities of use for APCs and other specific areas of the coastal zone.

-- identifying the state organization(s) intended to implement the program.

-- establishing a program for beach access and protection.

-- planning new and existing coastal energy facilities.

-- studying and possibly controlling shoreline erosion.

Public and local governmental participation are required as a part of the Section 305 program.

Implementation, or Section 306 grants, are given only after federal agency review of the proposed state management program and its approval by the Department of Commerce.

To secure approval, the state office of coastal zone management submits a program, with the state governor's approval, to OCZM. An Environmental Impact Statement drafted by OCZM is circulated for federal and public comment. Federal agencies are given an opportunity to comment on the state program, because after the program is approved by the Department of Commerce, many federal activities must be "consistent" with the state program and policies. After comments and responsive revisions, a final Environmental Impact Statement is prepared and the

Department of Commerce either approves or disapproves the proposed program and accompanying grants.

Some states, as a part of the Section 306 phase of the program, involve local governments and local planning procedures. For example, California relies on local coastal plans as an integral part of its state coastal-zone management program. These plans are prepared with assistance from the state office of coastal-zone management, and must be approved by the state coastal agency.

The goals of the Coastal Zone Management Act encourage consistency between federal agency actions and approved state management programs for the coastal zone. OCZM seeks this goal two ways. First, an approved state management program becomes an important reference document for federal agency planning. Certain actions require a certification of "consistency." Second, OCZM procedures allow a state to review certain proposed federal actions, for example, proposed Section 404 permits. When a difference arise, OCZM or the Secretary of Commerce resolves it.

Federally supervised plans for the exploration or development of the outer continental shelf (OCS), to the extent that they may affect the state coastal zone, must also be consistent with the state CZM program. The state may review the OCS plan and object to activities that are "inconsistent." However, the Secretary of Commerce may overrule the state if the activity is a condition of national security. The Coastal Zone Management Program is also discussed in Part I at pages oo, oo, oo, and oo.

Estuarine Sanctuary Program. The Estuarine Sanctuary Program is also authorized by the Coastal Zone Management Act of 1972. OCZM offers grants to coastal states to assist in acquiring estuarine sanctuaries to be used as natural field laboratories for coastal research. The program is intended to support the acquisition of representative examples of the important biological and physical characteristics that distinguish different natural features of the U.S. coastline. States that participate in the program agree to preserve and manage the sanctuary in the natural state.

Eighteen or more may eventually be selected as estuarine sanctuaries. Preliminary nominations have been completed. A community can check on the status of potential sanctuaries through the state office of coastal-zone management. (Grants for a sanctuary can be given even if the state Section 306 Coastal Zone Management Program implementation grant has not yet been approved.)

Another element of the Estuarine Sanctuary Program could provide grants to acquire beach accessways if the funds authorized for this purpose by the Coastal Zone Management Act are actually appropriated by Congress. As of fiscal 1978, this part of the program had made no grants.

The Estuarine Sanctuary Program is also mentioned in Part I at page oo.

Coastal Energy Impact Program (CEIP). Authorized by 1976 amendments to the Coastal Zone Management Act, the CEIP is a program of loan guarantees and grants to states and localities that need new community facilities as a consequence of coastal energy development, or that wish to improve or eliminate damages to environmental or recreational resources caused by coastal energy development.

The program has a ten-year life span, and Congress originally authorized $1.2 billion in aid. Actual appropriations have been considerably lower. Funds are allocated among coastal states by formulas that take into account both past and expected future coastal energy development. Though the formula is complex, once funds are allocated, procedures for grants to localities are relatively simple. They are outlined in both federal regulations and state procedures. The CEIP is also discussed in Part I at pages oo and oo.

4. National Marine Fisheries Service (Department of Commerce)

The National Marine Fisheries Services (NMFS) has responsibilities under the Fish and Wildlife Coordination Act to comment on proposed federal permits and activities and adjacent wetlands with special attention to consequences for fisheries. NMFS has five regional offices, in Massachusetts, Florida, California, Washington, and Alaska. Localities may find that NMFS personnel can informally explain technical aspects of different alternatives outlined in Environmental Impact Statements or other federal environmental review procedures.

