I.5.B.

COMPREHENSIVE COASTAL INVENTORY PROGRAM

FINAL REPORT

VOLUME I

Coastal Inventory Program
Commonwealth of Virginia

and

Tidal Rivers Inventory Project
Coastal Resource Management Program
Grant No. NA89AA-D-CZ134
Task 2A
Grant No. NA88AA-D-CZ091

COASTAL ZONE
INFORMATION CENTER

Compiled by

Marcia R. Berman
J. Berchman Smithson

Under the Direction of

Dr. Suzette M. Kimball
Dr. Carl H. Hershner, Jr.

Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Submitted To

Virginia Council on the Environment
Richmond, Virginia

Virginia. Coastal Zone Management Program

GC
1018
.C66
1991
v.1

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

Property of CSC Library

COMPREHENSIVE COASTAL INVENTORY PROGRAM

FINAL REPORT

VOLUME I

Coastal Inventory Program
Commonwealth of Virginia

and

Tidal Rivers Inventory Project
Coastal Resource Management Program
Grant No. NA89AA-D-CZ134
Task 2A
Grant No. NA88AA-D-CZ091

U.S. DEPARTMENT OF COMMERCE NOAA
COASTAL SERVICES CENTER
2234 SOUTH HOBSON AVENUE
CHARLESTON, SC 29405-2413

Compiled by

Marcia R. Berman
J. Berchman Smithson

Under the Direction of

Dr. Suzette M. Kimball
Dr. Carl H. Hershner, Jr.

Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Submitted To

Virginia Council on the Environment
Richmond, Virginia

GC1018 .C66 1991 V.1
24841936
APR 21 1997

VOLUME I.

TABLE OF CONTENTS

VOLUME I.

ACKNOWLEDGEMENTS i
EXECUTIVE SUMMARY ii

CHAPTER PAGE

1. INTRODUCTION 1

2. VIMS SHORELINE COVERAGE 6

3. VMRC SHORELINE COVERAGE 60

4. MAPPING SCALES 136

5. VIDEO COVERAGE 144

6. AERIAL IMAGERY 145

7. FLIGHT LINE COVERAGE 162

VOLUME II.

8. 1989 SHORELINE COVERAGE 1

9. SHORELINE STABILIZATION COVERAGE 8

10. SEDIMENT SAMPLE COVERAGE 21

11. TIDAL MARSH INVENTORY COVERAGE 69

12. LEFT/RIGHT BANK COVERAGE 108

13. RIVER REACH INFORMATION COVERAGE 111

14. PROCEDURE FOR ANALYZING THE HISTORICAL CHANGE IN SHORELINE POSITIONS 143

15. PROCEDURE FOR ANAYZING THE EFFECTS OF LANDUSE ON VEGETATED WETLANDS 146

16. PROCEDURE FOR ANALYZING THE SPATIAL AND TEMPORAL CHANGES IN WETLAND SPECIES 161

APPENDIX I 167

APPENDIX II 172

LIST OF FIGURES

FIGURE PAGE

1. Virginia Marine Resources Commission Shoreline Map Index 61

LIST OF TABLES

TABLE		PAGE
1.	Shoreline Stabilization Structures, Westmoreland County - L6452540	12
2.	Shoreline Stabilization Structures, Westmoreland County - R6452540	13
3.	Shoreline Stabilization Structures, Westmoreland County - L6302560	15
4.	Shoreline Stabilization Structures, Westmoreland County - L6602540	17
5.	Shoreline Stabilization Structures, Westmoreland County - L6602520	19
6.	Shoreline Stabilization Structures, Westmoreland County - R6602520	20
7a.	Sediment Survey Data - Grain Size Percentages Westmoreland County - Foreshore	46
7b.	Sediment Survey Data - Grain Size Statistics Westmoreland County - Foreshore	48
8a.	Sediment Survey Data - Grain Size Percentages Westmoreland County - Backshore	50
8b.	Sediment Survey Data - Grain Size Statistics Westmoreland County - Backshore	53
9.	Westmoreland County Foreshore Slope Inventory	54
10a.	Sediment Survey Data - Grain Size Percentages Lancaster County - Foreshore	56
10b.	Sediment Survey Data - Grain Size Statistics Lancaster County - Foreshore	57
11a.	Sediment Survey Data - Grain Size Percentages Lancaster County - Backshore	59
11b.	Sediment Survey Data - Grain Size Statistics Lancaster County - Backshore	60
12.	Lancaster County Foreshore Slope Inventory	62

LIST OF TABLES (continued)

TABLE		PAGE
13a.	Sediment Survey Data - Grain Size Percentages Richmond County - Foreshore	63
13b.	Sediment Survey Data - Grain Size Statistics Richmond County - Foreshore	64
14a.	Sediment Survey Data - Grain Size Percentages Richmond County - Backshore	65
14b.	Sediment Survey Data - Grain Size Statistics Richmond County - Backshore	66
15.	Richmond County Foreshore Slope Inventory	67
16.	Northumberland County Foreshore Slope Inventory	68

APPENDICES

APPENDIX PAGE

1. Completed Topographic Coverages 167

2. High Resolution Shoreline Coverages 172

ACKNOWLEDGEMENTS

This project is funded in part by the Commonwealth of Virginia, and the Virginia Council on the Environment from the Coastal Resource Management Program of the National Oceanic and Atmospheric Administration (Grant numbers NA89AA-D-CZ134 and NA88AA-D-CZ091).

Special thanks to Sharon Dewing, Julie Glover, Anna Kenne, Paula Hill, Martha Craig, and Rebecca Harrison for their laborious efforts digitizing and coding the map coverages. Berch Smithson was responsible for data management, and Gary Anderson and John Posenau provided computer assistance. Sediment samples were collected by Julie Glover, Jim Perry, George Thomas and Angela Bryant. Sediment samples were processed by Cindy Fischler at the VIMS Sediment Laboratory. George Thomas, Carl Hershner, Sr., Bo Dame, Lauro Calliari, Marcia Berman, and Julie Glover were responsible for field surveying efforts. Sharon Dewing, Julie Bradshaw, Martha Craig and Laura Grignano assisted in data entry and delineations.

Dr. Robert Byrne, Scott Hardaway, Adam Frisch, and the staff of the Wetlands Research Program at the Virginia Institute of Marine Science provided data for inclusion in the GIS database.

Additional thanks should be extended to Ruth Hershner and Sylvia Motley for their assistance in the final publication.

EXECUTIVE SUMMARY

The Virginia Institute of Marine Science has completed the first year of a long-term project designed to map and catalog various components of the 5,000 miles of tidal shoreline in Virginia. Initial investigations have focused on the geographic region bounded by the Potomac and Rappahannock Rivers (Northern Neck). Information pertaining to shoreline positions, recent changes in shoreline positions, boundaries of tidal and non-tidal wetlands, sediment characteristics, and shore zone slope measurements have been collected, digitized, and sorted in a vector-based geographic information system (GIS) and analyzed to determine regional patterns of shore zone characteristics. In addition, concomitant studies performed under the aegis of the ongoing Tidal Rivers Inventory Project have demonstrated the utility of these data to address management issues pertaining to natural pressures, such as potential sea level rise, and anthropogenic pressures created by development in the coastal zone. This report represents the combined efforts of the two programs; the Coastal Inventory Program and the Tidal Rivers Inventory Project, together known as the Comprehensive Coastal Inventory Program.

CHAPTER I. INTRODUCTION

I. INTRODUCTION

Background.

The activities incorporated in the Comprehensive Coastal Inventory are the result of a union of two programs, each in support of initiatives advanced by either the Executive Office or the General Assembly. One activity is the development of the Tidal Rivers component of the ECOMAPS project, managed by the Council on the Environment and designed for broadscale use in state and local resource management. The second activity is a Coastal Inventory in support of policy issues relevant to the management of tidal shoreline erosion. The union of these programs has occurred because of the galvanizing effect of the the 1988 Chesapeake Bay Preservation Act, which addresses land use management in Tidewater Virginia to protect the water quality and habitats of the Chesapeake Bay estuarine system.

The Tidal Rivers Inventory Project was initiated in 1987 with funding from NOAA/CZM via the Virginia Council on the Environment. This activity, a subset of the larger-focus ECOMAPS Program, directed by the Council on the Environment, addresses the estuarine and tidal freshwater environments. Initial phases of the Tidal Rivers Project have been devoted to the development of an integrated data base within the framework of a computerized geographic information system (GIS) in support of the needs of resource planners and managers. Achievements within the first two years of the Tidal Rivers Initiative have been documented in a series of annual final reports. Through this activity, the importance was demonstrated of a state-wide GIS capability to examine the spatial relationships between environmental and cultural attributes and obtain quantitative data on the interactions among the attributes at any map scale selected.

Concurrent with the Commonwealth's efforts to coordinate a state-wide Virginia Rivers Inventory, House Joint Resolution No. 46 (1986) established the Joint Subcommittee Studying the Commonwealth's Shoreline Erosion Policy to "study whether the Commonwealth's shoreline erosion policy reflects an appropriate balance between the rights of individual property owners and the Commonwealth's responsibility to protect the environment." (House Document No. 41, 1987, p. 3). During a two-year period, the Study Committee examined many of the issues, studied alternate approaches used in other states and recommended some changes in policy. (House Document No. 41, 1987; House Document No. 44, 1988).

Pursuant to those activities, the Study Committee recommended the development of a Coastal Inventory that focused on the physical aspects and natural processes associated with the Commonwealth's tidal shorelines. As part of that inventory, the Committee also recognized the need to establish a methodology for determining the boundaries of lands that may be in state ownership. In response to a specific request from the Joint Subcommittee, a proposal (House Document No. 44, 1988) for a Coastal Inventory was developed.

In a separate but relevant activity, the 1988 General Assembly passed into law the Chesapeake Bay Preservation Act, the roots of which rest in the recommendations of the Governor's Land Use Roundtable. That act vests in a state/local program the stewardship of the use of lands in Tidewater Virginia such that water quality and habitat value of the Chesapeake Bay estuarine system are protected from further degradation. The program is fundamentally dependent on the capabilities of local governments to delineate various ecological and physical parameters in coastal reaches and to evaluate the responses of these areas to various natural and anthropogenic stresses.

The primary focus of a Coastal Inventory, as proposed to the General Assembly, is to delineate environmentally sensitive areas for management considerations. The Study Committee recognized the utility of a Coastal Inventory to efforts of several state agencies, including the Chesapeake Bay Local Assistance Department; boards and commissions, including the Chesapeake Bay Local Assistance Board and the Board for the Conservation and Development of Public Beaches; and the partner localities of Tidewater Virginia. Throughout all discussions there remained the concept that the Coastal Inventory and the Tidal Rivers Inventory are strongly linked in terms of intent, goals, and methodology. In fact, these efforts are seen each as a part of the total ECOMAPS Project that will provide additional data layers to the program. As such, standards relating to quality assurance, format, dissemination of information, and regional priorities that have been developed in Richmond by the Council on the Environment are applied to each inventory component.

The Coastal Inventory and the Tidal Rivers Inventory differ in the specific data layers that they seek to delineate. However, they are so strongly interrelated for application of decisions on land use management and the development of critical preservation areas, that they must continue in tandem as a unified Comprehensive Coastal Inventory (CCI). Reporting of activities will henceforth incorporate aspects of both initial programs under the comprehensive program.

General Objective.

The specific objective of the Comprehensive Coastal Inventory is to develop, create, update, and maintain a GIS-format inventory of the Virginia tidal shoreline. The focus will be the delineation of environmentally sensitive zones for shoreline management programs. The flexibility of the GIS base will allow the system to be queried for quantitative assessments of shoreline conditions. Subsequent research efforts may allow the development of causal models from the data base. The following elements are specifically targeted for coverage:

Tidal wetlands inventories
Watersheds
First-order streams
Transportation network
Elevation
Shoreline position (tidal datum)

Shoreline erosion/accretion
Dune/bluff presence and characteristics
General nearshore bathymetry
Nearshore sediment characteristics
General wind and wave climate
Nearshore land use
Distribution of shoreline structures
Land ownership: State and public claims

In addition, it is anticipated that an interface will be developed with other projects in the ECOMAPS Program, including soils information, non-tidal wetlands, shellfish beds, submerged aquatic vegetation and critical habitats.

Specific Objectives: 1989-1990.

* Develop and refine hardware and software capabilities

* Complete the data-layer coverages of the above-listed parameters for the Northern Neck region: Westmoreland, Lancaster, Richmond, and Northumberland Counties

* Provide a narrated video coverage of current coastal conditions to each of the affected local governments in the Northern Neck region

* Provide digital data sets to the Virginia Rivers Inventory for each of the elements surveyed

* Provide map folios and data descriptions for each layer of data

* Continue to develop a river system analytical framework (Pamunkey)

* Develop procedures to coordinate local needs with specific data

Summary of Results: 1989-1990.

The 1989-1990 data collection effort was limited geographically to the four counties commonly referred to as the Northern Neck: Westmoreland, Lancaster, Richmond, and Northumberland. Data acquisition methodologies, storage and retrieval techniques, and applications software were tested. In addition, field tests were made of surveying and mapping accuracy and tests of the impacts of scale on map precision and replication were completed (ref. Chapter 4). Of the 14 layers of data targeted for eventual inclusion, seven primary coverages were completed in-house. These include:

Tidal wetlands inventories
Shoreline position (3 levels: 1:1,000,000; 1:24,000; 1:5,000)
Shoreline erosion/accretion
Dune/bluff presence and characteristics (qualitative)
Nearshore bathymetry (limited to subaerial and intertidal areas)
Sediment characteristics
Shoreline structures (qualitative)

In addition, nearshore land use and elevation data have been supplied by the Department of Conservation and Recreation, Division of Soil and Water Conservation, so that the linkage between data collected for this program and those collected through the VIRGIS mapping effort may be established. First order stream and transportation network data were provided through the U.S.G.S. Digital Line Graph database. Quantitative assessments of watershed boundaries, public oyster grounds, and wind and wave climatology are underway. An assessment of state and public claims to coastal lands was completed for Accomack County and will be reported separately.

Selected accomplishments relative to specific task elements are detailed below:

1. Vertical aerial imagery was collected for each of four counties in the Northern Neck: Westmoreland, Lancaster, Northumberland and Richmond. Coverage included all tidal shorelines, to the head of each tidal creek (ref. Chapter 6). Imagery was photographed by VIMS photographers from the VIMS research aircraft (1953 de Haviland Beaver) at a scale of 1:7200 (1"=600'). The imagery will be used to update shoreline positions for calculations of erosion and accretion and to update the wetlands inventories. The 1989 aerial imagery was organized into annotated reference notebooks for each county that explained methodology, flight lines, reference locations, and other information pertinent to the interpretation of the photography.

2. Oblique video imagery was acquired for all tidal shorelines in each of the four Northern Neck counties (ref. Chapter 5). The imagery was filmed at an altitude of 500 ft using 20-minute broadcast quality video cassettes. The tapes have been edited and narration added. The narrative explains basic concepts of shoreline processes and how those processes can be used to provide better management in coastal areas. The specific physical, biological, and anthropogenic conditions of each segment of tidal shoreline are explained.

