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Shoreline Erosion in the Commonwealth of Virginia: Problems, Practices, and Possibilities

Robert J. Byrne

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for the
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FOREWARD

This report, Shoreline Erosion in the Commonwealth of Virginia: Problems, Practices, and Possibilities, is a report on the physical, legal, and economic aspects of shoreline erosion in Virginia. Although erosion is a physical process, it generally is not perceived as a problem until it has an economic impact on either an individual, community, or resource. As management of the impacts of erosion involves land use, economic, and legal issues as well as a technical assessment of the problem, an interdisciplinary approach was required. Authors Byrne and Hobbs are physical scientists with experience and interest in the workings of the shoreline. Theberge is a lawyer specializing in marine affairs. Kerns, Langeland, and Scheid are resource economists and environmental planners; and Barber and Olthof are land use planners. The division of responsibilities followed the obvious lines. The physical scientists described the problem and its causes and provided the technical analysis of the shoreline. The economists explored the costs of erosion and of combating erosion and developed the economic decision framework. The planners considered the institutional arrangements and policies necessary for the rational treatment of erosion; and the legal experts researched the existing body of law pertaining to shoreline erosion. The four groups functioned as a team with continuous interaction and discussion among all participants.

The document was prepared in three drafts. Draft 1, October 1978, determined the organization and thrust of the final report. It was a presentation of all information available at that time and was given very limited circulation for review and critique. Draft 2, February 1979, was a modification of the earlier draft incorporating the completed Middlesex County Pilot Study, some of the suggestions offered to the first draft, and other such additions and alterations as deemed necessary. The second draft received an extremely limited distribution as the differences between it and the third or final draft were minor. This third or final draft is a revised and edited version of the second. Authors Byrne and Hobbs were responsible for the compilation and editorial continuity of the finished document.

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CHAPTER 1

INTRODUCTION

1.1 The Intent of the Study

Tidal shoreline erosion is a pernicious problem in Virginia and the mitigation of its impacts is by no means a simple matter either technically, legally, economically, or institutionally. However, the Coastal Zone Management Act of 1972 and its amendments of 1976 have afforded the opportunity to examine the issues and the possibilities for mitigation of erosion impacts in the light of serious issues. The basic issues include the role of the State or locality in controlling human behavior along the shoreline of the Commonwealth, and the justification for the expenditure of public funds to protect private property. Moreover, there is a spectrum of legal issues associated with actions along the shoreline and with various management strategies.

The basic intent of this report is to provide a framework for decision making by the legislative branch and/or executive branch policy makers. This framework provides a mechanism to determine the costs and benefits for possible alternate approaches derived from the technical assessment of the problem. In addition, the report provides an examination of the legal issues which might arise.

The final program to cope with mitigation of the impacts of erosion should be tailored to meet the needs of the Commonwealth of

Virginia, yet at the same time be an approvable program in the view of the National Oceanic and Atmospheric Administration. The need to fulfill the federal requirement is pragmatic; if successful in this, federal monies may be available to, at least partially, fund the implementation of the program. The federal requirements are, as listed in the Federal Register, Vol. 43, No. 41, March 1978.

Rules and Regulations
923.26 Shoreline Erosion/Mitigation Planning.

(a) Requirement. In order to meet the requirements of subsection 305 (b)(9) of the Act and to coordinate these requirements with those subsections 305(b)(3) and 306(c)(9), States must include a planning process that can assess the effects of shoreline erosion. Evaluation must include assessment of ways to mitigate, control or restore areas adversely affected by erosion. This process must include:

(1) A method for assessing the effects of shoreline erosion;
(2) Articulation of State policies pertaining to erosion, including policies regarding preferences for non-structural, structural and/or no controls;
(3) A method for designating areas for erosion control, migitation and/or restoration as areas of particular concern or areas for preservation and restoration, if appropriate;
(4) Procedures for managing the effects of erosion, including non-structural procedures; and
(5) An identification of legal authorities, funding programs and other techniques that can be used to meet management needs.

(b) Comment. Statutory Citation, Subsection 305(b)(9):

The management program for each coastal state shall include ... (9) A planning process for (A) assessing the effects of shoreline erosion (however caused), and (B) studying and evaluating ways to control, or lessen the impact of, such erosion, and to restore areas adversely affected by such erosion.

(1) The basic purpose in developing a process to evaluate and, if appropriate, to control and mitigate shoreline erosion is to assure consideration of erosion impacts within the purview of a State's management program. Since the specific planning requirements called for in this section are closely related to the broader requirements of areas of particular concern and areas for preservation and restoration, many of the requirements called for in paragraph (a) above can be met by completing the work called for in 923.21 and 923.24.

(c) Comment. With respect to the requirements of (a)(1) above, States should consider the following: (1) Loss of land along the shoreline or along estuarine banks, whether this loss is caused by actions of man or by natural forces, and whether these actions are regularly occurring, cyclical, or one-time events; and (2) the cause of these effects (e.g., man-made vs. natural forces); the effects of erosion on adjacent land and water uses as well as the impacts of mitigation or restoration of eroded areas on adjacent shorelines, littoral drift, and other natural ecological processes such as accretion.

The purpose of such assessments will be to determine how, if at all, States will want to handle erosion control, mitigation and/or restoration.

(d) Comment. In addressing the requirements of (a)(2) above, States should consider non-structural and structural options as well as the possibility of allowing erosion and accretion to continue to occur without management intervention. It is not the intent of these planning requirements to imply that an appropriate State response to erosion necessarily requires control (either of a structural or non-structural nature). In some locations along a State's coast, it may be appropriate to articulate a policy of non-control, given the cause of erosion, the configuration of the coastline or the adverse impacts that may result from control techniques. An example of where a policy of non-control may be appropriate is along barrier islands where there is substantial natural erosion and accretion due to littoral drift. In cases where State policy is not to control erosion, either in selected locations or along the entire coastline, the rationale for such policy should be stated explicitly. In evaluating ways to control or

lessen erosion impacts, either through non-structural or structural techniques, States should take into account such considerations as shoreline configuration, extent of the problem, costs of alternative solutions, and incorporation of existing management techniques. States also should take particular account of the National Flood Insurance Progam (24 CFR 1909 et seq.), and regulations of the Federal Insurance Administration on flood-related erosion-prone areas (24 CFR 910.5).

(e) Comment. In addressing the requirements of (a)(3) above with respect to areas for preservation or restoration, States may consider complete re-establishment of the pre-erosion shoreline or other more limited rebuilding of an eroded area. Both natural and developed areas may be considered for restoration purposes. Due to restrictions on the use of section 306 funds (see 923.95), no means of restoration proposed by States may be eligible for section 306 funding, or funding under other sections of the Act. Despite this restriction on the use of section 306 funds, States should not feel restricted as to the means of restoration proposed as part of the management program and should give particular attention to coordination of shoreline erosion management of objectives with funding programs pursuant to the U.S. Army Corps of Engineers Beach Erosion Control Program (33 U.S.C. 426 et seq.) and the Hurricane Protection Program (33 U.S.C. 701 et seq.) and other statutes as may be appropriate.

(f) Comment. State coastal zone management programs that are submitted and approved prior to October 1, 1978, may submit this planning element as a program amendment by, but no later than, September 30, 1978, or this element may be included as part of the basic program submission submitted and approved prior to October 1, 1978. State coastal zone management programs submitted prior to October 1, 1978, but approved on or after that date, must include this planning element as part of the basic program submission. State coastal zone managements submitted for approval after October 1, 1978, must include this element as part of the basic program submission.

The Federal requirements, while quite broad in view, do require an in depth examination of the problem. Within the Virginia Coastal

Resources Management Program "Highly Eroded Areas", those areas experiencing erosion rates greater than two feet per year, have been preliminarily identified as hazardous. Those areas, when finally designated as hazardous, will require closer attention and presumably, greater state oversight in management than those with lesser erosion rates.

Any examination of the problem of mitigation of the impacts of erosion requires a statement of the impacts and the ramifications of mitigation. In Virginia the impacts of tidal shoreline erosion are:

1) Loss of fastland property and improvements thereon,
2) Loss of taxable lands within lcoalities,
3) Influx of the eroded sediments into the estuarine system and its flanking tidal creek entrances, and
4) Supply of sand to beaches fringing the Bay system and the ocean shoreline.

While the first three impacts may be perceived as disbenefits the fourth "impact" is a definite benefit as fastland erosion is the principal supply of sand to beaches fringing the bay. The physical importance of beaches will be established in the following chapters. The important point is that strategies involving inhibition or prohibition of erosion also involve the loss of sand supply and consequent diminution of beaches, a principal resource of the shore system.

Management of the impacts of erosion involve either one or a combination of two broad strategies:

1) Non-structural controls such as construction set-back lines or other zoning mechanisms which attempt to prevent victimization of property improvements from erosion.

2) Structural controls which attempt to inhibit the physical process of the fastland.

Within the context of these two broad strategies legislators and policy makers face the nexus with legal issues: non-structural regulation faces the issue of "taking" while any publicly funded assistance for relief of the costs of structural control faces the issue of "why, and to what extent" should the "public" relieve the cost burden of the few who own shoreline property and who are thereby frequently viewed as "privileged". The philosophical foundations for argument of these fundamental issues is left to the legislative bodies and executive policy makers. To us the philosophical foundation rests in the balance between points of view, perhaps equally arguable:

1) The shoreline, a limited resource, is intrinsically a public resource in the stewardship of temporary landlords. As such, the public has a vested interest to manage, and to at least partially finance, the prudent use, preservation and development of that resource. It would appear that this view may also embody an obligation to public access since public participation in financing is granted.

2) The government has the obligation to prevent and/or control its citizens from victimization by hazards to life and property.

3) A third possible case is that wherein protection of private property results in the benefit through increased tax revenues to a local, larger public and to the state's populace at large. This case may be exemplified by those areas in Virginia dependent upon the shoreside tourist industry and services thereto. However, these areas embody the greatest damage risks due to demand for shorefront

facilities and the consequent temptations to develop too close to the erosion and flooding jeopardy zone. These cases thus require particular attention.

Our task is to supply insight into the problem and tools (and the limitations of those tools) which might be used in reaching a decision. The tools are imperfect, but the decisions cannot await perfect tools.

1.2 The Format of the Report

Chapter 2 is an explanation of the principal processes causing shoreline erosion and a description of the magnitude of shoreline erosion as revealed by comparing shoreline positions over a one century time period.

Chapter 3 addresses the problem of erosion in the light of its effects and discusses the preliminary designation of hazard areas in terms of erosion rates. It also reviews the current status of how private property owners cope with the erosion problem. This review indicates that a coordinated community response over integral shoreline segments is preferred to the existing piecemeal approach.

Chapter 4 is a review of existing policies in Virginia. In addition, this chapter surveys the principal Federal programs dealing with the mitigation of erosion's impacts.

Possible management strategies are presented in Chapter 5. The first sections of the chapter deal with the kinds of technical and

economic information and analyses required to select the most appropriate strategy from a set of possible strategies. Later sections outline an economic decision making framework which incorporates the economic information and costs for various treatments of the shoreline. As management strategies must be selected with an awareness of potential legal issues, analyses of three particularly germane issues are presented: individual liability for downdrift impacts; liability of the State for adverse effects of shoreline protection; and finally the issue of "taking".

Chapter 6 is a discussion of the Middlesex County Pilot Study. The discussion includes the details of the technical procedures, the technical analysis and formulation of management options, and the application of the economic decision framework to the suggested options.

Chapter 7 contains several recommendations that, if implemented, should serve to decrease the problems caused by erosion. Chapter 8 contains several specific suggestions for the implementation of the recommendations.

CHAPTER 2

THE NATURE OF TIDAL SHORELINE EROSION IN VIRGINIA

2.1 The Erosion Processes.

The Commonwealth, having a tidal shoreline exceeding 5,000 miles in length, is graced with a wide diversity of shore types which include the low-lying barrier islands of the Eastern Shore, the ocean front headland-barrier spit of southeastern Virginia, and the shores of Chesapeake Bay and other estuaries which range from high bluffs to tidal marshes. To obtain a true perspective of shore erosion as a natural phenomenon, one must examine the recent geologic setting of the region.

The principal natural processes responsible for erosion are the long term changes in the level of the sea, the waves generated by local or distant winds and short term water level fluctuations occurring during storms. About 14,000 years ago the polar ice caps, formed indirectly from water of the world's oceans, were extensive, and sea level was about 300 feet lower than its present elevation. The ocean shorelines off what is now Virginia were then located near the edge of the continental shelf, about 60 nautical miles from the entrance to Chesapeake Bay. Of course, the Bay and its rivers were not estuaries at that time, but rather were an upland drainage network leading to the sea. The gorges of the rivers were deeper than now because the fluvial action tended to scour channels as the rivers

flowed down to the sea. As the ice caps began to melt and recede, the elevation of the sea started to rise. This world-wide rise of sea level is called the eustatic sea level rise. Local changes of relative sea level, however, are the result of two components, the eustatic sea level rise and the isostatic changes which are due to local subsidence or uplift of the earth's crust. According to Rosen (1976), the best estimates for local, relative sea level rise are obtained from comparison of long term mareograph data. Using data from Hicks and Crosby (1974) and Holdal and Morrison (1974), Rosen computed rates of sea level change for several Chesapeake Bay System locations. His results varied from an average rise to 21 inches per century at Old Point Comfort in the City of Hampton to a fall of 1.8 inches per century in the City of Richmond.

An "average" for sea level rise in the Chesapeake Bay area is about 0.01 feet per year or 1 foot per century (Hicks, 1972). This average includes shorter term variations of several years duration which may be appreciably larger or smaller. Although this rate of sea level rise is small its effect is dramatic. Because the fringes of the ocean and the Bay are, generally, gently sloping each decade brings constant encroachment against the fastland. Of course, the gentle action of sea level rise does not by itself erode the fastland but it constantly elevates the point of application of the erosive forces of the waves.

An analogy with a sawmill is fitting. Sea level rise represents the belt advancing the saw blade while wave action represents the cutting teeth.

Another important aspect of sea level rise is its effect on the sedimentation characteristics of the Chesapeake Bay and its tributary rivers. When sea level was lower the fluvial action of the freshwater rivers tended to carry sand and silt to the edge of the sea. Today, however, the coarse grained materials, sand and gravel are deposited in the tributary reaches near the fall line which separates the Piedmont from the Coastal Plain. The fall line extends approximately along the Route I-95 corridor through Richmond, Fredericksburg, and Washington. Moreover, saline oceanic waters now enter the Bay and tributaries. The net effect of the circulation between the entering oceanic waters and freshwater introduced from the rivers (James, York, etc.) is to trap the fine grained sediments, the silts and clays, within the estuaries. Thus, very little of the sediment delivered to the estuary system, either from the tributary freshwater rivers or from shoreline erosion, escapes from the mouth of the Chesapeake Bay into the ocean.

When visiting the ocean shores of Virginia an observer may notice wave conditions ranging between "fair weather" and those of a storm. Fair weather waves are characterized by generally well defined gentle undulations which break on the beach face with apparent regularity. These waves are generated by wind fields relatively far offshore and then travel to distant shores. During a storm, however, strong local winds generate waves which mix with those generated offshore. The result is an apparent maelstrom with waves of all sizes and shapes. Generally speaking, "fair weather" waves (called swells) carry sand from the immediate nearshore bottom and deposit it on the beach.

Storm waves, on the other hand, tend to remove sand from the beach itself and to deposit it in nearshore waters in accumulations called bars. When the fair weather swell waves return, the material stored in the bars is driven back to the beach face. Thus, there is a periodic shift of sand between the beach and the nearshore. Another very important aspect of wave behavior on beaches is that waves drive sand along the shore. This occurs when, as is usually the case, the breaking wave crests approach at an angle to the shoreline. This action of the waves provides the principal supply of sand which works along the shore and is deposited in the entrances to inlets and creeks.

An observer visiting the shore of the Chesapeake Bay and the wider parts of the tributary estuaries would witness the same wave behavior except the wave heights would be smaller and the time between successive waves shorter. This is due to the fact that the degree of wave development is strongly dependent on fetch, the "over the water" distance the wind blows. Of course the distances across the Bay are much smaller than those found on our ocean coast.

The beaches fringing our coastline are natural formations created by wave action as the waves expend their energy. Beaches are, in fact, recognized as the most efficient dissipators of wave energy. Thus, aside from their intrinsic attractiveness to man, beaches are protective structures which inhibit erosion of the fastland.

During storms (northeasters) and hurricanes, the strong winds push additional water against the ocean coast and into the Bay. As a

result, the normal rise and fall of tide oscillates around an elevated mean water level. While the storm surge generally ranges between one and two feet, it may be several feet in magnitude. For example, the extremely severe northeast storm of March 1962, resulted in water elevations at Norfolk of 6.1 feet higher than predicted.

Aside from the obvious hazard of flooding low-lying areas the surge permits the erosive action of the waves to attack the fastland, directly above the usual buffer provided by the beach. The effect is further accentuated if the storm occurs in conjunction with the higher, or spring, tides of the lunar month.

Tidal currents, the water movements resulting from the rise and fall of the tide, play a secondary role in shoreline erosion since the current speeds are small except near inlets where their influence is a dominate force. Away from inlets the tidal currents tend to move the sand stirred up by waves slowly along the coast. In some areas within the estuaries, local conditions result in strong currents not associated with inlets and which directly influence bank erosion. One example of this occurs at bends in the rivers.

It is of interest to see how these elements interact during the passage of a typical northeast storm. With the onset of the storm the northeast or easterly winds generate large waves which impinge on the open coast beaches. Because of the large, steep waves and accompanying storm surge large volumes of sand are removed from the ocean beaches. Some of this material will be moved offshore for temporary storage in sand bars and some will be driven alongshore to

storage in inlets or to beach areas on the fringe of that storm's influence. Within the Bay and tributary rivers the intensity of erosion will depend on the path and strength of the storm. When the local easterly winds in the Bay are sustained at 20 mph or greater the waves become quite large and the attack is focused on the western side of Chesapeake Bay and the lower reaches of the tributary estuaries. After the storm center has passed offshore or to the north, the winds shift to the northwest quadrant. These winds, accompanied by a clear sky, are frequently stronger and of longer duration than those experienced during the "storm". Now the ocean front beaches tend to recover some of the sand from the offshore bar. But in the Bay the focus of wave attack simply shifts. Now the eastern side of the Bay receives wave attack. Because the major tributary estuaries have a northwest-southeast orientation their banks also receive substantial wave attack during northwest winds.

2.2 The Magnitude of Erosion.

To gain a first order insight of the magnitude of shoreline changes within the Bay System, Byrne and Anderson (1977) compared the earliest reliable maps (1850's) with a series of 1940-1960 maps and charts for 2,365 miles of the Bay system. Byrne (1973) made a similar study of the barrier islands and the Corps of Engineers (1970) studied the coastline between Cape Henry and the Virginia - North Carolina border. The summarized results (Table 1) show that over 28,000 acres (about 44 square miles) of land were lost during the recent past century (1850-1950).

Table 1

Areas Losses Due to Erosion Circa 1850-1950

Atlantic Coast SE Virginia	27 miles	- 40 acres
Atlantic Coast Eastern Shore	84 miles	- 7,228 acres
Virginia Chesapeake Bay and Tributaries	2,365 miles	-21,079 acres
Total	2,476 miles	-28,347 acres

The ocean coastline segments show characteristically different erosion responses than the Bay system. The barrier islands are, for the most part, sand starved islands segmented by tidal inlets. The net littoral drift is directed to the south. The northernmost islands (Wallops, Assawoman, Metomkin, and Cedar) have retreated in a fashion so that the new shoreline parallels the older. The erosion rates on Metomkin and Cedar Islands are greater than the other two. The central section of the island chain, Parramore, Hog and Cobb Islands, are flanked by deep inlets which strongly influence their gross behavior. Over recent times these islands have accreted on the northern ends due to local trapping of sand which bypasses the adjacent inlet. The retreat of the southern portions of the islands has been dramatic (up to 50 feet per year on Hog Island). The southern section of chain, ending with Smith Island, have retreated in a nearly parallel fashion, Smith Island at about 25 feet per year. Meanwhile, Fishermans Island, which is at the toe of the peninsula,

has accreted to a four fold increase in area during the century studied.

The ocean coastline of Virginia south of Cape Henry is characterized by zones of alternating shoreline advancement and recession. If the erosion history of total shoreline length between Cape Henry and the North Carolina border (27.4 miles) is averaged over the long term, the annual recession rate is about 0.7 feet. Although the average erosion rate is relatively small the entire ocean shore front is subject to severe erosion during northeast storms and hurricanes. Experience in the past has demonstrated high property damage.

The Lower Chesapeake Bay shoreline and that of its tributary estuaries, the James, York, Piankatank, Rappahannock, and Potomac Rivers, is highly dissected by entrances to creeks so that there is a high degree of variability in shoreline response within and between adjacent segments. Again referring to gross average the eastern and western shores of the Chesapeake Bay lost about 12 acres per mile per century. The southern sides of the tributaries have experienced somewhat greater erosion due to the more direct attack from northwesterly winds. Although individual segments of the shoreline have experienced erosion rates exceeding 7 feet per year, one or two feet per year is more common. For the 2,365 miles of Bay system shoreline measured, the average erosion rate was 0.7 feet per year. Slaughter (1964) estimated that the Chesapeake Bay has one of the nation's highest rates of erosion for tidewater areas.

The products of shoreline erosion, sand, silt and clay, contribute a significant fraction of the total sediment load trapped in the Bay System. Byrne and Anderson (1977) estimated that the total amount of over 270,000,000 cubic yards of material was eroded from the Virginia portion of the Chesapeake Bay system between 1850 and 1950. This volume is about one third the volume of water in the entire York River estuary. The sand fraction derived from erosion is the principal source of beach materials. The silt and clay fractions, however, contribute to the general sedimentation of the channels and flanks of the estuaries. Although the volume of suspended sediment entering the Virginia estuary system has not been determined precisely, interpretation of available records indicates that deposition from the upland drainage basins of the Potomac, Rappahannock, York and James River is about 4 million tons per year. If we assume that 30 percent of the material derived from shore erosion is silt and clay, then it appears that about 1 million tons per year are injected into the system via shoreline erosion. Thus, the total silt/clay deposition is about 5 million tons per year, of which 20 percent is derived from shore erosion.

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CHAPTER 3

THE PROBLEM OF SHORELINE EROSION

3.1 The Effects of Erosion

Tidal shoreline erosion is a problem only because it challenges our occupation of the shore zone and use of contiguous waters and subaqueous bottoms. The attractions to the shores are manifold and the pressures for occupation are growing. The principal effects of tidal shore erosion in Virginia are, without rank of position:

1) Loss of fastland property and improvements thereon,
2) Loss of taxable lands within localities,
3) Influx of eroded sediments into the estuarine system and its flanking tidal creek entrances, and
4) Principal supply of sand to beaches fringing the Bay system and ocean shoreline.

The first two effects are generally perceived as adverse impacts. The third effect, while a natural consequence of shore erosion, may be perceived as a disbenefit since the fine grained sediments contribute to the shoaling of navigational waterways, and the silting of oyster rocks whereas the sand size materials may deposit in the entrances to feeder creeks, thereby reducing navigability. The fourth effect, the supply of sand to the fringing beaches, is decidedly a beneficial aspect of shore erosion. Within the Chesapeake Bay system and along the ocean shoreline the principal source of beach material is sand derived from fastland erosion. This fact complicates strategies to

alleviate the impacts of erosion because reduction of the sediment sources by shoreline protection structures diminishes the sand supply available to adjacent beaches.

3.2 The Problem in Light of the Effects

In viewing the problem of shore erosion, it is necessary to contrast the oceanic segments of the shoreline with those of the Bay System. For the most part the barrier islands of the Eastern Shore, aside from Wallops Islands which is owned by the federal government and used by NASA, are held by either private, state, or federal concerns as a natural preserve. While light recreational use of the islands is likely, erosion per se, will not be a problem as far as hazards to property improvements are concerned. In a sense the barrier islands may be viewed as a protective barrier to the mainland spine of the Eastern Shore. While still susceptible to flooding during extreme storms and hurricanes, the eastern edge of the spine is protected from significant erosion. A potential exception to this is the region adjacent to Metomkin Bay where the protective spit has been breached and wave penetration into the Bay is increasing.

The coastline between Cape Henry and the state border is varied. The beach-tourism/residential zone of Virginia beach between Cape Henry and Rudee Inlet is established and the management goal is obvious: To maintain the beach as the economic base of the tourist industry. Thus far, and in spite of trials, this goal has been met. The cost of the maintenance will continue to rise. The Sandbridge

region, where development is private, is subject to storm flooding and deflation due to overwash. There is increasing acceptance of the fact that the ocean shoreline is dynamic and frontal losses are expected. Development, nonetheless, proceeds perilously close to the beach and within the dunes. South of Sandbridge, the shoreline is a natural preserve variously under State or Federal auspices.

The southern end of Chesapeake Bay from Cape Henry to Willoughby Spit and the Bay frontage of the City of Hampton experiences partial oceanic conditions gated by the mouth of Bay and the long fetch to the north. Because of the moderate to high residential and tourism development these shorelines are subject to high erosion risks during storms. A significant fraction of these are also subject to the risk of tidal flooding.

While occupancy of the ocean shore zone is an accepted hazard, within the Chesapeake Bay System erosion is perceived in a different way; the inevitability of loss is not granted. Erosion of the shoreline is perceived as a highly personal battle. The average property owner does not perceive sedimentation of the estuaries as a problem (although he may justify an erosion control permit application by citing this as a secondary benefit).

The deposition of the erosion products in the Bay System does, no doubt, have some impact on the economic resources of the system. Sedimentation on productive oyster grounds is one example. The cost of maintaining dredged navigation channels and the cost of dredged

material displacement should, in part, also be considered a cost of erosion. A problem arises in specifying how much shoaling at a given site is due to products from shoreline erosion. Given the present state of knowledge about sediment circulation, the best one can say is that shoreline erosion is a proximal cause of deposition on the flanks of the river. It is doubtful that the state of the art will ever permit exact specification of the amount of silt and clay from an eroding bluff that will reach a specific deposition site. Moreover, it is recognized that resuspension by wave action stirs the sediments on the flanks and redistributes materials to more distant locations.

Before assessing the magnitude of critical erosion (defined herein as greater than 2 feet per year with endangered property improvements) it is of interest to examine the occupation of the Bay System shoreline. Housing density per shoreline mile was approximated by tabulating the structures within 200 feet of the shoreline, as shown on 1968 U.S.G.S. Topographic maps (see Table 2).

Although these data were from dated source material, the current conclusion remains that most of the shoreline is sparsely settled. The density class 26-30 houses per mile represents an averaged individual frontage of 200 feet or less. If one considers areas with this or greater housing densities (including "cities") as "developed" areas, the total mileage of "developed" shoreline is 158 miles.

The length of critical shoreline erosion as estimated from VIMS' Shoreline Situation Reports indicates that approximately 12 miles of

TABLE 2

HOUSING DENSITY ALONG THE

VIRGINIA CHESAPEAKE BAY SYSTEM SHORE

Housing Density Class (Structures Per Mile)	Number of Miles
0- 5	2,314
6-10	378
11-15	171
16-20	98
21-25	65
26-30	34
31-35	16
36-40	9
41-45	2
46	6
*City	91
Total	3,184 miles

* Individual structures not shown on maps in areas designated as densely developed or city.

shoreline within the Bay System show historical (1850-1950) erosion rates greater than 2 feet per year plus endangered property improvements. Assessment by the Corps of Engineers (Baltimore District, 1976), indicates approximately 26 miles of critical residential shoreline. (The difference is attributed to the Corps' use of an erosion rate of greater than 1.5 feet per year.) At first glance the relatively low length of "critical" erosion shoreline leaves the impression that erosion is not a serious problem. The numbers are approximate, however, and do not give a complete picture of potential losses of improvements to property. Considering only 12 miles of critical shoreline the protection of that length at $40 per foot is over 2.5 million dollars. The comparison between "critically" eroding shoreline and the housing density distribution indicates that most development has occurred along shorefronts experiencing low or moderate erosion rates. Aerial observation of the Virginia shoreline corroborates that most development occurs within fringing embayments and large creek sytems.

Until recently no detailed studies have been performed to estimate the value of eroded property or the loss of tax base for various localities. However, a limited economic study was performed (The Virginia Tidal Riverbank Erosion Survey, 1962) for 951 miles of shoreline which included the north and south shores of the Rappahannock and 292 miles of the Potomac. This study considered erosion during the 47-year period, 1909-1956, and used estimated property values for 1960. For the study area considered, about 1,335

acres were lost during the 47-year period with a value of about $117,000. While these losses do not appear large (about $90 per acre or $123 per mile), it must be remembered that erosion is, in fact, highly localized. Moreover, shorefront property value has dramatically escalated since 1960.

A later section of this report includes an economic analysis of the real and potential effects of shoreline erosion on a limited area. An increased level of understanding of the economics of shoreline erosion should improve the ability to select a satisfactory strategy for coping with the problem.

3.3 Erosion As A Hazard

While tidal shoreline erosion in Virginia has not been a direct cause of loss of life, significant property losses have occurred along many segments of the shoreline. The "Ash Wednesday" storm of March 1962 caused widespread damage along the coastline of Virginia. As recently as April 1978 a northeast storm caused such substantial damage to the Ocean View - Willoughby Spit section of Norfolk and to other coastal reaches of Virginia that the area was declared a disaster area.

During major storms lower lying areas generally experience the joint hazards of erosion and flooding. In such cases the damage levels may be extreme.

As indicated in the Introduction, "Highly Eroding Shorelines" have been identified as a Geographical Areas of Particular Concern in the Virignia Coastal Resources Management Plan. As such, these areas

will require particular attention for consideration of alleviating the impacts of erosion. As an interim designation, those shoreline reaches subject to an erosion rate greater than 2 feet per year have been classified as "Highly Eroding Shorelines". The erosion rate of greater than 2 feet per year was selected as the criterion because it significantly exceeds the average erosion rate for the Bay System shoreline which as determined by Byrne and Anderson (1977) was approximately 0.7 feet per year. Therefore, selection of shoreline erosion rates greater than 2 feet per year represents those shoreline segments which have experienced erosion rates significantly greater than the average erosion rate. Table 3 indicates the erosion rate versus affected mileage for the various counties within the Chesapeake Bay System according to Byrne and Anderson (1977). Within the Chesapeake Bay System, some 243 miles of shoreline are so affected. Of these, about 60 miles are marsh shoreline. With the inclusion of the ocean shorefront the total increases to about 330 miles of which about 120 miles is marsh or low barrier island.

It is very important to note that this delineation is based upon a comparison of mean high water line positions designated on map series generated in the 1850s and a series surveyed between 1950-1968. It does not identify areas which were stabilized in the interim or subsequent period. In addition, a more appropriate delineation would be that of the retreat rate of the bluff line or fastland boundary of upland vegetation in non-bluff areas. This is the case because the water line can fluctuate markedly due to seasonal or long term modulations of sand on the beach. Bluff retreat or fastland boundary

Table 3

SHORELINE EROSION RATES FOR TIDEWATER VIRGINIA
CHESAPEAKE BAY SYSTEM

Erosion Rates (Ft./Yr.) / +County	Miles of Eroding Shoreline					Erosion Rates >5 Ft./Yr.	
	0-1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	Rate (Ft./Yr.)	Length (Miles)
*Accomack	0.3	18.5	10.6	6.6	6.1	32.6 20.0	0.3 3.0
Caroline	3.5	3.5					
Charles City	6.1	11.6	1.1				
Chesterfield	3.6	5.1	0.5			20.7	3.9
Essex	1.7	11.5	13.4	9.1	0.9		
Gloucester	24.9	21.8	8.5	1.4	0.7		
Hampton	1.9	3.1	2.4	0.9	1.9	6.4	2.5
Henrico	0.6	1.7				6.1	0.2
*Isle of Wight	3.9	12.9	1.4	7.0			
James City	2.7	17.0					
*King George		7.0	1.7				
King and Queen	1.8	2.2					
King William	0.8						
Lancaster	1.7	12.3	7.2	0.4	1.7	7.9 5.6 6.0 6.6 5.1	4.1 0.8 0.5 1.0 0.7
Mathews	1.9	15.1	12.7	2.1	3.5	30.9 8.0 7.1	0.1 0.5 3.6
Middlesex	1.6	16.8	4.1	3.7	0.6	6.5 6.1	0.9 1.8
New Kent	1.1	4.6					
Newport News	2.6	6.3	0.5				
*Norfolk		3.0	0.7				
*Northampton	1.1	4.5	8.3	3.1	2.4	5.7 7.0	1.8 1.3
*Northumberland	1.6	8.8	10.3	5.7	8.0	5.2 7.1 6.1 10.6 5.7	2.4 0.4 3.3 0.6 1.3
Prince George	6.8	16.4	2.0				
*Richmond	0.5	8.5	9.7	2.0			
*Suffolk		1.6	1.3				
Spotsylvania	0.5	1.9					
Surry	0.3	15.8	2.5			11.8	3.8
*Virginia Beach					6.0		
*Westmoreland	2.3	5.0	11.3	7.1	1.5		
York	9.1	21.8	5.0	6.0		7.4	0.6
Total (Miles)	82.9	258.1	115.2	55.1	33.3		39.4

CUMULATIVE MILES OF EROSION

Erosion Rates (Ft./Yr.)	>0	>1	>2	>3	>4	>5
Miles of Shoreline	584.0	501.1	243.0	127.8	72.7	39.4

+ Does not include Fairfax, Prince William, and Stafford Counties for which there was no data.

* Includes only a portion of the county.

Data from: "Shoreline Erosion in Tidewater Virginia", Byrne and Anderson, Special Report in Applied Marine Science and Ocean Engineering Number 111 of the Virginia Institute of Marine Science, 102 pages; 1977.

retreat, on the other hand, generally represents the seaward limit of potential occupation or development. The present designation of areas having "Highly Eroding Shorelines" is therefore considered preliminary. Refined and more appropriate criteria for final designation are presented in the Recommendations in Chapter 7.

3.4 Coping With Erosion - The Present

At the present time the Commonwealth does not have a coherent program to alleviate the impacts of erosion for private property owners. Mitigation of the erosion impact has been the responsibility of the individual, shorefront-property owner. In some cases, the property owners have moved their residences back from the shore. However, by far most have installed shorefront structures to reduce or stop erosion. Several problems arise from this piecemeal approach.

1) In many cases the actions of an individual may exacerbate the erosion problem of adjacent property owners by trapping the littoral drift supply and/or by localized effects at the ends of structures.

2) Because various shorefront property owners may treat their individual lots at different times, interaction among adjacent or nearby structures may result in less effective erosion control.

3) Because individual property owners may select the structural approach for their property on the basis of intuition, their own observations, or on outside advice from people with varying degrees of expertise, many reaches represent a smorgasbord of structural methods. Frequently the mixed methods do not interact favorably for uniform protection.

4) Because shoreline protection is expensive, some property owners accept the lowest cost proposals only to find later that poor quality construction has resulted in loss of their total investment. At present there are no minimum standards for erosion abatement construction. Furthermore, while many of these structures require State or Federal permits, the

permitting agencies do not, at present, formally examine the adequacy of design or construction details of the proposed structures.

5) Once installed, virtually all structures require maintenance for long term effectiveness. As individual lot owners change, maintenance is not kept up, leading to premature loss or replacement of the structure.

Rather than the chaotic approach illustrated above, shoreline erosion needs to be addressed on a reach basis with full consideration for the net effectiveness of the structural or other methods employed. A reach is a shoreline unit wherein there is mutual interaction along the shore in response to the forces of erosion and/or the sediment supply. The methods employed within a reach should be selected to meet the shoreline management strategy for that reach. For example, consider a segment of shoreline which has wide creek mouths flanking it on both sides. Since there is likely little sand by-passing across the creek mouths, that shoreline segment may be considered an entity to itself with respect to erosion processes. To further exemplify, let us take a hypothetical case where half the shoreline reach is a high bluff of sandy material and that erosion of the bluff results in a sand supply to the other half of the reach. As conditions of individual management now stand, we might find that a land owner downdrift of the bluffed region would install groins (colloquially called jetties) to trap some of the sand, thereby widening his beach and inhibiting fastland erosion. At some later date the owner(s) of the bluffed region might decide to construct a revetment or bulkheads to inhibit or stop erosion of their property. In doing so, the local supply of sand to the groin field would be diminished leading to

failure of such a protection strategy. The downdrift property owner would then have to make a larger investment in an alternate strategy which was independent of reliance on an updrift sediment supply. This example clearly illustrates a circumstance wherein a coordinated community response to the erosion problem within an affected reach would be advantageous. Real case examples are abundant in the Chesapeake Bay System. The case for coordinated strategies along entire reaches is so strong that every effort toward such response should be endorsed. Such coordinated response will require expert analysis of the shoreline condition and design of appropriate structures. This requirement will necessitate enhanced advisory or engineering services, be they private or public.

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CHAPTER 4

EROSION/ACCRETION AFFECTING

CURRENT LAW AND POLICIES IN VIRGINIA

4.1 Current Law

Any attempt to understand or reconcile our present law concerning accretion and erosion would be incomplete without first examining the common law which is the historical foundation of current law and policies. The following definitions are useful as a starting point:

> Erosion - The gradual eating away of the soil by the operation of currents or tides.(1)
>
> Alluvion - That increase of the earth, on a shore or bank of a stream or the sea, by the force of water, as by a current or waves, which is so gradual that no one can judge how much is added at each moment in time.(2)
>
> Accretion - The act of growing to a thing; usually applied to the gradual and imperceptible accumulation of land by natural causes, as out of the sea or a river.(3)
>
> Avulsion - The removal of considerable quantities of soil from the land of one man, and its deposit or annexation to the land of another, suddenly, and by the perceptible action of water.(4)
>
> One authority states the general rule of accretion as follows:
>
> Under both the common law and civil law, when a river occupies land by erosion, the landowner loses title. He gains if the river recedes. The law of accretion was adopted with the common law of England... passed by Congress.(5)

This section states the general rule quite well. The riparian owner generally loses title when his land is eroded and gains when alluvion is deposited by accretion. These basic principles were recognized in Shively v. Bowlby(6) and St. Clair v. Lovingston.(7) In

St. Clair, an important distinction was made between avulsion and accretion or erosion. The English courts, in applying the principle of de minimus non curat lex(8) (the law does not care for trifling matters), set the stage for a distinction between gradual (trifling) changes and significant or avulsive changes. The U.S. Supreme Court addressed this issue in St. Clair v. Lovingston when they set forth the following judicial test for distinguishing gradual from avulsive changes in the shoreline.

