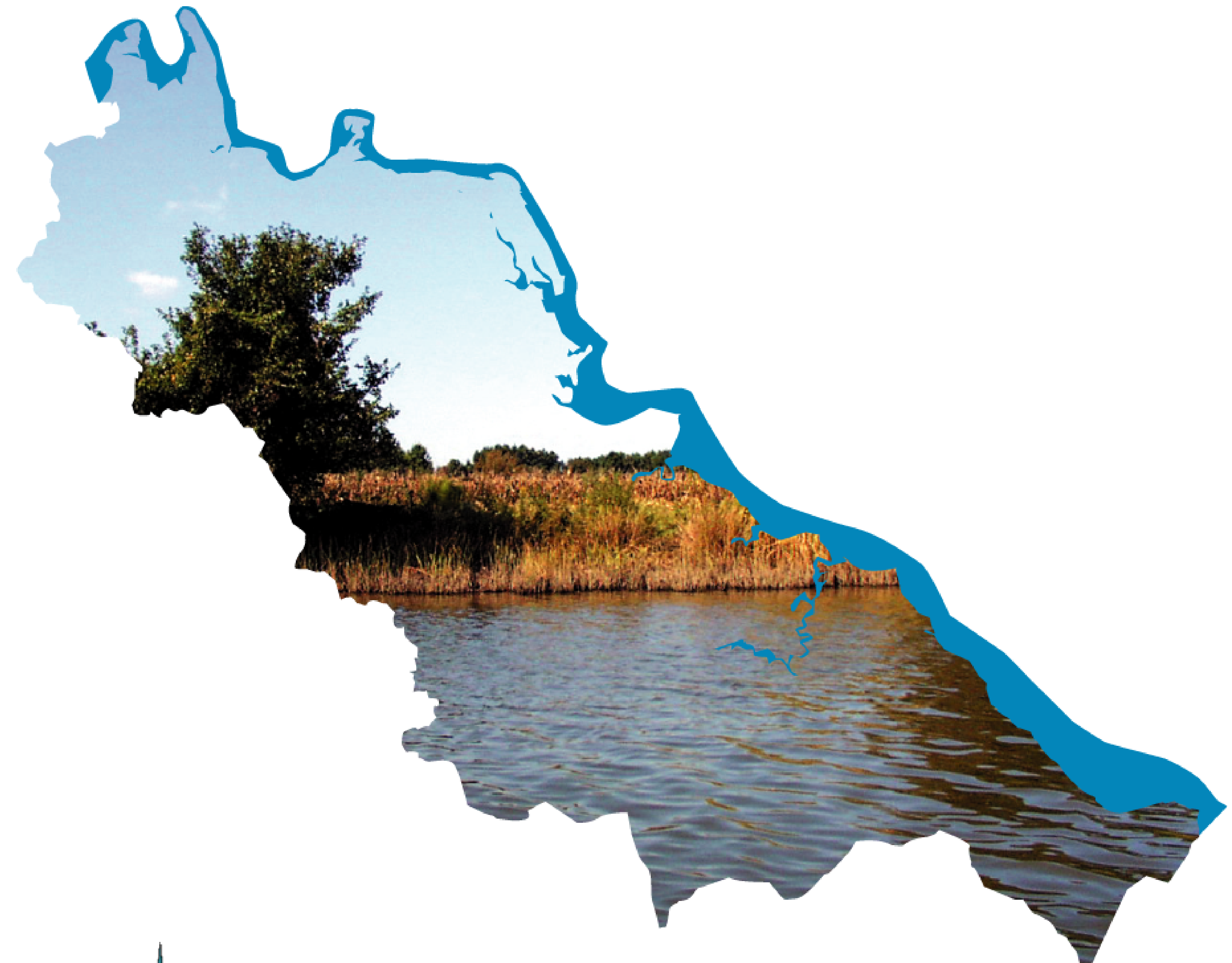
Essex County and the Town of Tappahannock Shoreline Situation Report



Prepared By:
Comprehensive Coastal Inventory Program
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Va. 23062

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Center for Coastal Resources Management
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Prepared By (in alphabetical order):

Marcia Berman
Harry Berquist
Sharon Dewing
Julie Glover
Carl Hershner
Tamia Rudnicky
Dan Schatt
Kevin Skunda

Project Supervisors:
Marcia Berman - Director, Comprehensive Coastal Inventory Program
Carl Hershner - Director, Center for Coastal Resources Management

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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 (Rogers et.al., 1976).

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 distributed in hardcopy. The digital GIS coverages developed for the report are available on the web at *www.vims.edu/ccrm/gis/gisdata.html*. CCI is exploring techniques for serving the publications online. Those interested should check the CCI web site periodically at *www.vims.edu/ccrm/publications.html*.