3. The most important data set that has been acquired for this project is a high-resolution, accurate, baseline shoreline measurement, against which all other data sets are plotted (ref. Chapter 3). The Virginia Marine Resources Commission (VMRC) mapped a high-resolution, double-precision shoreline data set from 1976 aerial photography. Research shows these to be the most accurate shoreline maps currently available in the Commonwealth. Through a cooperative arrangement with the VMRC, these maps have been made available for digitizing and entering into the Comprehensive Coastal Inventory. Digitizing has been completed for the Northern Neck area.

4. Sediment size data and shoreface slope measurements are necessary to forecast potential storm surge incursion and erosion rates as well as provide a data base from which to manage the Commonwealth's sand allocation procedures through the Shoreline Programs Bureau of the Department of Conservation and Recreation. Sediment samples and beach slope measurements have been collected from the subaerial and intertidal beaches at 500-meter intervals along the tidal shorelines, or wherever there is a significant change in sediment size or beach slope (ref. Chapter 10).

5. The extent and characteristics of tidal wetlands in the Northern Neck were digitized from the existing Tidal Marsh Inventory Reports published by the Wetlands Research Program at the Virginia Institute of Marine Science (ref. Chapter 11). Other regions of interest in Tidewater Virginia have also been included in the GIS database (Appendix 1). A system query will produce both maps of wetlands and tables of various attributes associated with each area. In addition, a comparative study was made of changes in wetland areas in King William County over a 38-year time period.

6. The 1981 Shoreline Inventory and subsequent 1985 update, performed by VIMS, maps shoreline type, engineering structures, erosion rates and land use on a reach-by-reach basis. This information has been transferred to an INFO format and has been adapted for use in the Comprehensive Coastal Inventory (ref. Chapter 13). The video and aerial imagery are being used to update this data base. Information included in this data base covers historical, long-term (100-yr) rates of shoreline change, coastal type (bluffs, sandy beaches, wetlands, etc.), shoreline orientation, land use, and structures. These data now provide a solid qualitative data base. In future years, these data will be updated and digitized to provide a basis for quantitative comparisons.

7. Three tests were performed to determine the software capabilities relative to posing possible management scenarios. In one case, the impacts of inundation on tidal wetlands in the Pamunkey River study area due to sea level rise were evaluated (ref. Chapter 16). The second scenario uses aerial imagery and the GIS system to delineate shoreline type versus upland land use, and establishes a method by which the functional value of existing wetlands can be evaluated on a reach by reach basis (ref. Chapter 15). The third test developed the requisite procedures for analyzing rates of shoreline change through a site test (ref. Chapter 14).

8. In order to match shorelines mapped from the recent aerial imagery to the baseline shoreline digitized from the VMRC maps, it is necessary to survey physical features from the imagery and relate those features to control points on the shoreline maps. The Potomac shorelines of Westmoreland county were surveyed using a total station system. This provides very high resolution (0.02 % error) control points. However, the time and cost to produce the survey are prohibitive on a Bay-wide basis within the scope of this project. Surveys using satellite-derived global positioning systems have been researched and demonstrated. These methods are cost-effective and provide accuracy to within 1.5 meters. A cost and efficiency analysis was performed that indicated the desirability of GPS for the applications considered within the scope of this project.

CHAPTER II. VIMS SHORELINE COVERAGE

II. VIMS SHORELINE COVERAGE

The Shoreline Coverage (SHL) is a record of the mean high water shoreline position digitized at a scale of 1:24,000 from the U.S. Geological Survey 7.5 minute topographic map series. The U.S. Geological Survey reports an error of approximately +/- 10 meters in the position of this line. The coverage serves as the base shoreline for subsequent coverages like the Tidal Marsh Inventory (TMI) and Flight Line Coverage (FLL) which are plotted at 1:24,000. Following is documentation pertaining to the SHL coverage and a complete map folio of existing records. Maps are represented here at a scale of 1:68,000 for publication purposes only.

GEOGRAPHIC DATA SET DESCRIPTION

VIMS GIS Lab Prefix SHL

Data Layer Name Tidal Shoreline, Medium Resolution (MLW)

Description Tidal Shoreline digitized at 1:24,000. These follow the 'blue line' shoreline appearing on USGS topos, representing MLW. These coverages are used as the base map for subsequent layers (such as TMI).

Year(s) Collected Latest USGS Topo available

Base Maps used for Digitizing mylar USGS Topo maps

Digitizing Scale 1:24000 Map Projection UTM Zone 18

Geographic Extent Selected areas of Coastal VA., generally the same geographic coverage as the VIMS Tidal Marsh Inventory (TMI) layer.

How Collected (Describe):

Tidal shoreline was followed at operator determined digitizing rate.

Actual/Intended Use or Purpose:

Used as the base coverage for all other coverages digitized at a scale of 1:24,000.

VA TIDAL RIVERS INVENTORY

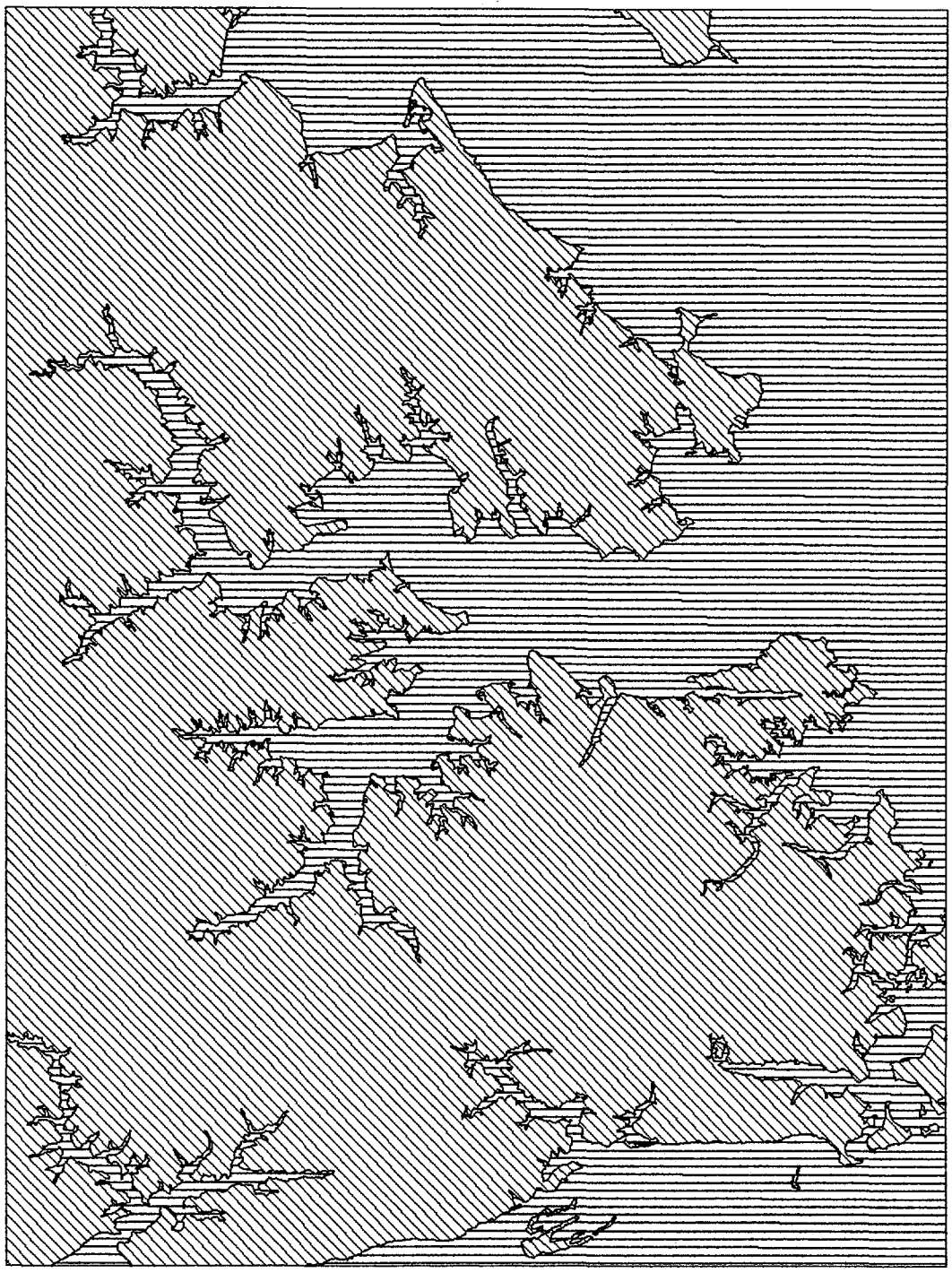
AVERAGE TIME AND DISC SPACE USED*

SHORELINE INVENTORY

MAP NUMBER	TIME	DISC SPACE
SHL5207	7.0	237568
SHL5208	4.0	118784
SHL5210	4.5	69632
SHL5307	4.5	188416
SHL5310	4.0	94208
SHL5407	5.0	212992
SHL5409	2.5	114688
SHL5413	3.5	90112
SHL5414	5.0	102400
SHL5415	4.75	122880
SHL5506	3.5	77824
SHL5507	10.75	278528
SHL5512	13.0	131072
SHL5513	5.0	163840
SHL5514	3.0	94208
SHL5515	1.0	61440
SHL5607	10.75	231424
SHL5610	6.0	73728
SHL5611	1.0	73728
SHL5612	9.0	131072
SHL5613	3.0	73728
SHL5707	5.5	126976
SHL5710	1.75	77824
SHL5711	11.00	139264
SHL5712	3.0	86016
SHL5713	4.0	122880
SHL5802	1.75	81920
SHL5804	15.0	249856
SHL5807	10.0	245760
SHL5808	1.0	26864
SHL5809	7.75	118784
SHL5810	7.0	88920
SHL5811	2.0	40960
SHL5812	4.75	110592
SHL5813	2.5	92160
SHL5814	1.0	61440
SHL5903	20.5	425984
SHL5905	8.0	106696
SHL5907	11.0	409600
SHL5908	7.0	192512
SHL5909	3.75	92160

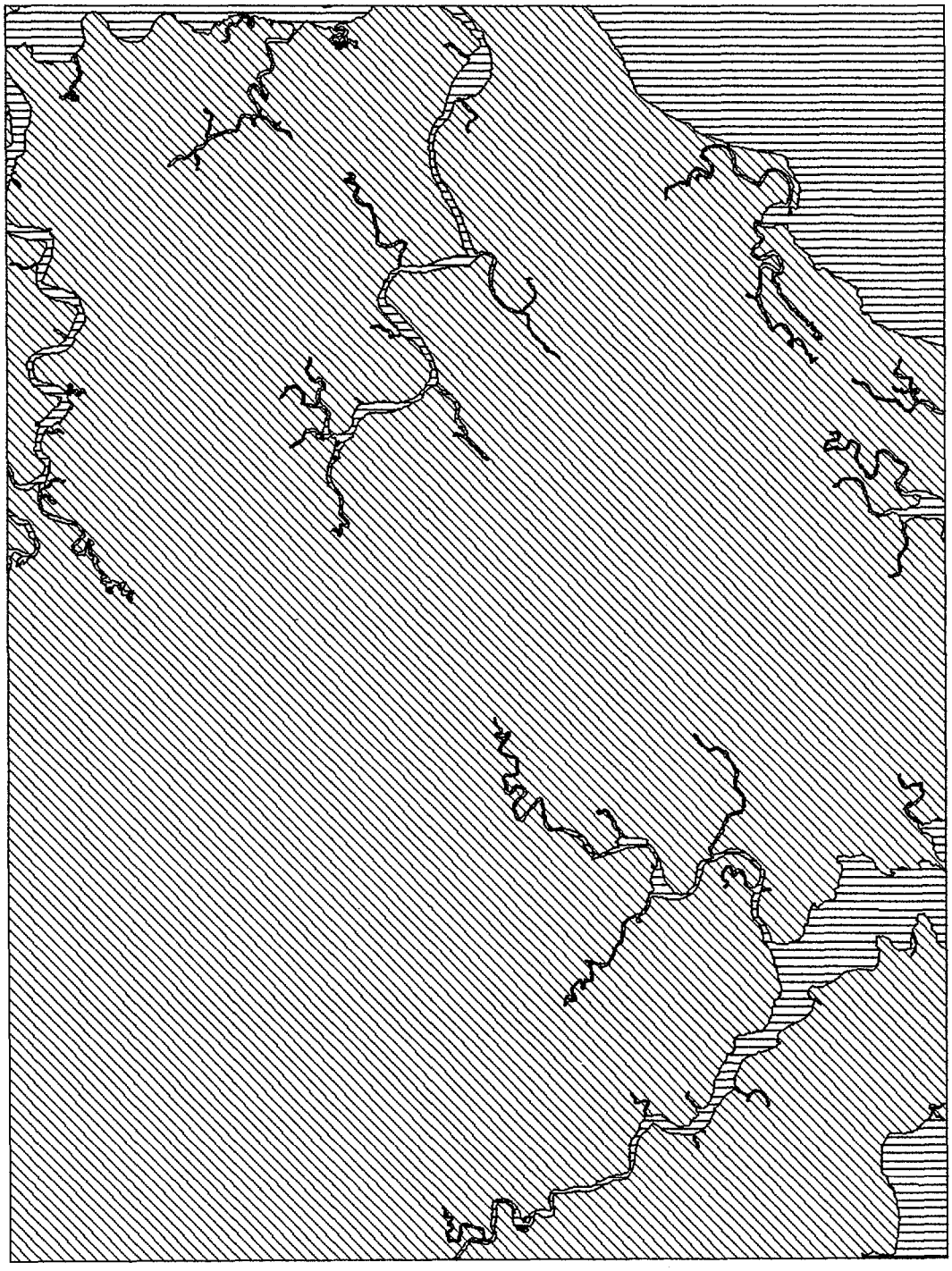
MAP NUMBER	TIME	DISC SPACE
SHL5910	13.0	67584
SHL5911	2.0	36864
SHL5912	18.0	233472
SHL5913	2.0	65536
SHL6006	6.0	245760
SHL6007	11.5	196608
SHL6008	18.5	417792
SHL6009	4.5	71680
SHL6010	7.0	77824
SHL6011	17.25	278528
SHL6012	4.75	192512
SHL6103	11.0	286720
SHL5904	17.00	196608
AVERAGE	6.7	149856.4

