

Shoreline Situation Report HENRICO, CHESTERFIELD, AND RICHMOND



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Special Report In Applied Marine Science and Ocean Engineering Number 98 of the

VIRGINIA INSTITUTE OF MARINE SCIENCE

Gloucester Point, Virginia 23062

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CHAPTER 1

INTRODUCTION

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1.1 PURPOSES AND GOALS

It is the objective of this report to supply an assessment, and at least a partial integration, of those important shoreland parameters and characteristics which will aid the planners and the managers of the shorelands in making the best decisions for the utilization of this limited and very valuable resource. The report gives particular attention to the problem of shore erosion and to recommendations concerning the alleviation of the impact of this problem. In addition we have tried to include in our assessment some of the potential uses of the shoreline, particularly with respect to recreational use, since such information could be of considerable value in the way a particular segment of coast is perceived by potential users.

The basic advocacy of the authors in the preparation of the report is that the use of shorelands should be planned rather than haphazardly developed in response to the short term pressures and interests. Careful planning could reduce the conflicts which may be expected to arise between competing interests. Shoreland utilization in many areas of the country, and indeed in some places in Virginia, has proceeded in a manner such that the very elements which attracted people to the shore have been destroyed by the lack of planning and forethought.

The major man-induced uses of the shorelands are:

- Residential, commercial, or industrial development

- Recreation
- Transportation
- Waste disposal
- Extraction of living and non-living resources

Aside from the above uses, the shorelands serve various ecological functions.

The role of planners and managers is to optimize the utilization of the shorelands and to minimize the conflicts arising from competing demands. Furthermore, once a particular use has been decided upon for a given segment of shoreland, both the planners and the users want that selected use to operate in the most effective manner. A park planner, for example, wants the allotted space to fulfill the design most efficiently. We hope that the results of our work are useful to the planner in designing the beach by pointing out the technical feasibility of altering or enhancing the present configuration of the shore zone. Alternately, if the use were a residential development, we would hope our work would be useful in specifying the shore erosion problem and by indicating defenses likely to succeed in containing the erosion. In summary our objective is to provide a useful tool for enlightened utilization of a limited resource, the shorelands of the Commonwealth.

Shorelands planning occurs, either formally or informally, at all levels from the private owner of shoreland property to county governments, to planning districts and to the state and federal agency level. We feel our results will be useful at all these levels. Since the most basic level of comprehensive planning and zoning is at the county or city level, we have executed our report on that level although we realize some of the information

may be most useful at a higher governmental level. The Commonwealth of Virginia has traditionally chosen to place, as much as possible, the regulatory decision processes at the county level. The Virginia Wetlands Act of 1972 (Chapter 2.1, Title 62.1, Code of Virginia), for example, provides for the establishment of County Boards to act on applications for alterations of wetlands. Thus, our focus at the county level is intended to interface with and to support the existing or pending county regulatory mechanisms concerning activities in the shorelands zone.

1.2 ACKNOWLEDGEMENTS

This report was prepared with funds provided by the Research Applied to National Needs Program (RANN) of the National Science Foundation through the Wetlands/Edges-Program of the Chesapeake Research Consortium, Inc. The report was published with funds provided to the Commonwealth by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, Grant Number 04-5-158-50001. Gaynor Williams assisted with data reduction. Beth Marshall typed the manuscript. Bill Jenkins and Ken Thornberry prepared the photographs. We would like to thank the numerous other persons in Virginia and Maryland who have assisted our work with their suggestions and criticisms of our ideas and methods.

CHAPTER 2

APPROACH USED AND ELEMENTS CONSIDERED

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2.1 APPROACH TO THE PROBLEM

In the preparation of this report the authors utilized existing information wherever possible. For example, for such elements as water quality characteristics, zoning regulations, or flood hazard, we reviewed relevant reports by local, state, or federal agencies. Much of the desired information, particularly with respect to erosional characteristics, shoreland types, and use was not available, so we performed the field work and developed classification schemes. In order to analyze successfully the shoreline behavior we placed heavy reliance on low altitude, oblique, color, 35 mm photography. We photographed the entire shoreline of each county and cataloged the slides for easy access at VIMS, where they remain available for use. We then analyzed these photographic materials, along with existing conventional aerial photography and topographic and hydrographic maps, for the desired elements. We conducted field inspection over much of the shoreline, particularly at those locations where office analysis left questions unresolved. In some cases we took additional photographs along with the field visits to document the effectiveness of shoreline defenses.

The basic shoreline unit considered is called a subsegment, which may range from a few hundred feet to several thousand feet in length. The end points of the subsegments were generally chosen on physiographic consideration such as changes in the character of erosion or deposition. In those cases where a radical change in land use occurred, the point of change was taken as a boundary point of

the subsegment. Segments are a grouping of subsegments. The boundaries for segments also were selected on physiographic units such as necks or peninsulas between major tidal creeks. Finally, the county itself is considered as a sum of shoreline segments.

The format of presentation in the report follows a sequence from general summary statements for the county (Chapter 3) to tabular segment summaries and finally detailed descriptions and maps for each subsegment (Chapter 4). The purpose in choosing this format was to allow selective use of the report since some users' needs will adequately be met with the summary overview of the county while others will require the detailed discussion of particular subsegments.

2.2 CHARACTERISTICS OF THE SHORELANDS INCLUDED IN THE STUDY

The characteristics which are included in this report are listed below followed by a discussion of our treatment of each.

- a) Shorelands physiographic classification
- b) Shorelands use classification
- c) Shorelands ownership classification
- d) Zoning
- e) Water quality
- f) Shore erosion and shoreline defenses
- g) Potential shore uses
- h) Distribution of marshes
- i) Flood hazard levels
- j) Shellfish leases and public shellfish grounds
- k) Beach quality

a) Shorelands Physiographic Classification:

The shorelands of the Chesapeake Bay System may

be considered as being composed of three interacting physiographic elements: the fastlands, the shore and the nearshore. A graphic classification based on these three elements has been devised so that the types for each of the three elements portrayed side by side on a map may provide the opportunity to examine joint relationships among the elements. As an example, the application of the system permits the user to determine miles of high bluff shoreland interfacing with marsh in the shore zone.

For each subsegment there are two length measurements, the shore-nearshore interface or shoreline, and the fastland-shore interface. The two interface lengths differ most when the shore zone is embayed or extensive marsh. On the subsegment maps, a dotted line represents the fastland-shore interface when it differs from the shoreline. The fastland-shore interface length is the base for the fastland statistics.

Definitions:

Shore Zone

This is the zone of beaches and marshes. It is a buffer zone between the water body and the fastland. The seaward limit of the shore zone is the break in slope between the relatively steeper shoreface and the less steep nearshore zone. The approximate landward limit is a contour line representing one and a half times the mean tide range above mean low water (refer to Figure 1). In operation with topographic maps the inner fringe of the marsh symbols is taken as the landward limit.

The physiographic character of the marshes has also been separated into three types (see Figure 2). Fringe marsh is that which is less than 400 feet in width and which runs in a band parallel to the

shore. Extensive marsh is that which has extensive acreage projecting into an estuary or river. An embayed marsh is a marsh which occupies a reentrant or drowned creek valley. The purpose in delineating these marsh types is that the effectiveness of the various functions of the marsh will, in part, be determined by type of exposure to the estuarine system. A fringe marsh may, for example, have maximum value as a buffer to wave erosion of the fastland. An extensive marsh, on the other hand, is likely a more efficient transporter of detritus and other food chain materials due to its greater drainage density than an embayed marsh. The central point is that planners, in the light of ongoing and future research, will desire to weight various functions of marshes and the physiographic delineation aids their decision making by denoting where the various types exist.

The classification used is:

Beach

Marsh

Fringe marsh, < 400 ft. (122 m) in width
along shores

Extensive marsh

Embayed marsh, occupying a drowned valley or
reentrant

Artificially stabilized

Fastland Zone

The zone extending from the landward limit of the shore zone is termed the fastland. The fastland is relatively stable and is the site of most material development or construction. The physiographic classification of the fastland is based upon the average slope of the land within 400 feet (122 m) of the fastland - shore boundary. The general classification is:

Low shore, 20 ft. (6 m) or less of relief; with
or without cliff

Moderately low shore, 20-40 ft. (6-12 m) of
relief; with or without cliff

Moderately high shore, 40-60 ft. (12-18 m) of
relief; with or without cliff

High shore, 60 ft. (18 m) or more of relief;
with or without cliff.

Two specially classified exceptions are sand
dunes and areas of artificial fill.

Nearshore Zone

The nearshore zone extends from the shore zone to the 12-foot (MLW datum) contour. In the smaller tidal rivers the 6-foot depth is taken as the reference depth. The 12-foot depth is probably the maximum depth of significant sand transport by waves in the Chesapeake Bay area. Also, the distinct drop-off into the river channels begins roughly at the 12-foot depth. The nearshore zone includes any tidal flats.

The class limits for the nearshore zone classifications were chosen following a simple statistical study. The distance to the 12-foot underwater contour (isobath) was measured on the appropriate charts at one-mile intervals along the shorelines of Chesapeake Bay and the James, York, Rappahannock, and Potomac Rivers. Means and standard deviations for each of the separate regions and for the entire combined system were calculated and compared. Although the distributions were non-normal, they were generally comparable, allowing the data for the entire combined system to determine the class limits.

The calculated mean was 919 yards with a standard deviation of 1,003 yards. As our aim was to determine general, serviceable class limits, these calculated numbers were rounded to 900 and 1,000

yards respectively. The class limits were set at half the standard deviation (500 yards) each side of the mean. Using this procedure a narrow nearshore zone is one 0-400 yards in width, intermediate 400-1,400, and wide greater than 1,400.

The following definitions have no legal significance and were constructed for our classification purposes:

Narrow, 12-ft. (3.7 m) isobath located < 400
yards from shore

Intermediate, 12-ft. (3.7 m) isobath 400-
1,400 yards from shore

Wide, 12-ft. (3.7 m) isobath > 1,400 yards

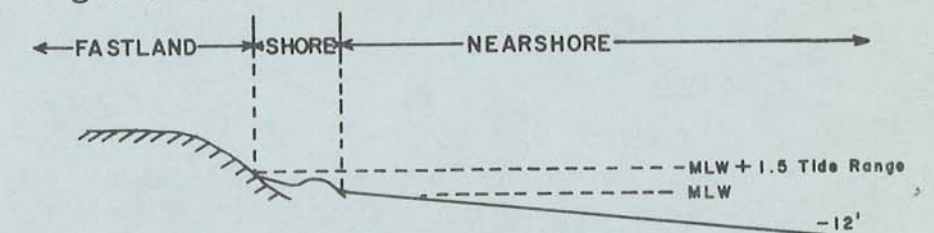
Subclasses: with or without bars

with or without tidal flats

with or without submerged

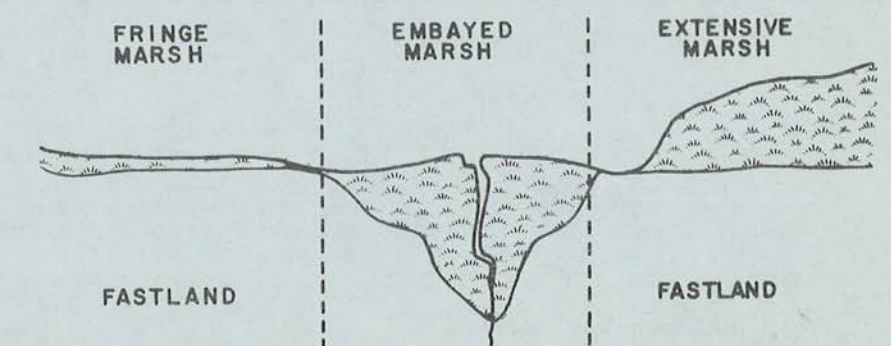
vegetation

Figure 1



An illustration of the definition of the three components of the shorelands (cross-section).

Figure 2



A generalized illustration of the three different marsh types (map view).

b) Shorelands Use Classification:

Fastland Zone

Residential

Includes all forms of residential use with the exception of farms and other isolated dwellings. In general, a residential area consists of four or more residential buildings adjacent to one another. Schools, churches, and isolated businesses may be included in a residential area.

Commercial

Includes buildings, parking areas, and other land directly related to retail and wholesale trade and business. This category includes small industry and other anomalous areas within the general commercial context. Marinas are considered commercial shore use.

Industrial

Includes all industrial and associated areas. Examples: warehouses, refineries, shipyards, power plants, railyards.

Government

Includes lands whose usage is specifically controlled, restricted, or regulated by governmental organizations: e.g., Camp Peary, Fort Story.

Recreation and Other Public Open Spaces

Includes designated outdoor recreation lands and miscellaneous open spaces. Examples: golf courses, tennis clubs, amusement parks, public beaches, race tracks, cemeteries, parks.

Preserved

Includes lands preserved or regulated for

environmental reasons, such as wildlife or wildfowl sanctuaries, fish and shellfish conservation grounds, or other uses that would preclude development.

Agricultural

Includes fields, pastures, croplands, and other agricultural areas.

Unmanaged

Includes all open or wooded lands not included in other classifications:

- a) Open: brush land, dune areas, wastelands; less than 40% tree cover.
- b) Wooded: more than 40% tree cover.

The shoreland use classification applies to the general usage of the fastland area to an arbitrary distance of half mile from the shore or beach zone or to some less distant, logical barrier. In multi-usage areas one must make a subjective selection as to the primary or controlling type of usage.

Shore Zone

Bathing
Boat launching
Bird watching
Waterfowl hunting

Nearshore Zone

Pound net fishing
Shellfishing
Sport fishing
Extraction of non-living resources
Boating
Water sports

c) Shorelands Ownership Classification:

The shorelands ownership classification used has two main subdivisions, private and governmental, with the governmental further divided into federal, state, county, and town or city. Application of the classification is restricted to fastlands alone since the Virginia fastlands ownership extends to mean low water. All bottoms below mean low water are in State ownership.

d) Water Quality:

In areas where it is applicable, we have utilized the Virginia Bureau of Shellfish Sanitation Commission's water quality data and classification. Their data consist of coliform and fecal coliform counts at stations near shellfish grounds. In areas such as the fresh water, tidal James where the Commission does not maintain sample stations, we have been forced to seek other data.

For the Henrico-Richmond-Chesterfield Shoreline Situation Report we have used the slack water data collected on December 13th, 1974, by V.I.M.S. This data consists of dissolved oxygen (D.O.) content, Biological Oxygen Demand (B.O.D.), and water temperature. The data are discussed elsewhere in the text.

e) Zoning:

In cases where zoning regulations have been established the existing information pertaining to the shorelands has been included in the report.

f) Shore Erosion and Shoreline Defenses:

The following ratings are used for shore erosion:

slight or none - less than 1 foot per year
moderate - - - - 1 to 3 feet per year
severe - - - - - greater than 3 feet per year

The locations with moderate and severe ratings are further specified as being critical or noncritical. The erosion is considered critical if buildings, roads, or other such structures are endangered.

The degree of erosion was determined by several means. In most locations the long term trend was determined using map comparisons of shoreline positions between the 1850's and the 1940's. In addition, aerial photographs of the late 1930's and recent years were utilized for an assessment of more recent conditions. Finally, in those areas experiencing severe erosion field inspections and interviews were held with local inhabitants.

The existing shoreline defenses were evaluated as to their effectiveness. In some cases repetitive visits were made to monitor the effectiveness of recent installations. In instances where existing structures are inadequate, we have given recommendations for alternate approaches. Furthermore, recommendations are given for defenses in those areas where none currently exist. The primary emphasis is placed on expected effectiveness with secondary consideration to cost.

g) Potential Shore Uses:

We placed particular attention in our study on evaluating the recreational potential of the shore zone. We included this factor in the consideration of shoreline defenses for areas of high recreational potential. Furthermore, we gave consideration to the development of artificial beaches if this method were technically feasible at a particular site.

h) Distribution of Marshes:

The acreage and physiographic type of the marshes in each subsegment is listed. These estimates of acreages were obtained from topographic maps and should be considered only as approximations. Detailed county inventories of the wetlands are being conducted by the Virginia Institute of Marine Science under the authorization of the Virginia Wetlands Act of 1972 (Code of Virginia 62.1-13.4). These surveys include detailed acreages of the grass species composition within individual marsh systems. The material in this report is provided to indicate the physiographic types of marshes and to serve as a rough guide on acreages until detailed surveys are completed. Additional information of the wetlands characteristics may be found in Coastal Wetlands of Virginia: Interim Report by Marvin L. Wass and Thomas D. Wright, SRAMSOE Report No. 10, Virginia Institute of Marine Science, 1969, and in other VIMS publications.

i) Flood Hazard Levels:

The assessment of tidal flooding hazard for the whole of the Virginia tidal shoreland is still incomplete. However, the United States Army Corps of Engineers has prepared reports for a number of localities which were used in this report. Two tidal flood levels are customarily used to portray the hazard. The Intermediate Regional Flood is that flood with an average recurrence time of about 100 years. An analysis of past tidal floods indicates it to have an elevation of approximately 8 feet above mean water level in the Chesapeake Bay area. The Standard Project Flood level is established for land planning purposes which is

placed at the highest probable flood level.

j) Shellfish Leases and Public Grounds:

The data in this report show the leased and public shellfish grounds as portrayed in the Virginia State Water Control Board publication "Shellfish growing areas in the Commonwealth of Virginia: Public, leased and condemned," November, 1971, and as periodically updated in other similar reports. Since the condemnation areas change with time they are not to be taken as definitive. However, some insight to the conditions at the date of the report are available by a comparison between the shellfish grounds maps and the water quality maps for which water quality standards for shellfish were used.

k) Beach Quality:

Beach quality is a subjective judgment based on such considerations as the nature of the beach material, the length and width of the beach area, and the general aesthetic appeal of the beach setting.

CHAPTER 3

PRESENT SHORELINE SITUATION

CHAPTER 3
PRESENT SHORELANDS SITUATION

3.1 THE SHORELANDS OF HENRICO AND CHESTERFIELD COUNTIES

This study is concerned with that part of the James River in Henrico and Chesterfield Counties that is below the fall line and thus, subject to tidal influences. For the purposes of this study, the starting point is the I-95 bridge at Richmond. The James River here is 900 feet wide, though it rapidly narrows to 500 feet. The river then slowly increases in width, reaching 1,100 feet just before Turkey Island. At Bermuda Hundred, the river is 2,100 feet wide.

The study area consists of the two counties separated by the James River: Chesterfield and Henrico Counties. The City of Richmond is Subsegment 1A in Henrico and Segment 1 in Chesterfield. Richmond has 5.9 miles of shore on the Chesterfield side of the river and 1.2 miles of shore on the Henrico side. The rest of Henrico County contains 31.5 miles of fastland and 35.0 miles of shoreline. Chesterfield County has 43.6 miles of fastland and 45.2 miles of shoreline.

Over half (56%) of Henrico County's shorelands are low shore. Twenty-five percent of the fastland is moderately low shore, ten percent is moderately high shore, with or without bluff, and six percent is high shore, with or without bluff. All areas of high shore are located along the nearly straight stretches of the river from the end of the Richmond City Limits to Dutch Gap. The fastlands in the City of Richmond are equally divided between low and moderately low shore.

The shore zone of Henrico County is mostly fringe marsh (75%). The bulk of the rest of Henrico's shore is extensive marsh (20%). Four percent is embayed marsh. Along the nearly straight stretch of the river from Richmond to Dutch Gap, ninety-eight percent of the shore is fringe marsh. The other two percent is artificially stabilized.

On the Chesterfield side of the river, sixty-three percent of the fastland is low shore. Fourteen percent of the shorelands are moderately low shore, ten percent are moderately high shore, with or without bluffs, and thirteen percent are high shore, with or without bluffs. In the City of Richmond, eighty-three percent is low shore and eleven percent is moderately high shore with bluff. The other seven percent is divided among moderately low shore (3%), moderately high shore (1%), and high shore (2%).

The majority (63%) of Chesterfield County's shore zone is fringe marsh. Thirty-four percent of the shore is extensive marsh, the rest being about equally divided between artificially stabilized and embayed marsh.

Data collected by V.I.M.S. on December 13, 1974 at five stations along the James between miles 68 (Bermuda Hundred) and 83 (near Richmond) indicated no water quality problems at that time. The D.O. ranged from 11.2 to 13.1 ppm, B.O.D. from 1.7 to 4.2 ppm, and water temperature from 5.8 to 4.3°C. The D.O.'s were near saturation level for the water temperature and the B.O.D.'s showed no significant depression.

On December 17, 1975, the James River basin was closed to all shellfish and finfish harvesting for an indefinite time. This was due to chemical

contamination from "Kepone", which had been manufactured at one of Hopewell's chemical plants.

The shorelands of Richmond in both Chesterfield and Henrico Counties are used for industrial purposes. Richmond is a customs port of entry. There are two city-owned wharves: Richmond Deepwater Terminal and Richmond Upper Marine Terminal. These two facilities handle a variety of cargo from ocean-going vessels. There are other, private barge wharves which mainly handle gravel and construction material. Another major facility is the Sewage Treatment Plant, which is located along the Chesterfield side of the river. All of the shorelands in Richmond are zoned for heavy industrial use.