1.2 Description of the Locality

Essex County is approximately 286 square miles of land area, with 28 square miles of major surface water (Figure 1). Essex County is located on the Middle Peninsula in Virginia. The county borders King George to the north, Westmoreland and Richmond County to the northeast, Caroline and King and Queen County on the west boundary, and Middlesex County along the southeast. The southern boundary is contiguous to the Dragon Swamp which drains into the Piankatank River. Its eastern shore runs along the Rappahannock River. The center line of the Rappahannock River separates Essex County from Richmond County at its southern limit, and Westmoreland and King George County as you move upriver. The Dragon Run divides Essex from King and Queen County. The major waterway influencing the coastal character of the county is the Rapphannock River. Several creeks draining into the Rappahannock include Piscataway Creek, Hoskins Creek, Mount Landing Creek, Quioccasin Creek, Sluice Creek, Occupacia Creek, Colemans Creek, and Baylor Creek.

The town of Tappahannock runs inland from the Rappahannock River and serves as the only major business center in the county, as well as the county seat. The focus of development is here in Tappahannock, with few other major residential developments outside the town limits. The surrounding county of Essex is basically rural in character.

The 1998 Comprehensive Plan for Essex County reports that nearly 62% of the land cover is forested. Agricultural uses account for 31%, including cropland and pasture land. Residential and other use of the land account for only 6%. Residential areas are more prevalent within the Town of Tappahannock, and southeast along the Rappahannock (Redman Johnston Associates, 1998).

Tidal shoreline protection is afforded through regulations established by the Clean Water Act, and the Chesapeake Bay Preservation Act. The county designated the entire landmass to be a Resource Management Area. Designated Resource Protection Areas (RPAs) are consistent with the regulations set forth in the Chesapeake Bay Preservation Act (100 foot buffers landward of all streams, adjoining wetlands, and related sensitive areas) (Redman Johnston and Associates, 1998).

1.3 Purpose and Goals

This shoreline inventory has been developed as a tool for assessing conditions along the tidal shoreline in Essex County. Recent 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. The survey extends from the border of Essex and Middlesex County on the Rappahannock and extends up the Rappahannock into Portobago Bay. Piscataway Creek, Hoskins Creek, Mount Landing Creek, Quioccasin Creek, Sluice Creek, Occupacia Creek, Colemans Creek, and Baylor Creek are included in this survey (Figure 1).

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. From existing literature and the current survey, Chapter 4 reports the general state of the county's shoreline, and integrates a series of maps which illustrate current conditions.

1.5 Acknowledgments

This report has been primarily funded by the Comprehensive Coastal Inventory Program (CCI) with monies appropriated by the General Assembly. The Virginia Coastal Resources Management Program at the Department of Environmental Quality provided funds to support data processing through Grant # NA770Z0204 of the National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management, under the Coastal Zone Management Act of 1972, as amended. The Chesapeake Bay Local Assistance Department supported the publication of this report through award number 011D300.

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 eight categories (Table 1). The categories provide a simple assessment of land use, and give rise to land management practices which could 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.

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, 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.

A GPS operator observes shoreline conditions from a shoal draft boat.

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 croplands
Residential	includes single or multi family dwellings
Commercial	includes industrial, small business, recreational facilities
Bare	lot cleared to bare soil
Timbered	clear-cuts
Unknown	land use undetectable from the vessel

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. 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, which are constructed to protect shorelines 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.

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

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 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

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	includes private and public
boat house	P	all covered structures, assumes a pier
marina	L	includes piers, bulkheads, wharfs

collection is performed. Kinematic data collection is a collection technique where data is collected continuously along a pathway (in this case along the shoreline). 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.