* TIME IN HOURS, DISC SPACE IN BYTES



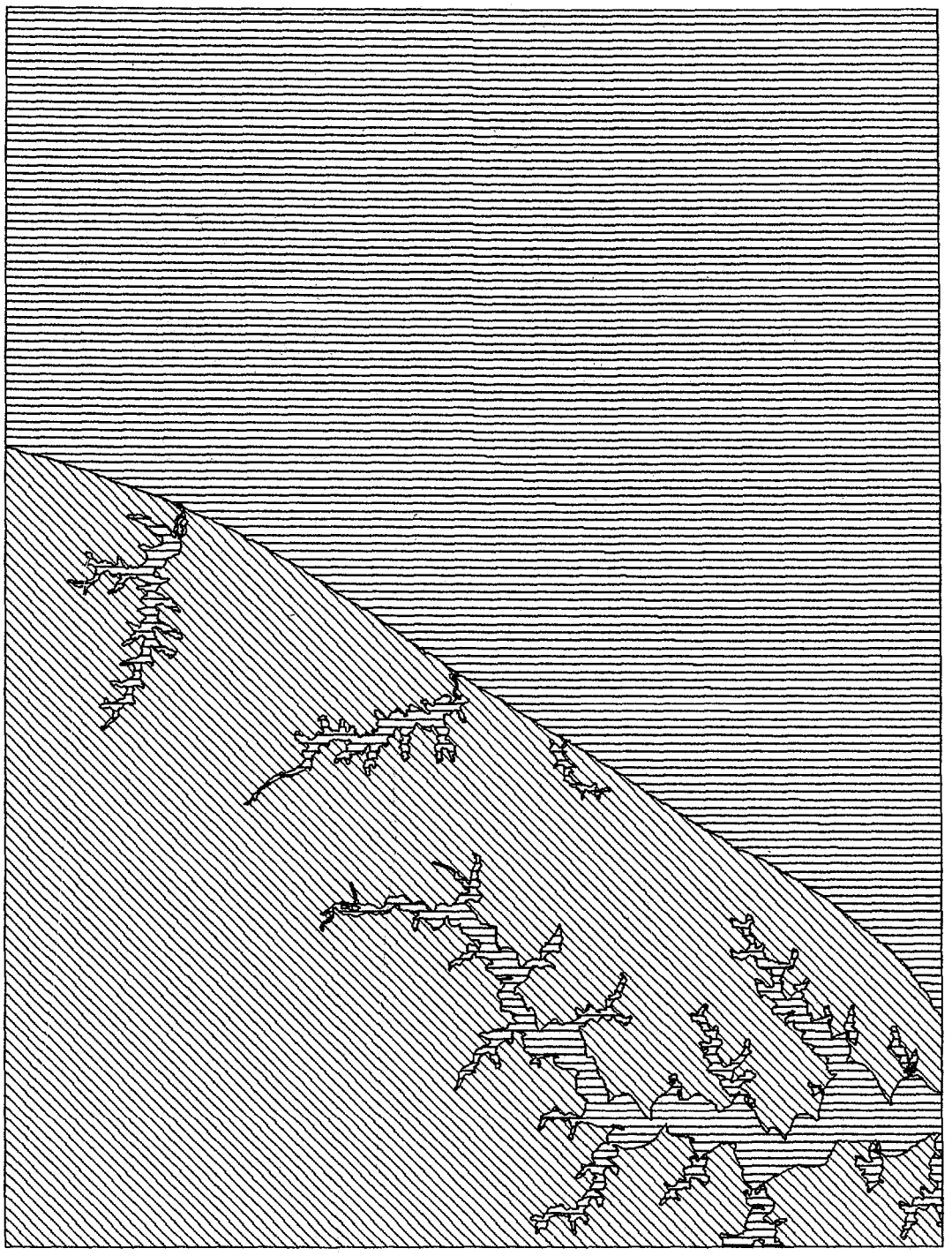
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
ACHILLES
GLOUCESTER CO

SHL5907
UPLAND
WATER



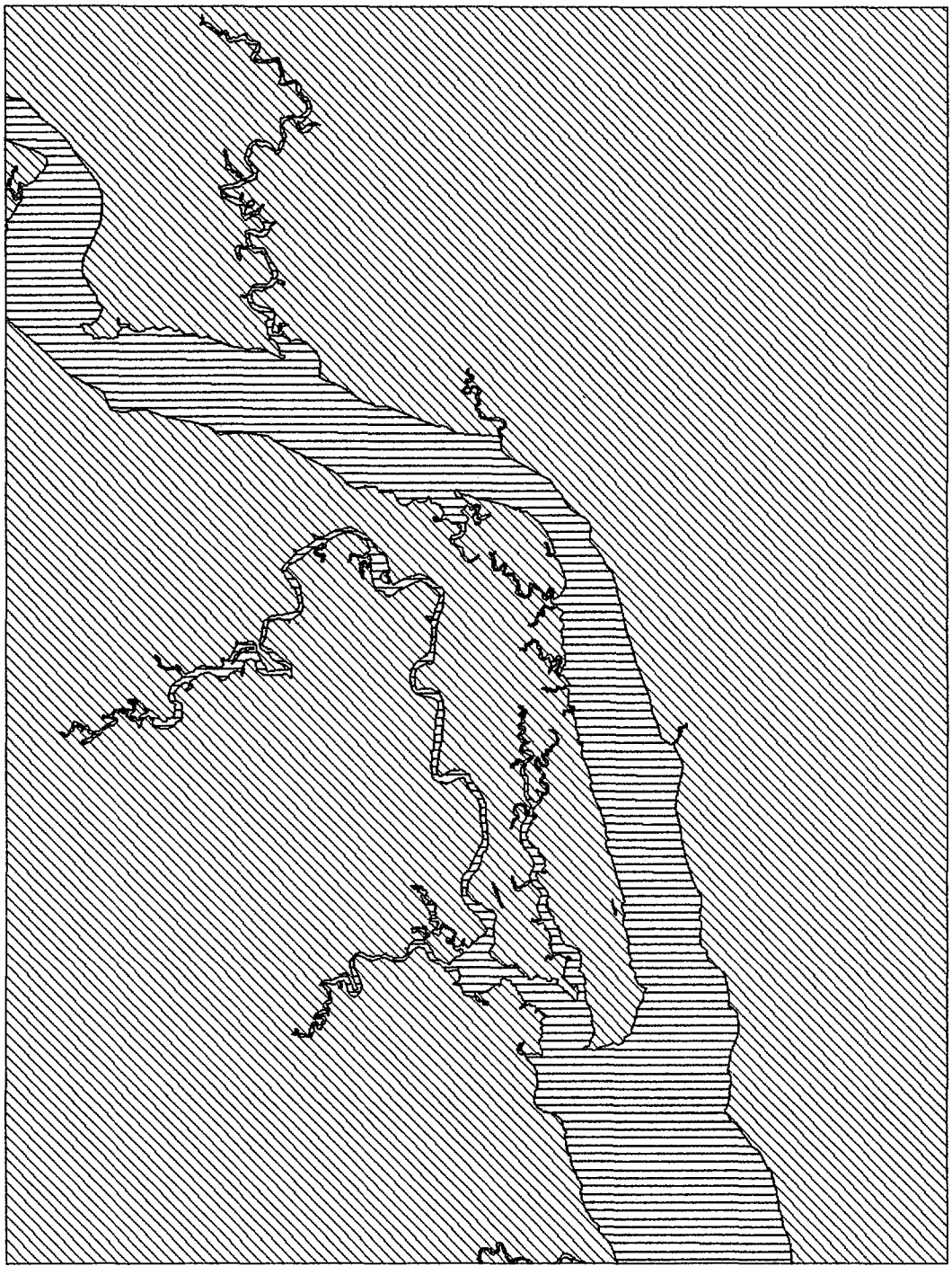
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
BENNS CHURCH
ISLE OF WIGHT CO

SHL5804
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
BURGESS
NORTHUMBERLAND CO

SHL6012
UPLAND
WATER

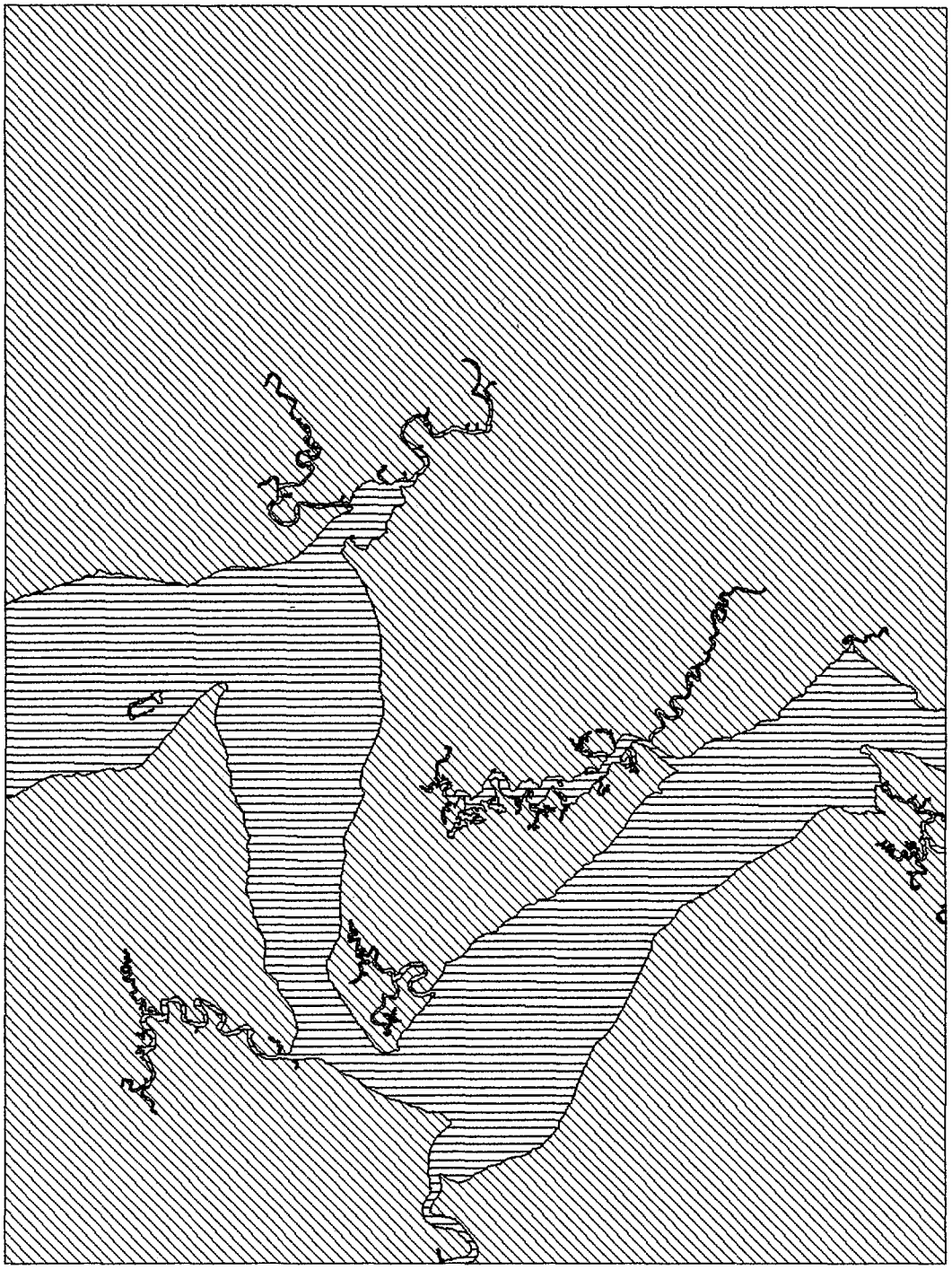


VIMS COASTAL INVENTORIES
1:24000 SHORELINE
CHAMPLAIN
WESTMORELAND CO

SHL5513

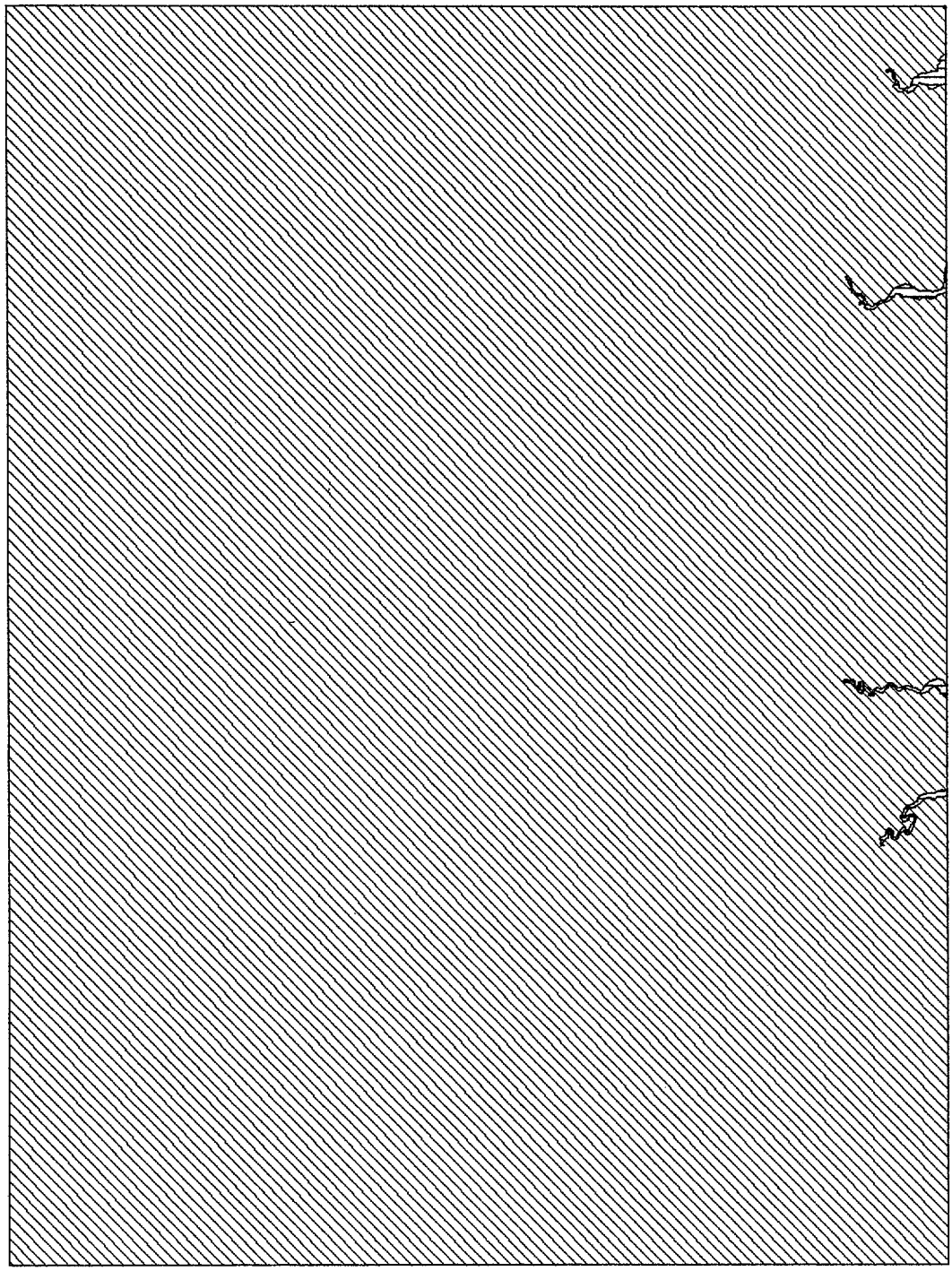
UPLAND

WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
CHARLES CITY
CHARLES CITY COUNTY

