Stafford County shoreline protection report, Potomac River, Aquia Creek : Prepared for County of Stafford, Department of Planning and Community Development

VHB : Vanasse, Hangen and Brustlin, Inc.

Virginia Institute of Marine Science

Report

Task 69 FY 1993 FINAL PRODUCT Stafford Shoreline Protection Report

Shoreline Protection Report

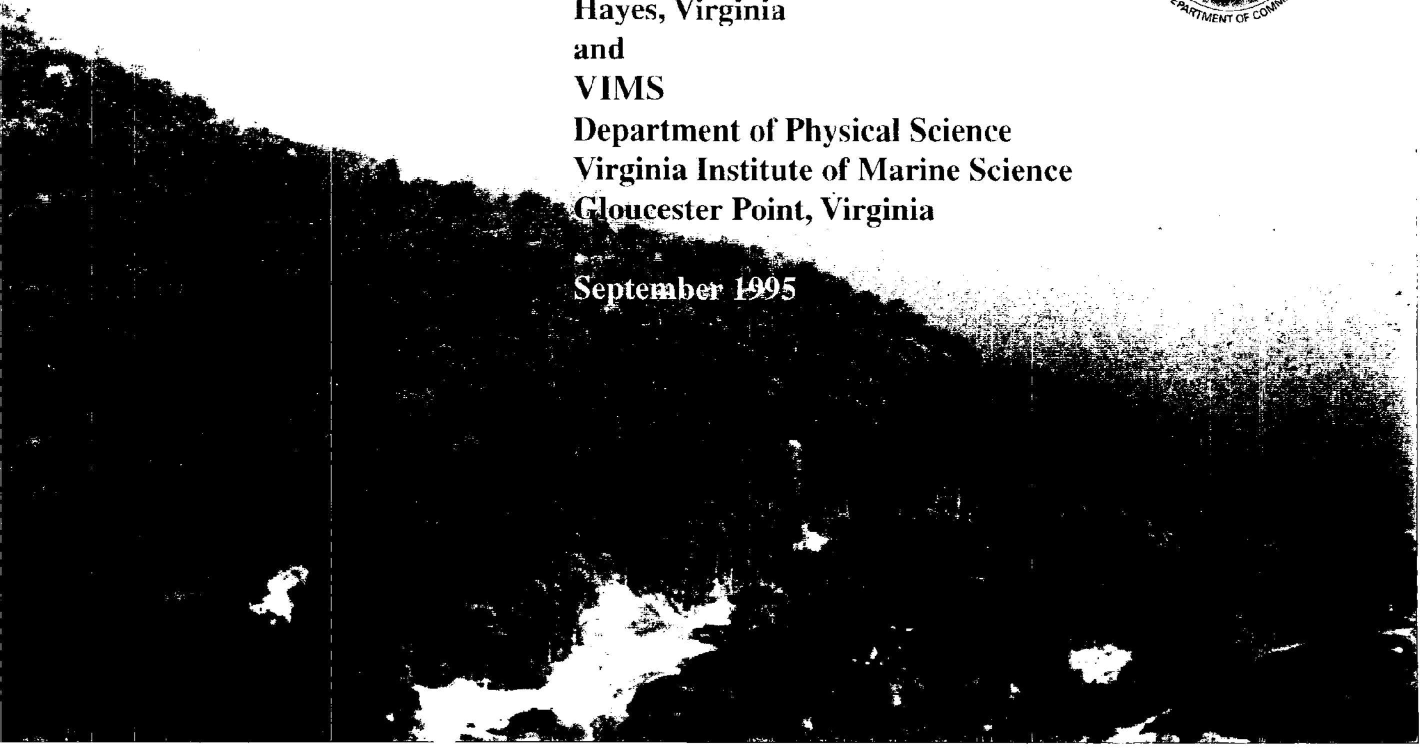
Potomac River and Aquia Creek

Stafford County, Virginia

Prepared For: **County of Stafford, Virginia**

Prepared By: **VHB**
Vanasse Hangen Brustlin, Inc.
Hayes, Virginia
and
VIMS
Department of Physical Science
Virginia Institute of Marine Science
Gloucester Point, Virginia

September 1995



STAFFORD COUNTY SHORELINE PROTECTION REPORT

STAFFORD COUNTY SHORELINE PROTECTION REPORT
POTOMAC RIVER, AQUIA CREEK
STAFFORD COUNTY, VIRGINIA

Prepared for:

County of Stafford
Department of Planning and
Community Development
1300 Courthouse Road
P.O. Box 339
Stafford, VA 22554

Prepared by:

VHB
Vanasse Hangen Brustlin, Inc.
Environmental Services
Abingdon Office Park, Suite 12
7188 Chapman Drive
Hayes, Virginia 23072

and

VIMS
Department of Physical Sciences
Virginia Institute of Marine Science
P.O. Box 1346
Gloucester Point, Virginia 23062

Principal Investigator: R. Neville Reynolds
Co- Principal Investigator: C. Scott Hardaway

September 1995

VIRGINIA COASTAL RESOURCES MANAGEMENT PROGRAM
September 1995

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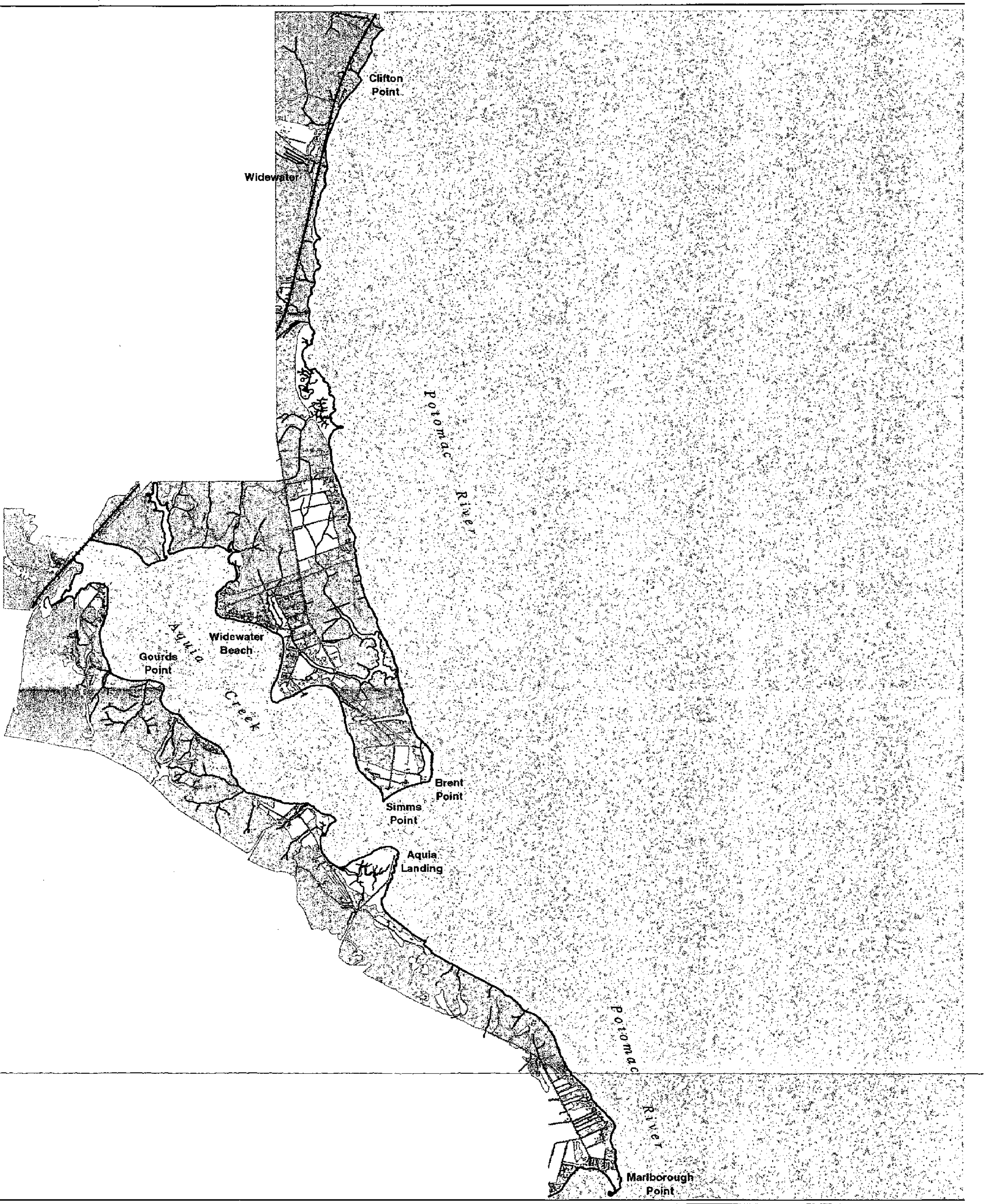
INTRODUCTION

The shoreline of Stafford County is a valuable natural resource with a diversity of features ranging from steep sandstone bluffs to broad freshwater marsh systems. With direct exposure to wind driven wave action, much of the County shoreline is experiencing severe erosion, resulting in the loss of valuable land and wildlife habitat.

Located between the metropolitan areas of Washington, D.C. and Richmond, Virginia, Stafford is experiencing considerable development pressures, particularly along its waterfront. In an effort to protect their investments, many property owners have installed shoreline protection devices, such as bulkheads, revetments, and groin systems with varying levels of success. A planned approach to shoreline stabilization based on a thorough understanding of acting coastal processes will increase the effectiveness of these efforts and preserve or enhance valuable County resources.

Stafford County's stated purpose for developing this Shoreline Protection Report is to encourage management, protection, and stabilization of the shoreline area in a manner that will protect natural resources and limit the loss of property and wildlife habitat. Control of shore erosion will also provide a foundation for the improvement of water quality by increasing the buffering capacity of the nearshore and by reducing sediment and nutrient supplies to County waters. Where possible, enhancement of natural features is desired. The focus of this study is the Potomac River shoreline from Marlborough Point to Tank Creek and the Aquia Creek shoreline from the RF&P Railroad bridge to the Potomac River (Figure 1). The report is comprised of the following components:

- Inventory of shoreline development over the past twenty years including coastal structures along the shoreline, as well as changes in land use. This element of the report provides a clear understanding of past development trends as they relate to the type of shoreline protection installed. This information was compiled in GIS format.
- Scaled vertical aerial photographs of the project shoreline.
- Aerial video tape of the shoreline.
- Overview of various shore protection goals and strategies.



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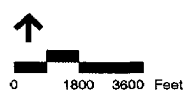
Stafford County Virginia
Shoreline Characteristics

Figure 1

Study Area



STUDY.DWG

- Wave Climate Analysis.
- Shoreline Assessment that provides a description of the shoreline conditions and recommendations for shore protection methods that will accomplish the primary goals of the County.

The following sections of this document include a description of the methods used, a brief discussion of key shoreline management goals and erosion control alternatives, and a characterization of the Potomac River and Aquia Creek shorelines with recommendations for effective shore protection strategies. The intent of this report and associated data base is to: 1) assist County planners and members of the Stafford County Wetlands Board in making informed decisions regarding shore protection and waterfront development along the Aquia Creek and Potomac River shorelines; and, 2) provide a basis for educating waterfront property owners on effective erosion control methods that meet the County's shoreline management goals.

METHODOLOGY

DATA COLLECTION

The base-line information collected for this report was obtained through the following sources:

- Aerial photography of shoreline: 1973 slides, 1985 video tape, 1994 video tape, and 1994 scaled vertical photographs (Appendix A)
- Field investigations
- Topographic and planimetric mapping--200' scale
- Wind Data--Fort Belvoir
- Bathymetric charts
- USDA Soils Survey for Stafford County and King George County
- VIMS Tidal Marsh Inventory (VIMS, 1975)
- U.S. Fish and Wildlife Services (USFWS) Threatened and Endangered Species Inventory
- Virginia Department of Conservation and Recreation - Natural Heritage Division Threatened and Endangered Species Survey
- USGS Quadrangle Sheets--Widewater and Passapatanzy
- Available literature and technical reports

DATA ANALYSIS

Shoreline Inventory

A key element in the analysis of shoreline conditions was an historical inventory of land use patterns and erosion control structures in the project area. For the Potomac River shoreline, this was performed through the review of aerial photography for 1973, 1985 and 1994; for Aquia Creek, only the 1973 and 1994 photography was available. A series of forty codes was developed for various coastal structures and land use categories (Table 1). Aerial photographs and videotapes were then viewed and the shoreline and land characteristics were recorded on 1988 topographic/photogrametric maps of the shoreline. This spatial data was then transferred digitally into ARCADD, a geographic information system (GIS). To simplify the resulting data base for graphic display, the coding system was reduced to five shoreline attributes and seven land use attributes, as shown on Figures 8-33.

Table 1 **STAFFORD COUNTY SHORELINE ATTRIBUTE CODES LIST**

Shoreline/Structure Codes		Shoreline Land Use Codes	
Codes	**Structure**	**Codes**	**Land Use**
0	Boundary	23	No aerial coverage/creeks/bodies of water
1	Riprap	30	Private--residential (multi-, single-family)
2	Bulkhead	31	Private--agriculture--(crops, pasture, tree)
3	Jetty	32	Private--unmanaged wooded
4	Groin fields	33	Private--unmanaged new wooded
7	Breakwaters	34	Recreational--county/city (public beaches)
9	Groinfield and bulkhead	35	Recreational--state/federal (state parks)
10	Groinfield and riprap	36	Recreational--private (local community)
11	Groinfield, bulkhead and riprap	37	Federal--residential
13	Bulkhead and riprap	38	Federal--unmanaged wooded
18	No structures--shoreline unstable, erosion	39	Federal--unmanaged nonwooded
20	Miscellaneous	40	Commercial--marinas, fish docks, sewage plants
21	Closure line	41	Industrial--shipyards
22	No structure--stable shoreline	42	State--residential
23	No aerial coverage/creeks/water bodies	43	State--agricultural
24	Marsh (extensive)	44	State--unmanaged wooded
25	Marsh (fringe)	45	State--unmanaged nonwooded
		46	County/City--residential
		47	County/City--agricultural
		48	County/City--unmanaged wooded
		49	County/City--unmanaged nonwooded
		50	Miscellaneous--public or private roads

Spatial information on hydric soils, wetlands and threatened and endangered species habitats were also entered into the system. The data base from the GIS was transferred to Microsoft EXCEL for reduction which involved comparing the changes in shoreline and land use characteristics on a linear foot basis. The results of this analysis are provided in the sections of this document detailing the Potomac River and Aquia Creek Shorelines.

Wave Climate Analysis

The wave climate along the project shoreline was determined through wave hindcasting and wave refraction analysis. Wind data from Fort Belvoir was used to drive the SMB wind/wave model. To predict wave growth for wind speeds and fetch distances, the SMB model uses procedures developed initially by Sverdrup and Munk (1947), revised by Bretschneider (1966). It is essentially a shallow water, estuarine, wind-wave prediction model.

The hydrodynamic model RCPWAVE was utilized to obtain a better understanding of wave refraction and attenuation across the nearshore estuarine shelf of the Potomac River shoreline in Stafford County. RCPWAVE was developed by the U.S. Army Corps of Engineers (Ebersole et al. 1986) and is a linear wave propagation model designed for engineering applications. This model computes changes in wave characteristics that result naturally from refraction, shoaling, and diffraction over complex shoreface topography. To this fundamental linear theory based model, VIMS has added routines take into consideration recent advancements in the understanding of wave bottom boundary layers in order to estimate wave energy dissipation due to bottom friction (Wright et al. 1987).

For this report, four (4) bathymetric grids were created along the Potomac River shoreline of Stafford County (Appendix B). Each grid is composed of grid cells that are 10 meters wide along the x-axis (offshore) and 20 meters wide along the y-axis (alongshore). Modal and storm waves are input along the river side of each grid for running RCPWAVE. Model output is in the form of wave vectors that depict changes in wave direction and wave height as they enter the nearshore region on their way to shore. Specific wave heights, periods and wave direction are discussed in the Shoreline Assessment, and vector plots are included in Appendix B.

Reach Assessment

The first step in developing a shoreline management strategy is to conduct a site, or reach, assessment. Technical assessment of a reach involves six principal elements (Hardaway and Byrne, in prep):

1. Determination of the limits of the reach. A reach is defined as a segment of shoreline wherein the erosion processes and responses are

mutually interactive. For example, appreciable littoral sand would not pass the boundaries of a reach. Reach boundaries may include major points, creek mouths and changes in shoreline orientation.

2. Determination of the historical rates and patterns of erosion and accretion of the reach.

3. Determination within the reach or the sites of the induced sand supply and the volume of that sand supply for incremental erosion distances. Often there are adjacent subreaches that are regions of sediment source, sediment transport and/or sediment accretion.

4. Determination of effective wave climate and the direction of net littoral drift, and, if possible, estimation of the magnitude of drift rates.

5. Estimation of erosion causing factors other than wave induced, such as groundwater or surface runoff.

6. Estimation of potential and active sources of nutrient loading (i.e., farmland or residential land) and the pathways by which this occurs such as by surface runoff, eroding sediments and/or groundwater discharge.

Using the information derived from the shoreline inventory and wave climate analysis, these six steps were followed in the present study to provide a sound basis for assessment of shore protection strategies along the Potomac River and Aquia Creek shorelines.

SHORELINE MANAGEMENT CONSIDERATIONS

ENVIRONMENTAL CONSIDERATIONS

Successful shoreline management is based on a thorough understanding of acting coastal processes. Key considerations include the physical and biological setting of a particular site as well as the hydrologic conditions that produce shore erosion. Accordingly, the shoreline assessment for the Potomac River and Aquia Creek provides a discussion of these conditions in the study area. For the reach assessment, the project shoreline was divided into 15 reaches; eight on the Potomac River and seven on Aquia Creek (Figure 2). These reaches were defined by major points of land or other prominent physiographic features such as creeks and marsh headlands. General characteristics and their relevance to shore erosion problems are discussed in the following paragraphs, while more detailed descriptions of specific reaches are provided in later sections of this report.

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

As noted above, the project shoreline was first divided into specific reaches--eight on the Potomac River shoreline and seven on Aquia Creek. For each individual reach, its boundaries will first be identified, followed by a discussion of general land use. The soils are identified according to the Soil Survey for Stafford and King George Counties (USDA, 1973). General patterns of upland runoff within the reach are also discussed, and significant watersheds are identified since overland runoff may be a large contributor to erosion in the shore zone.

Upland Bank and Shoreline Characteristics

The upland bank height, composition and nature of erosion are discussed for each reach. The upland banks are composed of sediments of varying mixtures of gravel, sand, silt and clay and may be actively eroding, partially or completely stable. Generally, there is fairly active upland bank erosion along the Potomac River and Aquia Creek shorelines.

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Stafford County Virginia
Shoreline Characteristics

Figure 2

Study Area Reaches

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The upland banks vary considerably in elevation and composition. In general, there is relatively little sand by volume being eroded from the shore banks of the Potomac River in Stafford County simply because the banks are predominately silty to clayey fine sand. Bank erosion is not only caused by wave action scouring the base of the banks, but also by upland runoff, freeze-thaw processes and mass wasting especially along the higher bluffs.

The geology of the Potomac River banks in Stafford County include exposures of strata of Eocene age (Aquia and Nanjemoy Formations) between Potomac Creek and Aquia Creek where bluffs rise to elevations over 100 feet. Cretaceous age (Potomac Group), an erosion resistant strata, outcrops around Clifton Point just south of Quantico Marine Corps Base. The lower Widewater Peninsula is mostly lowland deposits of Pliestocene age that are associated with old fluvial and estuaraine terraces along the Potomac River (Miller, 1983).

A discussion of shoreline characteristics addresses features such as beaches, marsh fringes and existing protection structures. Fallen trees and slump blocks along the shore are evidence of active upland bank erosion. It should be noted that the sediments that compose the narrow beach areas along the Potomac River are derived from erosion of adjacent upland banks. In the case of Stafford County, the percentage of sandy material is relatively small compared to the volume of eroding upland bank.

Historic erosion rates and annual estimates of the volume of eroded bank sediments for the Potomac River are derived from Miller (1983). The shoreline reaches included in this study roughly correspond to Miller's (1983) reach designation. Erosion rates and the volume of sediment eroded is provided in Appendix C.

Nearshore Characteristics

For ease of discussion, the nearshore region element focuses on the position of the -6 foot MLW contour obtained from the 7.5' topographic quadrangles (Widewater and Passapatanzy: bathymetry added in 1982).

The nearshore slope can have a significant impact on wave attenuation across the shallow estuarine shelf. This is also true up Aquia Creek, but to a lesser degree, because it is more fetch and depth limited. Important features in the nearshore element are shoals and zones of deep water near the shore. Shoal regions tend to reduce wave energy while deep nearshore areas may actually enhance incoming wave trains by increasing wave height, especially during storm events.

The submerged aquatic vegetation (SAV) population will also impact the impinging wave climate. In the case of the Stafford County shorelines, the main species is Hydrilla. Hydrilla is a prolific subaquatic grass that can grow as very dense patches and can actually act to attenuate wave energy if the stand is extensive enough.

Hydrodynamic Setting

Wave Climate

The general wave climate along the Potomac River reaches is dominated by north to east to southeast wind driven waves. The strong northerly winds dominate this region of the coastal plain (VIMS 1975). (Shoreline erosion becomes most active when strong winds blow under storm conditions with elevated water levels (i.e., storm surge)) However, the annual wave climate tends to set beach planforms and can be a major component of littoral drift especially with the sand deficient nature of this system. Overall, southerly winds tend to have a greater frequency but less velocity.

Limited wind data from Fort Belvoir (VIMS 1975) depict the percentage of time winds blow from all directions (Table 2). The winds that impact the Potomac River shoreline in Stafford County come from northerly, easterly and southerly directions. These have been broken down into 3 sextants for comparison. For example, for the 3 sextants, the total percent of southerly winds is 13.1% whereas the northerly winds total is 9.0% and the easterly winds comprise 5.6% for those directions that most frequently impact the Potomac River shores.

A modal wind condition and consequently a modal wave condition was developed from the aforementioned wind data (VIMS 1975) and SMB procedure. The modal condition was determined to be the 10 mph wind condition where minimal wave orbital bottom velocities develop at the -12-foot MLW contour. Lesser wind conditions are considered insignificant to wave generation. Severe storm conditions are estimated to be developed during sustained 30 mph winds with the corresponding storm surge of 1.2 meters for an approximate 25 year return interval. The modal and storm scenarios were used to run RPCWAVE.

The results of this procedure are displayed in Appendix B. Generally, as waves cross the nearshore region, they tend to bend or refract as they "feel" the bottom and turn roughly parallel to bottom contours. The refraction process also involves wave attenuation by the bottom, which reduces waves in height as they reach the shoreline.

Much of the bank erosion occurs during storm events with subsequent sediment transport rates and directions depending on storm duration and

Table 2 **FREQUENCY OF SURFACE WIND DIRECTION AND SPEED %**

Knots	1-3	4-6	7-10	11-16	17-21	22-27	%	Mean Wind Speed	Fetch Miles
Dir.									
N	1.0	2.1	1.5	.5			5.2	6.3	*
NNE	.5	.8	.4	.1			1.8	5.2	5
NE	.5	.9	.5				2.0	5.2	4
ENE	.4	.6	.3				1.3	4.9	3
E	.9	1.2	.5	.1			2.6	4.9	3
ESE	.7	.8	.3				1.7	4.4	8
SE	.9	1.4	.7	.1			3.0	5.1	5
SSE	1.0	1.5	.7	.1			3.3	4.9	
S	1.8	3.1	1.7	.2			6.8	5.4	
SSW	.7	1.5	.9	.1			3.2	5.6	
SW	.6	1.1	.6	.1			2.4	5.5	
WSW	.4	.5	.3				1.2	5.1	
W	1.1	1.4	1.0	.4	.1		4.0	6.3	
WNW	1.7	1.4	1.4	1.1	.3	.1	6.0	7.5	4
NW	1.7	2.4	3.1	2.1	.4		9.8	8.3	
NNW	.9	1.7	1.8	.9	.1		5.1	7.6	
VARBAL									
CALM							40.1	3.8	
	14.8	22.5	15.5	5.8	1.0	.3	100.0		

From hourly observations for all months from 1957 to 1970 at Fort Belvoir/Davison A.A.F. ,Virginia intensity. Modal wave conditions operate almost exclusively on the beach zone under more normal or seasonal water levels.

The Aquia Creek shoreline is very fetch limited. The average width from the mouth to the railroad bridge is about three nautical miles (nm), while the width is approximately one nm. Due to the relatively sheltered condition, a detailed wave climate analysis was not performed for the Aquia Creek shorelines.

Littoral Processes

This element in the reach discussions reflects the impact of hydrodynamic forces (waves and tides) on the material resistance of the land and nearshore substrate. The patterns of erosion and net direction and rate of sediment transport are critical elements in understanding the ongoing process of shoreline erosion and how to develop coastline management strategies.

Four bank/shore types become important in the scheme of shoreline erosion: eroding beaches/spit, upland banks, marsh fringe and protected shorelines. The recent geomorphic evolution of estuarine shorelines is an interplay with these four features. They create differentially eroding shorelines which allow us to better ascertain the impinging wave climate by identifying the tangential bank and/or beach features. The tangential features, the offsets in the bank created by differential erosion along with wave climate analysis allows us to develop a fairly accurate picture of how the shoreline has evolved over time.

SHORELINE MANAGEMENT OBJECTIVES

The first step in developing a framework for shoreline management is to establish clear objectives toward which erosion control strategies can be directed. In developing this Shoreline Protection Report, the following objectives have been considered:

1. Prevent loss of taxable land and protect shoreland improvements.

2. Protect, maintain, enhance and/or create wetlands habitat; both vegetated and non-vegetated.

3. Address water quality by managing upland runoff and groundwater flow by maintaining vegetated wetland fringes in the nearshore area.

4. For a proposed shoreline stabilization strategy, address potential secondary impacts within the reach. These may include the potential to cut off sand supplies to downdrfit beaches or encroachment into subaqueous land and wetlands.

5. Provide access and/or create recreational opportunities such as a beach area.

These objectives must be assessed in the context of the shoreline reach. The differing (and possibly conflicting) objectives of property owners within a reach must be considered when implementing shoreline management strategies. While all objectives should be considered, every one will not carry equal weight. In fact, satisfaction of all objective for any given reach is not likely, as some may be mutually exclusive (Bryne, et al., 1979).

SHORELINE PROTECTION STRATEGIES

Four general shore protection strategies have been considered for each shoreline reach in the study area:

No Action: The No Action strategy is essentially to allow natural processes of shoreline erosion and evolution to continue as they have for the past 15,000 years over the latest sea level transgression. Indeed erosion may not be viewed as a problem until property improvements are threatened. In the case of Stafford County, this is the case in numerous situations to date. The real issue in developing a shoreline protection plan is how future development and land values will impact the shoreline and natural resources of the County and the adjacent tidal waters. Therefore, the No Action strategy may or may not be appropriate.

Defensive Approach: The Defensive Approach refers to the use of shoreline protection structures such as wood bulkheads, concrete seawalls and rock revetments. These structures are commonly emplaced along the base of an eroding upland bank as a "last line of defense" against the erosive forces of wave action and storm surge.

Offensive Approach: The Offensive Approach to shoreline protection refers to structures that are built into the littoral zone and beyond to address the impinging waves before they reach upland properties. These structures are most commonly groins, but over the past decade the use of offshore breakwaters have become an important element for shoreline protection. The use of offensive structures, especially breakwaters, requires a thorough understanding of littoral processes acting within a given reach of shoreline.