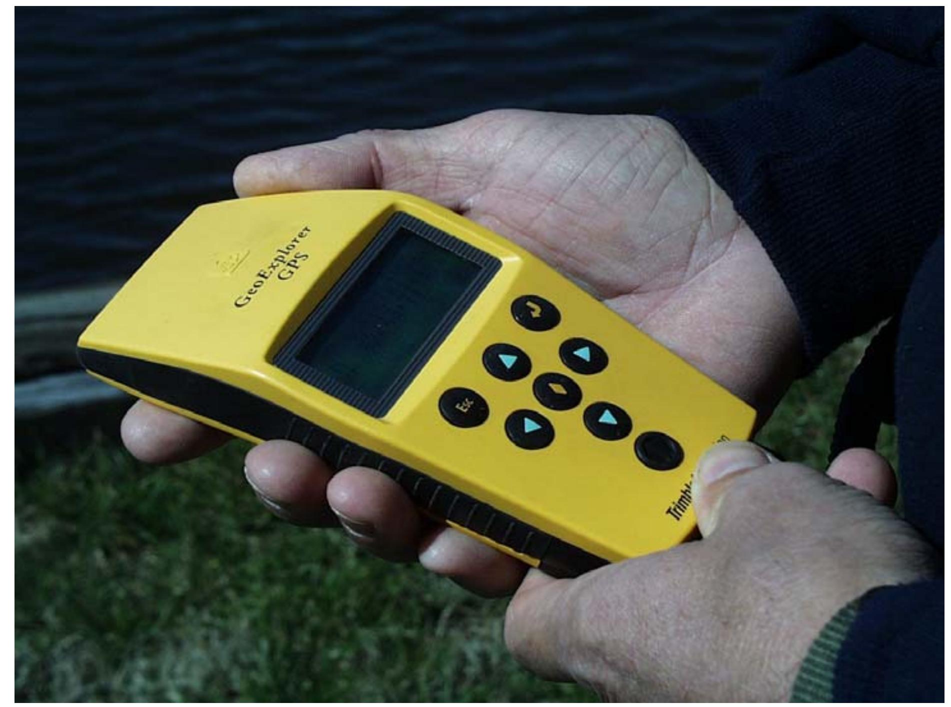
Static surveys pin-point fixed locations which occur at very short intervals. The boat actually stops to collect these data, and the boat operator must hold the boat against tidal current, and surface wind waves. Static surveys log 10 GPS observations at a rate of one observation per second at the fixed 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 they are surveying 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 which describe the shoreland's land use, bank condition, and shoreline features present. The survey, therefore, is a complete suite 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. The VIMS' base station was used for most of the data processing in Essex County. Data from base stations maintained by the United States Coast Guard at Cape Henry, or the VA Department of Transportation in Richmond were also available. Both of these stations are no longer active.



A hand-held Trimble GeoExplorer logs field data observed from the boat.

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 (essex_lubc), a shoreline structure coverage (lines only) (essex_sstruc), and a shoreline structure coverage (points only) (essex_astruc).

2.4b.) GIS Processing: GIS processing uses ESRI's ArcInfo® GIS software, and ERDAS' Imagine® software. Several data sets are integrated to develop the final inventory products. First, the shoreline situation data are derived from the GPS field data, and the three coverages discussed above. The attributes are summarized in Tables 1, 2, and 3. Second, the basemap coverage is derived from a digitized record of the high water shoreline illustrated on 7.5 minute, 1:24,000 USGS topographic maps for the study area. Since it is available for the entire Tidewater area, this shoreline has been selected as the baseline shoreline for development of all Shoreline Situation Reports. The digital coverage was developed by the CCI program in the early 1990s using most recent topographic maps available. These maps range from the late 1960s to the early 1980s. As USGS updates these maps, revisions to the digital basemap series can be made. Finally, the third data set integrated is digital color infra-red imagery known as Digital Ortho Quarter Quadrangles (DOQQs). These products are circulated by the USGS. DOQQs are fully rectified digital imagery representing one quarter of a USGS 7.5 minute quadrangle. They were released in 1997, and use imagery flown in 1994. The imagery are used as background during 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.

GIS processing includes two separate parts. Step one checks the relative accuracy of the shoreline coverage. Since this coverage was developed from topographic maps dating back to the 1960s, significant changes in the shoreline orientation may have occurred. While this process does not attempt to recompute 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 behind the digitized USGS shoreline coverage. The operator looks for areas where the digitized shoreline departs greatly from the land water interface depicted in the background image. The digitized shoreline coverage is then corrected to align more closely with the land water interface displayed using Imagine's onscreen digitizing techniques. This revised shoreline coverage is used in all subsequent inventory steps and products.

Step two 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 corrected 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. The corrected shoreline is the base coverage. The remaining processing re-codes the base shoreline coverage for the 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: Large format, 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 (> 10 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 grayscale version of this same image is used for Plates B and C.

For publication purposes the county is divided into a series of plates set at a scale of 1:12,000. The number of plates is determined by the geographic size and shape of Essex County. An index is provided in Chapter 4 which illustrates the orientation of plates to each other. The county was divided into 24 plates (plate 1a, 1b, 1c, etc.), for a total of 72 map compositions.

Tables 4 and 5 quantify features mapped in the count. These are generated using frequency analysis techniques in ArcInfo. Table 4 bases its calculations on the river reaches which were delineated in the 1970s by VIMS' coastal geologists to represent short, process similar stretches of shoreline. They provide a unit of measure for comparative purposes over time (Byrne and Anderson, 1983). The reach boundaries are illustrated in Figure 2. Table 4, quantifies present conditions (1999) on a reach by reach basis. There are 39 reaches in Essex County (reaches 25-72). Table 4 reports the linear attribute data as a percent of the total reach length, and point data as the number of features per reach.