> The test as to what is gradual and imperceptible, in the sense of the rule is, that though witnesses may see from time to time that progress has been made, they could not perceive it while the process was going on.(9)

The distinction between avulsive action and gradual or imperceptible accretion or erosion is of critical importance. If accretion or erosion occurs, title changes; title does not change if avulsion occurs.(10) The doctrine of avulsion has been largely overlooked in Virginia, but has not been neglected in other states. As applied in New York, the following two cases will illustrate the potential significance of the avulsion doctrine. In City of new York v. Realty Associates(11), the court held that a riparian owner was not divested of title, even temporarily, to land lost by submergence caused by reason of avulsion. This doctrine was expanded by a 1975 case, Trustees and Freeholders of Commonalty of Town of Southampton v. Heilner(12), which held the "owner of land abutting a navigable bay has the right to reclaim land lost through sudden submergence, but not that part of the land lost through erosion."(13)

This doctrine of avulsion could have a significant impact if applied to its maximum extent as it was in Freeholders v. Heilner. For example, under the New York rule, a landowner who lost forty feet during a storm would not only retain title to the submerged lands, but would be allowed to reclaim the land taken by nature's action. Possible stumbling blocks to the application of such a rule could be Sections 62.1-1 and 62.1-3 of the Virginia Code(14) which gives the State jurisdiction over the beds of state waters. Careful reading of these statutes indicates, however, that the State has jurisdiction over bottom lands owned by the Commonwealth. On this point there is little room for debate. The key principle on which a landowner could rely is that when the change is sudden or avulsive, title does not change. Therefore the Commonwealth does not own the beds land created by avulsive action and the State would not have jurisdiction under 62.1-1 and 62.1-3 over these newly created bottom lands. Conversely, when the loss of property is due to erosion, the gradual eating away of the shoreline, the state gains title and the landowner loses title.

The law of accretion and erosion is reflected in two Virginia cases. In Chesapeake and Ohio Railway Co. v. Walker(15), the court held that the appellant, as successor in title to a tract of land, was entitled to accretions to that property. In Steelman v. Field(16), the court held:

> The increase of land adjacent to the seashore, derived from alluvial deposits, happening so gradually that the increase could not be observed while actually going on, although a visible increase took place from year to year, belongs to the owner of the land bounded upon the sea. The riparian owner gains

> accretion, whether by reliction; the gradual and imperceptible recession of the water, or by alluvion; the gradual and imperceptible accretion from the water.(17)

The court in Steelman reasoned that access to water was one of the values of riparian land and adoption of any other rule would deny the riparian owner access and destroy the riparian nature of the land. The court went on to hold:

> Section 3574 of the Code of 1819, (Section 62.1-2 of the current Code), in terms extends the rights of riparian owners of lands on bays, rivers, creeks and shores of the sea to low water mark, however, as this line may change either for the advantage or disadvantage of the riparian owner, low water mark remains his true boundary under the Virginia statute. The title of the Commonwealth to public waters likewise shifts with the shifting sands.(18, see also 19)

These two cases effectively demonstrate that Virginia has adopted the general rules of erosion and accretion as inherited from the common law of England. Virginia courts have yet to come to grips with the doctrine of avulsion, but the majority rule seems likely to prevail.

One additional doctrine merits discussion before advancing to specific laws regarding Virginia's erosion problem. This is the doctrine of reemergence. An explanation follows:

> Where a landowner loses acreage to a navigable river by erosion, title to this acreage is transferred by law from him to the state or owner of the bed. If the river were to move in the other direction and replace the same acreage with accreted land, the landowner would obtain title by the doctrine of accretion. If the river were moved by an avulsive shift rather than by slow and imperceptible accretive movements, some jurisdictions recognize the "doctrine of reemergence," and hold that title to such land revests in its former owner.(20)

This rule is therefore the exception to the normal rule regarding avulsion. Normally, title does not change as the result of an avulsive action, but when an avulsive action recreates a former estate, title revests in the original owner. This doctrine is important to our study because when a lot (Lot A) erodes gradually away and is totally submerged, the next landowner behind this lost lot (the owner of Lot B) becomes a riparian owner and thereby receives an economic windfall. The question which is next posed is what occurs when accretions attach to Lot B and part of the land that was formerly Lot A is reformed. The answer suggested by the above passage is that if the reformation is a gradual accretion, title goes to the owner of Lot B, but if the deposit is the result of an avulsive sudden change the doctrine of reemergence will apply and the owner of Lot A can reclaim his reformed property. Obviously, because two conditions must be met (1) total erosion of Lot A; and 2) the avulsive reemergence of what was formerly Lot A), the doctrine of reemergence is seldom applicable, and no instance of its application has been found in Virginia law. Its existence should nevertheless be noted.

4.2 Shoreline Erosion Policy in Virginia

Many states have passed legislation and invested large sums of money to deal with the shore erosion problem. Despite the fact that erosion is a serious problem in Virginia, the Commonwealth has taken little action to address shoreline erosion. There are four sections of the Code of Virginia which deal with the erosion problem. The Shore Erosion Control Act (21), presented below is basically a statement of policy.

Article 2.2 Section 21-11.16 states the policy:

> Declaration of policy. The shores of the Commonwealth of Virginia are a most valuable resource that should be protected from erosion which reduces the tax base, decreases recreational opportunities, decreases the amount of open space and agricultural lands, damages or destroys roads and produces sediment that damages marine resources, fills navigational channels, degrades water quality and, in general, adversely affects the environmental quality; therefore, the General Assembly hereby recognizes shore erosion as a problem which directly or indirectly affects all of the citizens of this State and declares it the policy of the State to bring to bear the State's resources in effectuating effective practical solutions thereto. (1972, c. 855)

The act also gives the Virginia Soil and Water Conservation Commission responsibility to coordinate shore erosion control programs and authorizes the Commission to hire one shore erosion engineer to assist in carrying out these programs. However, the act is simply a statement of policy; it contains neither organizational nor enforcement provisions. Further, no funds have been appropriated since passage in 1972 to hire the shore erosion engineer.

One year later another Virginia statute, the Erosion and Sediment Control Law(22), delegated responsibility to the Virginia Soil and Water Conservation Commission to create an erosion and sediment control program. The act calls for the Commission to cooperate with soil and water districts and local governments in developing a statewide coordinated erosion and sedimentation program. The statute, however, specifically excludes tidal shore erosion control projects approved by the Marine Resources Commission from coverage. A review of this legislation and the guidelines promulgated by the Soil and

Water Conservation Commission indicates that the law is primarily intended to address the problem of upland erosion and sedimentation rather than the particular problem of shoreline erosion in coastal areas. Thus, Virginia is still without a comprehensive statewide approach to the coastal erosion problem.

The Code of Virginia further authorizes the creation of the Virginia Beach Erosion Commission to deal with shoreline problems in the Virginia Beach oceanfront area.(23) The Commission has addressed the beach stability problem by implementation of an extensive beach nourishment program. In 1977 approximately 285,000 cubic yards of sand were used to stabilize the Virginia Beach shoreline. 160,000 cubic yards of this sand were pumped from Rudee Inlet, and the remainder trucked in from Fort Story. This massive beach nourishment program was carried out on a budget of $945,000. Of this money, $150,000 was a direct appropriation from the General Assembly.(24) The Army Corp of Engineers provides 50 percent matching funds for new source materials to be applied to the shoreline. The remainder of the funds came from the "sand tax" which is levied by the city on the resort (hotel/motel) shoreline owners. Under this special tax scheme, the monetary burden of financing shoreline protection is placed on those who benefit most from the program. The money collected is not spent solely on shoreline nourishment, however. Other programs funded by the Virginia Beach Erosion Commission include offshore surveys and channel maintenance. One significant problem looms on the horizon for Virginia Beach; the sand stockpile at Fort Story is virtually depleted

and an alternative sand source must be found if the nourishment program is to continue as in the past.

Norfolk has received a $90,000 appropriation from the General Assembly. The Community Improvement Department of the City of Norfolk is charged with responsibility for these funds and for development of an effective erosion plan. Current plans include a channel bypass feasibility demonstration to be conducted at the Little Creek Channel, beach nourishment, (similar to the Va. Beach Program), an analysis of long range sources of sand, and the development of long range strategies to deal with the overall shoreline erosion problem in Norfolk.(25)

In 1978 the General Assembly established the Coastal Erosion Abatement Commission(26) to study the effects of erosion on the beaches, islands and inlets of the Commonwealth and shall make such recommendations as are deemed necessary to prevent the further destruction of these valuable natural resources. The Commission is scheduled to complete its study and report its findings to the Governor and the General Assembly no later than December 1, 1979.(27) The work of this Commission and the recommendations made by them may well represent the future of Virginia's shoreline erosion laws.

Section 15.1-31 of the Virginia Code (1960) is significance in terms of state and local liability for actions taken to control erosion. According to this section:

> (a) Any county, city or town may construct a dam, levee, seawall or other structure or device.....the purpose of which is to prevent the flooding or inundation of such county, city, or town, or part thereof.

(b) The General Assembly withdraws the right to bring....any action at law or suit in equity against any county, city, or town because of, or arising out of the design, maintenance, performance, operation or existence of such works.....but this provision shall not be construed to authorize the taking of private property without just compensation....(28) (emphasis added)

Although erosion is not specifically cited as a rationale for this section, erosion can cause flooding and inundation and action taken to control erosion may arguably fall within the purview of this provision. Any ambiguities regarding this section may be resolved by the simple addition of the word "erosion" (see Chapter 8.5 F) to the enumerated hazards of flooding and inundation. This freedom from tort liability could also be made available to the political subdivisions of the state by simple amendment. Any changes to or interpretations of this section must be consonant with Article I, section 11 of the Virginia Constitution prohibiting taking or damaging of private property for public use without just compensation.

4.3 Federal Programs

A survey of applicable Federal law pertaining to shoreline erosion is important when considering development of a state erosion plan. Several Federal agencies have addressed the problem and are currently involved with the shoreline erosion problem on a national scale. These agencies include: The Office of Coastal Zone Management in the National Oceanographic and Atmospheric Administration (NOAA), as administrators of the Coastal Zone Management Act of 1972, as amended in 1976(29); the United States Army Corps of Engineers(30);

the National Flood Insurance Administration (NFIA); and, to a limited extent, the Small Business Administration.

One of the paramount considerations when adopting a state erosion program should be compliance with Section 305(b)(9) of the CZM. States must meet these requirements to qualify for Federal funds to implement a state coastal zone management plan.

Those shoreline areas identified as Geographic Areas of Particular Concern, as erosion hazard areas must meet the requirements of Section 923.21:

> Sec. 923.21 - Areas of Particular Concern
>
> For areas designated as GAPC's a state must:
>
> 1. Describe the nature of the concern and the basis on which designations are made.
>
> 2. Evaluate areas of significant hazard if developed, due to storms, slides, floods, erosion, settlement, and saltwater intrusion, to determine if such areas should be addressed by a special management program (GAPC).
>
> 3. Describe how the management program addresses and resolves the concern on which such a designation is based.
>
> 4. Provide guidelines regarding uses in the designated areas, including uses of lowest priority, in order to:
>
> a. provide an adequate basis for special management in areas of particular concern, and
>
> b. provide a common reference point for resolving conflicts.
>
> 5. GAPC's must be designated in sufficient detail so that affected landowners, governmental agencies, and the public can determine with reasonable certainty if

an area is or is not designated (maps are suggested).(31)

The United States Corps of Engineers maintains a Beach Erosion Control Program defined in the Flood Control Act of 1962 (PL 87-874):

Sec. 426e - Federal Aid in Protection of Shores and Declaration of Policy (Condensed from 33 U.S.C. 426 et seq.)

1. Policy - "With the purpose of preventing damage to the shores of the United States and promoting and encouraging healthful recreation of the people, it is the policy of the U.S. to assist in the construction, but not the maintenance, of works for the restoration and protection against erosion by waves and currents, of the shores of the United States."

2. Federal Contribution

a. In the case of any project the Federal contribution shall not exceed one-half of the total cost of the project.

b. In the case of projects for restoration and protection of publicly owned parks and conservation areas, the Federal contribution may be as much as 70 percent of the total costs (exclusive of land costs), when such areas:

1) Include a zone which excludes permanent human habitation;

2) Include but are not limited to recreational beaches;

3) Satisfy adequate criteria for conservation and development of natural resources;

4) Extend landward to include protective dunes, bluffs, or other natural protective features where appropriate.

5) And provide essentially full park facilities for public use.

c. All of the requirements of (b) above will meet with the approval of the Chief of Engineers.

d. Federal participation in projects providing hurricane protection may be not more than 70 percent of the total cost exclusive of land costs.

3. Definition of "construction"

a. When the most suitable and economical remedial measures would be periodic beach nourishment, the term "construction" shall be construed to include such artificial supply of sand.

4. Shores other than public will be eligible for Federal assistance if:

a. There is benefit such as that arising from public use;

b. There is benefit from the protection of nearby public property; or

c. If the benefits to those shores are incidental to the project; and

d. The Federal contribution shall be adjusted according to the degree of such benefits.

Allotment to States, Localities

1. Not more than $1,000 shall be alotted for any simple project (Sec. 426g).(32)

The policies outlined above indicate that only shoreline projects which benefit public lands are eligible for Federal assistance. The Corps is quite active in the field of shoreline erosion and has developed considerable expertise in this particular area of coastal zone management. In addition the U.S. Corps of Engineers is authorized (Section 55, Public Law 93-251, Water Resources Development Act of 1974) to provide technical advisory services to any duly authorized agency of any State, county, city or subdivision thereof. While these services do not include funding of structural or

non-structural controls, technical advice and comment on engineering design is supplied. If the costs of technical services exceed $3,000, the District level authority must secure Division level authorization.

The Federal Insurance Administration (FIA) is involved, although to a more limited extent, with the erosion problem. Compliance with the requirements of the Flood Disaster Protection Act of 1973, which amended Section 1302 of the National Flood Insurance Act of 1968 to extend flood insurance coverage to "damage and loss resulting from the erosion and undermining of shorelines by waves or currents in lakes and other bodies of water exceeding anticipated cyclical levels", must also be considered. This language has caused technicians some difficulty as it is difficult to determine what constitutes "anticipated cyclical levels". This difficulty has in fact hampered development of practical regulatory and insurance policies.(33)

Section 1910.5 of the National Flood Insurance Program proposed a set-back requirement for lands designated as type E zones by the Administrator of FIA. The FIA has been unable to develop useful guidelines for determining when erosion damage is covered, and therefore this section has not achieved any of the goals which Congress had intended in the legislation amending the Flood Disaster Protection Act of 1973. This standstill in development is confusing and difficult for both technicians and communities seeking the protection that the FIA was mandated to provide.

Recent discussion with FIA officials indicates a desire to repeal the V zone (coastal high hazard area) and the E zone (special

flood-related erosion hazard area) provisions of the Flood Disaster Protection Act of 1973, as amended.(34) Officials indicated a desire to place the erosion provision in another program, possibly the Coastal Zone Management Program. One may place some significance on the fact that to date no E zones have been designated by the administrator.

A study was recently completed (June, 1978) by the Great Lakes Basin Commission Standing Committee on Coastal Zone Management.(35) Because of the difficulties in implementation the FIA has been experiencing, the Study recommends repeal of the erosion coverage sections of the Flood Disaster Protection Act, and that a national program be established to provide financial assistance for state level implementation of erosion plans developed pursuant to Sec. 305(b)(9) of the Coastal Zone Management Act. A brief summary of the study is included in Appendix C.

The Small Business Administration makes low or no-interest loans available following storm related damage. In order to be eligible for this relief a designation as disaster area must be declared. An assessment of damage by the Governor and, in some cases, a follow up by the President is necessary, but the potential availability of such funds should not be overlooked.

ENDNOTES

1) Black's Law Dictionary, revised fourth edition.
2) Id.
3) Id.

4) Id.
5) Thompson on Real Property, Vol. 5A p. 2562 1957 (Repl. Vol.)
6) Shively v. Bowlby, 152 U.S. 1, 35 (1893).
7) St. Clair v. Lovingston, 90 U.S. (27 Wall.) 49 (1874).
8) 2 Blackstrone commentaries 262.
9) St. Clair v. Lovingston, see note 7.
10) City of New York v. Realty Associates, 176 N.E. 171, 265 N.Y. 217 (1931).
11) Id. as above.
12) Trustees and Freeholders of Commonalty of Town of Southampton v. Heilner, 375 NYS 2d 761, 84 Mix 2d 318 (1975).
13) Id. as above.
14) Va. Code Ann. Sec. 62.1-3.
15) Chesapeake and Ohio Railway Co. v. Walker, 100 Va. 69,40 S.E.633 *(1902).
16) Steelman v. Field, 142 Va. 383, 128 S.E. 558 (1925).
17) Id. as above.
18) Id. as above.
19) See also Va. Code Ann. Sec. 62.1-2.
20) 14 Arizona Law Review 325 (1972).
21) Va. Code Ann. Secs. 21-11.16 thru 21-11.9.
22) Id. at 21.89-1 thru 21.89-15.
23) Id. at 62.1-153.
24) Ken Melson, Va. Beach Erosion Commission, personal communication (1978).
25) Don Mathias, Norfolk Community Improvement Dept. personal communication (1978).
26) Senate Joint Resolution No. 22, February 15, 1978.
27) Id. as above.
28) Va. Code Ann. Sec. 15.1-31.
29) Coastal Zone Management Act Amendments, 1976; 16 U.S.C. 1451 et. seq.
30) U.S. Army Corps of Engineers Beach Erosion Control Program, 33 U.S.C. 426 et. seq.
31) 43 Fed. Reg. 8403 (1978).
32) Id. at 30.
33) Quotes from a report by the FIA for the National Conference on Coastal Erosion, July 1977.
34) Discussion with Nick Lally, Chief, Flood Plain Management, and Kennon Garvey, staff, FPM, FIA, Washington, August, 1978. Paper presented at "The National Conference on Coastal Erosion," July 6-8, 1977, by FIA staff.
35) Erosion Insurance Study conducted by the Erosion/Hazard Management subcommittee of the Great Lakes Basin Committee Study Coastal Zone Management. June 1978.

CHAPTER 5

MANAGEMENT STRATEGIES - POSSIBILITIES AND CONSTRAINTS

5.1 Elements to be Considered in Formulating A Strategy

A number of considerations are required before any particular management strategy can be reasonably selected for any reach of coastline under consideration. The factors in that planning process are:

1) A statement of the erosion induced problem,
2) A clear statement of the management goal(s) for that reach.
3) A complete technical assessment of the options for structural and non-structural treatment and a statement of the trade-offs within and among options,
4) An assessment of the costs and benefits of the various technical options in light of current and projected or planned land use characteristics, and
5) An assessment of possible mechanisms to fund the mitigation program. These institutional considerations include the distribution of costs between private and public sectors.
6) An examination of legal issues.

Of course the resolution of the legal issues involved in various strategies is critical to successful management. The remainder of this section discusses these elements.

5.1.1 Statement of the Erosion Induced Problem. The erosion induced problem may differ appreciably for different reaches within the same region. However the underlying cause of the problem is an erosion rate which is perceived as intolerable for one reason or another. In one reach the erosion rate may be so high that regulation of building activity in that hazard zone is deemed necessary. In another reach, shoreside tourist facilities and/or the beach itself, the keystone of the tourist attraction, may be eroding.

5.1.2 Management Goals for a Reach. The management goal(s) may be framed in terms of the principal effects of erosion (Chapter 1):

1) To reduce, eliminate, or prevent the victimization of existing or future property owners by the loss of property, property improvements, and productive use of property due to erosion,
2) To reduce the loss of taxable lands within localities.
3) To reduce the influx of erosion products into the estuarine system and its flanking tidal entrances, and
4) To maintain a supply of sand to beaches within the reach.

Certainly other management goals may be stated; however, these goals (individually and in combination) must be viewed as the principal choices for the program within the reach. Not all goals will have equal weight for any given reach. In fact, satisfaction of all of the goals for any reach is not likely as some are mutually exclusive.

5.1.3 Technical Assessment of Options. The technical assessment for options within a reach involves five principal elements:

1) Determination of the limits of the reach. A reach is a segment of shoreline wherein the erosion processes and responses are mutually interactive. Appreciable littoral sand supply, for example, would not pass the boundaries of the reach. A reach may also be defined as shoreline segment wherein manipulation of the shoreline within that segment would not directly influence adjacent segments;
2) Determination of the rates and patterns of erosion and accretion within the reach;
3) Determination within the reach or the sites of erosion induced sand supply and the volumes of that sand supply for incremental erosion distances (also determine the sand volumes lost from the reach);
4) Determination of the direction of net littoral drift, and, if possible, estimation of the magnitude of gross and net drift rates;
5) Estimation of erosion causing factors other than wave induced, such as ground water or surface runoff.

The importance of these five elements can be illustrated by considering an example. Suppose we have a shoreline reach in which one-half is an eroding bluff containing a high percentage of sand and there is a strong net littoral drift such that as erosion of the bluff proceeds the sand supplied by erosion acts to supply beach materials

to the downdrift beaches which may also be eroding. This case nicely illustrates the interactive nature of processes within a reach since the erosion of the bluff supplies sand to the beach fronting the bluffs as well as the downdrift beaches in the same reach. The sand supply, in turn, retards the erosion rate by at least partially maintaining the beach. Elements such as these are cornerstones in the evaluation of various options. For example, if the decision were made to stop erosion of the bluff with the installation of a riprap revetment, that action influences the options remaining for the remainder of the reach. For example, the installation of a groin field in the downdrift portions of the reach would be a marginally effective action as the sand supply required for their proper function would be starved by preventing continued erosion of the sandy bluffs. It is this type of interactiveness between components of the reach which must be considered in the formulations of options.

5.1.4 Economic Assessment of Costs and Benefits, An Economic Decision Framework. The objectives of the economic assessment methodology is to estimate those costs and benefits which are necessary for a comparison of alternative erosion control strategies. Alternative strategies include both structural and non-structural measures as well as a no-action strategy. The methodology provides for an assessment of benefits and costs on the basis of a shoreline reach.

Control measures may have an impact on benefits and costs in three different shore areas:

1) Shore zone - a buffer between the water body and the fastland. The seaward limit is essentially the mean low water line which generally separates the steeper slope of the foreshore from the low tide terrace of lesser slope. The landward limit is the fastland which is generally discernable by a topographic feature such as a bluff face or upland vegetation.

2) Nearshore zone - the nearshore zone extends waterward from the shore zone to the 12-foot contour.

3) Fastland zone - the zone extending from the landward limit of the shore zone is termed the fastland. Fastland is relatively stable and is the site of most material development and construction.

Calculations of costs and benefits should include the impact of controls on each of these areas. Either private or public entities may incur costs and accrue benefits. Therefore, total costs and benefits are calculated with a secondary breakdown between private and public entities.

Section 6.2 of this report is a application of the economic assessment methodology or decision framework. The following discussion of the factors and methods included in the case study is intended to serve as a guide to the process of economic assessment.

5.1.4.1 Costs. For each shoreline reach, an assessment of options was made by shoreline erosion technical experts. Appropriate

structural control measures were proposed. Structural controls include measures or combinations of measures from the following general categories:

groin fields	riprap revetments
bulkheading or seawalls	perched beach
contouring of the fastland	jetties at inlet entrances

Costs of implementing the proposed structural control measures were based on standard cost guides with costs in present dollar values. For activities such as dredging and beach nourishment continuing expenditures were discounted to a present value.

Another cost factor assigned to costs of structural controls was the cost of technical assistance. This type of assistance would be provided by shoreline technical experts and includes:

1) work of technicians including the measuring of erosion rates, interpreting maps and photos, and tabulating data;
2) scientific analysis including field, laboratory and office work using data from number one;
3) general oversight for technical aspects of erosion control programs.

In addition to the impact on the value of property and improvements in the fastland zone, structural measures may result in impacts in both the shore and nearshore zones. The impact on costs are generally described as the changes in opportunity to use a resource - in this case a change in the flow of service from the water based activity. These activities include:

1) change in water quality,

2) change in fish and plant resources,

3) marina locations,

4) restrict or change recreation uses,

5) shellfish harvest,

6) congestion of waters,

7) change in potential flood damages.

With the exception of information on dredging and beach replenishment, measurements of the impact of control measures on the nearshore and shore areas were unavailable. A complete evaluation of these impacts was outside the scope of this study. Therefore, only limited information for these activities could be included in the analysis.

A second set of costs were derived from estimated decreases in values of property and improvements or losses from restrictions on use of resources because of implementation of selected non-structural control measures. Non-structural controls include the following categories:

1) ownership restrictions - such as public acquisitions, easements, etc.;

2) regulating actions - such as permitting, zoning, setback lines, etc.;

3) relocation - this measure involves relocation of major structures;

4) financial incentives - such as taxation, low interest loans, grants, etc.;

5) insurance programs.

Values are calculated for each reach on the basis of a "without" and "with" approach. That is, values for resources and their uses were estimated for the current situation and compared to their values after implementation of a control measure.

The third set of costs were those associated with transaction and administration activities involved in the actual implementation and control of the program. Cost categories include:

1) ownership restrictions (includes relocation),

2) regulatory action,

3) financial incentives,

4) data collection/planning,

5) educational/assistance.

Where appropriate, legal costs and the cost of administering compensation programs were included. These costs, as with the first two sets, are calculated as an average for a reach.

Administrative and transaction costs for an ownership restriction or regulating action program were based on implementation and control of that program for a shoreline reach area. Likewise, costs were calculated for administering a financial/incentive program which included grants, taxation, loans, and insurance programs.

Costs of data collection/planning/research include necessary activities to allow for a comparison of benefits and costs of alternative management strategies. This category included costs of

collection of real estate and assessment data, land use information, calculation of changes in values of property and improvements and land uses in each shoreline reach area, and costs of analyzing the impact of various control strategies on costs and benefits.

This third set of costs are extremely important to the process of making comparisons between various levels of jurisdictional control over management strategies.

5.1.4.2 Benefits. Benefits from erosion control measures may accrue in all three shore areas - the shore zone, nearshore zone and fastland zone. However, as with the cost calculations, only limited "information" exists for the impacts in the shore and nearshore zone. Benefits associated with dredging and beach replenishment were included for the shore zone. Benefits from accretion and the flow of services from water-borne activities were excluded because information on those activities was not readily available.

On-shore benefits of structural control measures were derived by applying a "without" and "with" control analysis. Benefits were derived by calculating future erosion damages which would be prevented by implementing erosion control measures. These benefits are calculated for four categories:

1) land use (productivity)
2) buildings and structures
    a. dwellings
    b. other buildings on land (sheds, garages, barns, etc.)
    c. structures on water (piers, docks, boat houses, etc.)

3) property values (land minus improvements)

4) loss of tax revenue.

Sources of data used to establish values and procedures used to calculate values are explained in detail in Appendix A of this report. Application of the procedure to a case study area is presented in Section 6.2 of this report.

5.1.4.3 Establishing Values for Current Situation.

Evaluation of the impact of erosion control strategies on value of property (including improvements) and uses of that property for each individually owned parcel was based on the value of those resources in a status quo state (that is, let erosion continue without additional control measures) compared to the value with control strategies. Therefore, values for the resources in the identified impact area were established as the basis for calculation of impact costs and benefits.

For purposes of this study, the value of property and improvements of individually owned parcels was determined for both a 100-foot and 200-foot depth frontage as well as a 10-year, a 15-year, a 30-year, and a 67-year erosion rate depth area and then consolidated for each identified reach. These six alternative impact areas will allow a decision maker to compare the magnitude of costs and benefits of various management strategies. The six alternatives were selected because the 100-foot and 200-foot depth frontage are commonly suggested management strategies. Also, recent erosion rates are approximate indicators of future erosion rates for 10, 15, and 30-year periods and many control structures are amortized on those years of useful life. Likewise the 67-year erosion rate has been suggested for

use in the federal flood insurance program. The 67-year period is based on the average useful life of residential structures.

5.1.4.4 Establishing Impact Values for Insurance Programs. As indicated in Chapter 4.3 of this report, discussions with Federal Insurance Administration (FIA) officials indicate a desire to repeal the V zone (coastal high hazard area) and the E zone (special flood-related erosion hazard) provisions of Flood Disaster Protection Act of 1973, as amended, and place those provisions into another program, possibly the Coastal Zone Management Program. Day-to-day erosion and bluff type undercutting would be excluded from the FIA program. Over-wash type erosion flood problems or unanticipated recession of the shoreline where erosion is associated with inundation would be covered under the normal flood disaster program. That insurance covers structures and contents of those walled and roofed structures but generally does not cover boat houses over the water. Land is excluded because it is generally not tied to disaster relief. Docks and appurtenant structures are not covered.

In addition to the option of removing erosion from the program, four other options are suggested for consideration. The four options are:

1) total prohibition of new construction in erosion hazard areas,
2) setback requirements within erosion zones,
3) no insurance zones as an alternative to setback requirements, and
4) moveable structures and buffer zones.

This study acknowledges that a difference in insurance rates may be tied to erosion characteristics or erosion control practices. Also, insurance rates are directly related to structure evaluation and flood proofing. Because the insurance rate structure (both subsidized and actuarial) is dependent on many variables, unknown at this time, no attempt was made to calculate those differences or the cost and benefits of flood proofing and structure elevation which will remain as part of the provisions of the traditional flood insurance program.

Nevertheless the established values for property and improvements were used to provide sufficient information as to the probable impacts of the proposed insurance alternatives.

5.1.4.5 Use of Costs and Benefits in Evaluation of Management Strategies. The calculated costs and benefits values were consolidated into a summary budget for each study reach. Detailed procedures for construction of the budget is explained in Appendix A. The compilation of the costs and benefits into the summary budget provided the basis for making the following comparison for each shoreline reach:

1) between no-control (continue as is) and selected control measures for selected areas,
2) between various levels of control as represented by the proposed options for each reach,
3) between structural and non-structural control measures, and
4) distribution of costs and benefits between private and public sector.

An important constraint and limitation to the analysis is the current inability to relate cost for each level of control (the marginal cost) to the benefits for each level of control (the marignal benefit). That analysis is needed before the optimal level of control for each area can be determined. Our analysis does, however, provide reasonable estimates for selected levels of control.

A secondary use of the consolidated figures on the value of resources in a status quo state within each reach and for each depth frontage area or erosion rate depth area was to provide a comparison of the magnitude of costs and benefits involved in various policy actions. For example, costs and benefits were calculated for impacts from such proposed insurance related practices as total prohibition of construction in an area, open space requirements, setback requirements and relocation costs. The analysis provides a realistic assessment of the magnitude of costs and benefits associated with each option. (See Section 6.4 of this report)

5.1.4.6 Evaluation of Policies on Management Strategies. The consolidated budget figures also provide necessary cost and benefit data for use in making a policy decision on the best management strategy. Costs and benefits on the basis of total costs and benefits and between private and public entities can be allocated amongst various management strategies which are based primarily on the level of jurisdictional authority and control.

5.2 A Guide to Institutional Alternatives

A variety of public and semipublic tools exist for dealing with shore erosion specifically and shoreland use generally. These tools,

described in the following section, can be grouped in several broad categories: direct ownership and control; use regulation; incentive measures; and educational/advisory services. In the case of public actions other standards become relevant in assessing appropriateness. These include principles of: 1) equity in the distribution of public costs and benefits; 2) maximized administrative efficiency and coordination; and 3) maximized return on investment except where superceded by the public need.

A number of institutional alternatives are available for applying structural and non-structural solutions to shoreline erosion problems. They can be employed by local, state and federal governments alone or in combination with private interests. An outline of the alternatives follows.

5.2.1 Public Ownership and Land Dedication. Full or partial public ownership of land (and/or structures) offers the most direct means of managing erosion-prone shorelines. Outright ownership of erodable property would basically insure full control of development, plus proper construction and maintenance of shoreline structures in these areas. But it is a limited approach. In the case of property acquisition, major limiting factors include purchase costs of the property and selection of a party to be responsible for the property.

Funds for selective acquisition of shoreland areas could be raised either through an earmarked appropriation from the state's general fund, or through solicitation of funding from foundations (e.g., the Nature Conservancy). In the case of appropriation, a state

funding priority scheme favoring shoreline preservation would need to be developed.

A related approach in developing shoreline areas is that of mandatory and/or voluntary dedication of public easements or property. Local governments are already empowered to require land dedication for public use as a condition of subdivision plat approval. Under Delaware's erosion control program, for example, the State will fund a shoreline stabilizing project if the property owners agree to allow access to the once private beach (Del. Code Ann. 6801 et seq.).

Voluntary dedication of easements or property would also be solicited for acceptance by third parties as gifts to be held in public trust, in combination with some of the regulatory and tax incentive tools discussed later in this section. It should also be noted that Corps of Engineers assistance for erosion control is only available for projects which benefit public use of shore property. Appropriate holding bodies for such properties could include special purpose federal, state, or regional authorities, local or regional special districts, quasi-public organizations or public trusts, and state agencies. Authorization for cooperation among local governments in such activity is provided by the "joint exercise of powers" provision of the Intergovernmental Cooperation Act of 1972. Federal Title V commissions such as the Coastal Plains Regional Commission provide a model for interstate cooperation.

5.2.2 Regulation and Use Restriction. Regulation of shoreline uses could take the form of several existing land/water use management models. It is important, however, to avoid new regulatory machinery

where possible. Regulatory approaches hold greater promise in the case of hazardous shorelines which were designated as GAPCs where the police power can be invoked.

Zoning is the basic tool provided to local governments for regulation of land uses. Enabling legislation currently allows local governments to establish shorelands zones within which minimum setbacks may be required, and also to establish special conditions for the development and use of environmentally-sensitive lands. The limiting factor in the shoreland zoning approach is the degree of dependence on state agencies created for information about local erosion rates and the likely inland extent of the problem. The federal Flood Insurance Administration has recently suggested several variations of the shoreland hazard zones. These boundaries would be determined by multiplying average useful lives of shoreline structures by the predicted local shoreline erosion rate. Within the zone, (a) future uses would be limited to open space, or else (b) specified "no-construction" setbacks would be created, inside of which new structures would either be prohibited or allowed only if capable of being relocated. The City of Virginia Beach has adopted specific building regulations applicable to areas subject to coastal storm flooding and wave action.

Subdivision and/or site plan review ordinances represent companion tools to local zoning ordinances more directly focused on construction standards. Subdivision regulations (now required of all Virginia localities) apply to land division and transfer, and allow localities to: 1) review plats for consistency with established

standards for erosion, drainage, and flood control; 2) require dedication or rights-of-way or land for public use as a condition of plat approval; and 3) reserve lands for future public acquisition on the basis of approved plans for public facilities. Recent authorization by the General Assembly to extend power of contract zoning (conditional rezoning) to all local governments is an important supporting measure. It allows these governments to negotiate with developers and produce binding agreements on specific uses to be permitted in particular districts. Assistance in assessing possible impacts of (or hazards to) various uses would need to be provided by the state or other sources, however.

Public acquisition of development rights allows the imposition of various forms of use restriction. One of the more frequent applications of the principle has been in the case of historic or scenic easements, where property owners agree to transfer certain development rights to the public while retaining ownership of the property. A more elaborate approach involves the creation of housing and redevelopment authorities, empowered under special legislation to purchase, clear, and return to market land at somewhat reduced value and with use restrictions. Authorization can also include provisions for design and construction of protective measures. Use of this device for the management of hazard areas specifically might require some clarification of the enabling legislation, but the most critical factors would probably be funding and staff. In Virginia, such authorities have functioned well only when federal funding has been available and in limited, intensively-developed areas where high costs

of operation are balanced by high returns in the form of hazard or blight reduction.

Virginia's wetlands legislation provides another regulatory model generally relevant to the erosion problem. Under the legislation all local governments in Tidewater Virginia are authorized to adopt wetlands zoning regulations for specified wetlands areas and to establish local wetlands boards with permit issuance authority over uses (less certain exempted uses) within these areas. Permit decisions of local wetlands boards are subject to review and override by the Virginia Marine Resources Commission (VMRC), and, in areas where local wetlands ordinances are not adopted, the VMRC retains direct control of wetlands uses. Variances for demonstrated hardships are permitted, as in the case of conventional zoning.

The regulatory jurisdiction of the VMRC also extends to activities upon subaqueous land, and provides still another regulatory framework. Under the State Code, the VMRC administers a permitting/leasing program for all uses of state-owned subaqueous land not specifically exempted, with provision for limited environmental impact assessment in coordination with the Virginia Institute of Marine Science and other advisory agencies of proposed actions.

5.2.3 Incentive/Disincentive Measures. Incentive measures for managing erosion-prone shorelines could include various combinations of grants, cost-sharing, and preferential tax, loan, and insurance policies* closely tied to the regulatory and advisory approaches

* Discussed in Section 4.3.

described elsewhere in this section. Maryland's Shore Erosion Control construction fund, which offers long-term, interest-free loans for construction of control structures, is one example of direct incentive approach. However, such programs might foster the individual piecemeal approach.

Another approach would involve the adoption of enabling legislation authorizing local governments to design, construct, and maintain shoreline defense structures on a shoreline reach basis, through creation of erosion abatement districts with limited bonding power. Under this approach shoreline property owners would request their local governments to create such a district, as in the case of present Watershed Improvement Districts under the Soil and Water Conservation Districts. The local government would then be authorized to issue special two-way bonds for financing the construction of suitable erosion abatement structures for the district and to assess individual property owners along the shoreline for the purpose of repaying the bonds and financing maintenance costs. Several coastal states use this approach to finance local erosion projects. A number of variations on this basic scheme are possible.

Incentives should be designed to encourage nonconflicting uses of the shoreline, as well as the replenishment (where feasible and necessary) of eroding shorelines, and the proper installation and maintenance of control structures. One major problem area is the present system of property taxation, which in effect tends to encourage transfer and development of shorefront property rather than retention in low-intensity use or improvement in the form of

flood-proofing or erosion defense. Local assessment of low-intensity shorefront land as commercial property, for example, now has the effect of forcing conversion to that use, because the carrying costs of holding the land in any lower use become prohibitive. Property tax exemptions and/or income tax credits for improvements to property in hazard areas could be offered, although these measures alone would probably not be sufficient to offset the true "costs" of improvements to property owners (or even retention in nonproductive use) because such improvements would seldom enhance the property's market value. This problem might be attacked more directly through broadening of the present land use assessment law or changing the assessment criteria to take into consideration raw land and use of structures as well as productivity of land.

5.2.4 Educational/Advisory Services. Educational and advisory services would constitute a key component of any erosion abatement program. Educational activities dealing with the erosion problem in large would need to be targeted separately to the general public and to officials, by means of meetings, brochures and newsletters, audiovisual packages, and other media. Some form of training/advisory program for local officials and program staff would probably be essential, along with the development of management guidelines for use in local planning and permitting activities.

Advisory services to current and prospective shorefront property owners would remain an important element of an overall management program, and might be expanded to include development of

state-of-the-art design and construction guidelines for marine contractors. Advisory services to private property as well as public bodies, are now available from the Virginia Institute of Marine Science and the Soil Conservation Service (USDA). The U. S. Corps of Engineers provides advice as well, upon request of duly authorized state and local agencies. One major addition to these existing services could be the establishment of a mandatory risk alert system, in which property title transfer would be preconditioned on acknowledgement of a shoreline property's erosion to the prospective owner. Lack of knowledge of risks has been a chronic problem producing both unnecessary liabilities in the form of shoreline improvements and poorly-designed remedial/protective structures which often increase the erosion threat to properties throughout the reach.