Headland Control: Headland Control is perhaps the most innovative approach to shoreline erosion protection because it addresses long stretches of shoreline and can be phased over time. The basic premise is that by controlling existing points of land or strategically creating new points of land (i.e., headlands), adjacent embayments can be predictably controlled by creating stable shore and beach planforms. The science and engineering of this type of strategy requires an even greater understanding of the littoral processes operating over time.

Coastal Structures

With almost ten miles of shoreline to be considered, there is the opportunity to employ a variety of coastal structures as part of a particular erosion control strategy. The optimum plan, developed after a more complete assessment of the site conditions and project objectives, will achieve a balance between long-term, predictable shore protection and cost. A brief description of each type of structure and schematic diagrams are provided in the following paragraphs and exhibits. The structures depicted include:

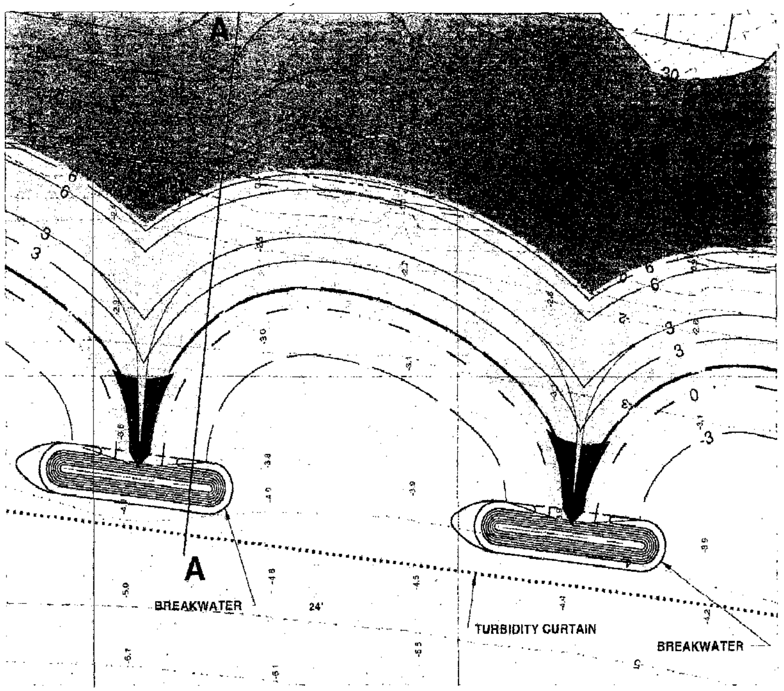
- Breakwaters (Figure 3)
- Interfacing structures - spurs, hooked groins, low breakwaters, etc. (Figure 4)
- Marsh toe revetments/sills (Figure 4)
- Headland control structures (Figure 5)
- Upland revetments (Figure 6)
- Bulkheads (Figure 7)
- Groins (Figure 7)

Breakwaters are "free standing" structures designed to address wave action by wave diffraction before it gets to the upland region (Figure 3). Attached or headland breakwaters require beach fill for long-term shoreline erosion control. Headland breakwaters can be used to accentuate existing features.

Marsh toe revetment/sill are low rock structures designed to be placed along a low eroding upland bank or eroding marsh shoreline (Figure 4). During storm events these structures are usually submerged and subject to waves breaking directly on or shoreward of their crests.

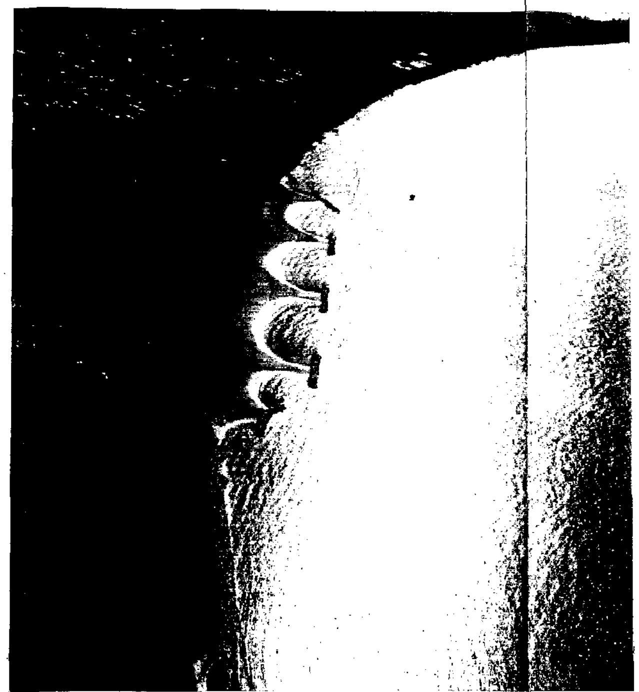
Spurs are similar to breakwaters in that they are "free standing" structures (Figure 4). The distinction is that spurs are attached to the shoreline at one end with the other end acting as a breakwater and impacting incoming waves through diffraction.

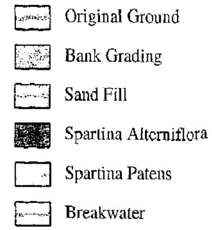
Headland control can be accomplished by any of the aforementioned structures and usually involves protecting a point or shore headland. By doing this, long reaches of adjacent shorelines can at least be partially

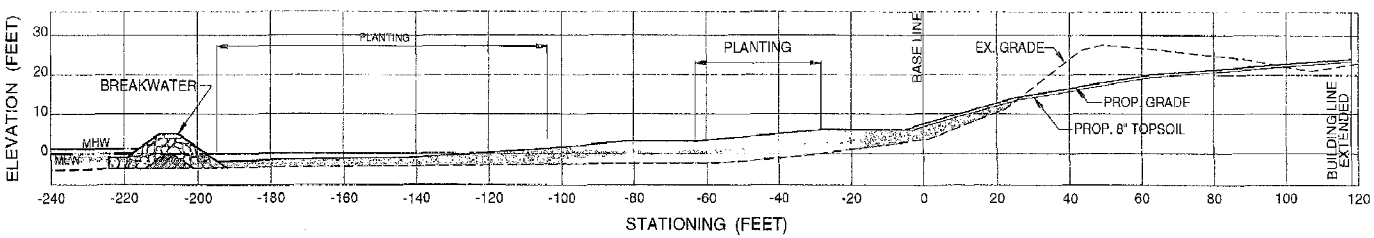


PLAN VIEW

0 40 80 FEET







SECTION A-A

0 16 32 Feet

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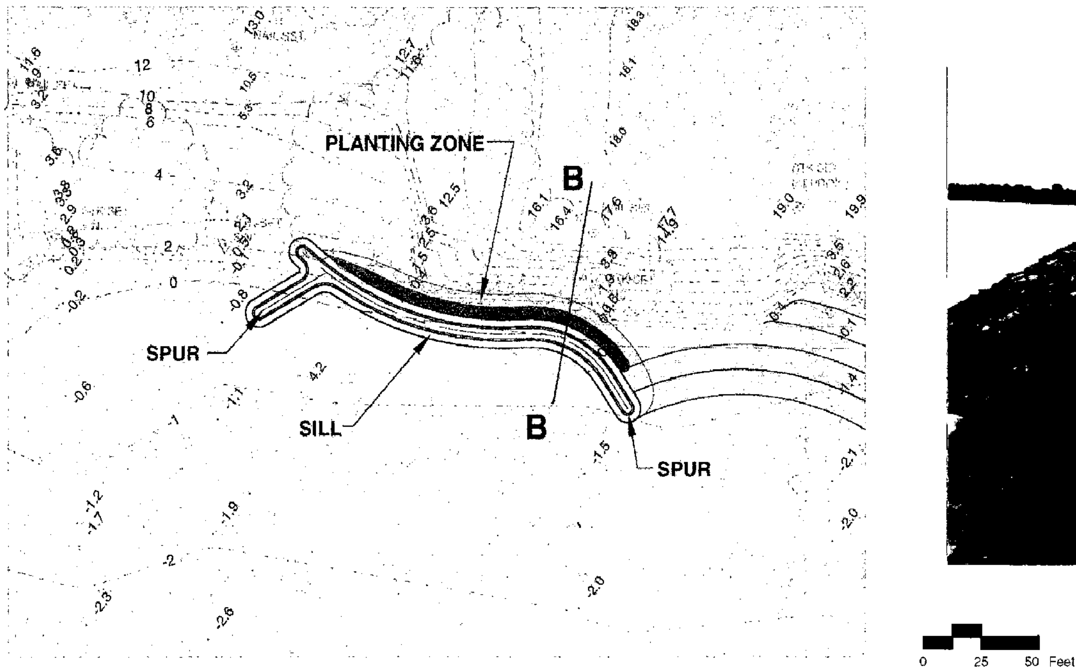
Figure 3

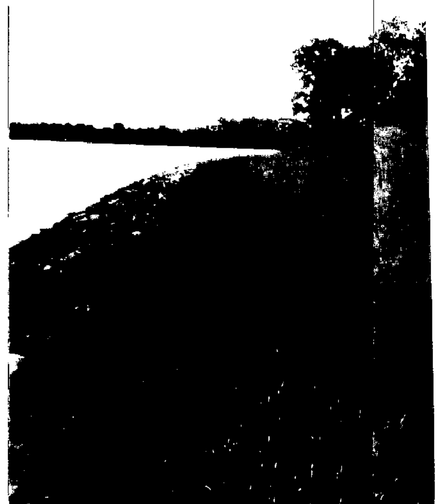
Typical Breakwater Configuration

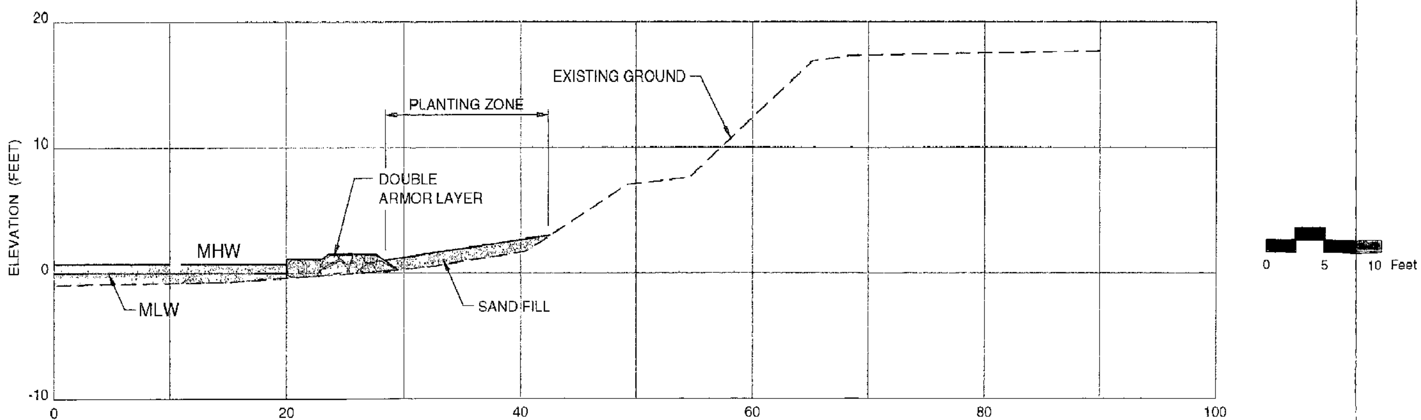
179GR2

- Original Ground
- Bank Grading
- Sand Fill
- Spartina Alterniflora
- Spartina Patens
- Armor Stone



PLAN VIEW





SECTION B-B

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Figure 4

Typical Sill & Spur Configuration

179GR1

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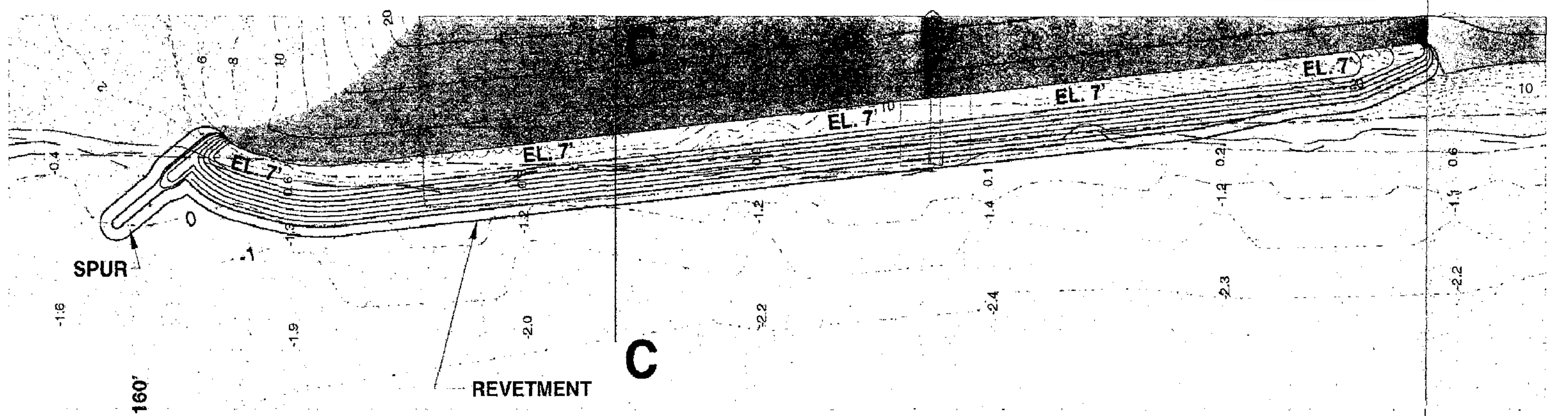
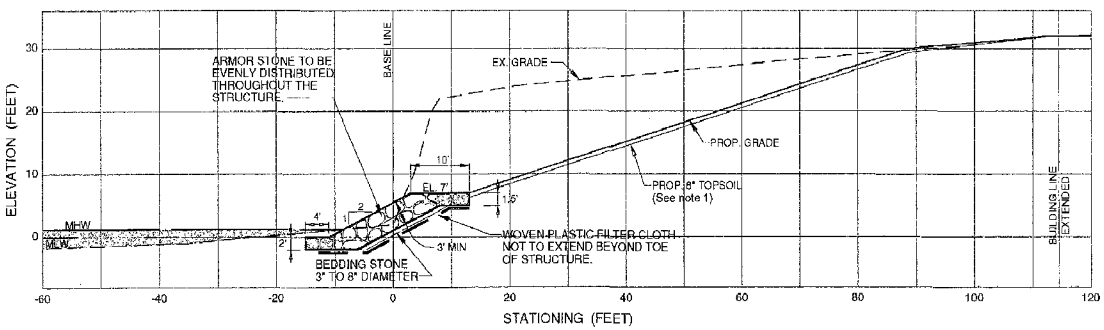
Figure 5

Reach Control Structures



PLAN VIEW

0 25 50 Feet



SECTION C-C

0 10 20 Feet

- Original Ground
- Bank Grading
- Revetment / Spur

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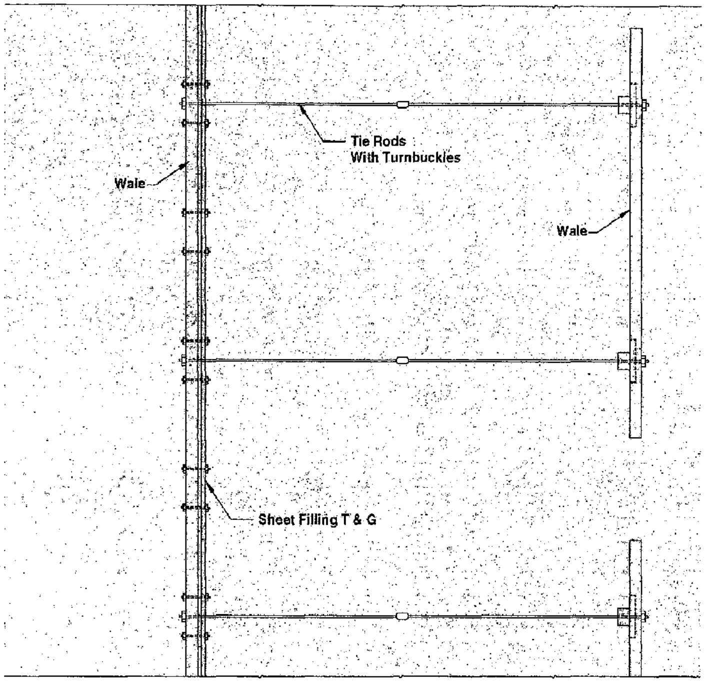
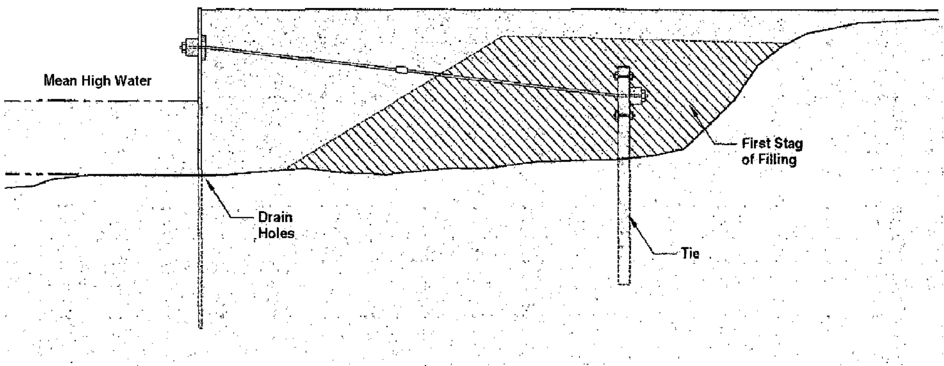
Figure 6

Typical Revetment Configuration

179GR3

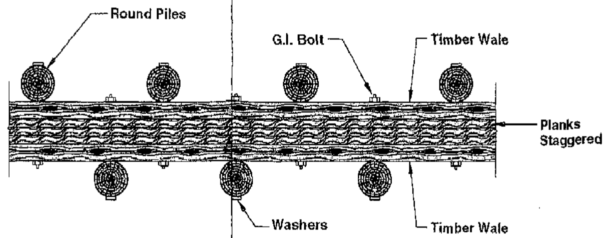


Plan View
N.T.S.

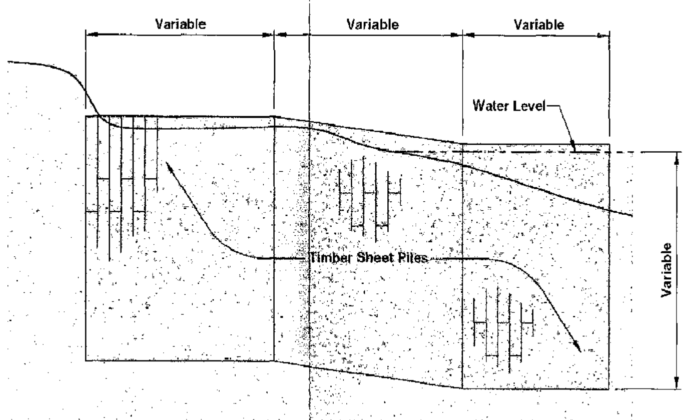


Cross Section
N.T.S.

Bulkhead
From AWPI 1969



Plan View
N.T.S.



Cross Section
N.T.S.

Groin
From USCE 1984

Vanasse Hangen Brustlin, Inc.

Figure 7

Bulkhead / Groin Detail

protected by encapsulating littoral sands to create a beach or by redirecting impinging waves so they have less impact alongshore (Figure 5).

Upland revetments are shoreline armoring systems that protect the base of eroding upland banks and are built across a graded slope (Figure 6). The dimensions of the structure are dependent on bank conditions and design parameters such as storm wave height and storm surge. These parameters also determine the size of rock that is required for long-term integrity of the structures.

Bulkheads are vertical structures constructed at the base of eroding upland banks (Figure 7).

Groins are timber or rock structures built perpendicular to shore for the purpose of trapping sand moving in the littoral system (Figure 7).

It is noted that each of these shore protection strategies may require environmental permits from the U.S. Army Corps of Engineers (USCE), the Virginia Marine Resource Commission (VMRC), Virginia Department of Environmental Quality (DEQ), and the Stafford County Wetlands Board.

The following matrix provides a general assessment of the shore protection strategies with respect to the stated management objectives.

For each objective, the rankings 1, 2, and 3 refer to good, fair and poor, respectively. The ability of groins to stop erosion is dependent on a source of sand. Marshes created for erosion control are limited to low fetch conditions (i.e., less than 0.5 miles). The following overall scores can be ranked as follows for comparison purposes.

Good/Low	Fair/Medium	Poor/High
7	12	18

Table 3 **SHORE PROTECTION MATRIX**

		Strategies			
Objectives	**Revetment/ Bulkhead**	**Groins**	**Marsh**	**Breakwaters**	**Headland Control**
Stop Erosion	1	2	1	1	1/2
Water Quality	3	2	1	1	1
Wetland Habitat	3	3	1	1	2
Access	3	2	2	1	1
Impacts	1	3	1	2	1
Costs	3	2	1	3	2
TOTAL	14	14	7	9	8/9

POTOMAC RIVER SHORELINE CHARACTERISTICS

REACH ONE

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

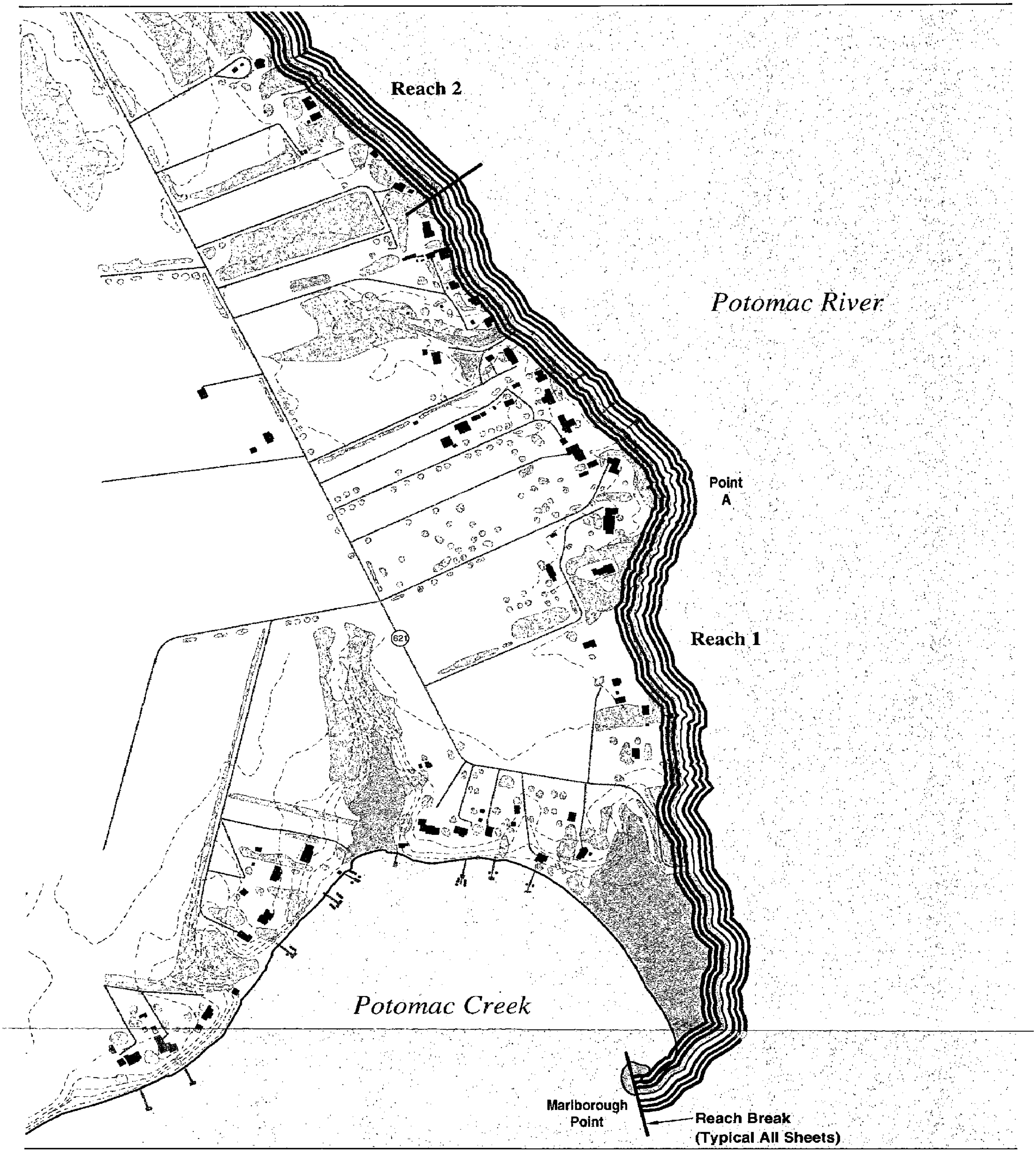
Reach P1 begins at the spit at Marlborough Point and extends northward approximately 4,500 feet to a point where the basal bank geology changes from a silty fine sand to an inundated erosion resistant marl (Figure 8). Land use is predominately rural residential.

The soil types, 100 feet from the shoreline, are Tidal Marsh (Tm),Woodston fine) sandy loam (WOA and Aura-Galestown Sassafras (AWD) complex. The drainage is generally flat and falling toward the Potomac River.

Upland Bank and Shoreline Characteristics

Marlborough Point is a low sandy spit fronting a narrow marsh approximately 1,200 feet in length from the spit tip to where the upland bank is encountered. The upland bank at that point is approximately 15 feet above MLW and rises slowly northwards to approximately 25 feet at the Reach P1/P2 boundary. Generally, the bank is composed of a silty fine sand with an historic erosion rate of 2 to 4 feet/year (VIMS, 1975). The banks have been extensively modified by various types of erosion control structures including wood and concrete bulkheads and revetments. Most of the structures do not appear adequate for long-term shoreline protection.

The shoreline along Reach P1 consists of a narrow sand beach zone that has been extensively modified by stone and broken concrete groins as well as a gapped gabion sill structure along the length of Marlborough Point. Small sand fillets have been trapped in some of the groin compartments and their orientation indicates a net southerly transport of littoral sands. Continued hardening of the upland banks through time has cut off the main source of sand within this reach. The relative lack of sand contained in the Marlborough Point spit system is evidence of the general lack of sand in the banks and the littoral system.



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 8
Potomac River
Reach 1

0 200 400 Feet

SH-LU.DWG

A slight shoreline protuberance at Point A tends to segment Reach P1 into two parts. Point A is a headland feature that is presently protected by a series of low rock groins. The shore segment to the south turns slightly westward creating a small curvilinear embayment.

Nearshore Characteristics

The nearshore region along the southern part of Reach P1 is bounded by a relatively wide shallow shelf that is over 1,500 feet from MLW to the -6 foot MLW contour. The bottom is a soft silty sand. This estuarine shelf narrows to about 700 feet offshore at Point A and the bottom becomes very rocky and hard. Aerial imagery indicates a small patch of Hydrilla in the shallow embayment just south of Point A. The -6 foot MLW contour extends to approximately 1,000 feet offshore north of Point A before trending shoreward to a point 700 feet offshore at the Reach P1/P2 boundary.

Hydrodynamic Setting

Wave Climate

The wave climate along Reach P1 and the Potomac River shorelines in Stafford County is dominated by northerly winds that tend to drive littoral sands southward or downriver (VIMS, 1975). Average fetch exposures into Reach P1 are 2.4 nm, 2.5 nm and 2.5 nm from the northeast, east and southeast respectively. Long oblique fetches to the north and SSE are 9.2 nm and 6.5 nm. The north fetch has greater potential impact to Reach P1 north of Point A as the shore turns more to the north and west.