5. Soil Conservation Service (Department of Agriculture)

The Soil Conservation Service (SCS) of the Department of Agriculture carries out a national soil and water conservation program directed at local problems. It assists in agricultural pollution control, environmental improvement, and rural community development. The resources of SCS are primarily devoted to the freshwater ecosystem and freshwater flooding problems, but its activities have an important influence on coastal floodplain management.

The SCS program provides assistance through locally organized and operated soil conservation districts, in coordination with state officials. There are about 2,950 conservation districts across the United States, serving as the primary point of contact for information on the SCS. In addition to providing assistance to individuals through the conservation district, the Service may:

-- cooperate in river-basin surveys and investigations

-- conduct investigations and surveys for proposed small watershed projects

-- cooperate in installing works and structures to reduce erosion, flooding, and sediment damage or to conserve water resources.

-- assist resource development and conservation, for historic, recreational, and agricultural resources

-- conduct Flood Insurance Rate Map studies under contract with the Federal Insurance Administration

Because of the variety of its capabilities, the Soil Conservation Service and its conservation districts may be a particularly valuable source of assistance, particularly to smaller communities.

One SCS program is likely to be particularly important to the management of coastal floodplains.

Rural Clean Waters Program. In 1977, amendments to the Clean Water Act authorized a new $600 million program to aid in implementing the "best management practices" provisions of Section 208 regional water quality plans (see page oo). The program is intended to rely on 5 to 10 year term agreements between rural land managers and conservation districts or other representatives of SCS. Funds will be available under these agreements to share in the cost of implementing such water-quality conservation practices as maintaining buffer strips and contour farming. The law calls for cost-sharing on a 50-50 basis, though the government will pay more than 50 percent of costs in some situations.

This program is just getting under way, based on an April 25, 1978, agreement between the EPA and the Department of Agriculture. EPA manages the basic Section 208 planning program that defines conservation practices to be implemented by the Rural Clean Waters program.

In general, the program will be available to a locality after EPA approval of those sections of the state "208" plan relating to agricultural pollution sources in a particular community. State and local soil conservation district, or other appropriate local agencies, will handle actual implementation of the contract program.

Localities and individuals should contact local soil conservation districts to determine the current status of the program.

The Rural Clean Waters program is also discussed at page oo.

6. 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 itself. For construction or development by others 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.; eleven U.S. Army Engineer Divisions, two or more Districts which serve as the field offices for 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 the Northeast 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.

-- to operate and maintain major water resources projects for navigable waters of the United States

-- to acquire, manage, and dispose of some types of federal land.

One program is directly relevant to local interests in floodplain management. Two other program areas are important to the policies recommended in Part I of this manual.

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. On a contract basis, the FPMS now also undertake studies on behalf of the Federal Insurance Administration. FPMS will provide additional planning assistance to communities participating in the NFIP if they request it. (Some coastal communities now in the regular phase of the NFIP qualified under Corps' FPMS studies rather than the Flood Insurance Rate Map used by the Federal Insurance Administration.)

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; and additional information is available from District Engineers' offices. The FPMS program is also discussed in Part I at page oo.

Flood Control Programs. The Corps builds structures to protect against hazards and restores 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 and not requiring specific congressional authorization are:

-- Aquatic Plant Control

-- (Small) Beach Erosion Control Projects

-- Flood Control, Coastal Protection Works, Rehabilitation

-- Emergency Coastal Protective Works

-- Protection of Essential Public Works

-- (Small) Flood Control Projects

-- Snagging and Clearing for Flood Control

-- (Small) Navigation Projects

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.

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. These programs are also discussed in Part I at pages oo, oo, and oo.

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 revision 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 between the 1899 and the 1972 laws lies in the activities covered by the permit. "404" permits set conditions for, or prohibit, discharge of dredged and fill material into water or wetlands. The 1899 law regulates various activities in 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 and the Corps standards required for issuance. Conditions may be attached to a permit.

Comments from particular federal agencies have special status in permit proceedings because of agreements between agencies. In particular, under the Fish and Wildlife Coordination Act, NEPA, and a special agreement between the Department of the Interior and the Secretary of the Army, the Fish and Wildlife Service (FWS) reviews all the Corps' permit applications and may recommend permit conditions to mitigate impacts on wildlife.

