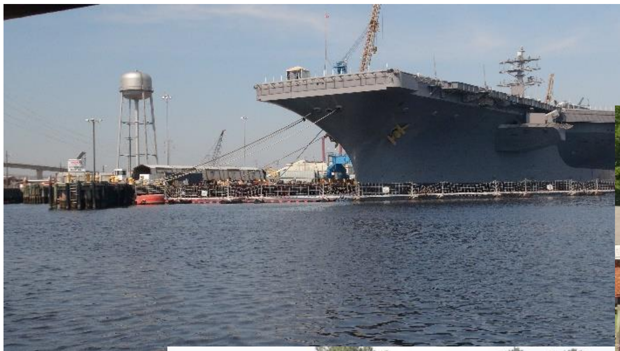
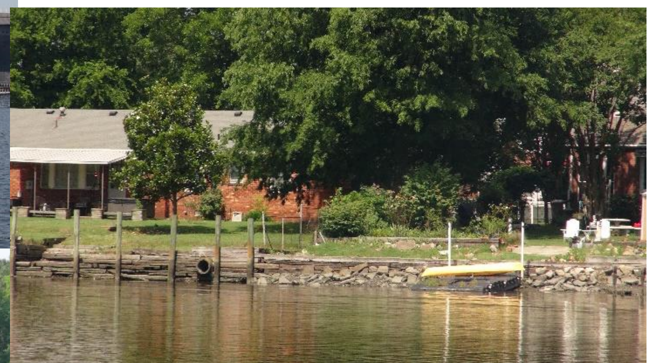
City of Portsmouth, Virginia
Shoreline Inventory Report
Methods and Guidelines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City of Portsmouth- Shoreline Inventory Report

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 that 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 locality by locality 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 desktop reference.

The Comprehensive Coastal Inventory Program (CCI) is committed to developing a revised series of Shoreline Situation Reports that address the management questions of today and take advantage of new technology. New techniques integrate a combination of Geographic Information Systems (GIS), Global Positioning System (GPS) and remote sensing technology. Renamed the Shoreline Inventory Reports, CCI began the development of this new series in the 1990s. The City of Portsmouth was first revised in 2008 with an extensive field effort. In 2015, the report has been updated using remote sensing techniques. Reports are now distributed electronically. The digital GIS shape files, along with reports, tools, and tables are available on the web at http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/index.html by clicking on City of Portsmouth.

1.2 Description of the Locality

The City of Portsmouth is part of the Hampton Roads metropolitan area in the Commonwealth of Virginia. It is located on the western side of the Elizabeth River directly across from the City of Norfolk.

According to the United States Census Bureau, the City of Portsmouth has a total area of 122 km^2 (47 mi^2), of which approximately 88 km^2 (34 mi^2) of it is land and 34 km^2 (13 mi^2) is water.

The City of Portsmouth is a historic waterfront city with a significant heritage. Due to its geographic location on the Elizabeth River, James River, and Chesapeake Bay, the City supports a substantial number of port facilities and other water-dependent industries, as well as waterfront residential properties. Several miles of its shoreline form part of the Port of Hampton Roads, the world's largest natural harbor and one of the busiest ports in the United States.

The majority of the City is developed. There is a broad spectrum of land uses: residential development of various classes, commercial and industrial areas, as well as governmental installations, such as the Norfolk Naval Shipyard, and the U.S. Naval Hospital.

The City of Portsmouth Comprehensive Plan ("Destination 2025") defines a clear vision of the City in 2025 through a set of specifics goals and policies. The Plan focuses in great detail on economic development and neighborhood quality. Nevertheless, to balance the extensively developed nature of the City, the Plan addresses different creative approaches to identify potential areas for parks and open space purposes (City of Portsmouth, VA – Official Website).

1.3 Purpose and Goals

This shoreline inventory is developed as a resource for assessing conditions along the tidal shoreline. These data provide important baseline information to support shoreline management and improve the decision making capacity of local and state governing boards. These data are also required to run the shoreline management model which defines Shoreline Best Management Practices (BMPs) for the city's tidal shoreline. Shoreline BMPs are found within the Comprehensive Coastal Resource Management Portal (CCRMP) for City of Portsmouth: http://ccrm.vims.edu/ccrmp/index.html.

This shoreline inventory was remotely generated using two sources: 2015 oblique Pictometry imagery available through Bing Maps, and 2013 high resolution imagery available from the Virginia Base Mapping Program (VBMP). The Tidal Marsh Inventory was updated during field surveys in June and August 2015. Shorelines of Baines Creek, Elizabeth River, Hampton Roads, Hoffler Creek, Lilly Creek, Paradise Creek, Scott Creek, Sterns Creek, and the Southern and Western Branches of the Elizabeth River were surveyed.

Conditions are reported for three zones: the riparian upland, the bank as the interface between the upland and the shoreline, and the shoreline itself; with attention to shoreline structures and hardening.

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 gives instructional details about the website where the data can be found.

1.5 Acknowledgments

This work was completed entirely with staff support and management from the VIMS Center for Coastal Resources Management.

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 (Berman and Hershner, 1999).

The 2015 inventory data for the City of Portsmouth were digitized from 2015 Pictometry imagery hosted by Bing online as well as 2013 VBMP imagery using on-screen, digitizing techniques in ArcGIS® - ArcMap (version 10.2.2). These data sources allowed the inventory to be generated without additional field work. All mapping was accomplished at a scale of 1:1,000.

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

2.2 Three Tiered Shoreline Assessment

The data developed for the Shoreline Inventory Report is based on a three-tiered shoreline assessment approach. This assessment characterizes conditions in the shorezone, which extends from the immediate riparian area to within 100 feet of the adjacent shoreline. This assessment approach was developed using observations made remotely at the desktop using high resolution imagery. To that end, the survey is a collection of descriptive measurements that characterize conditions.

The three shorezone regions addressed in the study are: 1) the immediate riparian zone, evaluated for land use, and tree fringe; 2) the bank, evaluated for height, cover, and natural protection; and 3) the shoreline, describing the presence of shoreline structures for shore protection and recreational uses. Each tier is described in detail below.

2.2a) Riparian Land Use: Land use adjacent to the bank is classified into one of eleven classes (Table 1). The classification provides a simple assessment of land use, for insight into land management practices that may be anticipated. Land use is measured as a length or distance along the shore where the practice is observed. The width of this zone is not measured. The presence of tree fringe is noted along land uses other than forest use.