Littoral Processes

As the upland banks in Reach P1 and Reach P2 are eroded, the sand fraction is transported alongshore by the predominant northerly wind/wave climate. Significant transport occurs during periods of high water and wind/wave activity usually associated with northeasterly storm events. Due to the silty nature of the eroding banks, the supply of beach sands is limited and the result is the existing narrow beach zone. Over the years, groins have been emplaced to trap the littoral moving sands and they have succeeded to a certain degree. However, they do not hold enough beach and backshore to create a long-term erosion control system.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 4 and 5. While there has been relatively little change in land use, increasing sections of the shoreline have stabilized. The preferred method of shore protection has been for hardening with revetments or bulkheads. Groins have also been used, although in several locations groin systems have been supplemented with bulkheads or revetments in later years. This is a direct indication of the limited sand supply in the littoral system. While the groins trap small sand fillets, the backshore width and elevation that develops is insufficient to protect upland banks from eroding.

Table 4

REACH P1 SHORELINE CONDITIONS (FT)

	1973	1985	1994
No Structures	4,438	3,108	486
Hardened	0	827	2,061
Groins	584	1,084	1,161
Breakwater/Sills	0	0	1,310

Table 5

REACH P1 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	1,585	1,734	1,310
Agricultural	246	0	0
Residential	3,145	3,286	3,710
Commercial	0	0	0
County	0	0	0
Miscellaneous (Roads, Railroads)	35	0	0

Shoreline Protection Strategies

No Action: Under this approach, the shoreline protection strategies employed along the reach would remain or continue. In the case of Reach P1, additional work will most likely be needed to maintain existing structures. This would consists of structural repair, replacement of bulkheads, and adding additional and/or larger stone along existing revetments.

Defensive Approach: Much of the shoreline is defended by bulkheads or revetments generally considered sub-standard for the potential wave climate. However, many have allegedly performed well for the last 10 to 15 years. The primary recommended strategy is to enhance existing bulkheads with rock placed as scour aprons, repair bulkheads and/or place additional rock as needed on existing revetments.

Offensive Approach: Existing groins and gapped sills represent offensive structures along Reach P1. The groins can be enhanced by adding rock.

The gabion sill is in its second iteration. The rock in the gabion baskets are too small to stand alone against wave attack when the basket deteriorates. However, large armor rock can be placed, at least along the riverside of the sill to offer some additional integrity.

Headland Control: It is possible to utilize Point A as a controlling headland along Reach P1. This can be done by insuring that it remains a headland by at least maintaining and/or reinforcing the existing groinfield. The embayed shoreline to the south will continue to trap sand and provide a somewhat protective beach. Further, enhancements to Point A may include building a low reef breakwater and adding sand to the system at that point. To carry this method to its full potential would require additional offshore structures and sand either side of Point A.

REACH TWO

Physical/Biological Settings

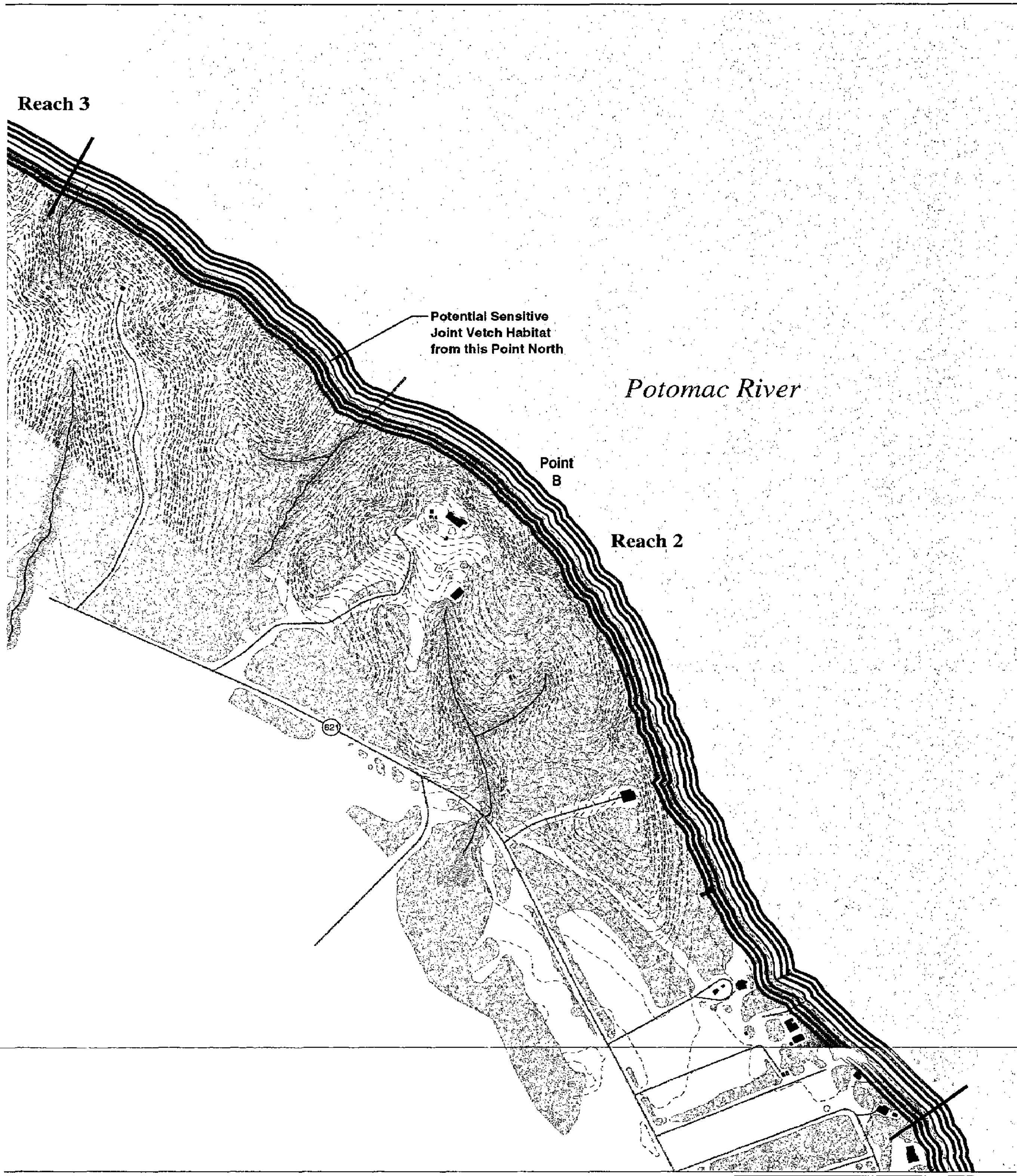
Reach Boundaries, Land Use, Soils and Drainage

Reach P2 is a shoreline extension of P1, but the bank composition and height change significantly (Figure 9). Reach P2 approximately extends from the designated southern boundary northward for approximately 5,500 feet to a point where the nature of the shoreline again changes. This change occurs in the form of a wide beach that marks the beginning of Reach P3. The land use along Reach P2 is primarily private residential and unmanaged wooded. The soils are composed of Sassafras fine sandy loam (SFC2) and Sassafras and Caroline sand and clay materials (SCF). The upland drainage is controlled by short, narrow watersheds some of which discharge over or through the top of the high bluff.

Upland Bank and Shoreline Characteristics

The bank heights along the southern 1,500 feet of Reach P2 are about the same as Reach P1 (i.e., 25 feet MLW) but quickly rise to almost 100 feet MLW over the next 1,000 feet of shore. These banks are vertically exposed and actively eroding. The historic erosion rate along Reach P2 is 1 to 2 feet/year.

The change in bank composition at the Reach P1/P2 boundary is due to a basal stratigraphic unit that is characterized as an indurated fossiliferous marine marl. This unit becomes thicker to the north and is a tightly packed silty clay with abundant shell fossils. It is also very resistant to erosion. This unit rises to the north along Reach P2. Bank erosion causes large pieces of the unit to fall and litter the shore zone. This "bank rock" in effect creates a wave buffer and reduces erosion of the base of the bank.



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
- Private Agricultural
- Private Residential
- Private Unmanaged
- Commercial Waterfront
- County
- Miscellaneous
- No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
- No Structures
- Hardened
- Breakwater / Sill
- Groins
- No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 9
Potomac River
Reach 2

0 200 400 Feet

The shoreline along Reach P2 is variable with very narrow beaches in places with numerous concentrations of the eroded bank unit. The bank face, although mostly exposed, slowly sloughs and slumps due to runoff and groundwater. The shear height of the bluff almost precludes any cost-effective major manipulation by heavy equipment.

A slight protuberance occurs at Point B which has become a large broad headland feature. This is also an area of a large accumulation of eroded "bank rock" that has helped maintain the point as a headland.

Nearshore Characteristics

The nearshore region along Reach P2 is relatively deep as the -6 foot MLW contour draws in to only approximately 200 feet from shore at Point B. The bottom is generally very hard and rocky with intermittent areas of softer silty fine sand. Aerial imagery shows the nearshore to be mostly void of subaquatic vegetation.

Hydrodynamic Setting

Wave Climate

The wave climate along Reach P2 is controlled by the deep nearshore bathymetry and a more northerly fetch exposure than Reach P1. Fetch exposures for mid-reach are 8.5 nm, 2.5 nm, 2.6 nm and 4.7 nm for the north, northeast, east and southeast directions respectively.

Littoral Processes

Point B is a major geomorphic feature not only for Reach P2 but for this section of the Potomac River shoreline. It appears to a point of divergence where sediments are transported to the north and south on either side. The deep, rocky nearshore is partially responsible for this as well as the rock hardened shoreline that allows northerly wave approach to directly impinge on the point.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 6 and 7. In Reach 2 there has been a significant increase in residential land use along the shoreline. As of 1994 this has not resulted in a direct increase in the length of shoreline that has been hardened. However, using Reach One as an example, it appears likely that shoreline hardening in this area can be expected to increase in the near future. One reason for the lack of shore protection structures may be the relatively resistant nature of the natural shoreline along this reach.

Table 6

REACH P2 SHORELINE CONDITIONS (FT)

	1973	1985	1994
No Structures	5,827	5,827	5,724
Hardened	0	0	103
Groins	0	0	0
Breakwater/Sills	0	0	0

Table 7

REACH P2 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	4,507	4,261	3,249
Agricultural	0	0	0
Residential	1,319	1,564	2,577
Commercial	0	0	0
County	0	0	0
Miscellaneous (Roads, Railroads)	0	0	0

Shoreline Protection Strategies

No Action: The relatively slow erosion rate and sparse development would preclude any structural modifications for some time. The "bank rock" will continue to slough and fall along the base of the bluff, thus offering protection. In order to apply this strategy it will be necessary to create an adequate setback for future development.

Defensive Approach: Rock revetments could be placed on some properties with greater ease than others. Access is a real problem from land and can be done best down the one major ravine. Bank grading to an acceptable slope (1V:2H) would require major bluff excavation and would have to be done along several hundred feet of shore to attain an interfacing grade with adjacent unprotected bluffs. Wood bulkheads may be difficult to install due to the rocky substrate. A revetment could be placed along the base of the bank and the bluff could remain as is. With the base of the bank protected, the bluff would continue to erode to a "natural" angle of repose. Some of the harder "bank rock" could be incorporated into the revetment as core material.

Offensive Approach: In the case of Reach P2, groins are not recommended simply because this is a zone of wave divergence and there is no natural sand supply to help augment beach fill that would be required for a groin system. Breakwaters would be expensive due to the need for large quantities of beach fill.

<u>Headland Control</u>: Enhancing existing headlands (i.e., Point B) with spur breakwaters is feasible but rather expensive. Once again some sand should be added to such a system. The small cove north of Point B would make a good candidate for applying this strategy. It would also be reasonable to construct a revetment across Point B and end it with spur breakwaters. Any of these actions would insure fixing Point B.

REACH THREE

Physical/Biological Settings

Reach Boundaries, Land Use, Soils and Drainage

Reach P3 begins where the high eroding bluff from the boundary at Reach P2 turns away from the river. This is an area where a broad beach has accumulated over the years (Figure 10). This bluff/beach area marks the beginning of Reach P3 which extends northwestward for about 5,200 feet to a marsh shoreline and consequent change in shore orientation. Reach P3 is rural residential and unmanaged woodland. The soils are Tetotom and Woodstown fine sandy loams (TeC2, WOB). The drainage falls into a small watershed that crosses the bluff and a minor creek exits at Point C.

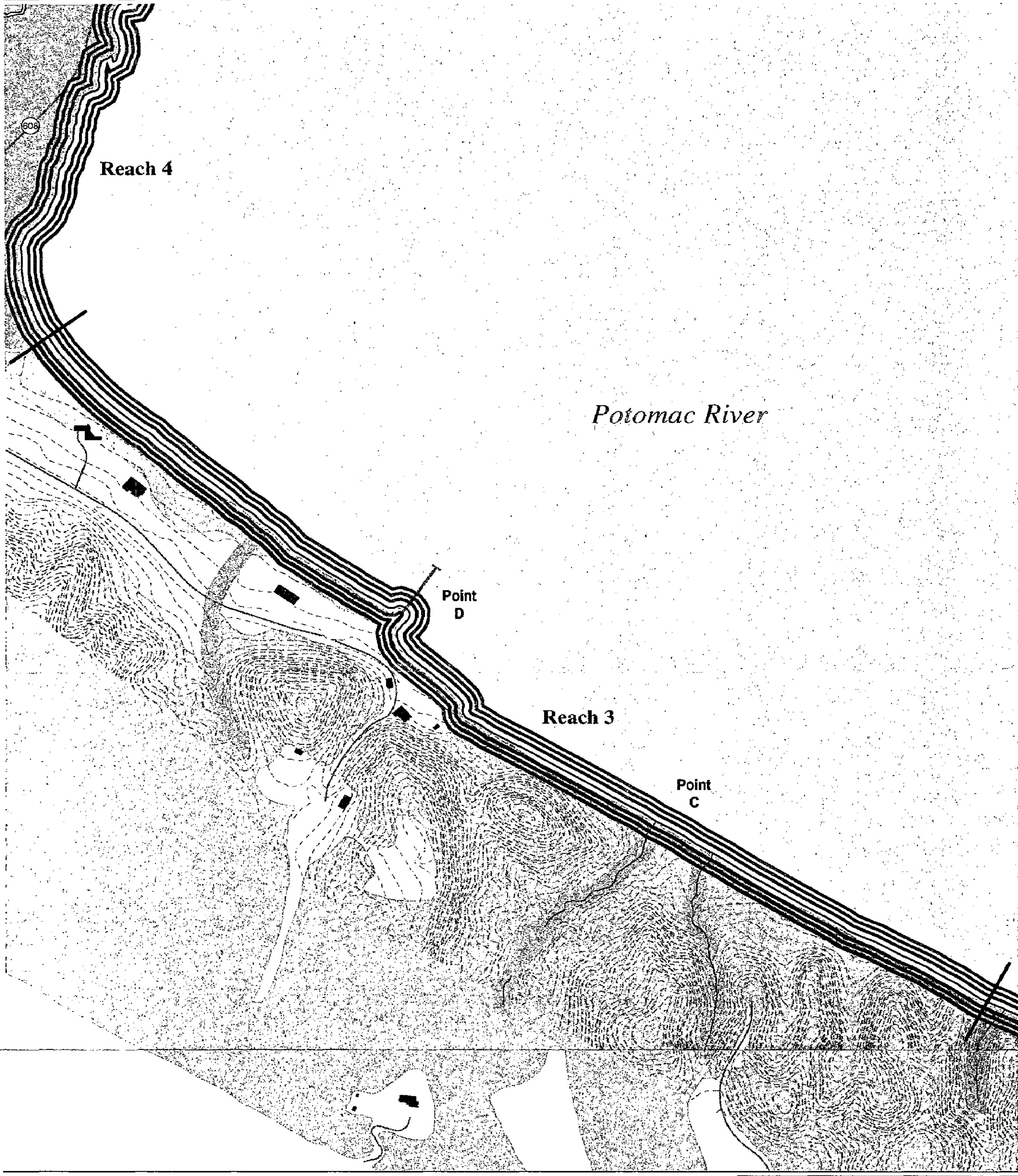
Upland Bank and Shoreline Characteristics

The high bluff falls back into the minor watershed at Point C. The floodplain of this watershed creates a recessed bank line and a low backshore which has been conducive to sediment accumulation. The bank line comes back toward the river just southeast of Point D. Point D consists of a steel bulkhead and pier which effectively segments Reach P3.

Northwest of Point D a gentle sloping terrace forms at about +25 feet MLW dropping to about +5 feet MLW and continuing to the marsh shoreline which comprises the P3/P4 boundary. The bluff face is stable as the beach widens along the southern half of Reach P3 before encountering a large steel bulkhead. Northwest of the bulkhead, the bank is low (+5 feet MLW) and eroding. The low bank then becomes a gentle slope that is protected by another beach area at the northwest end of Reach P-3.

The shoreline along Reach P-3 is mostly a relatively wide beach (15 to 30 feet) except in the area of the steel bulkhead. There are therefore two beach areas that are entrapped between natural and manmade headlands, and the result is a stable adjacent upland bank.

Nearshore Characteristics



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes
(Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes
(Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping
Prepared by Air Survey and Design, Inc.
from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia
Shoreline Characteristics

Figure 10

Potomac River
Reach 3

0 200 400 Feet

The nearshore area along Reach P3 is relatively deep at the P2/P3 boundary with the -6 foot MLW contour being approximately 300 feet offshore. Moving northwestward, the nearshore shelf becomes shallower and the -6 foot MLW contour is 2,500 feet offshore at the P3/P4 boundary. There is a very heavy cover of SAVs, especially in the embayed area between Point B and the P3/P4 boundary. The aspect of an embayment is formed between the P3 and P4 shorelines. This embayment (referred to as "Aquia Bay" in this report) is an area of sediment accumulation from sediment transport from the north and southeast. Bottom sediments are mostly very silty fine sands.

Hydrodynamic Setting

Wave Climate

The Reach P3 shoreline faces almost due northeast and has fetch exposures to north, northeast and east of 9.5 nm, 3.6 nm and 3.0 nm respectively. The widening shallow nearshore region tends to bend or refract incoming waves from all directions into "Aquia Bay." This is the driving force for sediment transport into "Aquia Bay" across the nearshore and along the shore.

Littoral Processes

"Aquia Bay" is a sediment sink for eroding bank sediments from reaches P2 and P4, and even reaches north of Aquia Creek (i.e., P5, P6, and P7), as sediment is carried south across the mouth of Aquia Creek via a large shoal region. The two beach areas in Reach P3 are "fed" by these littoral processes but the beach planform is set by frequent northerly winds including the occasional northeaster. Point D tends to act like a large groin or dam and segments the reach by controlling the beach to the northwest and scouring the shoreline to the immediate southeast, keeping sand from accumulating there even though two groins exist.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 8 and 9. As with Reach 1 an increase in residential land use is coupled with an increase in the length of hardened shoreline. The preferred shore protection strategy has been for revetments and bulkheads.

Table 8 **REACH P3 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	5,006	4,479	3,902
Hardened	99	624	1,204
Groins	0	0	0
Breakwater/Sills	0	0	0

Table 9 **REACH P3 LAND USE CONDITIONS (FT)**

	1973	1985	1994
Unmanaged	2,772	4,705	3,722
Agricultural	1,933	0	0
Residential	399	399	1,381
Commercial	0	0	0
County	2	2	2
Miscellaneous (Roads, Railroads)	0	0	0

Shoreline Protection Strategies

No Action: Given the relatively stable condition along the majority of this reach and the quality of the natural beaches, the no action alternative is appropriately applied.

Defensive Approach: While the defensive approach has been applied in several locations along Reach Three, the characteristics of the shoreline are more conducive to other protection strategies that are more consistent with the county's shoreline management objectives.

Offensive Approach: If necessary, placement of breakwaters is a viable alternative along this reach. The existing structures may provide some opportunities to begin or end an offensive system. Once again a source of sand is required. Particular care must be given to interfacing any shore protection system with the adjacent unprotected section of the reach.

Headland Control: There are no prominent opportunities for headland control measures in this reach.

REACH FOUR

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach P4 extends from the P3/P4 boundary northeastward for approximately 2,500 feet to Aquia Landing (Figure 11). The southern half of the reach is marsh and the northern half is a recreational beach area. All of Reach P4 is owned by the County of Stafford. Most of Reach P4 is Tidal Marsh (Tm) except for the very point at Aquia Landing which is Iuka fine sandy loam (Iu). Drainage is west into a low tidal marsh creek that flows into Aquia Creek.

Upland Bank and Shoreline Characteristics

An upland bank exists only along the northern part of the reach, part of which is manmade from road and park construction. The shoreline there is stabilized by a revetment and a series of four offshore breakwaters with beach fill. The shoreline along the southern half of Reach P4 is an eroding marsh that acquires a low beach at the P3/P4 boundary. That beach is the northern extension of the more extensive beach discussed in the previous reach section.

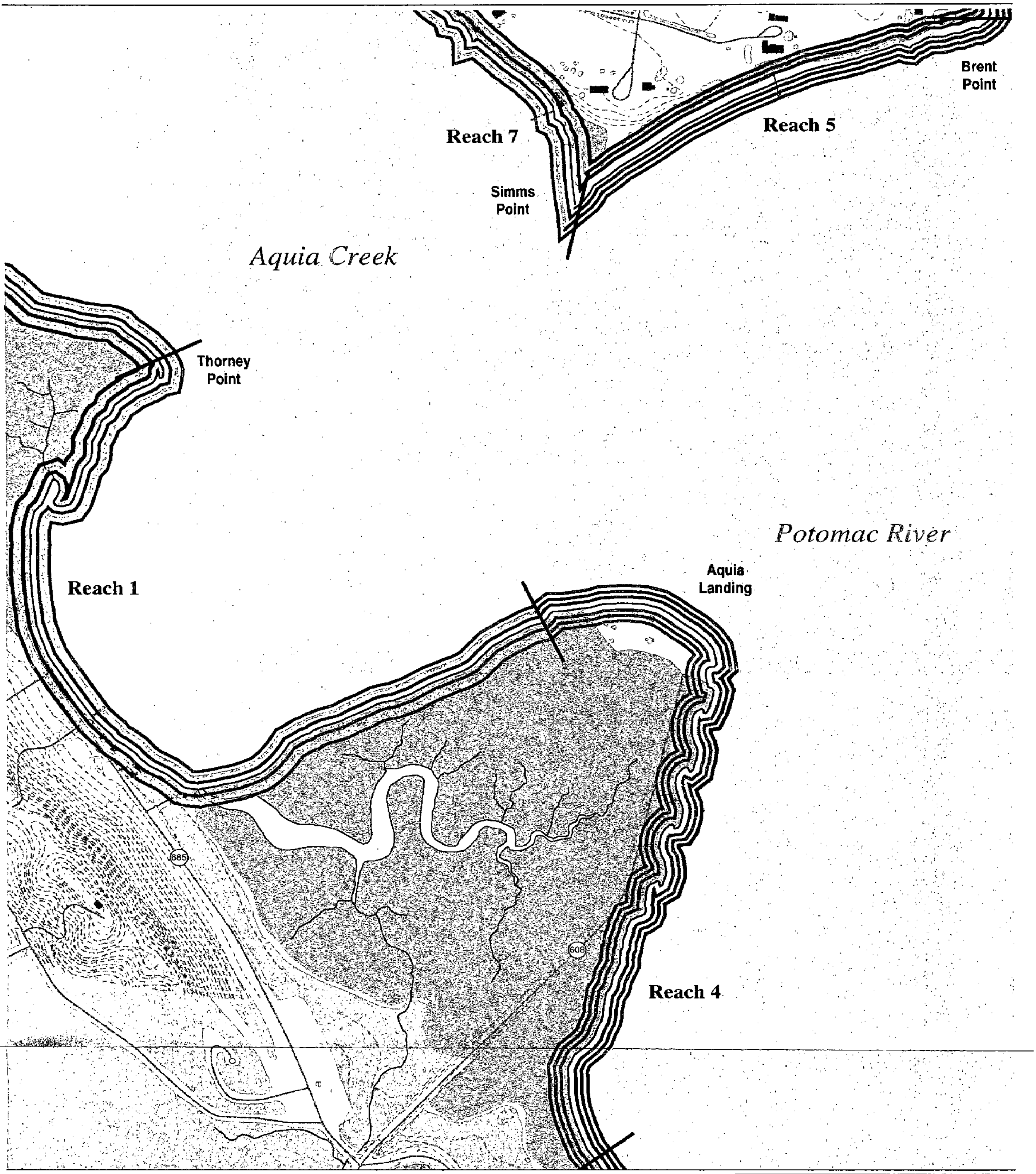
Nearshore Characteristics

The nearshore region of Reach P4 is a broad shoal, a continuation of the shoal region within the "Aquia Bay" feature as discussed in the previous section on Reach P3. The SAV population also continues around "Aquia Bay" along the nearshore region, but stops abruptly at the Aquia Landing Public Beach area.

Hydrodynamic Setting

Wave Climate

The shoreline orientation and shallow nearshore of Reach P4 attenuates waves approaching from the northeast, east and southeast with respective fetch exposures of 2.9 nm, 3.0 nm and 6.5 nm.



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 11
Potomac River / Aquia Creek
Reach 4 & 5 / Reach 1

0 200 400 Feet

Littoral Processes

The general northerly dominated wind/wave field forces what little beach material there is to be transported to the south into the bend of "Aquia Bay." Sand fill placed for the Aquia Landing breakwater project has essentially been encapsulated with relatively little loss of material since construction in 1987. The marsh shoreline continues a slow eroding pace and remains a zone of sediment transport.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 10 and 11. Changes along Reach Four reflect the breakwater project installed at Aquia Landing in 1988.

Table 10 **REACH P4 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	1,865	1,864	1,175
Hardened	300	703	992
Groins	1,463	1,060	0
Breakwater/Sills	0	0	1,461

Table 11 **REACH P4 LAND USE CONDITIONS (FT)**

	1973	1985	1994
	0	0	0
Unmanaged	0	0	0
Agricultural	0	0	0
Residential	0	0	0
Commercial	0	0	0
County	3,628	3,628	3,628
Miscellaneous (Roads, Railroads)	0	0	0

Shoreline Protection Strategies

No Action: Essentially one half of the reach is protected by the Aquia Landing breakwater system. The eroding marsh shore presents no apparent threat to upland improvements except possibly to a small part of the access road to Aquia Landing Public Beach.

Defensive Approach: The marsh shoreline could be protected with a marsh toe revetment or low sill structure.

Offensive Approach: Building offshore structures along the eroding marsh shore is probably not economically feasible. Once again a source of sand is required.

Headland Control: There are no feasible opportunities for headland control measures in this reach.

REACH FIVE

Physical/Biologic Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach P5 is the distal, downriver and downdrift end of the Widewater Peninsula. It extends from Simms Point to Brent Point and is comprised of approximately 2,000 feet of shoreline (Figure 11). Land use along this reach is rural residential. The upland drainage falls rather gently towards the river. Soils along Reach P5 are Sassafras fine sandy loam (SfC2) at Simms Point becoming Tetom fine sandy loam (TeA) at Brent Point.

Upland Bank and Shoreline Characteristics

The upland bank along Reach P5 is about +5 feet MLW at Simms Point and rises up to about +15 feet MLW at Brent Point. A small pond is currently located at Simms Point. The bank face along Reach P5 is intermittently eroding and stable with two properties utilizing revetments. Brent Point has eight small groins around its perimeter.