Tables 5 also quantifies features mapped along the rivers using frequency analysis techniques in ArcInfo. The values quantify features on a plate by plat 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 191.65 miles of shoreline were surveyed in the field. An additional 125 miles of shoreline were surveyed using remote sensing and photo interpretation techniques. These areas could not be reached by boat due to shallow water conditions. Since there is plate overlap, survey miles can not be reached by adding the total shoreline miles for each plate. The last row of Table 5 does, however, report the total shoreline miles surveyed for the county (316.65) and the total amount of each feature surveyed along the measured shoreline. Remember that only 191.65 miles of shoreline were surveyed in the field. The remaining 125 miles were surveyed remotely using image interpretation.

Pristine marsh habitat thrive along the Rappahannock.

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 within the SSRs can be integrated and synthesized 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 as significant a 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).

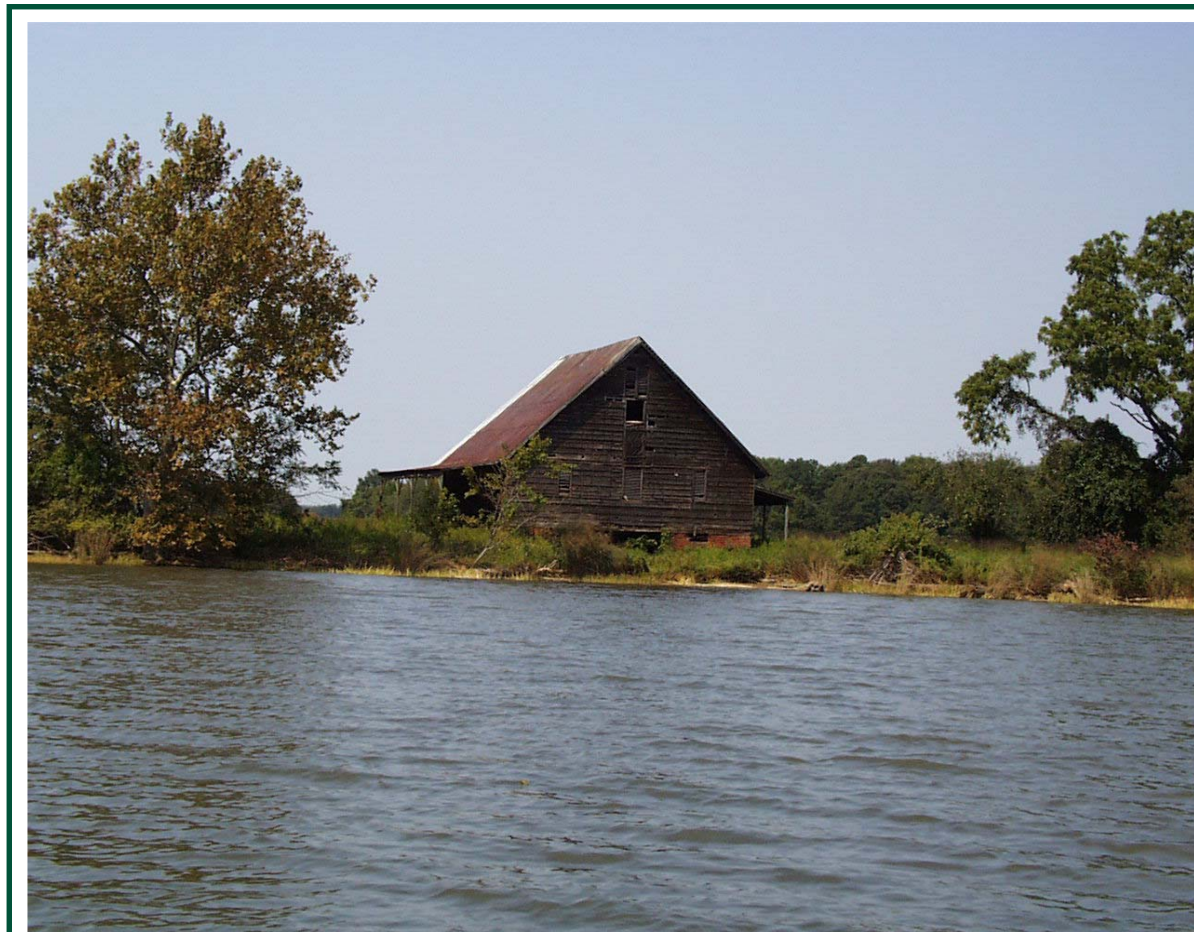
Plate B can be used to identify sites for BMPs. Look for where "red" (i.e. eroding) bank conditions persist. The thickness of the line tells something about the bank height. The fetch, or the distance of exposure across the water, can offer some insight into the type of BMP which might be most appropriate. 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.