South of the Richmond City Limits, there is a very abrupt reduction in the type and amount of formal land usage. Both Henrico and Chesterfield Counties are part of the National Flood Insurance Program. As such, development in the flood plains is restricted, or at least very limited. In Henrico, the flood plains are classified as Environmental Protection Areas (See Map 1E). Generally, no major construction can take place on the flood plains. The area is usually unmanaged, wooded or is used for agriculture. In Chesterfield County, forty-one percent of the shorelands are unmanaged, wooded. Thirty-nine percent of the lands are currently used for agriculture. Of the remaining lands, the Presquile National Wildlife Refuge accounts for nine percent of the shorelands, residential usage five percent, and industrial usage six percent. Less than one percent of the shorelands are used as recreational

areas.

In Henrico County, sixty-one percent of the shorelands are used for agriculture. Included in this figure is the Curles Neck Farm, which encompasses most of the Curles Neck area. Thirty percent of the shorelands are unmanaged, wooded. Residential usage accounts for six percent of the shore, the other three percent being used for industrial purposes. As in Chesterfield, less than one percent of the county's shorelands are used for recreational purposes. In Richmond, commercial and industrial concerns control the use of the shoreline. Virtually no land there is available or suitable for recreational development. If recreational areas for the metropolitan Richmond area are to be developed, they will have to be located in the surrounding lesser-developed counties.

Within Richmond's boundaries, one percent of the James's northern bank and thirty percent of the southern bank are city-owned. The rest of Richmond's shoreline is privately owned. Over ninety-nine percent of Henrico County's shorelands are privately owned, with less than one percent being federally owned. In Chesterfield County, ninety-one percent of the shorelands are privately owned and nine percent are federally owned.

The James River channel is used by ships going to the city-owned docks located at Richmond. The river is also heavily traveled by barges carrying sand, gravel, and construction materials to private wharves along the James. Sport boating and fishing are prevalent from Dutch Gap south, especially in the shallower meanders of the river.

3.2 SHORE EROSION SITUATION

The processes causing shoreline erosion along this portion of the James River are fairly limited. Compared to the open ocean, Chesapeake Bay, or even areas closer to the river mouths, the James River at Richmond, Chesterfield and Henrico is a lower energy water body. Wave erosion is generally not a significant problem.

In other areas of the James, a primary agent of erosion is wind generated waves. The growth and power of the waves is dependent upon several factors: (1) The fetch, or the over water distance across which the wind blows, (2) the depth of the water, (3) the velocity of the wind, and (4) the duration of the wind. Along the James River in Henrico and Chesterfield Counties, the fetch is very limited, due to the narrowness of the river and the many meanders. Thus, this agent of erosion has little effect on the area's shorelands.

Watershed runoff and flood events are the principal erosion agents in the subject area. Flooding affects the low areas in and around the river. The primary example of flood erosion here is in the meanders of the river. When the river rises so as to cover existing land in the meanders, the water attempts to follow the straightest course. Instead of following the existing river bed, the water will cut across the neck of land in the meanders. The Dutch Gap Cutoff was opened in 1870 by one such flood. (The other cutoffs forming Turkey Island, Hatcher Island, and Jones Neck along the James River are the results of the Corps of Engineers' channel improvements, not natural scour. These cutoffs would have been made naturally

over the course of time.)

Most of the erosion and accretion found along the upper James occurs at the bends in the river. The river current is fastest on the outside of the meanders and is much less on the inside. As a result, the outside bends erode while the inside bends accrete. Figure 3 is a drawing of a typical river meander. The amount and rate of erosion depends upon both the composition of the land in the bends and the speed of the current there. (The dotted line in Figure 3 represents pre-existing land.)

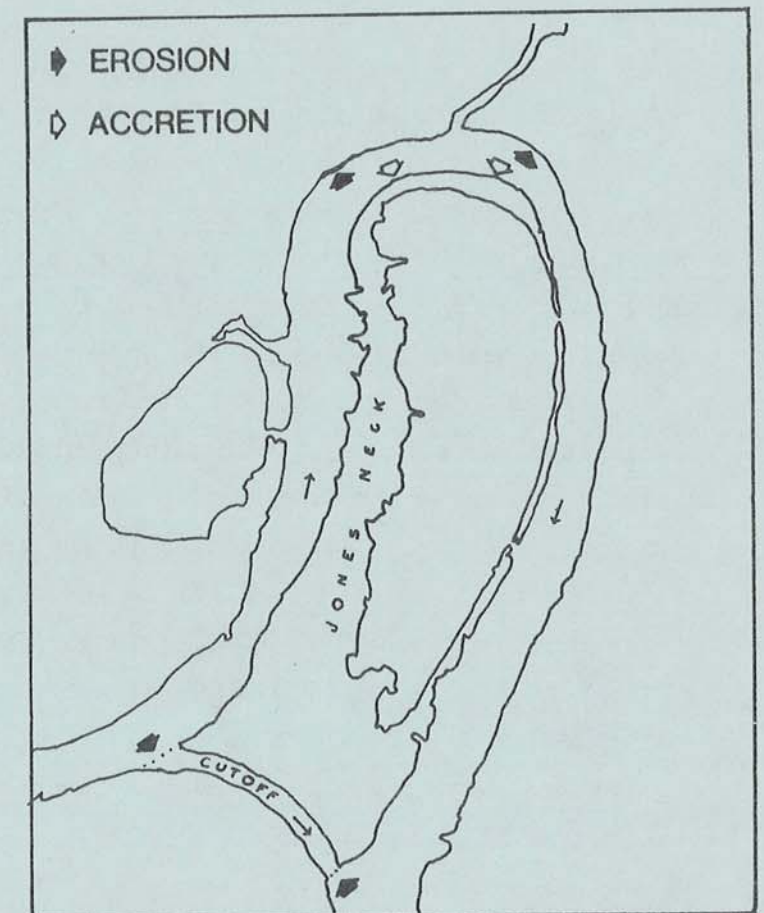


FIGURE 3. TYPICAL RIVER MEANDER

Much of the erosion along the banks of the river is due to "weathering," as it is largely a simple downslope wasting of the bluffs by rain runoff. The erosion is compounded when trees along the bluffs fall, carrying with them large amounts of soil. The Drewrys Bluff area (Figure 6) is one such example. The river has very little effect on most of this type of erosion. Only in times of extreme high water would the river become an erosive agent along parts of the bluff areas.

Man is also a common erosive force along the upper James River. Boat wake erosion is man's primary contribution. Large ships traveling the channel to Richmond leave a considerable wake. In the narrow portions of the river, the wakes can be very erosive. Along the meanders not used by large ships, tugs towing barges also leave considerable wakes. Though not a major erosion cause, wakes from ships and smaller craft do contribute to erosion.

The portion of Presque Island bordering Turkey Island Cutoff is severely eroding (see Figure 10). Erosion here can be attributed to a combination of factors. The island is situated in the last bend in the river above Hopewell. To the west, the river is about 1,100 feet wide; to the east, the river is 2,100 feet wide. On the west side of Presque Island, the fetch is S to N - 2.8 nautical miles. During storms, wind generated waves from the south are an important erosive agent to the east side of the cutoff.

Normal meander current trends also affect this part of the shoreline. Since the Turkey Island Cutoff is in a bend in the river, the current is

fastest on the outside of the bend, in this case the Presque Island shoreline. This area, as stated before, will erode.

There are other contributing factors in the erosion of the island, mainly boat wakes and flood waters. These elements, though, are not as destructive or prevalent as the other forces described.

In summary, erosion is not a critical problem along the upper James River. The normal river current is a primary agent of erosion. In the meanders, the outside of the bends are eroded. This erosion, plus erosion caused by flood waters, tend to cut a new channel across the narrow neck of land in the meanders. This occurred at Dutch Gap in 1870, though the other cutoffs were man-made. Table 1 is a summary of flood levels at several stations along the river. Weathering of the bluffs by rain runoff is another type of erosion common along the James River.

3.3 POTENTIAL SHORE USE FOR THE CITY OF RICHMOND AND THE COUNTIES OF HENRICO AND CHESTERFIELD

Shorelands are a limited resource in Virginia. Those near a metropolitan area such as Richmond are very limited, and as such should be preserved in their natural state whenever possible. It is unrealistic to think that all remaining shorelands be preserved. What is needed in any area is a balanced program of shoreline use. The needs of the area, of business and industry, and the recreational demands of the people should be taken into account in any type of planning.

There is an evident need in Richmond, Henrico, and Chesterfield for recreational areas. Since Richmond's shorelands are almost entirely used by business and industry, any shorelands recreational facilities will have to be developed in the counties.

3.31 Potential Shore Use for the City of Richmond

Characteristic of a metropolitan area, the City of Richmond's vacant land supply is nearly exhausted. Much of the land left is not suitable for development because of susceptibility to flooding (refer to Table 1), poor drainage, or steep slopes. Like other cities situated along rivers, industries are highly concentrated along the shorelands. Because of the great intensity of use, public access to the river is hampered and recreational opportunities are quite limited.

The floods of 1969 and 1972 seriously affected many industrial and commercial concerns along Richmond's shorelands. This was especially true of the prime industrial area of Shockoe Creek

and portions of the South Side. Sections of these areas have deteriorated and some businesses have shut down. If such flooding is allowed to continue, further deterioration will occur and, ultimately, the businesses will be forced to relocate. This would have a very severe economic impact on Richmond.

The U.S. Army Corps of Engineers has made a feasibility study of protecting the Richmond area from flooding to the height of the 100-year storm flood level. Their report, completed in October, 1974, presents a series of suggestions aimed at protecting those areas where it is economically feasible and at lessening the losses of those areas where protection is too costly. The areas where protection is feasible include the Shockoe Creek area and parts of the South Side. The study is currently under review, but it will probably be at least eight to ten years before any construction is initiated, given that the proposals are passed and funding is appropriated.

For those areas where protection is too costly, a series of nonstructural measures could be implemented. Such measures would include improved building codes, improved zoning regulations, and flood proofing. Although such measures would not eliminate flooding, they would diminish the extent of the flood damage. The National Flood Insurance Program, now available to businesses located in the flood plain, is another such nonstructural aid.

3.32 Potential Shore Use for Chesterfield County

The closeness of the metropolitan center of Richmond and the good access to that center via I-95 and Route 301 would seem to make Chesterfield

County a prime target for development by industrial and business concerns and by residential developers. As already stated, the shorelands of Richmond are heavily developed by industrial and commercial endeavors. However, the amount of shoreland in Chesterfield County suitable for development is limited.

Development in Chesterfield County has taken place along the two major highways, I-95 and Route 301, which parallel one another from Richmond to Petersburg. Business, commercial, industrial, and trucking concerns have all located here. Most of the shorelands close to Richmond are flood plains, where development is restricted by the county. The islands further downstream in the meanders are also too low for development. Of those left, the land along the old channel of the James River, south of Farrar Island, has a moderate development potential. However, the elevation of the land (at least 100 feet) would make access to the water very difficult and expensive. Formal development here would not be because of the usual water related potential but because of the scenic qualities of the land and its location.

Development further south of Richmond is possible, though the distance from the city detracts from commuter residence here. It is possible that lands here could be developed for residential use for commuters to Hopewell and its chemical plants. Though possible, the distance is still restrictive for such development.

Much of the land which is unsuitable for formal development in Chesterfield County is ideal for low intensity recreational parks. Richmond, like most metropolitan areas, has a shortage of

recreational facilities. The county's flood plains could be easily developed to accommodate picnickers and hikers. The flood waters could do only minor damage if no permanent structures are built along the shore in the lowlands.

It is logical to expect most development in Chesterfield to continue to be located on or near the major highways and I-95 Interchanges rather than on the shoreline. Low intensity usage along most of the county's shoreline seems best suited for the area. Though flood prone, the lowlands along much of the shoreline could become much needed recreational parks serving both the county and Richmond with only a minimum of expense.

3.33 Potential Shore Use for Henrico County

Our study area in Henrico County is served by only one major road, Route 5. Though heavily traveled, businesses and industry have, for the most part, ignored this section of the county. The area from the James River inland to Route 5 is characterized by much unused land and many acres of farmland. Curles Neck Farm occupies the entire Curles Neck area. Only in the areas adjoining the City of Richmond are there any industrial and major residential developments.

Various industries have located on the shoreline directly bordering Richmond. The Fulton Railroad Yards of the Chesapeake and Ohio Railroad lines are located behind the industries in this section, providing ready transportation for goods to and from industries. The industries, but not the railroad yards, are located in the flood plain and are very susceptible to flooding in the James.

The Richmond Heights area is located about

nine miles from Richmond. From here north to Richmond, the land has been developed for residential usage. This area has good, quick access to the city and is ideal for commuters. Houses along this part of the river are placed at least 3,000 feet into the fastland. Cliffs rising from 50 to 150 feet are located about 1,800 feet into the fastland. The lands toward the river from the cliffs either are wooded or are used for agriculture. There is no good access to this sparsely used area. This site has the potential to become a much needed public recreational park. There are only limited shorelands left in the area suitable for recreational development. The major drawback for any type of development here is the lack of access. Any road has to cross the cliffs further inland in order to reach the area. This would be costly. However, with few places along the shoreline available for public use, this area could prove worth the investment.

Residential development will probably continue at Richmond Heights, as there is still much land available. This area already has one major subdivision. Other subdivisions or extensions of the existing one are very likely to be built in the future.

Further from Richmond, at Dutch Gap, Route 5 is over four miles inland from the shore. There are only secondary roads located near the shoreline. The lands generally are used for agriculture. This area is probably too far from Richmond to have a prime residential development potential. Of course, there are probably numerous residents here who do commute to jobs in the city. The area's prime development potential would be

for low density recreational parks. Fort Brady, part of the Richmond National Battlefield Park, is located just across from Hatcher Island. A park in the adjacent area for camping, picnicking, and other activities is a possible use here. For the most part, the area is probably best left as a low density agricultural and residential community.

Most of the Curles Neck area is currently controlled by Curles Neck Farm. Any development would be at the expense of the present agricultural usage. This area being prime agricultural land, development here seems highly unlikely.

It can be expected, then, that most development in Henrico County will continue to be located close to Richmond. The currently unused land between Richmond Heights and the river holds promise as a recreational area. Though access to the area would be costly, these lands would meet some of the demands for public recreational facilities for Richmond and Henrico.

TABLE 1
FLOOD LEVELS OF JAMES RIVER
(CITY OF RICHMOND, CHESTERFIELD AND HENRICO COUNTIES)

Miles Above Mouth	Area Name	Floods From 1877-1944 (Average Ft. Above M.S.L.)	August, 1969 Camille Flood	June, 1972 Agnes Flood
104.0	Richmond City Lock	-	28.7	-
103.8	Richmond Lock Gage	25.0	28.6	36.5
103.6	Eastern Steamship Co.	24.8	-	-
103.4	Rocketts Gage	24.1	-	-
99.7	DuPont Pumping Plant	19.4	-	-
99.0	Deep Water Terminal	-	20.9	-
98.0	I-95 Bridge, Interchange 7	-	19.3	-
97.5	Mouth Falling Creek	16.9	-	-
94.0	Lone Star Industries	-	-	19.3
92.2	Dutch Gap Power Plant	-	13.7	-
91.8	Aiken Swamp	11.2	-	18.9
87.8	Meadowville	8.5	-	-
85.1	Deepbottom Boat Landing	-	-	12.2
82.3	Jones Neck	5.7	-	-
73.6	Bermuda Hundred	-	-	6.3
72.7	Bermuda Hundred	4.3	-	-

SOURCE: Unpublished report, Norfolk District, U.S. Army Corps of Engineers.



Figure 4



Figure 5

FIGURE 4: Concrete and steel boat ramp facility near Richmond. This marina, seriously damaged from flood waters in the Camille storm of August, 1969, has never reopened. Across the river is the Richmond Upper Marine Terminal.

FIGURE 5: A composite photo showing part of the Richmond Upper Marine Terminal facility. The wooden bulkhead fronting an alongside pier no longer has any protective value.

FIGURE 6: Drewrys Bluff area, Chesterfield County. Cliff erosion here is caused by down-hill rain runoff.

FIGURE 7: Across from Drewrys Bluff, Henrico County. This area is experiencing moderate erosion, as evidenced by the falling trees.



Figure 6



Figure 7



Figure 8

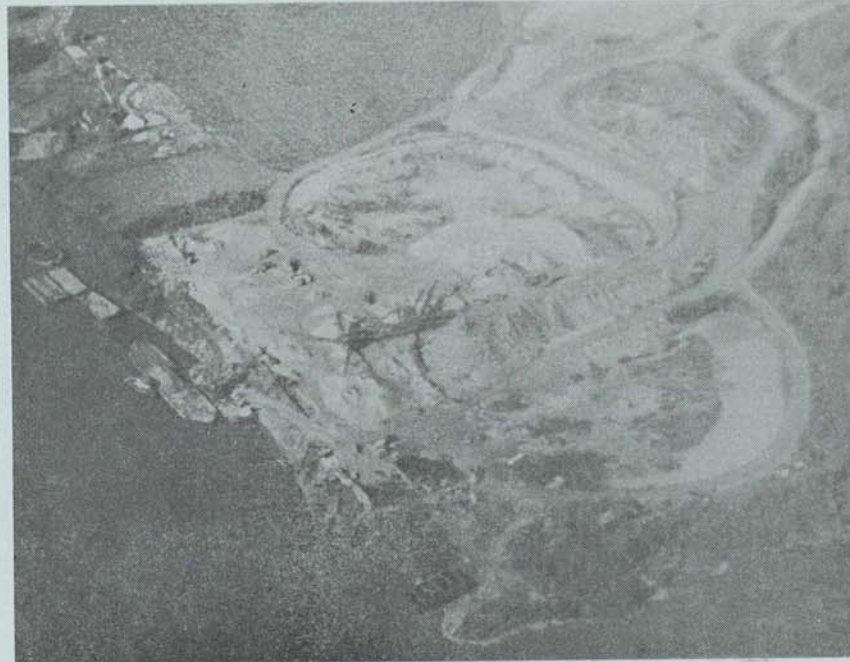


Figure 9

FIGURE 8: Close-up of beach material, Dutch Gap, Chesterfield County.

FIGURE 9: Aerial view of gravel pits, west of Turkey Island Creek, Henrico County.

FIGURE 10: Shoreline of Presquile National Wildlife Refuge bordering Turkey Island Cutoff. This stretch of shoreline has recently been experiencing severe erosion.

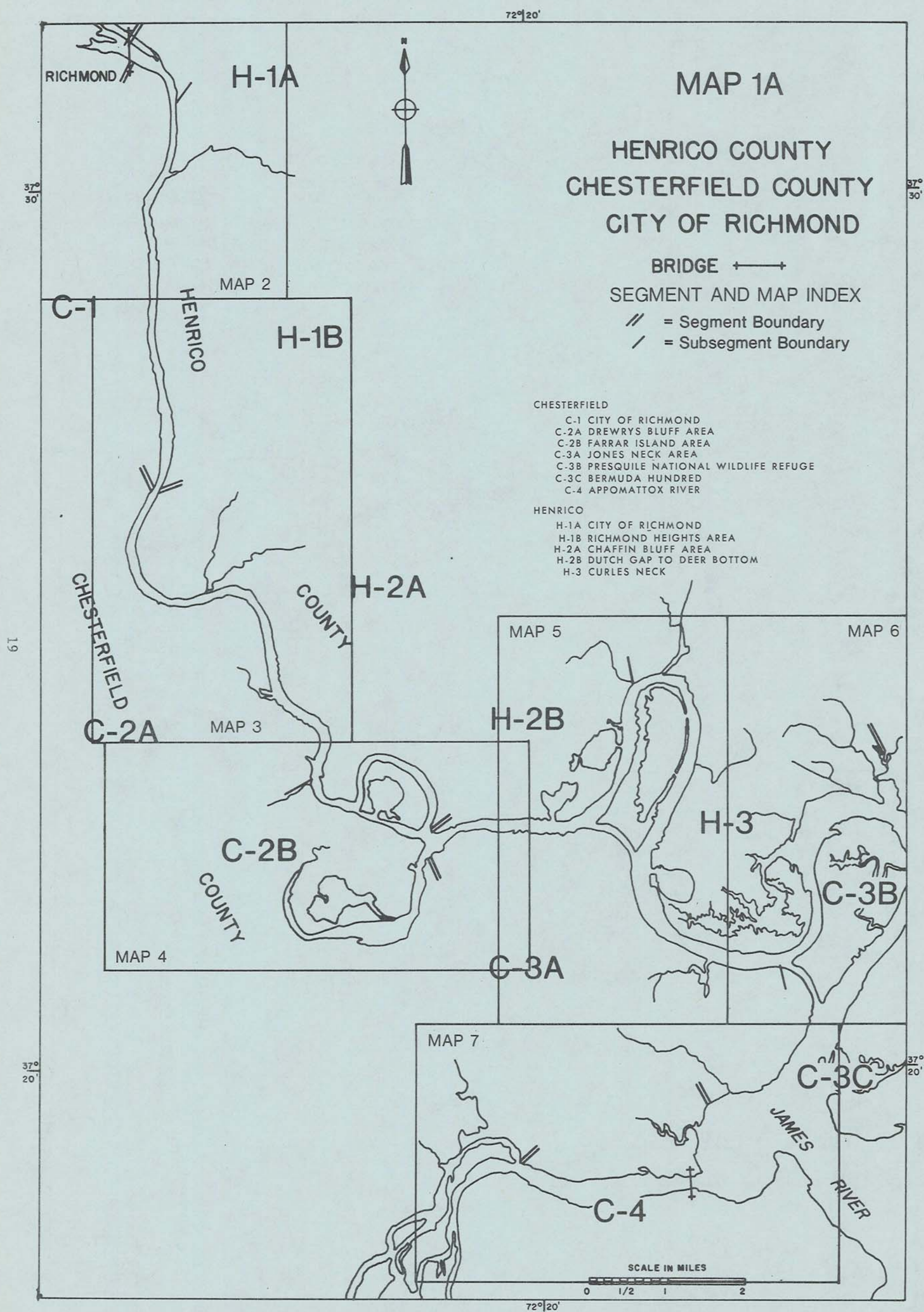
FIGURE 11: Across Turkey Island Cutoff from Presque Isle. Erosion here is very minor and is not a problem.