The shoreline is mostly a narrow beach and backshore that becomes wider from Brent Point to Simms Point. The wider beach provides bank protection toward Simms Point as evidenced by the stable bank slope. Simms Point is a spit feature. There is a small, eroding marsh fringe at Brent Point and, along with the groin field, is helping slow the erosion process there.

Nearshore Characteristics

The nearshore region along Reach P5 varies considerably in width with the -6 foot MLW contour located approximately 300 feet offshore at Simms Point. At this point, the main channel to Aquia Creek occurs. As one proceeds northeastward toward Brent Point, the nearshore becomes a very wide shoal region that extends almost 6000 feet (-6 feet MLW) toward the south southeast. There is evidence of SAVs in the nearshore as well.

Hydrodynamic Setting

Wave Climate

Reach P5 is somewhat protected from the dominant northerly winds by its southerly facing orientation where the fetch is approximately 1 nm. However, there is a fetch exposure to the east and southeast of 1.6 nm and 3.6 nm respectively. Wave processes are significantly impacted by the broad offshore shoal region. Reach P5 receives some wave activity from Aquia Creek from northwesterly wind events.

Littoral Processes

Reach P5 is the recipient of sediment from down the Potomac River (i.e., the Widewater Peninsula) and to a lesser degree, sediments moving down Aquia Creek. Simms Point is the geomorphic expression of bimodal sediment transport processes from Potomac River and Aquia Creek.

It must be kept in mind that the relatively wide beach areas along Reach P5 are the result of eroded sediments being carried into the reach where they accumulate as beach sands and shoals. This source of sand can be severely cut off as the Widewater Peninsula is developed and shoreline protection devices consequently installed. Over the long-term, the protective beaches along Reach P5 may be reduced in magnitude and effectiveness.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 12 and 13. While there has been an increase in residential development along this reach, there has been a decrease in protected shoreline. This is due to the deterioration of groin systems that have not been replaced.

Table 12 **REACH P5 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	1,608	1,607	1,766
Hardened	0	0	0
Groins	382	382	223
Breakwater/Sills	0	0	0

Table 13

REACH P5 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	667	1,363	1,013
Agricultural	696	0	0
Residential	627	627	977
Commercial	0	0	0
County	0	0	0
Miscellaneous (Roads, Railroads)	0	0	0

Shoreline Protection Strategies

No Action: Much of the upland bank along Reach P5 is stable due to the wide beach. Other areas, especially Brent Point will continue to erode as the marsh fringe becomes smaller.

Defensive Approach: This has been done along two properties where stone revetments have been built. Preserving Brent Point with a revetment is warranted. A sill or marsh toe revetment across the marsh fringe would provide some nearshore stability to Brent Point.

Offensive Approach: A gapped breakwater system is appropriate for Brent Point as long as it is properly interfaced into adjacent shores. Sand for beach fill is a necessary requirement.

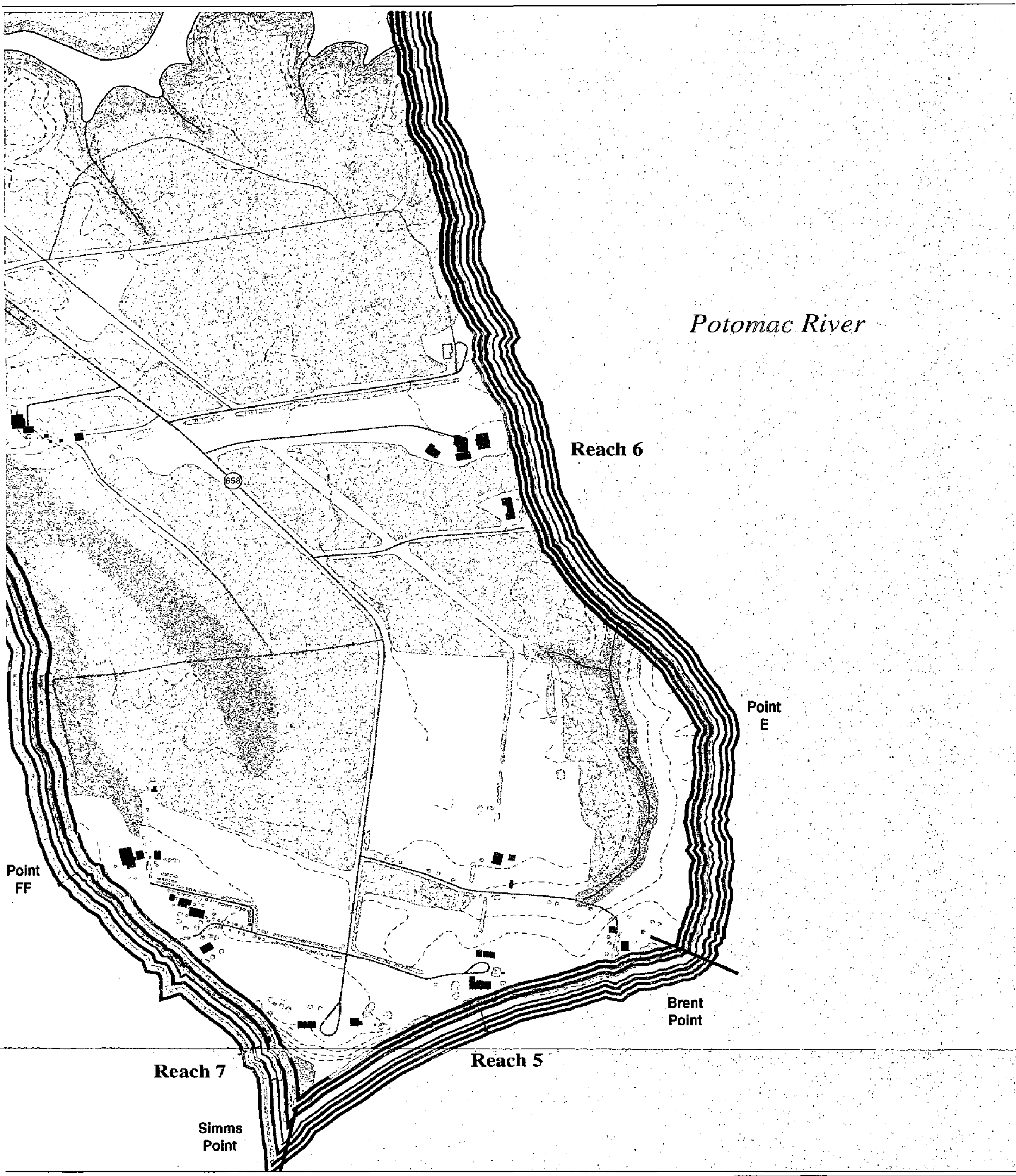
Headland Control: Brent Point is a major geomorphic feature and using it as the focus of a headland control system would provide shore protection to the north into Reach P6 and west across Reach P5. Simms Point should be incorporated in a headland control system to interface with Brent Point and provide a long-term cost effective approach to protecting Reach P5.

REACH SIX

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach P6 extends from Brent Point northward for approximately 14,000 feet to Brent Marsh (Figures 12, 13, and 14). Land use is mostly unmanaged wooded with a few residential lots and one residential area approximately 3,500 feet long just south of Brent Point. Brent Point is a tidal marsh area. Soils along Reach P6 vary from a Sassafras fine sandy loam on the south end of the reach to a Tetom fine sandy loam along most of the reach. A segment of Sassafras occurs just before Brent Marsh (Tm). Reach P6 is the



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

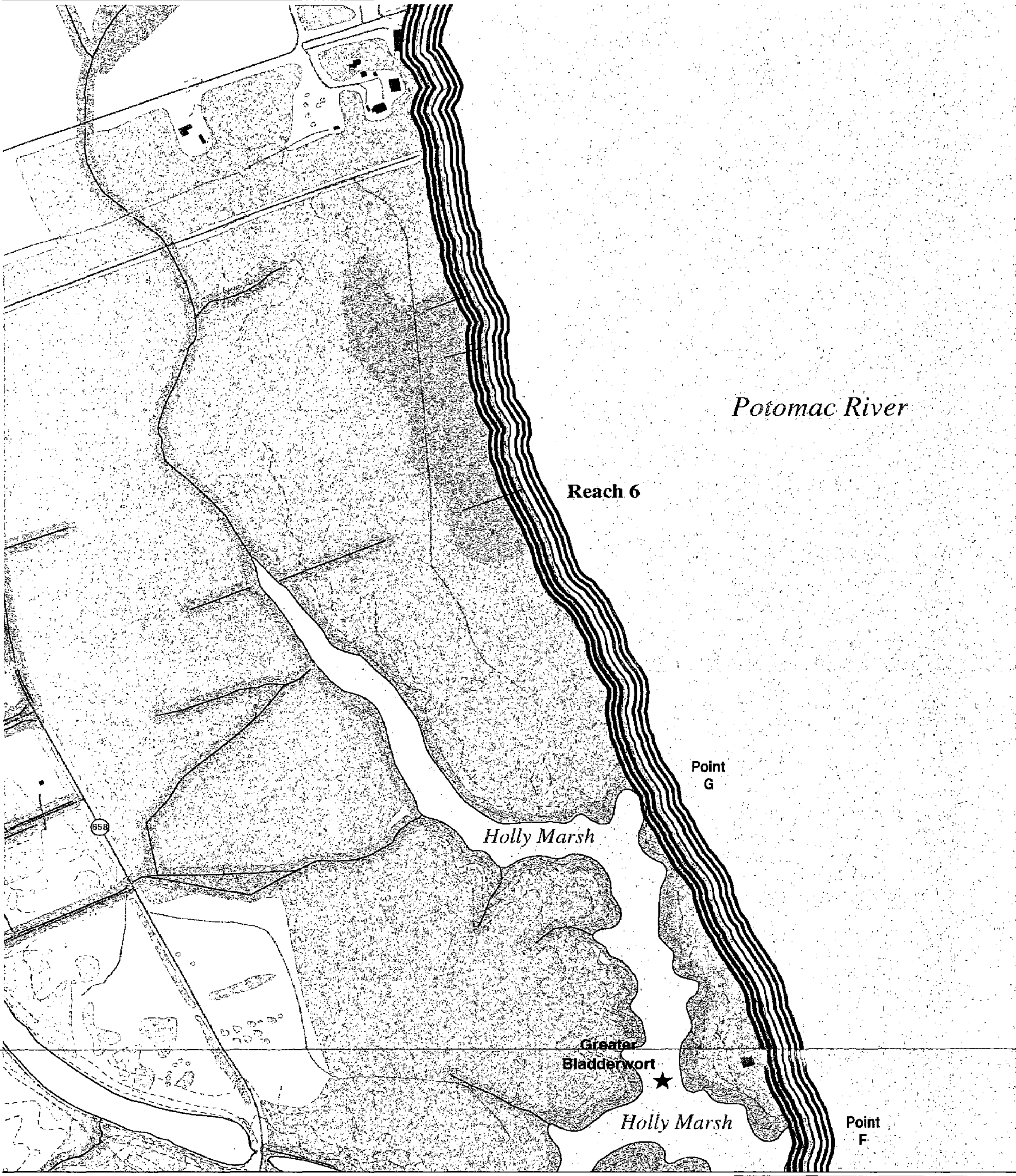
Stafford County Virginia Shoreline Characteristics

Figure 12

Potomac River

Reach 6

0 200 400 Feet



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
- Private Agricultural
- Private Residential
- Private Unmanaged
- Commercial Waterfront
- County
- Miscellaneous
- No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
- No Structures
- Hardened
- Breakwater / Sill
- Groins
- No Data

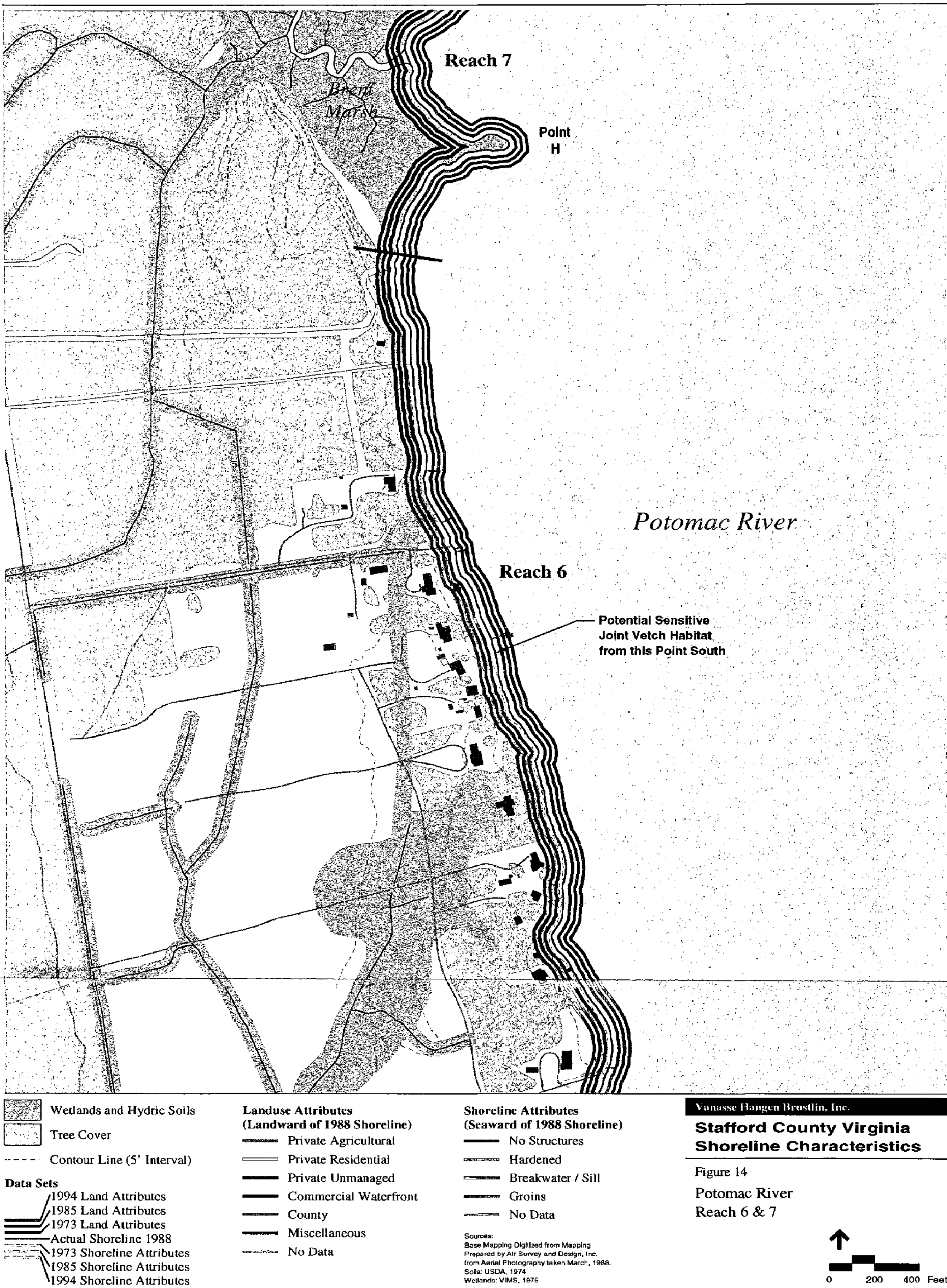
Sources:
Base Mapping Digitized from Mapping
Prepared by Air Survey and Design, Inc.
from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 13
Potomac River
Reach 6

0 200 400 Feet



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Stafford County Virginia Shoreline Characteristics

Figure 14

Potomac River Reach 6 & 7

Potomac River side of the rather flat Widewater Peninsula. The main drainage is associated with two small watersheds that become tidal marsh and enter the Potomac River at points E and F.

Upland Bank and Shoreline Characteristics

The upland bank along Reach P6 starts at Brent Point at approximately +20 feet MLW, drops slowly in elevation to approximately +10 feet MLW at around mid-reach, and remains so to the Reach P6/P7 boundary. The bank occurs as a vertically exposed actively eroding slope that is composed of a silty fine sand with an historic erosion rate of 1 to 3 feet/year (VIMS, 1975).

There is a noticeable lack of indurated sediments and rock in the banks along Reach P6 such as those found in the banks along Reaches P1, P2, and P3. This area is known as the Widewater Peninsula and the general geology differs.

Point G is approximately 1,000 feet north of Brent Point and is a major shore feature along this reach. Between Point G and Brent Point there are six wood groins that are partially detached and generally ineffective in supporting a beach.

Approximately 1,000 feet north of Point G there is a short shore segment (1,200 feet) with three residences. Each property owner has built a shore defense system beginning with a bulkhead on the southern most lot followed be two revetments on the northern two lots. The revetments appear to be poorly built since evidence of continued bank erosion exists behind them.

Between points F and G, there is a small island with a single resident. Two small gabion breakwaters were recently installed; some sand has been trapped but not enough to offer long-term protection. The position and size of the gabion structures and poor sand supply limit its ability to build the wide elevated backs shore that is needed to protect the eroding banks.

The 3,500 foot residential area south of Brent Marsh has been mostly hardened except for 200 feet in a small cove feature. The structures are revetments and bulkheads that appear to be well built for the most part. These are relatively new structures and their long-term effectiveness has yet to be ascertained. Also, there are only a few groins built along this reach, none of which have trapped any sand.

Although Reach P6 was technically ended at the beginning of Brent Marsh, at a feature we called Brent Marsh Point, it has a sheltering effect on the north end of Reach P6. This can be seen by trapped sand on the south side of the pier/groin structure at the Reach P6/P7 boundary.

Nearshore Characteristics

Reach P6 begins on the south end with relatively wide nearshore region where the -6 foot MLW contour is approximately 1,800 feet off Point G. The -6 foot MLW contour gradually draws closer to shore until it is approximately 1,000 feet offshore at the Reach P6/P7 boundary. There is a thick bed of SAVs that begin at Point G and continue north into Reach P7. Associated with the SAVs is a cross-hatched pattern in the very nearshore that suggests subtle bottom features such as large ripples or sand waves that are forced by a bimodal wave climate.

<u>Hydrodynamic Setting</u>

Wave Climate

The Reach P6 shoreline is oriented almost north-south with average fetch exposures to the northeast, east and southeast of 3.5 nm, 2.2 nm and 3.9 nm respectively. There is a long oblique fetch to the north northeast of about 13.2 nm.

Littoral Processes

There is little shoreline geomorphic evidence of a strong net littoral transport pattern other than minor but measurable upland bank offsets created by fallen trees and shoreline structures. These indicate that a net southerly transport is active along Reach P6. A slight reversal occurs at the Reach P6/P7 boundary with sand stacked against the south side of the existing pier/groin. This feature is assumed to be associated with the sheltering effect of Brent Marsh Point.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 14 and 15. Both a significant increase in residential land and shoreline stabilization is noted for Reach 6. Again the preferred method of erosion control has been bulkheads and revetments, with no use of offensive strategies. The fact that many groin systems have been supplemented with defensive structures reflects the lack of sand moving in the littoral system. This trend suggests that groins are generally not effective in this area.

Table 14 **REACH P6 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	11,449	10,761	9,157
Hardened	2,332	2,615	5,220
Groins	947	1,252	0
Breakwater/Sills	0	0	250

Table 15 **REACH 6 LAND USE CONDITIONS (FT)**

	1973	1985	1994
Unmanaged	10,318	8,689	9,435
Agricultural	1,551	1,551	0
Residential	2,760	4,387	4,952
Commercial	0	0	0
County	0	0	0
Miscellaneous (Roads, Railroads)	0	0	242

Shoreline Protection Strategies

No Action: The consequence of this approach will be the continued loss of upland property.

Defensive Approach: Approximately 5,400 feet of shoreline has been hardened by bulkheads or revetments. This is a viable solution to control erosion along the rest of Reach P6.

Offensive Approach: Any offensive structure including breakwaters and groins will require the use of beach fill from other sources to create a long-term cost-effective system. Groins are not recommended because of the lack of a natural supply of beach sand, and they would require continual beach maintenance.

Headland Control: There are numerous opportunities to control subtle headlands along Reach P6. In particular, Point G offers the most obvious headland situation which could be utilized, especially in conjunction with a headland approach at Brent Point.

REACH SEVEN

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach P7 extends from the P6/P7 boundary northward approximately 11,000 feet. It is essentially the entire shoreline area known as Brent Marsh (Figure 15). Brent Marsh is a tidal marsh fringe adjacent to a wooded and unmanaged upland and is drained by daily tidal action. The soil type is Tidal Marsh (Tm). Upland drainage enters Brent Marsh at several locations at the upper marsh/upland interface.

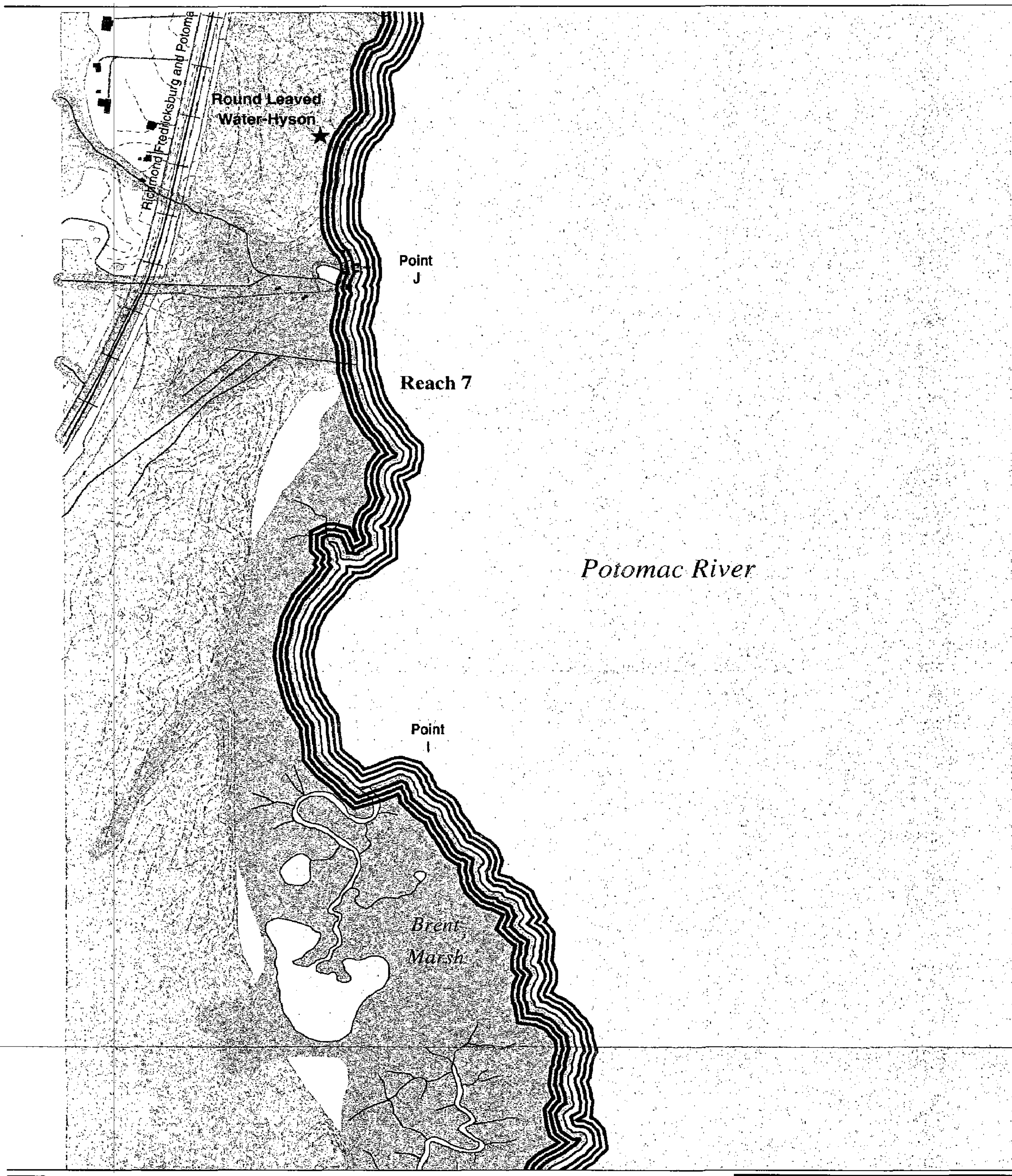
Upland Bank and Shoreline Characteristics

The drainage in Brent Marsh is controlled by tidal fluctuations across the marsh and two major tidal creeks within the marsh that enter the Potomac River at points H and I. Point H is just north of Brent Marsh Point and Point I enter into "Brent Marsh Bay." Brent marsh is fairly wide (1,000 feet) at "Brent Marsh Point" and gradually narrows to a point approximately 5,000 feet to the north where the marsh fringe discontinues for approximately 1,500 feet. Point J is a low upland area in the 1,500 foot fringeless shore where a landing and pier exist. The marsh begins again as a narrow fringe to the end of the reach. The marsh fringe was at one time continuous across the 1,500 foot shore segment according to 1937 aerial imagery, but has slowly eroded back to the upland.

The marsh shoreline occurs mostly as a low, undercut and actively eroding clay/peat scarp. The marsh fringe is very irregular with an undulating shore planform of small points and coves. "Brent Marsh Point" exists because of numerous shipwrecks that occur in the nearshore which have the effect of dampening wave action before it reaches the marsh shoreline. The landing at Point J has been hardened with dumped broken concrete.

Nearshore Characteristics

The nearshore at "Brent Marsh Point" is fairly narrow with the -6 foot MLW contour approximately 400 feet offshore. As the marsh shoreline turns



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping
Prepared by Air Survey and Design, Inc.
from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 15

Potomac River
Reach 7

0 200 400 Feet

landward at "Brent Marsh Bay", the -6 foot contour is approximately 1,200 feet offshore and remains there to the Reach P7/P8 boundary. There are numerous peat "tumps" in the very nearshore between "Brent Point Marsh" and "Brent Marsh Bay." These are erosional remnants left as the main marsh erodes. The nearshore is very soft being underlain with a soft clay/peat substrate. The SAV beds are very thick and continuous along Reach P7.

Hydrodynamic Setting

Wave Climate

Reach P7 has fetch exposures to the north northeast, northeast, east and southeast of 12.5 nm, 3.1 nm, 2.9 nm and 8.3 nm, respectively. This may be an area where southeasterly wind/wave energies are becoming greater relative to the northerly component.

Littoral Processes

"Brent Marsh Point" and its associated offshore shipwrecks offer a major shore feature that tends to shelter the very north end of Reach P6. There are no shore features or eroding sand being transported that give good evidence to littoral drift patterns. However, given the nature of the shore position and the drift patterns of adjacent reaches, a general southerly transport is indicated.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 16 and 17; generally, no changes are noted.

Table 16 **REACH P7 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	11,061	11,061	11,061
Hardened	353	353	362
Groins	0	0	0
Breakwater/Sills	0	0	0

Table 17

REACH P7 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	11,055	11,026	11,026
Agricultural	0	0	0
Residential	0	29	29
Commercial	357	357	357
County	0	0	0
Miscellaneous (Roads, Railroads)	0	0	0

Shoreline Protection Strategies

No Action: Since most of Reach P7 is marsh there may be little incentive to protect it. This strategy would allow the shore to remain essentially as an eroding marsh. However, as the fringe narrows, especially along the north end of the reach, the wave dampening ability will lessen and upland banks will begin to erode, as observed along the 1,500 foot fringeless section of shore.

Defensive Approach: The only existing defensive structure is at Point J. The 1,500 feet of low eroding upland bank could be rocked. Marsh toe revetments along the northern portion of Reach P7 would not be cost effective without a plan for the particular segment of shore. Access by land would be difficult due to poor foundation stability resulting from the soft nature of the substrate.