5.3 A Guide to Legal Issues in Management Strategy

5.3.1 Individual Liability for Downdrift Impacts of Shoreline Defense Structures.

The most important point to remember is that the law regarding liability for downdrift impacts is at the evolutionary or developmental stage. For this reason there have been few cases litigated on this point. Obviously, in situations where there is no statutory law and very few cases, it is difficult to make a judgement. This section discusses the common law right which allows a riparian owner to protect his property from the sea and analyzes the four cases which have been litigated on this point.

That an owner may protect his property from damage by the sea is widely recognized. This right is most commonly expressed as the Common Enemy Doctrine. An excerpt follows:

> Every proprietor of land exposed to the inroads of the sea may erect on his land groins, or other reasonable defenses, for the protection of his land against the inroads of the sea, although, by doing do, he may cause the sea to flow with greater violence against the land of his neighbor, and render it necessary for the latter to protect himself, by the erection of similar sea defenses. "Each landowner has a right to protect himself, but not to be protected by others, against the common enemy." But a man has no right to do more than is necessary for his defense and to make improvements at the expense of his neighbor.(1)

In Jubilee Yacht Club v. Gulf Refining Company(2), the reasoning cited above was followed. In this case the court held, "The erection of fences, walls, or other structures, or the making of excavations on his own land, is ordinarily within the absolute right of the owner, without reference to the incidental injury which thereby be caused to his neighbor."

Only one case, KatenKamp v. Union Realty Company(3), has been discovered in which a riparian owner has been held liable for downdrift impacts created by the erection of an effective groin. In KatenKamp the landowner was not attempting to protect his shoreline, which was rocky, and not in need of protection. The groin erected by the landowner was not to protect property as expressly sanctioned in the common enemy doctrine but to improve the land. The owner was quite successful in that he turned his rocky point into a sandy beach, but activities of this sort are improvement schemes and not protective measures. KatenKamp can be distinguished from the normal protection situation because the owner was attempting to change and improve his land, not merely to protect it.

In a Virginia Case, Burwell v. Hobson(4), an injunction against construction of a dike was upheld to prevent damage to lands behind a previously constructed dike on the opposite side of the creek. The applicability of the case to erosion liability is not as clear as KatenKamp since this case involves flooding damage rather than downstream erosion damage. It also appears to have been decided more on principles of easement and rights running with the land. Under the common enemy doctrine, the building of a dike, absent unreasonableness of construction or a scheme to improve and not protect property, should have been permissible in Burwell. This case may be interpreted to establish in Virginia a rule to liability between private parties based on priority in time that contravenes the generally accepted common enemy doctrine.

In summary, the question of individual liability for downstream impacts appears unsettled at this time.

5.3.2 State Liability. Several cases have been discovered in which a city, state, or the federal government has been held free of liability for actions causing erosion. In Paty v. Town of Palm Beach(5), the Florida Supreme Court held that the town was not liable for downdrift impacts of a town erected groin. In Pitman v. U.S.(6), the Federal Court of Claims held that the plaintiff's damage claim from erosion resulting from a Federal project was non-compensable. The U.S. Supreme Court held in Bedford v. U.S.(7), that:

> Damages to land by flooding as the result of revetments erected by the United States along the banks of the Mississippi River to

> prevent erosion of the banks from natural causes are consequential and do not constitute a taking of the lands flooded within the meaning of the Fifth Amendment to the Federal Constitution.

No Virginia cases dealing with the issue of state liability for downstream erosion impacts have been found. State liability for downstream impacts may occur in the protection of state lands from erosion, or, as a result of state actions to control erosion on private lands.

The Commonwealth of Virginia like many other states enjoys the protection offered by the doctrine of sovereign immunity. Sovereign immunity exempts the sovereign (in this case the state) from suit without its consent. The concept of sovereign immunity may be traced to ancient Roman law. Prosser(8) states the historical basis for the evolution of this immunity as follows:

> ...the origin of the idea underlying them in the common law seems to have been the theory, allied with the divine right of kings, that "the King can do no wrong," together with the feeling that it was necessarily a contradiction of his sovereignty to allow him to be sued in his own courts...when the individual sovereign was replaced by the broader conception of the modern state, the idea was carried over that to allow a suit against a ruling government without its consent was inconsistent with the very idea of supreme executive power.

This concept was applied in the United States in Cohen v. Va.(9) when Chief Justice Marshall stated that the United States would not be sued without its consent. This holding and others like it eventually led to the passage of the Federal Tort Claims Act(10) which subjected the U.S. to suit in tort. Regarding governmental immunity on a state level Prosser notes:

> The sovereign immunity likewise carried over from the English crown to the several American states. There was but one abortive attempt to change the rule; but it led only to the Eleventh Amendment to the federal Constitution, protecting any state from suit by a private citizen in the federal courts. Thereafter the doctrine became firmly established, that there is no state liability in tort unless consent is given.(11)

Case support for Prosser's statement quoted above is plentiful. An analysis of important Virginia cases on the topic of governmental immunity from suit follows.

Generally, the Commonwealth of Virginia cannot be sued without its permission. In Cornwall v. The Commonwealth(12), the court held, "No one can sue the State except by her consent and as provided by law." Despite its age, this 1866 holding still reflects Virginia law. The State acknowledged its duty to pay debts in Higginbotham's v. The Commonwealth(13), where the court stated, "The present State of Virginia is bound to the creditors of the state."

The immunity stated in Cornwall v. The Commonwealth was extended in Wilson v. State Highway Commissioner.(14) This case was one where a landowner attempted to sue the State Highway Commissioner in his official capacity, and others as individuals, for damages caused by negligent and unlawful acts of the defendants committed during the construction of a highway. The court held that the relationship between the Comissioner, his employees, and the State was such that any liability they incurred would be charged to the State. Therefore, they as agents of the State were entitled to immunity from suit. This case extended the State's immunity from suit to its agents and employees acting in their official capacity.

The holding in Wilson was further refined in Sayers v. Bullar.(15) In this case a landowner was attempting to sue the state for damage incurred when the state agents set off explosives which had the effect of stopping the flow of water from the plantiff's spring. This case held once again that agents of the state are immune from suit in tort. The court in Sayers held, "A State cannot be sued except by its permission, and even if the suit, in form, be against the officers and agents of the State, yet if, in effect, it be against the State, it is not maintainable." The court also stated the following situations in which an employee of the state might lose his right to immunity. "In a tort action against an employee of the state, allegation and proof of some act done by the employee outside the scope of his authority, or of some act within the scope of authority but performed so negligently that it can be said that its negligent performance takes him who did it outside the protection of his employment are required." The court further stated, "The immunity of the State from actions for tort extends to State agents and employees where they are acting legally and within the scope of their employment, but if they exceed their authority and go beyond the sphere of their employment, or if they step aside from it, they do not enjoy such immunity when they are sued by a party who has suffered injury by their negligence." Sayers v. Bullar strengthened the immunity from suit in tort which extends to State agents. This immunity was extended to the Elizabeth River Tunnel District in Tunnel District v. Beecher.(16)

The implications that these cases have on liability for shoreline erosion are apparent. An agent or employee of the state can incur no liability for negligence or any other tort so long as the act is within the scope of his employment and not performed in such a grossly negligent fashion as to take him outside of the protection his employment offers. For example, if an agent gives faulty advice concerning some shoreline structure and the structure subsequently fails or perhaps a downdrift neighbor files suit, the agent would be clothed with the states absolute immunity from suit in tort and therefore be able to escape liability. The state, of course, has this immunity and would also avoid liability. Only if the agent were grossly negligent or acting outside the scope of his employment could a successful action be maintained. In such a situation the suit would be against the agent as an individual and the State would still incur no liability.

The cases cited above are perhaps what led James A. Eichner, in A Century of Tort Immunities in Virginia,(17) [4 U. of Rich. 238, (1970)] to state:

> "Thus, the doctrine of a state's absolute immunity from suit in tort has become case hardened. Absolute immunity in negligence has been similarly extended to state-created authorities, despite the fact that such authorities have been held absolutely liable, without negligence, for property damage on state constitutional grounds." (emphasis added)

Since the matter of state liability for advisory services appears to be clear, the balance of this section will focus on the issues of property damage and compensation underlined above. Article I, Section II of the Constitution of Virginia states:

> That no person shall be deprived of his life, liberty, or property without due process of law; that the General Assembly shall not pass any law impairing the obligation of contracts, nor any law whereby private property shall be taken or damaged for public uses, without just compensation, the term "public uses to be defined by the Assembly"... (emphasis added)

This provision was held to be self-executing in Heldt v. Tunnel District.(18) In this case the court held that all that is necessary for a recovery is the showing of damage. Mrs. Heldt's buildings were damaged by water from the tunnel project, therefore she was entitled to recovery. It is important to note that this was an eminent domain case not a suit in tort. In Wilson v. State Highway Commissioner(19) the plaintiff was denied recovery because he already obtained relief in an eminent domain proceeding. This was also the case in Sayers v. Bullar(20), the plaintiff in that case suffered property damage, but the proper way to present the claim was in an eminent domain proceeding, not in a suit against a state agent. The Heldt decision was relied on in Morris v. Tunnel District.(21) In this case, the plaintiff alleged her property was damaged by the Tunnel District during construction of the Elizabeth River Tunnel. The Tunnel District defended on the grounds that they were immune from a tort action. This defense was without merit, because regardless of tort liability, self-executing provisions of the Virginia Constitution require compensation when private property is damaged for public use.

Quite clearly, if the state, or, a state commission or district takes or damages private property for public uses, compensation must be paid. This statement has significance in relation to potential legal liabilities which the state might incur when implementing a

mandatory shoreline erosion plan, or, when state action causes downstream impacts that damage or "take" private property.

State liability can be summarized by several general principles.

1) The Commonwealth can only be sued by its consent or as provided by law. Cornwall v. the Commonwealth, 82 Va. 644, (1866).

2) The statute which outlines the procedure for suits against the State is Virginia Code Ann. Sec. 8.01-192.

3) The State has retained absolute immunity from suit in tort and this immunity has been extended to State agents and commissions. [Wilson v. State Highway Commissioner, 174 Va. 82, 4 S.E. 2d 746, (1939). Sayers v. Bullar, 180 Va. 222, 22 S.E. 2d 9, (1942). Tunnel District v. Beecher, 202 Va. 452, 117 S.E. 2d 685, (1961).]

4) This immunity from suit in tort which has been extended to cover state agents and employees by implication protects state agents and the state from suits based on faulty or erroneous advice.

5) However, Article 1, Section 11 of the Virginia Constitution states that private property shall not be taken or damaged for public use without just compensation.

6) Article 1, Sec. 11 of the Virginia Constitution been held to be self-executing, and a landowner need only show damage to obtain compensation. [Heldt v. Tunnel District, 196 Va. 477, 84 S.E. 2d 511 (1954). Morris v. Tunnel District, 203 Va. 196, 123 S.E. 2d 398 (1962).]

7) Application of these principles to the shoreline erosion situation indicates that actions of the state or a subentity of the state for a public purpose which result in downstream impacts that damage or constitute a taking of private property must be compensated.

5.3.3 The Taking Issue as it Relates to Set-back Lines and Other Land Use Regulations

5.3.3.1 Introduction to the Set-back Concept. The purpose of this section is to examine the "taking issue" as it relates to set-back lines and other types of land use regulations. It includes a survey of zoning law in Virginia and an explanation of the compensation amounts due when a "taking" does occur. It also offers some suggestions for avoiding the "taking" problem.

A set-back line is essentially a land use regulation.(22) It is a form of zoning known as open space zoning, where construction is prohibited or severely restricted to preserve open space for a variety of public objectives.(23) In the case of a coastal construction set-back line, construction is prohibited or severely restricted seaward of the established line. The public objective to be sought in establishing a set-back line for Virginia's seashores is the protection of the Commonwealth's coastal areas from the type of development practices that endanger shorefront property and/or aggravate beach erosion.(24) A set-back line approach to the problem of shoreline erosion seeks a solution within the shoreline system, rather than the site-specific approach that has sometimes proven to be ineffective.(25)

A coastal construction set-back line may be established in two ways. The local planning commission of a county or municipality may create the line over lands under its jurisdiction.(26) The local board of supervisors would then implement the plan. Arguably, the power to establish a set-back line is within the power to zone, granted to the localities by the General Assembly in its enabling act.(27) The second method is the creation of a state-wide set-back line. This may be done by statute, which would confer upon a state agency the power and authority to establish the line on a locality by locality basis.(28) This method may be preferable in that there would be some assurance that the line would be drawn under one established set of criteria. The first method leaves the decision to the localities where various political and economic factors may work against its establishment. This set of problems might be alleviated by having local implementation of uniform state-wide guidelines.

The establishment of a set-back line, like any other land use ordinance, limits the use an owner may make of his property.(29) A state's power to limit the use of private property for the purposes of general welfare is not unrestricted. It is therefore necessary to examine the constitutional limits on the state's power to restrict the use of property and to determine whether the establishment of a coastal construction set-back line would be within those limits.

5.3.3.2 Constitutional Analysis. The power of the state to regulate the use of private land is its police power, the inherent authority of a state government to control the activities of

individuals in order to foster public health, safety, morals, and the general welfare. This authority is exercised through legislation which restrains and regulates the use of property.(30) The state's use of the police power to regulate the use of land is limited by two provisions of the U. S. Constitution. The Due Process Clause of the Fourteenth Amendment to the United States Constitution prohibits the state from depriving any person of property without due process of law,(31) and the Fifth Amendment, which has been incorporated into the Fourteenth, prohibits the taking of property for public use without just compensation.(32) The major issue in land use regulation involves the problem of determining which land use regulation constitutes a valid exercise of the police power and which regulation constitutes a "taking" for which the Fifth Amendment mandates compensation to the owner. The Supreme Court has considered the issue,(33) and numerous state courts have applied different judicial tests to decide the issue. To determine the constitutionality of a coastal set-back line, we must examine the tests laid down by the Supreme Court and various state courts.

The Supreme Court first considered the constitutionality of the state's application of the police power to private land use in Pennsylvania Coal Co. v. Mahon.(34) Mahon involved the Kohler Act,(35) a Pennsylvania statute which made it unlawful to mine coal so as to cause the caving in or collapse of public buildings, streets, bridges, churches, hotels, railroad stations, or any dwelling used for human habitation. It has been the practice of the mining companies in

the coal regions of the state to sell their land to private parties or to municipalities, reserving for themselves the mineral rights to these properties. When the companies proceeded to exercise their mineral rights on these properties, the shafts dug would undermine the support of the structures, resulting in the subsidence of the ground and the collapse of buildings. In 1921, the Kohler Act was passed by the legislature to remedy this hazard to public health and safety. Unsuccessful in the state courts, the Pennsylvania Coal Co. challenged the Kohler Act in the United States Supreme Court.(36)

The Pennsylvania Coal Co. challenged the statute on two grounds: That the statute impaired the obligation to contracts and that it took private property without compensation. Justice Holmes, writing for the majority, ignored the appellant's first contention and addressed the issue as follows: Was the Kohler Act an exercise of the police power designed to protect the people from the hazards of ground subsidence, or merely a means of obtaining a property right of the coal company without having to pay for it? Was the legislature attempting to accomplish by regulation what could only be accomplished by eminent domain? Holmes held that the problem was one of line drawing, that the difference between valid regulation and taking is one of degree, not of kind. "The general rule at least is, that while property may be regulated to a certain extent, if the regulation goes too far it will be recognized as a taking."(37) Holmes held that one of the most important factors to be considered in determining the limits of police power regulation is the extent of diminution of value

of the property due to the regulation.(38) In sum, the question would depend on the particular facts of the case. Holmes concluded that the Kohler Act violated the Fifth Amendment because the act made it commercially impractical to mine the coal, which was held to have the same effect as appropriating it.

In Mahon, Holmes established the balancing tests as a method(39) to determine the constitutionality of land use regulation. The societal benefit of the regulation is to be balanced against the impact of individual ownership of land, with diminution in value of the land to be an important factor in the decision.(40) In 1926, another landmark zoning case was decided. In Euclid v. Ambler Co.(41) a zoning ordinance which the plantiff contended was unconstitutionally reducing the value of his property and its marketability was upheld. The court stated, "The police power also supports, generally speaking, an ordinance forbidding the erection in designated residential districts, of businesses, houses, retail stores and shops, and other like establishments, also of apartment houses in detached house sections since such ordinances, apart from special applications, can not be declared clearly arbitrary and unreasonable, and without substantial relation to the public health, safety, morals, or general welfare."(42) This judicial statement can be interpreted as support for most of the zoning ordinances enacted by cities and counties today.

5.3.3.3 Four Tests Defined. State courts have not all followed the balancing/diminution of value test employed by Holmes in Mahon. Four tests have merged. These tests are: 1) the balancing

test, 2) the government enterprise, 3) the diminution in value test, and 4) the denial of all reasonable use test. An analysis of these tests for constitutionality of zoning regulations follows.

When a court employs the balancing test, compensation is due when the benefit conferred on the public by the regulation is outweighed by the loss sustained by the landowner. Thus, a regulation which appears to confer only a marginal public benefit may be invalidated where the loss to the individual landowner is great. Factors which are weighed in the balancing test include: whether or not the restricted use threatens public health, safety, or morals; whether the proposed use would constitute a nuisance; whether the entire property or only a portion of it is affected; whether or not a physical invasion of the land occurs under the regulation; whether the use regulated is an existing use or a future one;(43) and the extent of the regulation diminished the value of the land.

The government enterprise test distinguishes a valid regulation from one which constitutes a taking by examining the purpose for which the regulation was imposed. Under this test, private losses sustained due to regulations designed to resolve conflict within the private sector of society are non-compensable, while losses resulting from government regulations which enhance the value of some government regulation require compensation.(44) Put another way, the regulation is a valid exercise of police power if its purpose is to remedy a public harm, but, an unconstitutional taking if designed to confer a public benefit.(45) Applying this analysis, a New Jersey wetlands

regulation was struck down in 1963 as an attempt to use private land for a public benefit.(46)

Under the diminution in value test, compensation is due when the enforcement of the regulation destroys all or substantially all of the value of the property affected.(47) Except where the regulation is reasonably related to the public health or safety, or where the use prohibited would amount to a public nuisance, the courts applying this rule have usually required compensation where the regulation destroys all or substantially all the value of the property. This test can be distinguished from the balancing test in that a taking will be found without consideration of the public benefits where the loss is great, unless public health or safety is involved.(48)

The denial of all reasonable use test is similar to the diminution of value test. Where the regulation restricts the use of property such that all "reasonable", "practical", or "beneficial" uses of the land are denied, compensation is required.(49) At least one court has interpreted the test as requiring the denial of profitable use rather than the denial of any use.(50)

5.3.3.4 Examination of Virginia Case Law on Zoning. One must note from the above discussion of tests employed that the test selected by a state court has considerable impact of whether a land use regulation is held to be an uncompensated taking or valid exercise of police power. An analysis of recent zoning cases in Virginia to determine the test currently being utilized by Virginia Courts is

therefore necessary. An analysis of Board of Supervisors v. Allman,(51) Board of Supervisors v. Snell Construction Co.,(52) Board of Supervisors v. Williams,(53) Boggs v. Board of Supervisors,(54) and perhaps most importantly Board of Supervisors v. Rowe(55) yields the following situations in which zoning regulations have been struck down.

Case decisions demonstrate that the courts in Virginia have struck down zoning ordinances as unreasonable, where the party challenging the ordinance was able to show: 1) that contiguous or similarly situated property has been zoned or rezoned for a different use; 2) that the area around the property had changed since the original classification; 3) that the zoning ordinance left the landowner with no reasonable use for his property; 4) that the zoning ordinance was exclusionary or discriminatory; 5) that the existing ordinance failed to meet the needs of the community; 6) that public facilities were adequate to support the requested rezoning; 7) that the locality was zoning for aesthetic reasons; 8) that the purpose of the ordinance was to reduce the cost of government; 9) that the locality was zoning for socio-economic reasons; or 10) that the zoning ordinance would cause a large financial loss and only a small public benefit.

Virginia courts have evidenced a willingness to overturn zoning ordinances for a variety of reasons. The actual test employed by the court was perhaps best stated in Board of Supervisors v. Rowe.(56) In this case the court held that a use regulation provided by for statue

may nonetheless be held unreasonable if the cumulative effect is so overly burdensome as to constitute a taking of property without just compensation. The court in Rowe set forth the nexus between the equal protection and due process considerations raised in the review of the reasonableness of zoning ordinances, stating:

> "When a land use permitted to one landowner is restricted to another similarly situated, the restriction is discriminatory, and, if not substantially related to the public health, safety, or welfare constitutes a denial of equal protection of the law. A restriction on the right to use which thus denies equal protection also constitutes a "taking" of one of the most valuable components of the package of private rights, and absent just compensation, such a taking is a denial of due process of law."(57)

In conclusion, Virginia courts purport to apply a presumption of reasonableness to zoning ordinances enacted by local legislative bodies. However, recent decisions indicate that the Supreme Court of Virginia has in fact abandoned this presumption in favor of an expanded scope of review, which allows the court to substitute its judgement for that of the local government. The test the courts have been employing is similar to the diminution in value or denial of all reasonable use tests discussed earlier. These tests, if applied to a set-back ordinance, are likely to result in a determination that a "taking" has occurred. This difficulty will be examined in later paragraphs. The Supreme Court's failure to enunciate the standards which will govern its expanded scope of inquiry into local ordinances has hindered local governing bodies in their attempts to enact zoning ordinances which will withstand judicial challenge.

5.3.3.5 How Open Space Zoning Regulations and Coastal Set-back Regulations Have Fared in Virginia and Other States. Because open space zoning regulations have the characteristic of preventing or severly restricting structural development in particular areas, they differ significantly from the more conventional residential or industrial zoning regulations discussed earlier. Since open space zoning usually prohibits all permanent structural uses, they may reduce land values much more than does conventional zoning. The objective may not be the traditional one of protecting public health or safety, and therefore less precedent can be found for the use of the police power to serve these special objectives. While traditional zoning may provide reciprocal benefits, open space zoning provides less benefit, if any, to the affected landowners. These factors, coupled with a history of judicial reasoning that the value of a parcel of land is measured by its potential for development,(58) have resulted in difficulty for open space zoning regulations when confronted with a taking claim. While regulations which restrict uses posing threats to public safety and health are likely to be upheld,(59) where these factors are absent there is a greater judicial resistence.(60) These regulations are particularly vulnerable where a strict diminution or denial of all reasonable use test is applied.

Courts of Maine and Massachusetts have applied a diminution in value test to find that denial of a permit application under those states' wetlands statutes was an uncompensated taking of private property.(61) The rationale of the courts was that wetlands have

extraordinary commerical value, but almost no commercial value if one was prohibited from filling or making other changes which would destroy their unique natural value. Applying the government enterprise test, the New Jersey Supreme Court reached the same conclusion regarding a local wetlands ordinance.(62) A zoning amendment which classified a parcel of land "flood plain district" and which limited use to only open space uses was held to be a taking by the Connecticut Supreme Court.(63) The court held that the zoning rendered the use of the land impossible, and had depreciated the value of the land by at least seventy-five percent.

Set-back ordinances and regulations designed to protect beaches have fared better. As early as 1927 the U.S. Supreme Court upheld the consitutionality of a building ordinance with set-back lines of thirty-five feet intended primarily to preserve light and fresh air.(64) However, set-back requirements will almost invariably be held to be a denial of all reasonable use if no buildable space remains on the parcel.(65) The courts will generally examine the entire parcel to determine if reasonable use or value exist despite the set-back restrictions. Deep set-backs have been upheld where the property has been of sufficient size to provide buildable space outside the set-back area.(66)

The following three cases illustrate judicial treatment of zoning measures designed to protect the beach-dune interface. In McCarthey v. City of Manhatten Beach(67), an owner of beach front property challenged a local ordinance which restricted the use of his land to

recreational purposes. The owner contended that because the ordinance permitted no permanent structures on the land, and because he intended to erect houses on the land, the ordinance constituted a taking without just compensation. In upholding the ordinance, the court noted that the plaintiff had introduced no evidence relative to the value of the property, either before or after the ordinance was enacted, nor had the plaintiff shown that the property could not be used valuably in conformance with the ordinance. The court also pointed out that the property was from time to time covered by storm waters and subject to erosion. Thus, the court seemed to base its holding on two distinct grounds: that there was insufficient evidence introduced by the owner to show denial of all reasonable use or the requisite diminution in value, and that any structures on the land would be inherently unsafe due to their location and the regulation could be justified to protect future purchasers.(68)

Speigle v. Beach Haven(69) involved a local coastal construction set-back line which limited construction between the designated set-back line and mean high water mark. The purpose of the set-back was to protect the beaches and dunes from man induced erosion which would aggravate property damage caused by waves and storm tides. The plaintiff, in this case, owned four tracts of land, two of which were evenly divided between buildable and nonbuildable land. The other two parcels were located almost entirely seaward of the set-back line. In upholding the ordinance, the New Jersey court relied on the municipalities' unrebutted evidence of the danger posed to property

owners and the general public when construction occurred seaward of the set-back line. The court also noted that the plaintiff had failed to show a safe and economical use to which the property could be put.(70)

In most recent of the three cases, Lemp v. Town Board of Islip(71), the petitioner was denied a building permit to build a residence on her Fire Island beach front property. The challenged local-ordinance restricted uses in the beach/dune system to stairs, lookout platforms, and fences, unless a building permit was obtained from the local planning commisssion. The stated purpose of the ordinance was to safeguard life and property of the barrier beach. The court used a balancing test and concluded that a taking had resulted because the petitioner was denied all reasonable use of her property. The court held that because of provisions in the ordinance, the town must either grant the permit requested or institute condemnation proceedings.(72)

The constitutionality of a coastal construction set-back line, when confronted with a taking claim, depends upon the test employed by a court and its predilections toward these types of land use regulations. The Virginia Supreme Court has on numerous occasions upheld the validity of building set-backs and open space perimeter requirements. Set-backs have been upheld as reasonable to preserve public health by providing sun light and fresh air(73), and to protect against public danger from fire.(74) Decisions in other cases have rested on the "public welfare" concept.(75) However, the Virginia Supreme Court has held that set-back requirements will not be

sustained where they deny the owner all practical use of his property.(76)

When considering a taking claim, the Virginia Supreme Court has applied the closely related tests of diminution in value and denial of all reasonable use. A discussion of the holdings in two recent cases will illustrate the application of these two tests. In Boggs v. Board of Supervisors of Fairfax County(77), petitioner owned a parcel of land that had been rezoned for single family residential use. The owner argued that his land was unsuited for such use and offered evidence to show that an investment of $185,000 would be required before the land would be suitable for construction of single family dwellings. Evidence was also introduced that this cost precluded development and that the rezoning had the effect of making the property unmarketable. The Virginia Supreme Court held that, as the ordinance denied the beneficial use of the property by precluding all practical uses, the ordinance was invalid as to that property.(78)

Board of Supervisors of James City County v. Rowe(79) involved a challenge to a local zoning ordinance limiting the use of certain parcels to hotels, motels, service stations, gift shops, antique shops, and restaurants. The ordinance provided for a minimum lot size, a building set-back of seventy-five feet, and a requirement that owners dedicate the outer fifty-five feet of the set-back for construction of a service road. The court held that the dedication for the road would be generated by public traffic demands rather than by demands created by the development. Acknolwedging the authority of

the local government to adopt set-back restrictions, the court struck down the seventy-five foot set-back as confiscatory. The court-relied on evidence that the set-back provisions and open space requirements would prohibit construction on twenty-nine percent of the affected land, that portion having a market value of $1,959,167. The court found that the ordinance rendered seventeen of the fifty-one lots undevelopable. Finally, the court accepted evidence that the market value of the property dropped from $2.69 per square foot to $1.50 per square foot and that sales of those parcels stopped after the ordinance went into effect.(80)

In neither case was a balancing test employed to weight the social benefits against individual harm. Instead the court relied on evidence indicating the decline in value of the land and the restriction of uses. Because the tests applied have been diminution in value or denial of all reasonable use, and because the courts have relied on economic evidence to a large degree, it seems likely that a set-back ordinance or other land use regulation which prohibited construction on all or most of a parcel of land would constitute a taking and if just compensation were absent would be ruled unconstitutional.

Although it would appear that the Virginia Supreme Court looks with disfavor upon regulations which limit development of private land, the common law of Virginia has not unquestionably assumed that development and economic growth are synonymous with public good. One striking case which held contra is Southern Railway v. Richmond.(81)

In Southern Railway, a zoning action was upheld against a taking claim on the ground that the zoning ordinance served to preserve the harmony of the surrounding area. Compensation was denied despite substantial financial loss to the railroad. This case is clearly the minority and rather curious legal reasoning determined the outcome.

5.3.3.6 Tests for Valuation of Compensation Due a Landowner When a Taking Has Occurred. If one assumes that a given hypothetical regulation has been ruled on unconstitutional taking, the next important question to consider is the economic impact such a finding would have. Put another way, how much compensation will the State, locality, or other governing body be required to pay the affected landowner? The law of eminent domain is covered in Sections 25-46.1 through 25-253 of the Virginia Code. Complete procedures are spelled out there, but for the present purposes setting out the valuation tests and a quick explanation of the commissioner system will suffice.

Generally the amount of compensation due when property is taken is the fair market value of the property at the time of the taking.(82) Fair market value has been defined as the just compensation to which the landowner is constitutionally entitled. Fair market value has been judicially defined, in a definition similar to that of market price used in economics, as the price which one under no compulsion is willing to take for property which he has for sale, and, which another under no compulsion, being desirous and able to buy, is willing to pay for the property.(83)

When the property is merely damaged the test to be applied is the difference in value immediately before and immediately after taking, so interpreted as not to charge the owner with general benefits.(84) Every circumstance, present or future, which changes the present value of the property is to be considered in valuing the landowners' loss.

Procedurally the state must make an offer to purchase property which it intends to take.(85) If this offer proves unacceptable to the landowner, then either five or nine freeholders are appointed to determine what the fair market value of the loss of damages are.(86) The determination made by the freeholders or commissioners is treated with great respect by the courts.(87)

5.3.3.7 Possible Ways to Avoid the Taking Problem. It seems likley that if a set-back or other type of land use regulation were ruled a taking, the cost of compensating the landowner might outweigh benefits for the public or locality as a whole. For this reason possible strategies which would avoid this problem are important.

One method immediately apparent is the variance approach. If a landowner can show that the ordinance as applied to him would constitute an uncompensated taking; a variance can be granted which allows the landowner to proceed with the contemplated activity. This could also be accomplished via a permit system under which permits would only be issued for construction within the no-construction zone when to withold the permit would operate as a "taking." A

criticism of this technique is that allowing for variances or permits for construction in the no-construction zone would take the "teeth" out of the ordinance.

Another approach could be to give the landowner an option between accepting a setback or participating in a shoreline erosion control project. In this case, shoreland owners could avoid a setback if they participated in a control plan. In addition, financial incentives to join the program could be incorporated. Whether this approach would effectively alleviate the taking question is debatable, but such an arrangement would have a much better chance of surviving judicial scrutiny than would a less flexible approach.

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25) Proposals for Coastal Resource Management in Virginia (Sept. 1977) at iii.
26) See Notes, "Zoning, Planning, and the Scope of Judicial Review in Virginia," 25 Am. U. L. Rev. 497 (1976).
27) Va. Code Ann. 15.1-486 (1977) permits the governing body of any county or locality to enact zoning ordinances and ". . . it may regulate, restrict, permit, prohibit, and determine the following:. . .(c). . .and other open spaces to be left unoccupied by uses and structures."
    15.1-489 states: "Zoning ordinances shall be for the general purpose of promoting the health, safety, or general welfare of the public. . ."
    15.1-489 also specifies safety from flood and protection against loss of life due to flood as permissable zoning objectives.
28) See Fla. Stat. Ann. 161.053, where power to establish coastal construction set-back lines on a county basis is conferred upon the Division of Marine Resources of the Florida Department of Natural Resources.
29) For a description of the efforts involved in establishing a coastal construction set-back line in the state of Florida, see E. Olsden, "Northern St. Johns County Coastal Management Plan," Shore and Beach (June, 1976) at 29.
30) Chicago B. & L. Ry. v. Illinois ex rel Drainage Commissioners, 200 U.S. 561 (1906): Lawson v. Steele, 152 U.S. 133 (1894).
31) U. S. Const. amend. XIV, 1.
32) U. S. Const. amend. V.
33) Pennsylvania Coal Co. v. Mahon, 260 U. S. 393 (1922).
34) Id.
35) Pennsylvania Public Law 1192.
36) J. Banta, F. Bosselman, and D. Callies, The Taking Issue, (1973) at pp. 126-129.
37) 260 U.S. at 415
38) 260 U.S. at 413
39) 260 U.S. at 414
40) Duscik, supra note 9 at 165.
41) City of Euclid v. Ambler Realty Co., 272 U.S. 385 (1926).
42) Id.
43) See Town of Hillsboro v. Smith, 276 N.S. 48, 170 S.E. 2d 904 (1969): Gibson v. City of Oberline, 171 Ohio St. 1, 167 N.E. 2d 651 (1960).
44) Sax, "Takings and the Police Power," 74 Yale L. J. 36 91964).

45) Ducsik, supra note 10 at 161.
46) Morris County Land Improvement Co. v. Township of Parsippany - Troy Hills, 40 N.J. 539, 193 A.2d 232 (1963).
47) Note, "State and local Wetlands Regulation: The Problem of Taking Without Just Compensation," 58 Va. L. Rev. 882, 886 (1972).
48) Id. at 887.
49) Kusler, supra note 2 at 36.
50) Arverne Bay Construction Co. v. Thatcher, 278 N.Y. 222, 15 N.E. 2d 587 (1938).
51) Board of Supervisors v. Allman, 215 Va. 434, 211 S.E. 2d 48 (1975).
52) Board of Supervisors v. Smell Const. Co. 214 Va. 655, 202 S.E. 2d 893 (1974).
53) Board of Supervisors v. Williams, 216 Va. 49, 216 S.E.2d 33 (1975).
54) Boggs v. Board of Supervisors, 211 Va. 491, 178 S.E.2d 510.
55) Board of Supervisors v. Rowe, 216 Va. 128, 216 S.E.2d 199, (1975).
56) Id.
57) Id.
58) Brion, "Virginia Natural Resource Law and the New Virginia Wetlands Act." 30 W. and L. L. Rev. 19, 26 (1973).
59) See Speigle v. Beach Haven, 46 N.J. 479, 218 A.2d 129 (1966); McCarthy v. Manhatten Beach, 41 Cal. 2d 879, 264 P.2d 932 (1953), cert. den. 348 U.S. 817 (1954).
60) Kusler, supra note 2 at pp. 6-22.
61) State v. Johnson, 265 A.2d 711 (Me. 1971); Commissioner of Natural Resources v. Volpe, 349 Mass. 104, 206 N.E. 2d 666 (1965).
62) Morris County Land Development Co. v. Parsippany - Troy Hills Township, 40 N.J. 539, 193 A.2d 232 (1963).
63) Dooley v. Town Plan and Zoning Commission, 151 Conn. 304, 197 A.2d 770 (1964).
64) Gorieb v. Fox, 274 U.S. 603 (1927).
65) Hoshour v. Contra Costa County, 203 Cal. App. 2d 602, 21 Cal. Rptr. 714 (1962); Oschin v. Township of Redford, 315 Mich. 359, 24 N.W.2d 152 (1946); Faucher v. Building Inspector, 321 Mich. 193, 32 N.W.2d 440 (1948).
66) Kusler, supra note 2 at 56.
67) 41 Cal. 2d 879, 264 P.2d 932 (1953), cert. den. 348 U.S. 817 (1954).
68) Id.
69) 46 N.J. 479, 218 A.2d 129 (1966).
70) Id.
71) 394 N.Y.S.2d 517 (N.Y. Sup. Ct. Suffolk County, April 1, 1977).
72) Id.
73) Nusbaum v. Norfolk, 151 Va. 801, 145 S.E. 257 (1928).
74) Gorieb v. Fox, 145 Va. 554, 134 S.E. 914, aff'd 274 U.S. 603 (1926).
75) French v. Town of Clintwood, 203 Va. 562, 125 S.E. 2d 798 (1962).

76) Board of Supervisors of James City County v. Rowe, 216 Va. 1218, 216 S.E. 2d 199 (1975).
77) 211 Va. 488, 178 S.E. 2d 508 (1971).
78) Id.
79) 216 Va. 128, 216 S.E.2d 199 (1975).
80) Id.
81) See Southern Ry. v. Richmond, 205 Va. 699, 139 S.E.2d 82 (1964); G.L. Webster Co. v. Steelman, 172 Va. 342, 1 S.E.2d 305 (1939); Arminius Chemical Co. v. Landrum, 113 Va.7, 73 S.E. 459 (1912). But see American Cyanamida v. Commonwealth, 187 Va. 831, 48 S.E.2d 279 (1948).
82) Hunter v. Chesapeake & O. R. Co. 107 Va. 158, 59 S.E. 415 (1907); State Highway Comm. v. Crockett, 203 Va. 796, 127 S.E.2d 354 (1962).
83) Talbot v. Norfolk, 158 Va. 387, 163 S.E. 100, (1932); Appalachian Power Co. v. Anderson, 212 Va. 705, 187 S.E.2d 148 (1972).
84) Richmond & M. Ry. Co. v. Humphreys, 90 Va. 425, 185.E 901 (1894); State Hwy. Comm. v. Crockett, 203 Va. 796, 127 S.E.2d 354 (1962); Appalachian Power Co. v. Anderson, 212 Va. 705, 187 S.E.2d 148 (1972).
85) See Generally, Va. Code Ann. 25-46 to 25-254.
86) Id.
87) Id.

CHAPTER 6

ASSESSMENT OF OPTIONS TO MITIGATE THE EFFECTS OF EROSION: A PILOT STUDY IN MIDDLESEX COUNTY

6.1 Details of Procedures for Technical Assessment of Options.

The technical analysis of the shoreline and the formulation of options for the management or mitigation of erosion problems is a complex task consisting of several interlocking parts. First the basic, raw information or data concerning the area in question must be collected. That data must then be arranged, edited, or manipulated into meaningful groups. This process may itself generate the need for the collection of additional data. Finally the data must be analyzed and interpreted so that management options can be formulated and analyzed and entered into the economic model. The pilot study in Middlesex County was designed as a "learning" tool and as an example of the process. The general process and the specific study are described separately. Rather, the general process is described by an explanation of the methods used in performing the pilot study.

