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Northumberland County - Shoreline Situation Report

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Supported by the Virginia Institute of Marine Science, Center for Coastal Resources Management, Comprehensive Coastal Inventory Program

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Chapter 1. Introduction

1.1 Background

In the 1970s, the Virginia Institute of Marine Science (VIMS) received a grant through the National Science Foundation's Research Applied to National Needs Program to develop a series of reports which would describe the condition of tidal shorelines in the Commonwealth of Virginia. These reports became known as the Shoreline Situation Reports. They were published on a county by county basis with additional resources provided by the National Oceanic and Atmospheric Administration's Office of Coastal Zone Management (Hobbs et.al., 1975).

The Shoreline Situation Reports quickly became a common desktop reference for nearly all shoreline managers, regulators, and planners within the Tidewater region. They provided useful information to address the common management questions and dilemmas of the time. Despite their age, these reports remain a desk top reference.

The Comprehensive Coastal Inventory Program (CCI) is committed to developing a revised series of Shoreline Situation Reports which address the management questions of today. The series reports shoreline conditions on a county by county basis. New techniques integrate a combination of Geographic Information Systems (GIS), Global Positioning System (GPS) and remote sensing technology. Reports are now distributed electronically unless resources become available for hardcopy distribution. The digital GIS coverages, along with all reports, tables, and maps are available on the web at www.vims.edu/ccrm/gis/gisdata.html under Northumberland County Shoreline Situation Report.

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1.2 Description of the Locality

Northumberland County is situated at the eastern edge of Virginia's Northern Neck. The county is approximately 191 square miles of land area excluding water. The county is bisected by several major streams, and has significant shoreline along the Chesapeake Bay and the Potomac River. The southeast border is adjacent to Lancaster County, and the southwest Richmond County. Along the Potomac River to the north, Northumberland is adjacent to

Westmoreland County, and its eastern border is exposed to the Chesapeake Bay. In addition to the Potomac River and the Chesapeake, other major systems include Indian Creek, Dividing Creek, Mill Creek, the Great Wicomico River, and the Little Wicomico River which all drain into the Chesapeake Bay. Major tributaries to the Potomac include the Coan River, the Glebe, and the Yeocomico River. Hack and Hull Creeks also drain into the Potomac. These waterways were all surveyed as part of this inventory of shoreline conditions.

Northumberland County is a rural residential community with a population density that has increased very slowly over the last 15-20 years. According to the 1996 Comprehensive Plan, more than 30 percent of the land use is agricultural, and approximately 11% is commercial forests. The remaining land is developed for either residential or commercial uses (Northumberland County Planning Commission, 1996). Industrial development within the county centers around the waterfront and water uses. Residential development is dispersed both along roadways and waterfront. Large residential subdivisions are encouraged for the future.

Northumberland County's most recent comprehensive plan was completed in 1996 (Northumberland County Planning Commission, 1996). The plan recognizes several important considerations for future development. First, the physical constraints to development which soil properties, flood control, and protection of the natural environment. Second, the issue of water supply and the protection of existing and future supplies is noted. Erosion control at the shoreline and access to the water for public and private uses is addressed. Finally, consideration for re-development of intensely developed areas is mentioned. According to county planners, this plan is currently being revised.

Tidal shoreline protection is recognized to constrain and guide development activities at the shore. Regulations established through the Clean Water Act, and the Chesapeake Bay Preservation Act are discussed in the Comprehensive Plan. Northumberland has designated Resource Protection Areas (RPAs) consistent with the Act. Resource Management Areas (RMAs) are all other lands not designated a RPA. Within the RMA, Intensely Developed Areas (IDAs) are acknowledged. These are areas where development has already significantly altered the natural state of the landscape to the extent that more than 50% of the land surface is impervious (Northumberland County Planning Commission, 1996).

1.3 Purpose and Goals

This shoreline inventory is developed as a tool for assessing conditions along the tidal shoreline in Northumberland County. Field data were collected from June through October, 2000. Conditions are reported for three zones within the immediate riparian river area: riparian land use, bank and buffers, and the shoreline. A series of maps and tabular data are published to illustrate and quantify results of an extensive shoreline survey. Major tributaries discharging into the Chesapeake Bay along the eastern margin and the Potomac River to the north were surveyed. Ultimately, access and navigability determined the extent of the survey. Some areas were surveyed using remote sensing techniques through the use of photo-interpretation.

1.4 Report Organization

This report is divided into several sections. Chapter 2 describes methods used to develop this inventory, along with conditions and attributes considered in the survey. Chapter 3 identifies potential applications for the data, with a focus on current management issues. Chapter 4 indexes the series of maps which illustrate current conditions. The maps are located in the online appendix.

1.5 Acknowledgments

The Shoreline Situation Report for Northumberland County is report has been funded the Comprehensive Coastal Inventory Program (CCI) with money appropriated by the General Assembly, and the Virginia Coastal Resources Management Program at the Department of Environmental Quality, through Grant Number NA77OZ0204 of the National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management under the Coastal Zone Management Act of 1972, as amended.

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Chapter 2. The Shoreline Assessment: Approach and Considerations

2.1 Introduction

The Comprehensive Coastal Inventory Program (CCI) has developed a set of protocols for describing shoreline conditions along Virginia's tidal shoreline. The assessment approach uses state of the art Global Positioning Systems (GPS), and Geographic Information Systems (GIS) to collect, analyze, and display shoreline conditions. These protocols and techniques have been developed over several years, incorporating suggestions and data needs conveyed by state agency and local government professionals.

Three separate activities embody the development of a Shoreline Situation Report: data collection, data processing and analysis, and map generation. Data collection follows a three tiered shoreline assessment approach described below.

2.2 Three Tiered Shoreline Assessment

The data inventory developed for the Shoreline Situation Report is based on a three-tiered shoreline assessment approach. This assessment characterizes conditions in the shorezone, which extends from a narrow portion of the riparian zone seaward to the shoreline. This assessment approach was developed to use observations which could be made from a moving boat. To that end, the survey is a collection of descriptive measurements which characterize conditions. GPS units log location of conditions observed from a boat. No other field measurements are performed.

The three tiered shoreline assessment approach divides the shorezone into three regions: 1) the immediate riparian zone, evaluated for land use; 2) the bank, evaluated for height, stability, cover, and natural protection; and 3) the shoreline, describing the presence of shoreline structures for shore protection and recreational purposes. Each tier is described in detail below.

2.2a) Riparian Land Use: Land use adjacent to the bank is classified into one of ten categories (Table 1). The categories provide a simple assessment of land use, and give rise to land management practices that can be anticipated. GPS is used to measure the linear extent along shore where the practice is observed. The width of this zone is not measured. Riparian forest buffers are considered the primary land use if the buffer width equals or exceeds 30 feet. This width is calculated from digital imagery as part of the quality control in data processing.

Table 1. Tier One - Riparian Land Use Classes

Forest	stands greater than 18 feet / width greater than 30 feet
Scrub-shrub	stands less than 18 feet
Grass	includes grass fields, and pasture land
Agriculture	includes cropland
Residential	includes single or multi family dwellings
Commercial	includes small and moderate business operations, recreational facilities
Industrial	includes large industry and manufacturing operations
Bare	lot cleared to bare soil
Timbered	clear-cuts
Paved	areas where roads or parking areas are adjacent to the shore
Unknown	land use undetectable from the vessel

2.2b) Bank Condition: The bank extends off the fastland, and serves as an interface between the upland and the shore. It is a source of sediment and nutrient fluxes from the fastland, and bears many of the upland soil characteristics which determine water quality in receiving waters. Bank stability is important for several reasons. The bank protects the upland from wave energy during storm activity. The faster the bank erodes, the sooner the upland will be at risk. Bank erosion can contribute high sediment loads to the receiving waters. Stability of the bank depends on several factors: height, slope, sediment composition and characteristics, vegetative cover, and the presence of buffers to absorb energy impact to the bank itself.