Offensive Approach: The only offensive structure would be a low rock sill with marsh grass planting but like the defensive approach a proper plan needs to be established for a given segment of marsh shoreline as well as consideration of potential foundation problems. Breakwaters could be installed along the 1,500 feet of shore beginning at Point J, but, once again, the problem of sand supply exists. There may be a foundation problem there as well.

Headland Control: There will once again be a foundation problem but this type of shoreline is very conducive to headland control. The numerous existing points and coves offer opportunities to use marsh toe revetment, sills and spurs in various combinations to accentuate the points and shelter cove areas. The curvilinear embayment between points K and L is a good example of existing headlands that offer an opportunity for headland control. Some continued shoreline erosion might occur until relatively stable shore planforms are reached. This has also happened at "Brent Marsh Point" with the shipwrecks acting as headland control devices to a degree.

REACH EIGHT

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach P8 is the northern most segment of Stafford County shoreline along the Potomac River. It extends from the northern limit of Brent Marsh (Reach P7) to northward for approximately 8,000 feet to Tank Creek (Figure 16 and Figure 17). The land use along this reach is mostly wooded and unmanaged. There are two residences just south of Clifton Point. The upland generally drains toward the Potomac River. There are three small watersheds, as well as Tank Creek, and a similar sized unnamed watershed that passes Widewater and flows into the Potomac River.

Upland Bank and Shoreline Characteristics

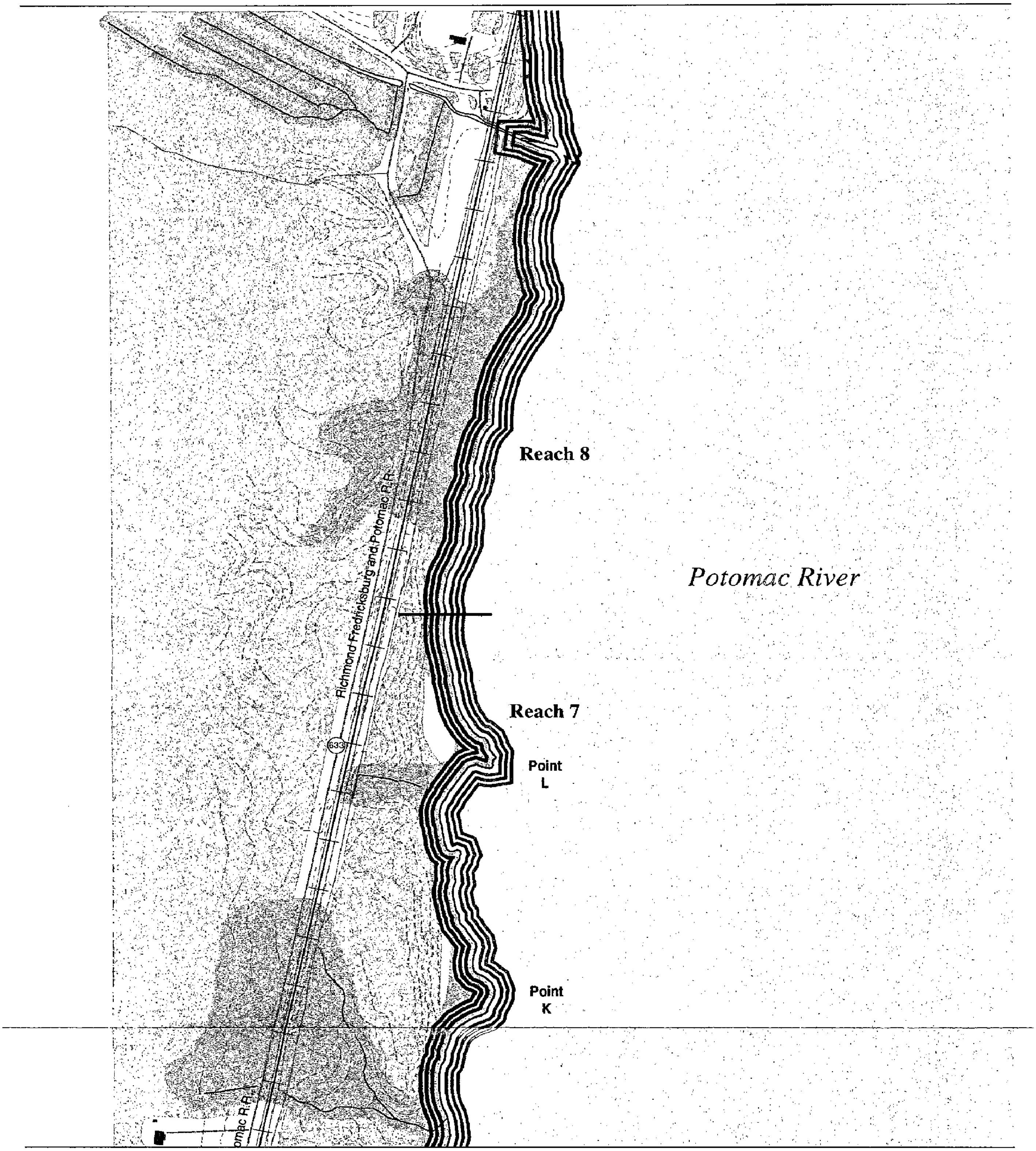
The upland bank along Reach P8 is approximately 10 feet MLW at the Reach P7/P8 boundary where Brent Marsh feathers out and rises northward to approximately 30 feet MLW just south of Tank Creek. The banks are composed of silty fine sand. At Clifton Point a basal sandstone becomes a prominent feature. Clifton Point has numerous very large (15 feet high by 30 feet long) boulders on the shore that are left behind as adjacent banks erode.

The banks are generally vertically exposed and eroding except for several stable bank areas that occur adjacent to pocket beaches. These pocket beach areas are formed by points of land where Tank Creek and "Widewater Creek" enter the Potomac River. The ebb shoals of these creeks have helped maintain relatively fixed points.

The shoreline along Reach P8 has narrow sand beaches that become wider in the pocket beach situations. The sand fillet just upriver of "Widewater Creek" is almost 100 feet wide at the creek mouth and 600 feet to the north narrows to less than 10 feet. Other beach areas occur just downriver of Clifton Point and Tank Creek, as well as several small beaches in between. These points are controlled by erosion resistant bank rock substrates.

Nearshore Characteristics

The -6 foot MLW contour stays approximately 1,100 feet offshore along the length of Reach P8 except at the very north boundary where it goes out 2,000 feet to a shoal point off Tank Creek. The shoal point is a major nearshore feature formed by the outflow of Tank Creek. A smaller nearshore shoal occurs where "Widewater Creek" enters the Potomac River.



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

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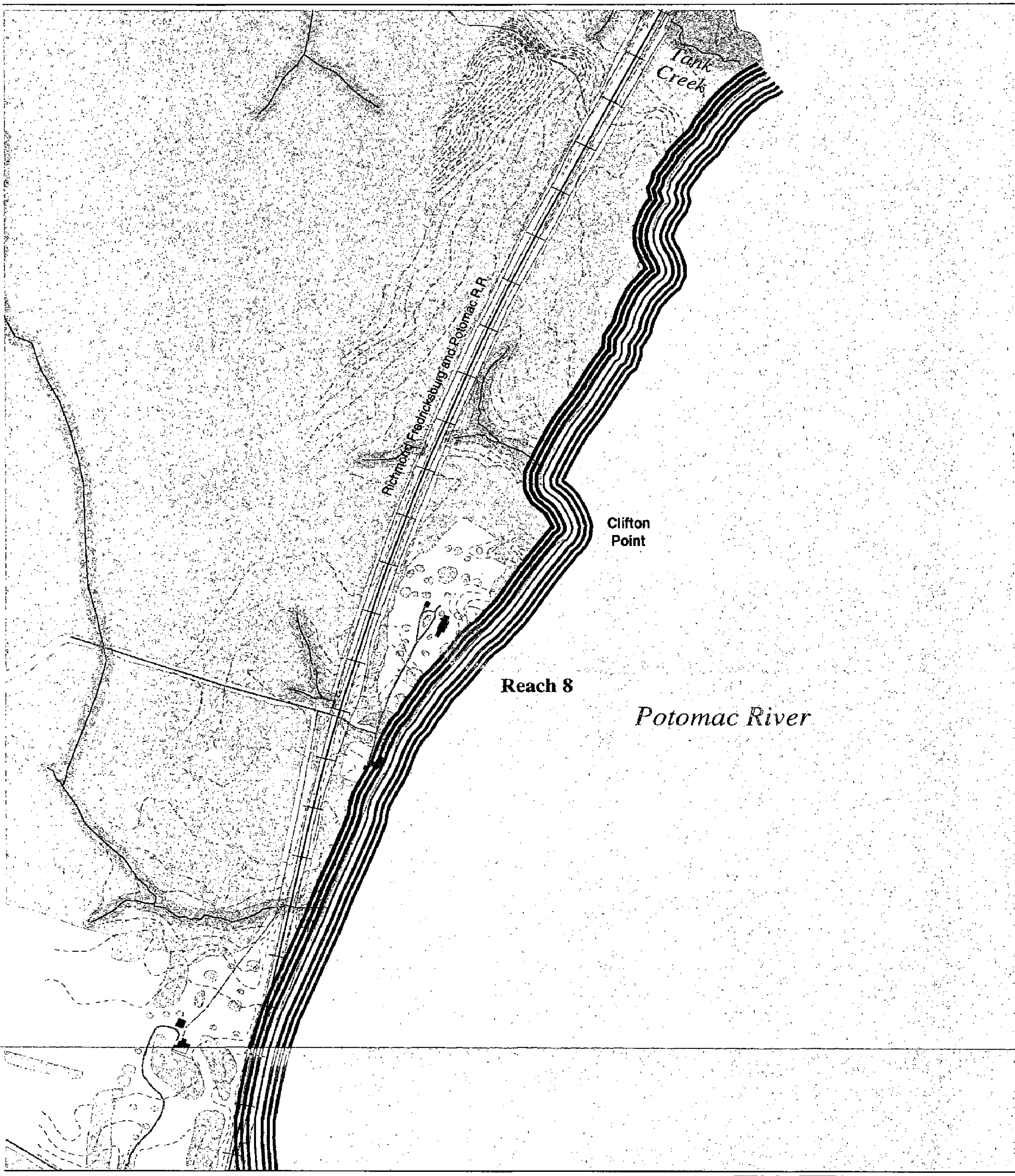
Stafford County Virginia Shoreline Characteristics

Figure 16
Potomac River
Reach 7 & 8

0 200 400 Feet



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 17
Potomac River
Reach 8

0 200 400 Feet

Extensive Hydrilla beds occur along the length of Reach P8. However, the beds become thinner along the nearshore between Clifton Point and Tank Creek.

Hydrodynamic Setting

Wave Climate

Reach P8 has fetch exposures to the northeast, east and southeast of 5.2 nm, 2.3 nm, and 5.1 nm respectively. Longer oblique fetches occur to the north northeast and southeast of approximately 19.0 nm and 9.4 nm respectively.

Littoral Processes

The geomorphic expression of the P8 shoreline, especially at Clifton Point and Tank Creek and the small headland and cove features between them indicate a net northerly littoral drift. The tangential beaches are facing southeast. This does not necessarily correspond to the wave refraction analysis, but it may be that the southerly wind climate becomes more dominate at that fetch relative to shoreline position along the Potomac River.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 18 and 19. While land use has remained unchanged, there has been an increase in shoreline hardening. Again the preferred method is a defensive strategy.

Table 18

REACH P8 SHORELINE CONDITIONS (FT)

	1973	1985	1994
No Structures	8,028	7,746	7,679
Hardened	805	1,088	1,155
Groins	0	0	0
Breakwater/Sills	0	0	0

Table 19 **REACH P8 LAND USE CONDITIONS (FT)**

	1973	1985	1994
Unmanaged	6,307	6,307	6,307
Agricultural	0	0	0
Residential	1,584	1,584	1,584
Commercial	0	0	0
County	0	0	0
Miscellaneous (Roads, Railroads)	943	943	943

Shoreline Protection Strategies

No Action: The long reaches of unmanaged woodland property provide a good opportunity for application of the no-action alternative.

Defensive Approach: Revetments or bulkheads have been placed at several locations along this reach and have effectively stopped erosion. This approach could be continued, although in the vicinity of the many subtle headlands and pocket beaches offensive approaches and headland control may be more appropriate, particularly if economical sand sources can be identified.

Offensive Approach: The headland-pocket beach configurations that exist naturally along this reach suggest that offensive approaches would be appropriate and could accentuate natural features. However, sand must be added to the system if adequate backshore elevations and widths are to be achieved.

Headland Control: The prominent and subtle headland features and adjacent pocket beaches provide excellent opportunities for headland control.

AQUIA CREEK SHORELINE CHARACTERISTICS

REACH ONE

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach A1 extends from Aquia Landing northwestward up Aquia Creek for approximately 4,500 feet around a small embayment to Thorney Point. Most of the reach is marsh except for approximately 600 feet of upland rural residential in the center of the embayment (Figure 11). Soils are Tidal Marsh (Tm) along the flanks of the embayment and the Sassafras-Aura-Caroline association in the center. Drainage from the upland is toward the marshes and creek.

Upland Bank and Shoreline Characteristics

The only upland area is in the middle of Reach A1 approximately +10 feet MLW. There is a hard surface road that passes less than 50 feet from the creek at that point where a timber bulkhead approximately 400 feet long supports the bank and offers land end access to three piers. There is a scarp along the base of the upland bank approximately 5 to 8 feet high exposed on either side of the bulkhead.

The marsh shorelines are associated with marsh points to the southeast and northwest that have tidal creeks that enter into the Reach A1 embayment. There is a narrow beach around Thorney Point in front of the marsh and another beach along the southeast shore of the A1 bay. A very low and narrow sand berm with trees occurs along the southeast limb of the embayment that separates the beach from the large marsh area behind Aquia Landing.

Nearshore Characteristics

Nearshore region in the Reach A1 embayment is very shallow. The -3 foot MLW contour lies 800 feet off the center of the bay but comes within 150 feet from Thorney Point. Hydrilla almost completely fills the shallows of the Reach A1 bay.

Hydrodynamic Setting

Wave Climate

Located at the mouth and downstream end of Aquia Creek, Reach A1 is exposed to northeast wind/wave activity. The southeast (northwest facing) marsh shore can be impacted by northwesters along the length of Aquia Creek.

Littoral Processes

There is little sediment transport evident along Reach A1. The exception is at Thorney Point where southeast moving sand lobe or spit reflects sediment transport driven by northwesters and modified by northeasters. The sand for the Thorney Point spit was most likely derived from bank erosion upstream. As those shores are presently protected, that source of sand has been essentially eliminated.

The narrow beach along the southeast marsh shore was most likely transported into the A1 bay from erosion of Aquia Landing before it was hardened with a revetment. Sand can also be seen up and into the mouth of the tidal creek along that same shore.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 20 and 21. Only minor changes are noted.

Table 20 **REACH A1 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	4,267	N/A	3,696
Hardened	221	N/A	792
Groins	0	N/A	0
Breakwater/Sills	0	N/A	0

Table 21

REACH A1 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	1,633	N/A	1,633
Agricultural	0	N/A	0
Residential	578	N/A	578
Commercial	0	N/A	0
County	1,671	N/A	1,671
Miscellaneous (Roads, Railroads)	604	N/A	604

Shoreline Protection Strategies

No Action: All upland property along this reach and the associated improvements have been bulkheaded. Since no development is likely along the remaining reach because of the marsh land and since the erosion rate is very low, this approach is appropriate.

Defensive Approach: The existing bulkhead along the middle bay shoreline need only be maintained. Bulkheads or revetments could be emplaced along the remaining unprotected upland bank.

Offensive Approach: The use of sills and beach fill to establish a marsh fringe is very feasible in lieu of long-term maintenance of the bulkhead.

Headland Control: Thorney Point is a major headland feature and should be evaluated for its long-term stability as the updrift source of material has been halted. It may play a more important role in addressing Reach A2.

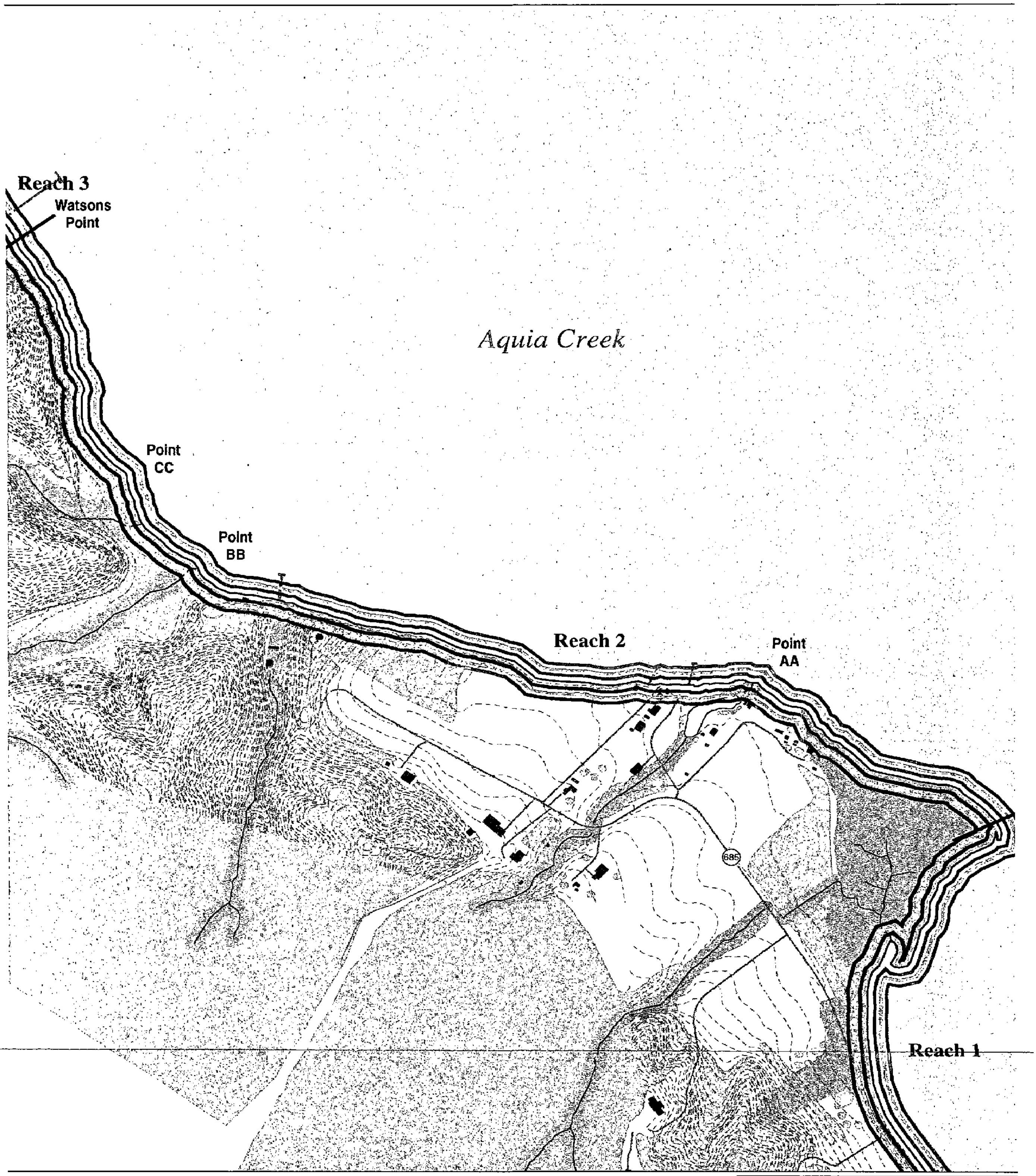
REACH TWO

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach A2 extends from Thorney Point northwestward along the south shore of Aquia Creek to Watsons Point, a shoreline length of approximately 5,400 feet. Reach A2 occurs as a roughly curvilinear embayment that is rural residential along most of its length (Figure 18).

Two small upland watersheds drain into Aquia Creek at points AA and BB. The drainage at Point AA appears to be contained in some fashion to keep the channel from migrating. The soils are part of the Sassafras-Aura-



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

- Private Agricultural
- Private Residential
- Private Unmanaged
- Commercial Waterfront
- County
- Miscellaneous
- No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

- No Structures
- Hardened
- Breakwater / Sill
- Groins
- No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 18

Aquia Creek

Reach 2

0 200 400 Feet

Caroline association; deep well-drained soils having sand clay loam, heavy clay loam, or clay subsoil.

Upland Bank and Shoreline Characteristics

The upland bank along Reach A2 starts as a low marsh at Thorney Point and rises at the upland/marsh interface to approximately +5 feet MLW. This extends to just beyond Point AA where it gradually reaches +10 feet MLW. This 10 foot terrace continues around and into the watershed at Point BB. A 10 to 12 foot basal bank scarp approximately 200 feet in length occurs just down from Point BB. From Point BB the bank rises quickly to more than +50 feet MLW with a 2 to 4 foot basal scarp. The upland bank then drops down to approximately +10 feet MLW at Watsons Point.

The first 2,000 feet of the 10 foot terrace starting up from Thorney Point has mostly been protected with bulkheads or revetments. There is another shore segment approximately 200 feet long near Watsons Point that has bulkhead sand groins. The remaining shoreline along Reach A2 has a narrow beach zone in front of a slowly eroding upland bank. Although the upper bank face is mostly stable, a wave cut basal scarp is evident which always bodes for potential long-term bank face instability.

Nearshore Characteristics

The nearshore is relatively shallow with the -3 foot MLW contour averaging approximately 300 feet offshore. The only noticeable patch of SAVs occur just upstream of Point BB.

<u>Hydrodynamic Setting</u>

Wave Climate

The very fetch limited wave climate is controlled by the northeasters and northwesters along Reach A2. However, the potential for boat wake activity is quite real in a relatively narrow creek with a large quantity of displacement hull pleasure craft.

Littoral Processes

The northwesters appear most dominant as evidenced by the orientation of beach fillets in existing groins. However, northeast events will most likely impact the upper beach and base of bank during periods of high water.

<u>Historic Characteristics</u>

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 22 and 23. As observed in reaches along the Potomac River, there is a significant increase in the length of hardened shoreline along this reach. Defensive strategies have been preferred.

Table 22

REACH A2 SHORELINE CONDITIONS (FT)

	1973	1985	1994
No Structures	5,252	N/A	3,238
Hardened	222	N/A	2,238
Groins	0	0	0
Breakwater/Sills	0	0	0

Table 23

REACH A2 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	4,306	N/A	3,684
Agricultural	0	N/A	0
Residential	1,169	N/A	1,792
Commercial	0	N/A	0
County	0	N/A	0
Miscellaneous (Roads, Railroads)	0	N/A	0

Shoreline Protection Strategies

No Action: This is an appropriate strategy taking into account the potential instability of the unprotected upland banks.

Defensive Approach: The existing structures appear adequate for the wave exposure along Reach A2. Loss of intertidal habitat will continue if the defensive approach is employed along the remainder of the reach. In a sheltered creek environment shore zone habitat is probably more important to marine resources than on the high energy riverine shores.

Offensive Approach: Since there is no significant source of sand, beach fill must be used to create beach and marsh substrate situations. In Aquia Creek the use of low rock sills, short groins and small breakwaters in combination with beach fill and marsh plantings are very viable options and go a long way to fulfilling all the aforementioned shoreline management objectives.

Headland Control: Headland and reach control opportunities exist adjacent to existing structures and at Point CC where a low shore protuberance and tidal flat occur.

REACH THREE

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach A3 in Aquia Creek extends from Watsons Point northwestward to Gourds Point a distance of approximately 3,500 feet (Figure 19). Land use is mostly rural residential that becomes wooded unmanaged toward Gourds Point. Soil types are part of the Sassafras-Aura-Caroline association. The upland banks drain toward Aquia Creek.

Upland Bank and Shoreline Characteristics

The upland bank planform of Reach A3 occurs as a shallow curvilinear embayment that is interrupted by Point DD, which is bulkheaded marina. There are a few other bulkheads and short groins heading back toward Watsons Point. Between Point DD and Gourds Point a small embayment is formed. Watsons Point, Point DD and Gourds Point are relatively low 10 foot banks, while the remaining banks rise up to 100 feet above Aquia Creek. Gourds Point proper has a small tidal creek at its apex. The undeveloped upland banks are very stable and vegetated along their upper slopes but large wave cut scarps 10 to 12 feet high occur along their base.

The unprotected shoreline along Reach A3 has very narrow beach, the sand of which is derived from the erosion of the base of the upland banks. A somewhat wider beach occurs in the Gourd Point/Point DD embayment, where sand is trapped as a pocket beach.

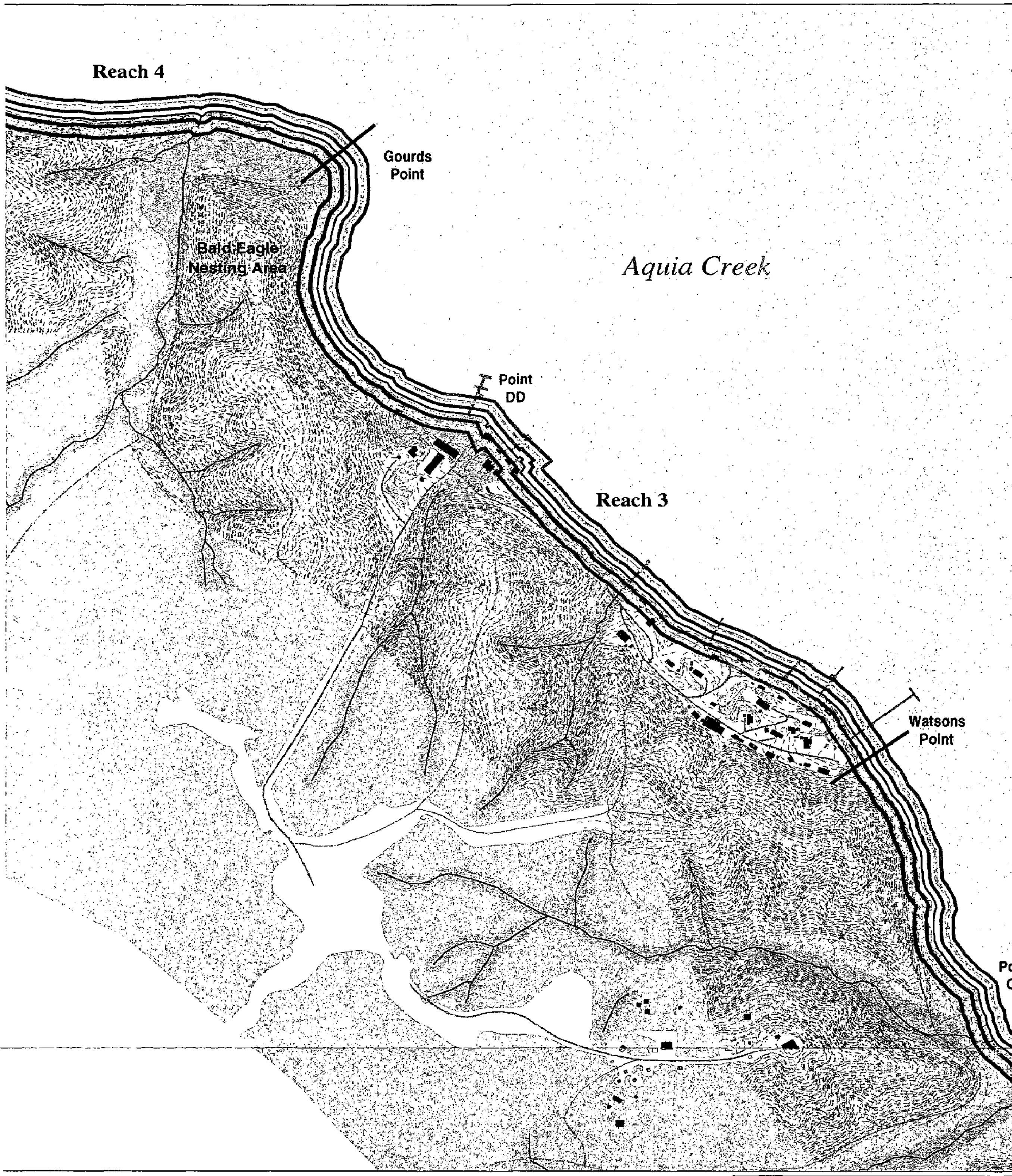
Nearshore Characteristics

The nearshore along Reach A3 has the -3 foot MLW contour approximately 550 feet offshore. The nearshore becomes slightly narrower at Watsons Point and Gourd Point with the -3 foot MLW contour occurring approximately 300 feet offshore. There appears to be little or no SAVs along this reach.