6.1.1 Data Acquisition. The first combined step in data acquisition and analysis is to acquire current 7 1/2 minute (1 to 24,000 scale) topographic maps and the N.O.S. Hydrographic (Nautical) charts of the area and to delineate the shoreline reaches. Because a reach is a relatively independent unit and because any action within a reach is likely to affect other portions within the reach, the reach is the appropriate unit of the study. Individuals experienced in

working with shoreline processes should be able to give at least preliminary reach delineations from the topographic maps. Analysis of additional data may necessitate minor changes in reach boundaries. The Middlesex County study area is depicted on the Wilton and Deltaville 7-1/2 minute topographic maps (Fig. 1). We elected to study three reaches. Reach 1 extends approximately 12,000 feet from the mouth of Mill Creek to Bush Park Creek, Reach 2 extends 14,700 feet from Bush Park Creek to Sturgeon Creek, and Reach 3 is approximately 9,300 feet of shoreline around Stingray Point.

As the pilot study was conceived as a learning tool as well as an example of the analytical process, we chose to examine areas with differing land use characteristics for various reasons such as general familiarity with the area, available information, logistical considerations and location within the Middle Penninsula Planning District, we decided upon Middlesex County. In choosing specific sub-areas of the county we looked for areas that were undeveloped, established, or developing, and that had eroding shorelines. The active shoreline constraint limited our search to the Rappahannock River and Chesapeake Bay areas of the county. Most of the shore areas along the Piankatank River and along the many creeks would not have a shoreline that was physically active to the degree needed to justify an erosion study.

As by definition a reach is a relatively closed unit, it should, at a minimum, contain an area of erosion and an area of deposition; or there might be significant communication with the offshore but only

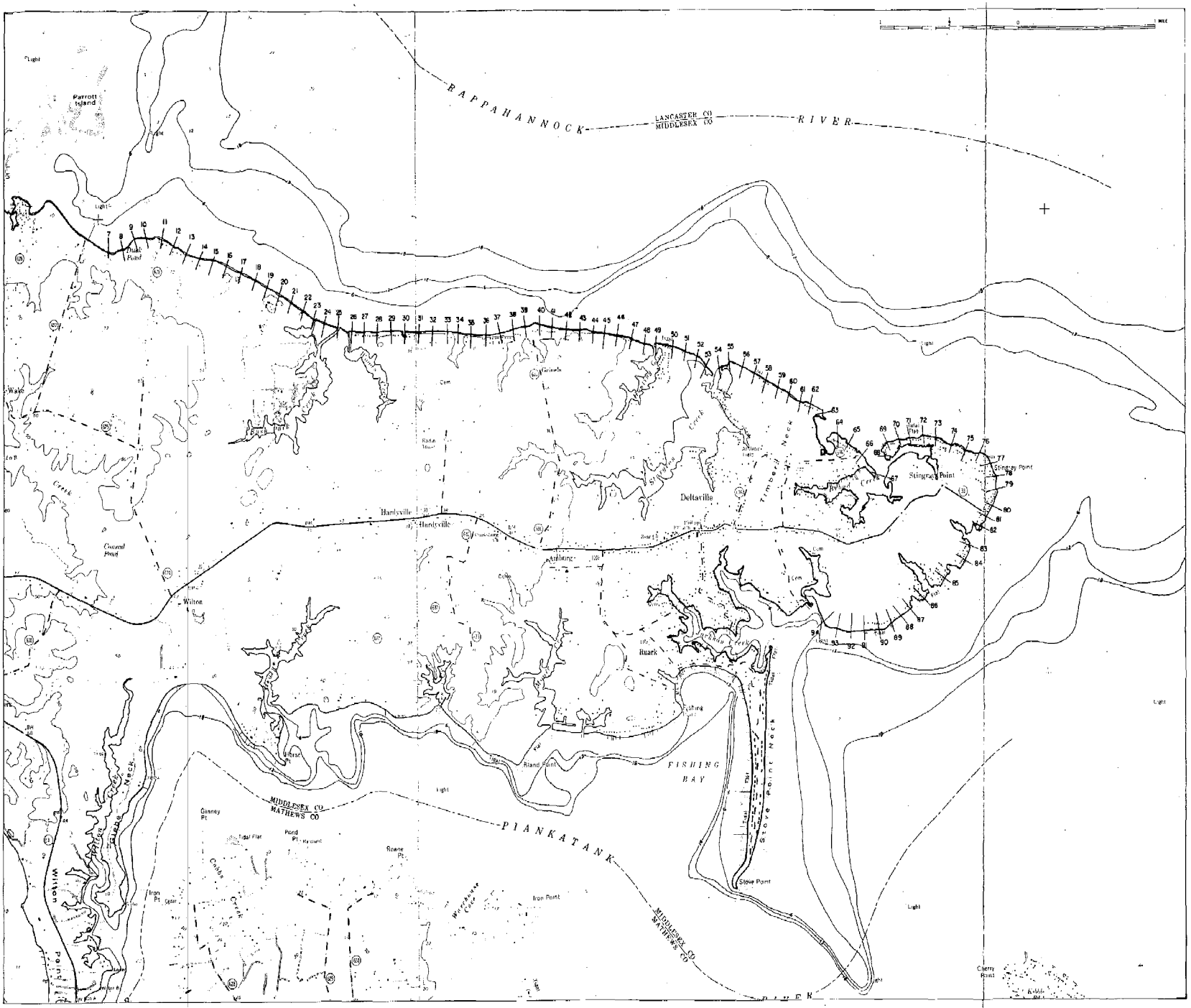

FIGURE 1. COMPOSITE TOPOGRAPHIC MAP OF STUDY AREA WITH TRANSECTS

limited alongshore communication between littoral systems. On that basis we may divide a reach into segments. Each zone of erosion or of deposition or intermediate areas, if any, being a separate segment.

Reach 1 was interesting because it offered a dynamic shoreline as evidenced by eroding high bluffs (Figs. 2 and 3) and a history of erosion indicated by earlier studies. Beginning with the bluff zone we began our search for reach boundaries. Differential accumulation of sediment against the groins near the bluff area indicated that very little, if any, sediment moved from the east of the bluff zone. The entrance to Bush Park Creek (Fig. 4) has a small spit growing toward the east. Also the jetty on the east side of Woods Creek, which is a few yards from Bush Park Creek, appeared to be an efficient trap for any material moving east to west. Therefore the Bush Park Creek-Woods Creek mouth area is a logical reach boundary as little sediment appeared to move across it.

Moving west from the bluff area sediment appeared able to move without natural impediment to the mouth of Mill Creek. The area between Greys Point (the Norris Bridge) and Mill Creek appeared to be relatively inactive. In any event there was no evidence of communication between the shore adjacent to the bluff area and the area across the mouth of Mill Creek. Thus Mill Creek is the other boundary of the reach.

Within the reach, segment divisions fill out fairly readily. The mouth to the creek is itself a sediment trap and is obviously

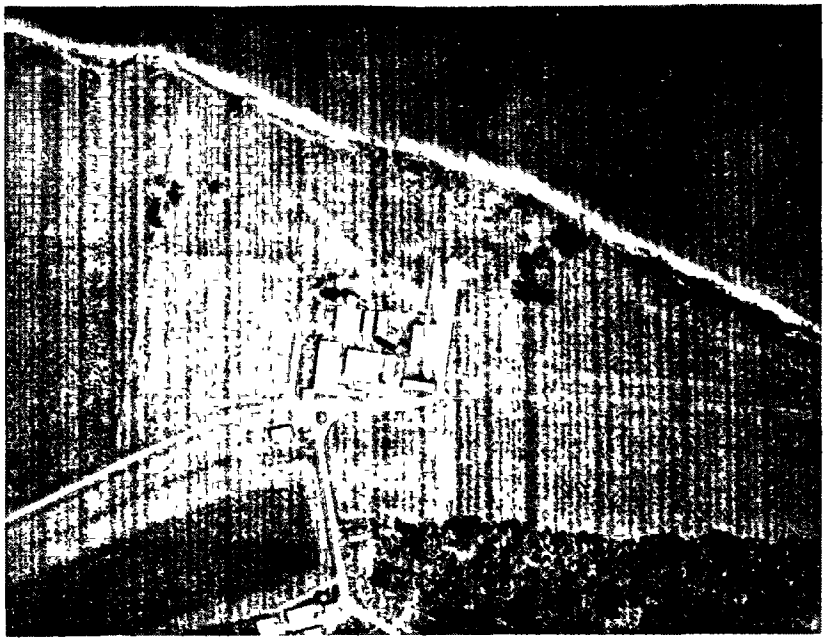

FIGURE 2

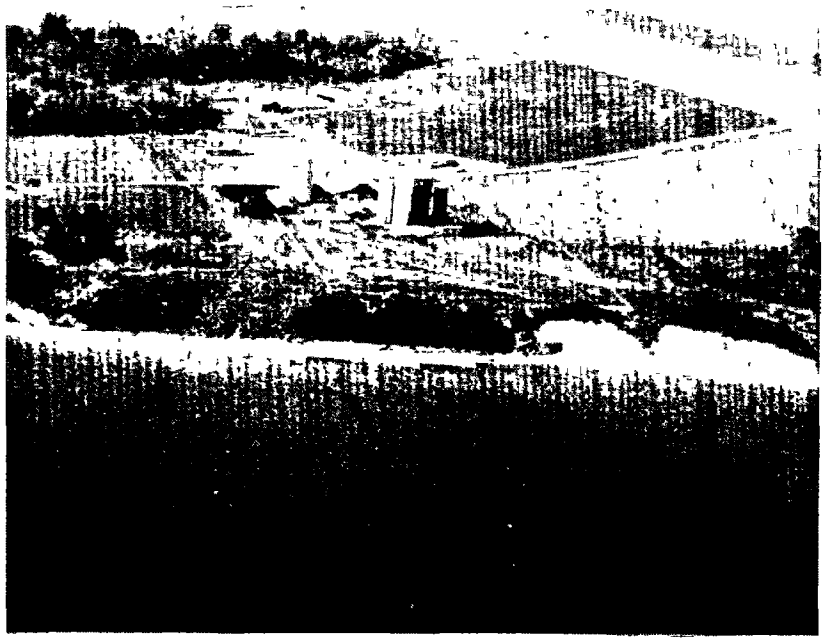

FIGURE 3

FIGURE 2: Vertical photograph of a portion of Segment 3 of Reach 1. The filling of the groins indicates a right-to-left (east to west) longshore transport.

FIGURE 3: An oblique photograph of the central shoreline portion shown in Figure 2. The oblique shows the bluff better than does the vertical. Also the raw, unvegetated bluff, an obvious sediment source, is seen not to supply material for filling the groins; thus longshore transport must be east to west.

different from the adjacent shoreline. The low spit-like section east of the bluffs and the bluff area itself are obvious separate units. The area west of the bluffs and east of the Duck Pond mini-barrier is a segment in part by virtue of its location between the obvious segments of the bluff and the Duck Pond mini-barrier or marsh front beach. The area between the Duck Pond segment (Fig. 5) and the New Mill Creek Wharf near the terminus of route 627 appears somewhat different in morphology and process from the area between it and Mill Creek, hence they became separate segments.

The area now designated as Reach 2 was chosen because it is a stretch of shore that is experiencing residential development. Observation of the many and varied attempts at shore protection indicated that the area had, at least in part, a dynamic shoreline. Here the reach boundaries were fairly easy to define. The Bush Park Creek mouth had already been determined as reach boundary during the consideration of Reach 1. Looking to the east, the two possibilities for reach boundaries are Hunting Creek and Sturgeon Creek. Observation of the oblique photographs lead one to believe that there is a reasonable amount of interaction between the littoral systems on either side of Hunting Creek. Therefore Hunting Creek is not a reach boundary. On the otherhand, the spit growing east into Sturgeon Creek and jetty at the eastern shore of Sturgeon Creek indicate that the creek is a suitable reach limit. Reach 2 was divided into five segments. The central segment of the reach is shown in Figure 6. A comparison of the reach descriptions of the Description and Analysis

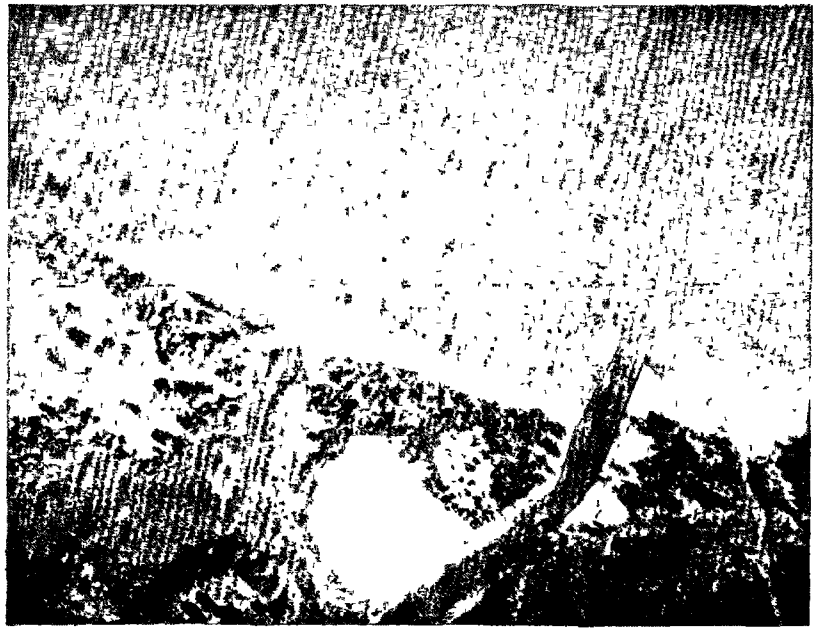

FIGURE 4

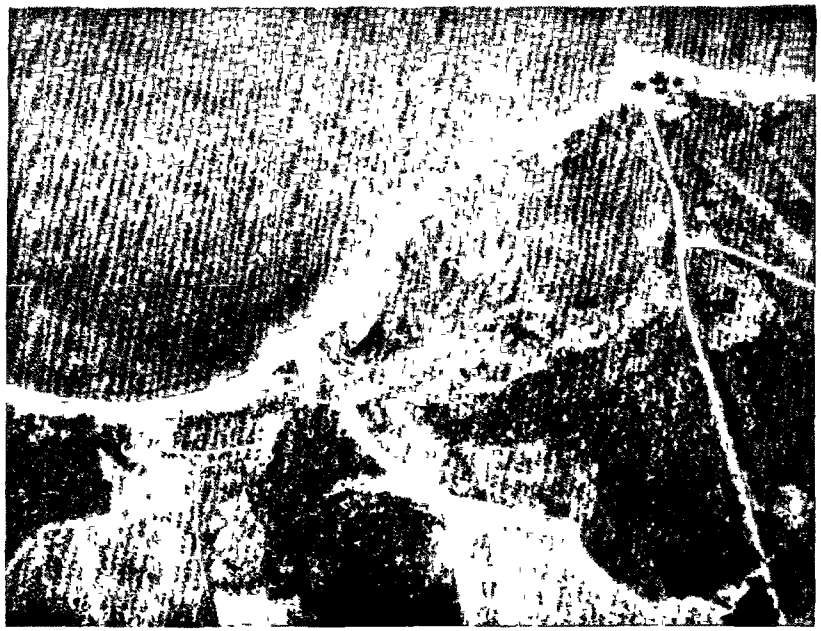

FIGURE 5

FIGURE 4: Segments 1 and 2 of Reach 1, the dredged entrance to Bush Park Creek. The eastern (right) jetty of the large dredged channel appears to be a major barrier to longshore transport and is the boundary between Reach 1 and Reach 2. The large white area in the bottom center of the photograph is a spoil disposal site.

FIGURE 5: Segment 5 and portions of Segments 4 and 6 of Reach 1. Segment 5 is a low barrier which separates the ponds from the river. Even though the groins have trapped some sand and widened the break, the area is not suitable for development.

of Options sheet and the topographic map in Figure 1, will provide an adequate explanation of segment definition.

For a third area, we wanted a fairly highly developed area. The Stingray Point area adjacent to Sturgeon Creek (Figs. 7, 8, and 9) fulfilled the lines of an erosion prone shoreline backed by development. Again one boundary, Sturgeon Creek, was already defined. The other boundary was determined by study of the maps and photographs. There appears to be little communication across the first cove south of the end of Route 33. This cove was chosen as the other limit of Reach 3. As the problems and character of Reach 3 are constant, the reach was not divided into segments.

To obtain erosion rates, both long-term averages and short-term variability, it is necessary to assemble as complete a library of historical maps, charts and photographs of the area as possible. Additionally, recent oblique and vertical photography should be and were acquired. As will be discussed in later paragraphs, the plan data can be rectified to a common scale so as to determine locations and rates of shoreline change. For the pilot study, we were able to obtain maps or charts from the periods 1851 to 1856, 1907 to 1908, and 1942. All were film base positives that previously had been rectified to a scale of 1 to 20,000. We then traced the three shorelines onto tracing paper using road intersections or other similar "permanent" land marks to assure proper registration of the images. This enabled us to see the relative position of the shoreline at each of the three time periods.

FIGURE 6

FIGURE 7

FIGURE 6: A vertical photograph of Segment 3 in Reach 2. The one area of significant accretion in the Reach. The shoreline progradation accentuates the degree to which the houses are set back from the shore.

FIGURE 7: An oblique view of the spit that has grown westward from Stingray Point, Reach 3, toward Broad Creek. The irregular shoreline and the varying lengths and spacings of the groins are evidence of the non-uniform approach to shore protection that has been followed.

FIGURE 8

FIGURE 9

FIGURE 8: A vertical photograph of the central portion of Reach 3.

FIGURE 9: An oblique photograph of the area in the upper center portion of Figure 8. It is much easier to see the nature of the riprap protection here than it is in the vertical.

To quantify the shoreline change the 1942 shoreline as a base and plotted transects perpendicular to the shoreline at 500-foot intervals were then plotted. The displacement of the shoreline was plotted at each transect.

More recent shoreline changes were determined by comparison of aerial photographs. Black and white, 9-inch, aerial mapping imagery from 1937, 1960, and 1968 were compared to enlargements of black and white 70 mm vertical imagery made for this project. Figures 2, 4, 5, 6, and 8 are examples of this photography. The 1978 prints were used as a base upon which the other images were superimposed allowing measurement of shoreline change. The superimposition was accomplished using either a Bausch and Lomb ZT-4H Zoom Transfer Scope (ZTS) or an Art-O-Graph Model 55-C Map-O-Graph, which is a reflecting, opaque projector. The ZTS serviced only very small areas requiring frequent adjustment and re-registration of the images whereas the Map-O-Graph displayed larger areas necessitating less frequent adjustments but required greater time for each set up and registration. In both instances the process is simplified if the images to be compared are of nearly the same scale. If the equipment had been available, the comparisons would have been made with the use of a graphic digitizer and computer plotter. The Erosion/Insurance Study conducted by the Erosion/Hazard Management Subcommittee of the Great Lakes Basin Commission Standing Committee on Coastal Zone Management (1978) contains a review and analysis of the several methods of map and photo comparison. As with the older maps and charts, it is necessary to use

common land marks to register the images with one another. Because much shoreline development has taken place in recent years, the 1968 and 1978 photographs had a greater number of land marks (roads, etc.) than the 1960 and 1937 photographs. Thus the greater field of view of the Map-O-Graph gave it a distinct advantage over the ZTS when comparing the older images. Using the ZTS it was frequently necessary to use field or tree lines and dirt trails whereas using the Map-O-Graph more roads were able to be used.

A series of transects at 500-foot intervals, similar to that described for the 1942 charts, was drawn on the current Deltaville (1964) and Wilton (1964, photorevised 1973) topographic maps. The transects were then transferred to the 1978 imagery allowing measurements of shoreline retreat to be made. Although the transects on the topographic sheets do not directly coincide with those on the 1942 charts, they are close enough to allow interpolation. Table 4 and other tables in this chapter use the transect numbers of the most recent maps. The rates of the shoreline retreat can be determined by simple division of linear retreat by time.

The photos were also used to inventory the structures along the shoreline at different times. As evidenced by Table 5, much of the shoreline development has occurred since 1960.

While the maps and photo analyses were being performed in the lab, other persons were in the field or were studying the oblique and the vertical photographs preparatory to going into the field.

Even though they cannot be readily used for measurement, the oblique photographs are often more serviceable than the verticals for the interpretation of coastal processes. Field investigations are needed for verification of the impressions gained from the imagery, for sediment sampling, and for the determination of the integrity of shore protection structures. Although difficult or impossible to quantify, the value of on-site investigation cannot be underestimated.

6.1.2 Data Analysis. When all the data has been assembled it is possible to obtain (1) the overall picture of erosion in the reach and (2) the variation in processes across the reach.

On the joint basis of general observation of the shoreline geomorphology, the differential accumulation of sediment against groins, and the consideration of fetch and wind, we determined that the direct net of longshore drift is upstream, that is east to west. Thus any action taken along the shore will most likely have the greatest secondary impact on the segment(s) to the west. Therefore in our consideration of the area we "thought" from east to west. That is, if a segment were eroding and it were proposed to halt that erosion, say by construction of a seawall, after considering the very local consequences of the construction of a structure, e.g. seawall, the impact on the next segment down drift must be considered. For example, Segment 3 of Reach 1, in the pilot study area, is an area of bluffs eroding at an average rate of over a foot per year. By determining the percent of the bluff sediment that is sand, and thus is likely to remain on the beach, and by calculating the volume of

material eroded from the bluff yearly, it is possible to estimate the quantity of sand made available to the longshore system. Here we estimated 2,400 cubic yards of sand per year. If this material were not available to the longshore system, (1) the beach in Segment 3 would be consumed, (2) the erosion of Segment 4 would increase, and (3) the beach in Segment 4 also might be consumed. Possibly the increased erosion would carry through to include Segments 5, 6, and 7 as well.

The study approach has been to suggest possible shore protection actions, if necessary, for a segment, to estimate the cost of construction, and to assess the benefits and problems of the suggested action. Then our attention is given to the next segment downdrift and its problems were analyzed in the light of the proposed action in the adjacent segment. We continued this process throughout the segment for a number of courses of action. Because this pilot study is intended for wider use than the study area, we added the theoretical condition of larger erosion rates for analysis as well.

6.1.3 Results of Physical Aspects of Pilot Study. The following pages present much of the data and analytical results of the physical aspects of the pilot study. The data include descriptions of segments and options for the three reaches, erosion rates by period and transect (Table 4), a list of shoreline structures (Table 5), and lengths of artifically stabilized areas around Stingray Point (Table 6).

REACH 1. BUSH PARK CREEK TO MILL CREEK — DESIGN AND ANALYSIS OF OPTIONS

SEGMENT	1	2	3	4	5	6	7	SUMMARY
LOCATION (TRANSECTS)	Entrance to Bush Park Creek (25)	Spit section west of entrance (23,24)	Farmed bluff area (17-23)	From western limit of (3) to Rt. 628 (Duck Pond's Point) (11-17)	West from Rt. 628 to end of Duck Pond region (7-11)	From western limit of (5) to Rt. 627, New Mill Creek Wharf (5-7)	From Rt. 627 to entrance to Mill Creek (1-5)	
LENGTH	Approximately 300 feet	700 feet	2,600 feet	3,700 feet	1,800 feet	1,100 feet	1,800 feet	12,000 feet
EROSION RATES	The average historical erosion rates are: 1851-1942: 0.6 ft./yr. 1907-1942: 0.9 ft./yr.	The average historical erosion (from west to east) are: 1851-1942: 0-0.4 ft./yr. 1907-1942:2.4-0.9 ft./yr. 1960-1978:2.8-1.7 ft./yr.	The average historical erosion rates are: 1851-1942: No change at extremes to 1.3 ft./yr. toward middle. 1909-1942: No data for west section; slight accretion at middle, erosion to 2.4 ft./yr. for the east section. 1960-1978: Erosion along entire section ranging from 1.1-4.4 ft./yr.	The average historical erosion rates are: 1851-1942: Accretion of 1.1 ft./yr for east section; erosion ranging from 0.9-1.3 ft./yr. for remaining area. 1909-1942: No data. 1960-1978: Accretion of 1.1 ft./yr. at the middle, minor erosion in the west section, erosion ranging from 1.1-3.3 ft./yr. in the east section.	The average historical erosion rates are: 1851-1942: Erosion ranging from 1.1-3.1 ft./yr. 1907-1942: No data. 1960-1978: No data for western section, erosion of 3.9 ft./yr. at the middle, accretion of 3.3 ft./yr. toward the east.	The average historical erosion rates are: 1851-1942: Erosion ranging from 1.8 ft./yr. at the extremes to 2.0 ft./yr. at the center. 1907-1942: No data. 1960-1978: No data.	The average historical erosion rates are: 1851-1942: Erosion ranging from 0.6-1.8 ft./yr. 1907-1942: No data. 1960-1978: No data.	
COMMENTS	Acts as sand trap for westward net littoral drift. Frequent dredging is required at an estimated 500 cu. yds. per year. Inlet was altered and jettied in 1970.	Low-lying subject to retreat due to updrift trapping of littoral drift. Some hazard from tidal flooding. Generally not suitable for development without significant alteration.	High, up to 35 feet, bluffs, upper portion very sandy with lower silty, fossiliferous strata. Erosion supplies approximately 2,400 cu. yds. of sand (worth $10,800 at $14.50 per cu. yd.) per foot of bluff retreat. There are approximately 8 groins in the segment. SOURCE	Low. Subject to tidal flooding. Pre-1800 accretion. Some development. Several groins, 200+ feet of bulkhead. A few piers.	Low spit. Subject to tidal flooding hazard. NOT DEVELOPABLE. Pre-1800 accretion.	Low shore, no development yet, receives sand from (5) and east.	Low shore, western half is narrow beach.	

REACH 1 - OPTION 1

SEGMENT	1	2	3	4	5	6	7	SUMMARY
PREFERRED ACTION	Require dredged sand be placed on downdrift (westward) beaches.	No structural modification. Inhibit development.	No structural modification to shore face. Reverse grade and drain bluff crest. Would require a "set back" on new construction.	Field of low profile groins approximately 60 ft. long, 90 ft. apart, with an anticipated 15-year life span. New fastland development to flood resistant or flood proof standards.	No shoreface structures.	No shoreface structures.	No shoreface structures except a terminal groin or jetty at western limit of segment.	A program of limited action to moderate but not halt erosion. The program has a minimum of negative downdrift consequences. It is, in part, the completion of the present approach. Minimal dredging, 2,600 feet of bluff crest work, 41 groins with spoilers.
ESTIMATED COSTS	500 cu. yds. per year at $4.50 per cu. yd. $2,250 per year or $33,750 for 15 years.		$5.00 per foot for drainage and grading, $13,000. (See value of erosion products above). Or approximately $0.33 per foot per year for a 15-year life span.	Approximately 40 groins, 60 ft. long at $25 per foot plus $200 spoilers on each groin. $68,000. Or, counting minor maintenance , $1.25 per foot per year for the 15-year life span. Cost does not consider contribution of existing structures.			1 300-foot (minimum) groin at $35 per foot plus $300 spoiler. $10,800 with a 15-year life or $700 per year with minimum maintenance.	$125,550, or $10.46 per foot, or $0.70 per foot per year for 15 years.
BENEFITS	Supplies sand nourishment worth $2,250 per year to an eroding area. Compensates for the interruption caused by the jetties to the natural littoral drift.	Only benefits are passive in that there are no negative consequences associated with structures. Area benefits from action for Segment 1.	Area continues to be a supply of material for downdrift beaches. Erosion is slightly diminished.	Decreases shoreline retreat. Holds a good recreational beach which, in turn, offers some protection from storms and flooding. Also as they fill, they pass sediment to downdrift areas.	Passive benefits only.	Passive benefits only.	Traps last of material in longshore drift building a beach and lessening erosion. Cost equivalent of $4.50 for each cu. yd. trapped. Lessens filling of Mill Creek thus decreasing need for dredging of public boating area at $4.50 per cu. yd. Improves shelter to Mill Creek.	A trade off. Erosion is allowed to continue but is diminished. The structures serve to maximize the benefits of erosion.
PROBLEMS	Minimal. Might cause a slight increase in local turbidity at time of dredging. Prohibits alternate use of dredge spoil. Would require reconsideration if material became too silty.	Does nothing to lessen erosion. Is in effect a prohibition to development; a diminuation of alternate land use capabilities.	Erosion is only minimally diminished. Alternate uses of fastland are restricted.	Does not halt erosion or significantly lessen the hazard of tidal flooding. Does not protect against severe events. Initiation of the groin field probably necessitates its completion. New building to "flood resistant" standards is probably more expensive.	Does not reduce erosion.	Does not reduce erosion.	None.	Land use controls - set backs - may be required for "unprotected" areas.

REACH 1 - OPTION 2

SEGMENT	1	2	3	4	5	6	7	SUMMARY
ALTERNATIVE ACTION	As above.	As above.	As above plus low profile groins 60 feet long, 90 feet apart, estimated 15-year life.	As above. At a minimum, however hardening of the shoreline might be required.	As above.	As above.	As above except stone groin, plus hardening - riprap - of shore to +5 feet MHW.	A more active program of shoreline stabilization with greater downdrift problems and cost.
ESTIMATED COSTS	As above, $2,250 per year or $33,750 for 15 years.	As above.	$13,000 as above, plus 28 groins 60 feet long at $25 per foot plus $200 spoilers on each, or $47,600, total $60,600 or $4,040 per year.	$68,000 as above and/or riprapping to +5 feet MHW at $65 per foot, 50 year life. $240,500 if paid for in 15 years, $16,000 per year or $4.33 per foot per year.	As above.	As above.	1,800 feet of stone work at $65 per foot, $117,000 plus jetties and spoilers as above, $10,800, $127,800 total.	$462,650 or $38.58 per foot or $2.37 per foot per year, for 15 years, less residual value of stone work.
BENEFITS	As above.	As above.	Reduces erosion of bluff estimate by ½, reduces setback distance.	If groins only, benefit is as above but diminished. If riprap, erosion is halted for approximately 50 years.	As above.	As above.	As above, plus stabilizes shoreline for approximately 50 years.	Erosion of bluffs is reduced. Some portions of shoreline are stabilized for approximately 50 years.
PROBLEMS	As above.	As above.	Reduces sediment contribution of bluffs to downdrift system, thus accelerating downdrift erosion perhaps requiring riprap. Terminal groin effect.	Shorter lift span for groins. Loss of beach. Expense of riprap.	Future of area uncertain, as quantity of sand supplied by longshore drift is reduced.	As above.	Expense.	Increased expense. Loss of some beaches. The lessening of erosion in one area, accelerates it in another requiring increased protection.

REACH 1 - OPTION 3

SEGMENT	1	2	3	4	5	6	7	SUMMARY
If Erosion Were Over 3 Feet per Year A: PREFERRED ACTION	As above.	As above.	No shoreface structures. Significant setback requirement.	Groin field as I above, but a diminished life time, 10 years maximum.	No structures.	No shoreface structures.	No shoreface structures except terminal groin or jetty.	
ESTIMATED COSTS	$2,250 per year for 10 years.	As above.	As above.	$68,000 over 10 year life.	As above.	As above.	$10,800 over 10 year life.	$101,000 for 10 years, or $0.84 per foot per year.
BENEFITS	As above.	As above.	Area continues as a supply of sediment.	Relatively low cost. Erosion is slowed.	As above.	As above.	As in preferred action above.	Minimal.
PROBLEMS	As above.	As above.	Area continues to erode at a great rate. Significant setback is required.	Erosion is only diminished. Relatively short lift span of groins.	As above.	As above.	As above	Erosion is only minimally diminished.
B: ALTERNATIVE ACTION	As above.	As above.	Major revetment of bluff with riprap, reverse grade and drainage, etc.	Revetment.	Possible need for revetment if loss of updrift source causes accelerated erosion.	Possible need for revetment.	Terminal groin of stone and possible need for revetment.	Major protection effort.
ESTIMATED COST	$2,250 per year, 40 years $90,000.	As above.	Revetment to +9 feet MHW, slope work, etc., $130 per foot, $338,000.	Revetment at $120 per foot, $444,000.	Revetment if needed at $100 per foot, $18,000.	Revetment if needed at $100 per foot, $110,000.	Revetment if needed and groin at $100 per foot, $210,000.	$1,372,000 for 40 years, or $34,300 per year or $114.59 per foot, $2.89 per foot per year.
BENEFITS	As above.	As above.	Erosion is halted for 40+ years.	Erosion is halted for 40+ years.	Erosion is halted for 40+ years.	Erosion is halted for 40+ years.	Erosion is halted for 40+ years.	Erosion is halted.
PROBLEMS	As above.	As above.	Area is lost as a sediment source, beaches are sacrificed. Great cost.	Beaches are sacrificed.	Probable need to riprap, loss of beaches.	Possible need to riprap, beaches are sacrificed.	As above.	Expensive. Loss of beaches.

REACH 2. STURGEON CREEK TO BUSH PARK CREEK — DESIGN AND ANALYSIS OF OPTIONS

SEGMENT	1	2	3	4	5	SUMMARY
LOCATION (TRANSECTS)	Between Sturgeon and Hunting Creeks (49-53).	Bluff area west of Hunting Creek (44-48).	Beach area near Rt. 631 (36-44).	First half of bluff area west of Rt. 631 (30-36).	From western limit of 4 to Bush Park Creek (25-30).	
LENGTH	2,500 feet.	3,200 feet.	3,500 feet.	2,500 feet.	3,000 feet.	14,700 feet.
EROSION HISTORY	General long term moderate erosion, usually averaging over 1.5 feet per year.	General slight erosion, average rates normally under 1.5 feet per year.	1851 to 1942 major accretion, some averages exceeding 5 feet per year. More recently stable or very slight erosion.	General moderate to slight erosion with averages approaching 1.5 feet per year.	Usually slight average erosion, average rates approximately 1 foot per year.	
COMMENTS	A source area but possibly of insufficient magnitude to justify groins. There already are several hundred feet of bulkhead and 1 groin. Hunting Creek is jettied.	The low area adjacent to Hunting Creek is not suitable for development. The erosional bluff area already has approximately 25 groins. A sediment source.	Area of major accretion is probably anchored by "ancient" (1850s) structure. An excellent beach area. Tidal flooding a threat only in extreme storms.	Erosional bluff supplys an estimated 3,000 cu. yds. of sand to bidirectional longshore drift for each foot of retreat. Many groins and some bulkhead. One area is riprapped. Development is generally set back from bluff crests.	Similar to 4, except drift to west may dominate. Most of area has groins, there are many bulkheads. If it were desired to develop Woods Creek, access should be through Bush Park Creek entrance, closing the natural mouth of Woods Creek.	Sturgeon Creek is a natural boundary where the jetties at Bush Park Creek form an artificial boundary.
OPTIONS						
1:						
ACTION	No shoreface structures. A setback on new construction. Sand dredged from Hunting Creek should be used to nourish beaches, preperably on west side.	Leave as is with low profile groins. If able, vegetate bluff. Control access over bluff. Perhaps add spoilers to groins or build a sill.	No shoreface structures.	1) Low profile groins in areas not now so protected. 2) Setback line at bluff crest. 3) Reverse grade and control drainage over bluff crest. 4) Vegetate raw slopes.	(Area already protected by groins) 1) Control drainage and access over bluff. 2) Vegetate raw bluff. 3) Setback on new construction. 4) Establish bulkhead line near bluff face.	A moderate approach using existing structures.
ESTIMATED COSTS	Dredging of Hunting Creek mouth, $450 per cu. yd.	Spoilers: 25 at $200 each, $5,000, 15-year life for groins and spoilers. Sill: $15 per foot, 10-year life.		Bluff crest work at $5.00 per foot, $12,500. 6 groins 60 feet long at $25.00 per foot, plus spoilers, $10,200 for a 15-year life.	Bluff crest work at $5.00 per foot, $15,000.	$42,700 for a 15-year life or $10.20 per foot per year. If segment 3 is not counted, $0.25 per foot per year.
BENEFITS	Passive benefits only, except for nourishment from dredging. Value of benefit balances cost of dredging. Area remains a source.	Erosion diminished by (an estimated) half. Area remains a source of some sediment. Beaches are maintained.	Area remains an excellent recreational beach.	Area remains a sediment source both for 3 and 5. Erosion is diminished. Existing structures are utilized. Over bluff erosion is reduced.	Existing structures are utilized. Over bluff erosion is reduced. Bulkhead line might tend to decrease flanking failures.	Erosion is moderated with a minimum of problems.
PROBLEMS	Erosion is unchecked.	Erosion is only decreased.	None.	Erosion is not stopped. Value of source is diminished.	In future, bulkhead line might include some state bottoms.	Minimal. Erosion is not halted.
2:						
ACTION	Dredge Hunting Creek as above. Revet area to +5 MHW. 40-year life.	Revet area to +5 feet MHW. 40-year life.	No shoreface structures.	Revet area to at least +5 MHW. Reverse grade and drain bluff as above.	Revet area to at least +5 feet MHW. Reverse grade and drain bluff as above. Extend jetties at Bush Park Creek.	General shoreline stabilization.
ESTIMATED COSTS	2,500 feet at $55.00 per foot, $162,500.	3,200 feet at $65.00 per foot, $208,000.		2,500 feet at $65.00 per foot, $162,500 plus 12,500 from above, $175,000.	3,000 feet at $65.00 per foot, $195,000 plus $15,000 from above, plus 100 feet of jetty at $100 per foot, $10,000, total $220,000.	$765,000 with a 40-year life or $1.30 per foot per year, or $1.60 per foot per year if segment 3 is not counted.
BENEFITS	The shoreline is stabilized.	The shoreline is stabilized.		The shoreline is stabilized.	The shoreline is stabilized.	
PROBLEMS	The area is lost as a sediment source. Loss of beach.	The area is lost as a sediment source, loss of beach possibly threatening the beach in 3.	Future of beach uncertain. Source.	Area is lost as a sediment. Loss of beach.	Area is lost as a sediment source. Loss of beach.	
IF EROSION WERE DOUBLE:						
ACTION	Revetment to +8 feet MHW and bluff crest work. Bypass material dredged from Hunting Creek.	Revetment to +8 feet MHW and bluff crest work.	Possibly 30 groins, 90 feet long 120 feet apart, set 30 feet back into beach, plus spoilers.	Revetment to +8 feet MHW and bluff crest work.	Revetment to +8 feet MHW and bluff crest work. 200-foot jetty at Bush Park Creek.	Major protection. Estimated 40-year life.
ESTIMATED COSTS	Revetment at $110 per foot, bluff crest work at $5.00 per foot $287,500.	Same unit cost as in 1, $368,000.	$30.00 per foot of groin, $81,000 plus spoilers at $12.00 each, $6,000, $87,000 total.	Same unit cost as 1, $287,500.	Same unit cost as 1, $345,000 plus 200 feet of jetty at $150 per foot, $30,000, $375,000 total.	$1,405,000 or $2.40 per foor per year.
BENEFITS	The shoreline is stabilized.		Beach erosion is diminished.	The shoreline is stabilized.	The shoreline is stabilized.	
PROBLEMS	If any portion is protected, all must be. Area lost as source. Uniform protection might necessitate some use of state bottoms. Loss of beach.	Same as 1.	Future uncertain. Terminal groin problems.	Same as 1.	Same as 1.	