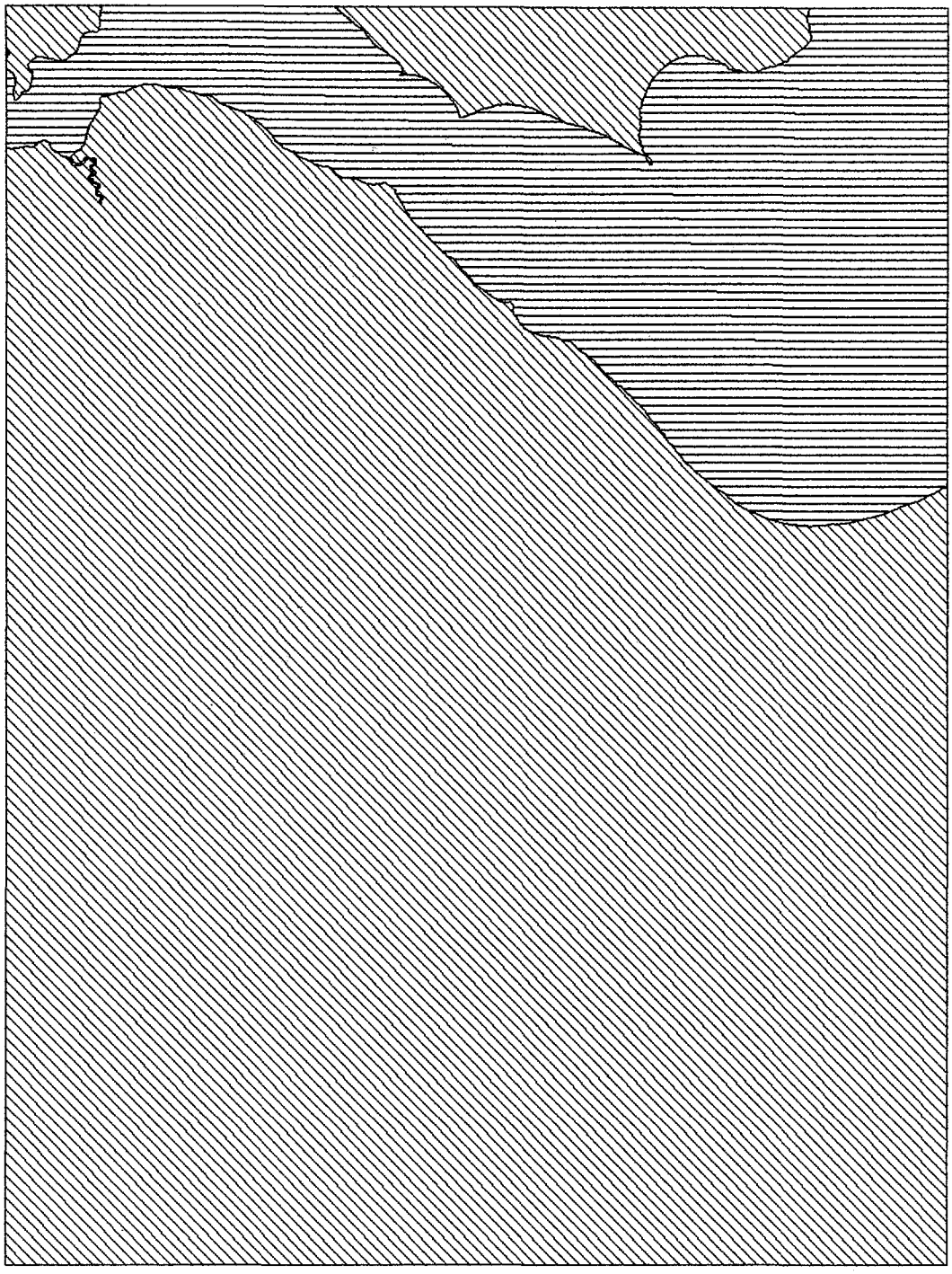
SHL5407
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
CHURCH VIEW
MIDDLESEX CO

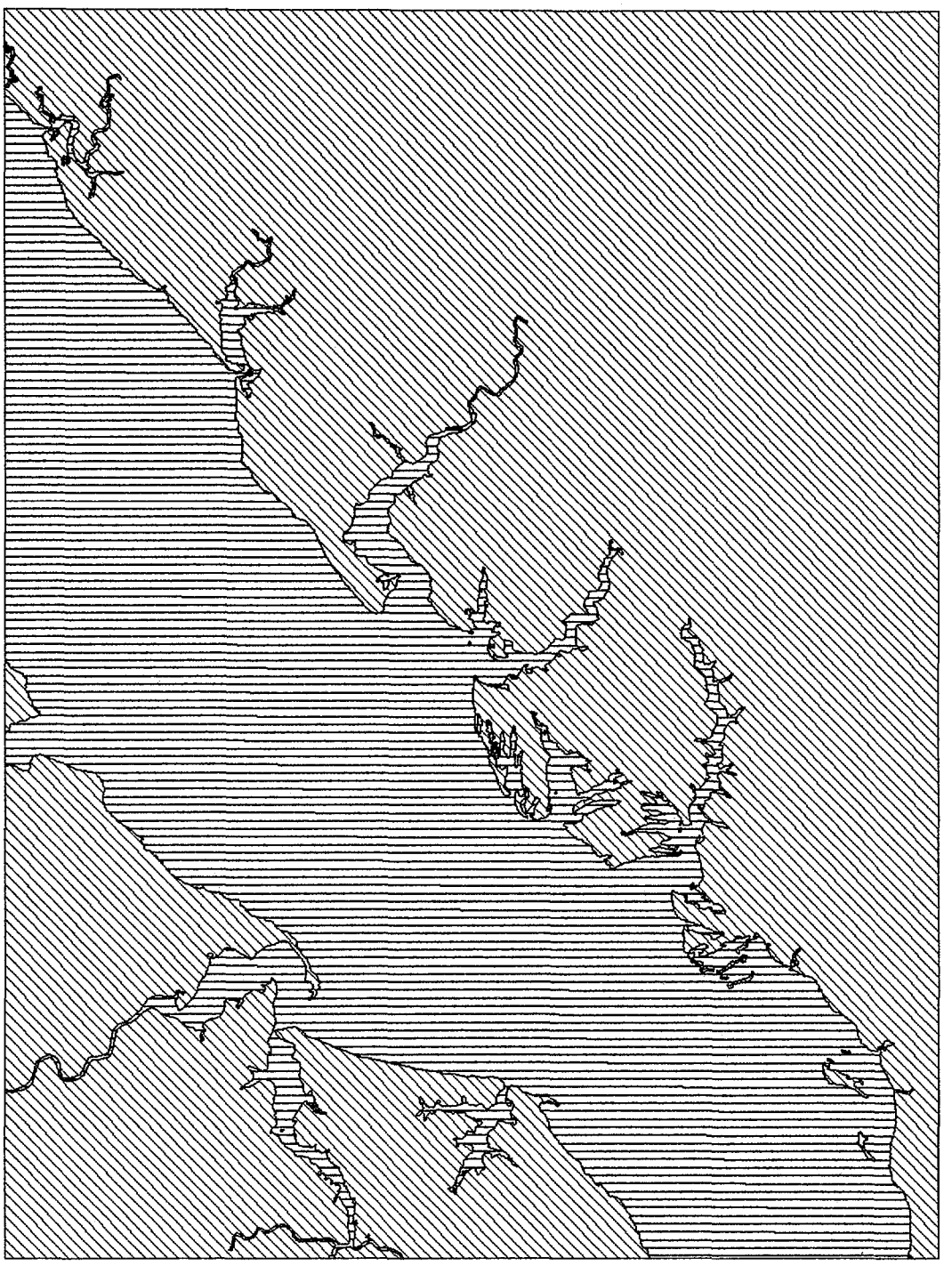
SHL5710

UPLAND
WATER



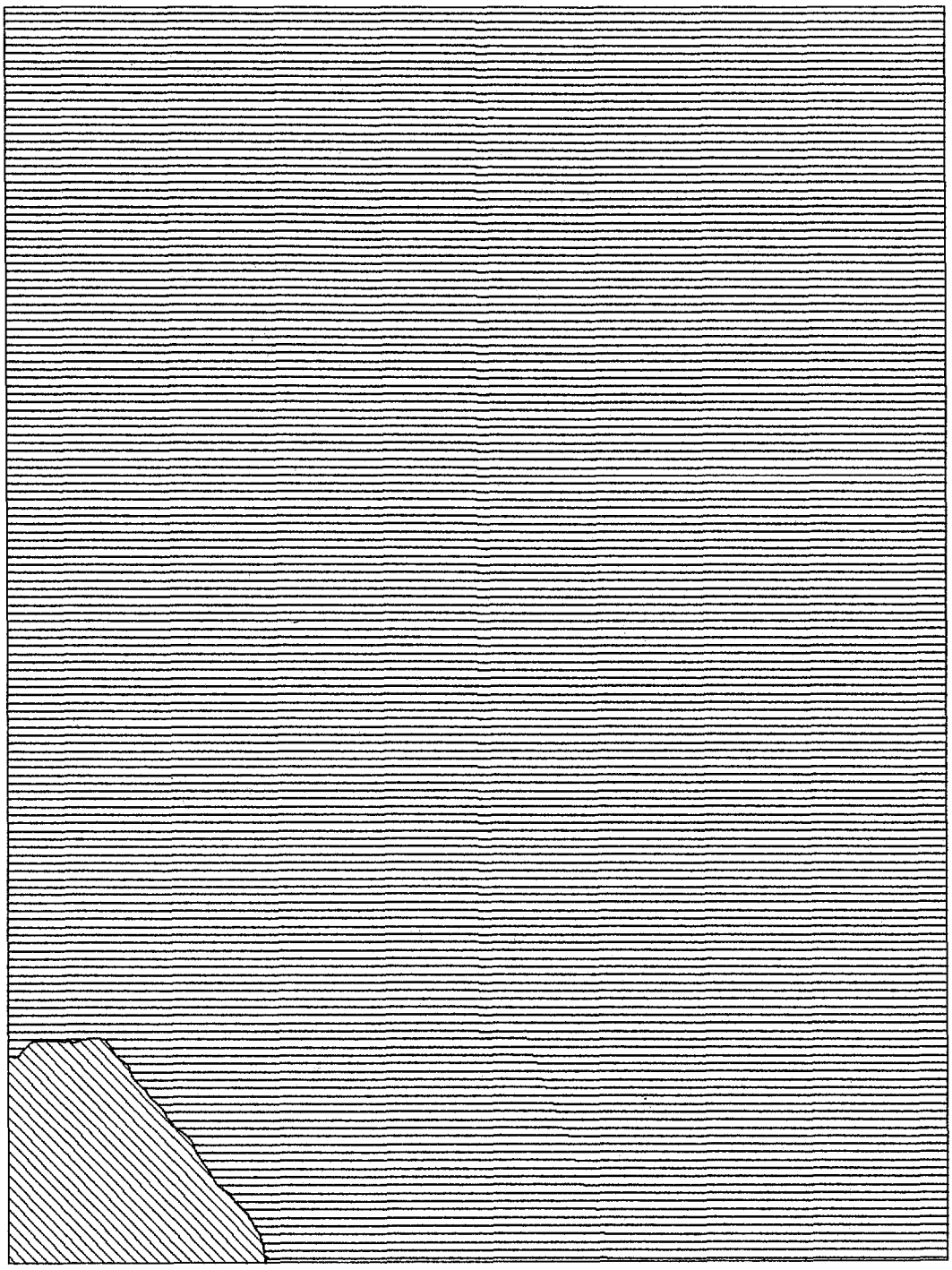
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
CLAREMONT
SURRY COUNTY

SHL5506
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
CLAY BANK
GLOUCESTER COUNTY

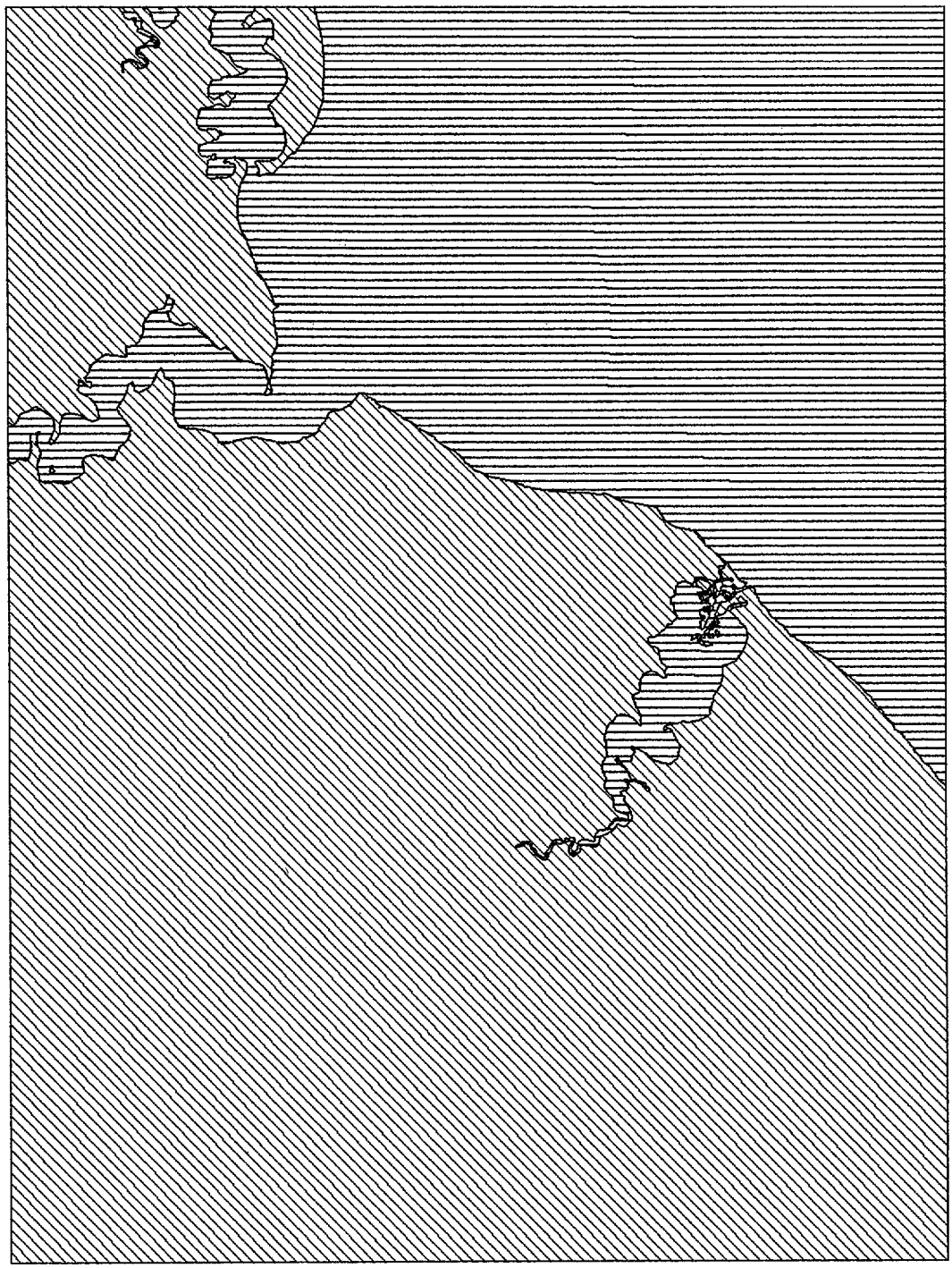
SHL5807
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
COLONIAL BEACH NORTH
WESTMORELAND CO