Table 1. Tier One - Riparian Land Use Classes

Forest	deciduous, evergreen, and mixed forest stands
Scrub-shrub	small trees, shrubs, and bushy plants
Grass	includes grass fields, and pasture land
Agriculture	includes cropland
Residential	includes single or multi-family dwellings
Commercial	small and moderate business operations, recreational facilities
Industrial	includes large industry and manufacturing operations
Military	includes all military installations
Bare	lot cleared to bare soil
Timbered	clear-cuts
Paved	areas where roads or parking areas are adjacent to the shore

Note: occurrence of tree fringe is noted along non-forest dominated shoreline

2.2b) Bank Condition: The bank assessment in this inventory addresses: bank height, bank cover, and the presence of natural buffers (beach, marsh) at the bank toe (Table 2). All attributes assessed for the bank are qualitative. The bank extends off the fastland, and serves as the seaward edge of the upland. It is a source of sediment and nutrient fluxes from the fastland, and bears many of the upland soil characteristics that 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 infrastructure 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 channel ward of the bank to absorb energy impact to the bank itself.

Bank height is reported as a range in feet. It is the height of the bank from the base to the top. The estimation of the bank height is based on imagery, field inspection, videography, LIDAR or a combination of all data sources.

Table 2. Tier 2 - Bank Conditions and Natural Buffers

Bank Attribute	Range	Description
bank height	0-5 ft	from toe of the bank to the top of the bank
	5-30 ft	from toe of the bank to the top of the bank
	> 30 ft	from toe of the bank to the top of the bank
bank cover	bare	<25% vegetated/structural cover
	partial	25-75% vegetated/structural cover
	total	>75% vegetated/structural cover
marsh buffer	no	no marsh vegetation along the bank toe
	yes	marsh or marsh island present
beach buffer	no	no sand beach present
	yes	sand beach present
Phragmites australis	no	no *Phragmites australis* present on site
	yes	*Phragmites australis* present on site

Bank cover is an assessment of the percent of cover on the bank face, and includes vegetative and structural cover, in this case. Therefore, if the entire bank has been covered with a revetment the bank will be classified as "total" cover.

At the base of the bank, marsh vegetation, sand beach or *Phragmites australis* may be present. Marshes and beaches offer protection to the bank and enhance water quality. Beaches were noted as part of the desktop survey. Marshes were delineated from high resolution imagery (2013 VBMP) as part of a separate activity (Tidal Marsh Inventory). Their locations were verified in the field (June and August 2015) and the vegetation communities, including the presence of *Phragmites australis,* were assessed to understand the distribution of marsh types within the major tributaries.

2.2c) Shoreline Features: Structures added to the shoreline by property owners are recorded as a combination of points or lines. These features include defense structures, such as riprap, constructed to protect the shoreline from erosion; offense structures such as groins, designed to

Table 3. Tier 3 - Shoreline Features

Feature	Feature Type	Comments
<u>Erosion Control Structures</u>		
riprap	L	
bulkhead	L	
dilapidated bulkhead	L	structure no longer performing its function
breakwaters	L	first and last of a series is surveyed alongshore
groinfield	L	first and last of a series is surveyed alongshore
jetty	P	
unconventional	L	constructed of nontraditional but permitted material
debris	L	constructed of unauthorized material (e.g tires)
marsh toe revetment	L	rock placed at the toe of the marsh
seawall	L	solid structure that performs like a bulkhead
<u>Recreational Structures</u>		
pier	P	includes private and public
dilapidated pier	P	appears unsafe
wharf	L	includes private and public
boat ramp	P	distinguishes private vs. public landings
boat house	P	all covered structures, assumes a pier
marina	L	includes infrastructure such as piers, bulkheads, wharfs; number of slips are estimated

L= line features; P= point features

accumulate sand in transport; and recreational structures, built to enhance public or private use of the water (Table 3). The locations of these features along the shore were identified and digitized at the desktop. Structures such as revetments and bulkheads are delineated as line features. Table 3 summarizes the features surveyed. Linear features are denoted with an “L” and point features are denoted with a “P.” The glossary describes these features, and their function along a shoreline.

2.3 Data Collection/Survey Techniques

Shoreline Inventory

The shoreline inventory data collection for the City of Portsmouth was performed at the desktop using ArcGIS® - ArcMap v.10.2.2. Land use, bank condition and shoreline features were digitized while viewing conditions observed in 2015 online Bing imagery as well as 2013 VBMP imagery. Pictometry imagery provides an excellent platform to assess changes in land use, presence of erosion control structures, and the location of private/public docks, boathouses, marinas, and boat ramps. All mapping was accomplished at a scale of 1:1,000.

Tidal Marsh Inventory

As indicated earlier, tidal marshes were delineated from 2013 VBMP imagery using onscreen digitizing techniques at a scale of 1:1,000. Bing and Google Earth online imagery was used to provide additional interpretive information to improve the accuracy of marsh boundaries. Marsh polygons were coded as either marsh or marsh island. Delineations were checked by a second party as part of the QA/QC.

After initial delineations were developed and checked, field maps were printed to illustrate the marsh polygons superimposed on the VBMP imagery. These maps were used during field surveys; which took place in June and August 2015.

Field collection of marsh data was performed primarily from a small shallow-draft vessel, navigating at slow speeds parallel to the shoreline. Surveys extended as far upstream as depth and field conditions allowed. Some additional data collection was performed by land where marshes were easily accessible from public lands. During surveys, marsh boundaries were verified, and wetland plant species observed within each marsh polygon were recorded along with relative cover estimates to determine marsh community types. Access to new tidal marsh inventories can be found here:
http://ccrm.vims.edu/gis_data_maps/static_maps/gis/tmi_updated.html

2.4 GIS Processing

Shoreline Inventory

The baseline shoreline was generated by digitizing the land-water interface using 2013 VBMP imagery at scale 1:1,000. Online Bing imagery from 2015 was also used to assist in areas where the land-water interface is obscured. The final delineated baseline shoreline represents the land-water interface and is not a tidally referenced or surveyed demarcation. The process was performed using ArcGIS® - ArcMap v.10.2.2 software. The QA/QC process for the base shoreline involves running topology rules to ensure that the arc has no overlapping segments or dangles. With this step, we define and enforce data integrity rules.

This shoreline is then coded for shoreline attributes observed in 2015 online Bing imagery, Google Earth, as well as 2013 VBMP imagery. All ancillary data resources are utilized for accuracy purposes including additional imagery from different year classes.

The GIS processing undergoes a rigorous sequence of checks and reviews to insure the accuracy. The coded shoreline is inspected by a second GIS analyst using all ancillary data resources that are available. The second stage in the QA/QC process involves additional inspection by another party professional. This individual inspects the coding for shoreline structures, shoreline access features, and the presence of beaches for the entire locality and makes corrections based on local site knowledge, and different image sources.