Figure 10



Figure 11



72°20'

MAP 1B

HENRICO COUNTY
CHESTERFIELD COUNTY
CITY OF RICHMOND

BRIDGE +—+

SHORELANDS TYPES

FASTLAND

Low Shore

Moderately Low Shore

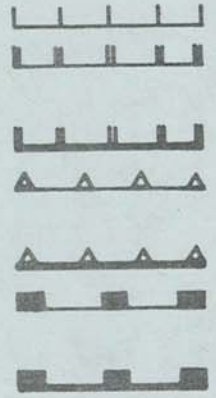
Moderately Low Shore
with Bluff

Moderately High Shore

Moderately High Shore
with Bluff

High Shore

High Shore
with Bluff



RICHMOND

H-1A

C-1

HENRICO

H-1B

CHESTERFIELD

C-2A

COUNTY

H-2A

H-2B

C-2B

COUNTY

C-3A

H-3

C-3B

C-3C

JAMES

RIVER

C-4

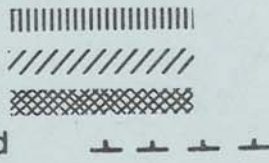
SHORE

Fringe Marsh

Extensive Marsh

Embayed Marsh

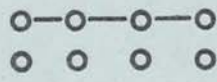
Artificially Stabilized



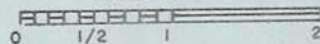
NEARSHORE

Narrow

Intermediate



SCALE IN MILES



72°20'

37°30'

37°20'

37°30'

20

37°20'

72°20'

MAP 1C

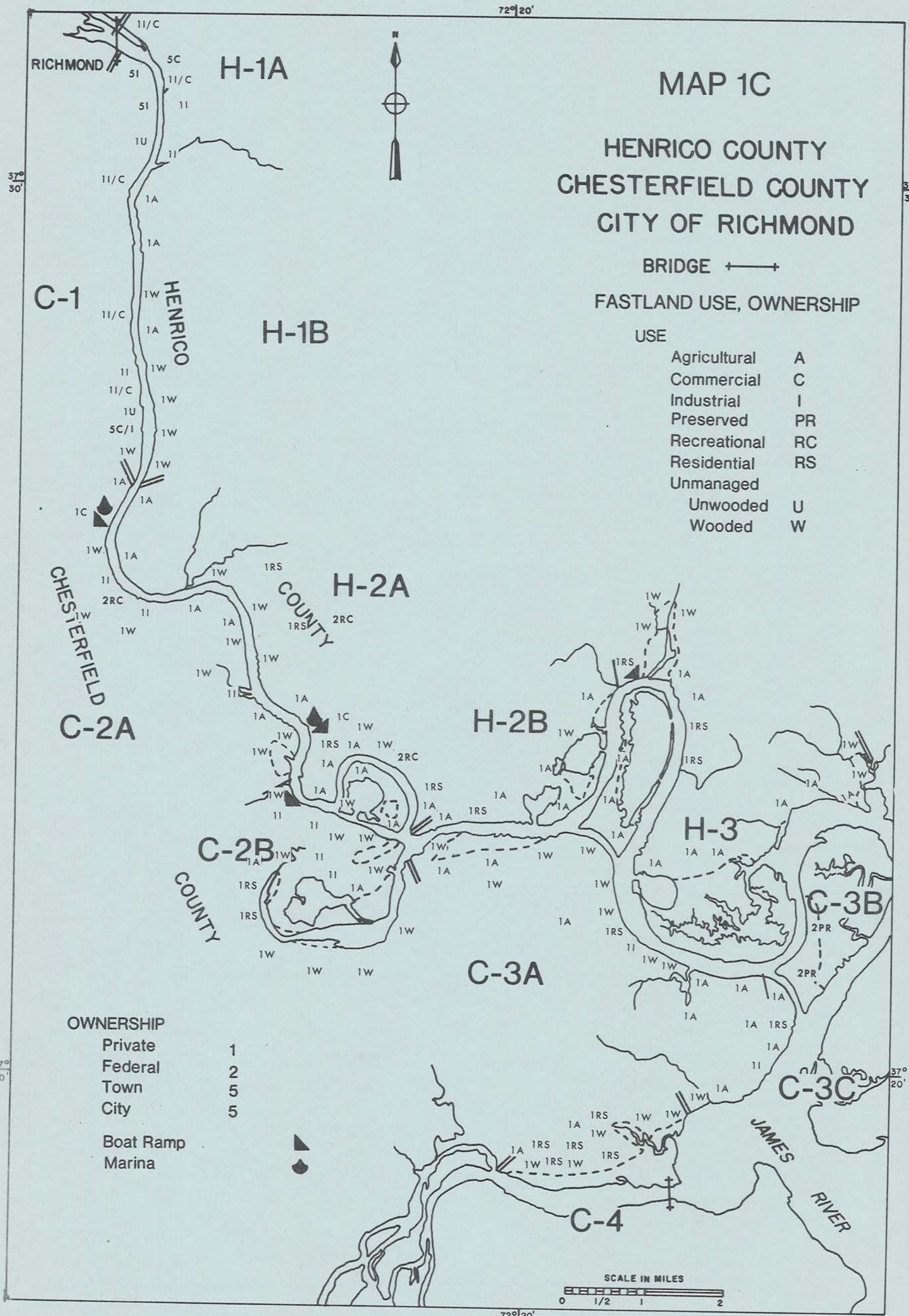
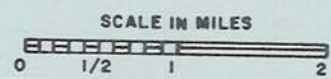
HENRICO COUNTY CHESTERFIELD COUNTY CITY OF RICHMOND

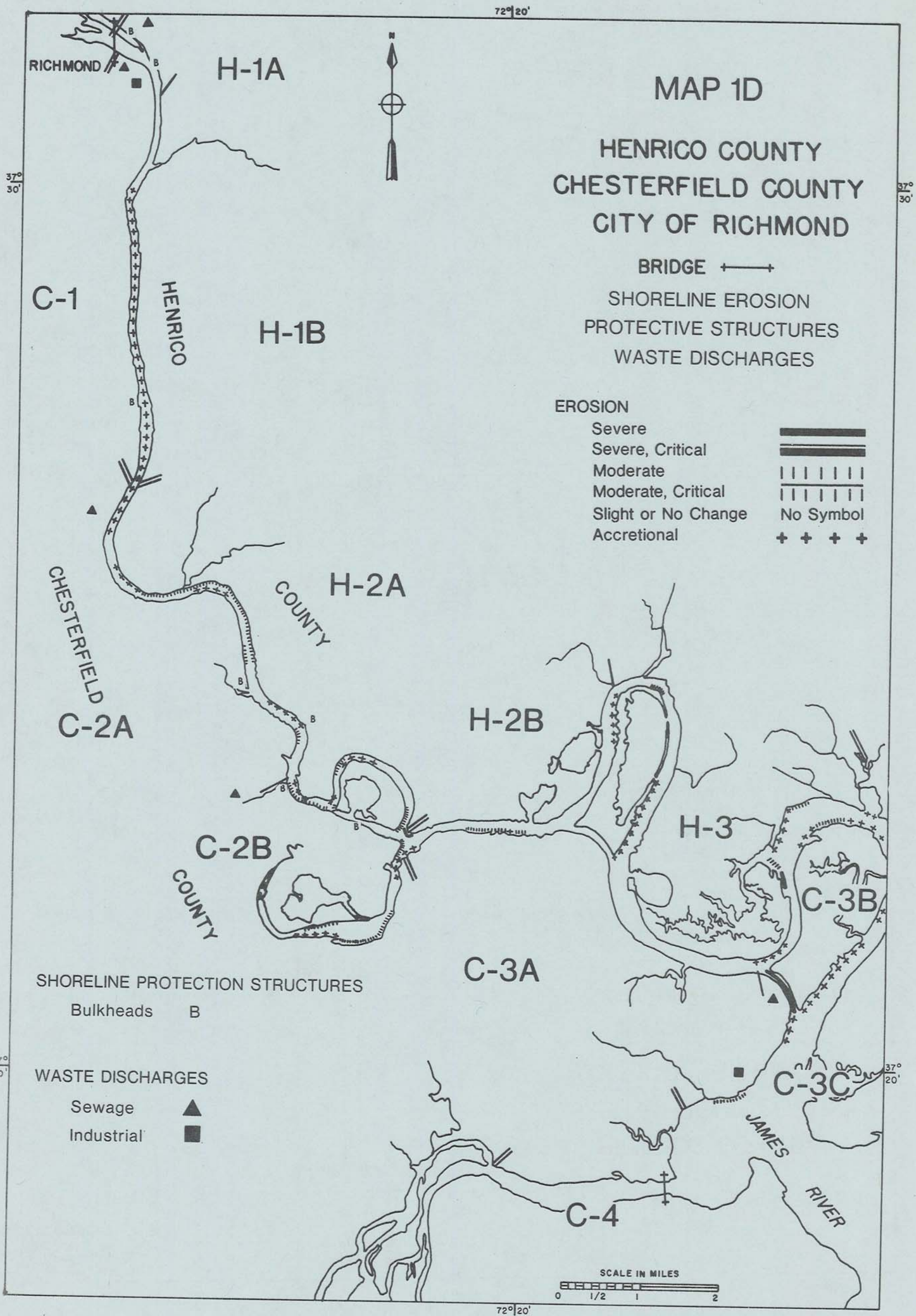
BRIDGE +—+

FASTLAND USE, OWNERSHIP

USE	
Agricultural	A
Commercial	C
Industrial	I
Preserved	PR
Recreational	RC
Residential	RS
Unmanaged	U
Unwooded	U
Wooded	W

OWNERSHIP	
Private	1
Federal	2
Town	5
City	5
Boat Ramp	
Marina	





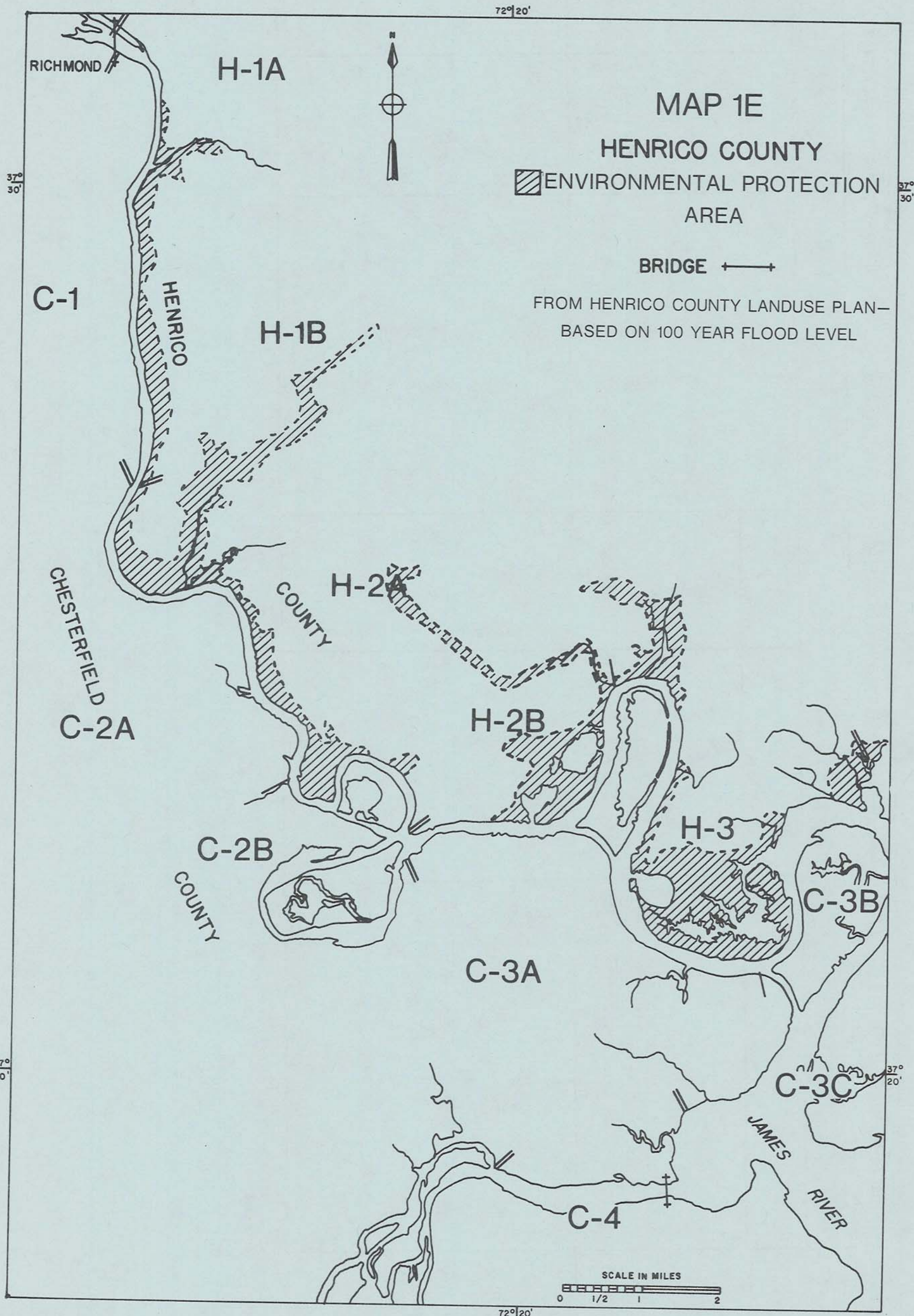


TABLE 2. CHESTERFIELD COUNTY, VIRGINIA SHORELANDS PHYSIOGRAPHY, FASTLANDS USE, OWNERSHIP (STATUTE MILES)

Ownership, use and physio- graphic classifi- cation	SHORELANDS PHYSIOGRAPHY												FASTLANDS USE						OWNERSHIP			TOTAL MILES	
	FASTLANDS						SHORE				NEARSHORE												
	LOW SHORE	MODERATELY LOW SHORE	MODERATELY HIGH SHORE	MODERATELY HIGH SHORE WITH BLUFF	HIGH SHORE	HIGH SHORE WITH BLUFF	ARTIFICIALLY STABILIZED	FRINGE MARSH	EMBAYED MARSH	EXTENSIVE MARSH	NARROW	INTERMEDIATE	AGRICULTURAL	RECREATIONAL	RESIDENTIAL	INDUSTRIAL	PRESERVED	UNMANAGED, WOODED	PRIVATE	FEDERAL	TOWN OR CITY	FASTLAND	SHORE
Subsegment																							
11	4.9	0.1	0.1	0.7	0.1		0.3	5.6			5.9					5.9			4.1		1.8	5.9	5.9
2A	5.3	0.7	0.3	0.3	0.2	0.9	0.1	6.2	0.4		6.7		2.8	0.2		0.8		3.9	7.5	0.2		7.7	6.7
2B	8.5	1.0	1.5	0.3	0.1	2.4	0.8	9.0	0.2	3.8	3.4		5.0		0.4	1.2		7.2	13.8			13.8	13.8
3A	6.6	2.0	0.8	0.1	0.7	1.0		6.0		5.0	10.6		6.5		0.5	0.2		4.0	11.2			11.2	11.0
3B	3.8							2.3		4.7	26.3						3.8			3.8		3.8	7.0
3C	2.1	0.3	0.3					2.7			2.2	0.5	1.9		0.2	0.3		0.3	2.7			2.7	2.7
4		2.6	0.6	0.3	0.5	0.4				4.0	3.1	0.9	0.8		1.0			2.6	4.4			4.4	4.0
TOTAL	31.2	6.7	3.6	1.7	1.6	4.7	1.2	31.8	0.6	17.5	38.2	1.4	17.0	0.2	2.1	8.4	3.8	18.0	43.7	4.0	1.8	49.5	51.1
% of FASTLAND	63%	14%	7%	3%	3%	10%							34%	0	4%	17%	8%	36%	88%	8%	4%	100%	
% of SHORELINE							2%	62%	1%	34%	75%	3%											100%

¹ City of Richmond.

² Does not include mutual nearshore with Subsegment 3C.

TABLE 3. HENRICO COUNTY, VIRGINIA SHORELANDS PHYSIOGRAPHY, FASTLANDS USE, OWNERSHIP (STATUTE MILES)																							
Ownership, use and physio- graphic clas- sification	SHORELANDS PHYSIOGRAPHY												FASTLANDS USE					OWNERSHIP			TOTAL MILES		
	FASTLANDS								SHORE				NEARSHORE										
	LOW SHORE	MODERATELY LOW SHORE	MODERATELY LOW SHORE WITH BLUFF	MODERATELY HIGH SHORE	MODERATELY HIGH SHORE WITH BLUFF	HIGH SHORE	HIGH SHORE WITH BLUFF	ARTIFICIALLY STABILIZED	FRINGE MARSH	EMBAYED MARSH	EXTENSIVE MARSH	NARROW											
Subsegment	LOW SHORE	MODERATELY LOW SHORE	MODERATELY LOW SHORE WITH BLUFF	MODERATELY HIGH SHORE	MODERATELY HIGH SHORE WITH BLUFF	HIGH SHORE	HIGH SHORE WITH BLUFF	ARTIFICIALLY STABILIZED	FRINGE MARSH	EMBAYED MARSH	EXTENSIVE MARSH	NARROW	AGRICULTURAL	RECREATIONAL	RESIDENTIAL	INDUSTRIAL	UNMANAGED, WOODED	PRIVATE	FEDERAL	TOWN OR CITY	FASTLAND	SHORE	
11A	0.6	0.6						0.2	1.0			1.2				1.2		1.0		0.2	1.2	1.2	
21B	2.4	2.1				0.3	0.3		5.1			5.1	2.1			1.0	2.0	5.1			5.1	5.1	
2A	6.4	0.3	0.1	0.2	1.3	0.1	1.4	0.2	9.8			7.1	5.5	0.1	0.7		3.7	9.9	0.1		10.0	10.0	
2B	3.9		0.4		1.3				5.7		0.6	3.9	4.2		0.4		1.1	5.6			5.6	6.3	
3	5.0	5.1		0.6	0.1				5.5	1.6	6.5	8.7	7.5		0.8		2.5	10.8			10.8	13.6	
TOTAL	18.3	8.1	0.5	0.8	2.7	0.4	1.7	0.4	27.1	1.6	7.1	26.0	19.3	0.1	1.9	2.2	9.3	32.4	0.1	0.2	32.7	36.2	
% of FASTLAND	56%	25%	2%	2%	8%	1%	5%						59%	0	6%	7%	28%	99%	0	1%	100%		
% of SHORELINE								1%	75%	4%	20%	72%										100%	