SHL5515

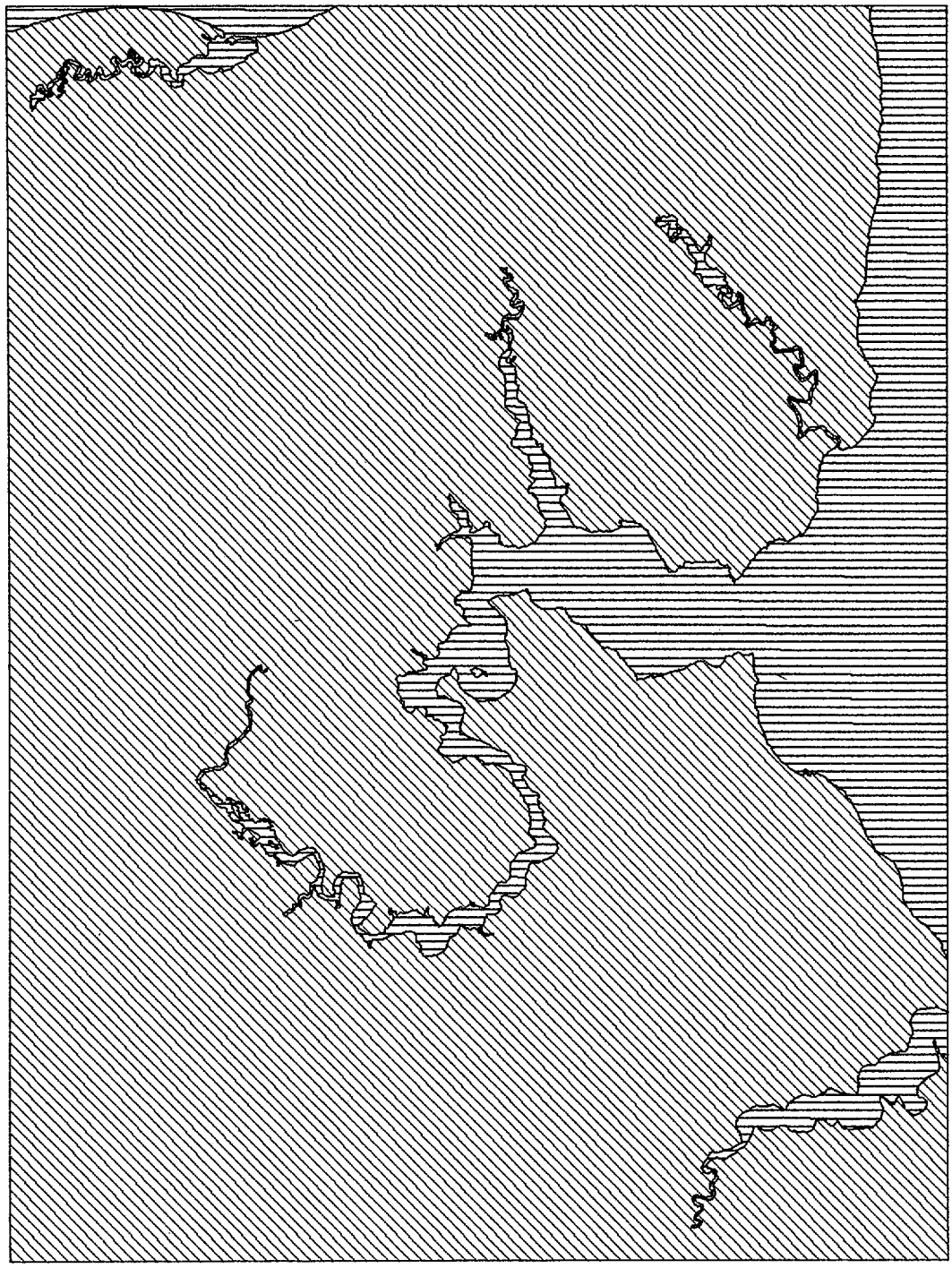
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
COLONIAL BEACH SOUTH
WESTMORELAND CO

SHL5514

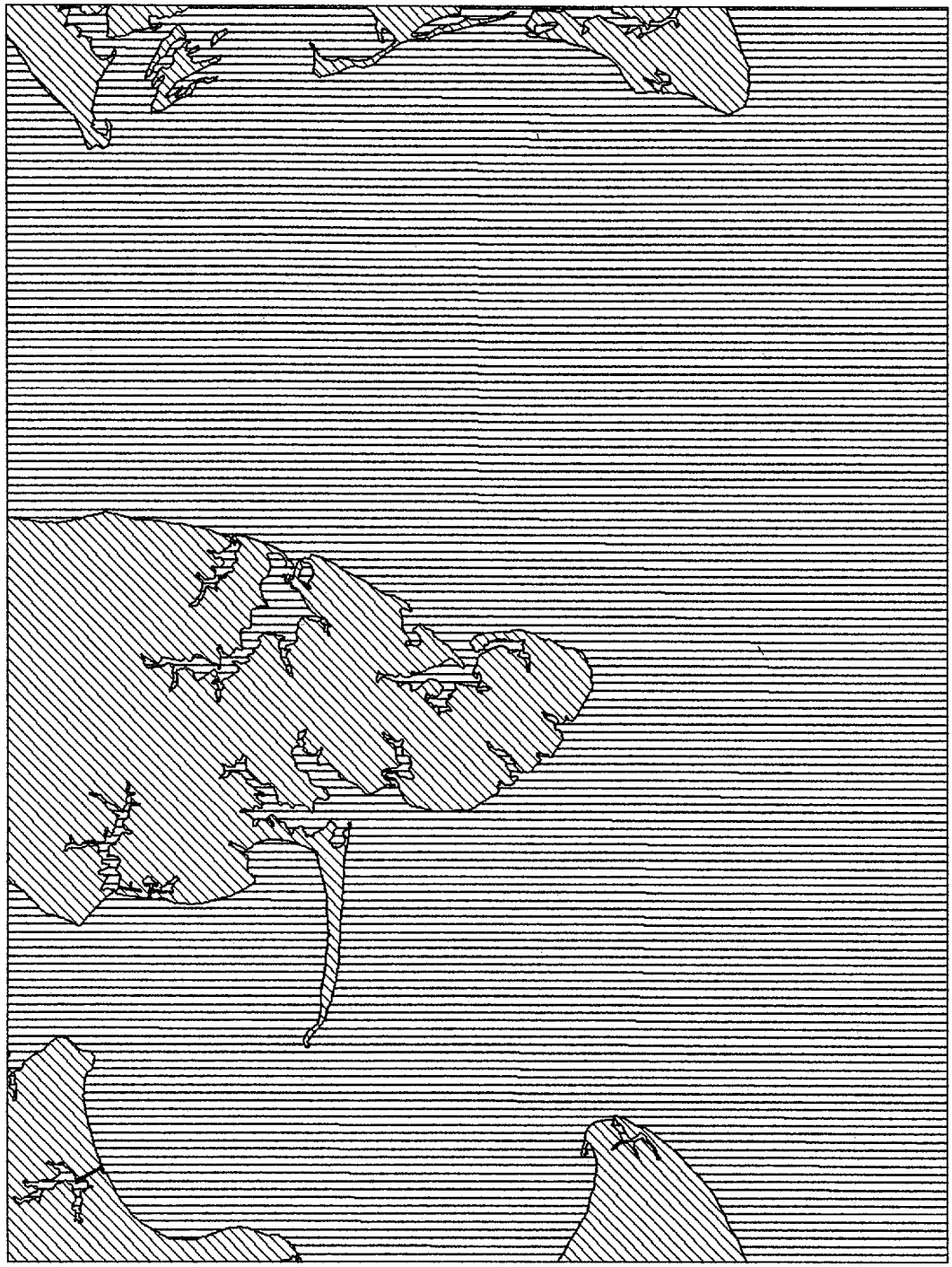
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
DAHLGREN
WESTMORELAND CO

SHL5415

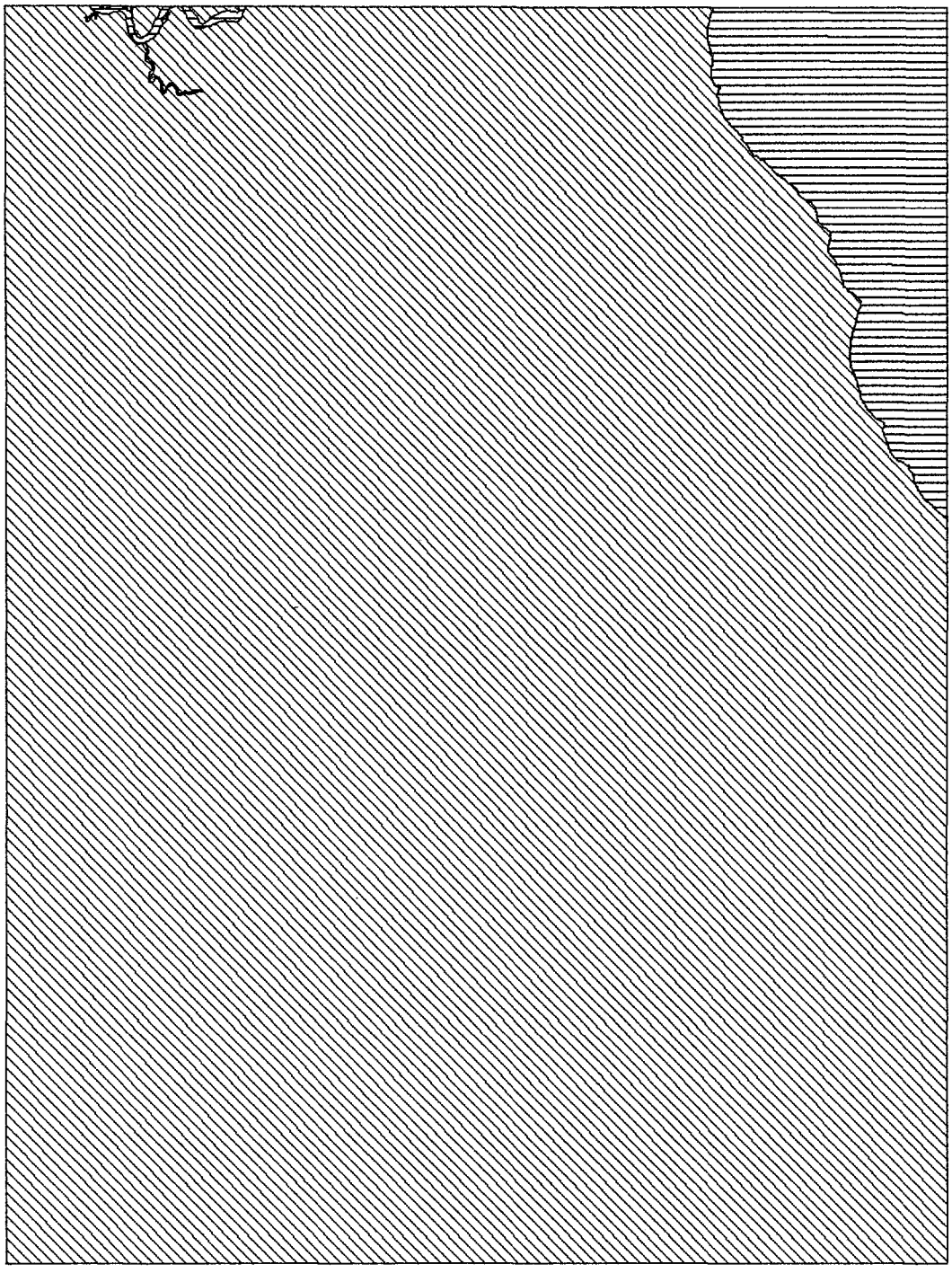
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
DELTAVILLE
MIDDLESEX CO