The final products are three newly coded GIS shapefiles: "Portsmouth_lubc_2015" (depicting land use and bank condition), "Portsmouth _sstru_2015" (depicting linear structures), "Portsmouth _astru_2015" (depicting point structures). Upon completion, frequency analyses are run on the data to develop summary tables, and an interactive map viewer is generated for the website.

Tidal Marsh Inventory

Following field work marsh boundaries are corrected, based on field observations, using ArcGIS® - ArcMap v.10.2.2. Plant identification data is entered in an Excel spreadsheet that is later joined with the ArcGIS marsh polygon layer. Quality control and assurance measures are performed, and maps and tables are generated for the website. The final product is a newly coded GIS shapefile: "Portsmouth_TMI_2015_final.shp".

2.4c.) Map Viewer and Summary Tables: The City of Portsmouth Shoreline Inventory is delivered to the end user through a website; http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/index.html (Figure 1.), by clicking on City of Portsmouth in the map or list of localities. The new format for Shoreline Inventories includes a map viewing tool rather than maps in pdf format. The map viewer allows users to interact with the datasets within a familiar "google" type map service that was developed with Javascript. Here users can view data of their choice and customize map products for printing themselves. Access to the GIS data, summary tables and methods report is also available through this website.

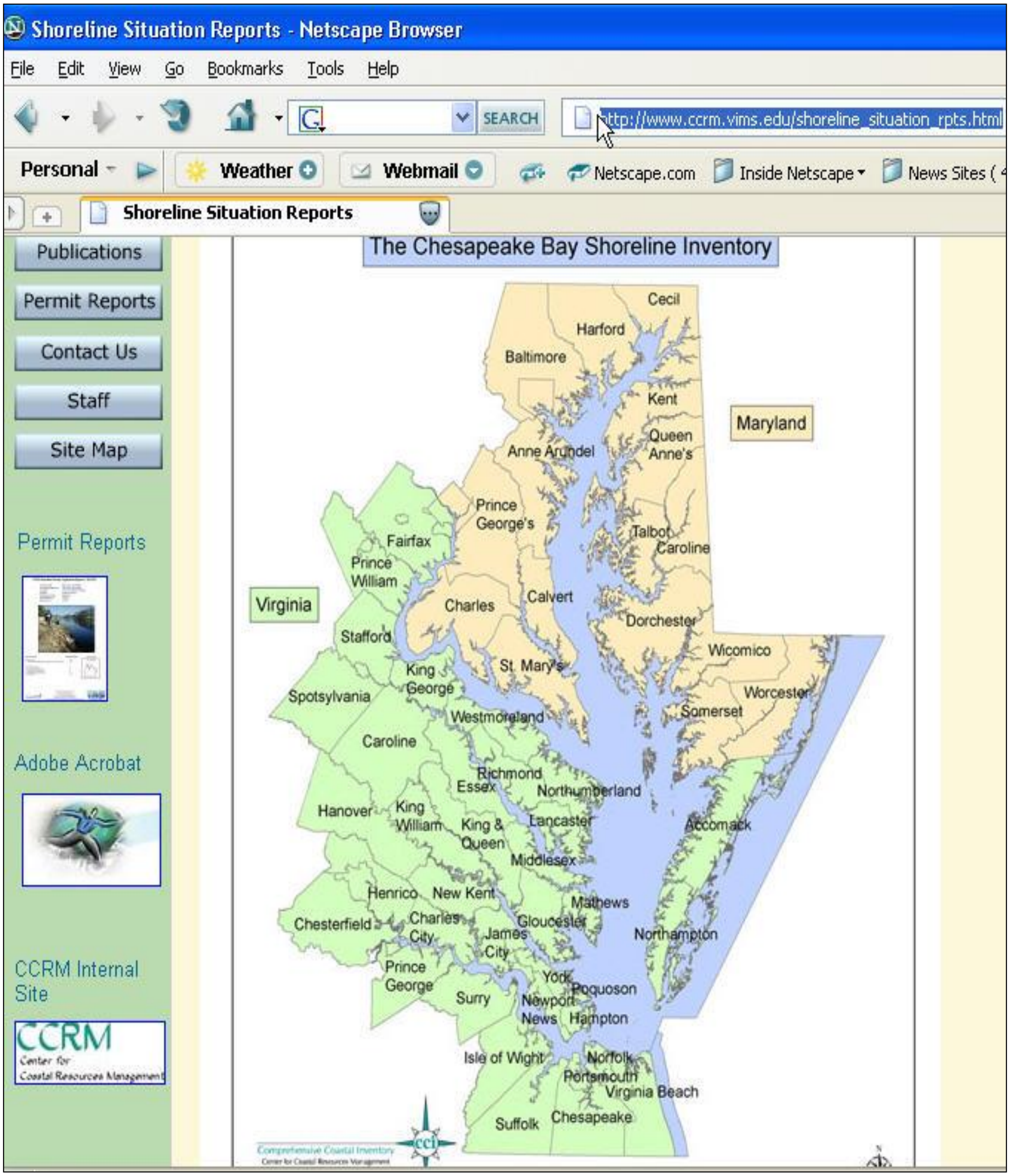

Figure 1. Shoreline Inventory Website

Summary tables (Tables 4-7) quantify conditions observed on the basis of river systems (Figure 2). Refer to Figure 2 for the location of these rivers systems. Note, river systems do not correspond to watershed boundaries. They were developed for convenience in reporting data.

In the City of Portsmouth, 97 miles of shoreline were remotely surveyed. All these areas are noted in Table 4.

Tables 4, 5, 6, and 7, quantify features and conditions mapped along the rivers using frequency analysis techniques in ArcInfo. For linear features, values are reported in actual miles. Point features are enumerated. Polygon features are reported in acres surveyed (marshes). These tables are downloadable as pdf files from the website. They are not included in this document.