The bank assessment in this inventory addresses four major bank characteristics: bank height, bank cover, bank stability, and the presence of stable or unstable natural buffers at the bank toe (Table 2). Conditions are recorded continuously using GPS as the boat moves along the shoreline. The GPS log reflects any changes in conditions observed.

Bank height is described as a range, measured from the toe of the bank to the top. Bank cover is an assessment of the percent of either vegetative or structural cover in place on the bank face. Natural vegetation, as well as rip rap are considered as cover. The assessment is qualitative (Table 2). Bank stability characterizes the condition of the bank face. Banks which are undercut, have exposed root systems, down vegetation, or exhibit slumping of material qualify as a "high erosion". At the toe of the bank, natural marsh vegetation and/or beach material may be present. These features offer protection to the bank and enhance water quality. Their presence is noted in the field, and a general assessment (low erosion/high erosion) describes whether they are experiencing any erosion. Depending on time of tide during the survey, it is sometime difficult to assess the true condition of the marsh. Sediment composition and bank slope cannot be surveyed from a boat, and are not included.

2.2c) Shoreline Features: Features added to the shoreline by property owners are recorded as a combination of points or lines. These features include defense structures, constructed to protect the shoreline from erosion; offense structures, designed to accumulate sand in longshore transport; and recreational structures, built to enhance recreational use of the water. The location of these features along the shore are surveyed with a GPS unit. Linear features are surveyed without stopping the boat. Structures such as docks, and boat ramps are point features, and a static ten-second GPS observation is collected at the site. Table 3 summarizes shoreline features surveyed. Linear features are denoted with an "L" and point features are denoted by a "P." The glossary describes these features, and their functional utility along a shore.

Table 2. Tier 2 - Bank Conditions

Bank Attribute	Range	Description
bank height	0-5 ft	from the toe to the edge of the fastland
	5-10 ft	from the toe to the edge of the fastland
	10-30ft	from the toe to the edge of the fastland
	> 30 ft	from the toe to the edge of the fastland
bank stability	low erosion	minimal erosion on bank face or toe
	high erosion	includes slumping, scarps, exposed roots
bank cover	bare	<25% cover; vegetation or structural cover
	partial	25-75% cover; vegetation or structural
	total	>75% cover; vegetation or structural
marsh buffer	no	no marsh vegetation along the bank toe
	yes	fringe or pocket marsh present at bank toe
marsh stability (if present)	low erosion	no obvious signs of erosion
	high erosion	marsh edge is eroding or vegetation loss
beach buffer	no	no sand beach present
	yes	sand beach present
beach stability (if present)	low erosion	accreting beach
	high erosion	eroding beach or non emergent at low tide

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Table 3. Tier 3 - Shoreline Features

Feature	Feature Type	Comments
Control Structures		
riprap	L	
bulkhead	L	
breakwaters	L	first and last of a series is surveyed
groinfield	L	first and last of a series is surveyed
jetty	P	
miscellaneous	L	can include tires, rubble, tubes, etc.
Recreational Structures		
pier/wharf	P	includes private and public
boat ramp	P	distinguishes private vs. public landings
boat house	P	all covered structures, assumes a pier
marina	L	includes piers, bulkheads, wharfs

2.3 Data Collection/Survey Techniques

Data collection is performed in the field, from a small, shoal draft vessel, navigating at slow speeds parallel to the shoreline. To the extent possible, surveys take place on a rising tide, allowing the boat to be as close to shore as possible. The field crew consists of a boat operator, and two data surveyors. The boat operator navigates the boat to follow the shoreline geometry. One surveyor collects information pertinent to land use and bank condition. The second surveyor logs information relevant to shoreline structures.

Data is logged using the handheld Trimble GeoExplorer GPS unit. GeoExplorers are accurate to within 4 inches of true position with extended observations, and differential correction. Both static and kinematic data collection is performed. Kinematic data collection is a collection technique where data is collected continuously along a pathway (in this case along the waterway). GPS units are programmed to collect information at a rate sufficient to compute a position anywhere along the course. The shoreline data is collected at a rate of one observation every five seconds. Land use, bank condition, and linear shoreline structures are collected using this technique.

Static surveys pin-point fixed locations that occur at very short intervals. The boat actually stops to collect these data, and the boat operator must hold the boat against tidal current, and surface wind waves. Static surveys log 10 GPS observations at a rate of one observation per second at the fixed station. The GPS receiver uses an averaging technique to compute one position based on the10 static observations. Static surveys are used to position point features like piers, boat ramps, and boat houses.

Trimble GeoExplorer GPS receivers include a function that allows a user to pre-program the complete set of features surveyed in a "data dictionary". The data dictionary prepared for this Shoreline Situation Report includes all features described in section 2.2. As features are observed in the field, surveyors use scroll down menus to continuously tag each geographic coordinate pair with a suite of characteristics that describe the shoreland's land use, bank condition, and shoreline features present. The survey, therefore, is a complete set of geographically referenced shoreline data.

2.4 Data Processing

Data processing occurs in two parts. Part one processes the raw GPS field data, and converts the data to GIS coverages (section 2.4a). Part two corrects the GIS coverages to reflect true shoreline geometry (section 2.4b).

2.4a.) GPS Processing: Differential correction improves the accuracy of GPS data by including other "known" locations to refine geographic position. Any GPS base station within 124 miles of the field site can serve as one additional location. A base station operated by the National Geodetic Survey in XXX, Virginia was used for most of the data processing in Northumberland County.

Differential correction is the first step to processing GPS data. Trimble's Pathfinder Office GPS software is used. The software processes time synchronized GPS signals from field data and the selected base station. Differential correction improves the position of the GPS field data based on the known location of the base station, the satellites, and the satellite geometry. When Selective Availability was turned off in late Spring, 2000, the need to post process data has nearly been eliminated for the level of accuracy being sought in this project.

Although the Trimble GeoExplorers are capable of decimeter accuracy (~ 4 inches), the short occupation of sites in the field reduces the accuracy to 5 meters (~16 feet). In many cases the accuracy achieved is better, but the overall limits established by the CCI program are set at 5 meters. This means that features are registered to within 5 meters (~16 feet) (or better) of their true position on the earth's surface. In this case, positioning refers to the boat position during data collection.

An editing function is used to clean the GPS data. Cleaning corrects for breaks in the data which occur when satellite lock is lost during data collection. Editing also eliminates erroneous data collected when the boat circles off track, and the GPS unit is not switched to "pause" mode.

The final step in GPS processing converts the files to three separate ArcInfo® GIS coverages. The three coverages are: a land use and bank condition coverage (acco_lubc), a shoreline structure coverage (lines only) (acco_sstruc), and a shoreline structure coverage (points only) (acco_astruc).

2.4b.) GIS Processing: GIS processing includes two major steps. Both use ESRI's ArcInfo® GIS software, and ERDAS' Imagine® software. Several data sets are integrated to develop the final inventory products. The processing is intended to correct the new GIS coverages so they reflect conditions at the shoreline, and not along the boat track. All attributes summarized in Tables 1, 2, and 3 are included. A digital shoreline coverage is generated to use as a basemap. Digital Ortho Quarter Quadrangles (DOQQs) flown in 1994 are used as the base mapping product to derive the shoreline coverage. DOQQs are fully rectified digital imagery representing one quarter of a USGS 7.5 minute quadrangle. They were released by USGS in 1997. This imagery is also used for all background imagery used in data processing and map production. They are an important quality control tool for verifying the location of certain landscape attributes, and provide users with additional information about the coastal landscape.

In step one, the shoreline coverage is derived from a digitized record of the land water interface observed on 1994 DOQQs. Since existing shoreline coverages were considerably out of date and proved to be quite inaccurate, a new digital shoreline record was generated using photo-interpretation techniques and DOQQ imagery. While this process does not attempt to re-compute a shoreline position relative to a vertical tidal datum, it adjusts the horizontal geographic position to reflect the present shoreline geometry. Using ERDAS' Imagine® software, the 1994 DOQQ imagery is displayed onscreen, and an operator digitizes the land water interface using photo-interpretation techniques. This new basemap does not represent a tidally corrected shoreline like other available datasets, however, the improved accuracy of the land water interface more than justifies the integration of this product for this project.