Hydrodynamic Setting

Wave Climate

The very fetch limited wave climate is controlled by the northeasters and northwesters along Reach A3. However, the potential for boat wake activity is quite real in a relatively narrow creek with a large quantity of displacement hull pleasure craft.



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 19
Aquia Creek
Reach 3

0 200 400 Feet

Littoral Processes

The sheltering effect of Gourds Point protects the adjacent small bay from direct northwest wave approach. The northeasterly events appear to control the bays littoral processes. Downstream toward Watsons Point the northwest impact appears as slight downstream offsets in the beach created by short groins.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 24 and 25. Land use along this reach has remained constant, while there has been an increase in shoreline stabilization. The preferred strategy has been bulkheads and revetments.

Table 24 **REACH A3 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	2,594	N/A	1,756
Hardened	707	N/A	1,453
Groins	682	N/A	773
Breakwater/Sills	0	N/A	0

Table 25 **REACH A3 LAND USE CONDITIONS (FT)**

	1973	1985	1994
Unmanaged	1,844	N/A	1,798
Agricultural	0	N/A	0
Residential	1,878	N/A	1,878
Commercial		N/A	
County		N/A	
Miscellaneous (Roads, Railroads)	260	N/A	306

Shoreline Protection Strategies

No Action: This is an appropriate strategy taking into account the potential instability of the unprotected upland banks.

Defensive Approach: The existing structures appear adequate for the wave exposure along Reach A3. Loss of intertidal habitat will continue if defensive approach is employed along the remainder of the reach. In a sheltered creek, environment shore zone habitat is probably more important to marine resources than on the high energy riverine shores.

__Offensive Approach__: Since there is no significant source of sand, beach fill must be used to create beach and marsh substrate situations. In Aquia Creek the use of low rock sills, short groins and small breakwaters in combination with beach fill and marsh plantings are very viable options and go a long way to fulfilling all the aforementioned shoreline management objectives.

__Headland Control__: Headland and reach control opportunity exists adjacent to Gourd Point in the small bay. If future land use conversion to rural residential occurs, then the sheltered bay already is set with headland control, and only minor treatment of problem areas with low sills and marsh plantings would be necessary.

REACH FOUR

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

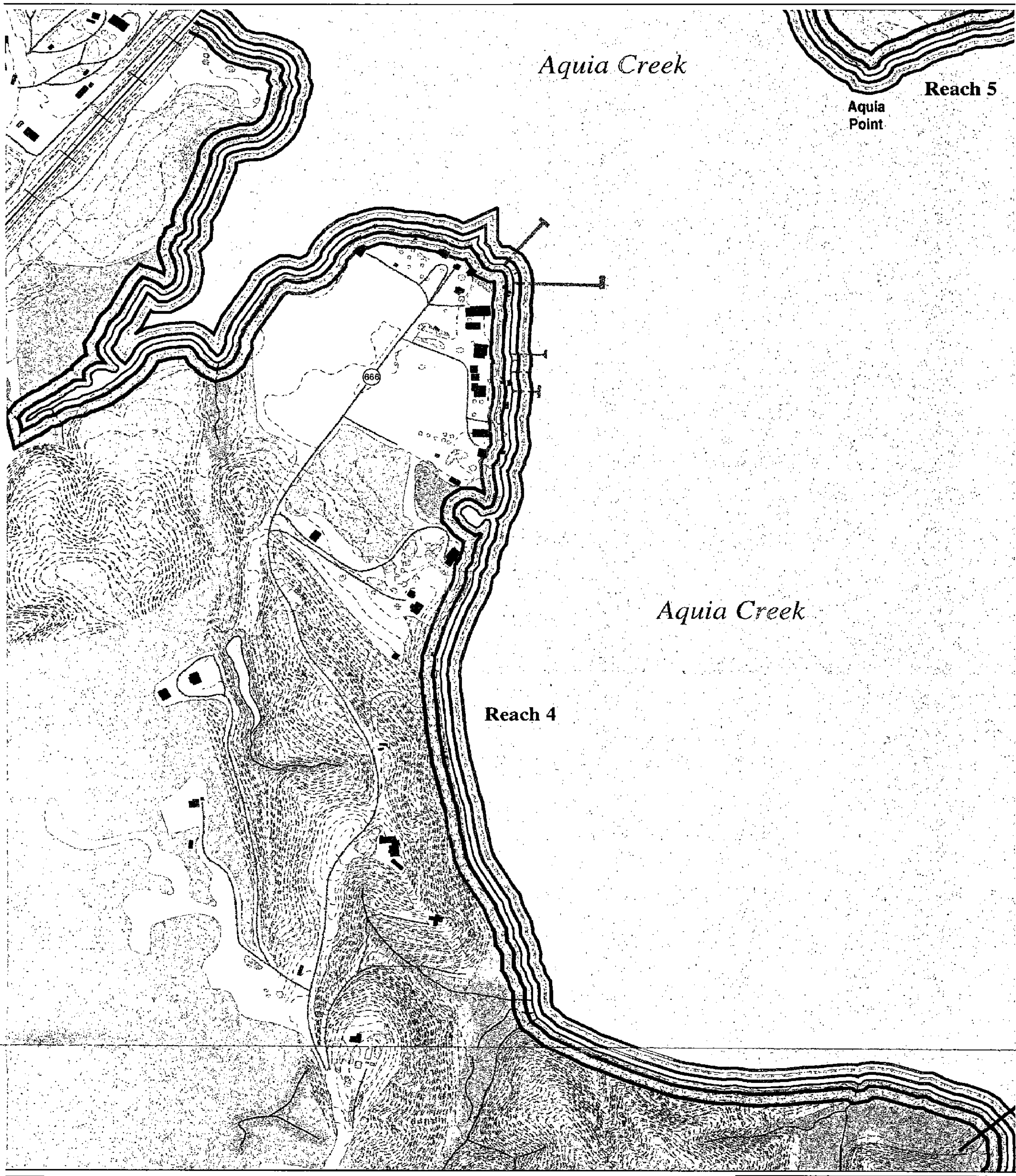
Reach A4 extends from Gourds Point to the RF&P Railroad bridge a shoreline length of approximately 11,000 feet. Except for the marina and residential area of "Marina Point," the land is mostly unmanaged wooded (Figure 20).

The upland drainage consists of three small watersheds. One is just upstream of Gourds Point, the second approximately 2,000 feet upstream of Gourds Point and the third is a tidal creek and pocket marsh between the railroad bridge and "Marina Point." Except for the pocket marsh (Tm) the soils are part of the Sassafras-Aura-Caroline association.

Upland Bank and Shoreline Characteristics

The upland banks start low at Gourds Point and quickly rise upstream of the tidal creek to over 100 foot MLW, drop back to accommodate the mid-bay drainage and rise back up and continue toward "Marina Point" where the bank drops down to +10 feet MLW. The shoreline around "Marina Point" has been protected mostly with bulkheads. The base of the undeveloped bank is undercut and exposed along its base with a 10 to 15 foot scarp.

The shoreline around Reach A4 has little or no beach. There is a small marsh fringe associated with the mid-bay drainage and pocket marsh. The lack of marsh fringe along the southside of Aquia Creek can be attributed to the high banks which shade the shoreline as well as with the northern exposure to storm wind/wave activity.



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping
Prepared by Air Survey and Design, Inc.
from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 20
Aquia Creek
Reach 4

0 200 400 Feet

Nearshore Characteristics

The -3 foot MLW contour occurs approximately 300 feet off "Marina Point" and Gourds Point and approximately 1,000 to 1,500 feet offshore of the adjacent embayment. That embayment is therefore very shallow with little or no SAVs present.

Hydrodynamic Setting

Wave Climate

Except for Gourds Point and "Marina Point", Reach A4 is fairly sheltered from northwest wind/wave action. Northeasters have some direct impact across the remainder of the reach but impacts are severely modified by the shallows.

Littoral Processes

Limited sand and sand movement is seen along Reach A4. However, enough wave energy is generated to warrant shoreline protection at "Marina Point."

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 26 and 27. A significant increase in shoreline hardening is observed for this reach, while there has been relatively little change in land use.

Table 26 **REACH A4 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	10,912	N/A	9,575
Hardened	442	N/A	1,675
Groins	0	N/A	106
Breakwater/Sills	0	N/A	0

Table 27

REACH A4 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	8,259	N/A	8,324
Agricultural	839	N/A	839
Residential	1,747	N/A	1,504
Commercial	300	N/A	568
County	0	N/A	0
Miscellaneous (Roads, Railroads)	211	N/A	122

Shoreline Protection Strategies Assessment

No Action: This is an appropriate strategy taking into account the potential instability of the unprotected upland banks.

Defensive Approach: The existing structures appear adequate for the wave exposure along Reach A4. Loss of intertidal habitat will continue if defensive approach is employed along the remainder of the reach. In a sheltered creek environment, shore zone habitat is probably more important to marine resources than on the high energy riverine shores.

Offensive Approach: Since there is no significant source of sand, beach fill must be used to create beach and marsh substrate situations. In Aquia Creek the use of low rock sills, short groins and small breakwaters in combination with beach fill and marsh plantings are very viable options and go a long way to fulfilling all the aforementioned shoreline management objectives.

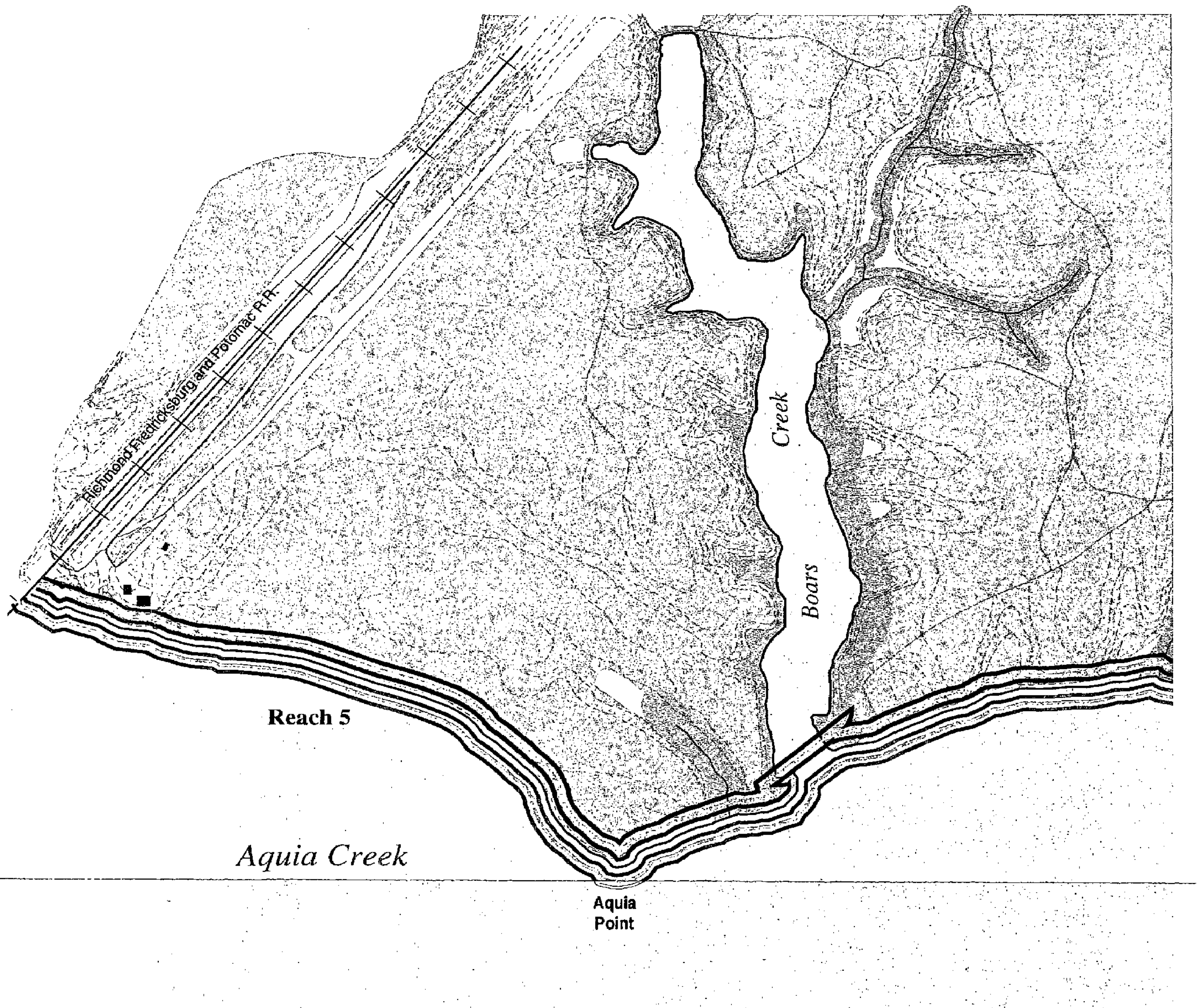
Headland Control: Headland and reach control opportunities are limited and occur within the broad embayed nature of the reach. It may be possible to use beach fill with some small rock breakwaters to control basal bank erosion along the eroding bank areas in the bay.

REACH FIVE

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach A5 extends from the RF&P Railroad bridge southeastward along the north shore of Aquia Creek to Bennetts Point, a distance of approximately 7,000 feet. Land use along Reach A5 is primarily wooded unmanaged (Figure 21 and Figure 22).



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

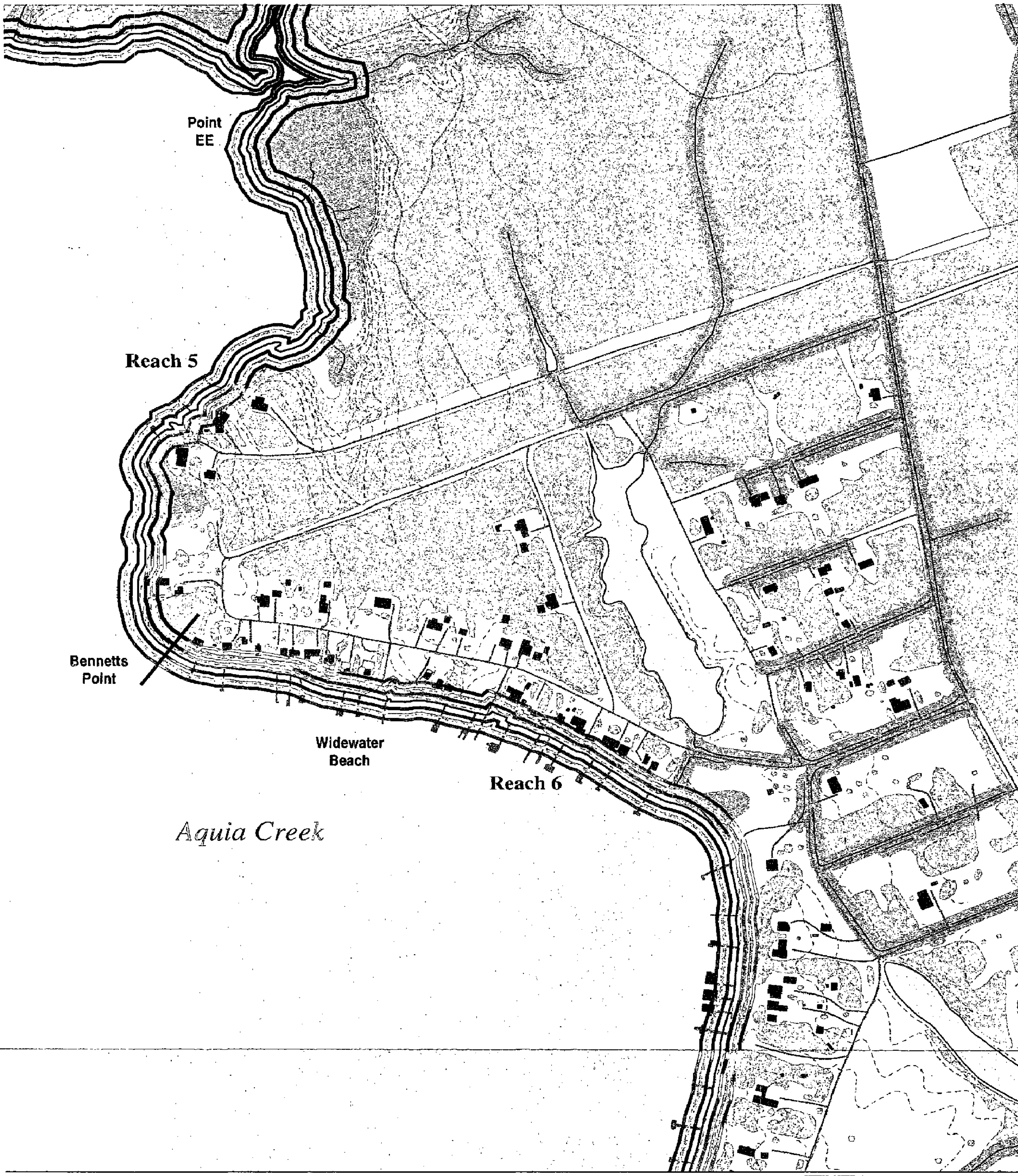
Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 21
Aquia Creek
Reach 5

0 200 400 Feet



Wetlands and Hydric Soils
Tree Cover
Contour Line (5' Interval)

Data Sets
1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)
Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)
No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping Prepared by Air Survey and Design, Inc. from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 22
Aquia Creek
Reach 5 & 6

0 200 400 Feet

The soils along the shore of Reach A5 are part of the Tetotom-Bladen-Bertie association except for the tidal marsh segments (Tm). The upland is lower and flatter that the south side of Aquia Creek and generally drains toward Aquia Creek and Boars Creek and the small tidal creek watershed with fringing marsh that outlets at Point EE.

Upland Bank and Shoreline Characteristics

The upland bank in Reach A5 starts at the RF&P Railroad bridge and drops in elevation to less than +5 feet MLW as it extends southeastward toward "Aquia Point." A 5 foot scarp occurs along the base. The shoreline then turns east into an embayment defined by "Aquia Point" and Bennetts Point where Boars Creek in encountered. The mouth of Boars Creek is approximately 150 feet across to the low upland bank that continues eastward between +5 and +10 feet MLW. The pocket marsh fringe associated with the small Point EE watershed is approximately 1,800 feet long and ends at the upland/marsh boundary near Bennetts Point. The Bennetts Point shoreline is rural residential and mostly bulkheaded.

The shoreline along Reach A5 has virtually no beach and the low upland banks and marsh shore are undercut. There are no littoral structures (i.e., groins) seen along this reach.

Nearshore Characteristics

The nearshore region along Reach A5 is very shallow as the -3 foot MLW contour extends off and connects "Aquia Point" and Bennetts Point. There does not appear to be any SAVs along this reach. However, some surface vegetation is visible at the mouth of Boars Creek.

<u>Hydrodynamic Setting</u>

Wave Climate

The embayed part of this reach is very sheltered from storm wind/wave action. Bennetts Point is impacted more from northwesterly events. Reach A5 is generally protected from northeasters.

Littoral Processes

Very limited wave action corresponds to little littoral transport activity.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 28 and 29. The trend towards increased lengths of hardened shoreline continues in Reach A5. Land use remained unchanged.

Table 28

REACH A5 SHORELINE CONDITIONS (FT)

	1973	1985	1994
No Structures	18,169	N/A	17,303
Hardened	0	N/A	734
Groins	0	N/A	133
Breakwater/Sills	0	N/A	0

Table 29

REACH A5 LAND USE CONDITIONS (FT)

	1973	1985	1994
Unmanaged	16,923	N/A	16,923
Agricultural	0	N/A	0
Residential	1,191	N/A	1,191
Commercial	0	N/A	0
County	0	N/A	0
Miscellaneous (Roads, Railroads)	51	N/A	51

Shoreline Protection Strategies

No Action: The undeveloped shoreline along Reach A5 has an imperceptible erosion problem except for the segment between railroad bridge and "Aquia Point." Therefore, no-action is a logical strategy except for maintaining protection of the railroad bridge abutment.

Defensive Approach: Building low rock revetments or timber bulkheads would be mostly appropriate for the shore segment from the railroad bridge to "Aquia Point."

Offensive Approach: Establishing marsh fringes along the upland banks would be a cost-effective and environmentally positive approach. A low sill or shore groin and a small volume of beach fill (marsh substrate) would be in order.

Headland Control: "Aquia Point" and Bennetts Point are exerting headland control to the adjacent embayment. "Aquia Point" and the point at the railroad bridge could act in unison to address the adjacent shore, if they were accentuated with rock spurs.

REACH SIX

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach A6 extends 5,000 feet from Bennetts Point to Shackley Point and bound the embayment at Widewater Beach (Figure 22). The land use is mostly rural residential. The upland drainage is creekward and the soils are part of the Tetotum-Bladen-Bertie association.

Upland Bank and Shoreline Characteristics

The upland bank occurs between +5 and +10 feet MLW along Reach A6. Most of the shore is bulkheaded except for exposed basal scarps at Bennetts Point and just upstream of Shackley Point. There are 33 piers along Reach A6.

The shoreline along Reach A6 is almost completely hardened with timber bulkheads except for a couple of stone revetments, a few groins and two midbay boat ramps that tend to act like short groins. The only beaches are narrow ones at Bennetts Point and Shackley Point in front of eroding banks.

Nearshore Characteristics

The -3 foot MLW contour is approximately 200 feet off Bennetts Point and Shackley Point, but occurs approximately 1,100 feet offshore of the Widewater Beach embayment. There is little or no SAV apparent offshore along Reach A6.

Hydrodynamic Setting

Wave Climate

Except for Bennetts Point and Shackley Point, the embayed shoreline at Widewater Beach is protected against northeasters. The west facing shore limb of the bay is more exposed to the northwest wind/wave activity. The entire bay is open to the southwest where high winds can impact the shoreline on an annual basis.

Littoral Processes

The relatively mild wave climate in the Widewater Beach bay shows a slight downstream movement of sand as evidenced by shoreline offsets and sand fillets against the north side of short groins.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 30 and 40. A significant increase in shoreline hardening is coupled with a minor increase in residential land use.

Table 30 **REACH A6 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	3,010	N/A	1,552
Hardened	2,206	N/A	3,663
Groins	109	N/A	109
Breakwater/Sills	0	N/A	0

Table 31 **REACH A6 LAND USE CONDITIONS (FT)**

	1973	1985	1994
Unmanaged	1,543	N/A	1,273
Agricultural	0	N/A	0
Residential	3,731	N/A	4,051
Commercial	0	N/A	0
County	0	N/A	0
Miscellaneous (Roads, Railroads)	0	N/A	0

Shoreline Protection Strategies

No Action: Most of the reach is already hardened.

Defensive Approach: Maintaining the existing structures would be the approach under this strategy category.

Offensive Approach: The are opportunities for small breakwaters and sills off Bennetts Point and Shackley Point.

Headland Control: This would coincide with the protection of Bennetts Point and Shackley Point and would extend into the management of the adjacent reaches A5 and A7.

REACH SEVEN

Physical/Biological Setting

Reach Boundaries, Land Use, Soils and Drainage

Reach A7 extends from Shackley Point to Simms Point a length of approximately 7,000 feet around a curvilinear embayed shoreline (Figure 23). Land use is mostly unmanaged wooded with several segments of rural residential. Upland drainage for this lower end of the Widewater Peninsula appears to fall toward Aquia Creek. The soils are in the Tetotum-Bladen-Bertie association.

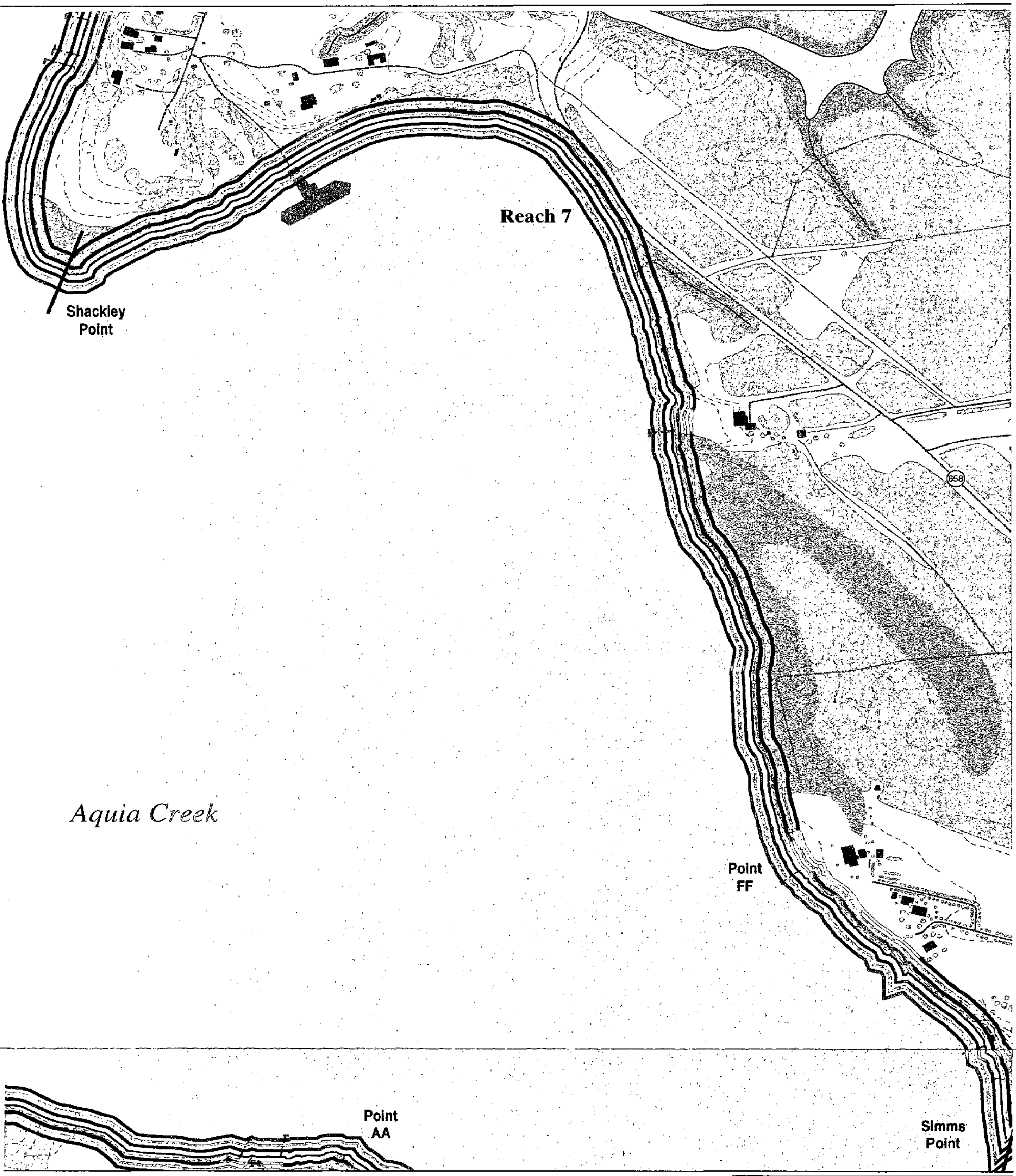
Upland Bank and Shoreline Characteristics

The upland bank is approximately 15 to 20 feet in elevation along Reach A7 with basal scarp that is only 2 to 4 feet along the upstream limb of the embayment. This scarp rises to almost 15 feet near Simms Point. An old wharf is present approximately 1,000 feet downstream of Shackley Point. On the Simms Point side of the bay, recent shoreline hardening is proceeding in the form of a stone revetment. A failed bulkhead is found adjacent to the revetment. Further toward Simms Point several hundred feet of timber bulkhead occurs.