1 City of Richmond.

2 City of Richmond Water: Henrico Land.

CHAPTER 4

4.1 TABLE OF SUBSEGMENT SUMMARIES

4.2 SEGMENT AND SUBSEGMENT DESCRIPTIONS

4.3 SEGMENT AND SUBSEGMENT MAPS

TABLE 4. SHORELINE SITUATION REPORT SUBSEGMENT SUMMARY FOR CHESTERFIELD COUNTY, VIRGINIA

SUBSEGMENT	SHORELANDS TYPE	SHORELANDS USE	OWNERSHIP	ZONING	FLOOD HAZARD	BEACH QUALITY	SHORE EROSION SITUATION	POTENTIAL USE ENHANCEMENT
C-1 CITY OF RICHMOND 5.9 miles (5.9 mi. of fastland)	FASTLAND: Low shore 83%, moderately low shore 3%, moderately high shore 1%, moderately high shore with bluff 11%, and high shore 2%. SHORE: Fringe marsh 96% and artificially stabilized 4%. NEARSHORE: Narrow. James River dredged to 18-25 foot depths.	FASTLAND: Industrial. SHORE: Access to boats at Richmond Deepwater Terminal. Other mostly unused. NEARSHORE: Mainly commercial shipping to Richmond.	Private, except for City-owned Sewage Treatment Plant and Richmond Deepwater Terminal.	Heavy industrial.	Severe, critical. Flooding is caused by heavy upstream rains. Industry and business are threatened.	No beaches.	Slight or no change. Accretion from Goode Creek south to City limits. There is 1,400 feet of effective bulkhead at Deepwater Terminal.	Low. The already high density industrial and commercial usage plus the severe flood hazard limits the amount and scope of new development along Richmond's shorelands.
C-2A DREWRY'S BLUFF AREA 6.7 miles (7.7 mi. of fastland)	FASTLAND: Low shore 69%, moderately low shore 9%, moderately high shore 4%, moderately high shore with bluff 4%, high shore 3%, and high shore with bluff 11%. SHORE: Fringe marsh 92%, embayed marsh 6%, and artificially stabilized 2%. NEARSHORE: Narrow throughout the subsegment.	FASTLAND: Agricultural 36%, recreational 3%, industrial 11%, and unmanaged, wooded 50%. SHORE: Some recreational and industrial usage. Mostly unused. NEARSHORE: Primarily for commercial shipping. Some sport boating and fishing.	Private, except for Federally owned Port Darling.	Mostly industrial. Some agricultural.	Moderate, noncritical.	No beaches.	Moderate, noncritical $\frac{3}{4}$ mile north of Proctors Creek. Slight or no change elsewhere. There is 800 feet of effective bulkhead near the gravel pits north of Proctors Creek.	Low. Fort Darling is a federally owned park. The rest of the shorelands are flood plains. Development would be very costly.
C-2B FARRAR ISLAND AREA 13.8 miles (13.8 mi. of fastland)	FASTLAND: Low shore 61%, moderately low shore 7%, moderately high shore 11%, moderately high shore with bluff 2%, high shore 1%, and high shore with bluff 17%. SHORE: Fringe marsh 66%, extensive marsh 27%, artificially stabilized 6%, and embayed marsh 1%. NEARSHORE: Narrow 25%. The rest of the nearshore is too shallow for classification.	FASTLAND: Agricultural 36%, residential 3%, industrial 9%, and unmanaged, wooded 52%. SHORE: Industrial at the power plant. Elsewhere, recreational usage. NEARSHORE: Mostly commercial shipping. Some sport boating, fishing, and other water sports.	Private, except for County-owned boat ramp at the VEPCO power plant.	Mostly industrial. Mixture of agricultural, business, and residential along Old Channel.	Moderate, noncritical, except for 3 houses on Hatcher Island and for one house on Farrar Island, which are critical.	No beaches.	Slight or no change to moderate, noncritical. Several areas in the meanders of the river are accreting at 2.0 to 6.7 feet per year. There is riprap along half of VEPCO's shoreline.	Low for the islands in the meander and for the VEPCO area. The area along the old channel of the James River, south of Farrar Island, has moderate development potential.
C-3A JONES NECK AREA 11.0 miles (11.2 mi. of fastland)	FASTLAND: Low shore 59%, moderately low shore 18%, moderately high shore 7%, moderately high shore with bluff 1%, high shore 6%, and high shore with bluff 9%. SHORE: Fringe marsh 55% and extensive marsh 45%. NEARSHORE: Narrow 97%. The rest of the nearshore is too shallow for classification.	FASTLAND: Agricultural 58%, residential 4%, industrial 2%, and unmanaged, wooded 36%. SHORE: Mostly unused. NEARSHORE: Commercial shipping, fishing, sport boating and other water sports.	Private.	Agricultural and heavy industrial.	Low, noncritical. All fastland is high enough to withstand floods.	Poor. A thin beach at top of Jones Neck.	Slight or no change to moderate, noncritical. Some accretion in several areas.	Low. The present use as a low density residential area seems best. Some areas with potential development lack good access.
C-3B PRESQUILLE NAT. WILDLIFE REFUGE 7.0 miles (3.8 mi. of fastland)	FASTLAND: Low shore. SHORE: Extensive marsh 67% and fringe marsh 33%. NEARSHORE: Narrow 89%. The rest of the subsegment nearshore included in Figures for C-3C.	FASTLAND: Preserved as a National Wildlife Refuge. SHORE: Unused, except for a ferry dock. NEARSHORE: Commercial shipping to Richmond. Also used for sport boating and fishing.	Federal.	Agricultural.	Low, noncritical.	No beaches.	Slight or no change to severe, noncritical. The shoreline facing Turkey Island Cutoff has severe erosion. Accretion on the eastern side of the island.	None. The area's status as a National Wildlife Refuge precludes any development on the island.
C-3C BERMUDA HUNDRED 2.7 miles (2.7 mi. of fastland)	FASTLAND: Low shore 79%, moderately low shore 11%, and moderately high shore 10%. SHORE: Entirely fringe marsh. NEARSHORE: Narrow 82% and intermediate 18%.	FASTLAND: Agricultural 69%, residential 7%, industrial 11%, and unmanaged, wooded 13%. SHORE: Mostly unused, except for Presquille Ferry dock. NEARSHORE: Commercial shipping to Richmond. Some sport boating and fishing.	Private.	Mostly heavy industrial with some agricultural.	Low, noncritical.	No beaches.	Slight or no change to moderate, noncritical. Accretion south of Turkey Island Cutoff of 7.3 feet per year.	Low. Present low density agricultural usage best suited for the area.
C-4 APPOMATTOX RIVER 4.0 miles (4.4 mi. of fastland)	FASTLAND: Moderately low shore 59%, moderately high shore 14%, moderately high shore with bluff 8%, high shore 10%, and high shore with bluff 9%. SHORE: Entirely extensive marsh. NEARSHORE: Narrow 77% and intermediate 23%.	FASTLAND: Agricultural 17%, residential 24%, and unmanaged, wooded 59%. SHORE: Mostly unused. Some waterfowl hunting. NEARSHORE: Commercial shipping to Petersburg. Sport boating, fishing, and other water sports.	Private.	Agricultural, except some residential into the fastland.	Moderate, noncritical.	No beaches.	Slight or no change.	Low. Extensive marsh covers the shoreline. Behind this, the fastlands are already developed as residential areas. South of Shand Creek, there is an unpopulated area that could be developed for low intensity recreation.

TABLE 5. SHORELINE SITUATION REPORT SUBSEGMENT SUMMARY FOR HENRICO COUNTY, VIRGINIA

SUBSEGMENT	SHORELANDS TYPE	SHORELANDS USE	OWNERSHIP	ZONING	FLOOD HAZARD	BEACH QUALITY	SHORE EROSION SITUATION	POTENTIAL USE ENHANCEMENT
H-1A CITY OF RICHMOND 1.2 miles (1.2 mi. of fastland)	FASTLAND: Low shore 50% and moderately low shore 50%. SHORE: Artificially stabilized 17% and fringe marsh 83%. NEARSHORE: Narrow. There is a dredged channel maintained to an 18 foot depth.	FASTLAND: Industrial. SHORE: Access to boats at Richmond Upper Marine Terminal and loading sand on barges elsewhere. NEARSHORE: Commercial shipping. Kanawha Canal used as dockage for small boats.	Private, except for City-owned Richmond Upper Marine Terminal.	Heavy industrial.	Severe, critical. Flooding from upstream rains cause heavy damage to industry here.	No beaches.	No data on erosion. Area appears stable. Bulkhead at Upper Marine Terminal partly of concrete and partly of wood. Wooden bulkhead in disrepair and of little use.	Low. Area already high intensity industrial usage. Kanawha Canal could be reopened for pleasure cruises and sight-seeing trips.
H-1B RICHMOND HEIGHTS AREA 5.1 miles (5.1 mi. of fastland)	FASTLAND: Low shore 46%, moderately low shore 41%, high shore 7%, and high shore with bluff 7%. SHORE: Entirely fringe marsh. NEARSHORE: Narrow. Channel maintained to depths of 18 to 25 feet.	FASTLAND: Agricultural 42%, industrial 19%, and unmanaged, wooded 39%. SHORE: Some fishing, mostly unused. NEARSHORE: Commercial shipping.	Private.	Mostly general industrial, some agricultural.	Moderate, critical and noncritical. Industry along the shoreline endangered by flooding.	No beaches.	Slight or no change. Parts are accreting at rates up to 2.9 feet per year.	Low. The land near the water is very susceptible to flooding. Though not suitable for formal development, some of these lands could be used as public recreational nature trails or parks.
H-2A CHAFFIN BLUFF AREA 10.0 miles (10.0 mi. of fastland)	FASTLAND: Low shore 64%, moderately low shore 3%, moderately low shore with bluff 1%, moderately high shore 2%, moderately high shore with bluff 13%, high shore 1%, and high shore with bluff 14%. SHORE: Fringe marsh 98% and artificially stabilized 2%. NEARSHORE: Narrow 71%. 29% of the waters are too shallow for classification.	FASTLAND: Agricultural 55%, unmanaged, wooded 37%, residential 7%, and recreational 1%. SHORE: Mostly unused. NEARSHORE: Commercial shipping to Richmond. Some sport boating and fishing around Hatcher Island.	Private, except for Federally-owned Port Brady.	Light industrial, residential, and agricultural.	Moderate, critical and noncritical. Several places are susceptible to flooding.	No beaches.	Slight or no change to moderate, noncritical. Erosion at Chaffin Bluff and near Fort Brady. Some effective riprap at a residence south of Kingsland Road.	Moderate. Several areas now used for agriculture are suitable for development. With demand for land increasing in Richmond, area will probably be developed. Low-lying lands would make nice public picnic and camping area.
H-2B DUTCH GAP TO DEEP BOTTOM 6.3 miles (5.6 mi. of fastland)	FASTLAND: Low shore 68%, moderately low shore with bluff 8%, and moderately high shore with bluff 23%. SHORE: Fringe marsh 90% and extensive marsh 10%. NEARSHORE: Narrow 62%. The remaining nearshore is too shallow to be classified.	FASTLAND: Agricultural 74%, residential 7%, and unmanaged, wooded 19%. SHORE: Mostly unused. Parts used for private recreation. NEARSHORE: Commercial shipping to Richmond. Also water sports, sport fishing and boating.	Private.	Agricultural.	Moderate, noncritical. Only marsh areas are flooded.	No beaches.	Slight or no change to severe, noncritical. Dutch Gap has eroded at a rate of 6.1 feet per year.	Low. Though most lands are suitable for development, they are too far from Richmond and Route 5 to be considered prime targets for expansion. The present low density usage seems best suited for the area's present needs.
H-3 CURLS NECK 13.6 miles (10.8 mi. of fastland)	FASTLAND: Low shore 46%, moderately low shore 47%, moderately high shore 5%, and moderately high shore with bluff 1%. SHORE: Fringe marsh 40%, embayed marsh 12%, and extensive marsh 48%. NEARSHORE: Narrow 64%. The remaining nearshore is too shallow to be classified.	FASTLAND: Agricultural 70%, residential 7%, and unmanaged, wooded 23%. SHORE: Sport boating and fishing in Curles Neck Swamp. NEARSHORE: Commercial shipping in channel. Elsewhere, sport boating, fishing, and water sports.	Private, except for State-owned boat landing west of Bailey Creek.	Agricultural.	Moderate, noncritical. Only Curles Neck Swamp is affected by flooding.	No beaches.	Slight or no change to severe, noncritical. Erosion of 3.0 feet per year on east side of Curles Neck Swamp. Accretion of 2.2 to 2.8 feet per year at other areas.	Low. Curles Neck is a prime agricultural area. Little or no development could take place unless the agricultural lands were to be sacrificed.

CITY OF RICHMOND, HENRICO COUNTY PORTION
SUBSEGMENT H-1A (Map 2)

EXTENT: 6,400 feet (1.2 mi.) of shoreline from the I-95 bridge to the Richmond City Limits. The subsegment also includes 6,400 feet (1.2 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 50% (3,200 ft.) and moderately low shore 50% (3,200 ft.).
SHORE: Artificially stabilized 17% (1,100 ft.) and fringe marsh 83% (5,300 ft.).
NEARSHORE: Narrow. There is a dredged channel up to the Kanawha Channel maintained to a depth of 18 feet.

SHORELANDS USE

FASTLAND: Industrial. The Richmond Upper Marine Terminal is situated just south of Gillie Creek.
SHORE: The shore zone here is very narrow. The only usage would be access to boats, especially for loading and unloading cargo and supplies at the Richmond Upper Marine Terminal.
NEARSHORE: Commercial shipping to Richmond Upper Marine Terminal wharf, barges to private wharves just south. The Kanawha Canal is generally used as a dockage by small, private boats.

SHORELINE TREND: The subsegment trends generally NNW - SSE.

OWNERSHIP: Private, except for the city-owned Richmond Upper Marine Terminal.

ZONING: The entire subsegment is zoned heavy industrial.

FLOOD HAZARD: Severe, critical. Richmond is subjected to all major floods in the river basin. Flooding here usually occurs in the winter and spring months, though the Agnes and Camille flooding, the worst since 1771, occurred in June and August respectively. In 1972, the Agnes flood waters crested at 36.51 feet above M.S.L. The predicted 100 year storm level for Richmond is 34.9 feet above M.S.L. The business community along the river is severely endangered by flooding and the resultant damages can be staggering.

BEACH QUALITY: There are no beaches in the subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: No data available.
ENDANGERED STRUCTURES: No data available.
SHORE PROTECTIVE STRUCTURES: There is about 900 feet of bulkheading at the Upper Marine Terminal primarily for retaining fill. Much of it is concrete and is in good condition. The wooden bulkheading fronting a marginal wharf here is in a state of deterioration and is now of little value. There is approximately 200 feet of bulkheading at the mouth of the Kanawha Canal. This lower section of the canal is now used as a navigable harbor and dock for small boats.

Suggested Action: Repair areas of bulkheading presently in disrepair.

OTHER SHORE STRUCTURES: There is a 750 foot marginal wharf at the Upper Marine Terminal and several smaller piers just south of there.

POTENTIAL USE ENHANCEMENT: The highly intensified industrial usage of the subsegment precludes any other usage for most of the area. The Kanawha Canal, listed on the National Register of Historic Places, could be reopened for pleasure cruises and sight-seeing trips.

MAPS: USGS, 7.5 Min.Ser. (Topo.), RICHMOND
Quadr., 1964, Pr. 1968.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H-1-1A/05-08.

Ground-VIMS 13Aug75 HR-1A/1-8, 16-18.

RICHMOND HEIGHTS AREA, HENRICO COUNTY, VIRGINIA
SUBSEGMENT H-1B (Maps 2 and 3)

EXTENT: 27,000 feet (5.1 mi.) of shoreline from the end of Richmond City Limits to the end of Richmond City water. The subsegment includes 27,000 feet (5.1 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 46% (12,400 ft.), moderately low shore 41% (11,000 ft.), high shore 7% (1,800 ft.), and high shore with bluff 7% (1,800 ft.).
SHORE: Entirely fringe marsh (27,000 ft.).
NEARSHORE: Narrow. There is a dredged channel maintained to depths of 18 and 25 feet from north to south respectively.

SHORELANDS USE

FASTLAND: Agricultural 42% (11,400 ft.), industrial 19% (5,200 ft.), and unmanaged, wooded 39% (10,400 ft.).
SHORE: Some fishing, mostly unused.
NEARSHORE: Commercial shipping to the Richmond Deepwater Terminal and Upper Marine Terminal. Barges carrying gravel and construction materials go to privately owned wharves upstream.

SHORELINE TREND: The shoreline trends basically N - S in this subsegment.

OWNERSHIP: Private.

ZONING: Mostly general industrial to .5 miles from the subsegment end. Agricultural zoning from there to the end of the subsegment.

FLOOD HAZARD: Moderate, critical and noncritical. Flooding here, as in Subsegment H-1A, can be the result of severe summer storms, upstream storm runoff, or remnants of tropical storms. The shorelands along this narrow part of the river are very vulnerable to flooding. The industries along the river suffered greatly from the Agnes and Camille floods of 1969 and 1972 respectively.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change for the northern portion of the subsegment. The remaining part has been accreting at an historical rate of 2.9 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: None.

Suggested Action: No action is needed.

OTHER SHORE STRUCTURES: None.

POTENTIAL USE ENHANCEMENT: Low. Though this area has a great deal of land currently either unused or under agricultural usage, this land, especially near the river, is susceptible to flooding. Any development should be placed well into the fastland. Some of the lands near the shore could be used for public recreational nature trails or other such low intensity recreational usage.

MAPS: USGS, 7.5 Min.Ser. (Topo.), RICHMOND
Quadr., 1964, Pr. 1968.
USGS, 7.5 Min.Ser. (Topo.), DREWRY'S BLUFF
Quadr., 1969.
G&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordan Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H-1B/09-19.

CHAFFIN BLUFF AREA, HENRICO COUNTY, VIRGINIA

SUBSEGMENT H-2A (Maps 3 and 4)

EXTENT: 52,800 feet (10.0 mi.) of shoreline from the end of Richmond City waters to Dutch Gap. The subsegment also includes 52,800 feet (10.0 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 64% (34,000 ft.), moderately low shore 3% (1,800 ft.), moderately low shore with bluff 1% (600 ft.), moderately high shore 2% (1,200 ft.), moderately high shore with bluff 13% (7,000 ft.), high shore 1% (600 ft.), and high shore with bluff 14% (7,600 ft.).

SHORE: Fringe marsh 98% (52,000 ft.) and artificially stabilized 2% (800 ft.).

NEARSHORE: Narrow 71% (37,600 ft.). The rest of the subsegment's waters are less than 12 feet in depth.

SHORELANDS USE

FASTLAND: Agricultural 55% (28,800 ft.), unmanaged, wooded 37% (19,800 ft.), residential 7% (3,600 ft.), and recreational 1% (600 ft.). There is a marina at the end of Kingsland Road and one at Fort Brady. This commercial usage is too small to be tabulated.

SHORE: Mostly unused. The Tidewater Yacht Agency shore is used for access to the water.

NEARSHORE: Commercial shipping to Richmond comprises most nearshore usage. There is also sport fishing around Hatcher Island.

SHORELINE TREND: The shoreline trends basically NW - SE.

OWNERSHIP: Private, except for Fort Brady, part of a Civil War Battlefield, which is federally owned.

ZONING: The section from the start of the subsegment almost to Chaffin Bluff is zoned light industrial. The Chaffin Bluff area is zoned residential. The rest of the subsegment is zoned agricultural.

FLOOD HAZARD: Moderate, critical and noncritical. Most residences in the subsegment are on land sufficiently high to withstand flooding. However, several places, namely the Tidewater

Yacht Agency and several residences along the shoreline, are endangered by flood waters.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to moderate, noncritical. The two areas of erosion are around Chaffin Bluff and near Fort Brady. The area north of Cornelius Creek has lost an average of 1.5 feet per year historically. The area west of Fort Brady has a retreat of 2.0 feet per year. There are also several areas which have been accreting at rates from 1.3 to 2.9 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: There is approximately 800 feet of riprap at a residence south of Kingsland Road. It seems effective at the present.

Suggested Action: None at present.

OTHER SHORE STRUCTURES: There are several boat-houses and associated piers at the marina at Fort Brady. The Tidewater Yacht Agency has 22 housed boatslips and 20 open slips. Wooden bulkheading along the banks is for retaining fill and for stopping boat wake erosion. The marina here has a concrete boatramp.

POTENTIAL USE ENHANCEMENT: Moderate. Several areas in the subsegment offer room for some development. The area from the subsegment start to Chaffin Bluff, though mostly undeveloped, is currently used for agriculture. Developmental pressures will increase for this land as other spots are developed. If development for residential use does take place here, several things should be taken into consideration. First, one third of this area is below the 10-foot contour. This land is very susceptible to flooding and thus, development here should be cautioned. Also, any development in the area should be set back into the fastland to be protected from erosion of the shoreline.

Some type of low intensity recreational activities could take place along the shorelands. Nature trails for hiking and picnicking, and camping facilities are some alternatives. Such low investment recreational areas are much needed in the Richmond area.

MAPS: USGS, 7.5 Min.Ser. (Topo.), DREWRY'S BLUFF Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H-2A/20-32;
C-H-2BA/33-52.

Ground-VIMS 13Aug75 HR-2A/19-21, 27, 32, 37.

DUTCH GAP TO DEEP BOTTOM, HENRICO COUNTY, VIRGINIA
SUBSEGMENT H-2B (Maps 4 and 5)

EXTENT: 33,400 feet (6.3 mi.) of shoreline from Dutch Gap to Deep Bottom. The subsegment includes 29,800 feet (5.6 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 68% (20,400 ft.), moderately low shore with bluff 8% (2,400 ft.), and moderately high shore with bluff 23% (7,000 ft.).

SHORE: Fringe marsh 90% (30,000 ft.) and extensive marsh 10% (3,400 ft.).

NEARSHORE: Narrow 62% (20,800 ft.). The remaining nearshore is too shallow to be classified.

SHORELANDS USE

FASTLAND: Agricultural 74% (22,200 ft.), residential 7% (2,000 ft.), and unmanaged, wooded 19% (5,600 ft.).

SHORE: Parts of the shore are used for private recreation. Most of the shoreland is unused.

NEARSHORE: Commercial shipping in the channel. Elsewhere in the subsegment, usage consists of water sports, sport fishing, and boating.