REACH 3 - STINGRAY POINT

DESCRIPTIONS AND ANALYSIS OF OPTIONS

LOCATION: Stingray Point area from mouth of Broad Creek to mouth of small cove south of terminus of Route 33. Erosion Transects 68-83.

LENGTH: 9,300 feet.

EROSION HISTORY: Erosion rates from 1851 to 1942 were great, ranging in averages from 3 to nearly 12 feet per year. More recently, 1960 to 1978, the shoreline has in large part been stabilized, hence the shoreline may demonstrate some accretion as well as diminished erosion rates.

COMMENTS: Low headland at mouth of Rappahannock River in Chesapeake Bay. Approximately 6,250 feet (or two thirds) or the 9,300 feet are already protected by riprap or bulkhead. Flooding is a potential problem.

OPTION 1

Action: Riprap protection of the yet unprotected areas, smoothing shoreline irregularities where possible.
Estimated Cost: 3,050 feet at $65 per foot, total cost $198,250 or $4,956 per year for 40 year life.
Benefit: Significant lessening of erosion of unprotected areas. A lessening of "flanking" failures of existing structures.
Problems: Probable loss of beaches. Flooding remains a potential problem. Probable need to use some nearshore state bottoms for smoothing.

OPTION 2

Action: Reconstruct major riprap to a common line and design.
Estimated Cost: $120 per foot, 50 year life, $1,116,000 total cost or $2.40 per foot per year.
Benefit: Shoreline is stabilized for 50+ years by a uniform method. Threat of tidal flooding is slightly reduced.
Problems: Probable loss of beach. Need for utilization of some state bottoms. Very large one time expense.

IN BOTH CASES

A 300 foot jetty-terminal groin at the end of White Cove. If $120 per foot, $360,000 with a 40-year life.

IF EROSION RATES WERE GREATER

Both options would remain, however construction costs would increase by 50% to 75%.

TABLE 4

Historical Erosion Rates
(Feet Per Year)

Middlesex County Pilot Study

Transect	1851-1942	1907-1942	1960-1978
1	- 1.5	ND	ND
2	- 0.6	ND	ND
3	- 0.7	ND	ND
4	- 1.6	ND	ND
5	- 1.8	ND	ND
6	- 2.0	ND	ND
7	- 1.8	ND	ND
8	0	ND	ND
9	- 3.1	ND	- 3.9
10	- 1.1	ND	+ 3.3
11	- 1.1	ND	0
12	- 1.3	ND	- 0.6
13	- 0.9	ND	0
14	- 1.1	ND	+ 1.1
15	0	ND	0
16	+ 1.1	ND	- 1.1
17	0	ND	- 3.3
18	- 0.4	ND	- 2.8
19	- 1.3	ND	- 4.4
20	- 0.7	ND	- 1.1
21	- 0.4	+ 0.9	- 1.7
22	0	- 1.9	- 2.8
23	0	- 2.4	- 2.8
24	- 0.4	- 0.9	- 1.7
25	- 0.6	- 0.9	ND

Historical Erosion Rates — Table 4 (cont)

Transect	1851-1942	1907-1942	1960-1978
26	- 0.7	+ 0.9	- 1.7
27	- 0.6	- 1.9	- 0.6
28	- 0.4	0	0
29	0	- 2.4	0
30	- 0.4	0	- 1.1
31	- 0.7	- 1.4	- 1.1
32	- 1.1	- 0.9	- 2.2
33	0	0	+ 0.6
34	- 0.9	0	+ 1.7
35	- 1.3	- 0.9	0
36	- 1.6	- 2.4	+ 0.6
37	+ 0.4	- 1.4	- 0.6
38	+ 2.6	+ 4.8	0
39	+ 5.1	+ 0.9	0
40	+ 3.1	+ 1.9	0
41	+ 2.2	+ 3.8	0
42	+ 0.6	+ 1.4	+ 0.6
43	- 0.7	- 1.9	- 1.1
44	- 2.0	- 3.3	0
45	- 1.5	- 3.3	- 1.1
46	- 1.5	- 3.8	- 1.7
47	- 2.4	- 4.8	- 0.6
48	- 2.2	- 1.9	+ 1.1
49	- 1.5	- 3.8	0
50	- 1.3	- 1.4	0
51	- 1.6	- 4.8	- 2.2
52	0	- 7.1	- 5.0
53	- 1.1	- 3.8	ND
54	- 1.5	- 4.8	ND
55	- 3.1	- 4.8	0

Historical Erosion Rates

Table 4 (cont)

Transect	1851-1942	1907-1942	1960-1978
56	- 3.1	- 3.3	- 1.1
57	- 2.4	- 3.8	- 2.2
58	- 2.7	- 3.8	- 1.1
59	- 2.2	- 3.8	- 3.3
60	- 1.8	- 3.8	- 2.2
61	- 6.6	- 8.1	0
62	- 6.2	- 6.2	0
63	- 6.6	- 6.7	+ 0.6
64	+ 1.5	- 2.4	+ 5.6
65	- 1.1	+ 2.9	0
66	- 1.6	0	- 1.1
67	ND	ND	ND
68	ND	+10.5	+ 3.3
69	ND	+ 6.3	+11.7
70	ND	- 4.3	+ 0.6
71	- 5.5	- 2.9	+ 1.1
72	- 4.6	- 3.3	0
73	- 5.1	- 3.3	0
74	- 5.1	- 6.7	- 0.6
75	- 5.7	- 8.6	- 1.1
76	- 7.3	- 9.5	- 2.8
77	-11.7	-13.8	+ 0.6
78	-11.4	-10.5	0
79	- 5.7	- 7.1	+ 2.2
80	- 5.5	- 4.8	- 1.1
81	- 4.6	- 2.4	0
82	- 3.3	- 2.4	0
83	- 3.3	- 7.1	0
84	- 0.4	- 2.9	+ 1.1
85	- 1.6	- 3.5	0

Historical Erosion Rates — Table 4 (concluded)

Transect	1851-1942	1907-1942	1960-1978
86	- 2.4	- 4.3	ND
87	- 1.4	- 2.4	+ 2.2
88	+ 0.7	+ 3.3	- 1.7
89	+ 0.6	0	- 0.6
90	+ 2.7	- 1.9	+ 1.7
91	+ 0.4	+ 1.9	- 2.8
92	+ 3.7	+ 4.8	- 2.2
93	+ 4.0	+ 9.5	- 1.1
94	+ 2.4	- 4.8	ND

TABLE 5

Shoreline Structures
Middlesex County Pilot Study

Area Number (By Transects)	1960 Structures	1978 Structures	Structures Common To Both Years
7- 8	-	-	-
8- 9	-	3 groins	-
9-10	-	1 groin	-
10-11	-	1 groin	-
11-12	-	1 groin	-
12-13	-	3 groins	-
13-14	-	2 groins, 50% bulkhead, 1 pier, 1 boat ramp	-
14-15	-	1 boat ramp	-
15-16	-	-	-
16-17	-	-	-
17-18	-	15% bulkhead	-
18-19	-	-	-
19-20	-	5 groins	-
20-21	-	3 Groins	-
21-22	-	-	-
22-23	-	-	-
23-24	-	-	-
24-25	-	1 jetty	-
25-26	-	1 jetty	-
26-27	-	5 groins, 25% bulkhead	-
27-28	-	10 groins, 100% bulkhead	-
28-29	-	9 groins, 100% bulkhead	-
29-30	-	9 groins, 5% bulkhead	-
30-31	-	6 groins, 40% bulkhead	-
31-32	-	5 groins, 100% bulkhead	-
32-33	-	2 groins	-
33-34	-	4 groins, 10% bulkhead	-
34-35	-	4 groins, 15% bulkhead, 35% riprap, 1 pier	-

Table 5 (cont)

Area Number (By Transects)	1960 Structures	1978 Structures	Structures Common To Both Years
35-36	-	50% bulkhead, 2 piers	-
36-37	-	-	-
37-38	-	-	-
38-39	-	-	-
39-40	-	1 boat ramp	-
40-41	-	1 pier	-
41-42	1 pier	2 piers	1 pier
42-43	-	-	-
43-44	-	3 groins	-
44-45	-	4 groins	-
45-46	-	5 groins	-
46-47	-	8 groins	-
47-48	-	4 groins	-
48-49	-	2 groins, 2 jetties	-
49-50	-	1 groin, 75% bulkhead	-
50-51	-	10% bulkhead	-
51-52	-	-	-
52-53	-	2 groins, 1/2 jetty	-
53-54	-	1/2 jetty	-
54-55	-	50% bulkhead	-
55-56	-	5 groins, 100% bulkhead	-
56-57	-	4 groins, 60% bulkhead, 10% failed bulkhead	-
57-58	-	4 groins, 60% bulkhead	-
58-59	-	1 groin, 50% bulkhead	-
59-60	-	1 groin	-
60-61	1 groin	1 groin, 20% bulkhead	-
61-62	2 groins	3 groins, 85% bulkhead, 5% failed bulkhead	-
62-63	10% bulkhead, 1 jetty	15% bulkhead, 85% riprap	-
63-64	-	-	-
64-65	1 groin	30% bulkhead	-

Table 5 (cont)

Area Number (By Transects)	1960 Structures	1978 Structures	Structures Common To Both Years
65-66	-	5 groins, 40% bulkhead	-
66-67	-	-	-
67-68	-	1 groin	-
68-69	1 groin	1 pier, 2 groins, 75% bulkhead	-
69-70	5 groins	6 groins(rip-rap), 100% bulk-head, 1 pier	3 groins
70-71	6 groins	7 groins, 100% bulkhead	-
71-72	3 groins	2 groins, 20% bulkhead	1 groin
72-73	4 groins	4 groins, 5% bulkhead, 75% riprap, 2 piers	1 groin
73-74	2 groins	1 pier, 6 groins, 70% bulkhead, 30% riprap	1 groin
74-75	1 groin	2 piers, 1 groin, 55% riprap, 30% failed bulkhead	-
75-76	-	95% riprap	-
76-77	35% riprap	100% riprap	-
77-78	3 groins	2 groins, 60% riprap, 20% bulkhead, 1 pier	-
78-79	-	70% riprap	-
79-80	4 groins	6 groins, 15% riprap, 25% bulkhead	4 groins
80-81	25% riprap	4 groins, 10% bulkhead, 45% riprap	25% riprap
81-82	2 groins	4 groins, 10% bulkhead, 10% riprap	1 groin
82-83	5 groins	5 groins, 30% bulkhead	-
83-84	3 groins, 20% bulkhead	6 groins, 100% bulkhead, 2 piers	3 groins, 20% bulkhead
84-85	1 jetty, 2 piers, 20% bulkhead	5 groins, 10% riprap, 40% bulkhead	20% bulkhead

Table 5 (concluded)

Area Number (By Transects)	1960 Structures	1978 Structures	Structures Common To Both Years
85-86	-	1 pier, 55% riprap	-
86-87	2 piers, 15% riprap	100% riprap, 2 piers	15% riprap
87-88	1 pier, 1 groin, 40% riprap	1 pier, 1 breakwater 65% riprap	40% riprap, 1 pier
88-89	1 pier	5 groins, 2 piers, 40% riprap	-
89-90	1 groin	4 piers, 4 groins	1 groin
90-91	-	4 groins, 1 pier	-
91-92	-	-	-
92-93	-	-	-
93-94	-	1 groin	-

TABLE 6

Artificially Stabilized Areas (Feet)

Stingray Point Area
Middlesex County Pilot Study

Area Number (By Transect)	1978 Shoreline (Feet)	Artificially Stabilized Shoreline (Feet)	Unprotected Shoreline
68-69	569.6	474.0	95.6
69-70	603.5	603.5	0
70-71	687.8	687.8	0
71-72	606.3	211.2	395.1
72-73	540.7	394.0	146.7
73-74	525.6	231.4	294.2
74-75	627.5	345.4	282.2
75-76	679.5	646.4	33.1
76-77	587.2	587.2	0
77-78	581.4	383.3	198.1
78-79	592.0	416.1	175.9
79-80	554.9	226.8	328.1
80-81	589.2	384.8	204.4
81-82	529.4	120.7	408.7
82-83	1089.7	539.6	550.1
Total	9364.3 Feet	6252.0 Feet	3112.3 Feet

6.2 Application of the Economic Decision Framework

Section 5.1.4 of this report provided a discussion of the objectives of the economic assessment methodology and of the various factors involved in that assessment. Also, it provided an explanation of the relationships among the economic assessment, technical assessment, and institutional mechanisms for various management strategies. Sources of data as well as the procedures which were used to calculate values are more fully explained in Appendix A. The purpose of this section was to apply the economic assessment methodology to the three separate "reaches" in a pilot study area in Middlesex County. The first step was to develop the cost and benefit values for the Summary Budget (as explained in Appendix A) for each reach. Reach number 1 (section 6.2.1) is used as an example to develop the procedure. Results only are presented for the second (section 6.2.2) and third (section 6.2.3) reaches.

6.2.1 Reach Number 1. The reach is that shoreline area which extends from the entrance to Mill Creek to the entrance to Bush Park Creek, a distance of 12,000 feet or 2.27 miles. The area is characterized by open space and agricultural areas with a few residential homes. The reach consists of seven individual segments and includes transects 1-25 (Figure 1, section 6.1.1).

Reach 1 contains 23 shorefront parcels of property with 21 being privately owned and two in public ownership. The evaluation procedures as described in Appendix section A.1.2 through section A.1.8 were used to evaluate the impact values for structures,

property, taxes and productive use for the two depth frontage areas and four erosion rate depth areas. Individual parcel values were summarized for the reach totals and presented in a working table which is then used to develop values for the Summary Budget as shown in section 6.2.1.7.

Working Table for Reach 1.

Area	Dwelling	Other Structures		Property	Total	Loss of Bldg. Site	Property Taxes Annual[1]	Use Productivity Annual[1]
		Land	Water					
	$	$	$	$	$	$	$	$
100'	116,500	8,750	11,950	1,822	139,022	-0-	7.84 (98.00)	26.81 (335.13)
200'	209,150	13,650	11,950	3,644	238,394	-0-	15.67 (195.88)	53.62 (760.25)
10 yr.	27,825	-0-	-0-	224	NA	-0-	1.00 (6.71)	2.70 (18.12)
15 yr.	27,825	-0-	-0-	337	NA	-0-	1.44 (12.33)	4.07 (34.84)
30 yr.	58,890	1,000	5,000	673	NA	-0-	2.89 (32.54)	8.14 (91.66)
67 yr.	79,620	5,200	9,700	1,503	NA	-0-	6.46 (80.36)	18.17 (226.03)

[1]Assume constant annual stream of benefits. Present worth (in parenthesis) was calculated at 8 percent discount rate:

10 yr.	15 yr.	30 yr.	67 yr.	Inf.
6.71	8.56	11.26	12.44	12.50

6.2.1.1 Potential Shoreland Erosion Loss. The first component of the Summary Budget in section 6.2.1.7 is a display of the maximum cost due to unabated erosion losses for each erosion rate year

for each category. Values for this display were extracted from the working table in section 6.2.1. and calculated according to procedures described in Appendix A.4.1. The following values represent the maximum benefit which would accrue to each category if erosion was completely abated as a result of implementation of controls.

	10 yr.		15 yr.		30 yr.		67 yr.	
	$		$		$		$	
	Private	Public	Private	Public	Private	Public	Private	Public
dwelling	27,825	0	27,825	0	58,890	0	79,620	0
land structures	0	0	0	0	1,000	0	5,200	0
water structures	0	0	0	0	5,000	0	9,700	0
loss of bldg. site	0	0	0	0	0	0	0	0
loss of taxes (property)	NA	7	NA	12	NA	33	NA	80
loss of prod. use	18	0	35	0	92	0	226	0
Total	27,843	7	27,860	12	64,982	33	94,746	80

These total values were transferred to the Summary Budget. This reach did not have any identified shoreland benefits accruing to the public sector except loss of taxes on property. However, some areas may have substantial other public benefits.

6.2.1.2 Assessment of Erosion Control Options. Four control options as discussed in section 6.1.3 were proposed for Reach 1.

Option I: Consists of a program of limited action to moderate but not halt erosion. Action would result in a minimum of negative downdrift consequences. The approach includes minimal dredging, 2,600 feet of bluff crest grade and drain work, and 41 groins with "spoilers".

Cost of structural controls:

Total current dollars - $125,550.00

Cost per foot - 10.50

Time period of effectiveness - 15 years

Expected effectiveness in control - 20 percent

(Percent expected effectiveness in control is an attempt to combine and quantify the expected life of the structure and its effect in reducing erosion. It is at best an approximation.)

Expected results - Erosion is allowed to continue but is diminished. Structures serve to maximize the benefits of erosion. In Segment 1, sand nourishment worth $2,250 per year is supplied to an eroding area. (Present worth of $2,250 annually for 15 years at 8 percent discount is $2,250 X 8.56 - $19,260). In Segment 7, longshore drift material is trapped and builds the beach. Also, there is a decrease in the need for dredging Mill Creek and an improvement in the boat shelter area in Mill Creek.

Option II: A more active program of shoreline stabilization with greater downdrift problems and costs. This approach includes all the work in option I plus additional groins in one segment and shoreline hardening in two other segments.

Cost of structural controls:

Total current dollars - $462,650.00

Cost per foot - $35.70

Time period of effectiveness - 25 years

Expected effectiveness in control - 50 percent

Expected results - Erosion of bluffs is reduced. Some portions of the shoreline are stabilized for approximately 50 years. Some beach areas are lost. Downdrift erosion may accelerate and the life span of some groins may shorten. Sand nourishment worth $2,250 per year or $24,008 for 25 years is still provided.

Option IIIA: The preferred action if erosion were over 3 feet per year. Strategy would differ from options I and II. Strategy would include a groin field in one segment, a terminal groin or jetty in another segment and dredging in a third.

Cost of structural controls:

Total current dollars - $101,000.00

Cost per foot - $8.40

Time period of effectiveness - 10 years

Expected effectiveness in control - 15 percent

Expected results: Erosion is only minimally diminished. The option still provides sand nourishment worth $2,250 per year or $15,098 for 15 years.

Option IIIB: This is an alternative action if erosion were over 3 feet per year. It would involve major protection efforts. In addition to actions in Option IIIA, it includes a revetment (most likely riprap) in several segments and a stone terminal groin.

Cost of structural controls:

Total current dollars - $1,372,000.00

Cost per foot - $115.50

Time period of effectiveness - 40 years

Expected effectiveness in control - 95 percent

Expected results: Erosion is halted but loss of some beach is expected because of the loss of sediment source.

Technical Assistance: This category includes the expense of technical assistance for shoreline evaluation, design of appropriate control structures, and on-going maintenance and field checks. A value was calculated as shown in Appendix A.2 for the reach and is the same regardless of which option is selected.

Technical assistance:

Direct personnel cost		
4 man-days per mile x 2.27 miles x $40 day	=	$ 363.20
Indirect personnel cost		
$363.20 (direct) x .70 (indirect rate)	=	254.24
Supplies		
$20 per mile x 2.27 miles	=	45.40

Scientific Analysis:

Direct personnel cost		
4 man-days per mile x 2.27 miles x $75 day	=	681.00
Indirect pesonnel cost		
$681.00 (direct) x .70 (indirect rate)	=	476.70

General oversight:

1 man-day per mile x 2.27 miles x $40 day	=	90.80
		$1,911.34

The values for each option and the total value for technical assistance are transferred to the Summary Budget in section 6.2.1.7.

6.2.1.3 Potential Impact From Restriction on Ownership. The impact on ownership restriction may result from either restrictions such as easements and acquisition or from regulatory actions such as zoning, permitting, and setbacks. Values were determined by the procedure as explained in Appendix A.1.

Maximum cost of restriction on the use of resources was based on the value of productive use of the land, value of impacted property, and loss of building site within the 100' and 200' areas.

	100'		200'	
	$		$	
	Private	Public	Private	Public
productive use	335	0	760	0
value of property	1,722	100	3,444	200
loss of bldg. site	0	0	0	0
Total	2,057	100	4,204	200

The total values were transferred to the Summary Budget in section 6.2.1.7.

6.2.1.4 Transaction and Administration. One value per reach for each of the five categories under transaction and administration were calculated based on the procedure as described in Appendix A.3.

Ownership category:

Reach 1 contains 23 parcels of property which could be subject to a taking action at a cost of $1,500 parcel.

23 parcels x $1,500 parcel = $34,000 maximum cost of an ownership program

Regulatory category:

Cost as estimated for a reach in Middlesex County.

$332.74 cost per reach

Financial or incentive category:

Cost as estimated for 23 parcels in Reach 1 in Middlesex County.

23 parcels x $27.02 parcel = $621.46

Data collection/planning/research:

Actual cost data for the example reaches in Middlesex County was $18.04 per parcel.

23 parcels x $18.04 parcel = $414.92

Education/information:

Will probably be part of an on-going program. A maximum expenditure of $1,000 should be established for this category. The value per reach for each category was transferred to the Summary Budget in section 6.2.1.7.

6.2.1.5 Potential Cost of Public Acquisition. The maximum cost of public acquisition is the value of all property and improvements in the 100 foot and 200 foot impact areas. Values were determined as explained in Appendix A.4.3. Values for public ownership were included in the total because transfer of publicly-owned property may occur between two public entities. Acquisition cost must be used conjunctively with other actions such as relocation potential and other ownership restriction activities.

	100' $	200' $
dwelling	116,500	209,150
land structures	8,750	13,650
water structures	11,950	11,950
property	1,822	3,644
Total	139,022	238,394

Acquisition costs can be allocated among federal, state, and local concerns in any manner desired. One proposal is for a 50 federal/50 non-federal program. These options are discussed in section 6.2.4. The total values were transferred to the Summary Budget in section 6.2.1.7.

6.2.1.6 Potential Cost of Relocation of Dwellings.

Relocation cost for moving all dwellings out of the 100 foot and 200 foot impact area is provided as an alternative to complete public acquisition. Relocation costs were calculated on the basis of the procedure discussed in Appendix A.4.3 for each dwelling presently located in the area and a total summed for the reach. Estimates for relocation cost for each dwelling were not permitted to exceed the assessed value of the dwelling.

	100' $	200' $
relocation cost	93,100	170,150

These values must be used in comparison with other alternatives. These costs can also be allocated on a cost sharing basis. One proposal is an 80 federal/20 non-federal share on grant programs and a

5 percent rate on loan programs. These options will be discussed in section 6.2.4. These values were transferred to the Summary Budget in section 6.2.1.7.

6.2.1.7 Summary Budget of Costs and Benefits for Reach 1.

	Costs			Benefits		
	Total	Private	Public	Total	Private	Public
	$	$	$	$	$	$
I. Potential Shoreland Erosion Loss Prevention						
10-yr erosion rate	27,850	27,843	7	-	-	-
15-yr erosion rate	27,872	27,860	12	-	-	-
30-yr erosion rate	60,015	64,982	33	-	-	-
67-yr erosion rate	94,826	94,764	30	-	-	-
II. Assessment of Erosion Control Options[1]						
Effectiveness						
Option Years Percent						
I 15 20	125,550			24,834[2]	5,572	2
II 25 50	462,650			56,516[3]	32,491	17
III 10 15	101,000	-	-	19,276[4]	4,176	2
IV 40 95	1,372,000	-	-	NA	NA	NA
Technical Assistance	1,911	-	-	-	-	-
Potential Impact from Restriction on Ownership						
100 foot depth	2,157	2,057	100	-	-	-
200 foot depth	4,404	4,204	200	-	-	-
Transaction and Administration						
Ownership	34,150	-	34,150	-	-	-
Regulatory	333	-	333	-	-	-
Financial	621	-	621	-	-	-
Data/Research	415	-	415	-	-	-
Education	1,000	-	1,000	-	-	-

	Costs			Benefits		
	Total	Private	Public	Total	Private	Public
	$	$	$	$	$	$
III. Potential Cost of Public Acquisition						
100 foot depth	139,022	-	139,022	-	-	-
200 foot depth	238,394	-	238,394	-	-	-
Potential Cost for Relocation of Dwellings						
100 foot depth	93,100	-	93,100	-	-	-
200 foot depth	170,150	-	170,150	-	-	-

[1]As many options as desirable may be included. The years indicate the project time period of effectiveness of controls. The percentage indicates effectiveness of structures for that option in controlling erosion.

[2]Includes $19,260 in sand nourishment benefits.

[3]Includes $24,008 in sand nourishment benefits.

[4]Includes $15,097 in sand nourishment benefits.

Evaluation of Summary Budget for Reach 1. Part 1 of the budget provides values for a maximum loss to shoreland resources if erosion were to continue unabated. These costs could accrue to either private or public parties. However, due to the nature of ownership in this sample, only loss of taxes accrue to the public section. As a result of erosion action, additional, unaccounted for, losses may accrue to the shoreline and nearshore areas. It is important to note a potential for additional costs to the State resulting from claims of damages caused by the downdrift impacts of erosion preventing structures. Article 1, Section 11 of the Virginia Constitution prevents "...any law whereby private property shall be taken or damaged for public uses, without just compensation...."[1]

This constitutional provision has been held to be "self executing", and all a landowner need show is damage caused by some state action in order to recover money. The concept was applied in an erosion context in Heldt v. Elizabeth River Tunnel Dist.[2] and Morris v. Elizabeth River Tunnel Dist.[3]

The difficulty of proof and the present uncertainty as to whether the State or an individual can be held liable for downdrift impacts from shoreline defense structures prevents the inclusion of the damage concept, in quantitative form, in our accounting of costs associated with shoreline erosion prevention. The potential of monetary outflows resulting from such damage claims should be noted, however.

[1] Va. Const. Art. 1, §11.

[2] Heldt v. Tunnel Dist. 196 Va. 477, 84 S.E. 2d 511 (1954).

[3] Morris v. Tunnel Dist. 203 Va. 196, 123, S.E. 2d 398 (1962).

Those losses are not included in these values because measurement of the losses and methodology to place a value on the losses do not presently exist. Control measures may prevent all or some of these losses and thus they become a benefit for evaluation of control options. Additional benefits other than prevention of losses (such as beach accretion) may accrue to private or public entities as a result of structural or non-structural control measures. Likewise, methodology for inclusion of these benefit values does not presently exist. Thus, actual benefits for control measures could be significantly higher than those which were included in the summary budget.

Part II provides the necessary data for cost and benefit comparisons. It provides total costs for implementation of structures for each option. These costs are given only as a total because they could be allocated to either the private or public sector. Technical assistance remains constant for the reach. Benefits for each option were calculated from the potential shoreland erosion loss prevention values based on percentage effectiveness of structures for that option in controlling erosion. For example, Option I was projected to be 20 percent effective in controlling erosion. Therefore, total benefits are: $27,872 x .20 = $5,574 + $19,260 sand nourishment for a total of $24,834.

In comparing the direct costs and benefits of each option for this reach, none of the options should be implemented. However, other

benefits (perceived and non-quantifiable benefits) may dictate selection of an option. If one of these options is selected for implementation only $5,569 under Option I, $32,491 under Option II and $1,392 under Option III should be allocated to private owner costs. Costs were allocated in this manner to equal identified private sector benefits. This does not mean that these are the only benefits which will accrue to the private sector, they are the only ones identified by the analysis and subject to allocation to the private sector.

The monetary costs of restriction on ownership in this open and undeveloped area was very small for both the 100' and 200' area with $2,157 and $4,404 respectively. However, the cost of an ownership type program with a taking action would be an additional $34,150, a significantly higher cost. For this reach other transaction and administration costs were small.

These costs and benefits are not simply additive; combinations of costs and benefits must be considered for each proposed management strategy.

Part III provides cost values which are not necessary for the benefit and cost evaluation but are necessary for a complete evaluation of available alternatives. Acquisition of property and improvements in the 100' or 200' impact areas may be a desirable management strategy or may be a requirement under the taking issue. The maximum cost of acquisition is $139,022 in the 100' area and $238,394 in the 200' area. If a large number of parcels in the reach

required acquisition as a part of ownership restriction or regulatory action, then the cost of the non-structural measures could easily be higher than some of the structural options.

A second important factor could be cost of relocation of dwellings. Relocation could decrease cost of acquisition and make an infeasible management strategy feasible. Relocation cost could decrease acquisition cost in the 100' area by $23,400 ($116,500 value of dwellings in section 6.2.1.5. minus the $93,100 for relocation of dwellings). That difference is $39,000 (209,150 - 170,150) in the 200' area. Savings from relocation are relatively small for this area as it is characterized by smaller homes where relocation costs are almost as large as the value of the houses. With larger, more expensive homes, relocation costs could be a significant factor in selection of management strategies.

Conclusion on Reach 1

Benefits of control in this reach were extremely small compared to cost of structural controls. The non-identified benefits would have to be at least three times as great as these identified benefits to make any option economically feasible. Cost of ownership restriction was extremely small unless acquisition was required. For this open and undeveloped area some form of ownership restriction in either a 100' or 200' area appears to be the only viable alternative.

6.2.2 Reach Number 2. The reach is that shoreline area which extends from Bush Park Creek to the Beach Area near State Route 631, a disance of 9,000 feet or 1.70 miles. The area is characterized by two sections of moderate density residential development and some high bluff areas. The reach consists of three individual segments and includes transects 25-44 (Figure 1, Section 6.1.1). Reach 2 contains 74 shorefront parcels of property with all 74 being privately owned.

Working Table for Reach 2.

Area	Dwelling	Other Structures			Total	Loss of Bldg. Site	Property Taxes Annual[1]	Use Productivity Annual[1]
		Land	Water	Property				
	$	$	$	$	$	$	$	$
100'	632,900	32,400	42,750	256,238	964,288	0	1,101.85 (13,773.13)	2.58 (32.25)
200	856,350	71,800	42,750	512,475	1,483,375	0	2,203.71 (27,546.38)	5.16 (64.50)
10 yr.	165,305	2,700	1,260	9,570	NA	0	41.28 (276.99)	0
15 yr.	170,525	7,300	3,600	14,200	NA	0	61.13 (523.27)	0
30 yr.	217,285	7,750	5,600	28,404	NA	0	122.25 (1,376.54)	0
67 yr.	290,475	11,250	11,900	63,427	NA	0	272.74 (3,392.89)	0

[1]Assume constant annual stream of benefits. Present worth (in parenthesis) was calculated at 8 percent discount rate:

10 yr.	15 yr.	30 yr.	67 yr.	Inf.
6.71	8.56	11.26	12.44	12.50

6.2.2.1 Potential Shoreland Erosion Loss

	10 yr. $		15 yr. $		30 yr. $		67 yr. $	
	Public	Private	Public	Private	Public	Private	Public	Private
dwellings	165,305	0	170,525	0	217,285	0	290,475	0
land structures	2,700	0	7,300	0	7,750	0	11,250	0
water structures	1,260	0	3,600	0	5,600	0	11,900	0
loss of bldg. site	0	0	0	0	0	0	0	0
loss of taxes (property)	NA	276	NA	523	NA	1,377	NA	3,393
loss of prod. use	0	0	0	0	0	0	0	0
Total	169,265	276	181,425	523	230,635	1,377	313,625	3,393

6.2.2.2 Assessment of Erosion Control Options.

Option I: Involves a moderate approach which would utilize existing structures. The suggestions include low profile groins and bluff area grading and drainage works for one segment and bluff grading and drainage plus bulkheading in another segment.

Cost of structural controls:

Total current dollars - $37,700.00

Cost per foot - $4.19

Time period of effectiveness - 15 years

Expected effectiveness in control - 50 percent

Expected results: Erosion is reduced but the sediment source is maintained.

Option II: Results in general shoreline stabilization. In addition to actions in Option I, revetments (probably riprap) in two segments

Cost of structural controls:

Total current dollars - $395,000.00

Cost per foot - $43.89

Time period of effectiveness - 40 years

Expected effectiveness in control - 95 percent

Expected results: Shoreline is stabilized. Beach area is lost because the source of sediment is lost.

Option III: The proposed action if erosion were double current rates. The approach would provide major protection of the shoreline. In addition to action as in Option II, additional revetment work in two segments and a substantial groin field in the third segment are needed.

Cost of structural controls:

Total current dollars - $749,500.00

Cost per foot - $83.28

Time period of effectiveness - 40 years

Expected effectivenss in control - 95 percent

Expected results: The shoreline is stabilized but all erosion is not diminished. The beach is lost as the sediment source is eliminated.

Technical Assistance:

Direct personnel cost

40 man-days per mile x 1.70 miles x $40 day = $ 272.00

Indirect personnel cost

$272.00 (direct) x .70 (indirect rate) = 190.40

Supplies

$20 per mile x 1.70 miles = 34.00

Scientific analysis:

Direct personnel costs

4 man-days per mile x 1.70 miles x $75 day = 510.00

Indirect personnel cost

$510.00 (direct) x .70 (indirect rate) = 357.00

General oversight:

1 man-day per mile x 1.70 miles x $40 day = 68.00

TOTAL $1,431.40

6.2.2.3 Potential Impact from Restriction on Ownership

	100'		200'	
	$		$	
	Private	Public	Private	Public
productive use	32	0	65	0
value of property	256,238	0	512,475	0
loss of bldg. site	0	0	0	0
Total	256,238	0	512,540	0

6.2.2.4 Transaction and Administration:

Ownership category:

Reach 2 contained 74 parcels of property which could be subject to a taking action at a cost of $1,500 per parcel

74 parcels x $1,500 parcel = $111,000

maximum cost of ownership program

Regulatory category:

$332.74 per reach

Financial or incentive category:

74 parcels x $27.02 parcel = $1,999.48

Data collection/planning/research:

74 parcels x $18.04 parcel = $1,334.96

Education/information:

A maximum expenditure of $1,000 is suggested.

6.2.2.5 Potential Cost of Public Acquisition

	100' $	200' $
dwelling	632,900	856,350
land structures	32,400	71,800
water structures	42,750	42,750
property	256,238	512,475
Total	964,288	1,483,375

6.2.2.6 Potential Cost for Relocation of Dwellings

	100' $	200' $
relocation cost	540,200	731,550

6.2.2.7 Summary Budget of Costs and Benefits for Reach 1

	Costs			Benefits		
	Total $	Private $	Public $	Total $	Private $	Public $
I. Potential Shoreland Erosion Loss Prevention						
10-yr erosion rate	169,541	169,265	276	-	-	-
15-yr erosion rate	181,948	181,425	523	-	-	-
30-yr erosion rate	232,012	230,635	1,377	-	-	-
67-yr erosion rate	317,018	313,625	3,393	-	-	-

	Effectiveness		Costs			Benefits		
	Years	Percent	Total $	Private $	Public $	Total $	Private $	Public $
II. Assessment of Erosion Control Options [1]								
I	15	50	37,700	-	-	90,974	90,713	261
II	40	95	395,000	-	-	220,411	219,103	1,308
III	40	95	749,500	-	-	220,411	219,103	1,308
Technical Assistance			1,431	-	-	-	-	-
Potential Impact from Restriction on Ownership								
100 foot depth			256,270	256,270	0	-	-	-
200 foot depth			512,540	512.540	0	-	-	-
Transaction and Administration								
Ownership			111,000	-	111,000	-	-	-
Regulatory			333	-	333	-	-	-
Financial			1,999	-	1,999	-	-	-
Data/Research			1,335	-	1,355	-	-	-
Education			1,000	-	1,000	-	-	-
III. Potential Cost of Public Acquisition								
100 foot depth			964,288	-	964,288	-	-	-
200 foot depth			1,483,375	-	1,483,375	-	-	-
Potential Cost for Relocation of Dwellings								
100 foot depth			540,200	-	540,200	-	-	-
200 foot depth			731,550	-	731,550	-	-	-

[1] As many options as desirable may be included. The years indicate the projected time period of effectiveness of controls. The percentage indicates effectiveness of structures for that option in controlling erosion.

Evaluation of Summary Budget for Reach 2. In Part II, benefits are significantly greater than cost for Option I but significantly lower for Options II and III. Even with added cost of technical assistance and administrative and transaction components Option I appears feasible and total costs should be borne by private owners. Unquantified benefits would have to be extremely large to justify the other two options.

Cost of restriction on ownership is high for this area. The $256,270 + $111,000 administrative and transaction costs give a total of $367,270. Any added cost of acquisition (minus difference in relocation) due to the taking issue would push this cost past that for structural controls in Option II and possibly Option III. The ownership restriction may have little impact on mitigation of erosion whereas structural Options II and III eliminate 95 percent of the erosion.

Conclusion on Reach 2

Option I is economically feasible. Options II and III appear to be better alternatives than non-structural ownership restrictions in this developing area. Approximately half of the cost on Option II should be borne by the public. A significantly larger amount of Option III cost should be borne by the public.

6.2.3 Reach Number 3. The reach is that shoreline in the Stingray Point area from the mouth of Broad Creek to the mouth of the small cove south of terminus of State Route 33, a distance of 9,300 feet or 1.76 miles. The area is characterized as a continuous segment of high density single-family residential units with many of those being summer or vacation homes and includes transects 68-83 (Figure 1, Section 6.1.1). Reach 3 contains 76 shorefront parcels of property with all 76 being privately owned. Approximately 6,250 feet of reach are already protected by riprap or bulkhead.

Working Table for Reach 3

Area	Dwelling	Other Structures		Property	Total	Loss of Bldg. Site	Property Taxes Annual[1]	Use Productivity Annual[1]
		Land	Water					
	$	$	$	$	$	$	$	$
100'	818,500	43,700	86,100	450,852	1,399,152	19,600	1,938.66 (24,233)	0
200'	818,500	43,700	86,100	901,704	1,850,004	19,600	3,877.33 (48,467)	0
10 yr.	386,045	2,050	28,400	26,350	NA	12,300	113.31 (760)	0
15 yr.	407,435	4,000	29,400	39,518	NA	12,300	169.93 (1,455)	0
30 yr.	431,900	5,000	30,400	79,036	NA	12,300	339.85 (3,827)	0
67 yr.	431,900	5,000	30,400	176,512	NA	12,300	759.00 (9,442)	0

[1]Assume constant annual stream of benefits. Present worth (in parenthesis) was calculated at 8 percent discount rate:

10 yr.	15 yr.	30 yr.	67 yr.	Inf.
6.71	8.56	11.26	12.44	12.50

6.2.3.1. Potential Shoreland Erosion Loss.

	10 yr.		15 yr.		30 yr.		67 yr.	
	$		$		$		$	
	Private	Public	Private	Public	Private	Public	Private	Public
dwelling	386,045	0	407,435	0	431,900	0	431,900	0
land structures	2,050	0	4,000	0	5,000	0	5,000	0
water structures	28,400	0	29,400	0	30,400	0	30,400	0
loss of bldg. site	12,300	0	12,300	0	12,300	0	12,300	0
loss of taxes (property)	NA	760	NA	1,455	NA	3,827	NA	9,422
loss of prod. use	0	0	0	0	0	0	0	0
	428,795	760	453,135	1,455	479,600	3,827	479,600	9,442

6.2.3.2. Assessment of Erosion Control Options for Reach 3.

Option I: Approach consists of riprap protection of unprotected areas and smoothing shoreline irregularities where possible and a jetty or terminal groin.