Step two in GIS processing corrects the coverages generated from the GPS field data to the shoreline record. These coverages, having been processed through GPS software, are geographically coincident with the path of the boat, from where observations are made. They are, therefore, located somewhere in the waterway. Step two transfers these data back to the corrected shoreline record so the data more precisely reflects the location being described along the shore.

The majority of data processing takes place in step two, which uses all three data sets simultaneously. The new shoreline record, and the processed GPS field data are displayed onscreen at the same time as ArcInfo coverages. The imagery is used in the background for reference. With the new shoreline as base coverage, the remaining processing re-codes the base shoreline attributes mapped along the boat track. Each time the boat track data (i.e GPS data) indicates a change in attribute type or condition, the digital shoreline arc is split, and coded appropriately for the attributes using ArcInfo techniques.

This step endures a rigorous sequence of checks to insure the positional translation is as accurate as possible. Each field coverage; land use, bank condition, and shoreline condition, is processed separately. The final products are three new coded shoreline coverages. Each coverage has been checked twice onscreen by different GIS personnel. A final review is done on draft hardcopy printouts.

2.4c.) Maps and Tables: Maps and tables can be viewed or downloaded as .pdf files. A color printer is required on the user end. Color maps are generated to illustrate the attributes surveyed along the shore. A three-part map series has been designed to illustrate the three tiers individually. Plate A describes the riparian land use as color coded bars along the shore. A legend keys the color to the type of land use.

Plate B depicts the condition of the bank and any natural buffers present. Three lines, and a combination of color and pattern symbology gives rise to a vast amount of bank and natural buffer information. One line depicts bank cover (inland line), a second line illustrates bank height and stability (middle line), and a third line describes any natural buffers present (channelward line). Erosional conditions are illustrated in red for both bank and buffer. Stable or low erosion conditions are illustrated in green. Bank height varies with the thickness of the line; where the thickest lines designate the highest banks (> 30 feet). Bank cover is distinguished by colors. Bare banks (<25% cover) are illustrated in pale pink, partial cover (25-75%) is illustrated by a pale orange line, and total cover (>75%) is indicated by a pale blue line. Natural buffers, when present, are described by small circles parallel to the shore. Open circles just seaward of the line indicate a natural fringe marsh along the base of the bank. Solid circles indicate a sand beach buffer at the base of the bank. It is possible to have both. The length of the symbology along the shore reflects the length alongshore that the features persist. The symbology changes as conditions change.

Plate C combines recreational and shoreline protection structures in a composition called

Shoreline Features. Linear features, described previously, are mapped using color coded bar symbols which follow the orientation of the shoreline. Point features use a combination of colors and symbols to plot the positions on the map.

DOQQ imagery are used as a backdrop, upon which all shoreline data are superimposed. The imagery was collected in 1994. The color infra red image is used as a backdrop to Plate A. A gray-scale version of this same image is used for Plates B and C.

For publication purposes the county is divided into a series of plates. Plates are scaled at 1:12,000 for publication at 11x17. Scale will vary if printed at a different size. The number of plates is determined by the geographic size and shape of Northumberland County. An index is provided that illustrates the orientation of plates to each other. The county was divided into 36 plates (plate 1a, 1b, 1c, etc.), for a total of 108 map compositions. The index can be used to locate the plate containing the area of interest. Each plate must be individually selected and viewed from the list on the list of the web page.

Tables 4 and 5 quantify features mapped along the rivers using frequency analysis techniques in ArcInfo. The values quantify features on a plate by plate basis. For linear features, values are reported in actual miles surveyed. The number of point features surveyed are also listed on a plate by plate basis. The total miles of shoreline surveyed for each plate is reported. A total of 555.98 miles were surveyed in the field. An additional 124.04 miles were surveyed using photo interpretation techniques applied to the DOQQs. These areas include headwaters of small creeks which could not be reached by boat. Since there is plate overlap, total survey miles can not be reached by adding the total shoreline miles for each plate. The last row of Tables 4 and 5 report the total shoreline miles surveyed (field and remotely) for the county (555.98 miles), and the total amount of each feature surveyed along the measured shoreline.

Chapter 3. Applications for Management

3.1 Introduction

There are a number of different management applications for which the Shoreline Situation Reports (SSRs) support. This section discusses four of them which are currently high profile issues within the Commonwealth or Chesapeake Bay watershed. The SSRs are data reports, and do not necessarily provide interpretation beyond the characteristics of the nearshore landscape. However, the ability to interpret and integrate these data into other programs is key to gleaming the full benefits of the product. This chapter offers some examples for how data from the SSRs can be analyzed to support current state management programs.

3.2 Shoreline Management

The first uses for SSRs were to prepare decision makers to bring about well informed decisions regarding shoreline management. This need continues today, and perhaps with more urgency. In many areas, undisturbed shoreline miles are almost nonexistent. Development continues to encroach on remaining pristine reaches, and threatens the natural ecosystems which have prevailed. At the same time, the value of waterfront property has escalated, and the exigency to protect shorelines through stabilization has increased. Generally speaking, this has been an accepted management practice. However, protection of tidal shorelines does not occur without incidence.

Management decisions must consider the current state of the shoreline, and understand what actions and processes have occurred to bring the shoreline to its current state. This includes evaluating existing management practices, assessing shore stability in an area, and determining future uses of the shore. The SSRs provide data to perform these evaluations.

Plate A defines the land use adjacent to the shoreline. To the extent that land use directs the type of management practices found, these maps can predict shoreline strategies which may be expected in the future. Residential areas are prone to shoreline alterations. Commercial areas may require structures along the shore for their daily operations. Others frequently seek structural alternatives to address shoreline stability problems. Forested riparian zones, and large tracts of grass or agricultural areas are frequently unmanaged even if chronic erosion problems exist.

Stability at the shore is described in Plate B. The bank is characterized by its height, its state of erosion, and the presence or absence of natural buffers at the bank toe. Upland adjacent to high, stable banks with a stable natural buffer at the base are less prone to flooding or erosion problems resulting from storm activity. Upland adjacent to banks of lesser height (< 5feet) are at greater risk of flooding, but if banks are stable with marshes or beaches present, erosion may not be a significant concern. Survey data reveals a strong correlation between banks of high erosion, and the absence of natural buffers. Conversely, the association between stable banks and the presence of marsh or beach is also well established. This suggests that natural buffers such as beaches and fringe marshes play an important role in bank protection. This is illustrated on the maps. Banks without natural buffers, yet classified as low erosion, are often structurally controlled with rip rap or bulkheads.

Plate C delineates structures installed along the shoreline. These include erosion control structures, and structures to enhance recreational use of the waterway. This map is particularly useful for evaluating requests from property owners seeking structural methods for controlling shoreline erosion problems. Shoreline managers can evaluate the current situation of the surrounding shore including: impacts of earlier structural decisions, proximity to structures on neighboring parcels, and the vicinity to undisturbed lots. Alternative methods such as vegetative control may be evaluated by assessing the energy or fetch environment from the images. Use this plate in combination with Plate B to evaluate the condition of the bank proposed for protection.

A close examination of shore conditions may suggest whether certain structural choices have been effective. Success of groin field and breakwater systems is confirmed when sediment accretion is observed. Low erosion conditions surveyed along segments with bulkheads and riprap indicate structures have controlled the erosion problem. The width of the shorezone, estimated from the background image, also speaks to the success of structures as a method of controlling erosion. A very narrow shorezone implies that as bulkheads or riprap have secured the erosion problem at the bank, they have also deflated the supply of sediment available to nourish a healthy beach. This is a typical shore response, and remains an unresolved management problem.

Shoreline managers are encouraged to use all three plates together when developing management strategies or making regulatory decisions. Each plate provides important information independent of the others, but collectively the plates become a more valuable management tool.