WIND AND SEA EXPOSURE: The shoreline first trends basically E - W, then NE - SW. At Dutch Gap, there is a fetch from the east of 2.1 nautical miles.

OWNERSHIP: Private.

ZONING: Agricultural.

FLOOD HAZARD: Moderate, noncritical. Flooding here, as in the other segments, is due to the runoff of heavy upstream rains. The marsh area from just southwest of Deep Bottom to the channel is susceptible to flooding, but no structures are endangered.

BEACH QUALITY: There are no beaches in the subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to severe, noncritical. Though most of the subsegment is fairly stable, Dutch Gap is experiencing severe

erosion, losing 6.1 feet per year historically.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: None.

Suggested Action: No action is deemed necessary at the present time. The eroding area at Dutch Gap is uninhabited so protective devices there are not feasible at this time.

OTHER SHORE STRUCTURES: There are several piers located in the Varina Farm area.

POTENTIAL USE ENHANCEMENT: Low. The majority of the shorelands here are used for agricultural purposes. These lands, though suitable for development, are not located close enough to Richmond or to Route 5 to be considered a prime area of potential development. The present low density residential - agricultural usage seems best suited for the area's present needs.

MAPS: USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 H-C-2-3A/53-66.

Ground-VIMS 13Aug75 HR-2B/42-46.

CURLES NECK, HENRICO COUNTY, VIRGINIA

SEGMENT H-3 (Maps 5 and 6)

EXTENT: 71,800 feet (13.6 mi.) of shoreline from Deep Bottom to the head of Turkey Island Creek. The segment also includes 56,800 feet (10.8 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 46% (26,400 ft.), moderately low shore 47% (26,800 ft.), moderately high shore 5% (3,000 ft.), and moderately high shore with bluff 1% (600 ft.).

SHORE: Fringe marsh 40% (29,000 ft.), embayed marsh 12% (8,600 ft.), and extensive marsh 48% (34,200 ft.).

NEARSHORE: Narrow 64% (46,000 ft.). The rest of the nearshore is too shallow to be classified.

SHORELANDS USE

FASTLAND: Agricultural 70% (39,600 ft.), residential 7% (4,000 ft.), and unmanaged, wooded 23% (13,200 ft.).

SHORE: In the Curles Neck Swamp, there is sport boating and fishing. Elsewhere, usage is limited to access to the nearshore waters.

NEARSHORE: There is commercial shipping to Richmond in the dredged channel. Elsewhere, sport boating and fishing, and other water sports constitute the nearshore usage.

SHORELINE TREND: The shoreline meanders around a NW - SE trend.

OWNERSHIP: Private, except for a state-owned boat landing west of Bailey Creek.

ZONING: Agricultural.

FLOOD HAZARD: Moderate, noncritical. The segment is subject to flooding caused by heavy upstream rains. Most of the fastland here is of sufficient height to be little affected by the waters. The flood waters of the Agnes storm in June, 1972, crested at 12.2 feet above M.S.L. at Deep-bottom Landing. Usually, only the Curles Neck Swamp and other marsh areas are inundated by flood waters. No structures are endangered.

BEACH QUALITY: There are no beaches in the segment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to severe, noncritical. There has been severe erosion on the east side of Curles Neck Swamp, just south of the mouth of the creek. Here, the marsh has lost 3.0 feet per year historically. At the southern bank of the creek mouth, the marsh has lost 1.0 feet per year. Picketts Wharf also has moderate erosion. Elsewhere in the segment, Point Brems, Turkey Island Creek mouth, and the southeastern part of Curles Neck Swamp have been accreting at rates of 2.2 to 2.8 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: No apparent protective structures. There may be some sort of defense structures at the numerous wharves located in the segment, but none could be ascertained from VIMS aerial photography of the area.

Suggested Action: None. The cost of protecting the eroding marsh areas would probably be prohibitive. Erosion to the fastland here is mainly due to rain runoff down the steep cliffs found along much of the shorelands.

OTHER SHORE STRUCTURES: There is a boat ramp just to the west of Bailey Creek. There are numerous piers spaced throughout the segment.

POTENTIAL USE ENHANCEMENT: Low. Curles Neck is a prime agricultural area. Little or no significant development could take place here unless the agricultural area were to be sacrificed.

MAPS: USGS, 7.5 Min.Ser. (Topo.), ROXBURY
Quadr., 1965.
USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP
Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), HOPEWELL
Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 H-C 3-3A/67-89.

Ground-VIMS 90Oct75 HR-3/64-68.

CITY OF RICHMOND, CHESTERFIELD COUNTY PORTION
SEGMENT C-1 (Maps 2 and 3)

EXTENT: 31,200 feet (5.9 mi.) of shoreline from the I-95 bridge, south, to the Richmond City limits. The subsegment also includes 31,200 feet (5.9 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 83% (25,800 ft.), moderately low shore 3% (800 ft.), moderately high shore 1% (400 ft.), moderately high shore with bluff 11% (3,600 ft.), and high shore 2% (600 ft.).

SHORE: Artificially stabilized 4% (1,400 ft.) and fringe marsh 96% (29,800 ft.).

NEARSHORE: Narrow. There is a maintained, dredged channel to the Richmond Lock. Dredged depths are 18 feet from the Lock, south, to Richmond Deepwater Terminal and 25 feet from there to the mouth of the river.

SHORELANDS USE

FASTLAND: Industrial. Industries in the segment include the Richmond Deepwater Terminal and the Sewage Treatment Plant near the bridge.

SHORE: The shore here is very thin, having no beaches or extensive or embayed marshes. Usage would consist of boat access, especially at the Deepwater Terminal.

NEARSHORE: Usage consists mainly of commercial shipping to the city wharves. Upstream from the wharves, usage is restricted to small boats.

SHORELINE TREND: The shoreline trends N - S in this segment.

OWNERSHIP: Private, except for the Sewage Treatment Plant and Richmond Deepwater Terminal, which are city owned.

ZONING: The entire segment is zoned heavy industrial.

FLOOD HAZARD: Severe, critical. Though the James River here is considered tidal, flooding is due to upstream runoff from severe storms. This area was inundated with flood waters by both the Agnes and Camille storms of 1972 and 1969 respectively. The Agnes flood waters crested at 36.51 feet above M.S.L.; the Camille waters crested at 28.61 feet above M.S.L. Both storms

caused heavy damage to the Southside area businesses and industries.

BEACH QUALITY: There are no beaches in this segment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Historically, accretion has been from 2.9 to 3.2 feet per year from just north of Goode Creek, south, to the city limits.

Elsewhere in the segment, there has been slight or no change in the shoreline.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: 1,400 feet of effective bulkheading, mostly at the Richmond Deepwater Terminal. Some bulkheading of steel interlocking sheet pile is located at the entrance to an unused concrete boat ramp - marina facility. This is mainly to combat boat wake erosion which could cause washing behind the marina's structures.

Suggested Action: No further action seems necessary, since the segment's shoreline is either relatively stable or accreting.

OTHER SHORE STRUCTURES: There is a 1,250 foot pier parallel to the shore at the Richmond Deepwater Terminal. Another pier is located at the sewage treatment plant.

POTENTIAL USE ENHANCEMENT: Low. This area is already densely developed for various industries and businesses. If any development should take place here, much effort and consideration should be given to the area's severe flood hazard. Buildings should be flood proofed to limit the damage caused by floods.

MAPS: USGS, 7.5 Min.Ser. (Topo.), RICHMOND
Quadr., 1964, Pr. 1968.
USGS, 7.5 Min.Ser. (Topo.), DREWRY'S BLUFF
Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H 1-1A/05-19.

Ground-VIMS 90Oct75 CF-1/9.
13Aug75 CF-1/10-15.

DREWRY'S BLUFF AREA, CHESTERFIELD COUNTY, VIRGINIA
SUBSEGMENT C-2A (Maps 3 and 4)

EXTENT: 35,600 feet (6.7 mi.) of shoreline from the end of Richmond City Limits to Proctors Creek. The subsegment also includes 40,800 feet (7.7 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 69% (28,000 ft.), moderately low shore 9% (3,800 ft.), moderately high shore 4% (1,600 ft.), moderately high shore with bluff 4% (1,600 ft.), high shore 3% (1,200 ft.), and high shore with bluff 11% (4,600 ft.).
SHORE: Fringe marsh 92% (32,800 ft.), embayed marsh 6% (2,000 ft.), and artificially stabilized 2% (800 ft.).
NEARSHORE: Narrow for the entire length of the subsegment.

SHORELANDS USE

FASTLAND: Agricultural 36% (14,600 ft.), recreational 3% (1,200 ft.), industrial 11% (4,400 ft.), and unmanaged, wooded 50% (20,600 ft.).
SHORE: Some recreational and industrial usage, mostly unused.
NEARSHORE: Primarily used for commercial shipping to Richmond. The nearshore is also used for sport boating and fishing.

SHORELINE TREND: The shoreline trends basically NW - SE.

OWNERSHIP: Private, except for the federally owned Richmond National Battlefield Park (Fort Darling, a Civil War fort).

ZONING: Mostly zoned industrial. The area around Fort Darling is zoned agricultural.

FLOOD HAZARD: Moderate, noncritical. Heavy upstream rains cause flooding in areas of the subsegment. An average of historical flood levels here range from 16.9 feet to 11.2 feet above M.S.L. The Agnes flood of June, 1972 crested at a level of 19.3 feet above M.S.L. at the Lone Star Industries property on Willis Road.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to moderate, noncritical. The area of most erosion is approximately $\frac{3}{4}$ mile north of Proctors Creek, where the historical rate has been 1.1 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: There is 800 feet of bulkheading near the gravel pits about $1\frac{1}{2}$ miles north of Proctors Creek. It seems to be working satisfactorily.

Suggested Action: None for the present.

OTHER SHORE STRUCTURES: There is a pier with boat slips at the mouth of Falling Creek. An oil wharf is located at Drewry's Bluff. There is also a pier with slips associated with the bulkheading north of Proctors Creek.

POTENTIAL USE ENHANCEMENT: Low. Except for the immediate area around Drewry's Bluff, most of the area's shorelands are flood plains. These areas are very susceptible to flooding and caution should be used in any type of development here.

MAPS: USGS, 7.5 Min.Ser. (Topo.), DREWRY'S BLUFF Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H-2A 20-32.

Ground-VIMS 13Aug75 CF-2A/22-26, 28-30.

FARRAR ISLAND AREA, CHESTERFIELD COUNTY, VIRGINIA
SUBSEGMENT C-2B (Map 4)

EXTENT: 72,600 feet (13.8 mi.) of shoreline from Proctors Creek to Dutch Gap. The subsegment includes 72,600 feet (13.8 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 61% (44,400 ft.), moderately low shore 7% (5,200 ft.), moderately high shore 11% (7,800 ft.), moderately high shore with bluff 2% (1,800 ft.), high shore 1% (800 ft.), and high shore with bluff 17% (12,600 ft.).
SHORE: Fringe marsh 66% (47,800 ft.), extensive marsh 27% (19,800 ft.), artificially stabilized 6% (4,000 ft.), and embayed marsh 1% (1,000 ft.).
NEARSHORE: Narrow 25% (18,200 ft.). The rest of the nearshore does not reach 12 feet in depth.

SHORELANDS USE

FASTLAND: Agricultural 36% (26,200 ft.), residential 3% (2,000 ft.), industrial 9% (6,600 ft.), and unmanaged, wooded 52% (37,800 ft.).
SHORE: Where the power plant is located, the shore usage is industrial. Elsewhere in the subsegment, especially along the Old Channel, usage is recreational.
NEARSHORE: There is commercial shipping through the Aiken Swamp - Dutch Gap Cutoff to the VEPCO power plant wharf and to the terminals in Richmond. Around Hatcher Island and along the Old Channel at Farrar Island, nearshore usage consists of boating, sport fishing, and other water sports.

SHORELINE TREND: The channel trends basically WNW - ESE. The shoreline has several wide meanders, combined making a figure 8.

OWNERSHIP: Private, except for a county-owned boat ramp near the VEPCO power plant.

ZONING: Mostly zoned industrial on the James. Along the Old Channel across from Farrar Island, zoning ranges from agricultural to business, with some residential.

FLOOD HAZARD: Moderate, noncritical for most of the subsegment; severe, critical for three

structures on Hatcher Island and for one house on Farrar Island. The flood waters of the Camille storm (1969) crested at 13.7 feet above M.S.L. at the VEPCO Power Plant at Dutch Gap. The Agnes flooding (1972) crested at 18.9 feet above M.S.L. at the Aiken Swamp Gage. Historically, flood waters at Aiken Swamp have averaged 11.2 feet above M.S.L.

BEACH QUALITY: There are no beaches in this sub-segment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: The erosion rate ranges from slight or no change to moderate, noncritical. There are also several areas of accretion. The area of most erosion has been the far westerly side of Farrar Island, which historically, has lost 2.7 feet per year. The tips of Hatcher and Farrar Islands at Dutch Gap have been losing 1.6 feet per year historically. Elsewhere, the northern-most part of Hatcher Island has been gaining 2.0 feet per year; the area of Farrar Island southwest of the power plant +6.7 feet per year, and the area almost at the sub-segment's end +4.5 feet per year.

ENDANGERED STRUCTURES: None at present. One house on the southwestern tip of Hatcher Island is encountering moderate erosion, and in several years if protective measures are not taken, will be endangered.

SHORE PROTECTIVE STRUCTURES: There is a dredged and riprapped slip to the west of VEPCO's power plant. About half of VEPCO's shoreline is riprapped.

Suggested Action: No action is necessary at the present time.

OTHER SHORE STRUCTURES: To the back of VEPCO is its outfall canal, which was dredged, then riprapped, with jetties at its mouth. Elsewhere, there is a pier at VEPCO, and one west of there, in the dredged slip. Below VEPCO's pier, there is a public boat landing.

POTENTIAL USE ENHANCEMENT: Low for Hatcher Island and Farrar Island. Both islands are too low to be safely developed. The VEPCO Power Plant is already located to the east of Proctors Creek. No other development here would be possible. The area along the old channel of the James River, south of Farrar Island,

has a moderate development potential. This land has an elevation of at least 100 feet, making it safe from any flooding. However, access to the water here would prove very difficult and expensive. Any development here would be due to the scenic qualities of the particular location and not to the usual water related development potential.

MAPS: USGS, 7.5 Min.Ser. (Topo.), HOPEWELL
Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), CHESTER
Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), DREWRY'S BLUFF
Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP
Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H-2-B-A/33-52.

Ground-VIMS 13Aug75 CF-2B/31, 33-36,
38-41.

JONES NECK AREA, CHESTERFIELD COUNTY, VIRGINIA
SUBSEGMENT C-3A (Maps 4, 5, and 6)

EXTENT: 58,200 feet (11.0 mi.) of shoreline from Dutch Gap to Turkey Island. The subsegment also includes 58,800 feet (11.2 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 59% (34,800 ft.), moderately low shore 18% (10,600 ft.), moderately high shore 7% (4,000 ft.), moderately high shore with bluff 1% (600 ft.), high shore 6% (3,600 ft.), and high shore with bluff 9% (5,200 ft.).

SHORE: Fringe marsh 55% (31,800 ft.) and extensive marsh 45% (26,400 ft.).

NEARSHORE: Narrow 97% (56,200 ft.). The rest of the subsegment's nearshore has less than 12-foot depths.

SHORELANDS USE

FASTLAND: Agricultural 58% (34,200 ft.), residential 4% (2,400 ft.), industrial 2% (1,000 ft.), and unmanaged, wooded 36% (21,200 ft.).

SHORE: Mostly unused.

NEARSHORE: Commercial shipping along the subsegment through Jones Neck Cutoff to various wharves nearer Richmond. There is also sport boating, fishing, and other water sports throughout the subsegment's waters.

SHORELINE TREND: The shoreline is trending basically NW - SE in the subsegment. There is a large meander (Jones Neck) and several other curves.

OWNERSHIP: Private.

ZONING: Agricultural from Dutch Gap to Meadowville Channel. Jones Neck and most of the rest of the subsegment is zoned heavy industrial.

FLOOD HAZARD: Low, noncritical. Any flooding here would be a result of heavy upstream rain runoff. Even in cases of heavy flooding, the only area susceptible to the waters would be the extensive marsh just east of Dutch Gap. All fastland in the subsegment is of sufficient height to preclude any flooding. No structures are endangered.

BEACH QUALITY: There is one, small section of thin beach at the top of Jones Neck.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to moderate, noncritical. Several areas are accreting. The two areas of most change have been the marsh area near Dutch Gap and Jones Neck. The marsh has been eroding at a rate of 1.1 to 1.2 feet per year historically. One point there has accreted at 1.6 feet per year. The western and lower eastern half of Jones Neck have been accreting at an historical rate of 2.7 to 4.8 feet per year. The northern tip of Jones Neck has been experiencing erosion of 1.0 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: None.

Suggested Action: No action seems necessary. The shoreline here is mostly stable.

OTHER SHORE STRUCTURES: None.

POTENTIAL USE ENHANCEMENT: Low. The present use as a low density residential area is best suited for the subsegment. There is room for some additional residential development, but the lack of good access to these areas could pose a problem.

MAPS: USGS, 7.5 Min.Ser. (Topo.), HOPEWELL
Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP
Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 H-C-2-3A/53-66;
H-C-3-3A/67-89.

PRESQUILE NATIONAL WILDLIFE REFUGE,
CHESTERFIELD COUNTY, VIRGINIA
SUBSEGMENT C-3B (Map 6)

EXTENT: 37,200 feet (7.0 mi.) of shoreline around Turkey Island. The subsegment also contains 20,000 feet (3.8 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Entirely low shore.

SHORE: Extensive marsh 67% (24,800 ft.) and fringe marsh 33% (12,400 ft.).

NEARSHORE: Narrow 89% (33,000 ft.). The rest of the subsegment's nearshore is included in the figures for Subsegment C-3C.

SHORELANDS USE

FASTLAND: The entire subsegment is preserved as a National Wildlife Refuge.

SHORE: Mostly unused. There is a ferry dock along the cutoff.

NEARSHORE: Commercial shipping to Richmond along the Turkey Island Cutoff. The rest of the subsegment's nearshore is used for sport boating and fishing, and for water sports.

SHORELINE TREND: The subsegment is an island located in a meander of the James River. It has no specific shoreline trend.

OWNERSHIP: Federal.

ZONING: Agricultural.

FLOOD HAZARD: Like other segments along the upper James River, flooding here is a result of heavy upstream rains. The marsh areas are susceptible to the flood waters, but the fastlands are high enough to withstand the flooding. There are no endangered structures.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to severe, noncritical. There is an area of moderate erosion located at the northern part of the subsegment. Here, the rate of retreat has been 1.2 feet per year. The shoreline facing the Turkey Island Cutoff is currently

experiencing severe erosion problems. Most of the eastern side of the island has been experiencing accretion ranging from 4.5 to 7.3 feet per year. The western side has experienced slight or no change in its shoreline.

ENDANGERED STRUCTURES: There are no structures endangered by erosion.

SHORE PROTECTIVE STRUCTURES: There is about 100 feet of wood bulkheading and rubble riprap located at the ferry dock on Presquile. It is in good condition and is effective.

Suggested Action: The severely eroding shoreline bordering the Turkey Island Cutoff should be studied with the view toward creating a system of shoreline defenses. Probably the best defense here would be to riprap or bulkhead the endangered area.

OTHER SHORE STRUCTURES: The Presquile Ferry dock.

POTENTIAL USE ENHANCEMENT: None. The area's status as a National Wildlife Refuge precludes any development on the island.

MAPS: USGS, 7.5 Min.Ser. (Topo.), ROXBURY
Quadr., 1965.
USGS, 7.5 Min.Ser. (Topo.), WESTOVER
Quadr., 1965.
USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP
Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), HOPEWELL
Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 CF-3B/90-99.

Ground-VIMS 90Oct75 CF-3B/51-52, 55-
60, 62-63.
13Aug75 CF-3B/47-50.

BERMUDA HUNDRED, CHESTERFIELD COUNTY, VIRGINIA

SUBSEGMENT C-3C (Maps 6 and 7)

EXTENT: 14,200 feet (2.7 mi.) of shoreline from west of the Turkey Island Cutoff to Shand Creek. The subsegment also includes 14,200 feet (2.7 mi.) of fastland.

SHORELANDS TYPE

PASTLAND: Low shore 79% (11,200 ft.), moderately low shore 11% (1,600 ft.), and moderately high shore 10% (1,400 ft.).

SHORE: Entirely fringe marsh.

NEARSHORE: Narrow 82% (11,600 ft.) and intermediate 18% (2,600 ft.).

SHORELANDS USE

PASTLAND: Agricultural 69% (9,800 ft.), residential 7% (1,000 ft.), industrial 11% (1,600 ft.), and unmanaged, wooded 13% (1,800 ft.).

SHORE: Mostly unused. There is a dock for the Presquile Ferry.

NEARSHORE: Commercial shipping to Richmond. There is also some sport boating and fishing, and water sports.

WIND AND SEA EXPOSURE: The shoreline trends basically N - S. Just east of Shand Creek, the fetch is SE - 3.2 nautical miles.

OWNERSHIP: Private.