Traditionally, this process involves the exchange of written comments. Some districts are experimenting with preliminary permit review conferences to expedite processing. If an applicant fails to meet objections made during the comment period, normally 30 days, FWS may require that the application be considered by higher ranking personnel in the Corps and in the Department of the Interior in Washington, D.C. Approximately 25 permits per year are subject to this formal and time-consuming procedure. For the remainder, conditions satisfactory to both FWS and the Corps are established at the District or Division level.

This program is also discussed in Part I at pages oo, oo, oo, oo, and oo. It is also a significant program for the U.S. EPA (see page oo).

7. U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (U.S. EPA) groups numerous federal programs relating to health and the environment under five program offices: Air and Waste Management; Water and Hazardous Materials; Enforcement; Planning and Management; and Research and Development. It is largely decentralized, and Regional Administrators in the ten standard federal regions have substantial autonomy in the execution of program elements within their region. There may be significant variations in procedures from region to region, within the limits of EPA's laws and regulations. Although most EPA programs are important to environmental quality in coastal areas, we have concentrated in this manual on programs established under the Clean Water Act because of the coincidence of environmental and hazard protection considerations in water quality management.

A number of U.S. EPA water quality programs are mentioned or discussed in Part I of this manual.

National Pollutant Discharge Elimination System (NPDES) (the Section 402 program). Two aspects of the NPDES program are likely to have come to the attention of local governments in conjunction with operation of local sewage treatment facilities. First, the NPDES standards for municipal waste discharges; and second, pretreatment standards for certain types of industrial and commercial hook-ups to municipal sewage systems. But, localities may actually work with state officials on these matters, because state agencies may assume key roles in this program. They should check first with state or regional water quality agencies for further details on this EPA program; only general outlines are presented here.

Five categories of standards for pollutant discharges into the nation's waters lie at the heart of the NPDES permit program: (1) existing sources of municipal and industrial wastes; (2) new sources of industrial wastes; (3) pretreatment standards for some discharges into public treatment systems that then discharge into the nation's waters; (4) oil and hazardous pollutants; and (5) water quality related effluent limitations that serve as a backstop where the previous four basic standards fail to adequately address water quality problems.

These standards are applied to permit applicants in stages. In 1972, Congress set 1977 as the target date for implementation of "best available" technology. For municipalities this meant secondary sewage treatment. This is sometimes called phase I of the clean-up effort. July 1, 1983 was set as the final date for implementation of water quality standards, and the 1977-1983 period is sometimes called Phase II. Amendments in 1977 made minor adjustments to this schedule; in particular, municipalities that failed to meet 1977 deadlines for secondary treatment were allowed case-by-case time extensions and the U.S. EPA also can now waive secondary treatment requirements for certain deep water ocean discharges.

This program also depends on the designation of "water segments"--surface waters with common hydrological, physical, chemical and biological aspects--that are to be classified according to the impact of the effluent standards enforced by the NPDES permit. If a segment will not meet water quality standards, even though the effluent standards are met, it is called "water quality limited" and stricter controls apply to new sources of pollution requiring NPDES permits.

This is a complicated process, whose terms are set by the state and the U.S. EPA. The law sets specific treatment goals, for instance secondary treatment of municipal sewage. Communities should be aware that the process reaches well beyond the municipal sewage treatment works; that it may assist in setting pretreatment standards for new industrial hook-ups to municipal treatment works; and that it depends heavily on public involvement for effective enforcement. Standards applied to other sources of pollution are phrased in terms of "Best Practicable Technology Currently Available" (pre-1983), and "Best Available Technology Economically Achievable" (by 1983). Official regulations found in the Code of Federal Regulations, Title 40, Part 125.

Oil and Hazardous Substances (the Section 311 Program).

Section 311 of the Clean Water Act continues a program set up in 1970 to deal with oil spills, and extends it to other hazardous substances as well. This program complements the NPDES permit program. It covers non-permit situations, primarily transportation, and is designed to discourage risks taken by those who transport hazardous substances through setting standards for specified shipment facilities; by setting fines and penalties for spills and other discharges that are graduated according to danger and "culpability" of the individual responsible (but which apply regardless of cuplability); and by providing for government clean-up where necessary. Regulations are found in the Code of Federal Regulations, Title 40, Subchapter D, "Water Programs." Regulations for hazardous substances were issued March 13, 1978, and may only be available from U.S. EPA regional offices.