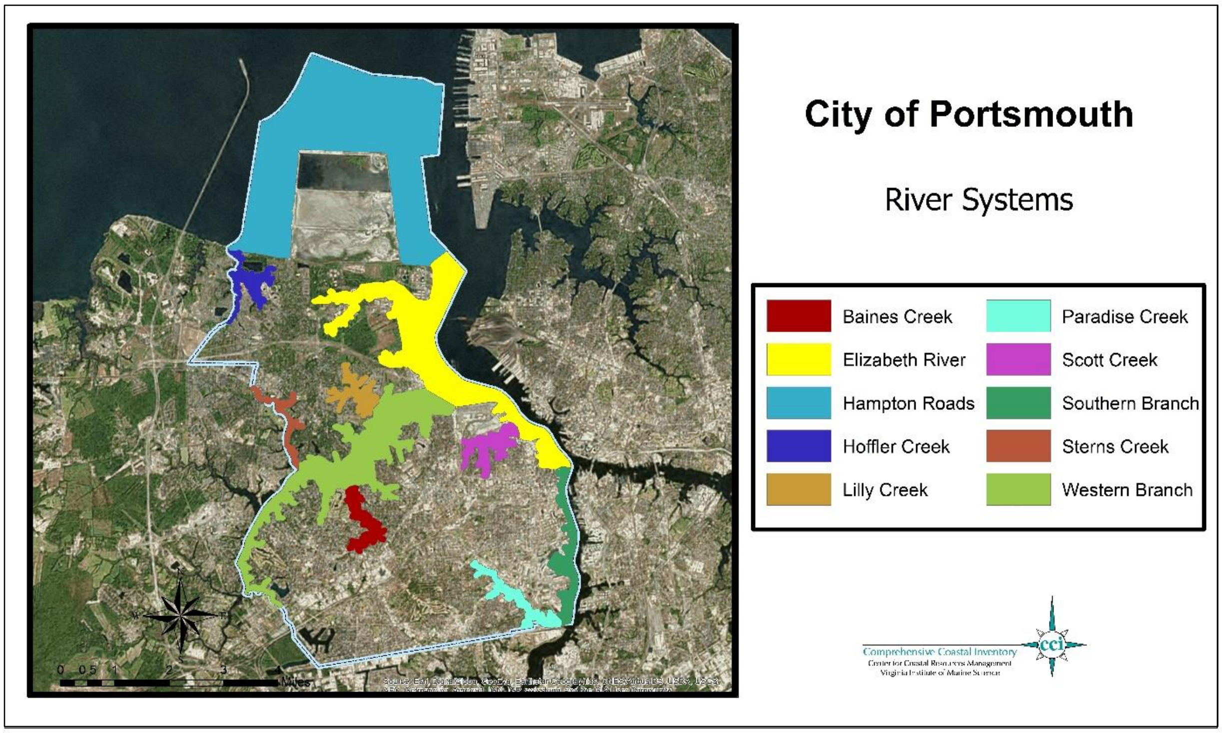

Figure 2. River Systems in the City of Portsmouth

Chapter 3. Applications for Management

There is a number of different management applications for which the Shoreline Inventory Reports support. This section discusses several high profile issues within the Commonwealth or Chesapeake Bay watershed. The inventories are data reports, and the data provided are intended for interpretation and integration into other programs. This chapter offers some examples for how data from the Shoreline Inventory can be analyzed to support current state management programs.

3.2 Shoreline Management

The first uses for Shoreline Inventory 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 that have persisted. At the same time, the value of waterfront property has escalated, and the exigency to protect shorelines as an economic resource using stabilization practices has also increased. 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 with respect to current states and future sea level rise scenarios, and determining future uses of the shore with regards to ecosystem services, economic development, and climate change impacts. The Shoreline Inventories provide data for such assessments. These data are currently being used to determine best strategies to counter erosion based on existing condition. Shoreline Inventories are the backbone for the development of Comprehensive Coastal Resource Management Guidance, the Shoreline Management Model and Shoreline Management Plans that integrate data and scientific rationale to strategize best management practices on a reach-by-reach basis (http://ccrm.vims.edu/ccrmp/index.html).

The importance of land use information should not be under estimated. Regarding shoreline management, land use data gives rise to the type of management practices one can expect to find along the shoreline. The land use data in the Shoreline Inventory illustrates current land use at the time of survey; which may be an indicator of shoreline management practices existing or expected in the future. Residential and commercial areas are frequently altered to counter act shoreline erosion problems or to enhance private access to the waterway. In contrast forested or agricultural uses are frequently unmanaged even if chronic erosion problems exist. Small forest tracks nestled among residential lots have a high probability for development in the future. These areas are also future target areas for shoreline modifications if development does occur.

In coastal Virginia, elevation ranges from near sea level to several hundreds of feet above mean low water. Strategies for managing coastal erosion, risk avoidance, and options for habitat conservation requires some knowledge of the coastal terrain. Low-lying banks will be at greater risk of flooding and erosion due to storms and sea level rise. High bluffs are more susceptible to failure in high energy settings than low energy settings. The bank height data can help you determine this level of risk, and the map viewer is the place to find these data.

Stability at the shore is characterized by the conditions at the bank, in particular. The bank is characterized by its height, the amount of cover on the bank face and the presence or absence of natural buffers at the bank toe. Survey data reveals a strong correlation between banks of high erosion, and the absence of natural buffers. Upland adjacent to moderately high, well covered banks with a natural buffer at the base is less prone to flooding or erosion problems resulting from storm activity. Upland adjacent to a bank of lesser height (< 5feet) is at greater risk of flooding, but if the bank is stable with marsh or beach present, erosion may not be a significant concern. In addition, this morphology is ideal for inland migration of marsh habitat under rising sea level.

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 by selecting these attribute features in the map viewer and assess their distribution.

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. In the near future, the Comprehensive Coastal Resource Management Portal (CCRMP) (http://ccrm.vims.edu/ccrmp/index.html) and the guidance contained therein will provide the shoreline best management practices directly. Currently, with the data here one can assess various conditions and attributes through the viewer as a means to evaluate planned projects that present themselves for review.

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. 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 may have secured the erosion problem at the bank, they have also deflated the supply of sediment available to nourish a healthy beach. The structure may actually be enhancing erosion at the base of the structure by causing scour from wave reflection. The deepening of the nearshore can adversely affect the benthic community. This is a typical shore response, now evident after years of observation, which has led coastal managers to revise their recommendations regarding structures for erosion control.

In the development of a shoreline management strategy, all these possibilities are taken into account. Shoreline managers are encouraged to use the three-tiered shoreline assessment approaches presented here when making regulatory decisions. Each assessment provides important information independent of the others, but collectively the assessments become a more valuable management tool. The Center for Coastal Resources Management (CCRM) is using these data to run the Shoreline Management Model that delivers best management practices to counter shoreline erosion. This product may already be available for your locality. Check the CCRMP website (http://ccrm.vims.edu/ccrmp/index.html) or http://ccrm.vims.edu/ for news and updates.

3.3 Stream Restoration for Non-Point Source Management

The identification of potential problem areas for non-point source pollution is a focal point of water quality improvement efforts throughout the Commonwealth. This is a challenge for any large landscape. Fortunately, we are relatively well informed about the landscape characteristics that contribute to the problem. This shoreline inventory provides a data source where many of these landscape characteristics can be identified. The three tiered approach provides a collection of data which, when combined, can allow for an assessment of potential non-point source pollution problem areas in a waterway. Managers can effectively target river reaches for restoration sites. Below, methods for combining these data to identify problem sites are described.