ZONING: Mostly heavy industrial. Some agricultural at Turkey Island Cutoff.

FLOOD HAZARD: Flooding here is a result of heavy upstream rains. Very little fastland is affected by such flooding, and no structures are endangered. The Agnes flood of June, 1972, the worst flood here since 1771, crested at 6.3 feet above M.S.L., flooding little land and endangering no structures.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to moderate, noncritical. Erosion of 1.1 foot per year has taken place along the shoreline east of Shand Creek. The shoreline just south of Turkey Island Cutoff has been accreting at a

rate of 7.3 feet per year, historically.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: There is approximately 100 feet of wooden bulkhead along the ferry dock at Turkey Island Cutoff.

Suggested Action: None for the present time. Erosion is not a significant problem in this subsegment.

OTHER SHORE STRUCTURES: The Presquile Ferry dock.

POTENTIAL USE ENHANCEMENT: Low. Most of the land here is used for agricultural purposes. Any significant development would sacrifice the present usage. VEPCO has a substation just south of Bermuda Hundred, which precludes any other development there.

MAPS: USGS, 7.5 Min.Ser. (Topo.), HOPEWELL
Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordon Point to Richmond, 1971.

PHOTOS: No VIMS aerial photos.

Ground-VIMS 90Oct75 CF-3C/53-54, 61.

APPOMATTOX RIVER, CHESTERFIELD COUNTY, VIRGINIA
SEGMENT C-4 (Map 7)

EXTENT: 21,000 feet (4.0 mi.) of shoreline from Shand Creek to Point of Rocks. The segment includes 23,000 feet (4.4 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Moderately low shore 59% (13,600 ft.), moderately high shore 14% (3,200 ft.), moderately high shore with bluff 8% (1,800 ft.), high shore 10% (2,400 ft.), and high shore with bluff 9% (2,000 ft.).

SHORE: Entirely extensive marsh.

NEARSHORE: Narrow 77% (16,200 ft.) and intermediate 23% (4,800 ft.).

SHORELANDS USE

FASTLAND: Agricultural 17% (4,000 ft.), residential 24% (5,400 ft.), and unmanaged, wooded 59% (13,600 ft.).

SHORE: Waterfowl hunting in areas. Mostly unused.

NEARSHORE: Commercial shipping along the Appomattox River to Petersburg. There is also sport boating, fishing, and other water sports in the nearshore.

SHORELINE TREND: The shoreline trends basically E - W.

OWNERSHIP: Private.

ZONING: Agricultural except for some residential into the fastland.

FLOOD HAZARD: Moderate, noncritical. Flooding here is a result of heavy rains along the headwaters of the James River. Flood waters here are of less height than those at Richmond. Only the shore zone of extensive marsh would be inundated at such times, and no structures would be endangered.

BEACH QUALITY: There are no beaches in this segment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: None.

Suggested Action: None. The area appears to be stable. The extensive marsh appears to be effective in combatting any incident erosion.

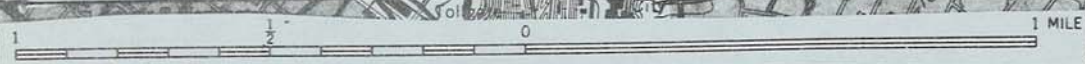
OTHER SHORE STRUCTURES: One bridge, Route 10, going to Hopewell, and a railroad bridge west of there.

POTENTIAL USE ENHANCEMENT: Low. The fastlands behind the marshes on the Appomattox River are already residential areas. Further development here could take place, though it would tend to crowd the area and spoil the natural beauty of the land. Just south of Shand Creek, there is an area that is unpopulated. This area could be developed into a low intensity recreational park, with nature trails and picnicking facilities.

MAPS: USGS, 7.5 Min.Ser. (Topo.), HOPEWELL Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordon Point to Richmond, 1971.

PHOTOS: No aerial VIMS photos.

77° 25'



MAP 2A

CITY OF RICHMOND
TOPOGRAPHY AND CULTURE
Segments H-1A, H-1B, C-1

- // = Segment Boundary
- / = Subsegment Boundary

H-1A

C-1

H-1B

C-1

77° 25'

43

37° 30'

37° 30'

77° 25'

MAP 2B

CITY OF RICHMOND

SHORELANDS TYPES

Segments H-1A, H-1B, C-1

FASTLAND

Low Shore

Moderately Low Shore

SHORE

Artificially Stabilized

Fringe Marsh

NEARSHORE

Narrow

H-1A

C-1

H-1B

C-1

44

37°
30'

37°
30'

77° 25'

77° 25'

1 MILE

MAP 2C

CITY OF RICHMOND

FASTLAND USE, OWNERSHIP, EROSION

Segments H-1A, H-1B, C-1

USE

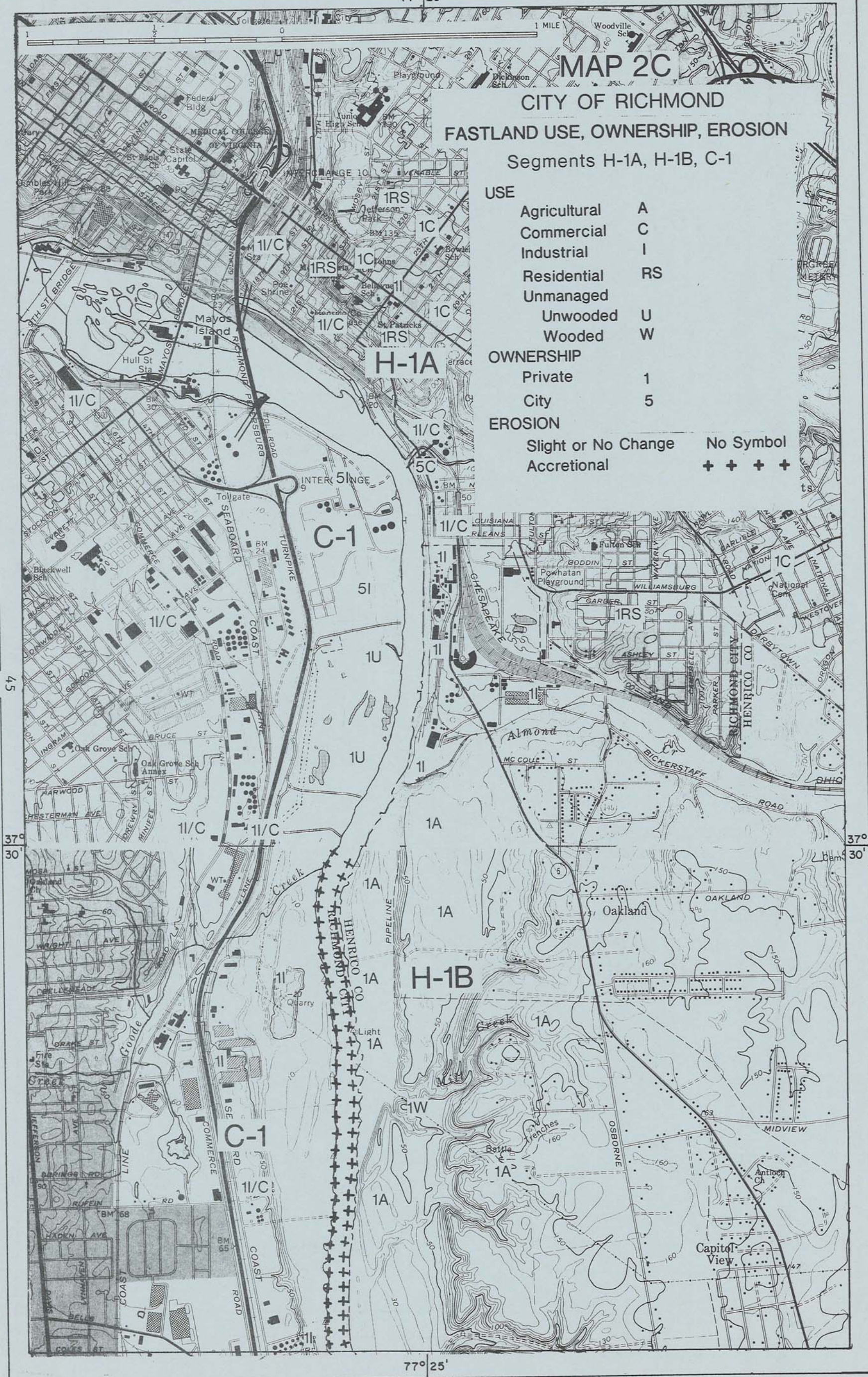
Agricultural	A
Commercial	C
Industrial	I
Residential	RS
Unmanaged	
Unwooded	U
Wooded	W

OWNERSHIP

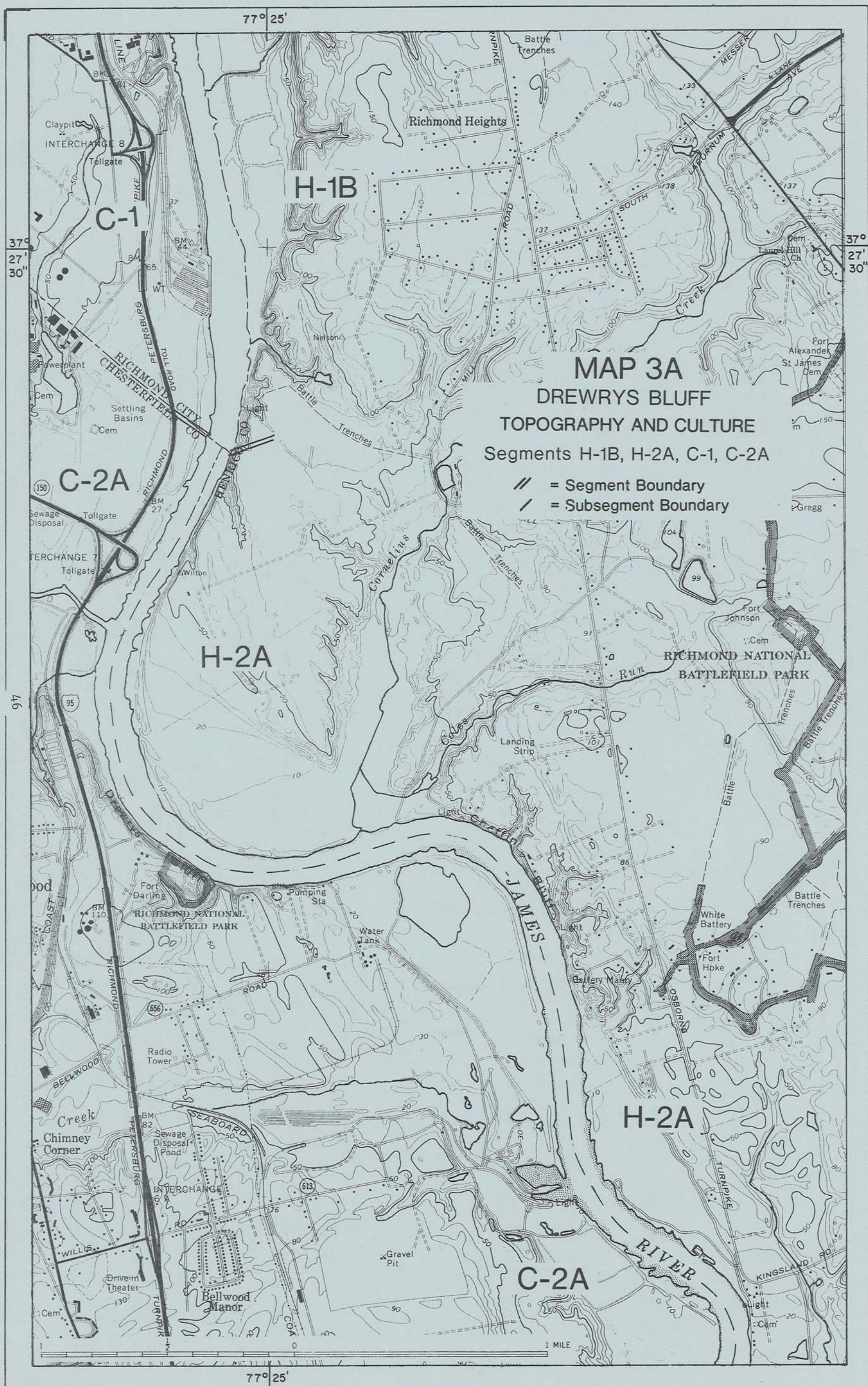
Private	1
City	5

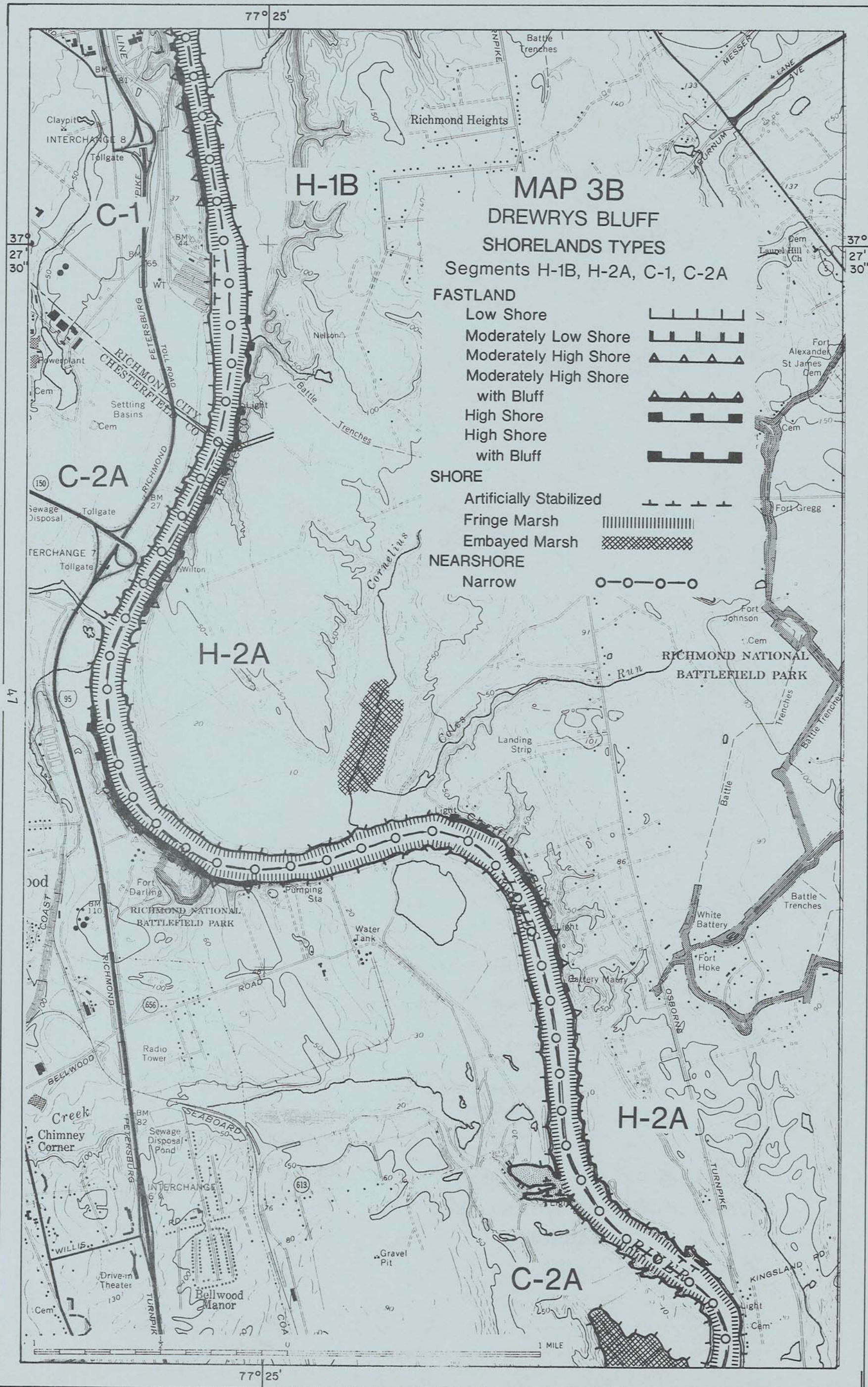
EROSION

Slight or No Change	No Symbol
Accretional	++++



77° 25'





77° 25'

MAP 3C

DREWRYS BLUFF

FASTLAND USE, OWNERSHIP, EROSION

Segments H-1B, H-2A, C-1, C-2A

USE

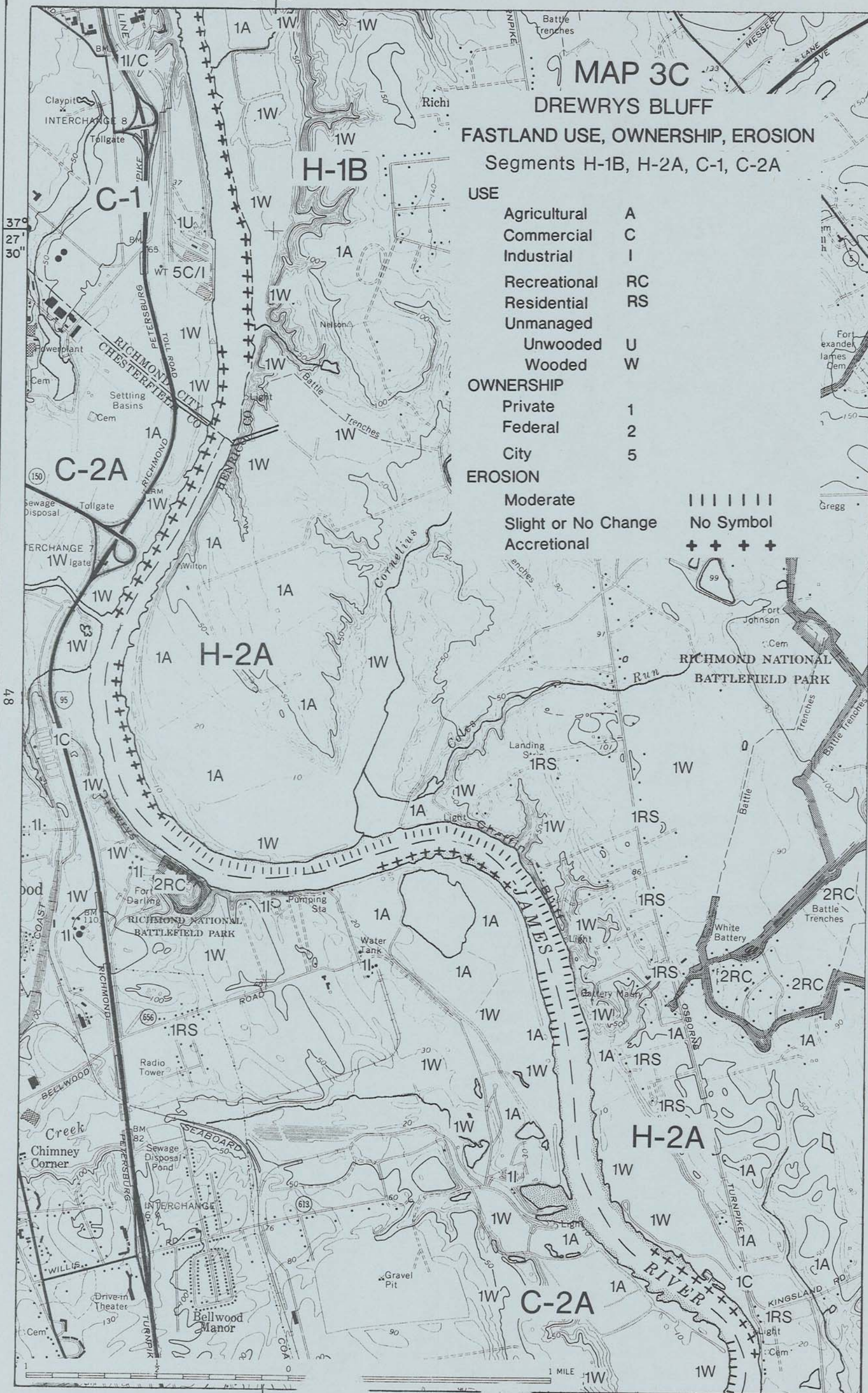
Agricultural	A
Commercial	C
Industrial	I
Recreational	RC
Residential	RS
Unmanaged	
Unwooded	U
Wooded	W