The shoreline along Reach A7 has an intermittent marsh fringe along the Shackley Point limb of the bay and a narrow beach along the Simms Point limb of the bay where the shore is unprotected. A beach protrudes at the location of the old wharf and is used as a landing. A low spit feature and blunted spit occur at Simms Point. A point pond has formed by the processes that created this accretional point.

Nearshore Characteristics

Except for the areas off Shackley Point and Simms Point, the adjacent bay is very shallow with the -3 foot MLW contour as much as 2,000 feet offshore. The are a modest amount of SAVs in the central portion of the embayed reach.



Wetlands and Hydric Soils

Tree Cover

Contour Line (5' Interval)

Data Sets

1994 Land Attributes
1985 Land Attributes
1973 Land Attributes
Actual Shoreline 1988
1973 Shoreline Attributes
1985 Shoreline Attributes
1994 Shoreline Attributes

Landuse Attributes (Landward of 1988 Shoreline)

Private Agricultural
Private Residential
Private Unmanaged
Commercial Waterfront
County
Miscellaneous
No Data

Shoreline Attributes (Seaward of 1988 Shoreline)

No Structures
Hardened
Breakwater / Sill
Groins
No Data

Sources:
Base Mapping Digitized from Mapping
Prepared by Air Survey and Design, Inc.
from Aerial Photography taken March, 1988.
Soils: USDA, 1974
Wetlands: VIMS, 1975

Vanasse Hangen Brustlin, Inc.

Stafford County Virginia Shoreline Characteristics

Figure 23
Aquia Creek
Reach 7

0 200 400 Feet

Hydrodynamic Setting

Wave Climate

Reach A7, like most of the north shore of Aquia Creek, is protected from direct wave attack during northeast storm events. Northwesters and southwesters will most effect the shore segment running upriver from Simms Point.

Littoral Processes

The limited sands along the shore of Reach A7 move mostly downstream. Simms Point is an accretionary nodal point that receives sand from bank erosion and subsequent transport from Reach A7 and Reach P5.

Historic Characteristics

The changes in land use and shoreline conditions over the period between 1973 and 1994 are depicted in Tables 28 and 29. The trend towards increased lengths of hardened shoreline continues in Reach A7. Land use remained unchanged.

Table 32 **REACH A7 SHORELINE CONDITIONS (FT)**

	1973	1985	1994
No Structures	6,207	N/A	5,306
Hardened	1,230	N/A	1,903
Groins	0	N/A	228
Breakwater/Sills	0	N/A	0

Table 33 **REACH A7 LAND USE CONDITIONS (FT)**

	1973	1985	1994
Unmanaged	5,904	N/A	5,904
Agricultural	0	N/A	0
Residential	1,358	N/A	1,358
Commercial	0	N/A	0
County	0	N/A	0
Miscellaneous (Roads, Railroads)	174	N/A	174

Shoreline Protection Strategies

No Action: This strategy would eventually allow the continued hardening of the shoreline with revetments and bulkheads.

Defensive Approach: It is important to build quality bulkheads and revetments. There should be no problem with addressing the limited wave energy along Reach A7.

Offensive Approach: Sills and breakwaters are a viable alternative along the remaining unprotected shores.

Headland Control : The shoreline around the embayment formed by Shackley Point and Simms Point is mostly curvilinear with those points offering the best headland control. The shore protuberance at Point FF could offer an intermediate headland to work in unison with Simms Point to address the adjacent shore.

CONCLUSIONS

The shoreline of the Potomac River and Aquia Creek have been evaluated with respect to physical conditions and historic shore protection trends. As land use changes to private residential development, greater segments of the shoreline become hardened. It is apparent that the preferred method of protection to date has been bulkheading and revetments. While this approach may effectively stop erosion, it does not achieve the stated goals of habitat protection and water quality improvement and tends to limit access for humans, as well as wildlife and waterfowl.

The sporadic use of groins, and more recently breakwaters and sills, indicate that an offensive approach to shore protection is acceptable to many land owners; however, this strategy is not wide spread. The use of groins alone offers limited long-term protection to eroding banks due to severely limited sand supplies.

Along many reaches of the shoreline, offensive approaches that incorporate sandy substrate and marsh plantings in combination with rock structures are highly appropriate. If designed properly, these alternatives provide protection to valuable waterfront property, as well as create a more natural land-water interface. Further, alternative methods serve to meet a greater number of the County's shoreline management objectives. These concepts can be suggested for waterfront land owners through the Planning Department and the County Wetlands Board to encourage shore protection strategies that are consistent with County shoreline management objectives.

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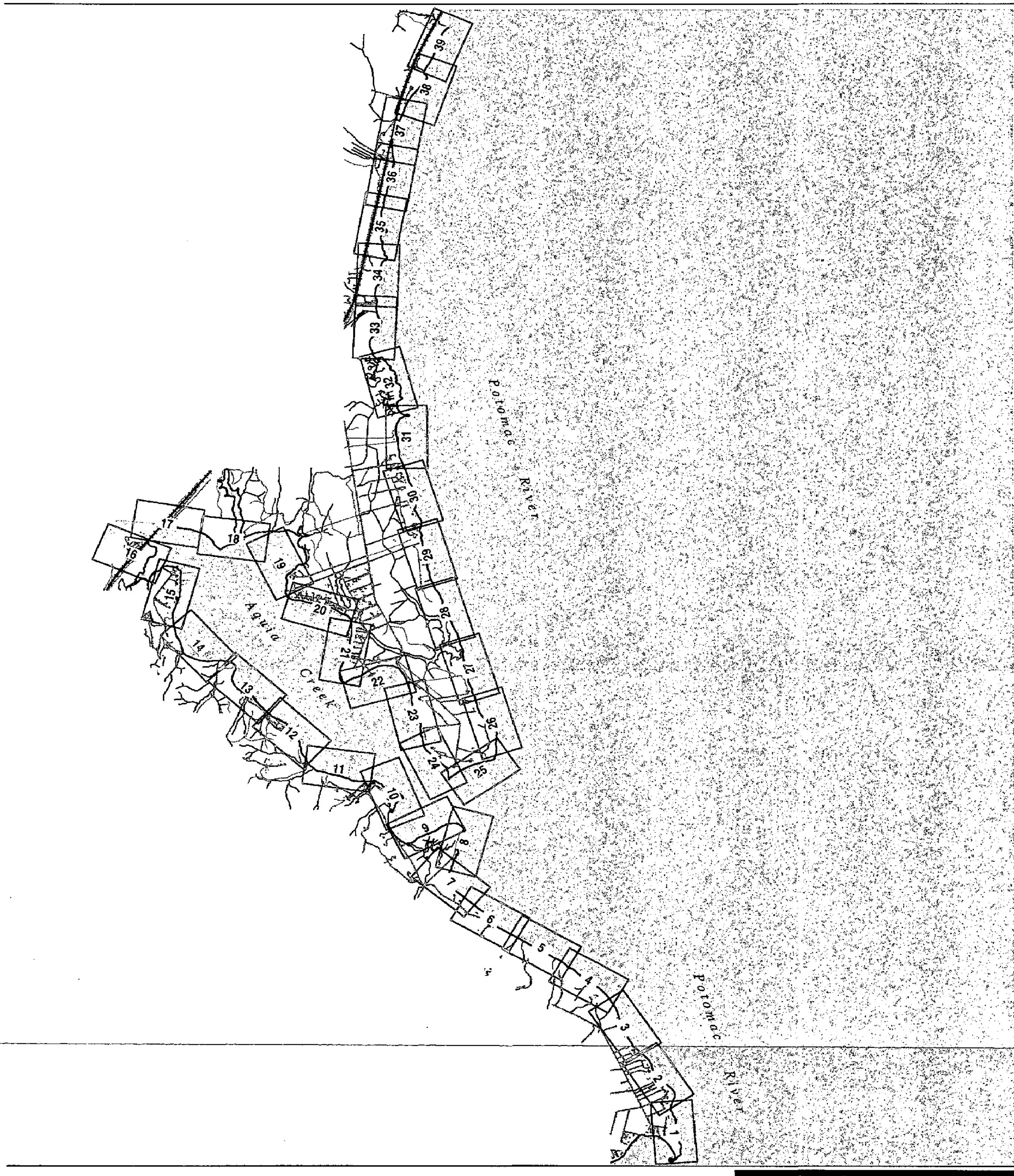
Virginia Institute of Marine Science 1975. Shoreline Situation Report, Stafford County, Virginia. Special Report 79 in Applied Marine Science and Ocean Engineering, Gloucester Point, Virginia, 55 p.

Wright, L. D., C. S. Kim, C. S. Hardaway, S. M. Kimball, and M. O. Green 1987. Shoreface and Beach Dynamics of the Coastal Region from Cape Henry to False Cape, Virginia. VIMS Contract Technical Report to the Virginia Department of Conservation and Historic Resources via Joint Commonwealth Programs Addressing Shore Erosion in Virginia, Gloucester Point, Virginia, 116 p.

Appendix A

Appendix A is a notebook of vertical aerial photographs of the project shoreline taken on October 6, 1994 at a scale of 1"=200'. The notebook is available for review at the Stafford County Department of Planning and Community Development. The following graphic provides an index to the photographs.



Vanasse Hangen Brustlin, Inc.

Stafford County Virginia
Shoreline Characteristics

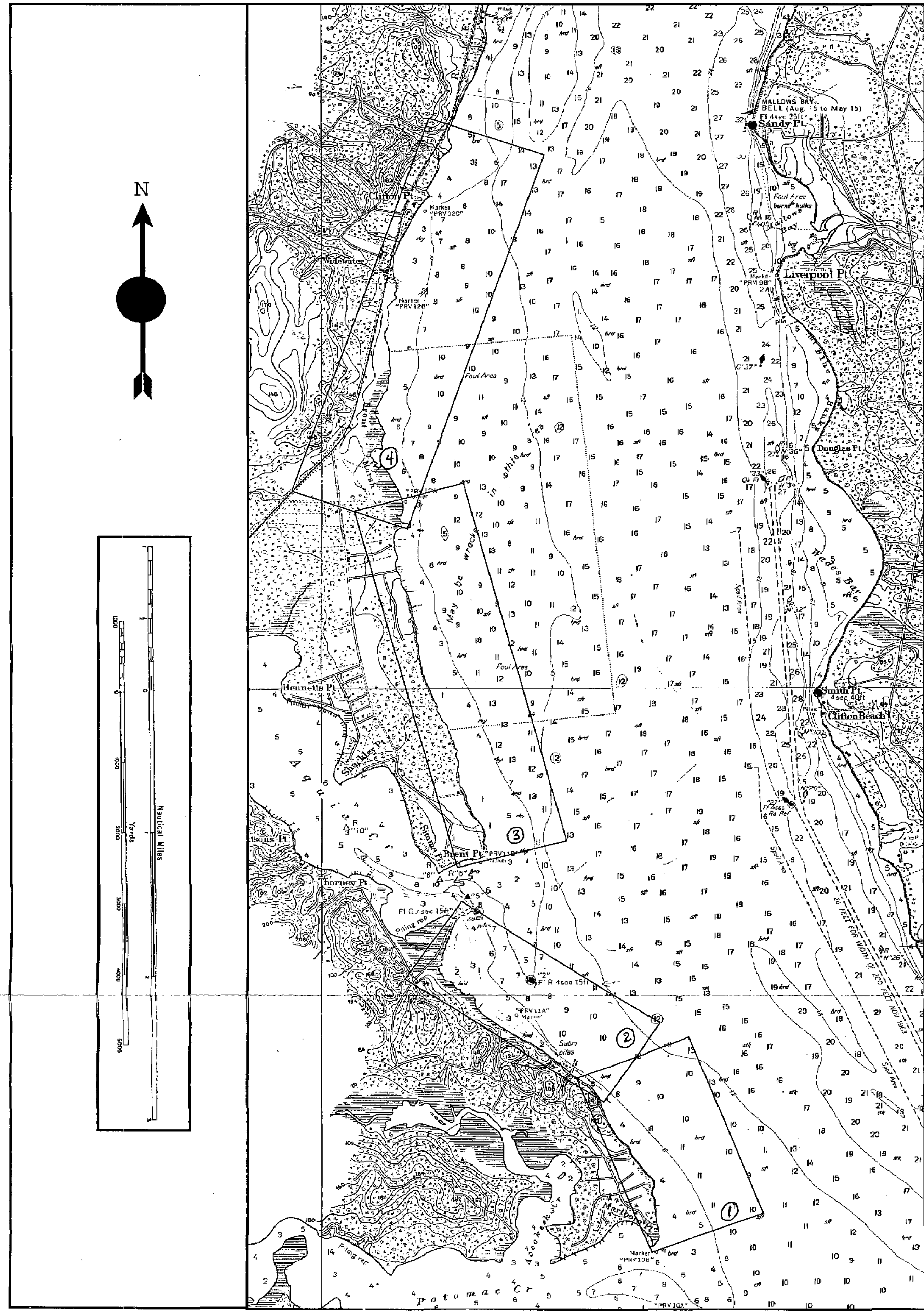
Study Area Photograph Index

0 1800 3600 Feet

Note:
Photography Taken October 6, 1994.

KEYPLAN.DWG

Appendix B



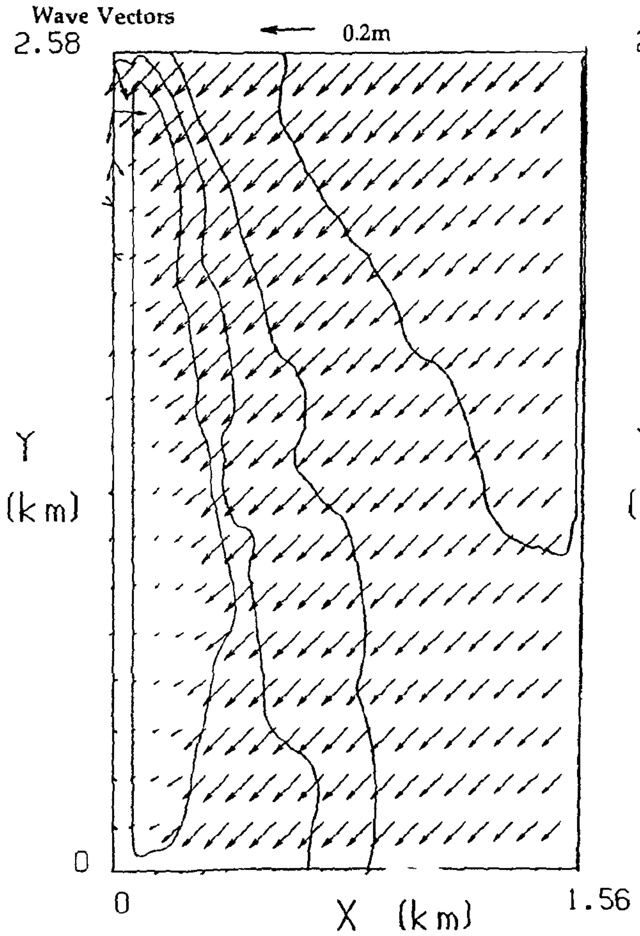
N
Nautical Miles
Yards
MALLOWS BAY BELL (Aug. 15 to May 15)
Sandy Pt
Mallows Bay
Clifton Pt
Widewater
Liverpool Pt
Douglas Pt
Wades Bay
Foul Area
May be wrecks in this area
Smith Pt
Clifton Beach
Bennetts Pt
Brent Pt
Thorney Pt
Marlboro Pt
Potomac Cr
1
2
3
4

Stafford County Grid 1

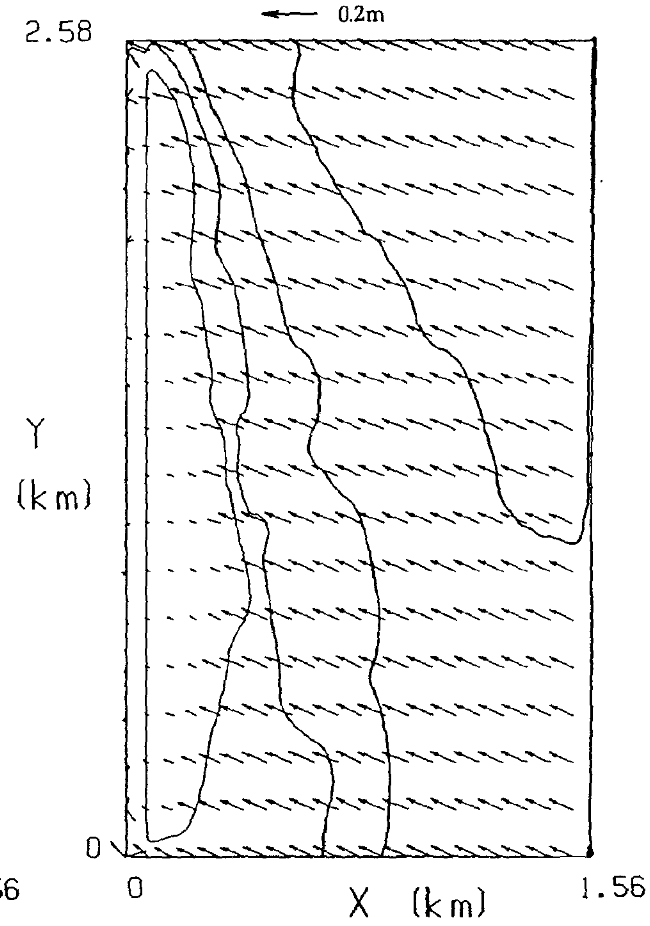
	Wave Height (meters)	Wave Period (seconds)	Direction of Wave Advance (degrees TN)	Surge (meters)
Modal Conditions				
Case 1	0.2	1.6	203	0.6
Case 2	0.2	1.7	270	0.6
Case 3	0.2	1.7	293	0.6
Storm Conditions				
Case 1	0.6	2.9	203	1.2
Case 2	0.6	2.9	270	1.2
Case 3	0.6	2.9	293	1.2