This abandoned farmhouse contributes to the scenic qualities of the river.



Chapter 4. The Shoreline Situation

The shoreline situation is described for conditions in Essex County along its primary and secondary waterways. Characteristics are described for all navigable tidal waterways contiguous to the Rappahannock River. A total of 316.65 miles of shoreline are described. Nearly 192 miles were surveyed in the field. The remaining 125 miles are described using image interpretation techniques and ancillary data sources. These areas are dominated by tidal headwater channels of the secondary creeks which wind upstream. Photo interpretation was made using DOQQs to detect land use, natural buffers, and shoreline structures. 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.

Brief descriptions of the county are provided on the basis of river segments, the boundaries of which are geographically determined. These descriptions summarize tabular data (Table 5) and notable features present. Three segments are defined. Segment 1 includes plates 1-5; Segment 2 includes plates 6-13; and Segment 3, plates 14-24. An index preceding the map compositions illustrates the plate boundaries. Important documentation pertaining to each plate follows the segment description below.

Installation of shoreline protection structures can temporarily degrade bank conditions.

New bulkhead is installed to protect the toe of this bare bluff on the Rappahannock River.

Segment 1 (Plates 1-5)

Description: Segment 1 begins at the county border adjacent to Middlesex County. It continues up the Rappahannock River from Jones Point north of McKans Bay to Piscataway Creek, below Tappahannock. The segment includes surveys of lower Cedar Creek, the entrance to Tuscarora Creek, Bellview Creek, and Piscataway Creek. Nearly 31 miles of shoreline was surveyed in Segment 1. The shore is oriented northwest-southeast, and along the Rappahannock, fetch is greatest in these directions. Therefore, winds from the northwest or southeast have the capacity to generate the largest waves. The riparian area includes a number of residential districts. This segment is significantly more developed than shoreline reaches to the north of Tappahannock. The upland illustrated in the plates shows a number of large farm tracts dispersed among forest stands.

Land Use: Land use along the main stem of the Rappahannock is dominated by residential use. The tidal creeks are dominated by forest and scrub-shrub cover. Of the measured shoreline (30.98 miles), 14.33 miles of shoreline is forested, and 9.45 miles is residential. Agriculture in the immediate riparian zone extends along less than 4% of the total shoreline. Much of the shoreline in Segment 1 has been developed. Approximately 42% of the surveyed miles are residential. Scrub-shrub comprises the majority of the remaining land cover, and dominates along Easton Cove and around Blackwalnut Ridge. Thirteen percent of the shoreline is forested, and 2% is commercial. A comparison with data reported in Rogers et.al., (1976), suggests land use along the main stem of the river has not changed significantly.

Bank Condition: Seventy-four percent of bank heights along this segment are below 5 feet. The majority of these banks are classified as stable or low erosion. Nearly 96% of the banks have total cover (between 75-100%). This includes vegetative as well as structural coverage. This contributes to the overall stability observed in the survey. There are banks higher than five feet observed along the main stem of the Rappahannock. These are the focus of the majority of banks classified as high erosion. In several of these areas, the eroding banks contribute sediment to the adjacent beaches. Marsh vegetation was observed along 20 miles of shoreline. Less than one mile showed obvious signs of erosion. One third of the shoreline measured has no marsh vegetation.

Installation of private pier along the Rappahannock.

According to Rogers et.al. (1976), flood hazard potential is low to moderate along most of this segment. Elevations were estimated to be slightly higher than those observed in Rogers et.al. (1976). During extreme high tides, a significant portion of the shore and inland marshes would be subject to flooding.

Shore Condition: Erosion control structures are found along the main stem of the Rappahannock to counteract wave and storm induced erosion. These include more than four miles of bulkheading, more than four miles of groin fields, and over three miles of riprap. The segment has 175 private piers, and 45 boathouses. An unusually high number of boat ramps (n=47) were located during the survey. Most of these are privately owned. There is one private marina operating. The historical erosion rates, reported in Byrne and Anderson (1983) for reaches within this segment, range between 1.5 and 3.3 feet/year.

Segment 2 (Plates 6-13)

Description: Segment 2 begins at the entrance to Piscataway Creek. It covers the main shoreline of the Rappahannock from the entrance of Piscataway Creek to approximately 2.5 miles northwest of Mallory Point. The following creeks are also delineated: Piscataway Creek, Hoskins Creek, and Mount Landing Creek. The segment is dominated by activities in and around the Town of Tappahannock (plates 9 and 11), and represents the most developed region within the inventory boundaries. Field surveys were performed between September 7-8, 1999.