3.3 Non-Point Source Targeting

The identification of potential problem areas for non-point source pollution is a focal point of water quality improvement efforts throughout the Commonwealth. The three tiered approach provides a collection of data which, when combined, can allow for an assessment of potential non-point source pollution problems in a waterway.

Grass land and agricultural land, which includes pasture land and cropland, respectively, have the highest potential for nutrient runoff. These areas are also prone to high sediment loads since the adjacent banks are seldom restored when erosion problems persist. Residential, bare, and commercial land uses also have the potential to contribute to the non-point source pollution problem due to the types of practices which prevail, and large impervious surface areas.

The highest potential for non-point source pollution combines these land uses with “high” bank erosion conditions, bare or nearly bare bank cover, and no marsh buffer protection. The potential for non-point source pollution moderates as the condition of the bank changes from “high” bank erosion to “low” bank erosion, or with the presence or absence of stable marsh vegetation to function as a nutrient sink for runoff. Where defense structures occur in conjunction with “low” bank erosion, the structures are effectively controlling erosion at this time, and the potential for non-point source pollution is reduced. If the following characteristics are delineated: low bank erosion, stable marsh buffer, riprap or bulkhead; the potential for non-point source pollution from any land use class can be lowered.

At the other end of the spectrum, forested and scrub-shrub sites do not contribute significant amounts of non-point source pollution to the receiving waterway. Forest buffers, in particular, are noted for their ability to uptake nutrients running off the upland. Forested areas with stable or defended banks, a stable fringe marsh, and a beach would have the lowest potential as a source of non-point pollution. Scrub-shrub with similar bank and buffer characteristics would also be very low.

A quick search for potential non-point source sites would begin on Plate A. Identify the “grass” or “agricultural” areas. Locate these areas on Plate B, and find those which have eroding banks (in red) without any marsh protection. The hot spots are these sites where the banks are highest (thick red line), so the potential sediment volume introduced to the water is greatest. Finally check plate C to determine if any artificial stabilization to protect the bank has occurred. If these areas are without stabilizing structures, they indicate the hottest spots for the introduction of non-point source pollution.

3.4 Designating Areas of Concern (AOC) for Best Management Practice (BMP) Sites

Sediment load and nutrient management programs at the shore are largely based on installation of Best Management Practices (BMPs). Among other things, these practices include fencing to remove livestock from the water, installing erosion control structures, and bank re-vegetation programs. Installation of BMPs is costly. Cost share programs provide relief for property owners, but funds are scarce in comparison to the capacious number of waterway miles needing attention. Targeting Areas of Concern (AOC) can prioritize spending programs, and direct funds where most needed.

Data collected for the SSR can assist with targeting efforts for designating AOCs. AOCs can be areas where riparian buffers are fragmented, and could be restored. Use Plate A to identify forested upland. Breaks in the continuity of the riparian forest can be easily observed in the line segments, and background image. Land use between the breaks relates to potential opportunity for restoring the buffer where fragmentation has occurred. Agricultural tracts which breach forest buffers are more logical targets for restoration than developed residential or commercial stretches. Agricultural areas, therefore, offer the highest opportunity for conversion. Priority sites for riparian forest restoration should target forested tracts breached by "agriculture" or "grass" land (green-fuscia-green line pattern; green-blue-green line pattern, respectively).

Plate B can be used to identify sites for BMPs. Look for where "red" (i.e. eroding) bank conditions persist. The thickness of the line tells something about the bank height. The fetch, or the distance of exposure across the water, can offer some insight into the type of BMP which might be most appropriate. Re-vegetation may be difficult to establish at the toe of a bank with high exposure to wave conditions. Plate C should be checked for existing shoreline erosion structures in place.

Tippett et.al.(2000) used similar stream side assessment data to target areas for bank and riparian corridor restoration. These data followed a comparable three tier approach and combine data regarding land use and bank stability to define specific reaches along the stream bank where AOCs have been noted. Protocols for determining AOCs are based on the data collected in the field.

3.5 Targeting for Total Maximum Daily Load (TMDL) Modeling

As the TMDL program in Virginia evolves, the importance of shoreline erosion in the lower tidal tributaries will become evident. Total maximum daily loads are defined as a threshold value for a pollutant, which when exceeded, impedes the quality of water for specific uses (e.g. swimming, fishing). Among the pollutants to be considered are: fecal coliform, pathogens, nitrogen, phosphorous, and sediment load.

Models will be developed to address each of these parameters. In upper watersheds, nutrient and fecal coliform parameters will be critical where high agricultural land use practices prevail. Sediment loads will eventually be considered throughout the watershed. In the lower watersheds, loads from shoreline erosion must be addressed for a complete sediment source budget. Erosion from shorelines has been associated with high sediment loads in receiving waters (Hardaway et.al., 1992), and the potential for increased nutrient loads (Ibison et.al., 1990). Virginia's TMDL program is now underway, and being administered through the Department's of Environment Quality and Conservation and Recreation. Impaired stream segments are being used to initially identify where model development should focus. For Virginia, this streamlining has done little to reduce the scope of this daunting task, since much of the lower major tributaries are considered impaired. Additional targeting will be necessary to prioritize model development.

Targeting to prioritize TMDL can be streamlined by using maps that delineate areas of high erosion, and potential high sediment loads. Plate B delineates banks of high erosion. Waterways with extensive footage of eroding shorelines should be targeted. The volume of sediment entering a system is also a function of bank height. Actual volumes of sediment eroded can be estimated by using bank height, and the linear extent that the condition persists along the shore. Bank height is an attribute defined in Plate B by the width of the line. Eroding banks (in red) with heights in excess of 30 feet (thickest lines) would be target areas for high sediment loads. Plate A can be used in combination with Plate B to determine the dominant land use practice, and assess whether nutrient enrichment through sediment erosion is also a concern. This would be the case along agriculturally dominated waterbodies. Table 4 quantifies the linear extent of high, eroding banks on a plate by plate basis.

Table 4. Northumberland County Shoreline Attributes - Riparian Land Use and Bank and Buffer Conditions - Plate Summary