OWNERSHIP

Private	1
Federal	2
City	5

EROSION

Moderate	
Slight or No Change	No Symbol
Accretional	+++++

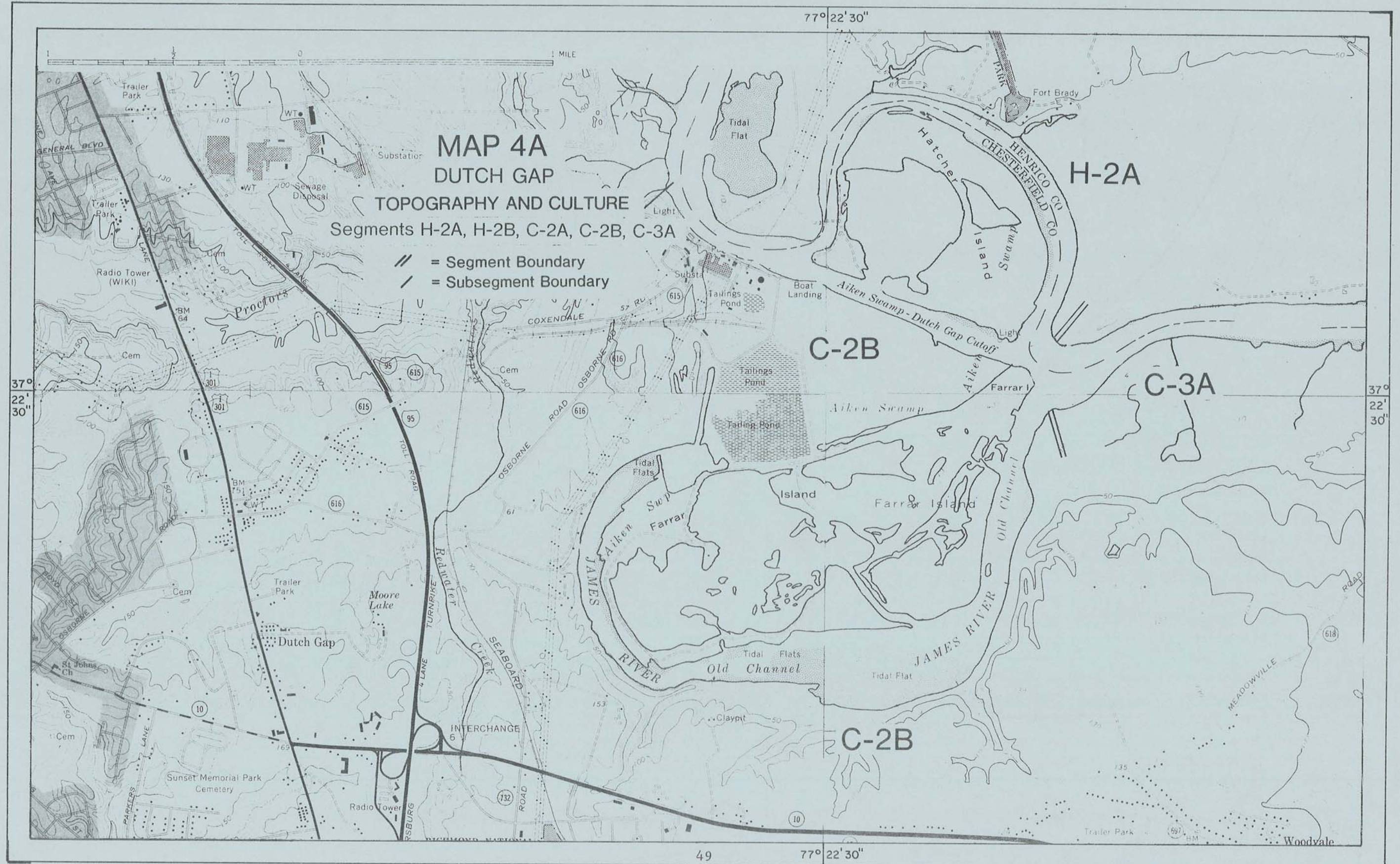
37°
27'
30"

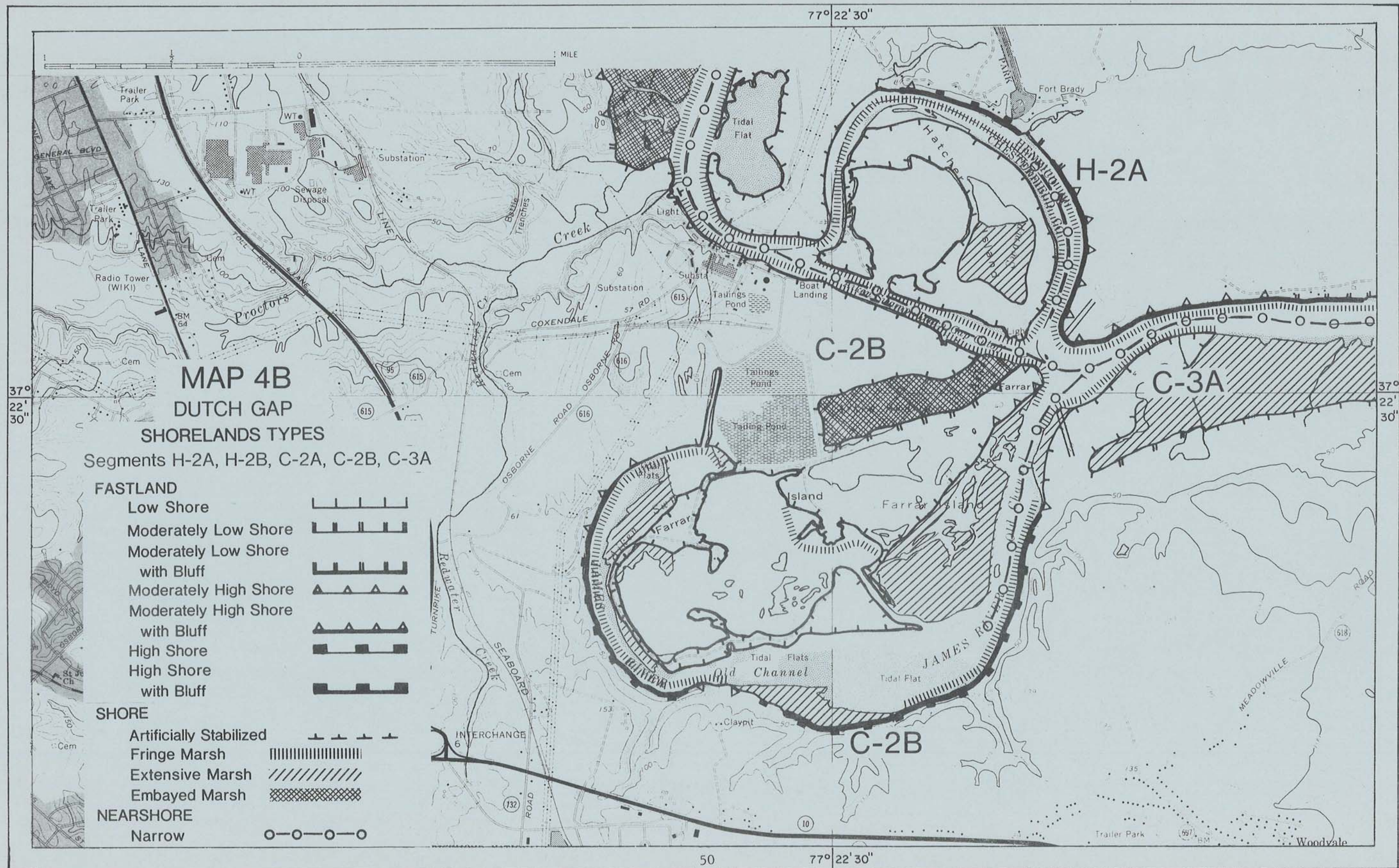
84

77° 25'

37°
27'
30"

77° 25'





MAP 4C

DUTCH GAP

FASTLAND USE, OWNERSHIP, EROSION

Segments H-2A, H-2B, C-2A, C-2B, C-3A

USE

Agricultural	A
Industrial	I
Recreational	RC
Residential	RS
Unmanaged	
Wooded	W

OWNERSHIP

Private	1
Federal	2

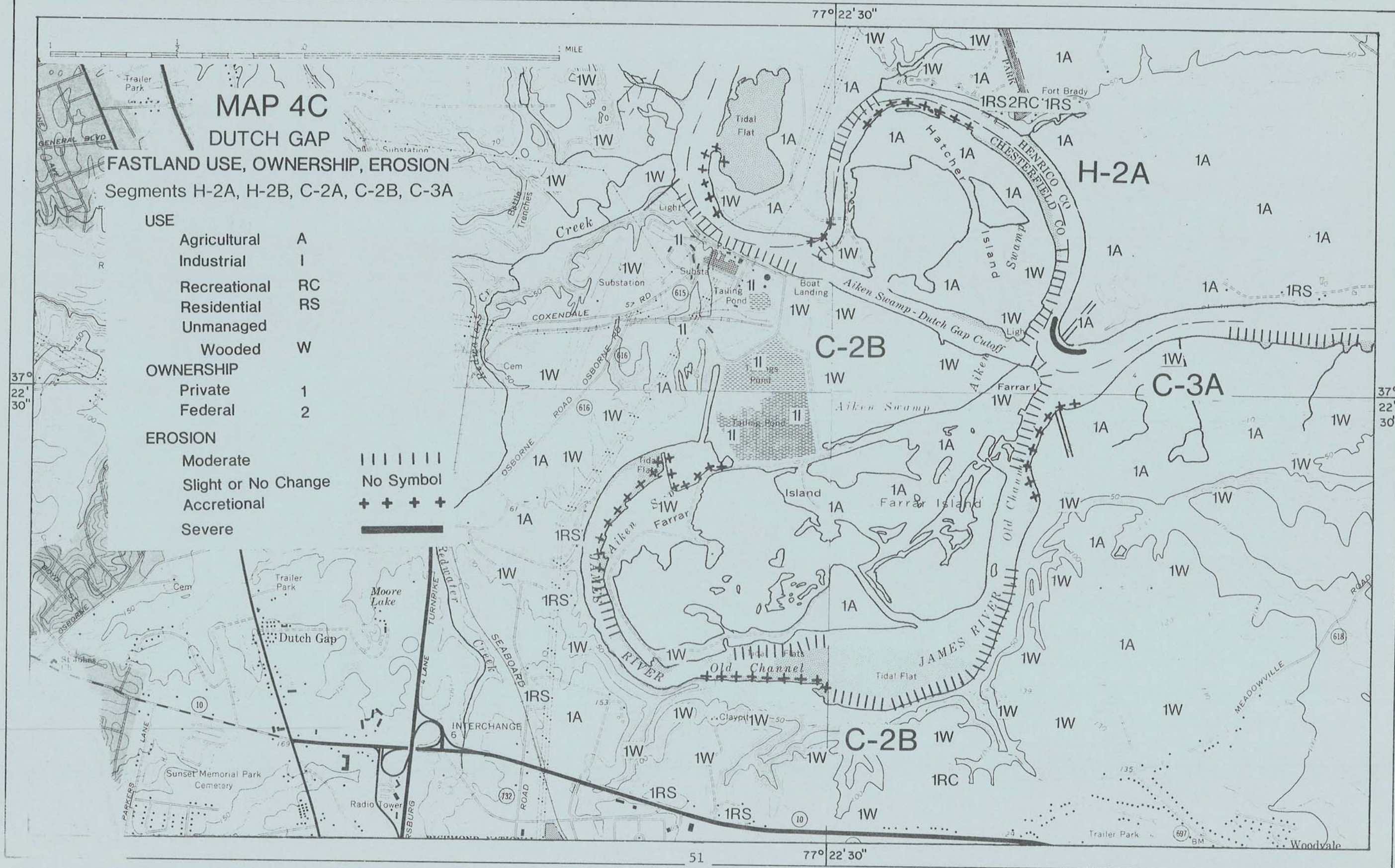
EROSION

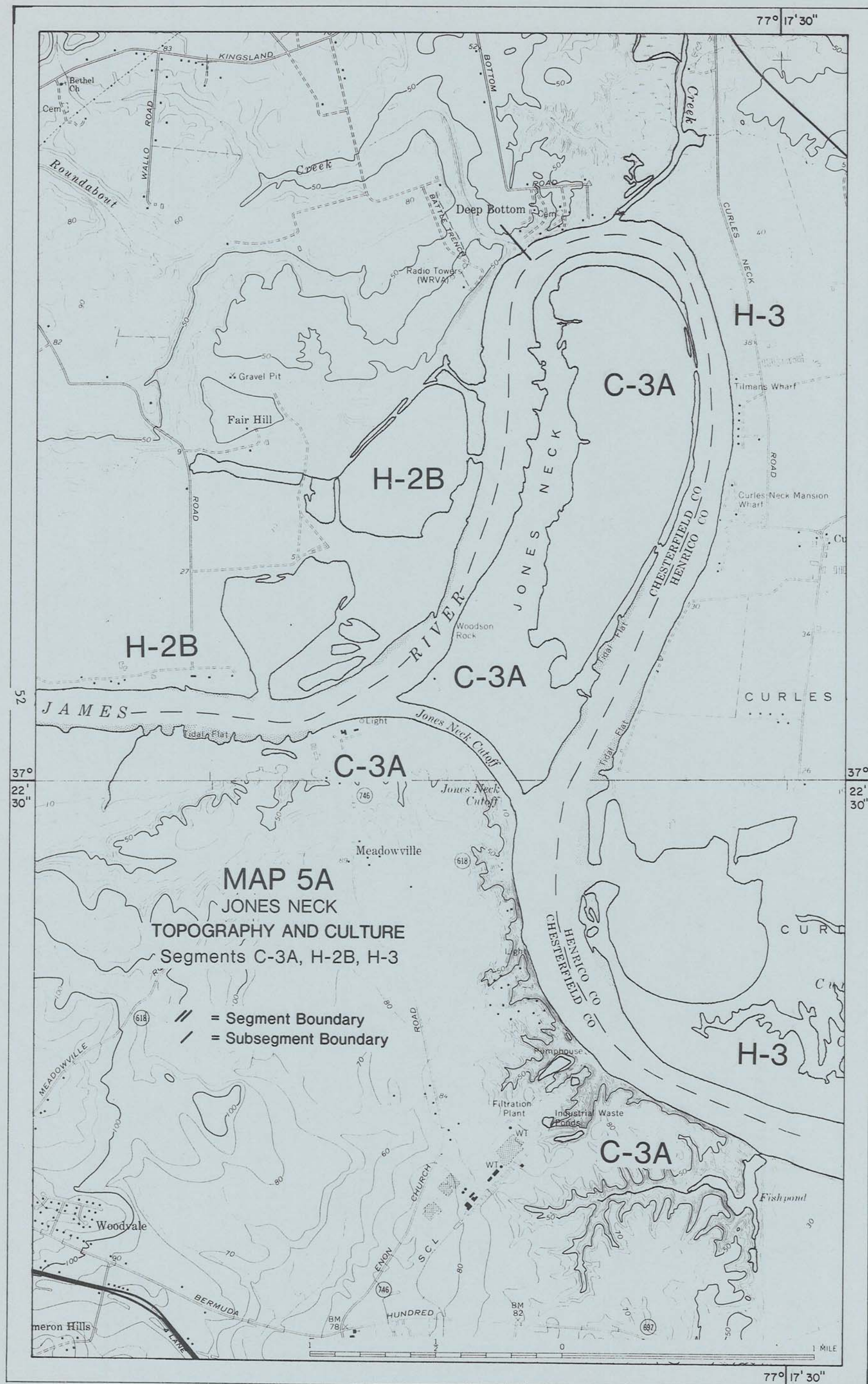
Moderate	
Slight or No Change	No Symbol
Accretional	+++++
Severe	—————