Water depths and bridge heights at the route 17 overpasses prohibit navigation above the tidal creeks at these points. Surveyed data for Piscataway, Hoskins and Mount Landing Creeks above the route 17 overpass were generated using remote sensing and photo interpretation techniques. The plate descriptions in Chapter 4 report the shoreline miles surveyed using this method. The photo interpretation assumed low erosion conditions along the banks and marsh edges of these stretches. As these reaches are subject to strong tidal currents, banks can be undercut which leads to slumping. This possibility could not be verified, but should be made aware. Bank height was delineated using topographic contours. Segment 2 includes 120.68 miles of shoreline.

Land Use: Land use along the shoreline is dominated by forest cover. Forest areas are most prevalent long the creeks. Residential use prevails along the main Rappahannock shoreline. Seventy four percent of the shoreline is forested, 16% is scrub-shrub, and less than 8% is residential. There is just over one mile of commercially developed shoreline within the town limits. Development in the upland is minimal. These patterns are consistent with an earlier assessment by Rogers et.al.,1976.

Bank Condition: Bank heights range from less than 5 feet to greater than 10 feet in Segment 2. Eighty-six percent the banks are below five feet in elevation. Bank heights greater than 10 feet were observed in Piscataway Creek and along sections of the Rappahannock. Overall bank stability persists except in isolated areas. The majority of eroding banks are located along the Rappahannock shore. Ninety-nine percent of the banks have total cover. Much of this was presumed from remotely sensed data products for the tributaries upriver of the Route 17 overpasses. According to Rogers et.al., 1976, flood potential in this area is generally low. The low-lying, exposed sections along the Rappahannock shoreline have a moderate to critical risk for flooding during storms. The low-lying, protected shorelines along the creeks are at less risk because of their limited exposure.

Old Marina at Hoskins Creek.

Shore Condition: Fringe marshes occur intermittently along the Rappahannock shoreline, and frequently along the creek shores. Eighty-six percent of the shoreline has some marsh frontage. Only 16.62 miles of the total 120.68 miles does not have marsh present. In contrast, there are very few beaches; only 1.88 total miles were observed. Bulkheads, groins, and riprap are installed along the Rappahannock shoreline for shore protection. There are no surveyed protection structures along the creeks. Shore protection structures are difficult to detect using remote sensing techniques and imagery at this resolution. Therefore, the absence of shore protection structures in areas above the bridge is not verified. Private, recreational structures are noted throughout the area. There are 167 docks observed, 36 boathouses, and 23 boat ramps. Two boat ramps are public access areas. One is located just southeast of the 360 bridge over the Rappahannock, and the second is located inside the entrance to Hoskins Creek. Shoreline erosion rates were estimated for the Rappahannock shoreline by Byrne and Anderson (1983). Rates ranged between 2.3-2.7 feet/year. No rates were computed for the creek shores.

Otterburn Marsh on the Rappahannock River.

Segment 3 (Plates 14-24)

Description: The last segment, Segment 3, extends from 2.5 miles northwest of Mallory Point to Portobago Bay. The segment includes 173.98 miles of shoreline. A percentage of the creek shoreline could not be accessed by boat and was surveyed remotely. Data represents conditions surveyed in September, 1999. Remotely sensed data sections describe conditions from 1994, when the imagery was flown. The survey describes the shoreline of the Rappahannock River as well as Broad Creek, Sluice Creek, Occupacia Creek, Farmers Hall Creek, and Elmwood Creek. In this segment, the Rappahannock River narrows considerably, and a number of large, pristine marsh habitats are found. The character of this segment differs greatly from Segments 1 or 2. Development here is dramatically reduced, and even shorefront development is not well established. The upland region is dominated by forest cover, with considerable amounts of scrub-shrub intermixed with a few large agricultural tracts.

Land Use: The majority of the riparian landcover is forested (69%). Residential use accounts for only 2% of the riparian area. Scrub-shrub accounts for more than 24%. There is a considerable amount of agricultural land use in the upland, however, a consistent forest buffer greater than 30 feet wide persists along most of these tracts. This is observed in the imagery illustrated on plate a(s). A very small commercial operation is located in Farmers Hall Creek. This operation extends along less than 0.02 mile of shore.

Bank Condition: Low (< 5 feet) stable banks persist along most of the shoreline here (94%). This may be do to the fact that almost 78% of the shore is protected by marsh vegetation. Also, the majority of the banks have total cover (171.88 miles). Short, intermittent stretches of sand beaches are found along plate 19. Eroding bluffs in this area provide the sediment source necessary to maintain these small sand lenses. The earlier Shoreline Situation Report evaluates the flood hazard here as low; siting marsh protection, low exposure, and high elevations as the reason (Rogers et.al., 1976).

Old boat house along the Rappahannock River.