Residential land and agricultural lands have the highest potential for nutrient runoff due to fertilizer applications. Agricultural lands are also prone to high sediment loads since the adjacent banks are seldom restored when erosion problems persist. Residential areas contribute to non-point source problems through leaking septic systems as well. Intensely developed areas which may include commercial and industrial sites have a high percentage of impervious surface which concentrates upland runoff into waterways.

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 low profile, 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.

To identify areas with the highest potential for non-point source pollution combine these land uses with "unstable" bank erosion conditions, bare bank cover, and no marsh buffer protection. The potential for non-point source pollution moderates as the condition of the bank changes from "unstable" bank erosion to "stable" 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 "stable" bank erosion, the structures are effectively controlling erosion at this time, and the potential for non-point source pollution associated with sediment load is reduced. If the following characteristics are delineated: low bank erosion, marsh buffer, riprap or bulkhead; the potential for non-point source pollution from any land use class can be lowered.

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, construction of living shorelines, and bank re-vegetation programs. Installation of BMPs is costly. There are cost share programs that 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 shoreline inventory can assist with targeting efforts for designating AOCs. AOCs can be areas where riparian buffers are fragmented, and could be restored. Information reported on riparian land use can be used to identify forest areas, breaks in forest coverage and the type of land use occurring where fragmentation has happened. 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.

An examination of conditions pertaining to the bank also contributes to targeting areas of concern with respect to sediment load sources to the watershed. The fetch, or the distance of exposure across the water, can offer some insight into the type of energy, potential for erosion, and the BMP that might be most appropriate. Marsh planting may be difficult to establish at the toe of a bank with high exposure to wave conditions. Look for other marsh fringe in the vicinity as an indicator that marshes can successfully grow. A riparian forest may include a tree canopy with overhang that could be trimmed to increase sunlight to promote marsh growth. Check for existing shoreline erosion structures in place. We can combine this information to assess where significant problems exist and what types of solutions will mediate the problems.

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 combined data for 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.

As water quality programs move into implementation phases the importance of shoreline erosion in the lower tidal tributaries will become evident. Erosion from shorelines has been associated with high sediment loads in receiving waters (Hardaway et al., 1992), and the potential for increased nutrient loads coming off eroding fastland is a concern (Ibison et al., 1990). Shoreline BMPs developed from the Inventory data may be considered as trade-off for nutrient reduction goals associated with Total Maximum Daily Loads (TMDLs) in the future. The extent to which this may be applied is undetermined.

Waterways with extensive footage of eroding shorelines represent areas that should be flagged as hot spots for sediment input. The volume of sediment entering a system is generally estimated by multiplying the computed shoreline recession rate by the bank height along some distance alongshore. Estimated bank height is mapped along all surveyed shorelines. Banks designated as bare and in excess of 30 feet would be target areas for high sediment loads. If these areas coincide with uplands in agricultural use, nutrient enrichment through sediment erosion is also a concern. Consult with table 5 for more information. Using the GIS data site-specific calculations can be made.

3.5 Summary

These represent only a handful of uses for the Shoreline Inventory data. Users are encouraged to consider merging these data with other local or regional datasets. Now that most agencies and localities have access to some GIS capabilities, the uses for the data are even greater.   The opportunity to update these datasets independently is not only possible, but probable. Historically, the development of the Chesapeake Bay Shoreline Inventory has evolved as new issues emerge for coastal managers, and technology improves. We expect to see this evolution and product enhancement continue into the future.

Chapter 4. The Shoreline Inventory for the City of Portsmouth

Shoreline condition is described for the City of Portsmouth along primary and secondary shoreline within the Chesapeake Bay watershed. A total of 97 miles of shoreline has been characterized.

Shoreline Inventory Reports are only available electronically. From this website: http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/index.html users can access the interactive Shoreline Inventory map viewer, electronic tables and report, GIS data, and metadata. The website is organized to encourage users to navigate through a series of informational pages before downloading the data. A map of the Chesapeake Bay region depicting counties and cities is shown on the main homepage for the Shoreline Inventory website (Figure 1). Scroll over the County/City name to link to the completed inventory or select “City of Portsmouth” from the list of completed inventories by state below the map.

After viewing the project summary and disclaimer on the City of Portsmouth Shoreline Inventory homepage, the user can select from five self-explanatory links on the page: map viewer, tables, report, GIS data, and historical report. The link to the map viewer will take you to the interactive Shoreline Inventory map viewer where data layers can be turned on and off in the side bar and displayed in the viewing window (Figure 3). The map viewer can be opened using any internet browser. When the map viewer is opened, a Welcome dialog box is launched that provides some useful information about the tool.

The Viewer has two panels: “Map Window”, where the map is displayed and “Map Contents and Legend”, where data that can be selected and viewed in the map window are listed. A tool bar is located along the top of the “Map Window” which gives users some controls for navigation and analysis (Figure 3.).

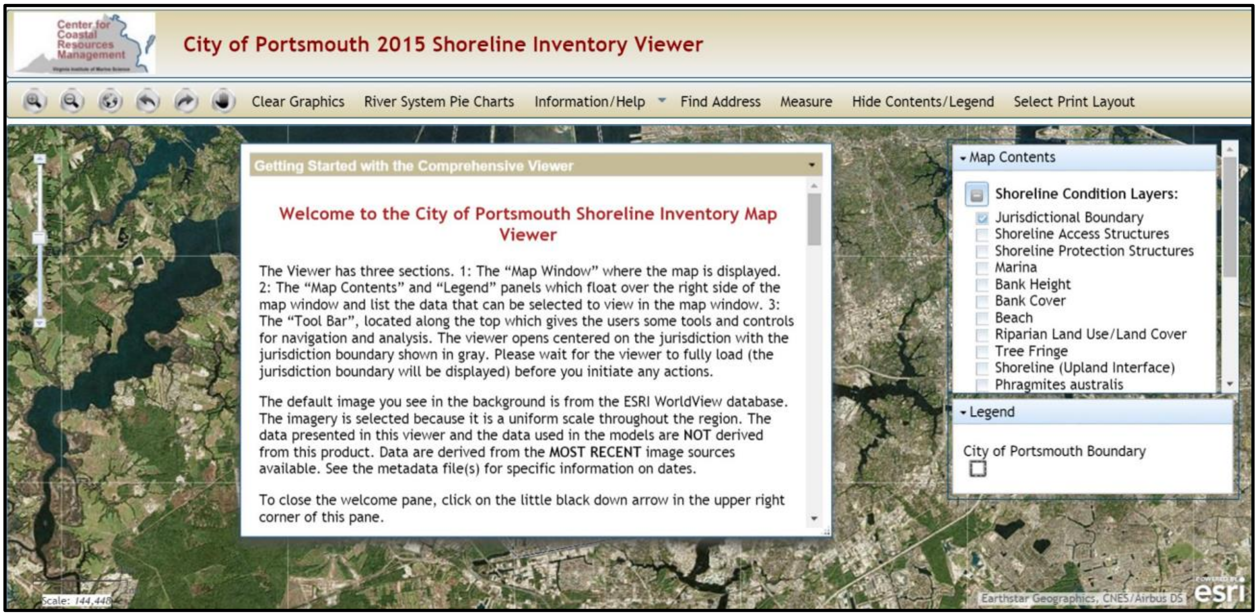

Figure 3. Opening page for the City of Portsmouth Shoreline Inventory Viewer

From the "Map Contents" the user may check various attribute layers on or off. The user must use the scroll bar on the far right to see the complete list of layers available. When layers are turned on, the corresponding legend appears in the "Legend" panel, and the data are displayed in the "Map Window" (Figure 4).