If a sheen of oil can be seen on the water, local residents should report the oily water to the U.S. Coast Guard. If an individual spills oil and other petroleum products from trucks, pipelines, drilling platforms, barges and the like, he must report to the Coast Guard. A penalty of up to $5,000 for each offense may be levied. In addition the Coast Guard may clean up itself and charge the polluter for the clean-up.

Hazardous substances are controlled by the Clean Water Act when a listed substance is discharged into the nation's waters without a permit (if a permit has been issued covering an industrial plant or other facility and a listed substance, NPDES enforcement procedures apply). Severe penalties apply for failure to report a spill. Culpability is not necessary for a penalty to result.

Communities will want to remain alert to these provisions. The oil spill controls can help protect local waters if residents promptly notify the Coast Guard of suspected spills. While spills of toxic chemicals may be more difficult to identify, they may be equally important to coastal fisheries and water supplies in the floodplain.

Vessel Sewage (the Section 313 program)

The Clean Water Act assigns the task of setting standards for on-board marine sanitation devices (toilets on vessels) to the U.S. Coast Guard. A community should consult with the Coast Guard if there are local problems with vessel sewage, because once their regulations are in place, they prevent alternative state or local controls. The Coast Guard has considerable discretion in the initial application of this section of the law. One special provision permits the designation of waters where no discharge can take place because of local pollution problems, or to protect drinking water supplies. Local action may influence such a designation because there must be adequate alternative facilities locally available before such a prohibition can be enforced. These provisions can be an effective method for dealing with diffuse pollution from vessels in accordance with Policy 3.

Areawide Water Quality Planning (the Section 208 program).

The basic building block for water quality planning funded by the federal Clean Water Act is the Section 208 plan. These are prepared by regional planning agencies for the most populous regions of most states, and by a state agency for the balance. The choices of agency and regions to be intensively studied are left to the states.

This program is well underway, and if intensive regional Section 208 planning is active in its area, a locality should be aware of the identity of the responsible agency. If the state is responsible for Section 208 planning for a locality, as is usually the case for areas where the Rural Clean Waters Program may become available, a locality is less likely to be aware of it. In either case, the state water quality agency, or the regional offices of the U.S. EPA should be able to provide information on the current status of the program.

Section 208 planning covers a large number of issues. The law mentions:

-- diffuse or non-point sources from agriculture and forestry

-- mining

-- construction

-- saltwater intrusion

-- solid waste disposal affecting surface or groundwater

-- hydrographic modification

-- pollution affecting groundwater

-- point sources of pollution

Because of the scope of the effort, state and U.S. EPA reviews and approvals leading to plan implementation are likely to approve a program in segments. For instance, the sections covering municipal sewage treatment facilities, and point sources with NPDES permits, or the section for agricultural sources covered by the Rural Clean Waters program of the Soil Conservation Service might be approved. Localities may aid in getting segments relating to construction practices and subdivision drainage controls approved and at the same time further many of the recommended policies of Part I. Regulations for this program are found in the Code of Federal Regulations, Title 40, Part 35.

Construction Grants for Municipal Sewage Treatment Facilities (the Section 201 program).

This program has many complexities explained in voluminous regulations found in the Code of Federal Regulations, Title 40, Part 35, and also codified in special volumes by the U.S. EPA with interpretative rulings that can be consulted in EPA offices. State water quality agencies set the priorities for grants among municipalities and regions in a state. They also set the detailed standards that determine what level of sewage treatment will be required and what means can achieve the needed water quality.

Changes to the Clean Water Act in 1977 emphasized new or alternative treatment technologies that are simpler and less costly than traditional central treatment plants though implementing the same water quality standards. Other recent changes in regulations are taking the President's Executive Orders on Floodplains and Wetlands into account. Information on these changes will be available through the state water quality agency and regional offices of U.S. EPA.

Dredge and Fill (the Section 404 program)

The 1977 Amendments to the Clean Water Act permit states to substitute their own program of controls on discharges of dredged or fill materials for portions of the program implemented by the U.S. Army Corps of Engineers. The U.S. EPA guidelines referred to as the "(b)(1)" guidelines, that set the basic framework for the Corps, also set the framework for the state program. After a state requests approval of its program, EPA is allowed 120 days to review and approve or disapprove the request.