Map Compositions

Essex County and the Town of Tappahannock

Plate 1

Location: Butylo to 1.5 miles west of Cedar Creek
Major River: Rappahannock River
Reach(s): 70 (partial), 71, 72
Total Shoreline Miles: 4.96
Shoreline Miles Surveyed: 3.36 (1.6 miles remotely surveyed)
Survey Date(s): 06/09/99 and 08/24/1999
Plate Rotation: 0 degrees

Plate 2

Location: 0.36 mile southeast of Layton Branch to 0.22 mile northwest of Garretts Marina
Major River: Rappahannock River
Reach(s): 70 (partial)
Total Shoreline Miles: 5.01
Shoreline Miles Surveyed: 3.88 (1.14 miles remotely surveyed)
Survey Date(s): 08/24/1999
Plate Rotation: 56 degrees W

Plate 3

Location: Bowlers Wharf to Browns Point
Major River: Rappahannock River
Reach(s): 68 (partial), 69, 70 (partial)
Total Shoreline Miles: 3.28
Shoreline Miles Surveyed: 3.28 (no remote survey)
Survey Date(s): 08/24/1999
Plate Rotation: 56 degrees W

Plate 4

Location: Eubank to 0.3 mile northwest Wares Wharf
Major River: Rappahannock River
Reach(s): 64 (partial), 65, 66, 67, 68 (partial)
Total Shoreline Miles: 5.81
Shoreline Miles Surveyed: 3.52 (2.29 miles remotely surveyed)
Survey Date(s): 08/24/1999 and 09/07/99
Plate Rotation: 56 degrees W

Plate 5

Location: 0.89 mile south Lowery Point to mouth of Piscataway Creek
Major River: Rappahannock River
Reach(s): 58 (partial), 59 (partial), 60, 61, 62, 63, 64, 65 (partial)
Total Shoreline Miles: 12.79
Shoreline Miles Surveyed: 12.79 (no remote survey)
Survey Date(s): 09/07/99
Plate Rotation: 25 degrees W

Plate 6

Location: Mouth of Piscataway Creek through Richmond Beach; Mouth of Piscataway Creek to 2.5 miles inland
Major River: Rappahannock River
Reach(s): 56 (partial), 57, 58, 59 (partial), 60, 61 (partial)
Total Shoreline Miles: 29.86
Shoreline Miles Surveyed: 29.86 (no remote survey)
Survey Date(s): 09/07/99
Plate Rotation: 90 degrees W

Plate 7

Location: Piscataway Creek 2.8 miles east and 1.5 miles west of U.S. Route 17 bridge.
Major River: Piscataway Creek
Reach(s): 59 (partial)
Total Shoreline Miles: 26.25
Shoreline Miles Surveyed: 17.90 (8.34 miles remotely surveyed)
Survey Date(s): 09/07/99
Plate Rotation: 90 degrees W

Plate 8

Location: Headwaters of Piscataway Creek
Major River: Piscataway Creek
Reach(s): 59 (partial)
Total Shoreline Miles: 11.72
Shoreline Miles Surveyed: 1.47 (10.25 miles remotely surveyed)
Survey Date(s): 09/07/99
Plate Rotation: 0 degrees

Plate 9

Location: Tappahannock and Hoskins Creek
Major River: Rappahannock River
Reach(s): 54 (partial), 55 (partial), 56 (partial)
Total Shoreline Miles: 20.72
Shoreline Miles Surveyed: 3.26 (17.47 miles remotely surveyed)
Survey Date(s): 09/07/1999 and 09/08/1999
Plate Rotation: 0 degrees

Private boat ramp in Hoskins Creek.

Plate 10

Location: Headwaters of Hoskins Creek
Major River: Hoskins Creek
Reach(s): 55 (partial)
Total Shoreline Miles: 4.99
Shoreline Miles Surveyed: 0 (100% remote surveyed)
Survey Date(s): not applicable
Plate Rotation: 90 degrees W

Plate 11

Location: Tappahannock to mouth of Mount Landing Creek
Major River: Rappahannock River
Reach(s): 52 (partial), 53, 54 (partial)
Total Shoreline Miles: 8.19
Shoreline Miles Surveyed: 4.99 (3.20 miles remotely surveyed)
Survey Date(s): 09/08/1999
Plate Rotation: 39 degrees W

Plate 12

Location: Mount Landing Creek
Major River: Mount Landing Creek
Reach(s): 51 (partial), 52, 53 (partial)
Total Shoreline Miles: 29.43
Shoreline Miles Surveyed: 1.81 (27.62 miles remotely surveyed)
Survey Date(s): 09/08/99
Plate Rotation: 0 degrees