Figure 4. Map Viewer illustrates Shoreline Access and Protection Structures for a section of the City

In Figure 4 Shoreline Access Structures, and Shoreline Protection structures are selected. Shoreline Access structures are point features that includes piers and boat ramps. The actual footprint of these structures is not measured; only their location. Shoreline Protection Structures are line features and are mapped and illustrated in the viewer to show where they occur along the shoreline. Figure 5 illustrates riparian land use in the riparian zone for the same section of the City.

Figure 5. Distribution of land use in the riparian zone is displayed for this region of the City.

The user can use the zoom and pan tools from the top toolbar or the slide bar on the left side of the map window to change their map extent. If the map resolution is exceeded the window will become illegible. Detailed information can be obtained about the data by selecting the “Information/Help” tab at the top of the map viewer. From here the inventory glossary and metadata records can be easily accessed. In Figure 6 the selection for metadata has been made and 5 possible records can be retrieved.

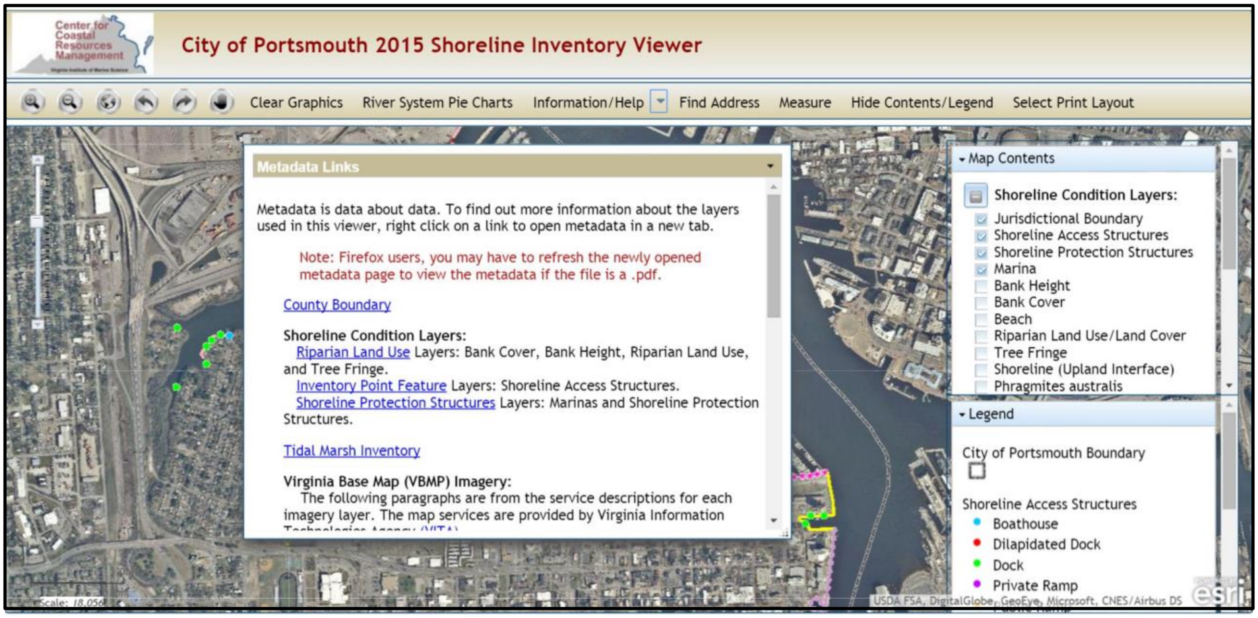

Figure 6. Link to Metadata records has been selected from the top Information tab in the toolbar.

The top toolbar also includes tabs to access some important status information for the locality. By clicking on the “River System Pie Charts” button, users can obtain a statistical summary distribution of the riparian land use and amount of hardened shoreline for a specific water body selected from the drop down menu in the upper left (Figure 7). More detailed results in table format can be found by clicking the City of Portsmouth Summary PDF button also in the window. The summary statistics are reported by river systems (Figure 2).

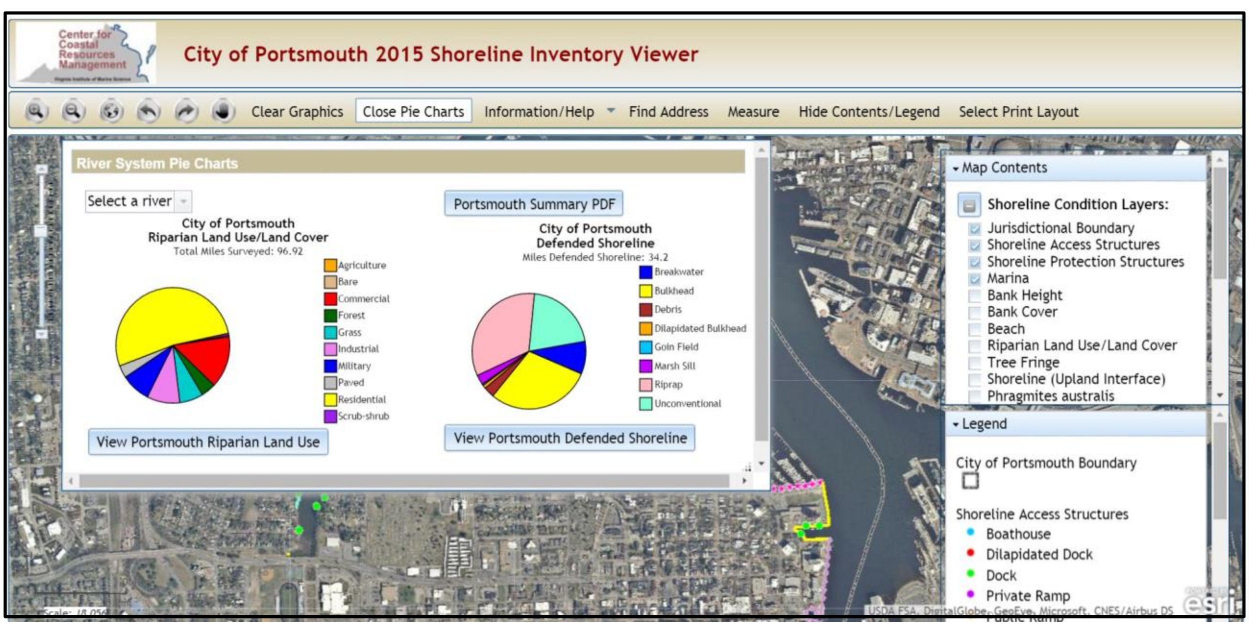

Figure 7. Pie charts display land use and shoreline hardening statistics for each tributary.