PLATE NUMBER	TOTAL MILES SURVEYED	RIPARIAN LAND USE (miles)										BANK (bank height and erosion status - miles of shore)												BANK COVER (miles)			BUFFER CONDITION			
												0-5 ft			5-10 ft			10-30 ft			>30 ft						BEACH PRESENT (miles)		MARSH PRESENT (miles)	
		agriculture	bare	commercial	forest	grass	industrial	paved	residential	scrub-shrub	timbered	low	high	undercut	low	high	undercut	low	high	undercut	low	high	undercut	bare	partial	full	eroding	stable	eroding	stable
1	19.94	0.33	0.00	0.90	5.42	0.08	0.00	0.02	12.60	0.59	0.00	17.90	0.80	0.62	0.59	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	2.52	17.18	0.33	0.06	0.15	8.41
2	26.10	0.95	1.39	0.08	9.73	0.12	0.00	0.02	8.36	5.45	0.00	18.79	3.31	3.26	0.24	0.15	0.34	0.00	0.00	0.00	0.00	0.00	0.00	2.07	6.53	17.51	4.35	1.09	5.31	9.05
3	26.21	3.22	0.55	0.12	8.72	1.31	0.00	0.00	10.17	2.12	0.00	14.64	4.89	0.78	3.15	1.93	0.51	0.15	0.16	0.00	0.00	0.00	0.00	0.96	5.52	19.73	3.17	1.00	2.00	13.46
4	12.59	3.31	0.00	0.00	4.50	0.24	0.00	0.00	4.06	0.46	0.00	8.10	1.21	0.46	1.89	0.70	0.03	0.09	0.12	0.00	0.00	0.00	0.00	0.19	0.99	11.41	0.00	0.00	0.28	9.63
5	16.66	2.05	0.00	0.00	12.01	0.28	0.00	0.00	0.74	1.58	0.00	12.76	2.98	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	1.55	14.90	3.61	0.61	5.26	7.97
6	18.62	2.71	0.00	0.00	4.39	0.13	0.00	0.00	2.42	8.96	0.00	14.32	1.18	1.05	1.29	0.20	0.42	0.16	0.00	0.00	0.00	0.00	0.00	0.46	1.01	17.15	7.28	1.42	9.48	5.54
7	13.51	0.73	0.00	0.14	9.28	0.29	0.00	0.00	3.06	0.00	0.00	4.64	0.37	0.85	4.19	0.75	1.90	0.47	0.25	0.08	0.00	0.00	0.00	0.42	1.37	11.72	0.00	0.20	0.03	8.93
8	26.69	2.33	0.00	0.43	11.00	0.95	0.00	0.02	9.48	2.48	0.00	14.55	2.28	0.63	5.42	2.93	0.64	0.18	0.07	0.00	0.00	0.00	0.00	0.46	4.60	21.63	1.25	3.73	1.39	13.96
9	22.05	2.72	0.00	0.16	8.23	0.50	0.00	0.00	7.91	2.53	0.00	8.88	0.83	0.89	3.83	2.60	0.97	1.64	0.98	0.83	0.21	0.35	0.03	0.98	5.69	15.37	3.64	2.00	1.18	9.92
10	19.96	0.09	0.00	1.04	8.07	0.29	0.00	0.18	8.04	2.24	0.00	7.81	0.69	0.51	3.09	0.96	1.31	1.03	0.63	0.36	1.93	0.97	0.68	0.74	4.93	14.30	2.24	3.23	2.26	7.19
11	14.70	0.00	0.00	0.27	11.01	0.25	0.00	0.09	2.82	0.26	0.00	3.30	0.24	0.06	5.54	0.78	1.18	1.21	1.21	0.74	0.07	0.39	0.00	0.52	1.81	12.37	0.29	1.37	4.42	4.38
12	16.30	0.00	0.02	0.06	10.28	0.53	0.00	0.00	4.17	1.24	0.00	4.63	0.37	0.34	5.06	1.19	1.28	1.47	1.27	0.38	0.07	0.19	0.04	0.99	2.45	12.85	0.72	1.75	4.01	6.43
13	15.54	0.00	0.00	0.05	12.86	0.02	0.00	0.07	2.38	0.13	0.04	6.79	0.00	0.04	6.28	0.29	0.25	0.85	0.37	0.17	0.15	0.34	0.02	0.03	1.38	14.13	0.00	0.17	1.26	12.67
14	20.28	0.72	0.00	4.00	5.52	0.31	0.00	0.01	8.41	1.30	0.00	14.14	1.30	0.19	2.79	0.73	0.51	0.00	0.62	0.00	0.00	0.00	0.00	0.93	3.56	15.80	2.09	2.74	0.80	6.67
15	23.42	1.59	0.00	2.94	4.66	0.72	0.11	0.22	12.56	0.54	0.08	14.09	0.22	2.85	4.05	0.58	1.39	0.05	0.02	0.17	0.00	0.00	0.00	0.33	4.49	18.59	0.12	1.43	0.19	7.28
16	22.36	1.34	0.00	3.42	6.28	0.22	0.00	0.26	8.81	2.02	0.00	19.01	0.25	0.15	2.75	0.04	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.33	3.37	18.65	0.70	4.95	0.88	9.30
17	18.67	0.91	0.00	0.00	11.99	0.07	0.00	0.00	3.50	2.20	0.00	16.63	0.23	0.11	1.17	0.23	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.25	2.23	16.19	0.15	2.87	0.02	10.65
18	29.38	1.69	0.10	0.76	6.24	0.30	0.00	0.00	13.48	6.83	0.00	20.56	0.83	0.51	6.34	1.04	0.00	0.04	0.06	0.00	0.00	0.00	0.00	0.51	6.75	22.13	0.87	4.52	0.37	17.54
19	25.92	0.96	0.00	0.11	9.72	0.00	0.00	0.00	13.20	1.93	0.00	10.11	0.24	2.01	9.40	0.85	2.53	0.71	0.07	0.00	0.00	0.00	0.00	0.12	2.93	22.87	0.00	2.80	0.95	10.90
20	21.77	1.31	0.00	0.44	12.03	0.23	0.00	0.00	6.77	0.99	0.00	15.55	0.13	0.19	5.41	0.22	0.05	0.22	0.00	0.00	0.00	0.00	0.00	0.33	4.04	17.39	0.00	0.73	0.00	7.21
21	9.56	0.94	0.00	0.10	3.84	0.15	0.00	0.00	4.04	0.49	0.00	7.24	0.81	0.11	0.77	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	3.04	5.88	0.64	2.34	0.00	3.44
22	19.09	0.45	0.00	0.00	15.71	0.05	0.00	0.00	2.73	0.15	0.00	18.32	0.00	0.09	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.65	18.37	0.00	0.16	3.54	5.23
23	16.72	0.07	0.00	0.00	8.58	0.00	0.00	0.00	4.60	3.48	0.00	16.08	0.39	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	1.53	14.86	0.63	1.95	2.14	4.85
24	15.27	1.14	0.00	0.00	9.57	0.04	0.00	0.00	2.83	1.70	0.00	13.73	0.04	0.46	0.72	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.39	14.73	0.49	0.99	0.00	4.03
25	15.66	0.05	0.00	0.00	5.12	0.45	0.00	0.00	6.81	3.25	0.00	11.32	0.09	0.14	2.90	0.52	0.25	0.39	0.05	0.00	0.00	0.00	0.00	1.05	1.63	12.98	0.00	2.75	0.14	5.67
26	17.92	0.36	0.00	0.00	14.96	0.27	0.00	0.00	2.24	0.04	0.06	11.02	0.07	0.00	4.17	0.31	0.00	2.19	0.15	0.00	0.02	0.00	0.00	0.97	3.94	13.01	0.00	0.00	0.00	3.95
27	21.13	0.71	0.21	0.00	6.92	0.15	0.00	0.07	12.00	1.07	0.00	20.61	0.49	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	0.98	19.04	0.25	1.73	0.05	9.74
28	19.26	3.03	0.00	0.95	4.84	0.82	0.00	0.00	7.23	2.39	0.00	16.15	0.35	0.20	1.44	0.17	0.35	0.56	0.04	0.00	0.00	0.00	0.00	0.07	1.79	17.40	0.43	2.66	0.39	8.24
29	12.21	0.64	0.05	0.33	7.59	0.53	0.00	0.00	2.26	0.82	0.00	6.66	0.18	0.00	2.82	0.43	0.04	1.60	0.32	0.15	0.00	0.00	0.00	0.83	1.82	9.56	0.00	0.34	0.17	7.36
30	10.98	0.00	0.00	0.00	10.55	0.00	0.00	0.00	0.40	0.03	0.00	9.06	0.00	0.00	1.18	0.10	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.11	1.12	9.75	0.00	0.08	0.00	9.02
31	13.46	2.01	0.00	0.00	3.07	0.25	0.00	0.00	8.06	0.08	0.00	7.57	0.58	1.04	2.22	0.63	0.77	0.52	0.12	0.01	0.00	0.00	0.00	0.00	1.26	12.20	0.00	0.09	0.56	6.09
32	19.83	1.31	0.00	0.76	3.18	0.46	0.00	0.00	10.62	3.50	0.00	15.98	0.81	0.97	1.43	0.41	0.12	0.10	0.00	0.00	0.00	0.00	0.00	0.05	0.58	19.20	0.00	2.98	0.96	8.51
33	8.12	2.03	0.00	0.00	2.37	0.06	0.00	0.00	1.51	2.15	0.00	7.75	0.05	0.00	0.13	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	7.89	0.00	2.44	0.20	4.56
34	18.23	1.83	0.00	0.78	5.61	0.00	0.00	0.00	7.68	2.34	0.00	12.77	0.22	0.34	3.58	0.63	0.00	0.41	0.17	0.11	0.00	0.00	0.00	0.49	1.26	16.48	0.17	2.13	0.28	7.11
35	15.21	1.37	0.00	0.52	4.88	0.37	0.00	0.08	6.77	1.23	0.00	8.10	0.50	0.44	2.07	0.74	0.74	1.01	0.32	1.00	0.00	0.00	0.29	0.20	1.89	13.12	0.21	0.33	0.38	7.10
36	9.50	0.18	0.00	0.02	6.17	0.00	0.00	0.00	2.66	0.47	0.00	6.03	0.00	0.00	2.41	0.24	0.20	0.49	0.00	0.11	0.00	0.00	0.00	0.00	0.98	8.52	0.00	0.00	0.00	5.10
Total	555.98*	36.73	2.06	11.52	249.07	8.65	0.11	0.77	187.16	59.74	0.18	367.91	24.22	17.11	82.51	19.66	14.76	14.46	5.98	3.66	2.43	2.21	1.06	14.17	77.82	464	31.43	48.63	44.59	245.65

* Total miles of shoreline surveyed for Northumberland County, of which 124.04 miles were remotely surveyed.