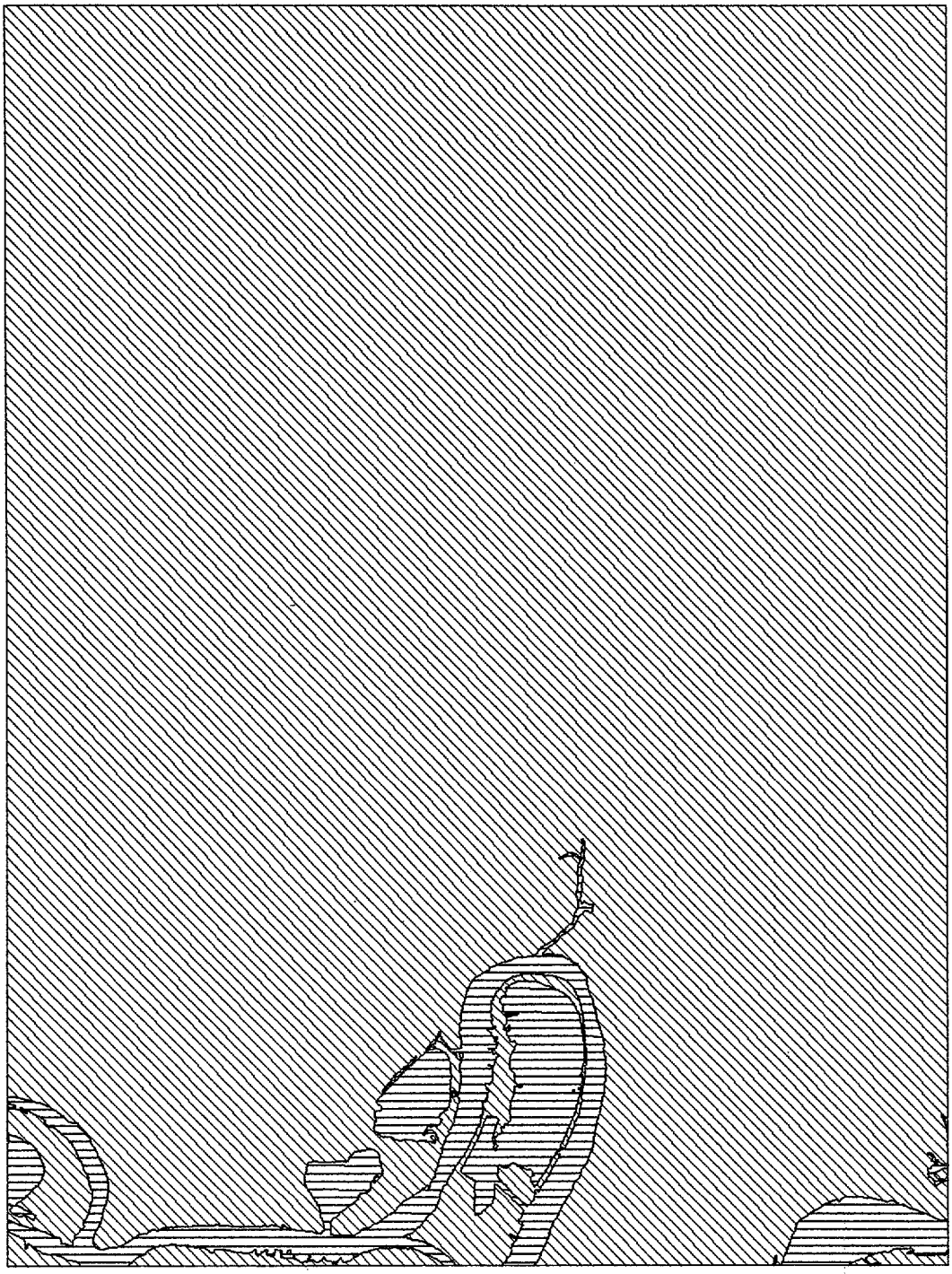
SHL6009

UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
DUNNSVILLE
ESSEX COUNTY

SHL5611
UPLAND
WATER



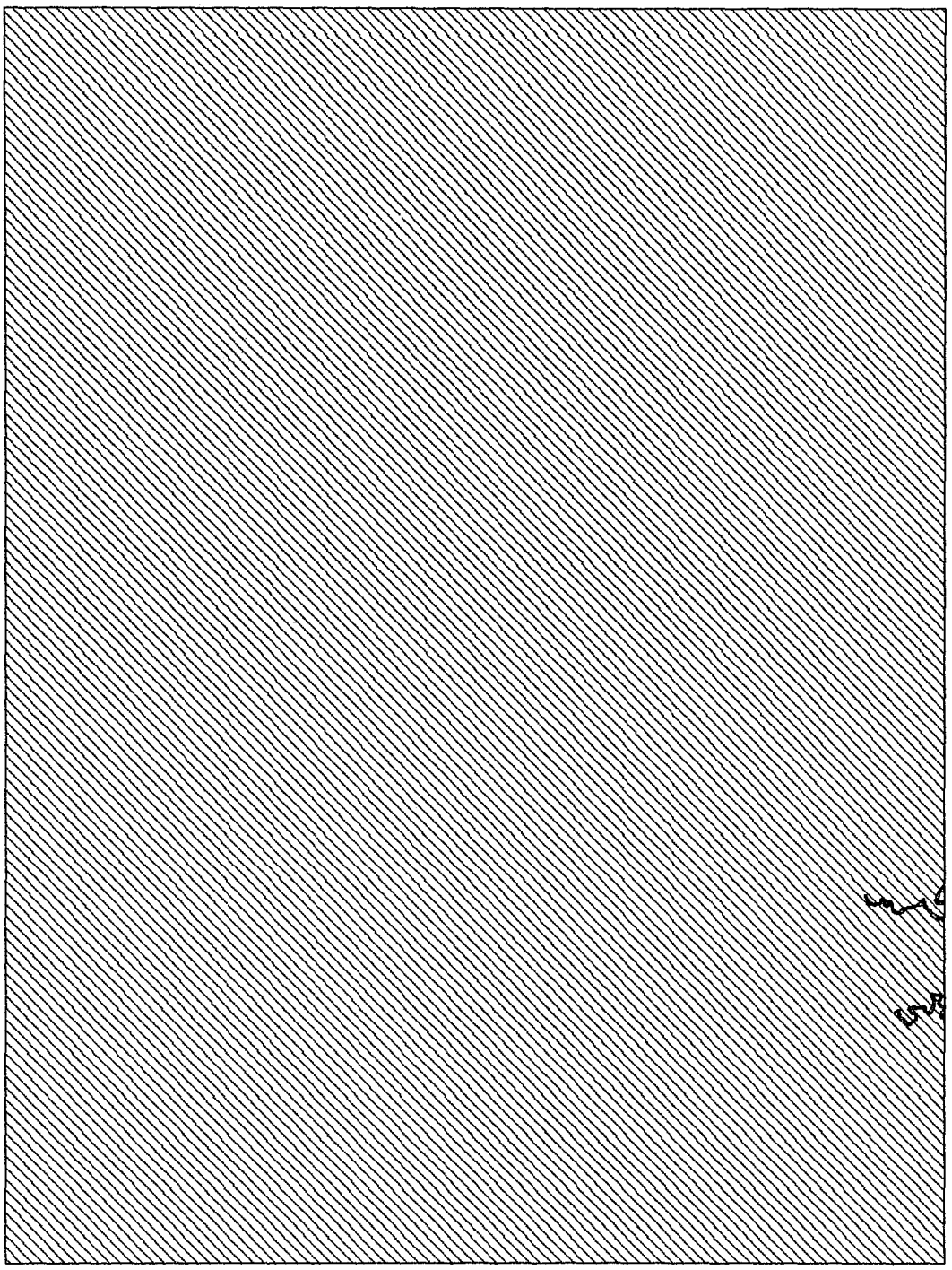
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
DUTCH GAP
CHARLES CITY COUNTY

SHL5208
UPLAND
WATER

VIMS COASTAL INVENTORIES
1:24000 SHORELINE
FLEETS BAY
LANCASTER CO

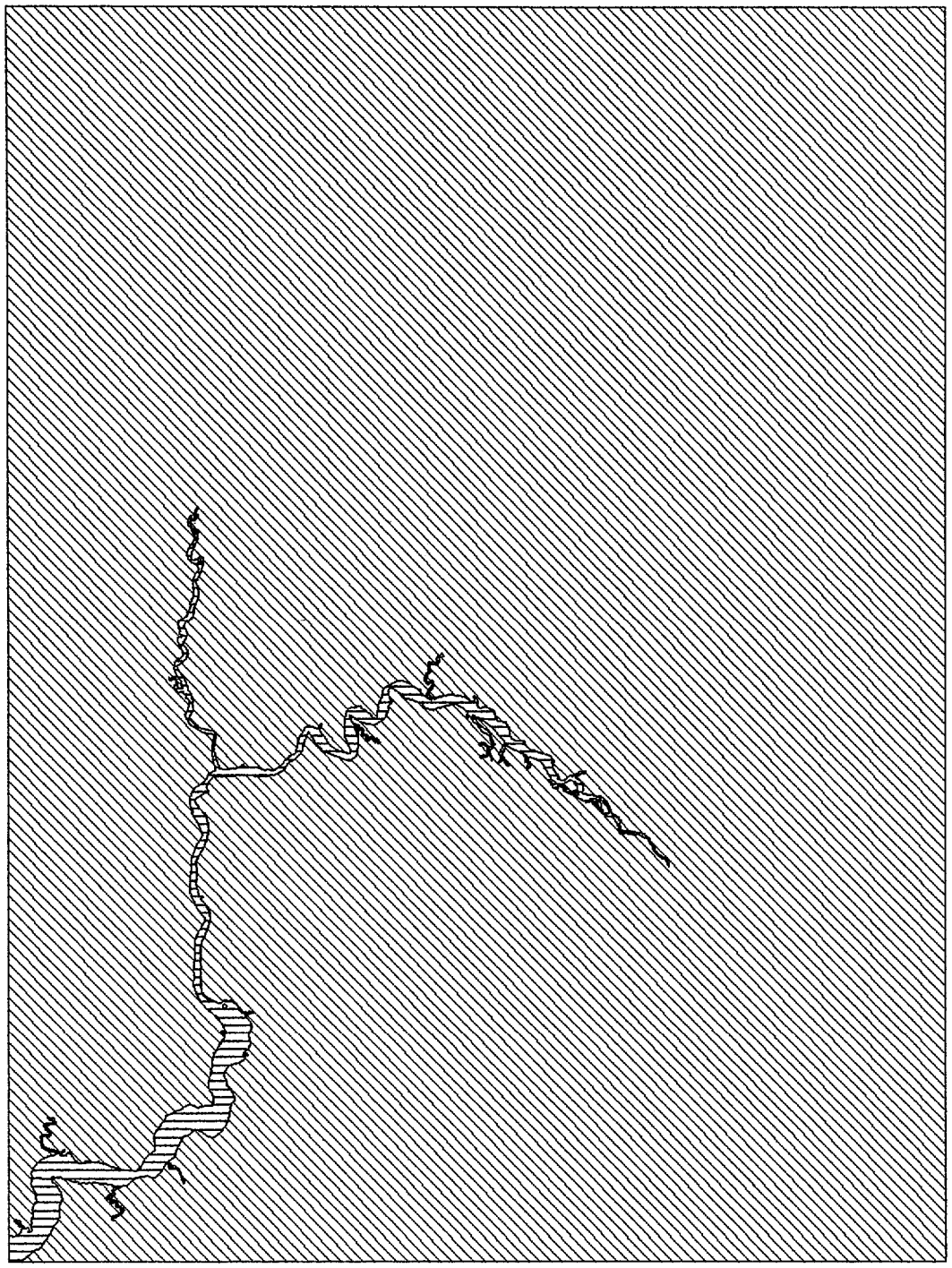
SHL6010

UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
GLOUCESTER
GLOUCESTER CO

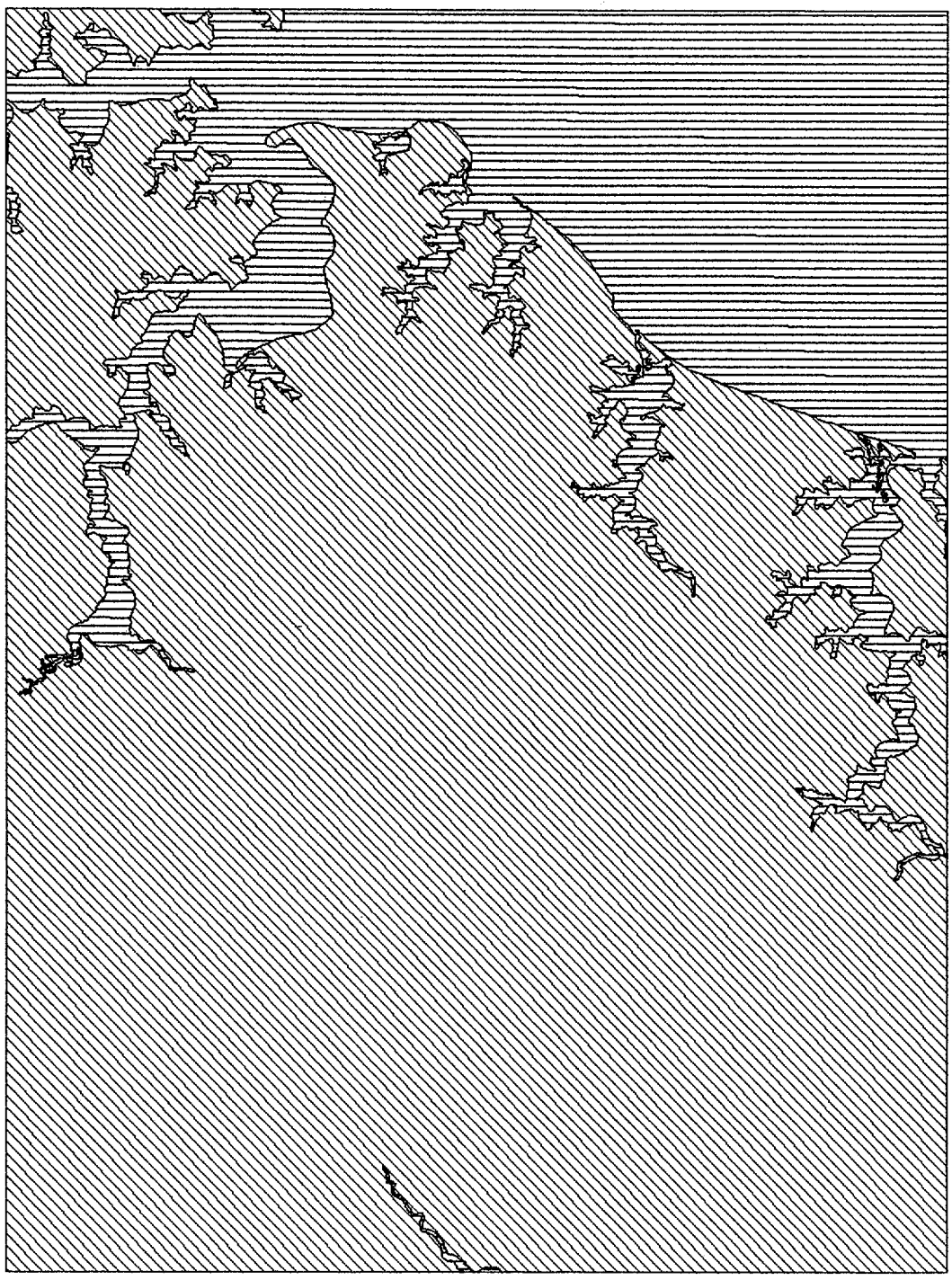
SHL5808
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
HAYNESVILLE
RICHMOND CO