Finally, users have the option to personalize their own maps (i.e. map extent, data displayed, map title, etc.) and save them as a pdf file by clicking “Select Print Layout” button. The page can be set up for printing to 8.5 x 11 portrait or landscape style. Figure 8 is an example of a customized map generated for a section of Scott Creek. Here the tidal marsh communities are displayed, and the community type is reported in the legend below the illustration.

The City of Portsmouth Shoreline Inventory is one of several products generated to assist with shoreline management within the community and beyond. The inventory is part of a larger collection of tools and guidance compiled within the Comprehensive Coastal Resource Management Portal (CCRMP); an initiative which will include all Tidewater localities. Release of the CCRMP for City of Portsmouth is anticipated by December 2015, and will be accessible through this site: http://ccrm.vims.edu/ccrmp/index.html.

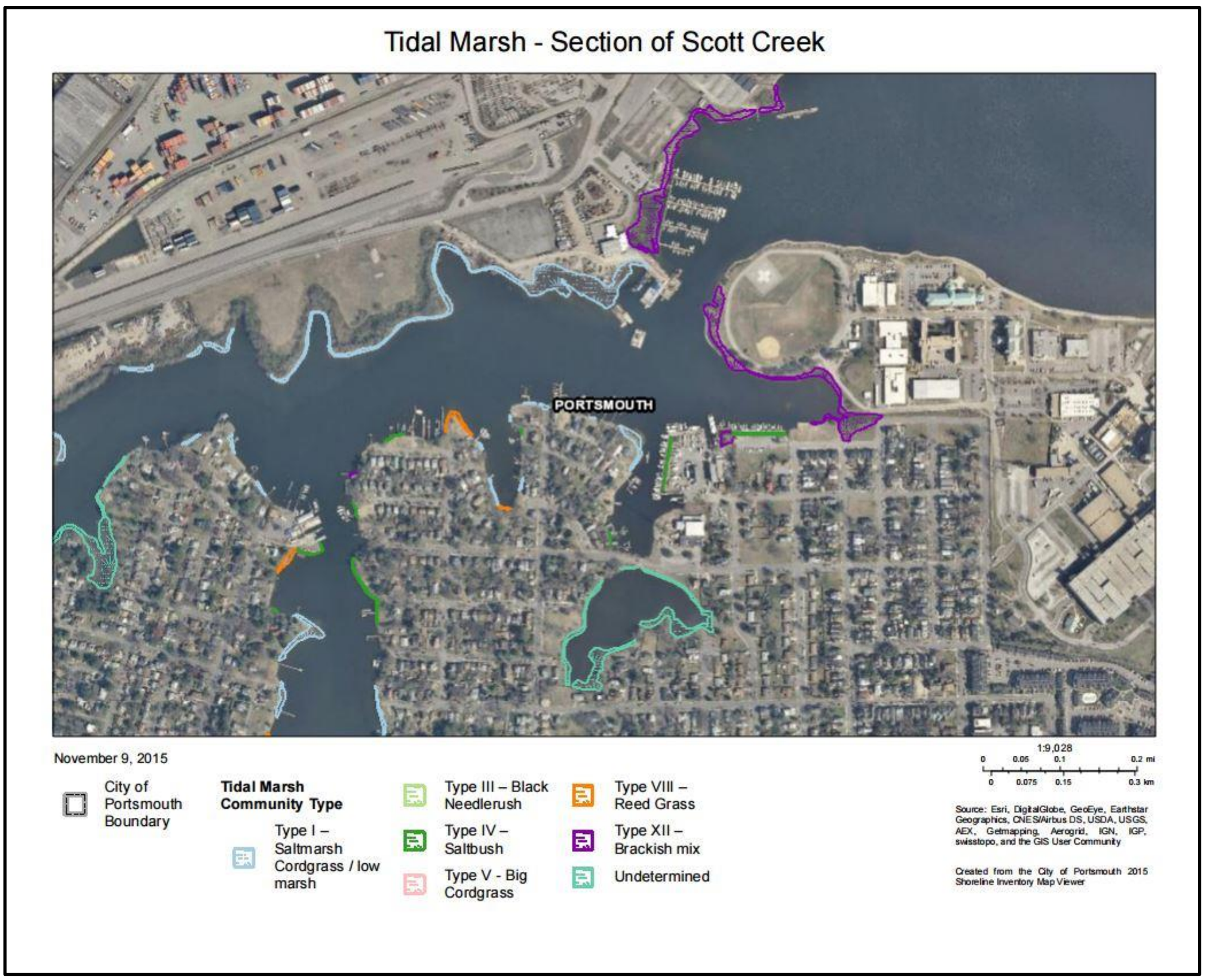

Figure 8. Customized print window for a section of Scott Creek

Glossary of Shoreline Features Defined

Agricultural - Land use defined as agricultural includes farm tracts that are cultivated and crop producing. This designation is not applicable for pastureland, which is coded as Grass.

Bank Cover – Bank cover is a classification based on the presence or absence of bare soil on the bank. "Cover" can include either vegetative or structural cover.

Bank Height – Bank height is the height of the bank from the base to the top. We estimate height from imagery, field inspection, videography, LIDAR or a combination of all data sources.

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

Beaches - Beaches are sandy shores that are visible during high tides. These features can be wide and persistent, or very thin lenses of sand.

Boathouse - 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 that offer only overhead protection. Since nearly all boathouses have adjoining piers, piers are not surveyed separately, but are assumed. Boathouses may be difficult to see in aerial photography.

Boat Ramp - Boat ramps are used to launch vessels of all types. 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. This inventory attempts to distinguish, when possible, private versus public ramps. Ramps located in privately owned, commercial marinas and residential communities are classified as private.