Table 5. Northumberland County Shoreline Attributes - Shoreline Features - Plate Summary

PLATE NUMBER	TOTAL MILES SURVEYED	SHORELINE FEATURES No. docks	No. dilapidated docks	No. boathouses	No. ramps private	No. ramps public	No. groinfields	No. marinas	No. jetties	No. breakwaters	Miles of misc	Miles of bulkhead	Miles of riprap
1	19.94	185	1	13	6	0	0	1	0	0	0.00	1.47	3.75
2	26.10	86	1	3	6	0	3	0	3	0	0.00	0.57	2.43
3	26.21	125	2	7	7	0	4	2	2	0	0.04	0.89	6.27
4	12.59	53	1	5	7	0	0	0	0	0	0.00	0.62	1.37
5	16.66	9	0	1	0	0	0	0	0	0	0.00	0.00	0.48
6	18.62	17	1	1	0	0	2	0	0	0	0.00	0.13	1.20
7	13.51	33	1	13	1	0	0	0	0	0	0.00	0.14	0.40
8	26.69	127	0	8	1	1	8	3	2	1	0.00	0.87	3.53
9	22.05	118	2	24	1	0	3	0	0	0	0.00	1.39	2.08
10	19.96	115	2	13	8	0	4	4	0	0	0.03	1.50	2.32
11	14.70	52	1	8	3	0	0	0	0	0	0.00	0.24	0.85
12	16.30	66	1	8	7	0	0	0	0	0	0.01	0.65	0.25
13	15.54	73	0	5	4	1	0	0	0	0	0.00	0.05	0.06
14	20.28	128	5	11	0	0	7	6	0	1	0.12	1.26	3.13
15	23.42	203	7	20	2	0	0	6	0	1	0.16	1.63	3.58
16	22.36	85	8	6	5	2	5	2	0	1	0.11	1.01	4.07
17	18.67	23	0	1	0	0	4	0	0	0	0.07	0.15	1.21
18	29.38	149	4	28	10	0	7	3	13	1	0.05	2.33	2.36
19	25.92	229	0	44	11	0	2	1	0	1	0.00	3.44	1.91
20	21.77	113	2	20	13	0	1	2	1	0	0.03	1.00	1.60
21	9.56	36	0	3	0	0	5	1	2	2	0.03	0.84	0.93
22	19.09	25	0	2	6	0	0	0	0	0	0.00	0.24	0.16
23	16.72	6	0	0	0	0	4	0	3	0	0.00	0.37	0.77
24	15.27	8	0	0	0	0	4	0	0	0	0.00	0.47	0.81
25	15.66	71	5	12	5	0	9	0	0	0	0.04	0.60	1.80
26	17.92	67	3	13	7	0	0	0	0	0	0.00	0.30	0.40
27	21.13	108	1	4	4	0	7	0	0	1	0.00	1.01	2.36
28	19.26	118	4	15	12	0	10	2	1	0	0.17	1.24	2.62
29	12.21	40	1	9	5	0	0	0	0	0	0.04	0.15	0.26
30	10.98	30	0	0	3	0	0	0	0	0	0.00	0.03	0.02
31	13.46	128	2	15	1	0	0	0	0	0	0.10	0.97	2.14
32	19.83	204	3	21	14	0	9	3	0	0	0.11	1.84	4.22
33	8.12	32	1	0	1	0	3	0	0	0	0.00	0.48	0.76
34	18.23	90	2	27	5	0	8	2	0	0	0.26	2.21	3.99
35	15.21	95	5	35	3	0	0	3	0	0	0.11	1.10	2.54
36	9.50	39	1	14	4	0	0	0	0	0	0.04	0.66	0.65
Northumberland Total	555.98	2563	52	324	130	4	91	27	19	6	1.05	26.08	54.19

Chapter 4. The Shoreline Situation

The shoreline situation is described for conditions in Northumberland County along primary and secondary shoreline. Characteristics are described for all navigable tidal waterways contiguous to these shorelines. A total of 555.98 miles of shoreline are described. Nearly 432 miles were surveyed in the field. For remotely sensed areas, photo interpretation was made using DOQQs to detect land use, natural buffers, and shoreline structures where possible. Along these tidal channels, upland banks are assumed to be well protected by vegetation, and erosion low. It is possible, however, for these banks to experience undercutting from tidal currents. This could not be verified since field visits were not performed. Bank height conditions along reaches characterized using remote sensing techniques were estimated from USGS 1:24,000 topographic maps.

A summary of the plates is given below. Refer to Tables 4 and 5 for attribute data. The GIS data is available for custom analyses.

Plate Descriptions

Plate 1
Location: Northeast shore of Indian
Major River: Indian Creek
Shoreline Miles Surveyed: 19.94
Survey Date(s): 5/31/2000
Plate Rotation: 90 degrees W
Scale: 1:12,000

Plate 2
Location: Mouth of Indian Creek to Bluff Point.
Major River(s): Indian Creek, Henrys Creek, Barnes Creek, Chesapeake Bay

Shoreline Miles Surveyed: 26.10

Survey Date(s): 5/31/2000

Plate Rotation: 90 degrees W

Scale: 1:12,000

Plate 3

Location: Jarvis Point to Hughlett Point, including lower Dividing Creek

Major River(s): Dividing Creek, Prentice Creek, Chesapake Bay

Shoreline Miles Surveyed: 26.21

Survey Date(s): 8/03/2000, 8/22/2000

Plate Rotation: 45 degrees W

Scale: 1:12,000

Plate 4

Location: Dividing Creek from Harveys to the Route 606 overpass on Dividing Creek

Major River: Dividing Creek

Shoreline Miles Surveyed: 12.59

Survey Date(s): 8/03//2000

Plate Rotation: 90 degrees W

Scale: 1:12,000

Plate 5

Location: Ingram Cove to Ball Neck

Major River: Chesapeake Bay

Shoreline Miles Surveyed: 16.66

Survey Date(s): 8/22/2000

Plate Rotation: 90 degrees

Scale: 1:12,000

Plate 6

Location: Cloverdale Creek, Dameron Marsh to lower Mill Creek

Major River: Cloverdale Creek, Ingram Bay, Chesapeake Bay, and Mill Creek

Shoreline Miles Surveyed: 18.62

Survey Date(s): 8/22/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 7

Location: Mill Creek

Major River: Mill Creek

Shoreline Miles Surveyed: 13.51

Survey Date(s): 8/22/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 8

Location: Major creeks within Ingram Bay from north shore of Mill Creek to Sandy Point

Major River(s): Mill Creek, Harveys Creek, Towles Creek, Cranes Creek, Southern entrance to Great Wicomico

Shoreline Miles Surveyed: 26.69

Survey Date(s): 6/26/2000, 8/23/2000

Plate Rotation: 90 degrees W

Scale: 1:12,000

Plate 9

Location: Lower Great Wicomico River

Major River(s): Great Wicomico, Whays Creek, Warehouse Creek, Gougher Creek

Shoreline Miles Surveyed: 22.05

Survey Date(s): 6/12/2000, 7/5/2000

Plate Rotation: 90 degrees W

Scale: 1:12,000

Plate 10

Location: Great Wicomico River from Mila to Glebe Point

Major River(s): Great Wicomico, Barrett Creek, Tipers Creek, Horn Harbor, Coles Creek

Shoreline Miles Surveyed: 19.96

Survey Date(s): 6/12/2000, 6/26/2000, 7/5/2000

Plate Rotation: 45 degrees W

Scale: 1:12,000

Plate 11

Location: Great Wicomico including Glebe Point, Eagle Point, Ball Creek and Tripers Creek.