No Symbol

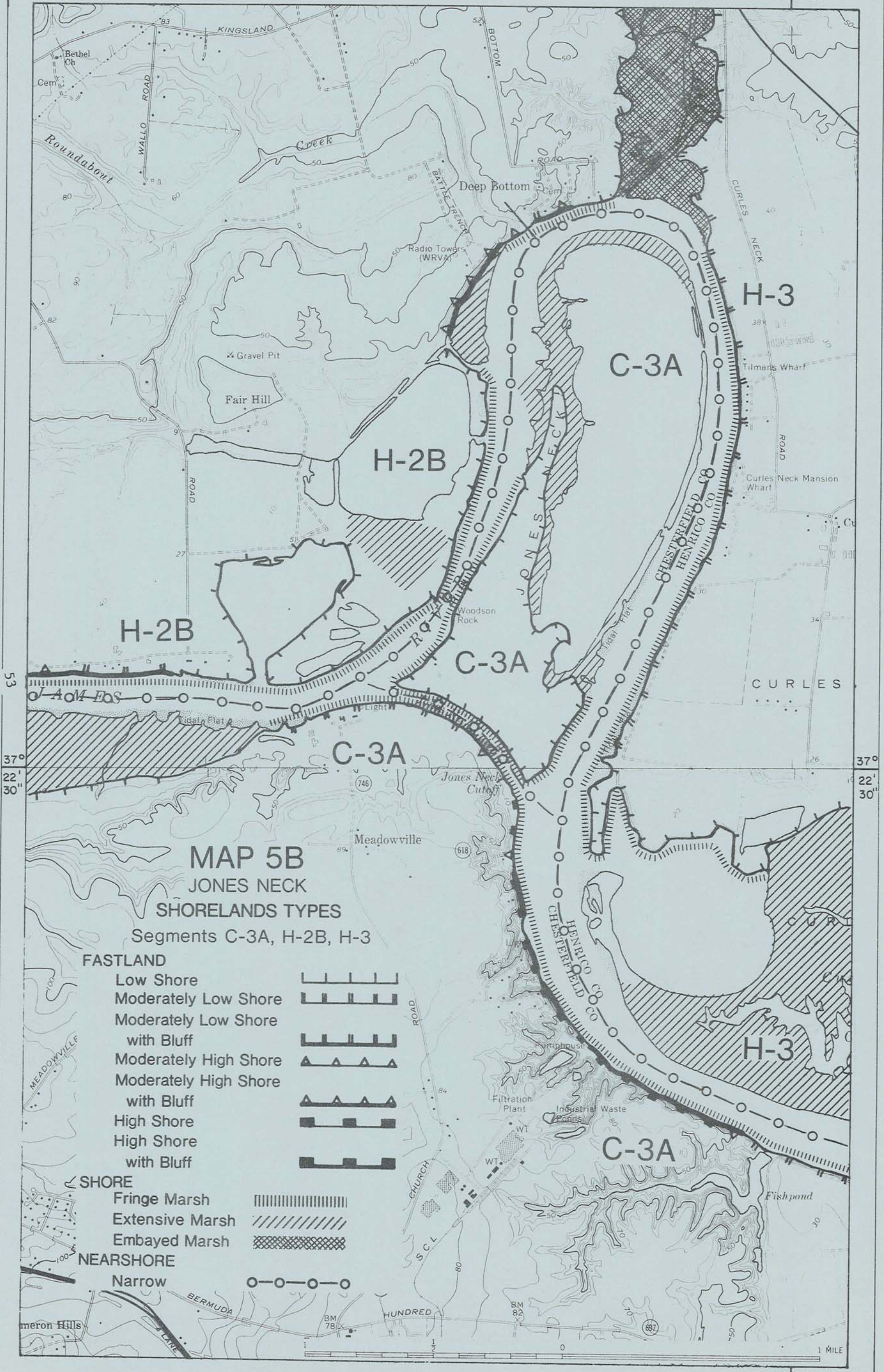
+++++

—————

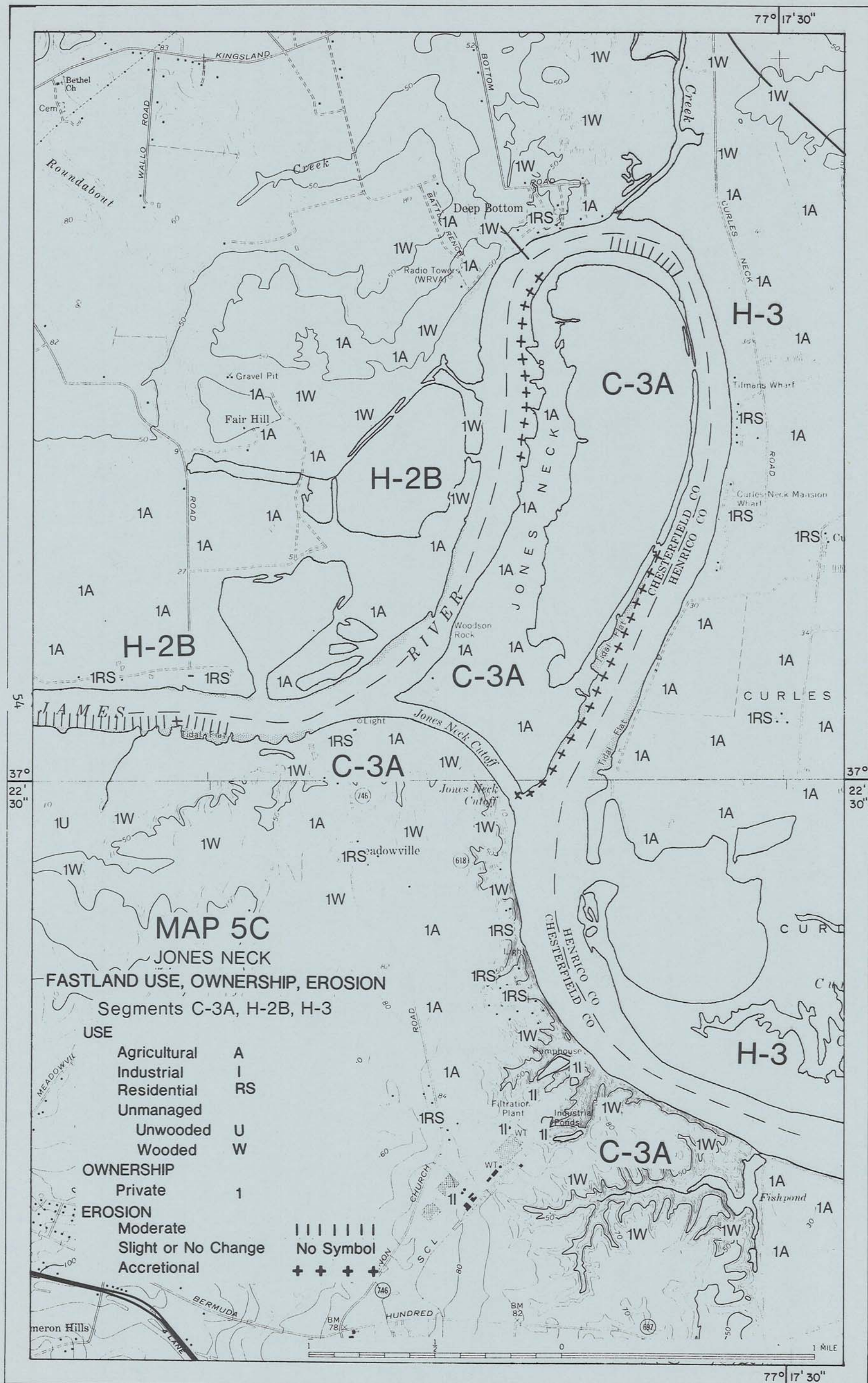


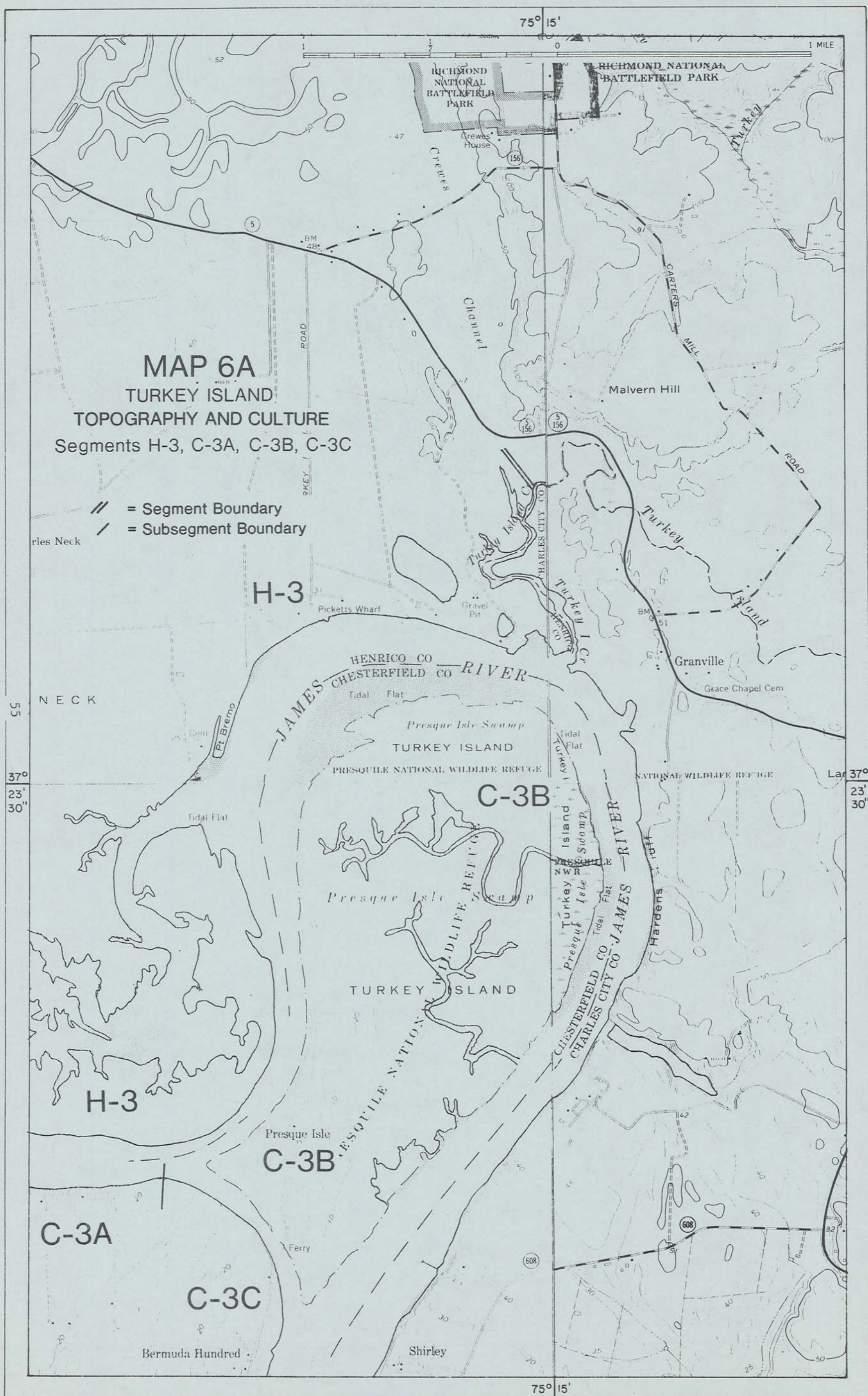


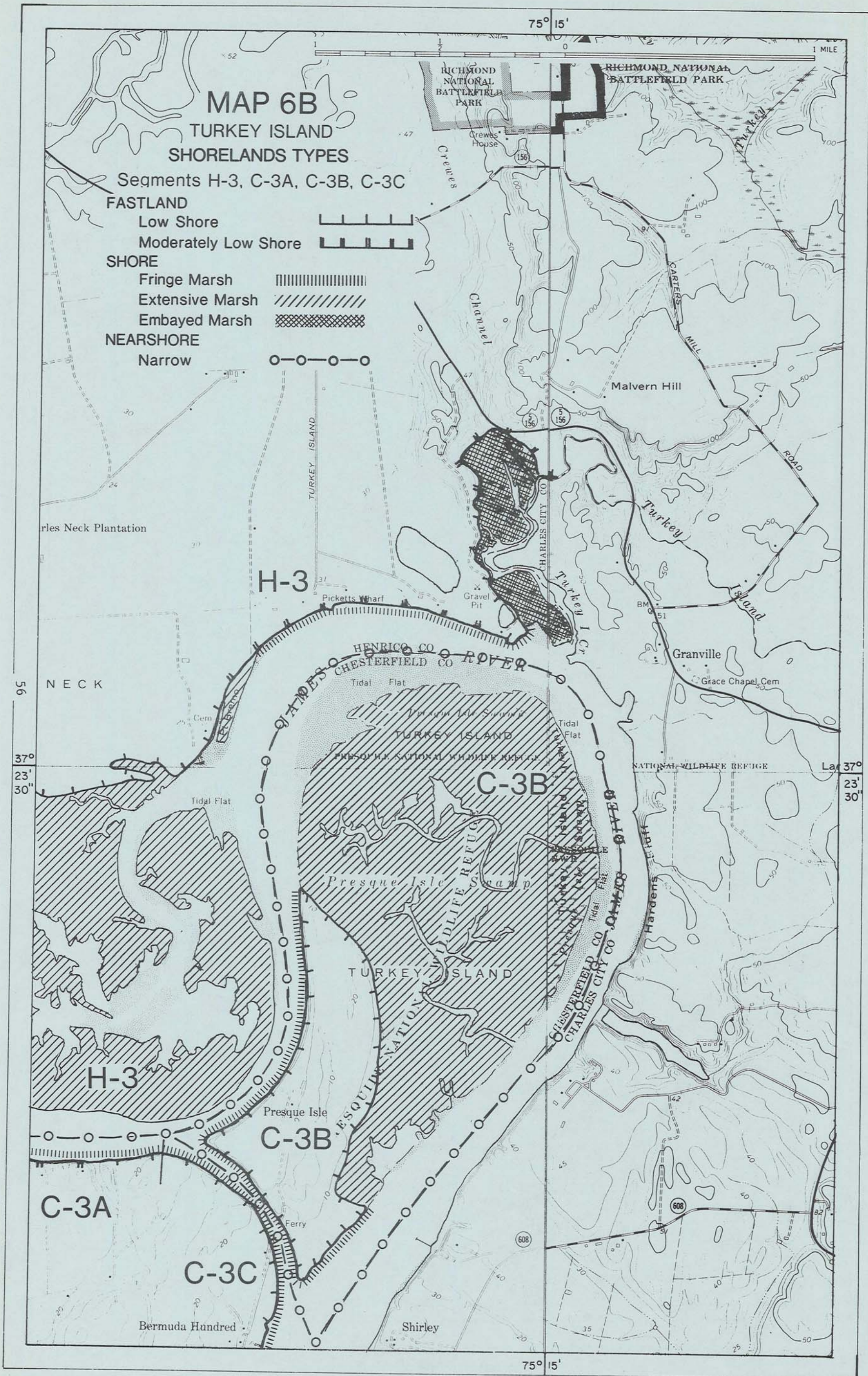
77° 17' 30"

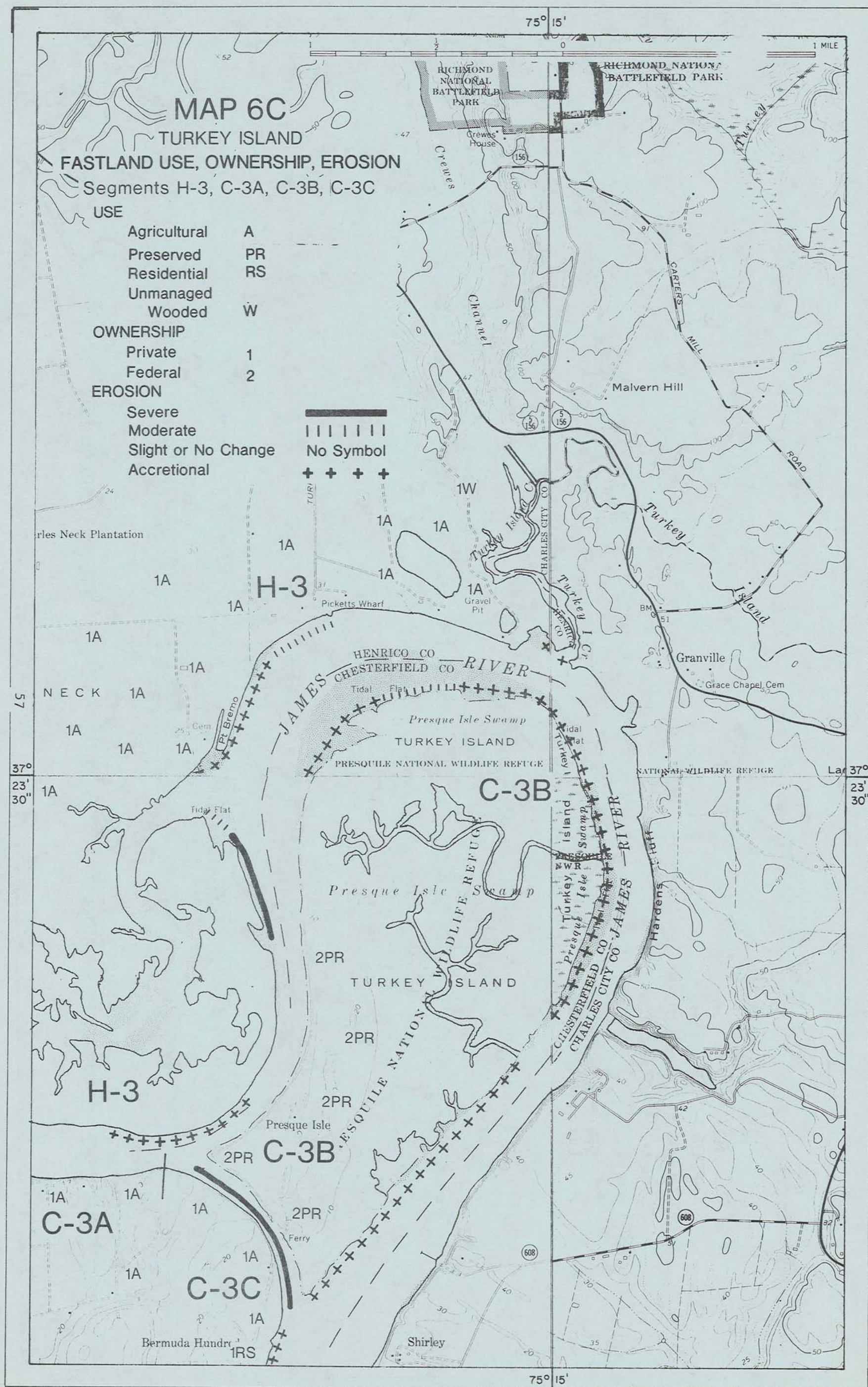


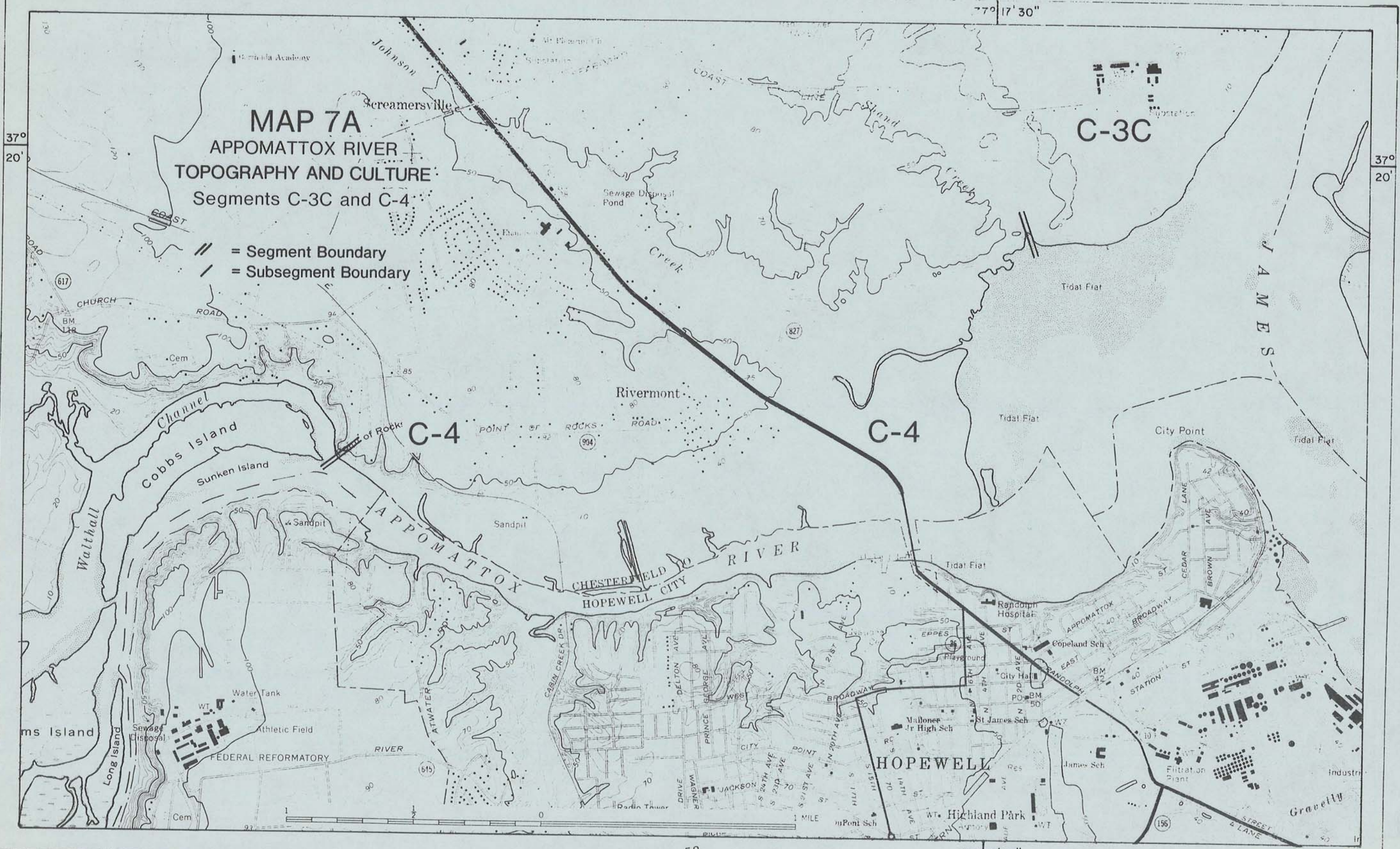
77° 17' 30"











MAP 7B

APPOMATTOX RIVER

SHORELANDS TYPES

Segments C-3C and C4

FASTLAND

Low Shore

Moderately Low Shore

Moderately High Shore

Moderately High Shore

with Bluff

High Shore

High Shore

with Bluff

SHORE

Fringe Marsh

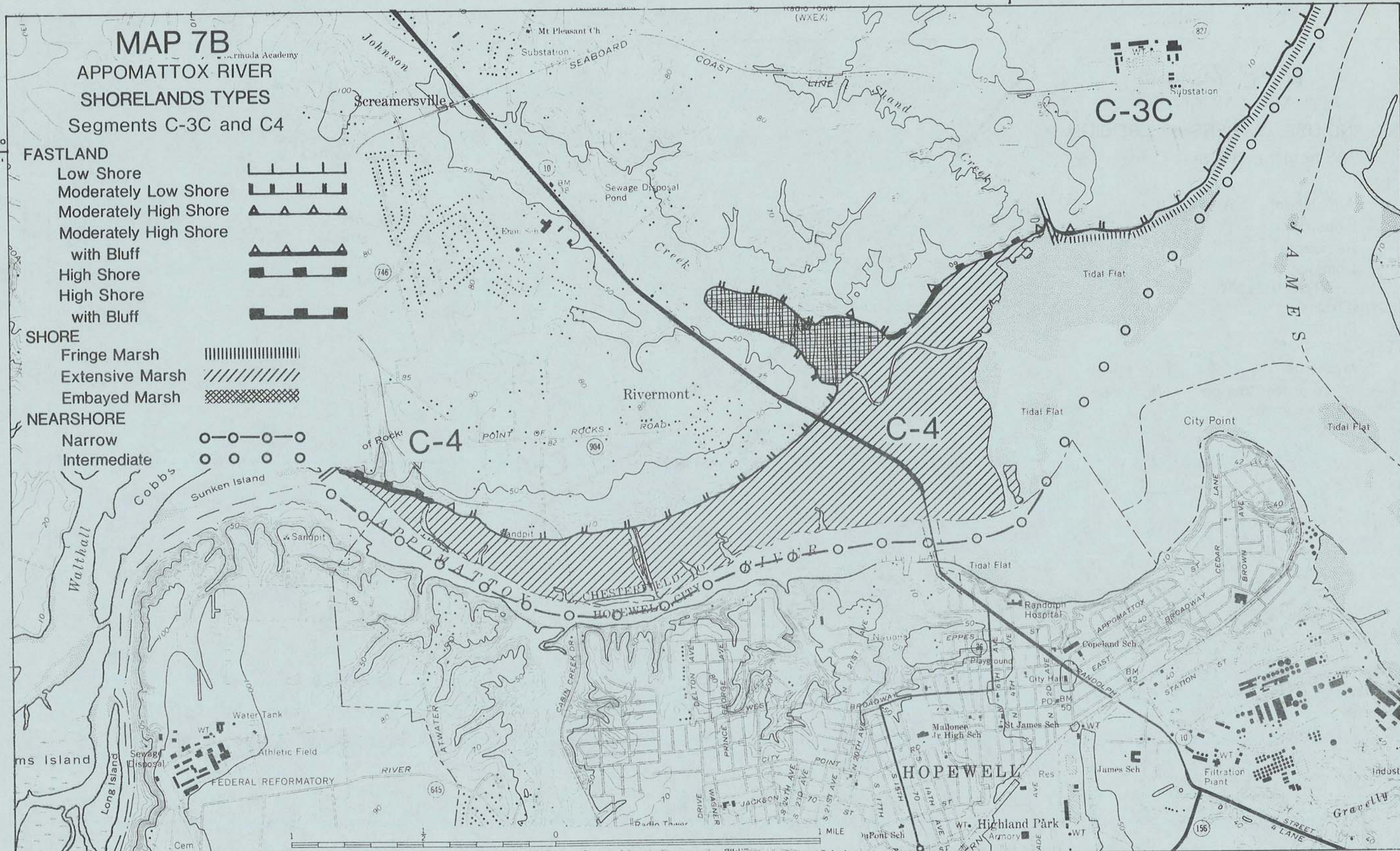
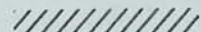
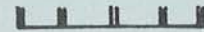
Extensive Marsh

Embayed Marsh

NEARSHORE

Narrow

Intermediate



MAP 7C

APPOMATTOX RIVER

FASTLAND USE, OWNERSHIP, EROSION

Segments C-3C and C-4

USE

Agricultural	A
Industrial	I
Residential	RS
Unmanaged	
Wooded	W

OWNERSHIP

Private	1
---------	---

EROSION

Moderate	
Slight or No Change	No Symbol