Cost of structural controls:

Total current dollars - $558,250.00

Cost per foot - $60.28

Time period of effectiveness - 40 years

Expected effectiveness in control - 95 percent

Expected results: Significant lessening of erosion of unprotected areas. A lessening of flanking failure of existing structures. Probable loss of some beaches.

Option II: Approach is to reconstruct major riprap to a common line and design plus the terminal groin.

Cost of structural controls:

Total current dollars - $1,476,000.00

Cost per foot - $158.71

Time period of effectiveness - 50 years

Expected effectiveness in control - 95 percent

Expected results: Shore stabilized for 50 years. Probable loss of some beach.

Technical Assistance

Technical assistance:

Direct personnel cost

4 man-days x 1.76 miles x $40/day = $ 281.60

Indirect personnel cost

$281.60 (direct) x .70 (indirect rate) = 197.12

Supplies

$20 x 1.76 miles = 35.20

Scientific Analysis:

Direct personnel cost

4 man-days x 1.76 miles x $75/day = 528.00

Indirect personnel cost

$528.00 (direct) x .70 (indirect rate) = 369.60

General oversight;

1 man-day x 1.76 miles x $40/day = 70.40

Total $1,481.92

6.2.3.3 Potential Impact from Restriction on Ownership.

	100'		200'	
	$		$	
	Private	Public	Private	Public
productive use	0	0	0	0
value of property	450,852	0	901,704	0
loss of bldg. site	19,600	0	19,600	0
Total	470,452	0	921,304	0

6.2.3.4 Transaction and Administration.

Ownership category:

Reach 3 contains 76 parcels of property which could be subject to a taking action at a cost of $1,500 per parcel.

76 parcels x $1,500 parcel = $114,000 maximum cost of ownership

Regulatory category:

$332.74 cost per reach

Financial or incentive category:

76 parcels x $27.02 parcel = $2,054

Data collection/planning/research:

76 parcels x $18.04 parcel = $1,371.04

Education/information:

A maximum expenditure of $1,000 is suggested.

6.2.3.5 Potential Cost of Public Acquisition.

	100' $	200' $
dwelling	818,500	818,500
land structures	43,700	43,700
water structures	86,100	86,100
property	450,852	901,704
Total	1,399,152	1,850,004

6.2.3.6 Potential Cost for Relocation of Dwellings.

	100' $	200' $
relocation cost	634,800	634,800

6.2.3.7. Summary Budget of Costs and Benefits for Reach 3.

	Costs			Benefit		
	Total $	Private $	Public $	Total $	Private $	Public $
I. Potential Shoreland Erosion Loss Prevention						
10-yr. erosion rate	429,555	428,795	760	-	-	-
15-yr. erosion rate	454,590	453,135	1,455	-	-	-
30-yr. erosion rate	483,427	479,600	3,827	-	-	-
67-yr. erosion rate	489,042	479,600	9,442	-	-	-
II. Assessment of Erosion Control Options[1]						
Effectiveness						
Option Years Percent						
I 40 95	558,250	-	-	459,256	455,620	3,636
II 50 95	1,476,000	-	-	464,590	455,620	8,970
Technical Assistance	1,482	-	-	-	-	-

[1]As many options as desirable may be included. The years indicate the projected time period of effectiveness of controls. The percentage indicates effectiveness of structures for that option in controlling erosion. Potential Impact from

	Costs			Benefit		
	Total $	Private $	Public $	Total $	Private $	Public $
Potential Impact from Restriction on Ownership						
100 foot depth	470,452	470,452	0	-	-	-
200 foot depth	921,304	921,304	0	-	-	-
Transaction and Administration						
Ownership	114,000	-	114,000	-	-	-
Regulatory	333	-	333	-	-	-
Financial	2,054	-	2,054	-	-	-
Data/Research	1,371	-	1,371	-	-	-
Education	1,000	-	1,000	-	-	-
III. Potential Cost of Public Acquisition						
100 foot depth	1,399,152	-	1,399,152	-	-	-
200 foot depth	1,850,004	-	1,850,004	-	-	-
Potential Cost for Relocation of Dwellings						
100 foot depth	634,800	-	634,800	-	-	-
200 foot depth	634,800	-	634,800	-	-	-

Evaluation of Summary Budget for Reach 3

As shown in Part I potential benefits from controlling erosion were relatively high but fairly constant for each erosion rate area in this developed area. The identified benefits for Option I were almost as large as the costs. Only a small number of unidentified benefits would make this option feasible. Almost all of the benefits are private and therefore, most of the cost should be borne by the private sector. Option II appears to be uneconomical. If it were implemented, a very large part of the cost would fall on the public sector.

Cost of ownership restrictions ($470,452 + $114,000 = $584,452) plus any cost of acquisition would make this alternative extremely expensive compared to Option I which controls 95 percent of the erosion.

6.2.4. Summary of Assessment Procedure. A complete economic evaluation of proposed control measures is not provided by the assessment procedure. Analysis of several important factors was not within the scope of this study. Those constraints to the analysis were clearly stated throughout the text. Within those constraints, certain conclusions can be stated. The assessment procedure clearly identifies those structural control options for which costs are greatly in excess of the expected benefits; such as Option II and IV in Reach 1, Option III in Reach 2, and Option II in Reach 3. Benefits other than those identified would have to be extremely large to justify the action. Several of the structural control options do have identified benefits nearly equal to or in excess of costs and would appear to be economically feasible. For instance, Option I and II in Reach 2 and Option I in Reach 3 are in this category.

The procedure also provides an indication of the relative magnitude of cost for the non-structural measures such as setback requirements. For instance, an ownership restriction without any public acquisition is relatively inexpensive in Reach 1, the open space and undeveloped area. Of course, acquisition in response to the taking issue would add significantly to that cost but would not

constitute a prohibitive expenditure. Non-structural controls become significantly more expensive and rival the magnitude of structural measures in the developing area, Reach 2. Of course, structural measures provide a degree of control whereas setbacks may only eliminate potential damages by restricting uses of that area. Non-structural measures become very expensive for the developed areas.

A general conclusion is that non-structural controls are more suitable for open space and undeveloped areas, and some form of structural controls are more suitable for developed areas. Of course, combinations of control measures may be appropriate for any of the areas.

The division where possible of costs and benefits between the private and public sectors provides a reasonable basis for consideration of allocation of the burden of costs of the program between these two sectors. The magnitude of the added cost of the proposed programs and the expected willingness and ability of each sector to pay for the programs is discussed in section 6.3 of this report. Section 6.4 of the report contains an application of the analysis to the federal flood insurance program.

Although the assessment procedure for this case study area was limited to impacts on agricultural and residential type resource areas which constitute most of Middlesex County and other similar counties

in the coastal area, the basic methodology could with slight modification be easily applied to commercial, industrial, and more urbanized areas.

6.3 Financial Factors and Successful Implementation of a Control Program.

The analysis in sections 6.2.1.7, 6.2.2.7, and 6.2.3.7 provided a rationale for distribution of erosion control costs between the private and public sectors. Successful implementation of a propsed program for any reach will depend on willingness of private property owners to construct or, where necessary, support the expenditure of public funds. Of course, one alternative is to use public funds in the form of local revenue, grants or loans for the total project.

6.3.1 Private Expenditures for Erosion Control. Many owners of private property located in the study area have already made expenditures to protect their property from erosion. While a detailed analysis of these expenditures was not available, some preliminary observations can be made. Two of the 23 parcels in Reach 1, the undeveloped area, had some structural controls. One large parcel with 4,295 feet of waterfront and a lot value of $346,400 had erosion control structures with an assessed value of $5,000. The other parcel with 724 feet of waterfront and valued at $83,900 had erosion control structures assessed at $2,500.

Twenty-six of the 74 parcels in Reach 2, the developing area, had erosion control structures. Those 26 parcels included a total of 3,160 feet of waterfront and had a total assessed value for erosion control structures of $39,400; an average expenditure of $12.46 per foot. The average value of the lots was $10,529. Only two lots with controls did not have some type of other improvement.

Forty-two of the 76 parcels in Reach 3, the developed area, had structural controls. Those 76 parcels contained a total of 3,197 feet of waterfront and a total assessed value for erosion control structures of $57,150; an average expenditure of $17.88 per foot. The average lot value was $10,659. Fourteen of these lots did not have other improvements.

While the values of control structures were taken from assessment records, they do indicate a willingness of private property owners to make expenditures to protect their property from erosion. The total cost per foot for several of the proposed control options compares favorably with the assessed value of previous private expenditutes of $12.46 per foot in Reach 2 and $17.88 per foot in Reach 3. The cost per foot for each proposed option was:

Reach 1, section 6.2.1.2:

Option I - $ 10.50 per foot

Option II - $ 35.70 per foot

Option III - $ 8.40 per foot

Option IV - $115.60 per foot

Reach 2, section 6.2.2.2:

Option I - $ 4.19 per foot

Option II - $ 43.89 per foot

Option III - $ 83.28 per foot

Reach 3, section 6.2.3.2:

Option I - $ 60.28 per foot

Option II - $158.71 per foot

An allocation of the total cost between private and public expenditures would make the comparison more favorable toward the private sector's willingness to pay for the private sector allocation of the cost of controls. Possible management strategies to enable an allocation of costs between the private and public sectors are discussed in section 5.2.

6.3.2 Payment of Public Sector Erosion Control Costs. Costs of erosion control measures were distributed in section 6.2 between private and public sectors on the basis of assignment of costs to the private sector equal to identified private benefits and the remainder to the public sector. A comparison of the ability of different localities to support a public coastal erosion program can be determined by using a measure of current fiscal effort. For purposes of this study fiscal effort is used: 1) to look at the ability of each locality to support an erosion control program by using its own resources; and 2) to provide a basis for establishing priorities in the allocation of state (or state controlled federal) funds among coastal localities.

Measures of fiscal effort must be used in a selective and careful manner with respect to certain limitations. The measure selected for this study is the best available for consideration of state/local grant arrangements but does not provide a consideration of the total fiscal differences. For instance, it does not provide a consideration of federal activities and the many complexities of marked interstate differences. It does not relate to overll service requirements or fiscal needs nor the authority and willingness of fiscal units to provide services. It is however a meaningful comparative measure of fiscal capacity and effort for local areas as it is used in this study.

The method used in this study to measure each localities fiscal effort as a percentage figure is:

$$\% \text{ fiscal effort} = \frac{\text{revenue from own sources per capita}}{\text{computed revenue capacity per capita}}$$

A detailed discussion of fiscal effort and how it is calculated is provided in Appendix B. This measure of fiscal effort provides a comprehensive picture of local effort and avoids some of the extremes inherent in the use of other methods. Table 7 provides the percentage fiscal effort as calculated from most recent data for coastal counties and cities.

TABLE 7

Fiscal Effort for Coastal Counties and Cities in Virginia

County or City	Revenue from Own Sources[1] Per Capita	Computed Revnue Capacity[2] Per Capita	Fiscal Effort
Counties	$	$	$
Accomack	143	259	55
Arlington	696	485	144
Caroline	170	309	55
Charles City	148	270	55
Chesterfield	429	325	132
Essex	185	377	49
Fairfax	675	422	160
Gloucester	193	339	57
Hanover	177	330	54
Henrico	383	360	106
Isle of Wight	229	284	81
James City	302	318	95
King George	188	322	58
King & Queen	147	309	48
King William	186	399	47
Lancaster	141	400	35
Mathews	140	325	43
Middlesex	144	367	39
New Kent	196	355	55
Northampton	126	215	59
Northumberland	165	354	47
Prince George	168	227	74
Prince William	552	308	179
Richmond	162	320	51
Southampton	133	224	59
Spotsylvania	249	341	73
Stafford	261	285	92
Surry	346	291	119
Westmoreland	145	314	46
York	253	270	94
Cities			
Alexandria	581	427	136
Chesapeake	287	223	129
Colonial Heights	246	292	84
Fredericksburg	356	345	103
Hampton	288	243	119
Hopewell	305	262	116
Newport News	350	267	131

Cities (continued)	Revenue from Own Sources[1] Per Capita $	Computed Revenue Capacity[2] Per Capita $	Fiscal Effort $
Norfolk	333	224	149
Petersburg	336	230	146
Portsmouth	303	226	134
Richmond	537	317	169
Suffolk	202	258	78
Virginia Beach	276	304	91
Williamsburg	386	476	81

Source of Data:

[1]Data obtained from report of Auditor of Public Accounts of Commonwealth of Virginia on Comparative Cost of County Government, 1977 and Report of Auditor of Public Accounts of Commonwealth of Virginia on Comparative Cost of City Government, 1977. See discussion of revenue from own sources in Section B.1.2.

The average fiscal effort for all coastal counties in Virginia was 75 percent with a high of 179 percent in Prince William and a low of 35 percent in Lancaster. For cities the average was 119 percent with a high of 169 percent in Richmond and a low of 78 percent in Suffolk.

6.3.2.1 Relationship Between Current Effort, Projected Erosion Control Costs and Grants-in-Aid. The comparative measures of fiscal effort can be used to project gross variations in the financial effort of jurisdiction for implementation of proposed programs with their own resources and to aid policy-making and administration with regard to grants-in-aid from one level of government to another. In fact, grants-in-aid are generally thought of in terms of providing equalization (and defining equalization as support for a level of public service without gross variation) in the financing effort of recipient jurisdiction.

The selected measure of fiscal effort is the best available and one alternative is for localities with an already high level of fiscal effort to have priority for grant funds in direct proportion to the calculated fiscal effort measure. However, there are constraints to a direct application as a priority scale for allocation of grants as the measure is more useful when used with other data. For instance, fiscal effort does not take into consideration any measure of need such as, in this case, level of erosion control requirements based on severity of the erosion problem. Consideration of two other

constraints is important but is outside the scope of this study. Allocation of grant funds for erosion control should be related to other aid programs and the effectiveness in use of previous grant funds should be used to modify a direct application of fiscal effort as a priority scale.

A comparison of the projected public cost of a proposed erosion control program and the locality's current fiscal effort provides a measure of the gross impact on the financial effort of that jurisdiction. This comparison can be used to indicate the ability of the locality to pay for the public portion (or total cost) of the proposed erosion control program cost. This comparison can also be used to modify the direct application of fiscal effort in development of a priority scale.

Options I and II for each of the 3 reaches were selected for analysis of projected public costs compared to fiscal effort. The procedure was to allocate projected erosion control costs to the private sector in an amount equal to the identified private benefits. The remaining costs are presumed to be a public responsibility. Because several structural, non-structural or any combination of control options are available within each reach, only direct costs of structural controls are used for this example. Table 8 provides a summary of these cost distributions. Also provided is the additional public cost per capita needed to support each option and the added percentage to fiscal effort.

TABLE 8

Impact of Costs for Selected Options on
Current Fiscal Effort

Category	Reach 1		Reach 2		Reach 3	
	Option I	Option II	Option I	Option II	Option I	Option II
Cost of option ($)	125,550	462,650	37,700	395,000	558,250	1,476,000
Private Benefits ($)	5,572	32,491	90,713	219,103	455,620	455,620
Private Cost ($)	5,572	32,491	90,713	219,103	455,620	455,620
Public Cost ($)	119,978	430,159	0	175,897	102,630	1,020,380
Population of Middlesex Co.[1]	7,200	7,200	7,200	7,200	7,200	7,200
Added cost per capita ($)	17.00	60.00	0	25.00	14.00	142.00
Amortized (Total)						
Years effective life	15	25	15	40	40	50
Annualized cost ($)[2]	14,335	42,604	4,323	32,958	46,725	122,654
Added cost per capita ($)	2.00	6.00	.60	4.60	6.50	17.00
Added percent points to effort (%)	1	2	0	1	2	5
Amortized (Public)						
Years effective life	15	25	15	40	40	50
Annualized cost ($)[1]	12,615	39,826	0	14,677	8,561	85,132
Added cost per capita ($)	1.75	5.50	0	2.00	1.20	12.00
Added percent points to effort (%)	1	2	0	1	1	4

[1] Based on assumption of constant population over period of analysis.

[2] Assume equal annual payments over effective life of option at 8 percentage interest rate.

The additional cost per person for each option is of course a one-time expenditure which could be paid in one year or over several years. Therefore the only basis of comparison with fiscal effort is to compare the per person increase as an annualized percentage increase in fiscal effort. Costs were amortized at an 8% rate over the years of effective life of the option. Middlesex County's fiscal effort was 39 percent, whereas the average for coastal communities was 75 percent (Section B.1.3).

Option II in Reach 3 would result in a significant increases in fiscal effort. The other options could conceivably be implemented with only a modest effort, particularly if implemented over a period of years. However, the total miles in these reaches only account for 2.6 percent of the shoreline in Middlesex County. Decision makers must have information on the total public cost of a program for each county. While complete data for determining cost for the total reach were not available for this study, a procedure is provided in the following section which will give a reasonable estimate.

6.3.2.2 Procedure for Estimating Public Cost of Total Shoreline Control. In order to determine an approximate cost of implementing erosion control options on all shoreland of the same predominate type as in each specific reach, information on shorelands use classification for Middlesex County was assembled. The shorelands were divided into two classes depending on use. Available data and cost information limited the analysis to these two classes. Class I

consisted of open and undeveloped land and included agricultural, recreational, government, preserved, and unmanaged land uses. Class II consisted of developed land and included residential, commercial, and industrial land uses. The miles of fastland in each class were determined, as well as their percentage of the total miles of fastland.

With certain assumptions, the public cost per foot for selected control options can be multiplied by the total miles of each class of shoreline in Middlesex County which is eroding and subject to management under the proposed options. The assumptions are:

1) The case study reach is representative of the total shoreline of that class,
2) that similar controls would be equally cost-effective for other reaches, and
3) that benefits of controls would be equivalent for other reaches.

For purposes of demonstrating the procedure for estimating public cost of erosion control for Middlesex County, scientists surveyed the total shoreline in the county and suggested the total miles in each class which had eroding shoreline and which may be suitable for management under these options. These projections are tentative and application of the procedure to other counties must be predicated on a detailed survey of the shoreline in those counties. A preliminary study of each area would be required to evaluate the reliability of other county estimates or to provide the basis for establishing a priority

For purposes of demonstrating the procedure for estimating public cost of erosion control for Middlesex County, scientists surveyed the total shoreline in the county and suggested the total miles in each class which had eroding shoreline and which may be suitable for management under these options. These projections are tentative and application of the procedure to other counties must be predicated on a detailed survey of the shoreline in those counties. A preliminary study of each area would be required to evaluate the reliability of other county estimates or to provide the basis for establishing a priority system for grant allocation as an alternative to direct use of the fiscal effort measure. Such a procedure would however provide the important link between fiscal effort and a measured need or service requirement for the priority index.

As shown in Table 9, Middlesex had 213 total miles of shoreland with 152.4 miles in Class I, open and undeveloped, and 60.6 miles in Class II developed. However, based on the projections only 25.3 miles of Class I and 17.0 miles of Class II use were eroding and possibly suitable for management under the proposed options.

For illustrative purposes (Table 10) only costs associated with structural costs in Option I, the least amount of effort needed, in both the open and undeveloped reach (Reach 1) and the developed reach (Reach 3) were used.

TABLE 9

PROJECTIONS OF CLASS I AND CLASS II AREAS IN MIDDLESEX COUNTY
WITH ERODING PROBLEMS

Class I - Open, Undeveloped, Recreational, etc.
Class II - Residential, Commercial, Industrial

Subsegment (From S.S.R.)	Fastland Length (mi.)	Class I (mi.)	Class II (mi.)	Potentially Eroding Shoreline & Fastland (1) (mi.)	Class I - Eroding (mi.)	Class II - Eroding (mi.)	Comments (2)
1A	6.6	4.7	1.9	4.7	2.2	1.9	Erosion in Class I up to 6'/yr. Small or no accretion.
1B	41.4	34.1	7.3	6.2	4.1	2.1	
2A	20.6	18.9	1.7	1.3	0.6	0.7	Erosion to 2'/yr.
2B	13.0	9.3	3.7	1.5	0.2	1.3	Erosion to 3.3'/yr.
2C	10.6	6.5	4.0	0	0	0	
3	24.5	21.2	3.3	9.0	7.0	2.0	Erosion 1.5 to 2.0'/yr.
4	36.9	19.5	17.4	10.8	6.8	4.3	0.6 mi. of accretion.
5A	11.0	1.5	9.5	4.6	0.6	4.0	
5B	24.7	18.6	6.1	9.1	1.4	0.3	Erosion 1.0 to 2.0'/yr.
6A	10.2	7.2	3.0	7.6	2.4	0.4	
6B	13.6	10.9	2.7	3.4	0	0	
Total	213.1	152.4	60.6	58.2	25.3	17.0	

(1) A subjective judgement includes shore with an open water exposure sufficiently great so as to cause one to suspect erosion.
(2) Much of the county's shore is in protected creeks, including much of the Piankatank River.

Data from: Middlesex County Shoreline Situation Report and Shoreline Erosion in Tidewater Virginia.

TABLE 10

Projected Costs of Implementing Selected Controls Options for the Total Shoreline in Middlesex County, Va.

Category	Class I[1]		Class II[2]	
	Open and Undeveloped Area		Developed Area	
	Total Cost	Public Share	Total Cost	Public Share
Feet of shoreland in reach (ft)	12,000	12,000	9,300	9,300
Cost of structures for reach ($)	125,550	100,716	558,250	102,630
Cost per foot ($)	10.50	8.40	60.28	11.00
Total feet shoreland class (ft)	133,584	133,584	89,760	89,760
Cost of structures total county ($)	1,402,632	1,122,106	5,410,733	987,360
Population of county[3]	7,200	7,200	7,200	7,200
Added cost per capita (5)[4]	195	156	752	137
Amortized (Total)				
Years effective life	15	15	40	40
Annualized cost ($)[4]	160,849	128,682	451,460	82,379
Added cost per capita ($)	2.34	17.87	62.70	11.44
Added percent points to effort (%)	6	5	17	3

[1]Figures based on data for Option I in Reach 1.

[2]Figures based on data for Option I in Reach 3.

[3]Assume constant population over period of analysis.

[4]Assume equal annual payments over effective life of option at 8 percent interest rate.

system for grant allocation as an alternative to direct use of the fiscal effort measure. Such a procedure would however provide the important link between fiscal effort and a measured need or service requirement for the priority index.

As shown in Table 9, Middlesex had 213 total miles of shoreland with 152.4 miles in Class I, open and undeveloped, and 60.6 miles in Class II developed. However, based on the projections only 25.3 miles of Class I and 17.0 miles of Class II use were eroding and possibly suitable for management under the proposed options.

For illustrative purposes (Table 10) only costs associated with structural costs in Option I, the least amount of effort needed, in both the open and undeveloped reach (Reach 1) and the developed reach (Reach 3) were used.

Based on this limited analysis, a program for only one county becomes extremely expensive.

The 25.3 miles of eroding shoreland classed as I would require a mimimum expenditure of $1,402,631 ($195 annual cost per person) in total cost with $1,122,106 ($156 added cost per person) of that allocated to the public sector. The 17.0 miles of eroding shoreland classed as II would require a minimum expenditure of $5,410,733 ($752 added cost per person) in total cost with $987,360 ($137 added cost per person) of that allocated to the public sector. These costs should be amortized over the life of the structure for comparison with fiscal effort. The added percentage points to fiscal effort as shown

in Table 10 provide a basis for comparison of the cost of an erosion control program for the county.

The use of Option I represents a minimum necessary effort for each reach and would result in significant increases in fiscal effort for both total cost or the public share. Added percentage points to fiscal effort was (5 + 3) 8 for only the public share of costs to (6 + 17) 23 for total cost including both the public and private share. These increases in percentage points of fiscal effort do represent a substantial increase in needed effort above the current 39 percent just to support one public service program of erosion control.

While this procedure provides a reasonable estimate, one limitation of this analysis is that cannot be extrapolated to all such areas in the Bay without a detailed technical assessment of the shoreline of those areas.

6.4 Application of Study Data to Federal Flood Insurance Program.

A complete analysis of the relationships between the Federal Flood Insurance Program and the shoreline erosion situation was not possible within the purview of this study. Nevertheless, some observations can be made. As explained in section 5.1.4.4 and section A.4.8. of this report, FIA officials indicate a desire to repeal the V zone (coastal high hazard area) and the E zone (special flood-related erosion hazard) provisions of the Flood Disaster Protection Act of 1973, as amended, and place these provisions into another program. In

addition to the option of removing erosion from the program, four other options were suggested (for explanation see section A.4.8.)

1) total prohibition of new construction in erosion hazard areas,
2) setback requirements within erosion zones,
3) no-insurance zones as an alternative to setback requirements, and
4) moveable structures and buffer zones.

Because information on past damages from flooding is available only on a high level of consolidation (county level) and the relationship of insurance coverage to this damage is unknown, the benefits of erosion control on insurance rates and flood damages cannot be estimated for this study. Also, the extent to which inplace erosion control measures impact insurance rates is not known.

The values for shoreland resources as given in section 6.2 indicate a probable impact for some of the proposed insurance alternatives.

a. A total prohibition of new construction and limiting future uses to open space in the 67-year erosion hazard areas may have little, if any, impact in the Reach 3 area which is already highly developed with single-family dwellings. In the Reach 1 and 2 areas, this action would limit potential increases in privately owned waterfront lot values if these areas could not develop to the same scale as the Reach 3 area. The average assessed value per square foot for lots (minus improvements) was

$0.91 in Reach 3, $0.66 in Reach 2 the developing area, and $0.31 in Reach 1 the undeveloped area. The area would lose tax revenues on these potential increased values. But it potentially could suffer higher flooding damages.

For some parcels in the 67-year hazard zone a limitation on uses would constitute a "taking" and would probably require compensation. The total value of prohibited uses could be estimated by comparing the difference in average value of improvements on developed lots (plus increases in lot value) and value of undeveloped lots.

b. The study data provides a good analysis of setback requirements for the 100 and 200 foot areas. The potential cost from restriction on ownership is provided in each summary budget for both depth areas. Not only are the costs of restricted ownership high in some cases but such action would likely involve a "taking issue" and involve the ownership type transaction cost plus the potential cost of public acquisition. Costs of setback requirements are relatively small for the undeveloped area in Reach 1, but prohibitively expensive for the developing and developed areas in Reaches 2 and 3 respectively. The magnitude of these costs in each reach are:

Reach 1	100' $	200' $
restriction on ownership	2,157	4,404
transaction & administration	34,150	34,150
public acquisition	139,022	238,394
TOTAL	175,329	276,948

Reach 2	100' $	200' $
restriction on ownership	256,270	512,540
transaction & adminstration	111,000	111,000
public acquisition	964,288	1,483,375
TOTAL	1,331,558	2,106,915

Reach 3	100' $	200' $
restriction on ownership	470,452	921,304
transaction & administration	114,000	114,000
public acquisition	1,399,152	1,850,004
	1,983.604	2,885.308

This setback action may have little impact on the rate of erosion but would result in benefits from a reduction of insurance coverage and disaster payments.

c. The no-insurance provision in the 30-year erosion rate zone would simply transfer any risk from coastal erosion to the private property owner from the federal insurance program.

Presumably, disaster assistance payment would be prohibited for these areas.

d. An analysis of buffer zones is covered in the discussion of each reach under Potential Impact from Restriction on Ownership and the ownership and regulatory category under Transaction and Administration.

A program of moveable structures could become extremely expensive. Additional cost would be imposed at the time of initial construction. Cost estimates for this type of building design are available in Elevated Residential Structures - Reducing Flood Damage Through Building Design: A Guide Manual, by the Federal Insurance Administration, HUD-FIA-184, September 1976. The actual relocation of dwellings is a costly alternative. Relocation cost for moving all dwellings from the 100' and 200' areas of the three reaches in the study are:

	Reach		
	1	2	3
	$	$	$
100'	93,100	540,200	634,800
200'	170,150	731,150	634,800

Similar projections could be projected for the total coastal area.

CHAPTER 7

COMMENTS AND RECOMMENDATIONS

7.1 COMMENTS

7.1.1 Individual action versus treatment of the "reach". The evidence that individual, piecemeal attempts at structural control of erosion are frequently ineffective, inefficient, and/or may have adverse impacts on adjacent property is sufficient to warrant implementation of management strategies which treat entire shoreline reaches as comprehensive units. In addition to the benefits of increased effectiveness and reduction of adverse impacts, a reach-comprehensive approach in all likelihood will have a lower unit cost.

7.1.2 Risk awareness. There are frequent instances of transfer of shoreline ownership wherein the new owner has only a vague or no awareness of the existence of an erosion problem. If they were aware of the risk, they could factor the cost of erosion prevention into the cost of ownership.

7.1.3 Highly Eroding Shorelines - Geographic Areas of Particular Concern. Inasmuch as highly eroding shorelines are considered as GAPC's, state oversight on management strategies and their implementation is appropriate. The central goal of management of the hazard is the reduction of the risk of victimization by erosion of both private and public property along the shoreline. In a broader

context the management strategy may be viewed as a mechanism to alleviate the problem for those shorefront owners now affected by the hazard and to reduce the potential for future victimization by the erosion. In both cases another objective is to reduce the cost to the public for emergency relief generated by imprudent occupation within the erosion zone. In the first case the strategy is to prevent the impending loss of existing structures. The second case represents actions designed to avoid future need for emergency measures.

7.1.3.1 Definition of the erosion zone. Shoreline segments experiencing average erosion rates greater than two feet per year have been defined as highly eroding areas. Given this definition, about 330 miles of shoreline have been given an interim designation as highly eroding areas zones. This interim designation is based upon a comparison of maps which exhibit the high water line published circa 1850 and circa 1950 (Byrne and Anderson, 1977). Although this is suitable as an interim designation which illustrates the magnitude of the problem, it is unsuitable for final delineation because:

1) The delineation does not account for shoreline segments which have been stabilized.

2) The averaging process used results in cases where the length of shoreline delineated is larger than actually experiencing an erosion rate greater than 2 feet per year.

3) Finally, the comparison was between high water lines. The high water line may show appreciable variability in position due to seasonal variation in wave input or to storms. A more

meaningful criterion would be the retreat of the fastland-shore boundary. This would be either a bluff line or the limit of permanent vegetation.

Given the above it is proposed that the final designation of the erosion zones be made using comparison of aerial photographs obtained at least 25 years apart. Preferably the shoreline should be rephotographed at the start of implementation and every 5 to 10 years thereafter, so that the extent and effectiveness of existing shoreline defense structures can be incorporated in the process of risk delineation. Guidelines for the determination or recession rates are provided in Appendix D.

7.1.3.2 Management Strategies. The management strategies adopted to cope with erosion must fulfill the management goal while withstanding the legal issue of taking. In this context the assessment of "risk" must be distinguished from the exposure to high erosion rates, or hazard. Hazard in the present application means exposure to shoreline retreat due to high erosion rates. Risk, on the other hand, incorporates the element of existing, planned, and potential use of the areas subject to the hazard. Thus management strategies should reflect, for the particular "hazard" designated reaches, the consideration of risk. The economic methodology provides a decision framework for comparing the risk associated with highly eroding areas which are at different levels of development and use.

7.2 Recommendations

It is recommended that:

1) The Commonwealth enhance its program of technical advisory services to private property owners, municipalities and counties including the establishment of a procedure to make the decision making methodology resulting from tis study available to local units of government.

2) It be the policy of the Commonwealth to augment the development and implementation of a public education program on tidal shoreline erosion.

3) It be the policy of the Commonwealth to encourage the treatment of shoreline reaches in shore erosion mitigation measures as opposed to individual lots. Furthermore, any programs of public cost sharing for erosion control mitigation should be restricted to reach comprehensive measures.

4) The Commonwealth should enable local governments to establish Erosion Abatement Districts wherein the locality would be empowered to provide financing programs for the mitigation of erosion impacts.

5) The Commonwealth should enable local governments to establish minimum setback lines along those shoreline segments with eroding areas shoreward of which new construction would be prohibited, restricted according to type of use, or allowed by permit with such conditions attached thereto as deemed appropriate by local governments.

6) Legislation be enacted which requires that the transfer of shoreline property be conditioned so that the prospective buyer signifies his awareness of the erosion rate of the property in question by requiring formal acknowledgement of that awareness.

7) The Commonwealth require subdivision ordinances, in localities with tidal shoreline, to provide a provision for protection from and mitigation of shore erosion. The locality thereto would:

a) Require a developer to post a performance bond for construction of erosion abatement structures;

b) Inspect such structures before releasing such bond;

c) Require an erosion mitigation or protection plan as part of the subdivision plat approval procedures.

8) Localities with todal shorelines should be specifically authorized to:

a) Prepare erosion abatement plans as part of their comprehensive plans, and

b) Provide that a purpose of zoning be to protect property from the hazards of shoreline erosion.

9) Localities with tidal shorelines be specifically authorized to construct, maintain, or repair erosion control structures free of legal liability for subsequent but unintended damage to or loss of private property which could be fully or partially attributed to such structures.

10) The Commonwealth (through the Virginia Institute of Marine Science) designate highly erodable areas by comparing aerial photographs at least 25 years apart and by determining the retrat of the fastland edge (bluffline or vegetation) through photogrammetric techniques.

11) The construction of erosion control structures should be placed under the review of suitably trained inspectors so as to insure the use of appropriate construction techniques and materials.

REFERENCE

Byrne, R. J. and G. L. Anderson. 1977. Shoreline Erosion in Tidewater Virginia. SRAMSOE No. 111, Virginia Institute of Marine Science Gloucester Point, VA., 102 pp.

CHAPTER 8

METHODS OF IMPLEMENTATION

8.1 Introduction

To implement the recommendations discussed in Chapter 7 a number of specific public policy actions by the Commonwealth can be suggested here. In the following list Chapter 7's recommendations are reordered slightly simply to highlight areas of linkage under existing legislation and also to present the recommendations in the form of a broad agenda for action in establishment of a state coastal erosion abatement and impact mitigation program.

A basic question arising from current state policy concerns the designation of a lead agency to direct such a program. Article 2.2, section 21-11.16 of the state Code ("Declaration of Policy," Shore Erosion Control Act) assigns broad responsibility to the Virginia Soil and Water Conservation Commission for coordination of shore erosion programs. To date, however, as noted previously, funding appropriations, to effectuate a program have not been adequate.

Following the discussion of recommendations, a) a draft version of a reconstituted Article 2.2, sec. 21-11.16,[1] b) supporting sample subdivision and zoning ordinance amendments, and c) sample language for possible incorporation in new enabling legislation to authorize creation of erosion abatement districts, are all presented.

8.2 Designation of Coastal Erosion Areas

Early action by the state in identifying and designating final high erosion areas will be needed prior to action on a number of this report's other recommendations, particularly those involving new regulatory activity at the local level. The designation procedure described in Chapter 7 represents the most practicable one now available, but a time frame for completion of "interim" designations by the state needs to be established. This time frame should be incorporated in Article 2.2, sec. 21-11.16 as well as any subsequent legislative or administrative proposals dealing with local planning and regulation of erosion area uses. Several examples are discussed later in this chapter. Designation of erosion areas will also establish an operational basis for conducting the state's program of financial assistance to localities for shoreline management.

8.3 Erosion Abatement Policy Addenda

Recommendations 1, 2, 3, and 7 in Chapter 7 all concern possible refinements in the state's present policies toward erosion control objectives and responsibilities. The following actions should be considered for possible use in implementing this aspect of the state's program.

A. Public Education Program

Recommended actions include:

Enhancement of state funding for development of a state research and public education program designed to address the causes and effects of coastal erosion and preferred methods of treatment. Accomplishment of the program's objectives will depend largely on the level of funding it receives.

B. Application of Erosion Abatement Measures By Shoreline Reach

Recommended actions include:

1. Amendment of Article 2.2, s. 21-11.16 to provide for the establishment of a cooperative state-local program of a) designating coastal erosion areas by shoreline reach and b) considering both structural and nonstructural methods of reducing erosion damages to an acceptable level.

2. Amendment of Title 15.1, chapter 11 (Planning, Subdivision of Land and Zoning) by addition of the following:
   a) A definition of "shoreline reach" in Art. 1, s. 15.1-430.
   b) A reference to study of erosion areas in Art. 4, s. 15.1-447.

C. Technical Assistance

Recommended actions include:

1. Initiation of a state training program placed under the direction of the state's lead agency in cooperation with the Virginia Institute of Marine Science and regional Soil and Water Conservation Districts. Such a program should provide:
   a) Training for local and state officials.
   b) Training for private marine contractors.

2. Development of shoreline erosion abatement "technical guidelines" by the state's lead agency in cooperation with the Virginia Institute of Marine Science, the state Soil and Water Conservation Commission, and appropriate local or regional agencies.

D. State Funding to Localities

An implicit assumption in Chapter 7's discussion of recommended actions is that funding to conduct a state program will, in fact, become available for allocation to responsible state agencies and local public agencies engaged in shoreline management. Early action should be taken by the state, however, to insure that such funding will be forthcoming on a continuing basis. Establishment of an Erosion Fund by the General Assembly is strongly recommended to insure this continuity. The sequence for establishing such a fund might consist of the following:

1. Designation of a lead agency to coordinate all financial assistance of the state to coastal localities for any projects within designated erosion hazard areas, and vesting of this agency with authority to promulgate rules and regulations regarding:

   a) Disposition of available funds, and

   b) Certification of prescribed erosion abatement plans submitted by funding applicants.

   Amendment of Article 2.2, s. 21-11.16 to provide for this designation and authorization is recommended.

2. Articulation of legislative priorities regarding costs and benefits to be accrued as a result of the program. This action could also be accomplished through amendment of Article 2.2, s. 21-11.16. A suggested listing of considerations for funding assistance would be the degree to which a proposed project:

   a) is intended to serve critical or hazardous erosion areas experiencing severe impact with determinations or impact based on erosion rate and economic impact analysis.

   b) is intended to serve aras offering superior suitability for public access to water.

   c) demonstrates greatest anticipated public benefits of state assistance in relation to anticipated costs.

   d) is intended to serve areas for which proven structural erosion abatement measures applied by shoreline reach exist or are planned.

As noted, funding for projects within designated erosion areas should be predicated on preparation and submission of acceptable abatement plans (supplemented with a financing element) according to the procedure outlined below in section 8.5.A.

8.4 Public Notification of Erosion Hazard

Recommended actions for insuring public notification of erosion rates include the following:

1. Development of model subdivision ordinance amendments[3] containing a provision for posting of signs in subdivisions within designated erosion areas indicating the area's existing and projected natural erosion rates. The model should include the following provisions for new shoreline property owners:
    a) The owner must be notified of and acknowledge the erosion rate for the local area.
    b) The owner must notify the local planning agent of major planned shorefront improvements.
    c) The owner is then notified of projected increases or reductions in the property's erosion rate resulting from the proposed improvement.
    d) The developer must then post a performance bond upon the property sufficient to offset costs of adequate abatement structure installation and maintenance prior to initiation of the planned improvement.