Major River(s): Great Wicomico, Ball Creek, Tripers Creek

Shoreline Miles Surveyed: 14.70

Survey Date(s): 6/26/2000, 7/5/2000, 8/22/2000

Plate Rotation: ~45 degrees west

Scale: 1:12,000

Plate 12

Location: Great Wicomico from Betts Mill Creek to Cedar Point

Major River: Great Wicomico along with Betts Mill Creek, and Blackwells Creek

Shoreline Miles Surveyed: 16.30

Survey Date(s): 6/21/2000, 6/26/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 13

Location: Upper Great Wicomico above Knight Run

Major River (s): Great Wicomico, Knight Run, Bush Mill Stream, and Crabbe Mill Stream

Shoreline Miles Surveyed: 15.54

Survey Date(s): 6/26/2000

Plate Rotation: ~45 degrees W

Scale: 1:12,000

Plate 14

Location: Ingram Bay, entrance to Great Wicomico tp Fleeton Point

Major River(s): Great Wicomic River, Cockrell Creek

Shoreline Miles Surveyed: 20.28

Survey Date(s): 6/12/2000, 6/13//2000, 6/14/2000

Plate Rotation: 90 degrees W

Scale: 1:12,000

Plate 15

Location: Cockrell Creek

Major River: Cockrell Creek

Shoreline Miles Surveyed: 23.42

Survey Date(s): 6/13/2000,6/14/2000

Plate Rotation: 45 degrees W

Scale: 1:12,000

Plate 16

Location: Chesapeake Bay from Fleeton to north end of Chesapeake Beach portion of Rock Gut.

Major River(s): Chesapeake Bay, portions of Cockrell Creek, Taskmakers Creek

Shoreline Miles Surveyed: 22.36

Survey Date(s): 6/13/2000, 8/23/2000

Plate Rotation: 45 degrees E

Scale: 1:12,000

Plate 17

Location: From north of Chesapeake Beach along bay shore to Rock Hole, south of Smith Point

Major River: Chesapeake Bay

Shoreline Miles Surveyed: 18.67

Survey Date(s): 8/23/2000

Plate Rotation: 45 degrees E

Scale: 1:12,000

Plate 18

Location: Smith Point, including lower Little Wicomico River from mouth to Bridge Creek

Major River(s): Chesapeake Bay, Little Wicomico River

Shoreline Miles Surveyed: 29.38

Survey Date(s): 8/8/2000 and 8/15/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 19

Location: Southern shore of Little Wicomico River from King Point to Cod Creek

Major River(s): Little Wicomico, Bridge Creek, Cod Creek

Shoreline Miles Surveyed: 25.92

Survey Date(s): 8/8/2000, 8/9/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 20

Location: Little Wicomico River from Flood Point beyond Spring Cove and Willis Creek.

Major River: Little Wicomico River

Shoreline Miles Surveyed: 21.77

Survey Date(s): 8/15/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 21

Location: Potomac River east of Vir-Mar Beach, Upper reaches of Ellyson Creel

Major River: Potomac River

Shoreline Miles Surveyed: 9.56

Survey Date(s): 8/15/03; 9/12/2000

Plate Rotation: ~15 degrees west

Scale: 1:12,000

Scale: 1:12,000

Plate 22

Location: Hack Neck, Upper branches of Little Wicomico River and Hack Creek

Major River (s): Little Wicomico, Hack Creek

Shoreline Miles Surveyed: 19.09

Survey Date(s): 8/9/2000, 8/15/2000, 9/18/2000

Plate Rotation: 45 degrees W

Scale: 1:12,000

Plate 23

Location: Potomac River along Vir-Mar Beach

Major River(s): Potomac River, Hack Creek, Flag Pond

Shoreline Miles Surveyed: 16.72

Survey Date(s): 9/18/2000

Plate Rotation: 45 degrees W

Scale: 1:12,000

Plate 24

Location: Potomac River in vicinity of Cubitt Creek

Major River: Potomac River, Cubitt Creek

Shoreline Miles Surveyed: 15.27

Survey Date(s): 9/18/2000

Plate Rotation: 45 degrees E

Scale: 1:12,000

Plate 25

Location: Potomac River along Hull Neck and Neuman Neck

Major River: Potomac River, entrance to Hull Creek, Corbin Pond

Shoreline Miles Surveyed: 15.66

Survey Date(s): 9/12/2000, 9/18/2000

Plate Rotation: ~45 degrees W

Scale: 1:12,000

Plate 26

Location: Hull Creek

Major River: Hull Creek

Shoreline Miles Surveyed: 21.13

Survey Date(s): 9/12/2000, 9/18/2000

Plate Rotation: 90 degrees E

Scale: 1:12,000

Plate 27

Location: Potomac River from Corbin Pond to Bay Quarter Neck (entrance to Cod Creek)

Major River(s): Potomac River, Presley Creek, Cod Creek

Shoreline Miles Surveyed: 21.13

Survey Date(s): 9/18/2000

Plate Rotation: 45 degrees W

Scale: 1:12,000

Plate 28

Location: Entrance to the Coan River including Great Point and Walnut Point

Major River(s): Potomac River, Coan River, Cod Creek

Shoreline Miles Surveyed:	19.26
Survey Date(s):	9/18/2000, 10/03/2000,
Plate Rotation:	45 degrees W
Scale:	1:12,000

Plate 29

Location: Coan River from Lake to entrance of Mill Creek

Major River: Coan River

Shoreline Miles Surveyed:	12.12
Survey Date(s):	9/20/2000, 10/11/2000
Plate Rotation:	45 degrees W
Scale:	1:12,000

Plate 30

Location: Upper reaches of Coan River

Major River: Coan Creek

Shoreline Miles Surveyed:	10.98
Survey Date(s):	10/11/2000
Plate Rotation:	45 degrees W
Scale:	1:12,000

Plate 31

Location: The Glebe including Wrights Cove and Glebe Creek

Major River: The Glebe, Wrights Cove, Glebe Creek

Shoreline Miles Surveyed:	13.46
Survey Date(s):	9/19/2000, 9/20/2000,10/3/03
Plate Rotation:	90 degrees W

Scale: 1:12,000

Plate 32

Location: Entrance to the Glebe, Lewisetta, Honest Point and Judith South

Major River(s): Potomac River, The Glebe, Kingscote Creek

Shoreline Miles Surveyed: 19.83

Survey Date(s): 8/24/2000, 9/20/2000

Plate Rotation: 45 degrees E

Scale: 1:12,000

Plate 33

Location: Potomac River from Garners Creek to Thicket Point (entrance to Yeocomico)

Major River(s): Potomac River, Yeocomico River

Shoreline Miles Surveyed: 8.12

Survey Date(s): 9/20/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 34

Location: Yeocomico River (south and west) from Barn Point to county border

Major River(s): South Yeocomico, West Yeocomico, Wilkins Creek, Mill Creek

Shoreline Miles Surveyed: 18.23

Survey Date(s): 9/20/2000

Plate Rotation: 0 degrees

Scale: 1:12,000

Plate 35

Location: Lodge, Harryhogan Point, and Dungan Point

Major River: Yeocomico River, Lodge Creek, Dungan Creek

Shoreline Miles Surveyed: 15.21

Survey Date(s): 9/19/2000, 9/20/2000

Plate Rotation: 90 degrees E

Scale: 1:12,000

Plate 36

Location: Northumberland-Westmoreland county border

Major River(s): Yeocomico, Hampton Hall Branch, headwaters of Mill Creek

Shoreline Miles Surveyed: 9.50

Survey Date(s): 9/20/2000

Plate Rotation: 45 degrees E

Scale: 1:12,000

Glossary of Shoreline Features Defined

Agricultural - Land use defined as agricultural includes farm tracts which are cultivated and crop producing. This designation is not applicable for pasture land.