Breakwaters - Breakwaters are structures that sit offshore and generally occur in a parallel series along the shore. Some breakwaters are attached to the land and are referred to as headland breakwaters. Their purpose is to attenuate and deflect incoming wave energy, protecting the fastland behind and between the structures.
The Shoreline Inventory does not map individual breakwaters. A breakwater "system" is delineated and depicted as a line parallel to the series of breakwaters. Breakwaters are distinguished from marsh toe revetments by the size of the structures and presence of a sand beach instead of a tidal marsh landward from the structures. The classification can include best professional judgment.

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.

From aerial photography, long stretches of bulkheaded shoreline may be observed as an unnaturally straight or angular coast. They are mapped and illustrated as linear features along the shoreline. In rare cases, the bulkhead may be located well inland from the depicted location because the coding follows a digital shoreline.

Commercial - Commercial is a land use classification denoting small commercial operations such as shops, restaurants, as well as campgrounds. These operations are not necessarily water dependent businesses.

Debris – Debris represents nonconforming materials and rubble dumped along the shoreline in a haphazard manner. Debris can include tires, bricks, broken concrete rubble, and railroad ties as examples. The inventory maps Unconventional instead of Debris when the material is deliberately placed for shoreline protection in a manner similar to riprap, bulkhead, and other shoreline protection structures.

Dilapidated Bulkhead – A bulkhead which has failed due to deterioration from age or storm damage is called a dilapidated bulkhead. In many cases the structure may not be able to perform erosion control functions any longer.

Dilapidated Pier – A pier which has failed due to deterioration from age or storm damage is classified as a dilapidated pier. The remnants of this structure may be original pilings only.

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.

Forest Land Use - Forest cover includes deciduous, evergreen, and mixed forest stands. of trees. The land use is classified as Forest if there is a dense cover of trees and no other land use category is apparent close to the shoreline, e.g. residential, commercial, industrial, agriculture, etc.

Grass - Grasslands include large unmanaged fields, managed grasslands adjacent to large estates, agriculture tracts reserved for pasture, and grazing. While a general rule of thumb will classify a tract as “grass” if a home sits behind a large tract of grass, a designation of “residential” may be made if there are similar tracts adjacent to each other. This designation can be determined using best professional judgment.

Groinfield - Groins are low profile structures that sit perpendicular to the shore. 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. Unless only a single groin can be detected, this inventory does not delineate individual groins in a groinfield. The groinfield is mapped as one linear feature parallel to the shoreline running along the length of the groin series. When effective, groins will trap sediment moving alongshore.

Industrial - Industrial operations are larger commercial businesses and can include areas where power plants, pulp mills, refineries, etc. are in operation along the coast.

Jetty – A jetty is a structure generally constructed of stone which is perpendicular to the shoreline and generally located at the entrance of tidal creeks and tributaries or marina boat basins. The function of a jetty is to prevent sediment transported alongshore from accumulating in the inlet.

Land Use – Land Use refers to the predominant condition in the immediate riparian area within 100 feet of the adjacent shoreline. While the actual assessment of land use is defined by a distance, the classification can include best professional judgment; particularly when development or other land use activity is setback on the parcel.

Marina - Marinas are denoted as line features in this survey. The infrastructure associated with the marina (e.g bulkheading, docks, wharfs, etc.) are not digitized individually. However, if a boat ramp is noted it will be surveyed separately and coded as private. Marinas are generally commercial operations. However, smaller scale community docks offering slips and launches for residences are becoming more popular. To distinguish these facilities from commercial marinas, the user could check the riparian land use delineation. If "residential" the marina is most likely a community facility. The survey estimates the number of slips within the marina and classifies marinas as those with less than 50 slips and those with more than 50 slips.

Marsh –Tidal marsh at least 20 sq.ft. in area, meeting the definition established in Virginia's Tidal Wetlands Act, and not otherwise considered a marsh island. In all cases, wetland vegetation must be relatively well established, although not necessarily healthy. In previous Tidal Marsh Inventories, marshes were further classified based on morphology and physiographic setting.

Marsh Island – A marsh island is a vegetated wetland that is completely isolated from the mainland and found in open water. A marsh that is surrounded by water due to dissection from small tidal creeks was classified as marsh, not a marsh island.

Marsh toe revetment (aka Marsh sill) –A low revetment placed offshore from an existing marsh or new planted marsh is classified as marsh toe revetment. The structure may include tidal openings to allow for the easy exchange of free swimming organisms during tidal cycles. Marsh toe revetments are mapped as offshore linear features running along the length of the structure. Marsh toe revetments are distinguished from breakwaters by the linear placement and presence of a tidal marsh instead of a sand beach landward from the structure. The classification can include best professional judgment.

Military – A land use classification of Military marks the location of federal military reservations. This classification is generally reserved for the section of the base where active operations and infrastructure exist. Expansive military property adjacent to these areas which are unmanaged forest areas, for example, may be classified as forest land use.

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 landings, or commercial facilities.

Phragmites australis – Also known as common reed or reed grass, *Phragmites* is an invasive wetland plant known to thrive in areas that have experienced disturbance. *Phragmites* is mapped in two ways as a tidal marsh community type where it is dominant (>50% cover) and also where it appears in mapped tidal marshes in any amount.

Residential – Residential land use includes single and multi-family dwellings located near the shoreline.

Riprap (aka Revetments) - Sloped structures constructed with large, heavy stone or other materials placed against the upland bank for erosion protection are classified as riprap. Riprap is mapped as a linear feature along the shoreline. Riprap is also used next to failing bulkheads (bulkhead toe revetments). The inventory maps only riprap when this type of structure is co-located with bulkheads. A similar structure is used to protect the edge of eroding marshes. This use is mapped as marsh toe revetment, not riprap.

Scrub-shrub - Scrub-shrub is a land use class that includes small trees, shrubs, and bushy plants. This land use is easily distinguished during remote sensing compared to Forest and Grass.

Timbered - Timbered or clear-cut land use is an area where all the trees have been cut down or removed for harvesting or in preparation for construction.

Tree Fringe - When the dominant riparian land use is not Forest but a line of trees is maintained along the bank edge, the land use is noted to include a tree fringe.

Unconventional - Unconventional features represent segments along the shore where alternative material has been deliberately placed for shoreline protection. Unconventional features may include unique materials placed in a similar manner as riprap or bulkheads, such as engineered pre-cast concrete products. It may also include unique placement or arrangement of conventional materials like riprap that does not fit other structure definitions. The inventory maps Debris instead of Unconventional when the material is haphazardly scattered and not providing any shoreline protection value.

Wharf – Typically describes a shore parallel structure where boats are tied. In this inventory, Wharf is generally associated with large industrial, public or commercial facilities.

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