States are allowed to assume the "404" responsibilities only for non-navigable waters and adjacent wetlands. This would exclude salt-water wetlands, and some areas of freshwater wetlands which remain subject to overlapping state and federal permit programs in many states.

In areas where the Corps implements the Section 404 requirements, the EPA advises the District Engineer on selected permit applications. It gives special attention to special procedures under that program that permit a "general permit" for classes of activities. A general permit can be issued if each action causes only minimal adverse impact on water quality, and if as a class in a particular location, the actions have minimal cumulative effect. Once issued, a general permit eliminates the requirement for a separate permit for each individual action. It may be valid for as long as ten years.

8. U.S. Fish and Wildlife Service (Department of the Interior)

The Fish and Wildlife Service (FWS) is a small agency with expertise in the biological sciences. Though it has field offices throughout the United States, it is probably best known locally for its management of a system of wildlife refuges. FWS, however, is the principle federal agency responsible for protecting, preserving, and enhancing wildlife resources, (and with the National Marine Fisheries Service, fish resources).

In addition to its refuge management responsibilities, the Service conducts a variety of research and advisory functions that can be important to coastal resources management. Few are discussed at length in this manual, because most services and advice are directed to other federal agencies. Localities seeking information about the expertise and interests of a particular office of the service should find out what its program responsibilities are.

Seven programs are particularly important to the Policies recommended in this manual:

Biological Services Program. The Office of Biological Services provides ecosystems information, baseline data, planning and impact evaluation methods and expertise. It has very few regional staff and concentrates on research subjects of national interest.

Land and Water Resources Development Planning Program. This provides environmental impact analysis, permit reviews and recommendations, and provides for direct assistance to other agencies. FWS impact analysis, reports and recommendations, principally for navigable waters, are handled primarily at the Regional and Field Office levels by the Division of Ecological Services. This program has a fairly substantial regional staff, spread among many small field offices.

Amendments to the Fish and Wildlife Coordination Act of 1958 broadened the authority of the FWS for consultations with other federal and state agencies for water-related permits and projects. The Service has developed a "Navigable Waters Handbook" that includes its formal guidelines under the Coordination Act for permits in navigable waters, and an extensive field manual filled with practical examples and advice. Other FWS "Handbooks" have been prepared for Fossil Fuel Power Plants, Stream Channelization, Habitat Evaluation, and Downstream Flow Needs.

Localities are likely to find field office personnel helpful in interpreting environmental consequences of proposed federal construction projects or permits for wetlands.

Biological (Environmental Contaminant Evaluation) Monitoring Program. This program attempts to define trends in chemical residues contaminating various fish and wildlife species. Organized under the Associate Director for Environment and Research, it reviews FWS policy on Service sponsored pesticide uses and provides technical assistance. The program assists in identifying declining coastal bird populations resulting from contamination, and identifying uncontaminated areas that continue to provide satisfactory habitat.

Migratory Birds and the Mammals and Nonmigratory Birds Programs. These provide direction for management and preservation of wildlife, birds and animals in close cooperation with state conservation departments. Under the Associate Director for Fish and Wildlife Resources, the programs also provide the framework for waterfowl hunting regulations and manages lands within the National Wildlife Refuge System.

Endangered Species Program. The Endangered Species Program works to preserve or restore both animal and plant species, subspecies, or populations listed by the Secretary of the Interior as endangered or threatened. FWS evaluates proposed federal actions and makes grants to states for protective programs.

Coastal Anadromous Fisheries Program. This FWS program sponsors conservation, development and enhancement of anadromous fish populations, i.e., those with spawning and juvenile growth in freshwater and maturation in marine waters. The program includes grant, technical assistance and resource management elements.

Grants-in-Aid (Federal Aid) Program. The FWS provides federal financial assistance to state game and fish agencies and revenue-sharing payments to counties made via the National Wildlife Refuge Fund. Research, land acquisition, property maintenance and improvement and hunter safety programs may be financed with these funds.