Plate 13

Location: Mallorys Point to within 0.45 mile of Jenkins Landing
Major River: Rappahannock River
Reach(s): 50 (partial), 51 (partial)
Total Shoreline Miles: 10.22
Shoreline Miles Surveyed: 10.22 (no remote)
Survey Date(s): 09/08/99
Plate Rotation: 0 degrees

Plate 14

Location: Jenkins Landing to 0.8 mile north of Sluice Creek
Major River: Rappahannock River
Reach(s): 39 (partial), 40, 49, 50 (partial)
Total Shoreline Miles: 49.42
Shoreline Miles Surveyed: 40.13 (9.35 miles remotely surveyed)
Survey Date(s): 09/08/1999 and 09/13/1999
Plate Rotation: 90 degrees W

Plate 15

Location: From 0.7 mile south of Daingerfield Landing around Paynes Island; Bridge Creek and portion of Occupacia Creek
Major River: Rappahannock River
Reach(s): 36 (partial), 37, 38 (partial), 39 (partial)
Total Shoreline Miles: 27.90
Shoreline Miles Surveyed: 6.02 (11.98 miles remotely surveyed)
Survey Date(s): 09/13/1999
Plate Rotation: 90 degrees W

Plate 16

Location: Farmers Hall Creek and mouth of Occupacia Creek
Major River: Occupacia Creek
Reach(s): 39 (partial)
Total Shoreline Miles: 11.92
Shoreline Miles Surveyed: 8.74 (6.89 miles remotely surveyed)
Survey Date(s): 09/13/99
Plate Rotation: 0 degrees

Plate 17

Location: South portion of Paynes Island to 0.84 mile west of Beverly Marsh; 3 mile section of Occupacia Creek
Major River: Rappahannock River
Reach(s): 35 (partial), 36 (partial), 39 (partial)
Total Shoreline Miles: 41.12
Shoreline Miles Surveyed: 26.47 (14.68 miles remotely surveyed)
Survey Date(s): 09/13/99
Plate Rotation: 90 degrees W

Plate 18

Location: Headwaters of Occupacia Creek
Major River: Occupacia Creek
Reach(s): 39 (partial)
Total Shoreline Miles: 18.19
Shoreline Miles Surveyed: 0.96 (17.27 miles remotely surveyed)
Survey Date(s): 09/13/99
Plate Rotation: 0 degrees

Plate 19

Location: From 1.5 miles southeast Hutchinson Swamp through Colmans Creek
Major River: Rappahannock River
Reach(s): 34 (partial), 35 (partial)
Total Shoreline Miles: 4.59
Shoreline Miles Surveyed: 4.11 (0.49 mile remotely surveyed)
Survey Date(s): 09/13/99 and 09/20/99
Plate Rotation: 0 degrees

Plate 20

Location: From Layton to Saunders Wharf
Major River: Rappahannock River
Reach(s): 32 (partial), 33, 34 (partial)
Total Shoreline Miles: 13.96
Shoreline Miles Surveyed: 13.96 (no remote survey)
Survey Date(s): 09/13/99 and 09/20/99
Plate Rotation: 0 degrees

Plate 21

Location: Saunders Wharf to 0.2 mile northwest of Stillwater Creek
Major River: Rappahannock River
Reach(s): 30 (partial), 31, 32 (partial)
Total Shoreline Miles: 7.81
Shoreline Miles Surveyed: 3.03 (4.78 miles remotely surveyed)
Survey Date(s): 09/20/99
Plate Rotation: 0 degrees

Plate 22

Location: North of Stillwater Creek to southern portion of Horse Head Point; Green Bay
Major River: Rappahannock River
Reach(s): 27 (partial), 28, 29 (partial), 30
Total Shoreline Miles: 6.21
Shoreline Miles Surveyed: 5.91 (0.30 mile remotely surveyed)
Survey Date(s): 09/20/99
Plate Rotation: 90 degrees W

Plate 23

Location: Horse Head Point and Green Bay
Major River: Rappahannock River
Reach(s): 27 (partial), 28, 29, 30 (partial)
Total Shoreline Miles: 7.03
Shoreline Miles Surveyed: 7.03 (no remote survey)
Survey Date(s): 09/20/99
Plate Rotation: 90 degrees W

Plate 24

Location: Green Bay, around Marsh Point, and into Portobago Creek
Major River: Rappahannock River
Reach(s): 25, 27 (partial)
Total Shoreline Miles: 11.10
Shoreline Miles Surveyed: 10.21 (0.89 mile remotely surveyed)
Survey Date(s): 09/20/99
Plate Rotation: 90 degrees W

Riprap and bulkhead protection.

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 and larger industrial facilities. 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.

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.

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

Undercutting along this fringe marsh due to tidal current erosion in Occupacia Creek.

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Fringe marshes along agricultural tracts provide a sink for nutrient runoff.