SHL5712

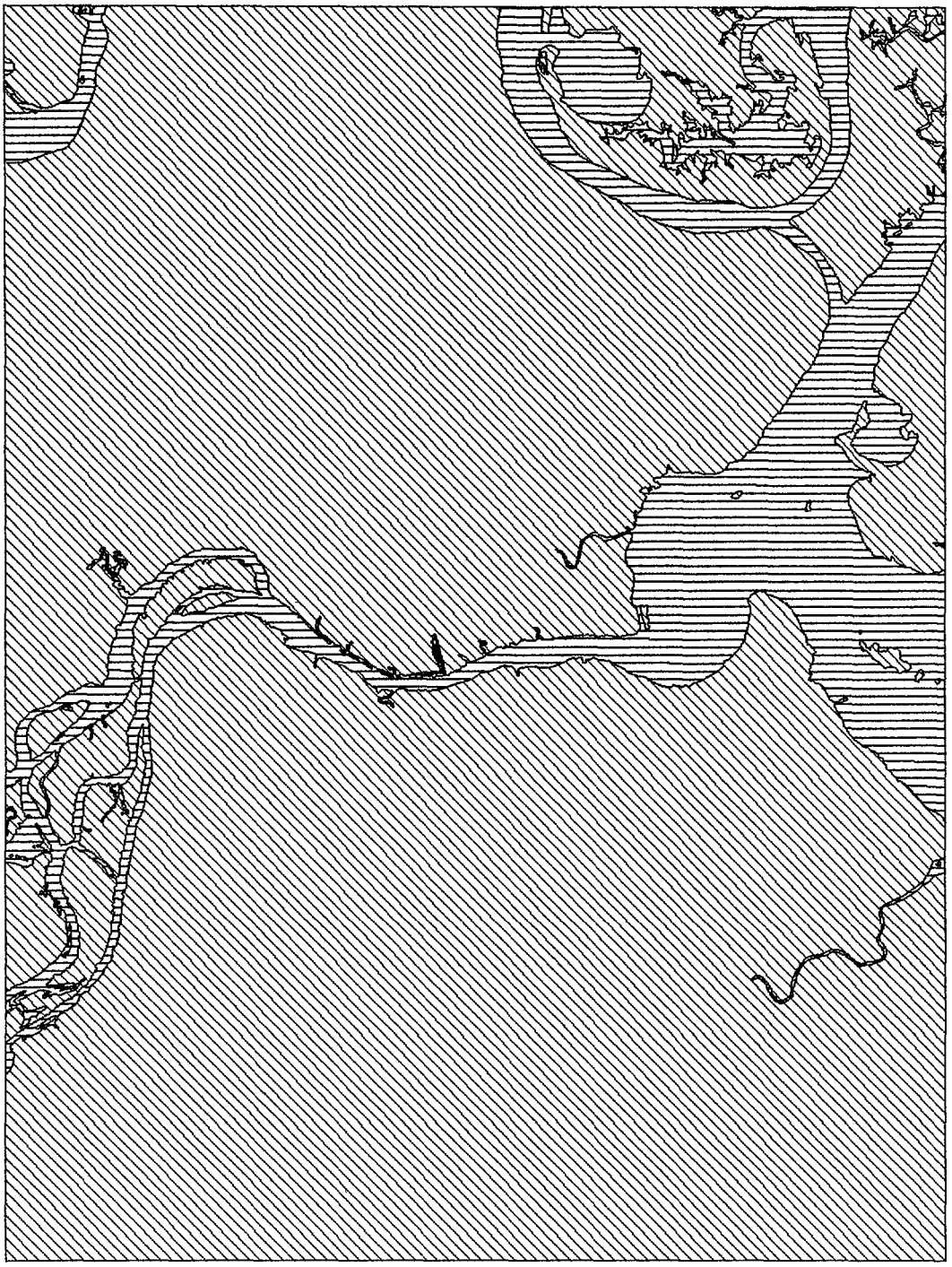
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
HEATHSVILLE
NORTHUMBERLAND CO

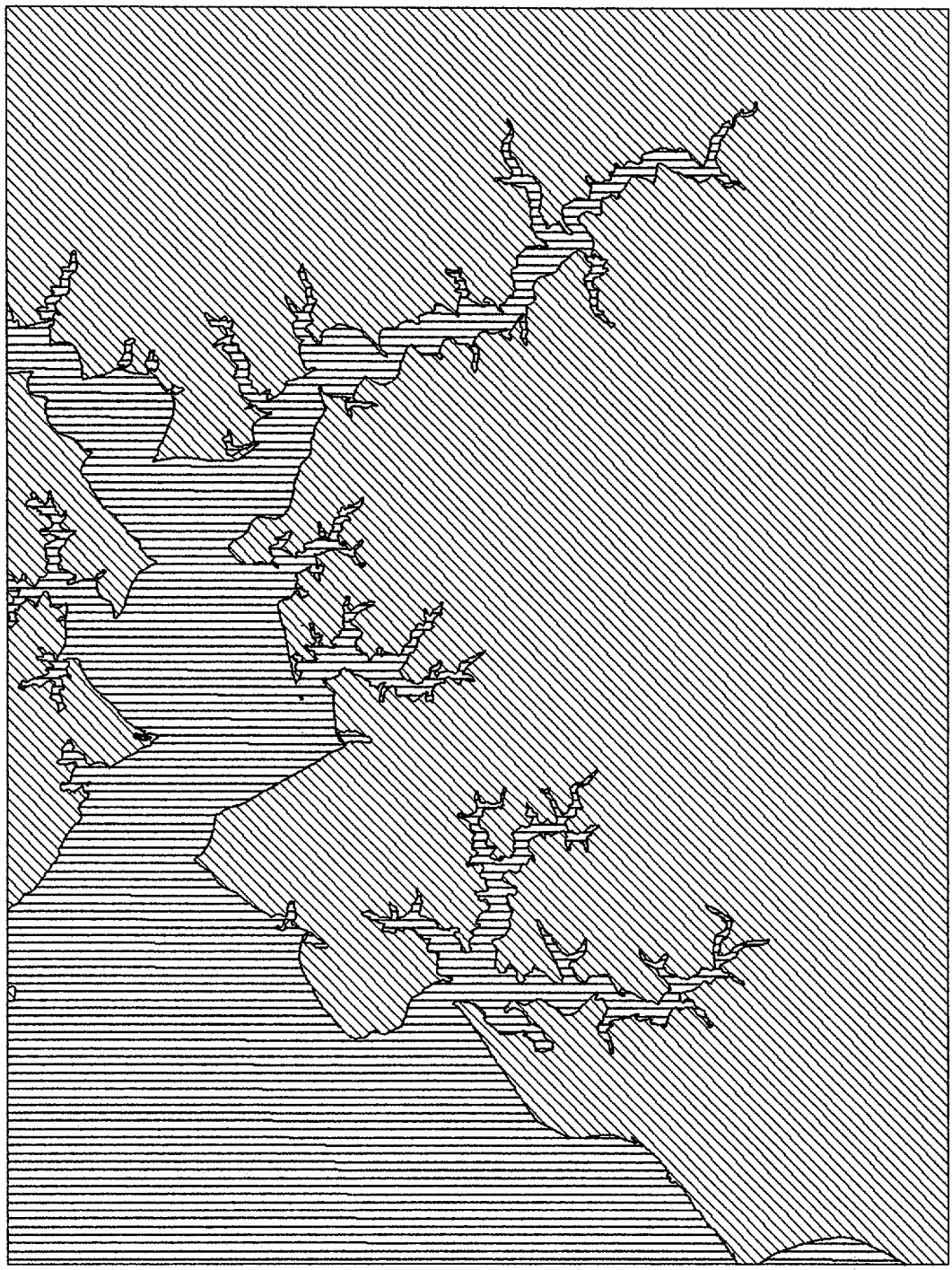
SHL5912

UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
HOPEWELL
CHARLES CITY COUNTY

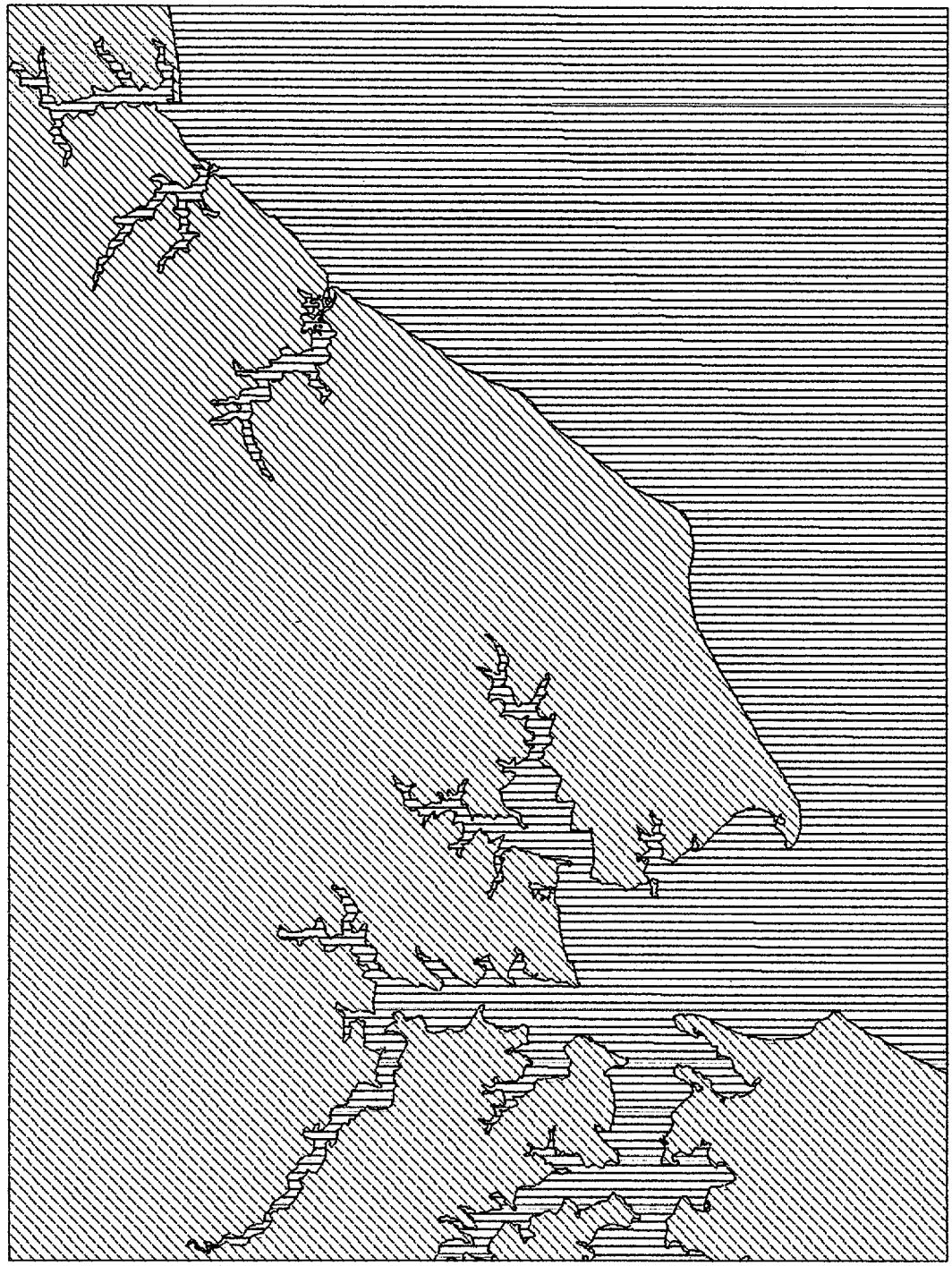
SHL5207
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
IRVINGTON
LANCASTER CO

SHL5910

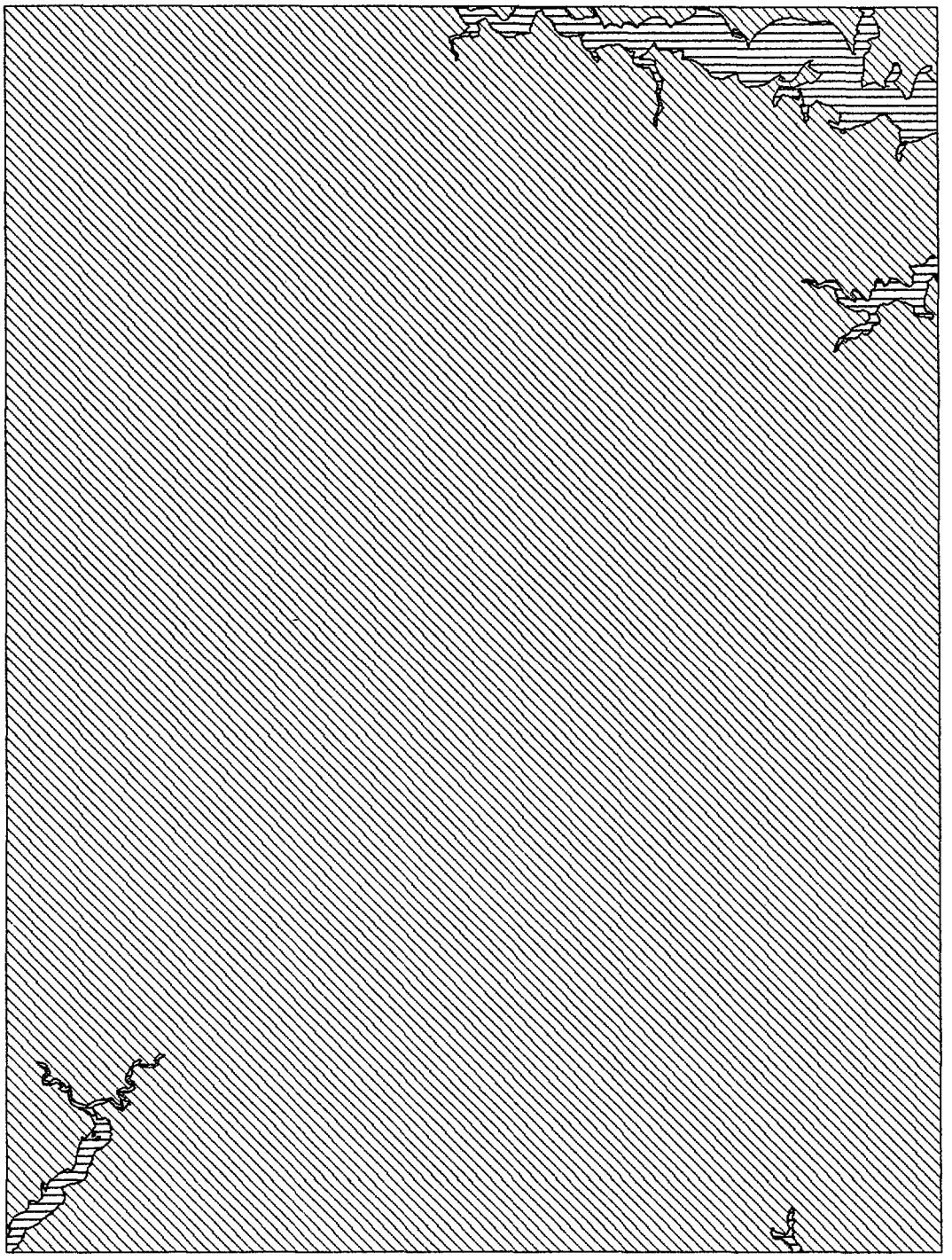
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
KINSALE
WESTMORELAND CO