Bare - Land use defined as bare includes areas void of any vegetation or obvious land use. Bare areas include those which have been cleared for construction.

Beaches - Beaches are sandy shores which are subaerial during mean high water. These features can be thick and persistent, or very thin lenses of sand.

Boat house - A boathouse is considered any covered structure alongside a dock or pier built to cover a boat. They include true "houses" for boats with roof and siding, as well as awnings which offer only overhead protection. Since nearly all boat houses have adjoining piers, piers are not surveyed separately, but are assumed. Boat houses may be difficult to see in aerial photography. On the maps they are denoted with a blue triangle.

Boat Ramp - Boat ramps provide vessels access to the waterway. They are usually constructed of concrete, but wood and gravel ramps are also found. Point identification of boat ramps does not discriminate based on type, size, material, or quality of the launch. Access at these sites is not guaranteed, as many may be located on private property. The location of these ramps was determined from static ten second GPS observations. Ramps are illustrated as purple squares on the maps.

Breakwaters - Breakwaters are structures which sit parallel to the shore, and generally occur in a series along the shore. Their purpose is to attenuate and deflect incoming wave energy, protecting the fastland behind the structure. In doing so, a beach may naturally accrete behind the structures if sediment is available. A beach nourishment program is frequently part of the construction plan.

The position of the breakwater offshore, the number of breakwaters in a series, and their length depends on the size of the beach which must be maintained for shoreline protection. Most breakwater systems sit with the top at or near MHW and are partially exposed during low water. Breakwaters can be composed of a variety of materials. Large rock breakwaters, or breakwaters constructed of gabion baskets filled with smaller stone are popular today. Breakwaters are not easily observed from aerial imagery. However, the symmetrical cuspate sand bodies which may accumulate behind the structures can be. In this survey, individual breakwaters are not mapped. The first and last breakwater in the series are surveyed as a ten-second static GPS observation. The system is delineated on the maps as a line paralleling the linear extent of the breakwater series along the shore.

Bulkhead - Bulkheads are traditionally treated wood or steel "walls" constructed to offer protection from wave attack. More recently, plastics are being used in the construction. Bulkheads are vertical structures built slightly seaward of the problem area and backfilled with suitable fill material. They function like a retaining wall, as they are designed to retain upland soil, and prevent erosion of the bank from impinging waves. The recent proliferation of vertical concrete cylinders, stacked side by side along an eroding stretch of shore offer similar level of protection as bulkheads, and include some of the same considerations for placement and success. These structures are also included in the bulkhead inventory.

Bulkheads are found in all types of environments, but they perform best in low to moderate energy conditions. Under high energy situations, the erosive power of reflective waves off bulkheads can scour material from the base, and cause eventual failure of the structure.

Bulkheads are common along residential and commercially developed shores. From aerial photography, long stretches of bulkheaded shoreline may be observed as an unnaturally straight or angular coast. In this inventory, they are mapped using kinematic GPS techniques. The data are displayed as linear features on the maps.

Commercial - Commercial zones include small commercial operations as well as parks or campgrounds. These operations are not necessarily water dependent businesses.

Dock/Pier - In this survey, a dock or pier is a structure, generally constructed of wood, which is built perpendicular or parallel to the shore. These are typical on private property, particularly residential areas. They provide access to the water, usually for recreational purposes. Docks and piers are mapped as point features on the shore. Pier length is not surveyed. In the map compositions, docks are denoted by a small green dot. Depending on resolution, docks can be observed in aerial imagery, and may be seen in the maps if the structure was built prior to 1994, when the photography was taken.

Forest Land Use - Forest cover includes deciduous, evergreen, and mixed forest stands greater than 18 feet high. The riparian zone is classified as forested if the tree stand extends at least 33 feet inland of the seaward limit of the riparian zone.

Grass - Grass lands include large unmanaged fields, managed grasslands adjacent to large estates, agriculture tracts reserved for pasture, and grazing.

Groinfield - Groins are low profile structures that sit perpendicular to the shore. They are generally positioned at, or slightly above, the mean low water line. They can be constructed of rock, timber, or concrete. They are frequently set in a series known as a groinfield, which may extend along a stretch of shoreline for some distance.

The purpose of a groin is to trap sediment moving along shore in the littoral current. Sediment is deposited on the updrift side of the structure and can, when sufficient sediment is available in the system, accrete a small beach area. Some fields are nourished immediately after construction with suitable beach fill material. This approach does not deplete the longshore sediment supply, and offers immediate protection to the fastland behind the system.

For groins to be effective there needs to be a regular supply of sediment in the littoral system. In sediment starved areas, groin fields will not be particularly effective. In addition they can accelerate erosion on the downdrift side of the groin. The design of "low profile" groins was intended to allow some sediment to pass over the structure during intermediate and high tide stages, reducing the risk of down drift erosion.

From aerial imagery, most groins cannot be observed. However, effective groin fields appear as asymmetrical cusps where sediment has accumulated on the updrift side of the groin. The direction of net sediment drift is also evident.

This inventory does not delineate individual groins. In the field, the first and last groin of a series is surveyed. Others between them are assumed to be evenly spaced. On the map composition, the groin field is designated as a linear feature extending along the shore.

Industrial - Industrial operations are larger commercial businesses.

Marina - Marinas are denoted as line features in this survey. They are a collection of docks and wharfs which can extend along an appreciable length of shore. Frequently they are associated with extensive bulkheading. Structures associated with a marina are not identified individually. This means any docks, wharfs, and bulkheads would not be delineated separately. Marinas are generally commercial operations. Community docks offering slips and launches for community residents are becoming more popular. They are usually smaller in scale than a commercial operation. To distinguish these facilities from commercial marinas, the riparian land use map (Plate A) will denote the use of the land at the site as residential for a community facility, rather than commercial.

Marshes - Marshes can be extensive embayed marshes, or narrow, fragmented fringe marshes. The vegetation must be relatively well established, although not necessarily healthy.

Miscellaneous - Miscellaneous point features represent short isolated segments along the shore where material has been dumped to protect a section of shore undergoing chronic erosion. Longer sections of shore are illustrated as line features. They can include tires, bricks, broken concrete rubble, and railroad ties as examples.

Paved - Paved areas represent roads which run along the shore and generally are located at the top of the banks. Paved also includes parking areas such as parking at boat landing, or commercial facilities.

Residential - Residential zones include rural and suburban size plots, as well as multi-family dwellings.

Riprap - Generally composed of large rock to withstand wave energy, riprap revetments are constructed along shores to protect eroding fastland. Revetments today are preferred to bulkhead construction. They reduce wave reflection which causes scouring at the base of the structure, and are known to provide some habitat for aquatic and terrestrial species. Most revetments are constructed with a fine mesh filter cloth placed between the ground and the rock. The filter cloth permits water to permeate through, but prevents sediment behind the cloth from being removed, and causing the rock to settle. Revetments can be massive structures, extending along extensive stretches of shore, and up graded banks. When a bulkhead fails, riprap is often placed at the base for protection, rather than a bulkhead replacement. Riprap is also used to protect the edge of an eroding marsh. This use is known as toe protection. This inventory does not distinguish among the various types of revetments.

Riprap revetments are popular along residential waterfront as a mechanism for stabilizing banks. Along commercial or industrial waterfront development such as marinas, bulkheads are still more common since they provide a facility along which a vessel can dock securely.

Riprap is mapped as a linear feature using kinematic GPS data collection techniques. The maps illustrate riprap as a linear feature along the shore.

Scrub-shrub - Scrub-shrub zones include trees less than 18 feet high, and is usually dominated by shrubs and bushy plants.

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