2. Amendment of Title 15.1, Chapter 11, Article 7 (Land Subdivision and Development) by addition of the following:

   a) A requirement that plans and specifications for erosion mitigation or abatement measures be submitted, in Article 7, s. 15.1-480.

   b) The words "erosion abatement" to s. 15.1-466.d.

   c) A new section to provide for inspection of abatement structure maintenance by a qualified agent.

3. Amendment of Title 55, Chapter 19 (Subdivided Land Sales Act) by addition of local erosion rate information material to required notices of intention filed with the Virginia Real Estate Commission (s. 329.2).

4. Adoption of new legislation requiring that prior to the sale of shorefront property, the prospective purchaser be notified, in writing, if the land be within a designated erosion area; and that if the land be within a designated erosion area, the prospective purchaser also be notified in writing of the rate of erosion of that land. The prospective purchaser of any shorefront land also should be advised, in writing, by the seller that the land in question may be subject to some degree of natural alteration due to the interaction of land and water.

8.5 Mitigation Measures

As noted in section 5.2.2 and elsewhere, the power to regulate shoreline uses in hazard zones resides largely with local governments,

and needs to be considered in close conjunction with abatement planning and financing methods. Recommended actions for addressing each of these three concerns include the following:

A. Development of Erosion Abatement Plans

1. Amendment of Title 15.1, Chapter 11 to provide a legal basis for local land management with the objective of preserving and protecting the state's coastal shorelines. Suggested additions include:

   a) Amendment of art. 4, s. 15.1-446 by addition of the words "erosion hazard."

   b) Amendment of s. 15.1-447.1 by addition of the words "erosion abatement and erosion damage prevention measures."

   c) Amendment of s. 15.1-447.2 by addition of the following:

   "(f) Erosion Abatement Plan for designated areas, to include:

   (1) Identification of available structural and nonstructural mitigation measures.

   (2) An environmental assessment of available mitigation measures.

   (3) Provision for a cost/benefit analysis of available mitigation measures."

B. Zoning

Recommended actions include:

1. Development of model zoning ordinance amendments[4] providing for creation of a floating, or overlay, "Erosion" district which would set forth:
   a) A legal basis for establishing the district.
   b) Provision for conditional permitting of specified shoreline uses, conditioned upon satisfaction of minimum shoreline defense standards determined by the local planning commission in consultation with the state's lead agency.
2. Amendment of Title 15.1, Chap. 11, Art. 8 (Zoning) by addition of the following:
   a) The word "erosion" to s. 15.1-489.1.
   b) The words "erosion damage protection" to s. 15.1-489.4.
   c) The word "erosion" to s. 15.1-489.6.
   d) The words "and shorelines" to s. 15.1-490.

C. Setback Regulation In Lieu of Zoning

Amendment of Title 15.1, Chap. 1, s. 29.2 (General Provisions) to authorize establishment of shoreline setback regulations within areas experiencing severe shoreline erosion or within other areas subject to approved state coastal resources management policies.

D. Subdivision Regulation

Recommended actions for regulation of coastal subdivisions are presented in section 8.4, above.

E. Erosion Abatement Districting (Cost-Sharing)

Provisions to insure adequate financing of public erosion abatement measures are considered critical to accomplishment of the overall management program. In combination with measures described earlier, the following is recommended:

1. Adoption by the state of new enabling legislation to authorize creation of erosion abatement districts corresponding in operation to water supply and sewage disposal authorities (Title 15.1, Chap. 28). Legislation should provide for:
    a) Creation of an erosion abatement district either by:
        (1) Petition of property owners residing within the political jurisdication and within a designated erosion hazard area; or
        (2) Request of the local governing body(s) prior to or following consideration by the local planning commission(s).

In the case of either (1) or (2) provision for preparation of a local erosion abatement plan supplemented by a financing element, prior to district establishment, should be set forth. Provision should also be made for optional assumption of erosion district powers and

responsibilities by the local governing body (or bodies) creating the district. A district would be governed by a board of directors with the following qualifications, powers, and duties:

a) A majority of board members must reside within designated erosion hazard areas within the jurisdiction(s) establishing the district.

b) Board powers would include:

(1) Power to receive and disburse funds.

(2) Power to impose assessments upon properties abutting designated erosion hazard areas on the basis of shorefront footage owned, in amounts sufficient to obtain adequate contributions toward costs incurred through provision of necessary shoreline impovements by the district.[5]

(3) Power to issue revenue bonds to finance necessary facilities, and power to seek financing support.

(4) Power to exercise eminent domain to acquire construction and maintenance easements provided by the district.

(5) Power to own and dispose of property, to contract for detailed structural designs, to obtain bids for construction of structures, and to construct and maintain structures and necessary facilities.

c) Upon creation, district board members should be empowered to address erosion abatement needs in designated erosion hazard

areas throughout the jurisdiction(s) upon petition of a majority of property owners within such areas or upon request by the local governing body(s). In such case, abatement plans with financing elements for each hazard area served should be required for submission to district, with provision for public hearing, prior to execution of an agreement to serve the area requesting the service.

F. Amendment 15.1-31

Amendment of 15.1-31 by inclusion of the words "erosion protection devices" in the list of "work" in section (a) and the words "or erosion control district" following "town" in both (a) and (c). These changes would serve to broaden 15.1-31 to include erosion protection devices in the list of construction a county, city or town could perform and be free from suit and to include "erosion control districts" in that freedom from suit. (see also Chapter 4.2).

The reworded section would read as follows:

§15.1-31. Construction of dams, levees, seawalls, etc.; certain proceedings prohibited. - (a) any county, city or town or erosion control district may construct a dam, levee, seawall, erosion protection devices or other structure or device, or perform dredging operations hereinafter referred to as "works", the purpose of which is to prevent the flooding or inundation of such county, city or town, or part thereof. The design construction,

performance, maintenance and operation of any of such works is hereby declared to be a proper governmental function for a public purpose. (b) The General Assembly hereby withdraws the right of any person, firm, cooperation, association or political subdivision to bring, and prohibits the bringing of, any action at law or suit in equity against any county, city or town or erosion control district because of, or arising out of, the design, maintenance, performance, operation or existence of such works but nothing herein shall prevent any such action or suit based upon a written contract, but this provision shall not be constructed to authorize the taking of private property without just compensation therefor and provided further that the flooding or inundation of any lands of any other person by the construction of a dam or levee to impound or control fresh water shall be taking of such land within the meaning of the foregoing provision. (Code 1950(Suppl.),§ 15-20.6; 1960,c.516; 1962,c.623; 1966,c270; 1968,c.793).

FOOTNOTES

[1]Refer to Appendix E.

[3]Refer to Appendix F.

[4]Refer to Appendix G.

[5]Through amendment of Title 15.1, Chap. 7, Art. 2 (Assessment for Local Improvements) so as to incorporate assessments imposed for the purpose of financing coastal erosion abatement structure installation and maintenance by the local governing body.

A P P E N D I C E S

APPENDIX A

PROCEDURES FOR ESTABLISHING COSTS AND IMPACT VALUES TO PROVIDE A COMPARISON OF ALTERNATIVE EROSION CONTROL STRATEGIES

This appendix provides an explanation of the data needs for the analysis as well as an indication as to the location of the data sources. It provides examples of the procedures used to calculate values for each component used to establish cost and benefit values. Finally, it provides an explanation of procedures used to allocate costs and benefits among alternative management strategies.

A.1 Establishing Values for Impact on Property, Improvements, and Land Use

Costs and benefits associated with various structural and non-structural controls for prevention of erosion-related damages must be determined. However, before a budget can be constructed, values for impact of erosion control strategies on property, improvements, and land use must be established. The following section describes the ground rules and methods for determining those values. Six areas of impact were used in the analysis. They were the 100' and 200' depth frontage areas and erosion rate depth areas for 10, 15, 30, and 67 year periods.

A.1.1 Establishing Area of Impact. Area for each setback or erosion year period was calculated for each property segment within the reach on basis of square feet or portion of acres involved. Step 1 in this process was to identify the area in each segment to be

impacted by the 10, 15, 30 and 67 year erosion rates. Areas were determined by multiplying the years in each period by the historical erosion rate in feet per year[1] by the years in that period for each individual transect--the point on the shoreline where a recession rate was calculated.

Example:

erosion rate	(feet/year) x	__ years =	_____ feet
	2.4 feet/year x	10 years =	24 feet

The resultant depth line for the number of feet of erosion for each period was measured from the point of high water mark and noted on aerial photographs of the individual parcels of property.

The second step in the analysis was to establish the working table of the present dollar values for each category for each parcel in the impact area. These values were consolidated for each reach (see section 6.2.1 for an example of a working table). The categories include: 1) land use, 2) dwellings, 3) other structures, 4) property values, and 5) loss of tax revenue. The following sections describe how these values were established.

A.1.2 Establishing Values for Land-Use. The land-use category includes annual productivity on agricultural and forest land. The values for agricultural and forest land-use were determined by multiplying number of acres in each soil capability class or site index grouping in the impact area by dollar value of average annual net return (rate) per acre for each class and summing for the total. Type of production and soil capability or site index grouping was

determined from use-value assessment in Commissioner of Revenue's office or soil survey and mapping data. The rate per acre for agriculture and forestry was obtained from use-value assessment analysis for Middlesex County[2].

By Soil Class in Agriculture

Soil Capability Class	Average Annual Net Return Per Acre Agriculture in Middlesex
I	$590
II	530
III	390
IV	290
V	200
VI	140
VII	60
VIII	40

By Site Index Grouping in Forestry

Site Index Grouping	Average Annual Net Return Per Acre Forestry in Middlesex
excellent	$375
good	280
fair	209
non-productive	50

Example:

2A agriculture-Class I and II; 2A forest - excellent

__ acres x rate/acre = $_____ value

2 acres x 590 rate/acre = $1,180 value
2 acres x 375 rate/acre = $ 749 value

Total Annual Net Return = $1,920 value

A.1.3 Establishing Values for Dwellings. Present value was obtained for dwellings on each shorefront parcel of property in the reach from recent assessment records in the Commissioner of Revenue's office for the county. If the dwelling was located in the 100', 200' or 10, 15, 30, or 67 year erosion area, the total value was recorded.

If not, a second cost component for dwellings was based on decrease in distance between dwelling and shoreline as a result of projected erosion action. Those values were based on recent research findings by Armstrong and Denuyl[3]:

> As distance declines to below 100 feet and to 75 feet between shoreline and dwellings, 30 percent of its value is lost.
>
> As distance declines from 75 to 51 feet, 70 percent of value is lost.
>
> As distance declines below 50 feet, 100 percent of value is lost. At this point, a buyer could not be found and a mortgage could not be obtained.

Current distance in feet between dwelling and shoreline was obtained by interpretation of aerial photography. The depth of the projected erosion action for each property segment for each erosion period was compared to this distance and values deducted accordingly.

Example:

Assessment market value of dwelling $40,000

Distance from shoreline is 110'

Erosion rate 2'/year for 15 year period
15 yr. x 2' yr. = 30 feet
110' - 30' = 80 feet
Thus, 30 percent of structure value lost:
$40,000 x 30% = $12,000

or

If structure were in the impact area of a 67 year period,
67 yr. x 2' yr. = 134 feet
134 ' > 110' thus:
The loss would be = $40,000

A.1.4 Establishing Values for Other Structures. Present value of "other" structures on land or water was obtained for each parcel from recent assessment records in the Commissioner of Revenue's office for the county. If structures were located in the impact area, the total value was recorded. Decrease in distance was assumed unimportant for this analysis. The decision rule was that structures on land maintain a constant value until the main structure is lost. At that time other structures on land lose all their value. Those structures on water lose total value if any erosion occurs.

The distinction as to whether a building was on land and subject to subsidized insurance or on water and not subject to insurance was important for evaluating impacts as they affect insurance programs.

A.1.5 Establishing Property Values-Soil Loss. Present value of property (minus improvements) for each parcel in the study area was obtained from assessment records in the Commissioner of Revenue's Office. Value was calculated on basis of square footage for use in determining value of loss due to erosion. That is, square footage in the parcel was divided by present value to obtain present value per square foot of the parcel.

Square feet in each setback or erosion year period impact area as previously obtained (section A.1.1.) was multiplied by the value per square foot to get a proportionate value per square foot of soil lost to erosion.

Example:

A 11.68 acre parcel valued at $0.16 per square foot with dimensions of 691.3 ft. of waterfront and 736 feet deep, and a 1.65 foot per year erosion 100' area:

69,130 sq. ft. of soil lost
at .16 per sq. ft.
69,130 x .16 = $11,061

200' area: 138,260 x .16 = $22,122

Years: annual erosion rate x years
x width of lot x value/sq. ft. =

10 yr:	1.65 x 10 x 691.3 x .16 =	$ 1,825
15 yr:	1.65 x 15 x 691.3 x .16 =	2,736
30 yr:	1.65 x 30 x 691.3 x .16 =	5,471
67 yr:	1.65 x 67 x 691.3 x .16 =	12,228

The total loss eventually will be reflected in tax revenues. Tax revenue loss is discussed in section A.1.8. The actual property value as explained in the next section may suffer little decline, however, until a lot is no longer deep enough to build on.

A.1.6 Establishing Property Value-Loss of Building Site. The basis for making calculations of losses due to inability to build on a lot was the subdivision regulations in Middlesex County which requires lot sizes on the following basis:[4]

Lot size with public water and sewer
80' width
10,000 sq. ft. area

only public water
100' width
15,000 sq. ft. area

only public sewer
80' width
12,000 sq. ft. area

neither public water or sewer
100' width
17,500 sq. ft. area

For our study, any lot size 80' width and 10,000 sq. ft. area could not be built on. Thus, any lot which became smaller than this because of erosion induced action would lose most of its value. Of course, alternative action may result in combining lots and thus the appraised value for some lots with smaller acreages are appraised at a positive value. Under recent assessment for Middlesex County, a lot totally eroded away or under water was valued at zero. Lots less than the size required for building are decreased in value but are not zero because other opportunities exist. Sixteen lots in our sample were identified by assessors as being too small to build on. The average market value of these lots was placed at $2,700.

Decision rules on lots: No loss in market value from soil loss until lot less than 80' width and 10,000 sq. ft. area.

Lots less than 80' width and 10,000 sq. ft. lose total value down to $2,700.

Lots almost totally under water lose total value.

A.1.7 Establishing Property Value-Loss of Amenity. Several recent research results confirm the existence of aesthetic value associated with shoreline location and several procedures for separating this value from the basic land values exist.[5]

The amenity value specific to the shorefront location is extremely hard to calculate. Many variables affect value of waterfront property. Among these are the depth of the water access, location, frontage feet, height above the water, erosion

characteristics. However, several sources provide basis for a reasonable estimate.

Based on recent market sales data for Middlesex, minimum value for waterfront lots over lots in an open field was approximately $7,000 per acre. Lots with access to water may be almost as valuable as waterfront but without the erosion problem. Lots (1/4 to 1/2 acre) go from $3,000 to $6,000 per lot. Waterfront lots start in the $10,000 - $12,000 range and go up to $19,000 per acre in exclusive areas.[6]

Brown and Pollakowski found proximity to shore of 100' to be worth $4,100 per unit more than to be over 500' back. Their analysis, and that of others, provides a positive value for close proximity shorefront property.[7] Although close proximity may provide an amenity value, erosion characteristics have been shown to negate some of that value.

The impact of erosion on value of a shorefront lot depends on depth of a particular lot. In large acreage areas belonging to one parcel, erosion of the waterfront does not destroy value of that frontage acreage. Loss of waterfront soil simply means any subdivided lot extends deeper into the owned property and the result is to substitute a waterfront use for other uses.

The following value assessments were assigned to various study parcels in Middlesex County during the 1978 reassessment.[8]

Type Use	Value Per Acre
good water front	$8,000
water view	4,000
creek front	2,500
low-marshy waterfront	2,500
tillable	1,000
timber	800
pasture	700
swampy	200

Thus, if waterfront replaces tillable areas, then the loss is not $8,000 per acre, but $1,000 per acre.

However, where a lot is owned separately from surrounding areas, that particular owner loses the value of the waterfront area if he can no longer build on it. Although second tier property may increase in value, that increase is limited because the first line owner maintains control over use as long as some of the front parcel is remaining.

A comparison of lot prices in the Middlesex County study area indicated a difference between waterfront and second tier lots to be approximately $4,000. This total value cannot be attributed only to amenity values. Lot size and other location factors must be considered.

Armstrong and Denuyl's findings provide some guidance in the evaluation of amenity value lost from erosion characterisitcs. Their basic conclusions are:[9]

> When vegetative cover of a parcel is lost due to erosion, the <u>normal</u> building lot parcel loses 25 percent of its amenity value.
>
> When the owner is no longer able to build on that lot, the remaining amenity value is lost.

Additional research and analysis is needed before calculation on amenity values can be utilized in this type study.

A.1.8 Establishing Property Value-Loss of Tax Revenue. While soil loss may not impact the actual market value of property until lot cannot be built on, eventually losses will be reflected in tax revenues. The recent assessment for Middlesex County supports this assumption. Whenever a property owner requested a tax reduction due to soil loss, it was granted. Thus, for purposes of this study the loss in dollar value was multiplied by the current Middlesex County tax rate of 43 cents per hundred valuation.

dollar loss x .43/hundred = annual tax loss

A.1.9 Costs of Relocation of Structures. Relocation may be a management alternative. Relocation for major structures may impose costs on either private or public parties and may be tied to public acquisition. A relocation cost was calculated for each major structure located in the impacted area. Size of dwelling was obtained from assessment records in Commissioner of Revenue's office. The attached schedule of costs for house relocation was utilized.[10] These values may be used with any combination of controls.

Relocation of House to a Non-Flood Site

1. General - Relocation of a house that is subject to frequent flooding involves the physical raising and moving of the superstructure to a new site beyond the limits of the flood plain. This entails disconnecting and capping all utilities at the present site, removal of obstructions enroute to the new location, construction of a new

foundation/basement at the relocation site, backfilling the existing basement, and landscaping both lots.

The cost for these items is evaluated on the relatively ideal premises that:

a. The house can be relocated with a 10-mile radius.
b. A new housing site is available along an existing public road with utility service.
c. The existing electrical and mechanical fixtures, in the house to be relocated, comply with local building codes.

The largest portion of the total cost for house relocation is the raising and moving of the superstructure. This cost increases significantly for a two-story house over a one-story dwelling, because of the additional problems encountered when moving a taller structure.

2. Cost estimates - Figure A1 gives the estimated cost for a typical house relocation, based on the previous assumptions, in proportion to the square foot area of the first floor. This cost does not include the expenses which may be incurred during relocation (such as, temporary disconnection of traffic signals and overhead powerlines and removal of trees). The curves are a result of the cost estimates compiled for the various houses visited and hypothetical houses. Because many of the houses in the areas inspected were of similar size, hypothetical homes had to be assumed to give the variation in floor area required for the curves. Such hypothetical homes are typical of those structures which were observed in the communities that were visited, although specific samples were not noted.

The costs for temporary disconnection of overhead transmission lines and traffic signals, along with the cost for the necessary tree removals, will be dependent upon the route to be traversed when moving the house. The costs for disconnections and removals are estimated as:

a. $1,500 per service interruption of overhead transmission lines.
b. $250 per intersection for service interruption of overhead traffic signals.
c. $400 per large tree removal.

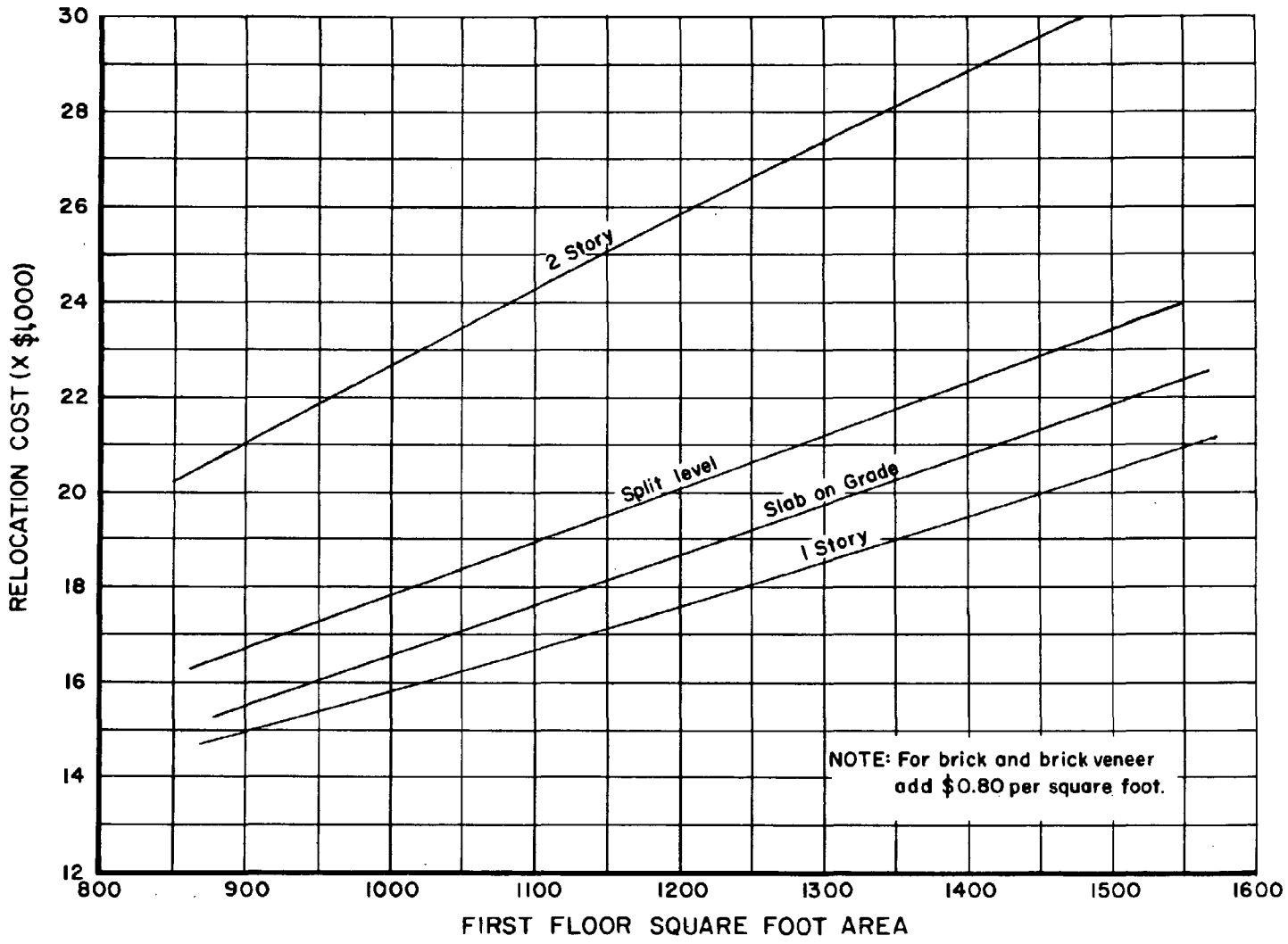

Figure A-1. House Relocation Cost. Source: IWR Pamphlet No. 4, U.S. Army Engineering District, Baltimore Md., July, 1977.

In the event that public utilities are not available at the proposed new site, an additional $2,700 is to be added to the figure obtained from the appropriate curve. This amount includes a 1,000 gallon septic tank at $500, drilling a 100-foot well at $800., and a 250-770 GPH well pump at $1,400.

A.1.10 Consolidation of Parcel Values into Reach Summary. Because the management decision framework should be placed on a reach-by-reach basis, the costs and benefit values to be used for comparative purposes are the consolidated reach values. Individual parcel values were consolidated into a reach summary. The established values for dwellings, other structures, property and loss of building site were expressed in present dollar values. Annual loss of property taxes and annual net return for land-use were also expressed in present value based on the following:

Assumption of constant annual stream of benefits based on a constant level of net profit and a constant tax rate over the period of analysis.

10 yr.	15 yr.	30 yr.	67 yr.	Inf.
6.71	8.56	11.26	12.44	12.50

A.2 Determining Cost of Structural Controls for Each Project Option

For each shoreline reach, sets of proposed appropriate structural control measures, hereafter called options, were selected by shoreline erosion technical experts.

A.2.1 Cost of Structures. The capital costs of implementing the proposed structural control measures were based on standard cost

guides with costs in present dollar values. The small amount of operation and maintenance costs were discounted to current dollars. Costs were determined for proposed structures in each segment of the reach and summed for the total reach. The expected effectiveness in percentage terms of control of erosion by the structural controls and time period of effectiveness were provided for each reach.

A.2.2 Costs of Technical Assistance. In addition to the direct costs of the control structures is the expense of technical assistance for shoreline evaluation, design of the appropriate control structure and on-going maintenance and field checks. These tasks involve three types of costs:

1) Technical work of measuring erosion rates and tabulating data - 4 man-days/mile of shoreline @ $40/day + $20/mile for supplies (overhead not included)

2) Scientific analysis of erosion rates including field, lab, and office work - 4 man-days/mile of shoreline @ $75/day (overhead not included).

3) General oversight of reaches with control structures including maintenance and field checks, e.g., routine and after storms @ $15 - 18,000 annually (overhead not included).

A.2.3 Shoreline and Nearshore Effects. In some cases, there may be impacts on the shoreline and/or the nearshore as a result of a control structure being constructed. These impacts, called external effects, impose costs or benefits on others. For instance, in the case of Reach 1, Segment 7, a 300 ft. terminal groin is the preferred action for Option I. The effects of such an action include reduced filling of Mill Creek, thus decreasing the need for dredging of public

boating area at $4.50 per cubic yard and improved shelter to Mill Creek. The groin, in addition to trapping longshore drift, building a beach, and minimizing erosion, also has the other nearshore effects. In this case, the effect is a benefit accruing to the public. Thus, the categories of shoreland and nearshore effects ensure consideration of such costs and benefits. However, with the exception of information on dredging and beach replenishment, measurements of the impact of control measures on the nearshore and shore areas are generally not available.

A.3 Calculation of Administrative and Transaction Costs

The transaction and administrative costs are important components of the analysis and may differ significantly for various management strategies. An explanation of cost calculations for five separate management categories is presented. Costs include direct and overhead expenses. Legal costs and administration of a compensation system if appropriate were included in each category. Costs are displayed on a reach-by-reach basis. The five categories are ownership, regulatory, financial/incentives, data collection/planning/research, and education/assistance.

A.3.1 Ownership. The ownership category encompasses such activities as public acquisition, easements, and programs for relocation of property.

Costs Per Reach

Costs per taking transaction (parcel)[12]

legal fees (15 hours @ $40/hr	= $	600
title examination	=	200
appraisal	=	200
other	=	500
Average cost per transaction		$1,500

number parcels in reach subject to taking[13] x $1,500 = $_____

A.3.2 Regulatory. The regulatory category includes permitting, zoning, and setback activities.

Cost Per Reach Plan

A. Plan Review

Personnel Costs

Direct: number hours x wage/hr = $_____

Indirect: Total direct x Indirect ratio = _____

Other Direct Costs

Travel (cost per plan)	= $	
Public Hearing (cost per hearing)	=	
Printing	=	
Equipment	=	
Other	=	
Total Other		= _____

B. Site Inspection and Enforcement:

Personnel Cost

Direct: number inspections x hours/inspection x wage/hour = $_____

Indirect: Total direct x Indirect ratio = _____

Other Direct Costs

Travel (cost/Inst. x Inspections	= $	
Printing	=	
Equipment	=	
Other	=	
Total Other		= _____
Total Cost per Reach Plan		= $_____

Example: For a Reach in Middlesex County

A. Plan Review:

Personnel Costs

Direct: 10 hours x $7.21 hour[14]		= $ 72.10
Indirect: $72.10 x .75[15]		= 54.08

Other Direct Costs

Travel ($16 per plan)[16]	= $16.00	
Public Hearing ($50 per hearing)	= 50.00	
Printing	=	
Equipment	=	
Other	=	
Total Other Direct		= $ 66.00

B. Site Inspection and Envorcement:

Personnel Costs

Direct: 3 inspections[18] x 3 hrs/inspection[19] x $7.21/hr.	= $ 64.89
Indirect: $64.89 x .75	= 48.67

Other Direct Costs

Travel ($9 x 3)[20]	= 27.00	
Printing	=	
Equipment	=	
Other	=	
Total Other Direct		= 27.00
Total Cost per Reach Plan		= $332.74

A.3.3 Financial/Incentives. This category includes grant and loan programs, taxation measures and insurance programs.

Costs of administering a financial or incentive program would entail the determination of adding-on to an existing institutional structure rather than establishment of a new program.

Costs Per Reach

Costs per transaction (parcel)

Grant application review and approval:
hours per application x wage/hour = $_____

Verification of request:

miles to site x 2 x rate per mile = _____
1 hour at site x wage/hour = _____

Total per parcel = $_____

Small Business Administration (SBA) financial assistance in the coastal area was estimated to involve approximately 1-1/2 hours for each application approval and review and one hour for site verification plus travel time.[21]

Example for Middlesex County:

Grant application review and approval:

1-1/2 hours per applicant x $7.21 hour $ 10.81

Verification of request:

30 miles x 2 x .15 mile 9.00
1 hour x $7.21 hour 7.21

Total per parcel $27.02

number parcels x $27.02 = cost per reach

A second basis for these calculations is the Maryland Department of Natural Resources - Shore Erosion Control Construction Loan Fund. The department supervises the design and erection of shore erosion protection devices financed by the fund. The Loan Fund is defined as:

> "The Shore Erosion Loan Fund, administered by the Shore Erosion Control Section of the Capital Programs Administration (Department of Natural Resources) provides no-interest loans to community or private property owners in need of shore protection. The fund is maintained by annual appropriations of approximately one million dollars by the General Assembly, and by repayment of loans through a special real estate tax levied by the State on private property benefiting from shore erosion control projects. The fund establishes priorities based on the rate of erosion, proximity of a structure to the eroding shoreline, the length of the eroding shoreline, and the number of property owners affected by the erosion. At the present level of funding, loans are generally given only in cases in which existing buildings are threatened by shore erosion. The fund designs and oversees construction and maintenance of the projects it finances. Perhaps more important, the Shore Erosion Control Section provides, upon request, technical assistance to any property owner the most appropriate method of protecting his property from shore erosion."

That program has an overhead budget (includes everything except funding for structures including vegetation cover) of approximately $220,000 per year and handles approximately 40 projects per year.[22] A project is defined as a property owner request for assistance.

Cost is approximately $55,000 per project. Of course to use this figure for our example would require us to drop the previous calculation of cost of technical assistance, scientific analysis and general oversight plus those type of cost which have been factored into cost of structural implementation.

A.3.4 Data Collection/Planning/Research. This category includes costs of activities necessary for collecting local area data, processing that data and setting up an erosion control program.

Costs Per Reach

Data Collection per parcel:

number of hours x wage/hour	= $_____
Translation of data per parcel:	
number hours x wage/hour	= _____
Analysis of alternatives per parcel:	
number hours x wage/hour	= _____
Total direct cost per parcel	= $_____
Indirect (64% of direct)	= _____
Total cost per parcel	= $_____

number parcels x average cost per parcel = total cost per reach

Example for reach in Middlesex County using actual values determined during the study.

Data collection per parcel[23]	
1/2 hour x $6 hr.	= $ 3.00
Translation of data per parcel[24]	
1/2 hour x $6 hr.	= 3.00
Analysis of alternatives per parcel[25]	
1/2 hour x $10 hr.	= 5.00
Total direct cost per parcel	= $ 11.00
Indirect (64% of direct)	= 7.04
Total cost per parcel	= $ 18.04

number of parcels x $18.04 = total cost per parcel

A.3.5 Education/Information. Unlike costs for the other four categories of transaction and administrative activities, costs for education and informational programs cannot readily be allocated on a per reach basis. In most instances, education and information programs would be incorporated as part of an on-going program. Activities would include presentations, newsletters, publications, and

possibly activities such as deed notification. A maximum expenditure should be established for this category.

A flat rate of $1,000 per reach is suggested for planning purposes.

A.4 Establishing Budget Summary for Cost and Benefit Comparison

The calculated values in section A.1, section A.2, and section A.3 were used to establish a budget summary for each reach. An example of that budget is presented in Section 6.2.1.7. This summary budget of costs and benefits provides all the necessary information for comparisons of alternative management strategies.

A.4.1 Part I of Summary Budget. Benefits which accrue to shoreland activities as outlined in section A.1 were consolidated by erosion year groups for each reach. The benefits were based on prevention of losses which would have occurred if erosion were to continue unabated for each of the erosion rate years. An alternative explanation is that benefits to be used in this column are the costs which would be incurred if erosion continued unabated for those year periods.

A.4.2 Part II of Summary Budget. As noted in section A.2, several structural control options should be considered for each reach. Costs and benefits for each option were consolidated for the reach for each option. Also provided were estimates of the expected years of effectiveness of the proposed measures and of the percentage

effectiveness of that option in controlling erosion. The potential shoreline erosion loss prevention values from Part I must be modified to reflect the percentage effectiveness for each option as noted under structural controls. For instance, if the percentage effectiveness is 50 percent then only half of the potential prevention of loss value can accrue as a benefit from implementation of the proposed structural controls.

Technical Assistance as given here is limited to assistance for shorline evaluation, design of structures, maintenance and field checks. Other assistance is included under Transaction and Administration Costs. Calculation of technical assistance costs was explained in section A.2.

Any cost incurred due to restriction to ownership from such non-structural measures as easements and public acquisition was calculated on basis of current use limitations. These costs were based on decreases in value of those uses as calculated in section A.1. For example, if an easement or buffer zone were established, then annual net return from agriculture production on that restricted area was lost to the owner. He may or may not receive compensation for the lost value. Costs or benefits resulting from changes in access or facility use are definitely legitmate considerations but are too varied to include in the analysis.

Regulatory actions such as zoning, permitting and setbacks may impact value of land use and property. Costs of limitation on

production was based on calculated production values for the impacted area. We assume these actions will not impact value of current structures except by relocation costs which are discussed in the next section of the report. Regulatory action will impact property values particularly if an action such as a setback requirement prevents future building on the impacted lot. Setbacks which provide for open space may actually increase the value of the property.[26] However, these setbacks generally range from 100' to 2000'. Our area is more closely related to lots of approximately 100' to 200' of depth. In instances where a regulatory action eliminates the use of a vacant lot for building purposes, that lot loses all its value except the $2,700 placed on unbuildable lots by the assessors.

Procedures for calculation of transaction and administration costs were explained in section A.3. The consolidated costs per reach were transferred to the budget summary.

A.4.3 Part III of Summary Budget. Public acquisition costs were based on fee simple purchase by government or some administrative group such as a local assessment district. These costs were derived from the calculations on property and structure present value appraisals as discussed in section A.1. Actual acquisition cost may be either higher or lower than the curent market appraisal. The budget summary provides total potential cost which can be used for an allocation of available funding based on percentage federal or

non-federal share as may be determined by the management strategies. For example, one proposal is a 50-50 share of acquisition costs.[27]

Relocation for major structures (this analysis was limited to dwellings) is an alternative to complete acquisition and may impose costs on either private or public parties. A relocation cost was calculated as explained in section A.1 for each major structure located in an impacted area. These values must be considered in evaluation of any combination of controls. The budget summary provides total potential cost for relocation which can serve as a basis for an allocation of relocation funding between federal and non-federal cost-sharing based on selected management strategies. It also provides for calculating cost associated with a loan program. For example, one proposal is for 80-20 cost-share and a 5 percent loan interest rate.[28]

A.4.4 Costs of Loans and Grants for Structures. Financial incentives such as loans and grants may be available to offset cost of control actions. Although not included in the budget summary, costs may be distributed among private and public entities based on specific program objectives. The Great Lakes Basin Commission in a recent study suggests 100 percent federal grants to protect public lands, grants for structures on a 50 federal/50 non-federal basis, and loans to private owners at a 5 percent interest rate.[29]

A.4.5 Consideration of Flood Insurance Program. While the budget summary does not contain a section for consideration of

insurance programs, the analysis can be used to analyze policy issues with respect to insurance programs.

The role that the Federal Flood Insurance Program plays could be limited to five options. The options are: 1) removing erosion from the flood insurance program; 2) total prohibition of new construction in erosion hazard areas; 3) setback requirements; 4) no-insurance zone as an alternative to setback requirements; and 5) moveable structures and buffer zone.

Employing four of the five options; i.e., 2) through 5) above, their impact on the property, improvements and use values can be determined in the following manner:

1. Total prohibition of new construction in erosion hazard areas.

    a. establish an erosion hazard zone by multiplying the average useful life of a structure by the predicted annual recession rate. FIA prefers a 67-year hazard zone (67 year as average useful life structure)
    b. limit future uses of erosion zone to "open spaces"
    c. insurance at subsidized rates for existing structures

2. Setback requirements within erosion zones.
    a. establish an erosion hazard zone by multiplying the average useful life of a structure by the predicted annual recession rate
    b. setback requirements would prohibit new construction in 30-year portion of zone

3. No-insurance zones as an alternative to setback requirements.
    a. establish an erosion zone by multiplying the average useful life of a structure by the predicted annual recession rate
    b. a 30-year zone would be established in which no insurance coverage would be provided for new construction
    c. insurance available in rest of zone

d. does not require a setback, just no insurance available for the 30-year zone

4. Moveable structures and buffer zone.
   a. combines elements of a sinking fund (insurance rate calculated so that at the time of loss, enough money would have been paid into the fund to cover the depreciated value of structure) and a 30-year no-insurance zone concept
   b. a short buffer zone would be maintained at all times and would probably be based on a five to ten year recession zone
   c. buffer zone would recede annually and no new structures be permitted
   d. new structures in 30-year setback would be moveable and would have to be moved when overtaken by limits of the buffer zone
   e. coverage would not be provided for losses to structures within the buffer

The aspects of the flood insurance program could be incorporated as the study progresses into calculations to focus on the costs and benefits of prohibiting construction in the erosion hazard areas (10, 15, 30, and 67 year zone); limiting uses to open space; requiring a 30-year setback zone; and relocating structures.

FOOTNOTES

[1]Based on erosion rates provided by VIMS scientist.

[2]Procedures For Determining Ranges of Use-Value....With 1978 suggested Use-Values, State Land Evaluation Advisory Committee, Richmond, Virginia, September 1977.

[3]Armstrong and Denuyl, "An Investment Decision Model for Shoreland Protection and Management, "Coastal Zone Management Journal, Vol. 3, No. 3, 1977 pp. 237-253. A study by Brown and Pollakowski confirms the existence of this valuation difference--Brown and Pollakowski, "Economic Evaluation of Shoreline," Discussion Paper #75-14, Institute for Economic Research, Univ. of Washington, November 1975.

[4]Subdivision Ordinance, Middlesex County, Virginia, prepared by The Middle Peninsula Regional Planning Commission and adopted by The Board of Supervisors of Middlesex County, Virginia, effective September 1, 1966.