APPENDIX I

MAJOR ENVIRONMENTAL VITAL AREAS OF THE COASTAL ZONE

Vital Area	Description and Function
Fresh water wetlands	Includes all vegated areas with saturated soils, permanently flooding or flooded long enough each year to support communities (two or more species) of water dependent plants. They include marshes, cypress domes, swamps, strands, bogs, sloughs, vegetated natural swales, and all other similar natural elements. They take up, convert, store, and supply basic nutrient to the local food chain and downstream to coastal ecosystems. They purify the water of contaminants. They act as aquifer recharge, flood storage and retention areas. They are intrinsically valuable, providing exceptional habitat and food for wildlife. They bind the soil, providing stability. They provide scenic and other amenity values.
Active dunes	Includes the frontal dune and all active secondary dunes; extending from the "toe" of the frontal dune or beach ridge (vegetation line) to the backside of the most inland active dune (active dunes visibly gain or lose sand; vegetated mostly with grasses rather than woody vegetation; includes beach ridges, scarps and other functionally equivalent structures. Dunes buffer the force of storm seas, and store and yield sand to instantly replenish storm losses, protecting duneland property and special backbeach and duneland turtle and bird habitats and nesting areas.
Coastal wetlands	Includes all vegetated marginal areas of estuaries to the normal highest tideline--various types of salt marshes and mangrove swamps--recognized as areas subject to periodic flooding by brackish or salty

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Coastal wetlands (continued)	water and vegetated with salt tolerant plant communities dominated by grasses, rushes, mangrove trees or other salt tolerant species. Upper wetlands lie between the normal highest tide mark and mean high water mark; lower wetlands between mean high and mean low water marks; each is characterized by different plant species and has different ecological functions. Upper wetlands regulate the flow of runoff waters, cleanse them of contaminants, intermittently export nutrients to the food chain, slow storm surges, provide habitat, stabilize soils, and offer open space/scenic benefits. Lower wetlands store nutrients and convert them to detritus (the key to the food chain of coastal ecosystems). Vegetation removes toxic materials, excess nutrients, and sediment. Vegetation also slows storm surge. Vegetation stabilizes shoreline, prevents erosion. Wetlands and tide creeks provide nurseries, other exceptional habitat, and scenic/open space benefits.
Edge zones	Includes natural transition areas (ecotones) at the boundary between land and water (normal highest water mark); normally visible as a band of high trees or other distinct vegetative assemblages. Edge zones provide unique breeding, roosting, and feeding places and support an increased abundance of fauna. They help to slow storm surges, stabilize the shore, retain and cleanse storm water runoff, and provide a visual screen.
Submerged grass beds	Includes concentrated beds of submerged grass in shallow coastal waters. Where marshes are scarce, grass beds play a dominant role by providing the nursery areas, general habitat, primary productivity, and nutrient storage. They supply food to grazing animals and detrital nutrient to the food chain. They add oxygen and stabilize bottom sediments.

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Tideflats	Includes unvegetated areas that are alternately exposed and inundated by the tide. They may be mudflats, or sandflats, depending on the coarseness of the material of which they are made. They provide feeding areas for fishes (high tide) or birds (low tide) and may produce a high yield of shellfish or baitworms. Tideflats are important energy storage elements for chemical nutrients.
Shellfish beds	Includes all concentrations of molluscan shellfish on flats, banks, bars, or other bottoms. Shellfish beds provide an important fishery resource and a food source for fishes, birds, and mammals. Oyster beds, particularly, provide an exceptional and unique habitat for a diverse association of aquatic species.
Coral reefs	Includes all coral reef structures. Fish, shellfish, and smaller marine organisms depend on the coral reef habitat for shelter and food, making it the center of the tropical biological community. As natural seawalls, coral reefs are the major storm defense for sub-tropical and tropical shores.
Kelp beds	Includes all concentrated beds of kelp in nearshore coastal waters. Kelp beds break the force of the sea and provide a strip of quieter water between them and the shore. They provide food and favorable habitat for many fishes, as well as sheltered nursery areas for their young.
Convergence areas	Includes all locations of high concentration of species, (often seasonally) for particular critical functions such as: (1) breeding areas, where species concentrate for procreation; (2) nursery areas where the new young prosper because of food, predator protection, and other conditions; (3) feeding areas in marine basins where species concentrate; (4) migration pathways, where animals travel along narrow pathways to feeding, breeding or wintering areas; (5) wintering areas, where species concentrate in special habitats.