Stafford County Grid 1 Modal Conditions

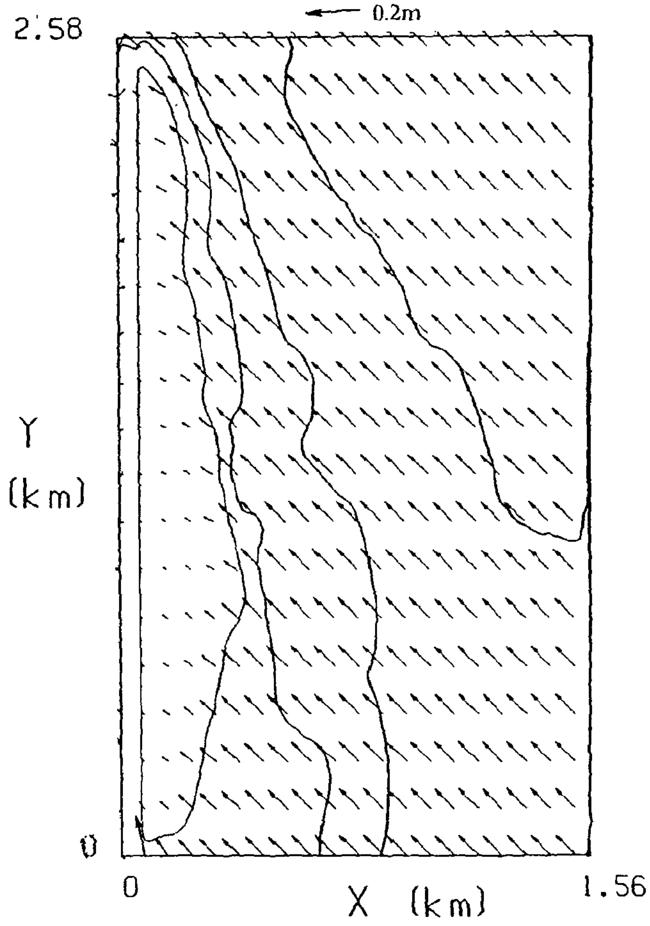
Case 1
H=0.2 m: T=1.6 sec: Ang=203°



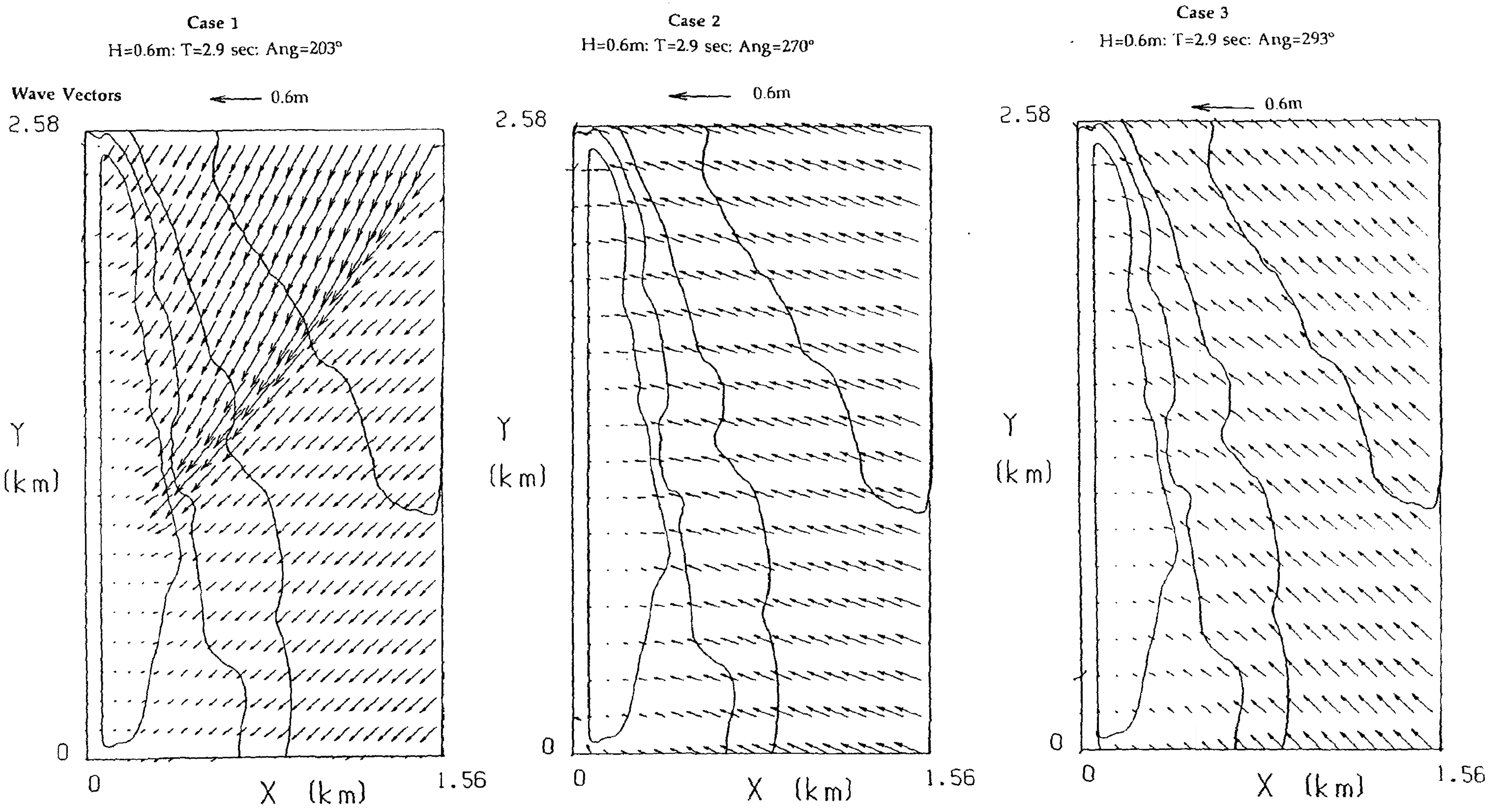
Case 2
H=0.2 m: T=1.7 sec: Ang=270°



Case 3
H=0.3 m: T=1.7 sec: Ang=293°



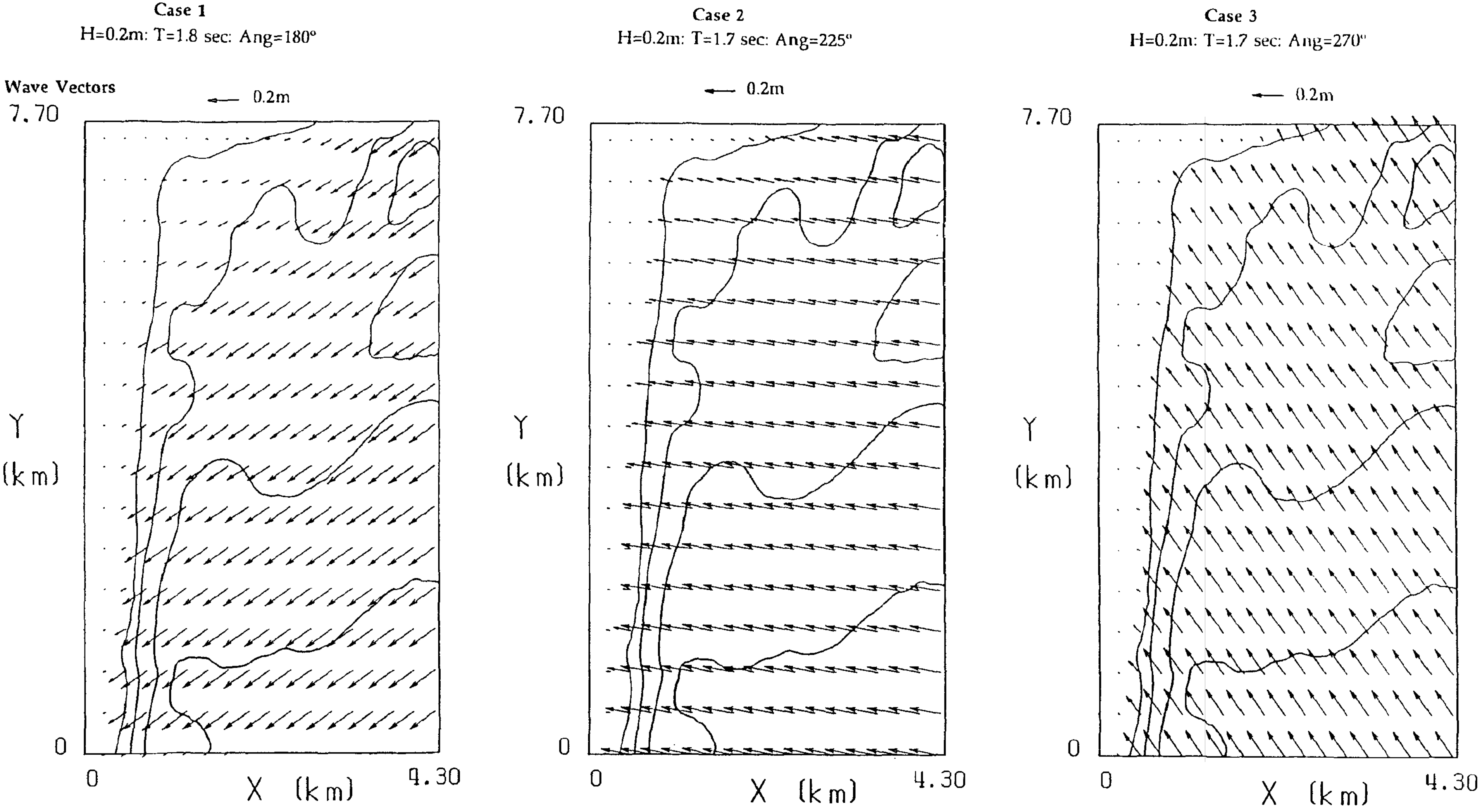
Stafford County Grid 1 Storm Conditions



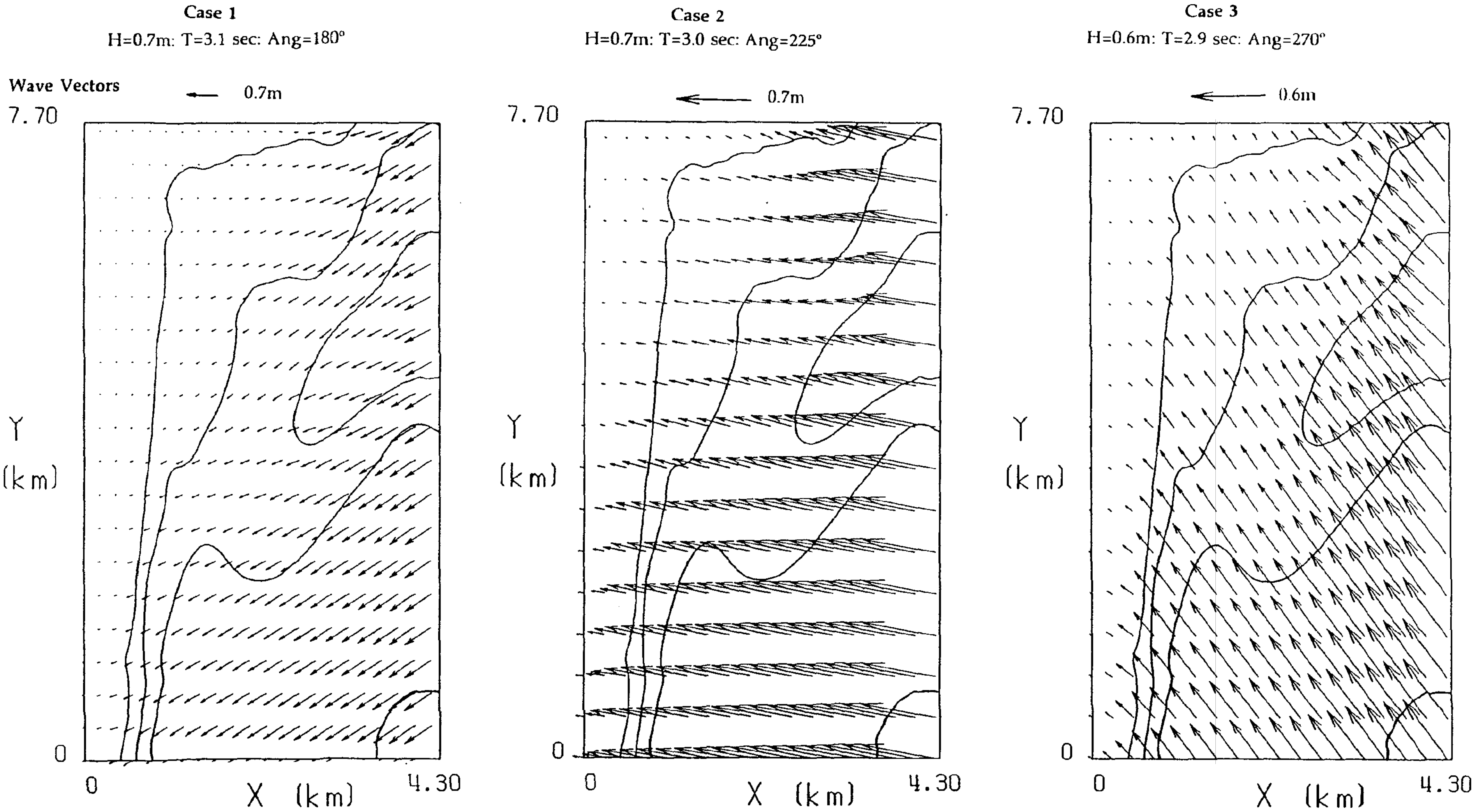
Stafford County Grid 2

	Wave Height (meters)	Wave Period (seconds)	Direction of Wave Advance (degrees TN)	Surge (meters)
Modal Conditions				
Case 1	0.2	1.8	180	0.6
Case 2	0.2	1.7	225	0.6
Case 3	0.2	1.7	270	0.6
Storm Conditions				
Case 1	0.7	3.1	180	1.2
Case 2	0.7	3.0	225	1.2
Case 3	0.6	2.9	270	1.2

Stafford County Grid 2 Modal Conditions



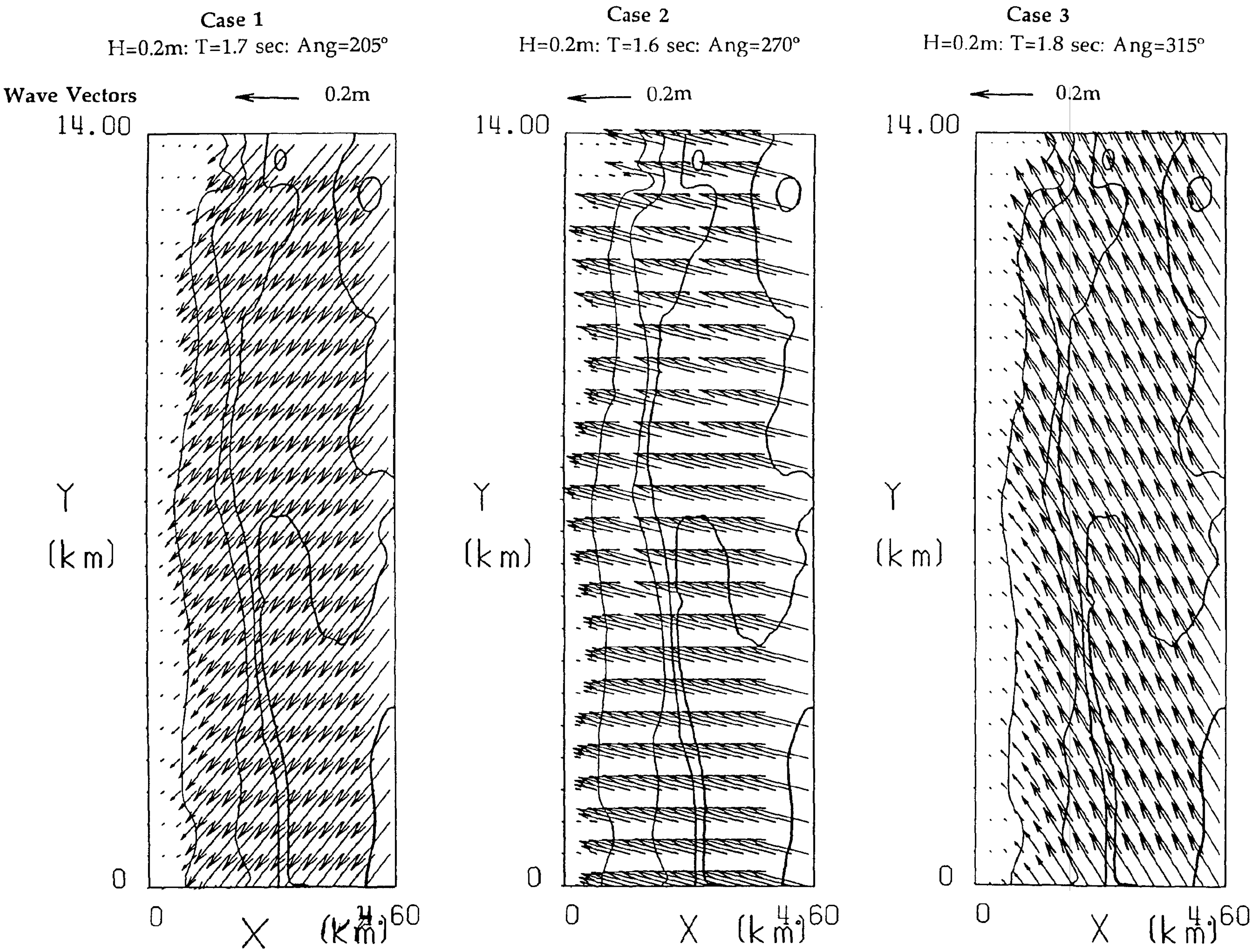
Stafford County Grid 2 Storm Conditions



Stafford County Grid 3

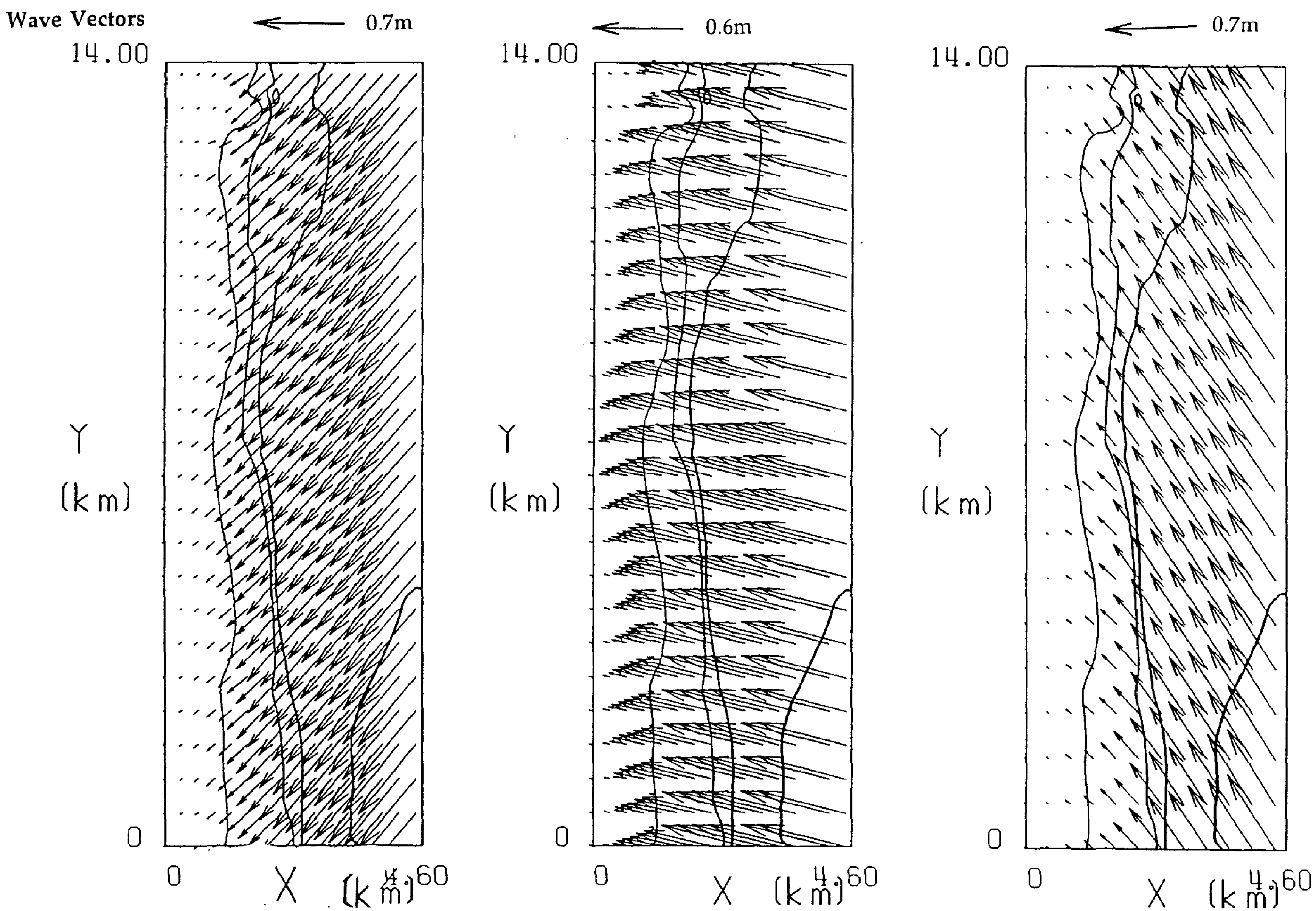
	Wave Height (meters)	Wave Period (seconds)	Direction of Wave Advance (degrees TN)	Surge (meters)
Modal Conditions				
Case 1	0.2	1.7	205	0.6
Case 2	0.2	1.6	270	0.6
Case 3	0.2	1.8	315	0.6
Storm Conditions				
Case 1	0.7	3.0	205	1.2
Case 2	0.6	2.7	270	1.2
Case 3	0.7	3.1	315	1.2

Stafford County Grid 3 Modal Conditions



Stafford County Gi [illegible] Storm Conditions

Case 1	Case 2	Case 3
H=0.7m: T=3.0 sec: Ang=205°	H=0.6m: T=2.7 sec: Ang=270°	H=0.7m: T=3.1 sec: Ang=315°



Stafford County Grid 4

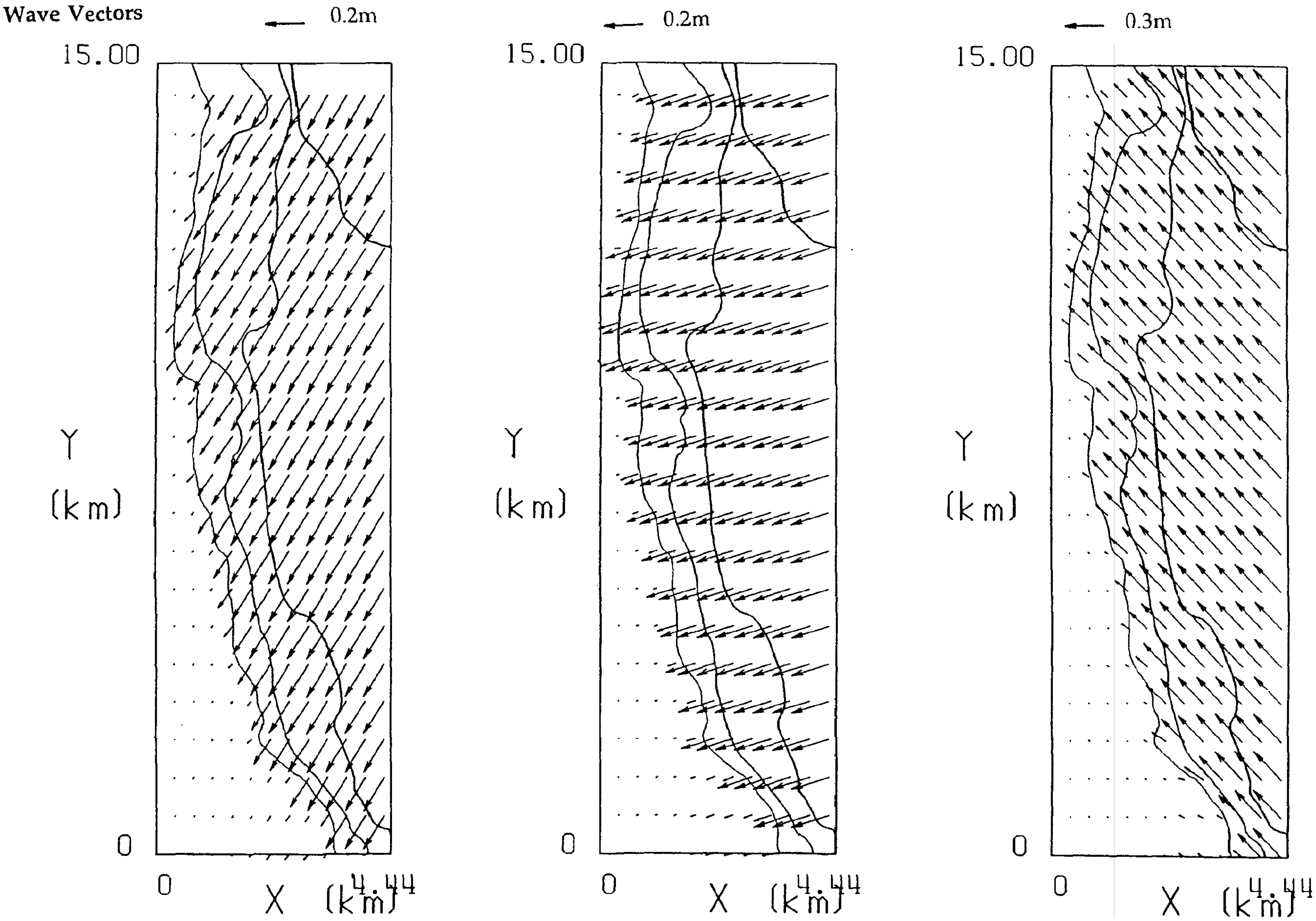
	Wave Height (meters)	Wave Period (seconds)	Direction of Wave Advance (degrees TN)	Surge (meters)
Modal Conditions				
Case 1	0.2	1.7	230	0.6
Case 2	0.2	1.6	270	0.6
Case 3	0.3	1.8	335	0.6
Storm Conditions				
Case 1	0.7	3.0	230	1.2
Case 2	0.6	2.8	270	1.2
Case 3	0.8	3.2	335	1.2

Stafford County Grid 4 Modal Conditions

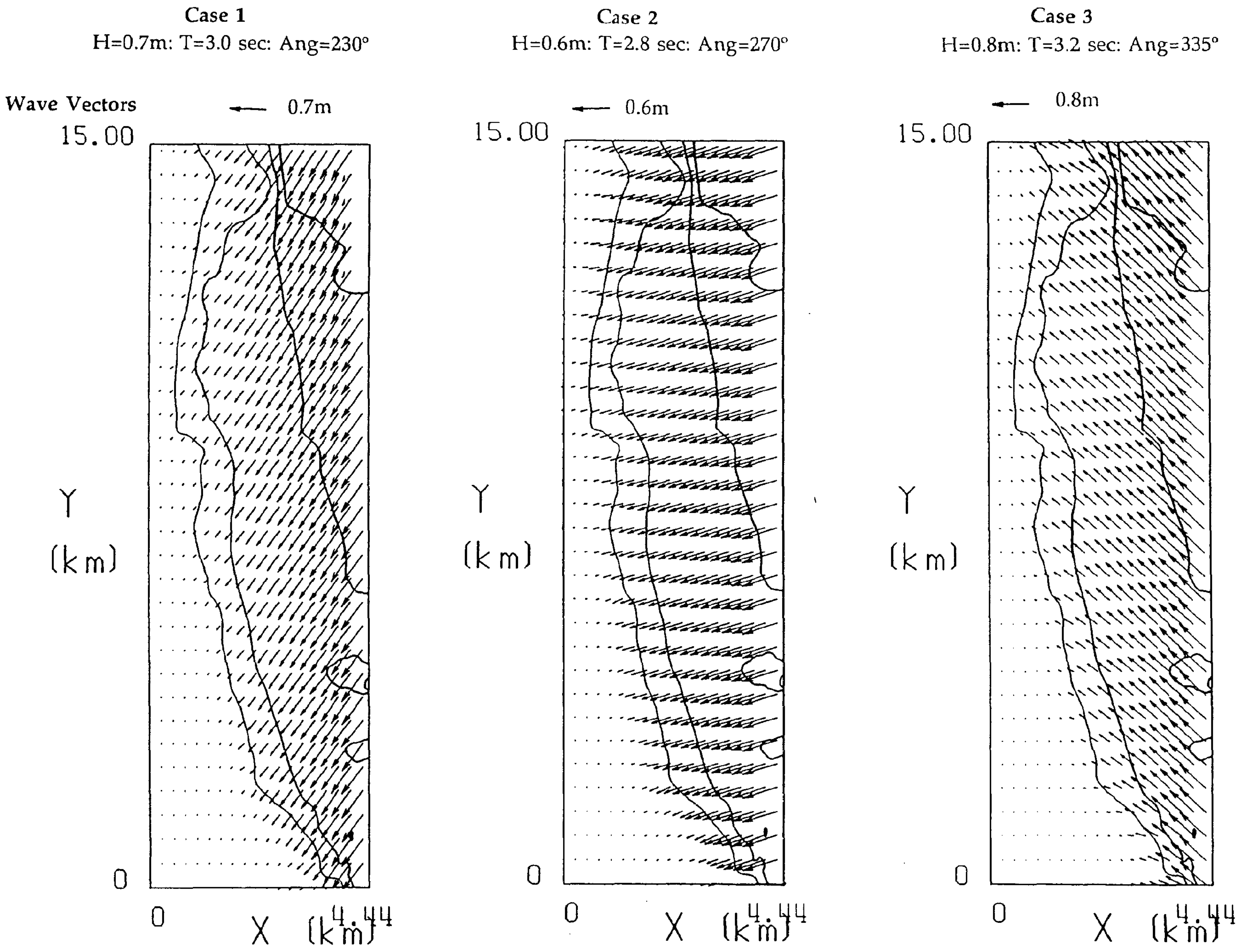
Case 1
H=0.2 m: T=1.7 sec: Ang=230°

Case 2
H=0.2 m: T=1.6 sec: Ang=270°

Case 3
H=0.3 m: T=1.8 sec: Ang=335°



Stafford County Grid 4 Storm Conditions

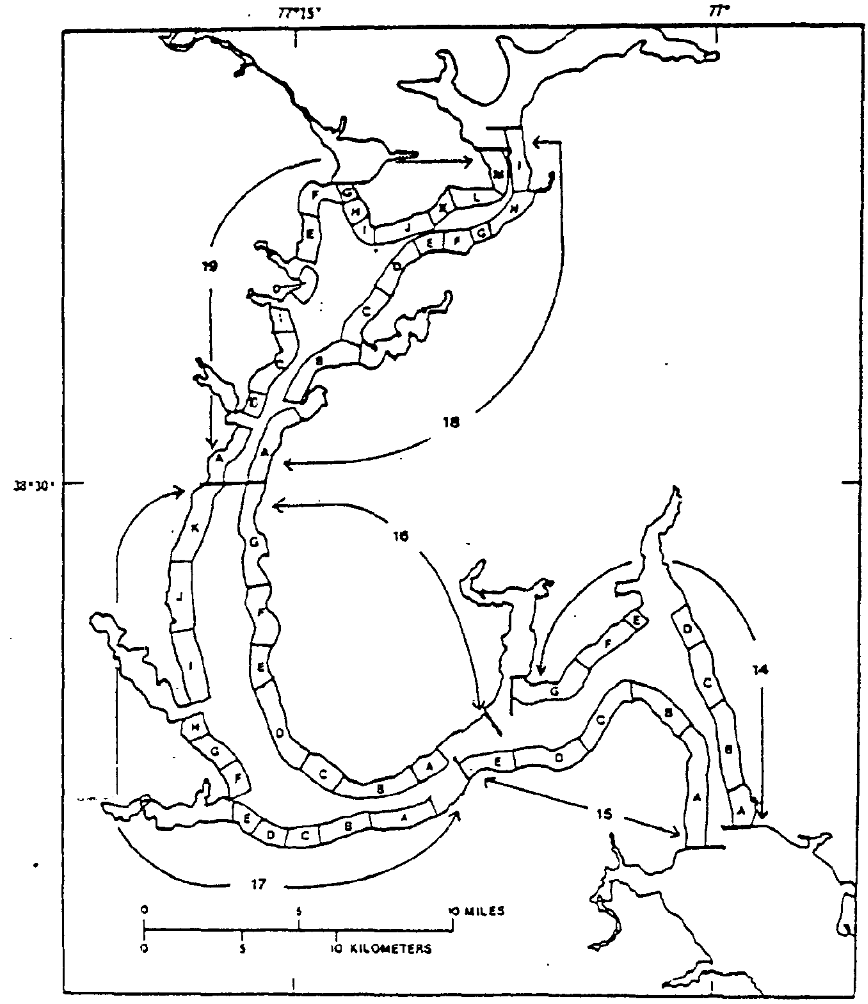


Appendix C

Table MEASURED EROSION RATES FOR SHORELINE SEGMENTS*

Reach	Segment	Coverage	Length (m) Carto-graphic	Length (m) Photo-grammetric	Mean Recession Rate (m/yr) Carto-graphic	Mean Recession Rate (m/yr) Photo-grammetric	Mean Volume Erosion Rate ($m^3/m/yr$) Carto-graphic	Mean Volume Erosion Rate ($m^3/m/yr$) Photo-grammetric
16	A	C	1170	-	-0.15	-	-0.41	-
	B	O	3410	3310	-0.10	+0.02	-0.23	-0.07
	C	O	2800	2740	-0.13	-0.13	-0.75	-0.84
	D	C	3910	-	-0.01	-	-0.12	-
	E	O	1750	1760	-0.05	-0.14	-0.27	-1.00
	F	O	4390	4370	-0.08	-0.31	-0.56	-1.77
	G	C	5850	-	+0.01	-	-0.17	-
17	A	C	3860	-	-0.02	-	-0.49	-
	B	O	2630	2540	-0.06	-0.04	-0.40	-0.20
	C	C	1870	-	+0.02	-	-0.13	-
	D	O	2120	2070	-0.25	-0.10	-1.47	-1.15
	E	O	570	570	-0.13	-0.14	-1.36	-1.26
	F	C	2540	-	-0.05	-	-0.46	-
	G	C	2130	-	-0.07	-	-1.38	-
Project Area	H	C	1520	-	-0.57	-	-0.52	-
	I	O	4330	4370	-0.16	-0.37	-0.72	-1.33
	J	C	4030	-	-0.83	-	-0.50	-
	K	C	4820	-	-0.00	-	-0.14	-
18	A	C	4160	-	-0.06	-	-0.61	-
	B	C	4440	-	-0.15	-	-0.77	-

* From Miller (1983)



Erosion Rate Key

Appendix D

Glossary of Terms

Beach Planform. Refers to the shape of the beach as seen in plan view. The shape of the beach planform, particularly between headland features, provides an indication of the direction of dominant wave approach.

Embayments. Curved , concave shoreline features often found between two prominent headlands along the shoreline.

Geomorphic Feature. Refers to those prominent features or shapes encountered on the shoreline which are formed by geologic processes.

Littoral Drift. Refers to the movement of sand in the littoral zone, or in that zone subject to the forces of wind driven wave action. Generally extends from the slope break where the beach face meets the nearshore bottom in the offshore direction to the limit of wave run-up in the backshore direction.

Tangential Reach: Refers to that section of the shoreline planform that is parallel to the crests of waves that approach the shoreline with greatest frequency or intensity.

Wave Diffraction and Refraction. Refers to the bending of waves that results as approaching waves encounter shoals and other features such as headlands or breakwaters. Waves are diffracted by features that extent above the water surface and refracted by subsurface features and bathymetry.