[5]Armstrong and Denuyl, op. cit.
Erosion/Insurance Study, by Erosion/Hazard Management Subcommittee of the Great Lakes Basin Commission Standing Committee on Coastal Zone Management June 1978.
Brown and Pollakowski, op. cit.
Polinski and Shavell, "Amenities and Property Values in a Model of an Urban Area," Jorunal of Public Economics, Vol. 5, 1976, pp. 119-129.

[6]"Wingate Appraisal Service Market Study, 1977" Report on file in Middlesex County Commissioner of Revenue's Office.

[7]Brown and Pollakowski, op. cit.
Wingate Appraisal Service Market Study, op. cit.

[8]Use value assessment information obtained from Commissioner of Revenue's Office for Middlesex County.

[9]Armstrong and Denuyl, op. cit.

[10]"Cost Report on Non-Structural Flood Damage Reduction Measures for Residential Buildings Within the Baltimore District," U. S. Army District, Baltimore, Md., IWR Pamphlet No. 4 July 1977.

[11]Excerpt from IWR Pamphlet No. 4, op. cit.

[12]These costs include only transactional costs, not cost of actual purchase, reimbursement, or relocation. Estimates obtained from the legal and right-of-way divisions of the State Highway Department. Estimates represent an average only as each case has a degree of variability. Court costs associated with the small number of cases (10-20 percent) which go to trial are not included.

[13]Taking is likely to be found only if the regulation totally restricts building on a parcel or has substantial economic impact upon the property.

[14]Man hour costs were figured on the basis of an annual salary of $15,000.

[15]Indirect cost ratio is the total of all costs considered indirect (secretarial, supplies, utilities, fringe, etc.) multiplied by total direct personnel costs. The .75 indirect cost ratio is based on Middle Peninsula Planning District Commission budget.

[16]Estimate for Middlesex County.

[17]Estimated cost of one public hearing in Middlesex County.

[18]Constitutes one inspection at start of project, one during the project construction and one at completion of project.

[19]One hour of travel each inspection and two hours at site.

[20]Each inspection - 60 miles round trip at $0.15 mile.

[21]Telephone conversation with Mr. Lou Hodges of the SBA in Richmond, Virginia.

[22]Telephone conversation with Mr. Tom Morris of the Maryland Department of Natural Resources, Annapolis, Maryland.

[23]Figures for data collection costs include the costs of assembling information on

1. property;
2. improvements; and
3. use value.

These pieces of information are transferred from the tax maps, the parcel index for the tax maps and the individual parcel tax assessment forms. The 30 minute per form is the time required to: locate the parcel; determine the owner; look-up the owner's assessment card in the file; and to copy the necessary information from the card to the Property Survey Form.

[24]The information collected on the Property Survey Form is translated into values for:

1. the property: total market value
   loss of building site
   amenity value
   loss of taxes
2. the improvements: dwelling
   other buildings and structures
   loss of taxes
3. the land use: loss of land

These values are calculated using procedures outlined in Chapter IV 2.a.

The approximate time for various calculations include:

Total time: 30 minutes per parcel

1. 100' and 200' setback and 10, 15, 30, and 67 yr. erosion rate areas required 5 min. per parcel.
2. figuring total square footage for irregular-shaped lots, using a digitizer (i.e., planimeter) @/10 min. per parcel
3. determining value of property per sq. ft. based on assessed value @ 5 min. per parcel
4. transferring the data on to the property, Improvements, and Use Value Form @ 10 min per parcel

[25]These costs are based on actual figures as derived for study of reaches in Middlesex County.

[26]Brown and Pollakowski, op. cit.

[27]Erosion/Insurance Study, op. cit.

[28]Erosion/Insurance Study, op. cit.

[29]Erosion/Insurance Study, op. cit.

APPENDIX B

MEASURE OF FISCAL EFFORT FOR SELECTED COASTAL LOCALITIES

B.1 Determination of Fiscal Effort for Selected Localities.

Fiscal effort can be used to compare the ability of localities to pay for a given erosion control program and to provide guidelines for the distribution of limited erosion control funds among localities. Fiscal effort as used in this study is a percentage measure of revenue from own sources per capita divided by revenue capacity per capita. The following sections provide a discussion of the rationale for using fiscal effort and then an explanation of each component of the ratio measure.

B.1.1 Fiscal Effort. Measures of fiscal effort are used for two primary purposes: 1) to measure the actual financing performance of a government against its estimated financial reach, and 2) to compare differences in relative government financial effort among localities. In dealing with fiscal effort we are seeking to measure governments' use of their potential financing capacity rather than to compare the resulting burdens that fall upon people in various areas. The two are likely to be related: in an area where governments are making greater-than-average use of their total potential financing capacity, the resulting burden upon local residents is likely also to be on the high side. But this is not necessarily the case, because some taxes and other governmental exactions can be shifted by those who pay them

in the first instance to someone else. For example, economists generally believe that most sales and excise taxes collected from producers, wholesalers or retailers are passed along to the buying public, whether as a specific extra charge or in the form of higher prices. But not all members of the "buying public" are residents of the taxing jurisdiction. Thus, in a local area with a large volume of tourist trade, heavy reliance upon sales taxes may load onto non-resident visitors a considerable fraction of the financing of public requirements. For such an area, one might find a comparatively high measure of relative revenue effort, even though, thanks to this targeting at the tourists, locally-borne tax burdens are only average or even low.

A considerable part of the capital outlay of local governments is financed by debt issuance. Debt financing may be viewed as one form of governmental effort, at least a short-run alternative to the raising of the same amount of revenue. Although debt issuance permits the postponement of the burdens flowing immediately from taxes or fees and other charges, it does involve a sort of sacrifice by the jurisdiction involved, a reduction in its future borrowing power and the acceptance of a future drain upon its resources for debt service. A major argument for trying to take account of the borrowing component of local financing is that this would permit the subclassification of "effort" along functional lines. On the other hand, to do that would imply that borrowed funds can be readily interchanged with governmental revenues, and that is not so. Bonds are usually issued

to finance particular capital outlays and cannot be diverted to other purposes. Furthermore, very special problems arise in trying to measure relative debt capacity. Accordingly, in the present study, capacity and effort have been measured and reported mainly in terms of revenue alone.

The formula selected for calculating fiscal effort is general revenue from own sources per capita divided by computed revenue capacity per capita. This procedure yields a percentage of fiscal effort.[1] This method was selected over other measures because it provides a comprehensive picture of local effort and avoids some of the extremes inherent in the use of other methods. For instance, two commonly suggested measures, revenue from own sources per $100 of true value of real estate and revenue from own sources per $100 of personal income, as sale measures of fiscal effort were rejected. True value of real estate per capita does not represent all locally raised revenue and may not be a good predictor of other revenue bases. Personal income as a measure of capacity many understate tax bases not locally owned. Another sole measure, real estate true tax rate was rejected because the relative importance of real estate taxes varies among rural and urban localities. The limitations on use of these sole measures are discussed further in the section on revenue capacity.

Figures on percentage of fiscal effort for coastal counties and cities in Virginia are presented in Table 7, Section 6.3.2.

Discussion on the two components of fiscal effort ratio revenue from own sources and revenue capacity, are presented in the following sections.

B.1.2 Revenue from Own Sources. Revenue from own sources is calculated for each city and county on an annual basis by the Auditor of Public Accouunts. That information is available in published reports.[2] General revenue from own sources includes: property taxes, penalties and interest; local sales taxes; taxes on utility services; motor vehicle licenses; permits, licenses and license fees; service charge on county owned enterprises; other local taxes; revenue form use of money and property; fines and forfeitures; and reimbursement for services to other localities. Figures for revenue from own sources per capita for coastal counties and cities are given in Table 7 of Section 6.3.2 of this report.

B.1.3 Revenue Capacity. Local fiscal capacity (the revenue capacity denominator in the formula) is a measure of the ability of a local government to obtain resources for public purposes. It is especially important to observe that fiscal capacity involves the financing capability of governments, rather than the economic well-being of people. Nevertheless the two are interrelated, because governments depend mainly for their financing upon taxes and other revenue sources that tap the income, transactions, or property holdings of people. A 1962 Advisory Committee on Intergovernmental Relations (ACIR) study found general similarity in the tax capacity

standing of various states whether gauged by personal income or in terms of the yield of a "representative tax system."[3] But that study also found some differences in the results of the two measures of individual states, and for smaller areas, a simple one-to-one relationship is even less likely to be found. This is particularly obvious in "tax havens" that have large industrial or commercial installments which give thier local governments a relatively rich revenue base, even though the residents may be few in number and poor in income and property holdings. But the revenue base of local governments near such tax havens often is less adequate than might be expected by reference only to the income of the residents, many of whom are employed in the haven area. The business property of the haven area is beyond the fiscal reach of these outlying areas. There are some communities, or even entire counties where, due to the location of state capitols or universities, or of federal installations, much of the local economy rests on governmental operations. Because the local governments that serve each areas cannot tax the public property involved, their fiscal capacity is likely to be less than that of other areas having a similar level of residents' personal income but a more usual mix of local economic activity.

As the frequent lack of close correspondence between the relative fiscal capacity of governments serving various areas and the relative economic well-being of the residents of such areas becomes increasingly apparent, it becomes more important to use some means of

measuring fiscal capacity that does not presume such a correspondence. The approach used in this study is the result of a more recent (1971) ACIR report, and is the basis for a State of Virginia Revenue Resources and Economic Commission Study (1975).[4] This approach accounts for nontax revenue as well as taxes, and rests on the proposition that, in trying to arrive at a meaningful summary measure or relative revenue capacity for various areas, it is best to weigh various detailed elements of potential capacity according to their relative contributions to the grand total of all revenues raised by state and local governments. Whether applied at the national level or on a with-in-state basis such a set of weights seems more likely than any alternative to give summary capacity estimates with which actual revenue-raising performances can logically be compared. It provides a reflection of the real world, rather than of some other set of assumed circumstances.

The method used in this study for estimating fiscal capacity is the "average effort" approach. This method gives a more balanced picture of local fiscal capacity than a single measure. In selecting this method, two other methods were rejected. The use of true value of real estate per capita as the sole measure of fiscal capacity was rejected because it does not represent all locally raised revenues, and in many cases, it is not a good predictor of other revenue bases. Although it is recognized that real estate is the most important source of local revenues, accounting for 50 percent statewide, the relative importance of real estate taxes varies.[5] As a rule, the real

property tax tends to be relatively more important as a revenue source in rural areas since they lack the variety of sources and commercial revenue bases available in urban areas.

Although Virginia counties and cities are prohibited from taxing income directly, it can be used as a general measure of ability to pay other taxes and nontax charges. The reason personal income has been rejected as the sole measure of fiscal capacity is that sole reliance on income as a measure of capacity understates tax bases not locally owned. The existence of a large public service corporation would not be reflected by an income measure despite the fact that it would represent a major tax base.

The method the Virginia Revenue Resource and Economic Commission uses to compute local revenue capacity is based on the Advisory Commission on Inter-governmental Relations (ACIR) "average effort" approach.[6] For each major tax source ACIR calculated the state's tax base and then multiplied the base by the weighted national average ratio of tax receipts to tax base. For their purposes, the Resource and Economic Commission multiplied each major tax base in a locality by the statewide average effort. For the purposes of this study, the statewide average efforts that the Commission determined are used to calculate the fiscal capacity per capita in each of the coastal counties and cities of Virginia.

The true value of real estate was multiplied by $.0106, and personal income, a proxy for non-property and non-sales taxes and

other revenue, was multiplied by $.0160. The number of motor vehicles was multiplied by $27.29, as a proxy for personal property taxes. The resulting products were added to local option sales tax collections to obtain computed revenue which was then standardized by dividing by population. Standardizing by resident population is a common method of making data for different size localities comparable. However, the population used in the denominator may not always be represented of the population receiving full range of governmental services. Most affected by such considerations are localities with military bases and colleges.

Example: Middlesex County

Data:

1.	True Value of Real Estate	=	$173,544,000
2.	Personal Income	=	$ 31,700,000
3.	Number of Motor Vehicles	=	$ 5,614
4.	Local Option Sales Tax Collections	=	$ 145,780
5.	Population	=	$ 7,200

$173,544,000 X $.0106	=	$1,839,566
$ 31,700,000 X $.0160	=	507,200
5,614 X $27.29	=	153,206
		$2,499,972

$2,499,972 + $145,780 = $2,645,752
$2,645,752 ÷ 7,200 = $367.00 per capita

The average fiscal capacity per capita for the coastal counties of Virginia was $324.00 with a high in Arlington County of $485.00 per capita and a low in Northampton County of $215.00 per capita. The average fiscal capacity per capita for the coastal cities was $292.00 with a high in Williamsburg of $476.00 per capita and a low in Chesapeake of $223.00 per capita. (Table B1)

Table B1. Average Fiscal Capacity Per Capita
for Coastal Cities and Counties

County or City	True Value of Real Estate[7] ($1,000)	Personal Income[8] ($1,000)	No. of Motor Vehicles[9]	Local Option Sales Tax Collections[10]	Population[11]	Average Fiscal Capacity Per Capita
Counties						
Accomack	432,059	144,800	21,374	603,800	30,900	259
Arlington	3,502,384	1,836,600	102,154	5,117,650	153,500	485
Caroline	298,107	79,500	10,403	119,380	15,900	309
Charles City	115,002	25,400	3,838	24,860	6,500	270
Chesterfield	1,740,921	727,100	81,525	2,691,140	107,700	325
Essex	173,251	36,900	6,035	348,280	7,800	377
Fairfax	11,500,334	4,569,900	373,980	16,288,830	525,500	422
Gloucester	338,264	90,400	12,798	374,080	17,000	339
Hanover	847,190	297,500	36,955	1,204,310	48,400	330
Henrico	2,886,679	1,324,900	119,597	7,557,910	173,900	360
Isle of Wight	321,839	100,400	13,522	399,060	20,400	284
James City	355,538	95,700	10,674	696,620	19,800	318
King George	177,916	56,500	6,805	112,120	9,600	322
King & Queen	117,761	29,500	4,037	24,350	6,000	309
King William	195,954	47,700	6,054	184,130	8,000	399
Lancaster	232,193	54,100	7,596	307,550	9,600	400
Mathews	163,583	38,400	5,874	124,290	8,100	325
Middlesex	173,544	31,700	5,614	145,780	7,200	367
New Kent	162,065	39,100	5,741	94,560	7,300	355
Northampton	164,347	60,200	8,875	355,870	15,400	215
Northumberland	216,598	48,400	7,349	127,430	9,600	354
Prince George	220,341	99,700	9,741	167,640	19,200	227
Prince William	1,994,200	759,300	86,070	3,940,790	128,500	308
Richmond	111,264	38,800	4,643	187,990	6,600	320
Southampton	233,001	76,800	10,699	158,900	18,500	224
Spotsylvania	469,651	119,800	19,058	863,560	24,300	341
Stafford	509,135	175,500	22,296	464,620	32,500	285
Surry	111,679	25,500	3,869	45,910	6,000	291
Westmoreland	261,314	58,200	9,603	239,080	13,400	314
York	447,584	176,900	18,209	460,870	31,600	270
Cities						
Alexandria	2,113,433	1,073,600	75,187	4,474,330	108,100	427
Chesapeake	1,078,541	552,900	65,668	1,964,270	107,600	223
Colonial Heights	212,277	122,600	11,865	452,170	17,100	292
Fredericksburg	233,878	122,100	11,622	1,146,780	17,100	345
Hampton	1,262,963	748,700	70,123	3,989,140	128,900	243
Hopewell	258,132	143,000	15,389	747,760	23,600	262
Newport News	1,723,836	851,200	78,392	3,361,180	139,900	267
Norfolk	2,242,736	1,564,400	135,999	9,333,170	276,000	224
Petersburg	394,277	260,900	24,531	1,802,180	47,000	230
Portsmouth	957,986	609,800	53,522	2,721,430	106,800	226
Richmond	2,782,383	1,790,700	126,649	10,140,240	226,400	317
Suffolk	608,403	250,400	27,136	999,560	47,300	258
Virginia Beach	3,352,094	1,390,500	141,066	6,371,360	223,700	304
Williamsburg	223,955	87,000	7,169	1,229,930	10,900	476

Fiscal Capacity computations are of little use when dealt with in an absolute sense. Since they are measurements of the potential reach of local governments in obtaining resources, fiscal capacity computations take on meaning only when viewed in terms of the previously discussed fiscal effort.

FOOTNOTES

[1]Fiscal Prospects and Alternatives: 1976, A Staff Report to the Revenue Resources and Economic Commission, June 1975, p. 88.

[2]Report of Auditor of Public Accounts of Commonwealth of Virginia on Comparative Cost of County Government, 1977, p. 14-15.

[3]Measuring the Fiscal Capacity and Effort of State and Local Areas, Advisory Commission on Intergovernmental Realtions, March 1971, p. 4.

[4]Fiscal Prospects and Alternatives: 1976, A Staff Report to the Revenue Resources and Economic Commission, June 1975, p. 82.

[5]Ibid.

[6]Ibid.

[7]Data obtained from the 1976 Virginia Assessment/Sales Ratio Study, Department of Taxation, Commonwealth of Virginia.

[8]One major problem concerning the proxy measures used is that the income amounts involved pertain to earnings as recorded on a "where-earned" basis, rather than according to the place where the income recipients reside. For most SMSA's and for individual counties the amount involved is undoubtedly very similar to that which would appear for income, similarly defined, on a "where-received" basis. However, there would be a material difference in some instances, particularly at the county level, due to commuting. The personal income data is obtained from the Tayloe Murphy Institute publication entitled, "Personal Income Estimates for Virginia Cities and Counties, 1969 to 1976" by John L Knapp and David C. Hodge.

[9]Data obtained from the County/City Vehicle Registration Count by the Department of Motor Vehicles, Commonwealth of Virginia.

[10]Data on taxable sales was obtained from the Tayloe Murphy Institute publication entitled "Department and Specialty Store Sales in Virginia - 1977," by Eleanor G. May. The local option sales tax is obtained by calculating 1 percnet of the total taxable sales of the locality.

[11]Population data was obtained from the Report of Auditor of Public Accounts of Commonwealth of Virginia on Comparative Costs of County Government, 1977, and Report of Auditor of Public Accounts of Commonwealth of Virginia on Comparative Cost of City Government, 1977.

APPENDIX C

Summary and Recommendations of the Erosion/Insurance Study conducted by the Erosion/Hazard Management Subcommittee of the Great Lakes Basin Commission Standing Committee on coastal Zone Management, June 1978.

Study Description

This study proposes a new solution to the problem of assisting private property owners and protecting the public interest in the nation's shoreline erosion hazard areas. This study recommends repeal of the erosion provisions of the National Flood Insurance Act of 1968, as amended (a recommendation supported by the Federal Insurance Administration), and replacing them with a new program that would provide financial assistance and considerable management flexibility to coastal states for implementing state erosion plans developed pursuant to the Coastal Zone Management Act of 1972, as amended. The study finds federal investment in erosion hazard areas to be in the national interest. The recommended program would not use public funds repeatedly or indefinitely.

The Great Lakes region has for many years been concerned with the use and management of shoreline erosion hazard areas. Responding to these concerns, Congress addressed this issue in the 1973 amendments to the National Flood Insurance Act. However, the ambiguous language of the erosion provisions of the act precluded successful implementation by the Federal Insurance Administration (FIA).

Recognizing these problems, the erosion hazard management subcommittee of the Great Lakes Basin Commission's Standing Committee on Coastal Zone Management agreed to undertake the Erosion/Insurance Study for FIA. This report on the study results from the five-month effort by representatives of four Great Lakes states, the U.S. Army Corps of Engineers, the Federal Insurance Administration and Fisheries and Environment Canada.

The purpose of the study was twofold:

(1) to develop and recommend a management program with appropriate means of compensation for shoreline erosion hazard areas which would be socially, economically, politically, and physically workable; and

(2) to develop guidelines for recession rate calculation for the Great Lakes shorelines.

The report is likewise organized into two main sections - one describes the development and details of the recommended management strategy which applies to the entire nation, and the second describes the recommended guidelines for Great Lakes recession rate calculation.

The following conclusions regarding management strategies were reached.

(1) The process of shoreline erosion and associated damage is not insurable.

(2) Erosion hazards not directly related to inundation do not readily fit within the National Flood Insurance Program developed pursuant to the National Flood Insurance Act of 1968, as amended.

(3) The erosion provisions of the Flood Insurance Act of 1968, as amended, should be replaced.

(4) There is significant national interest in and justification for federal investment in erosion hazard areas.

(5) There should be federal interest and a federal role in supporting the implementation of the state erosion plans developed pursuant to the Coastal Zone Management Act of 1972, as amended. There is presently not adequate support for implementation of the state erosion plans.

(6) Federal financial assistance is needed to implement the state erosion plans.

(7) State and/or local regulations of new development in the imminent erosion hazard zone would be required as a condition for federal assistance.

(8) If the state is to have a role in ensuring enforcement of the selected management techniques, special state enabling authority may be necessary.

(9) Considerable state flexibility in any erosion management program is necessary.

(10) If structural erosion protection is used in lieu of nonstructural controls, the devices must be designed with their effects on the entire coastal reach in mind, with legally binding assurances that the structures will be property installed and maintained.

(11) Substantial technical developments in recent years have been achieved for both recession rate calculation and design of shore protection structures.

Recommendations

(1) The erosion hazard insurance provision (Sections 1302(g) and 1370(c)) of the National Flood Insurance of 1968, as amended, should be repealed to eliminate the insurmountable technical and administrative problems that have resulted since 1973 from attempts to implement insurance program for coastal erosion.

(2) A national program should be established to provide financial assistance to states to implement the state erosion plans (developed pursuant to Section 305(b)(9) of the Coastal Zone Management Act of 1972, as amended). Flexibility must be retained at the state level to respond to particular circumstances related to erosion management, with implementing techniques including hazard area identification, technical assistance, state/local regulation, relocation, land acquisition and shore protection.

APPENDIX D

GUIDELINES FOR THE DETERMINATION OF EROSION RATES

(The following pages are reproduced, with modifications, from the Erosion/Insurance Study Conducted by the Erosion/Hazard Management Subcomittee of the Great Lakes Basin Commission Study Committee on Coastal Zone Management, June 1978).

DEFINITIONS

Bluffline: Due to geomorphic, climatic and hydrologic conditions, the feature which is indicative of an erosion problem is the retreat of the bluffline. For the purpose of this report, the bluffline is defined as the line which is the edge or crest of the segment of the shore elevated above the beach which normally has a precipitous incline on the waterward side. In low relief areas, it may be necessary to use some other diagnostic shoreland feature such as the line of permanent or stable vegetation in the backshore area for recession rate calculations. In the following test the words bluffline and the line of permanent or stable vegetation may be used interchangeably. The bluffline is a desirable reference point as:

a. Identification is not affected by changing water levels.
b. It is easily recognized and located without the aid of survey equipment.

Shoreland Manuscripts: Maps and other graphic displays of topographic and cultural features of the coastal area.

Recession Rate: The rate of retreat of a bluffline over a period of time, usually expressed in feet or meters per year.

Transect Line: The point on the bluffline where a recession rate measurement is made.

METHODOLOGY

To establish a bluffline recession rate, it is necessary to know the position of the bluffline at some specific point on the shore at a specific date in history. Then the present position of the bluffline at that point is measured and the rate of movement calculated.

Aerial Photography: Comparison between aerial photographs is a common method of determining bluff recession. This method provides an extensive, continuous and uniform record of bluffline location at a reasonable economic expenditure. In many instances, aerial photographs provide the best historic record of bluffline position since earlier documents do not adequately reference the bluffline.

Dates of Photography: The longest time span between sets of aerial photography of acceptable quality must be employed.

Photograph Quality: All new photography conducted to establish a modern bluffline record should be flown to current standards of accuracy similar to those established by the National Ocean Survey. In addition, flights must be timed to provide the best resolution and documentation of the bluffline positions.

Aerial photographic quality usually is a continuous variation of several parameters; resolution, contrast, tilt, scale, percent of land-water coverage, etc., which together determine whether an image is suitable to produce an accurate recession rate measurement. Because it is difficult to put exact limits on "low" versus "high" quality, reliance must be placed upon the professional judgement of the person using the photography. Generally the photography should meet the standards specifications for aerial mapping photography applicable at the time of photography.

Scales: The minimum contact scale of photographs to be used for recession rate calculations should be 1:20,000. It is desirable to use larger scale photography whenever possible to provide better definition of the bluffline and better resolution of the control points used to determine accuracy of scale and to compare photographs of different dates.

Availability: Aerial photographs from as early as 1938 are available for most of Virginia's coastal areas.

Instrumentation: The accuracy in the comparison of two sets of photographs achievable with the Zoom Transfer Scope is the minimum standard required. Any instrumentation which will meet or exceed ZTS accuracy is suitable for recession rate calculations.

Ground Surveys: It has generally been found that remeasurements of historic surveys such as historic plats do not produce accurate

bluffline recession rate calculations. This is because these surveys usually do not record the position of the bluffline, referencing instead either the water's edge or a specific elevation.

Modern subdivision mapping generally provides exact contouring mapping. These documents, along with the measurement of distances from monumented positions to the bluff edge, have the potential to provide the most accurate recession rate calculations possible once the time period covered becomes of sufficient length.

Shoreland Manuscripts: Recession rate calculation studies should take advantage of shoreline manuscripts which accurately depict the bluffline.

Scale: Shoreline manuscripts of a scale of 1:10,000 or larger should be incorporated into recession rate studies if they provide desirable time span data and are of sufficient accuracy.

Dates: All available shoreline manuscripts which meet other requirements can be employed regardless of document dates. Exceptions may occur in two instances:

(1) Long-term recession rates may vary from short-term rates. In this instance, the investigators may determine the shorter time span is more indicative of future erosion (see the section on Time Spans in the following pages).

(2) Manuscripts produced within the time span for which aerial photography exists should be included only if accuracy is

enhanced and the time span of the study is not shortened significantly (see the section on Time Spans).

Accuracy: Care must be taken to ensure that the bluffline drawn on a historic shoreline manuscript is presented as an accurately placed topographic feature and not merely an artistic display.

STANDARDS FOR ACCURACY

Modern Photography Mapping Standards: The following criteria should be used for establishing specific standards for all new aerial photography flights conducted for recession rate studies.

(1) Photography flights must be conducted during a leaves-off, snow-and-ice-free period.

(2) Sun angle should be chosen which best illuminates the bluff face.

(3) Sun angle must not be such as to allow sun glint (reflectance) to wash out (over-expose) the beach-bluff area.

(4) The percent of land-water coverage must be 50% to 60% land coverage.

(5) The scale of new aerial photography shall be no smaller than 1:10,000 with an optimal scale of 1:6,000 (1 in. = 500 ft.).

(6) Color photography is more desirable for bluffline identification. It is strongly recommended that color photography be selected at 1:10,000 scale and black and white photography at a scale of 1:6,000 or larger.

Additionally the applicable standard specifications for aerial photography and photogrammetric mapping should be applied.

Methodology for Determining Photograph Scale: Scale should be determined for every aerial photograph using the following guidelines:

(1) The scale may be calculated by making field measurements between clearly defined control points on the modern photograph.

(2) The scale distance measurement should be made parallel to the proposed recession rate measurements to compensate for directional variations in scale which may exist on the aerial photograph (tilt, paper shrinkage, etc.).

(3) The type of instrumentation employed or the judgement of the photogrammetrist may indicate that an average scale value will provide sufficiently accurate recession rate calculations.

Rate Spacing: There should be a minimum of five recession rate measurements per mile of shoreline, spaced at a maximum distance of 1,000 feet. Recession rate measurements shall be taken at even closer intervals when adjacent recession rates vary by one foot per year or more along blufflines which have few erosion control structures and two feet per year or more along blufflines which have few erosion control structures and two feet per year or more along blufflines where erosion control structures are predominant.

Predominance should be based upon the percentage of shoreline which has been "hardened" by shore protection, 25% or more of shore protection being considered the threshold. Predominance should also be based on the effective size of structures since one large pier can project a zone of influence for great distances along the shore. Professional judgment will be necessary in special situations. Where adjacent rates do fluctuate beyond acceptable values, recession rates should be measured, if possible, at succeedingly closer intervals until adjacent rate variation is reduced to proper levels or the rate spacing has been reduced to a minimum of 250 feet between transect lines.

When recession rates continue to fluctuate beyond the limits established above and the recession rate spacing has been reduced to 250 feet or as close as possible, breakpoints between areas of differing recession rates should be established. The location of the breakpoint between differing recession rates should be made on the following basis:

(1) large harbor structures

(2) river or stream mouths

(3) changes in physical characteristics

(4) erosion control structures that appear to cause anomalous recession rates

(5) if 1-4 are not applicable, place breakpoint at the midpoint between the two recession rates which fluctuate significantly.

TIME SPANS

Period of Record: The longest period of record for which accurate photographs and possible manuscripts exist should be employed to determine the long-term recession rates. This period of record should not go beyond the date of a known major shoreline change, but must be in excess of 25 years. If for example, a harbor structure has been in place for 30 years, the last 30 year period may be most indicative of future erosion. A minimum period of 25 years is required to reflect normal variations and to reduce the statistical variability of rates based on shorter time spans. If recession rate calculations are based on less than a 25-year period of record, the rates should be used only in conjunction with physical characteristics by reach, other documentation, and personal knowledge of historic erosion.

Maximum Age of Modern Photography: Photographs over five years old should not be used as the modern coverage.

MAPPING

Mapping Base: The mapping base to be used should be the most accurate display available reproduced at a scale of 1:10,000.

UPDATE OF DATA

Recalculation of Rates: Recession rate studies should normally be updated every ten years. In areas where erosion is severe (according

to local reports), or where property owners strongly disagree with results, the recession rates should be restudied as needed.

Update Studies: When previous studies are updated with new photography, the new study should be measured against the historic photography in order to increase the time span. However, with each new study the suitability of the historic photography must be reevaluated by weighing the value of time spans and the quality of historic photography.

TECHNICAL RECOMMENDATIONS

1. The longest period for which accurate data points exist should be employed.

2. It is imperative that new color aerial photography for the entire shore at a scale of 1:10,000 or larger be flown to the included specifications as soon as possible.

3. It is recommended that aerial photography be updated every ten years.

4. Ground surveys to reestablish historic land surveys should not be used for recession rate calculation unless the bluffline has been specifically recorded in the historic documents.

5. The establishment of ground monumented bluff positions should be encouraged to provide recession rate data for areas where accurate aerial photographs are difficult to obtain, to check on the accuracy

of other methodology, and to ultimately provide the ideal method of recession rate calculation. Paired monuments should be placed 1,000 to 2,000 feet apart and 100 to 250 feet landward of the bluffline. The paried monuments would then form a base line from which transects to the bluffline can be made at 200-to 400-foot intervals. Periodic remeasurement of these transects will indicate the recession rate. The monuments should be witnessed to local features for ease in reestablishing the measurement positions. The benefits of this recommendation will not be fully realized until some future time.

(6) An inventory and cataloging of all Virginia shoreland manuscripts of a scale of 1:10,000 or larger should be conducted, and the suitable manuscripts should be incorporated into recession rate calculations.

APPENDIX E

PROPOSED REVISION OF ARTICLE 2.2, s. 21-11.16

(Retain as presently written)

"Declaration of Policy. The shores of the Commonwealth..... therefore, the General Assembly hereby recognizes shore erosion as a problem.....in effectuating effective practical solutions thereto."

(Add)

To this end, the General Assembly specifically authorizes the implementation of a program of coastal erosion abatement and impact mitigation, placed under the overall direction of the _____ with the advice and assistance of such other State, regional, and local public agencies as may be concerned. Pursuant to this authorization, the _____ shall establish and promulgate a timetable for the designation of coastal erosion areas within the State, to be completed no later than _____ 19__; for which areas the following special provisions shall immediately apply:

1. All agencies of the State and its political subdivisions shall work cooperatively in seeking and applying the most suitable structural and nonstructural methods of coastal erosion abatement and impact mitigation within critically affected shoreline reaches. The _____ shall be authorized to coordinate this cooperative effort.

2. Financial assitance by the Commonwealth for the provision of public services or facilities within such areas shall be restricted to those areas for which an erosion abatement plan and financing element has been prepared and submitted to the _____ for certification, according to the provisions of Title 15.1, Chap. 11, Art. 4, Code of 1950 as amended.* The _____ shall also have authority to establish such other guidelines and criteria as may be needed to accomplish the objectives set forth in this article.

It is the desire of the General Assembly to assure that consideration be given to the following factors in the provision of state financial assistance: the degree to which:

(a) a project is intended to serve intensely developed coastal areas experiencing severe erosion impacts.

(b) a project is intended to serve areas offering superior suitability for public access to water.

(c) anticipated public benefits of State assistance have been demonstrated to be greatest in relation to anticipated costs for a particular project.

(d) a project is intended to serve areas for which proven erosion abatement structures applied by shoreline reach exist, or are planned.

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* Refers to a proposed new section added to title 15.1 providing for erosion abatement plans. See Section 8.5.A.

APPENDIX F

SAMPLE SUBDIVISION ORDINANCE AMENDMENTS

For addition to Section _____ (Requirements for Improvements, Reservations, and Design):

1. .1 GENERAL IMPROVEMENTS

   Characteristics of the Land. Land which the Planning Commission finds to be unsuitable for subdivision or development due to (list of factors, to which should be added): erosion which will be reasonably harmful to the safety, health, and general welfare of the present or future inhabitants of and subdivision and/or its surrounding areas, shall not be subdivided or developed unless adequate methods are formulated by the developer and approved by the Planning Commission in consultation with appropriate advisory authorities. Such land shall be set aside for uses as shall not involve such a danger.

2. .2 LOT IMPROVEMENTS

   Shoreline Erosion Abatement. For subdivided properties within or abutting designated coastal erosion hazard areas, no plat shall receive approval until the property's existing and projected natural erosion rates have been recorded on the plat and until provision suitable to the administration of this Ordinance for posting of signs upon the site to indicate these erosion rates have been set forth by the property's subdivider.

In addition, prior to approval of the preliminary plat by the Planning Commission the subdivider shall also submit for review and approval of the Commission an erosion abatement plan, which shall contain the following:

1. Identification of structural and nonstructural erosion abatement measures available to mitigate any anticipated increases in the property's erosion rate or in hazards to property resulting from the proposed project.
2. An assessment of anticipated environmental effects of the proposed project and of available erosion abatement measures.
3. An assessment of the comparative cost effectiveness of available erosion abatement measures.
4. Identification of a single erosion abatement measure of combination of measures most suitable for application to mitigate any anticipated increases in the property's erosion rate or in hazards to property resulting from the proposed project.

The administration of this Ordinance shall determine a suitable amount to be required of the project applicant in the form of a performance bond or other security for performance, which shall be sufficient to accomplish the proposed erosion abatement plan.

.3 Permitted Uses. Sructures shall be used only for the following purposes, and except as provided herein, in each case subject to approval by the local planning commission in accordance with the standards set forth in this section and the standards set forth in Article ***.

1. Any existing use, accessory use, or sign permitted in the zoning district in which the premises are situated and upon which the EH Erosion Hazard District is superimposed; except that any use requiring new construction or alteration of shoreline structures or land shall be subject to special review and approval by the local planning commission in consultation with the (State's lead agency).

2. Any conditional use permitted in the zoning district in which the premises are situated, subject to the standards and procedures of this Ordinance for approval of conditional uses and subject to report by the local zoning administrator in accordance with the purposes and standards of the EH Erosion Hazard District.

*** Refers to that section dealing with site plan approval.

APPENDIX G

SAMPLE ZONING ORDINANCE AMENDMENTS

(For addition to ordinance text):

.1 Purpose of District. The purpose of this district is to provide for protection against property damages, hazards to safety, and accelerated loss of shoreland resulting from alteration of physical features within highly erodable coastal shoreline areas. It is the purpose of the district to minimize development within such areas, except insofar as proposed uses can be demonstrated to be compatible with the standards set forth in this section.

.2 Application of District. The EH Erosion Hazard District is created as a special district to be superimposed upon other districts contained in these regulations, following a determination of the existence of severe erosion rates and/or potential, severe erosion impacts in specific locations by the local governing body and the (State's lead agency). EH Erosion Hazard District boundaries are delineated on the official zoning Districts Map and the District will be described by a special symbol. Permissible uses, housing types, minimum height, and accessory uses and accessory signs within the EH District shall be determined according to regulations established for the districts upon which the EH district is superimposed, except as those regulations may be modified by application of special regulations for EH Districts set forth herein.

3. Any special exception or variance permitted in the zoning district in which the premises are situated, subject to the standards and procedures of this Ordinance for approval of special exceptions and variances and subject to report by the local zoning administrator and specific findings of the Board of zoning Appeals regarding the purposes and standards of the EH Erosion Hazard District.

.4 Approval By the Local Planning Commission. Within an EH Erosion Hazard District no building shall be constructed or altered and no land be disturbed until after a request for approval by the local planning commission has been made and until action by the local planning commission to approve or deny approval of the proposed action has been taken. Approval shall not be granted until after a written report has been prepared by the local zoning administrator with the advice and assistance of _____ and submitted to the local planning commission. The report shall set forth the following details:

1. Existing projected natural erosion rates of the area within which the proposed action would be taken.
2. Projected effects upon these erosion rates resulting from the action proposed.
3. Projected effects of local erosion upon the physical structure or alteration planned.

4. A description of measures planned to mitigate the effects of the action upon erosion rates, and/or effects of local erosion upon the project, projected to result from the action proposed.

The local planning commission's decision to approve or deny approval of the proposed action shall be based upon consideration of the report, and also upon consideration of the following:

1. The public necessity of the proposed action.
2. The public purpose or interest in land or buildings to be protected or served.
3. The characteristics or significance of the shoreline reach within which the action would be taken.
4. The nature and extent of physical alteration proposed and its potential beneficial or adverse effects upon natural erosion rates.
5. The general compatibility of the site plan; and, in the case of installation or expansion of shoreline erosion defense structures, the quality of design, arrangement, and materials proposed to be used.
6. Any other factors which the local planning commission deems to be pertinent.

In all cases the decision by the local planning commission shall be made within ____ days of the filing of a notification of intent by the applicant with the local zoning administrator.

.5 Conditions Imposed by the Local Planning Commission. In approval of any proposal under this section, the local planning commission may limit such approval by such reasonable conditions as the case may require, including, but not limited to, the specifications enumerated in Articles ___ for conditional uses and in Article ___ for the Board of Zoning Appeals. Favor shall be given to uses for which measures designed to abate severe erosion or to mitigate its adverse effects are proposed by the applicant, or may be negotiated by the applicant and the local planning commission or Board of Zoning Appeals in consultation with the (State's lead agency).

(Also for addition to Ordinance text):

Requirements for Site Plans, Content and Form. (To the listing of factors required to be shown in preliminary and final site plans, add):

For projects on properties within or abutting coastal erosion hazard areas, notation of the existing and projected natural erosion rates of the site(s), and the location, size, and projected change in natural erosion rates expected to be produced by any existing or planned erosion abatement structures.