SHL5813

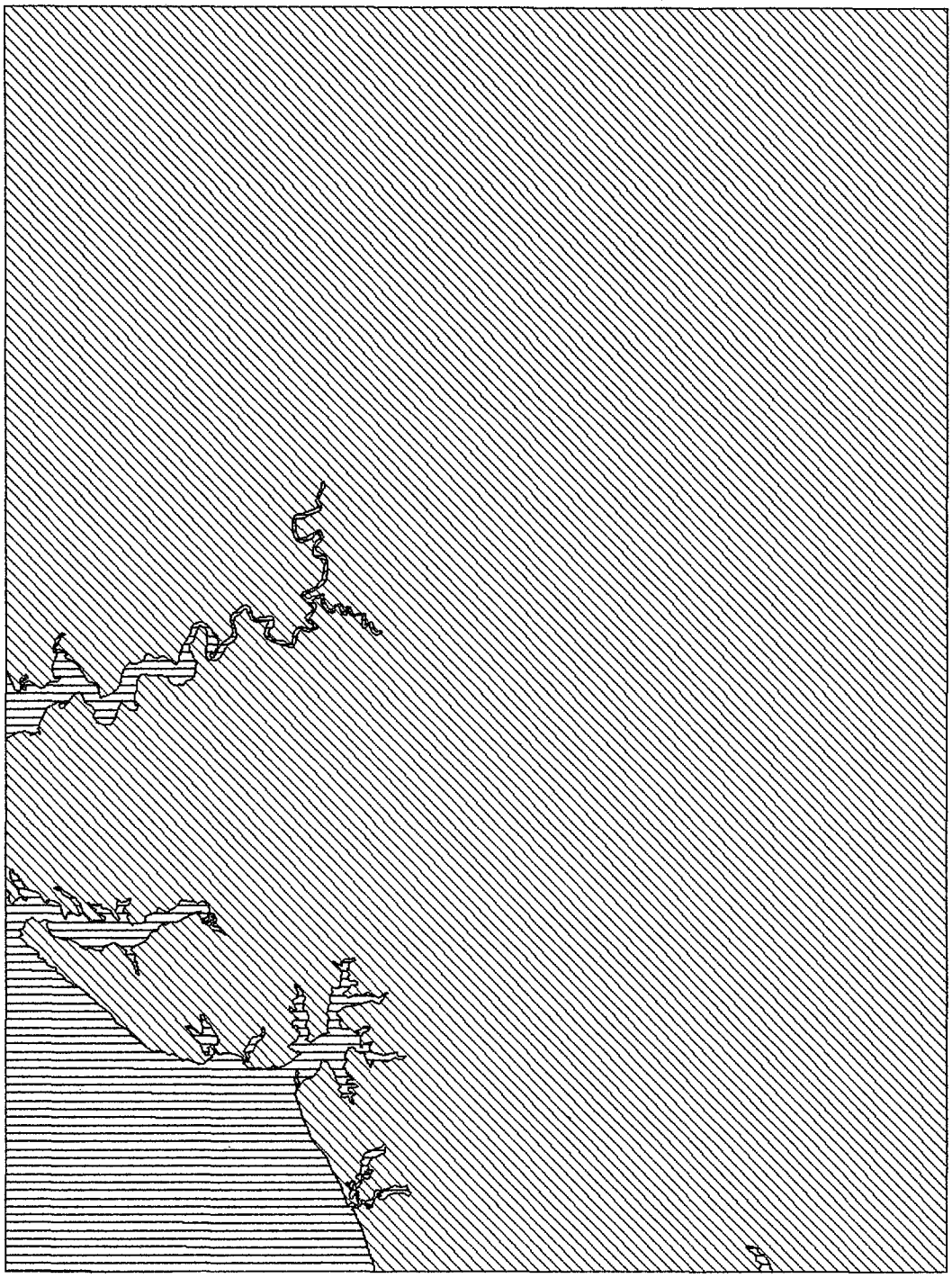
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
LANCASTER
NORTHUMBERLAND CO

SHL5911

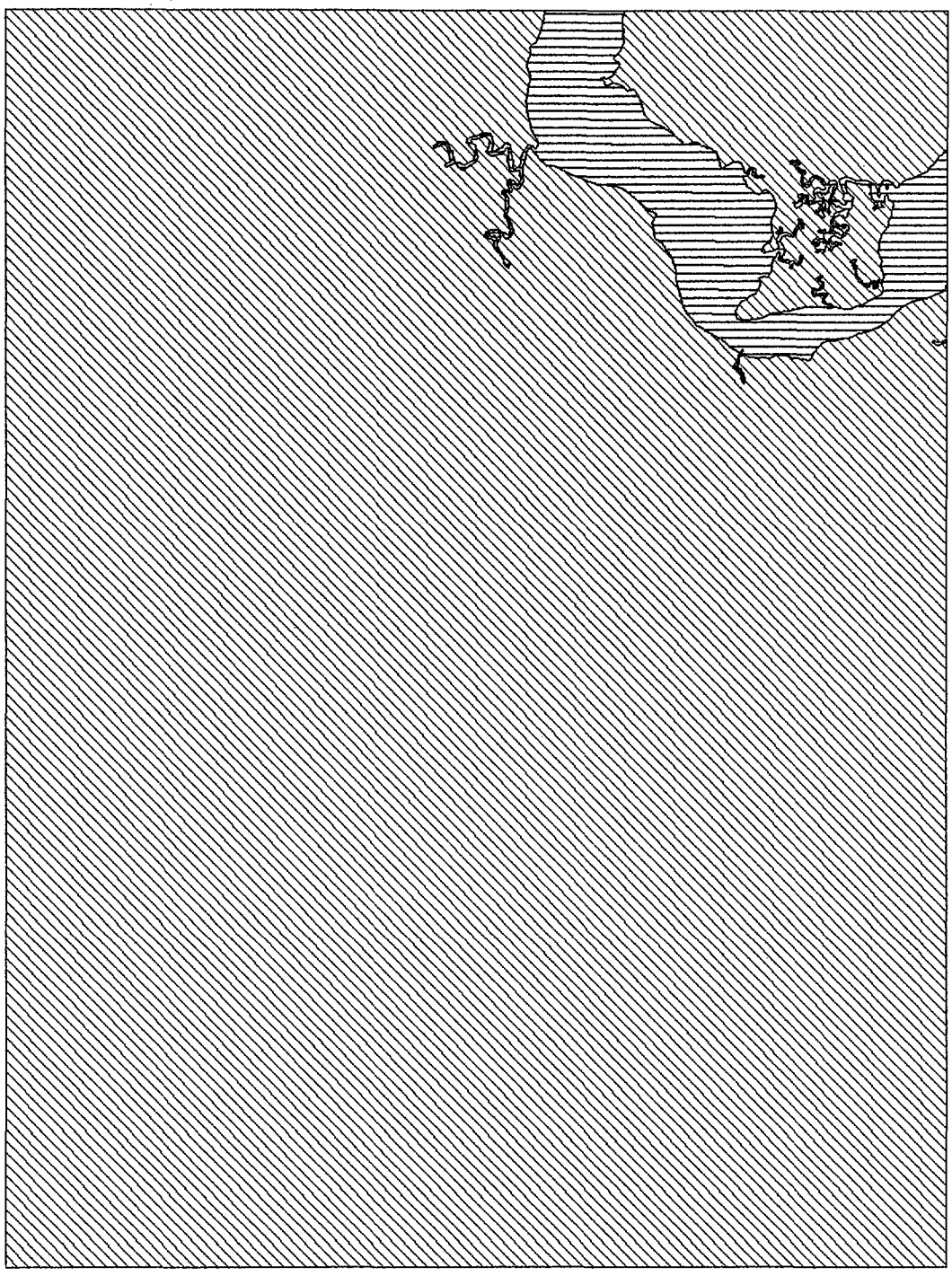
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
LIVELY
LANCASTER CO

SHL5811

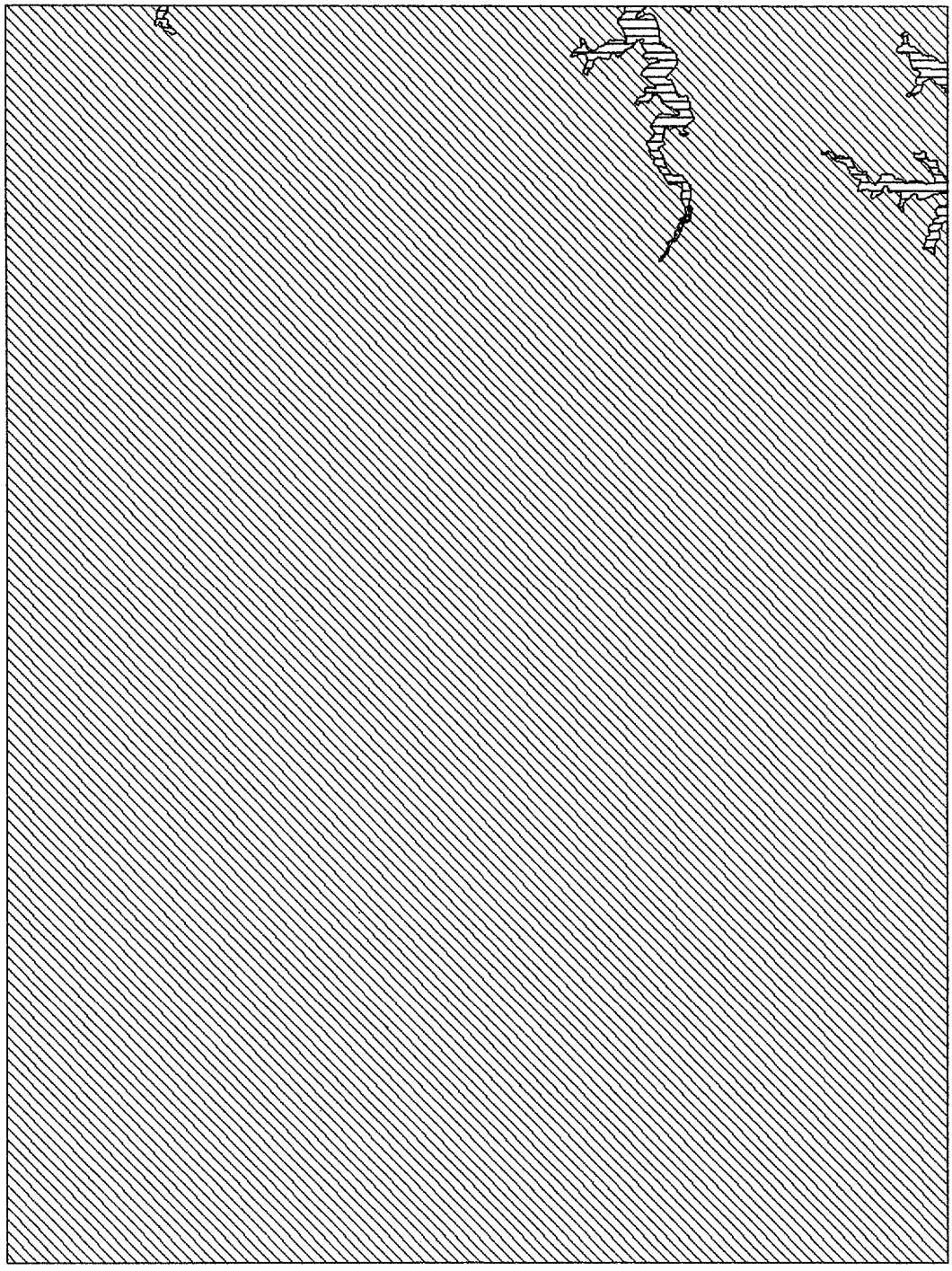
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
LORETTO
WESTMORELAND CO

SHL5413

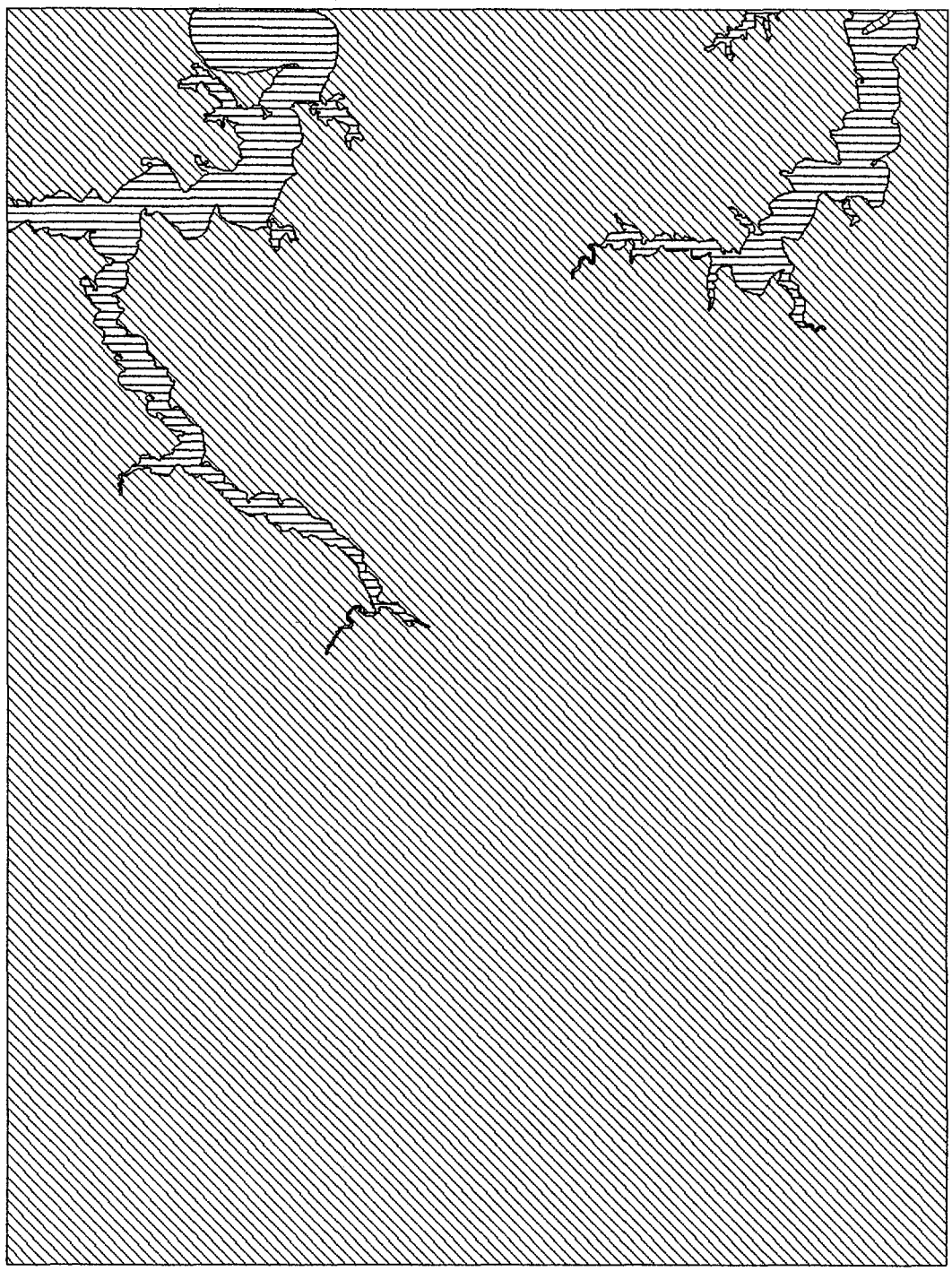
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
LOTTSBURG
NORTHUMBERLAND CO

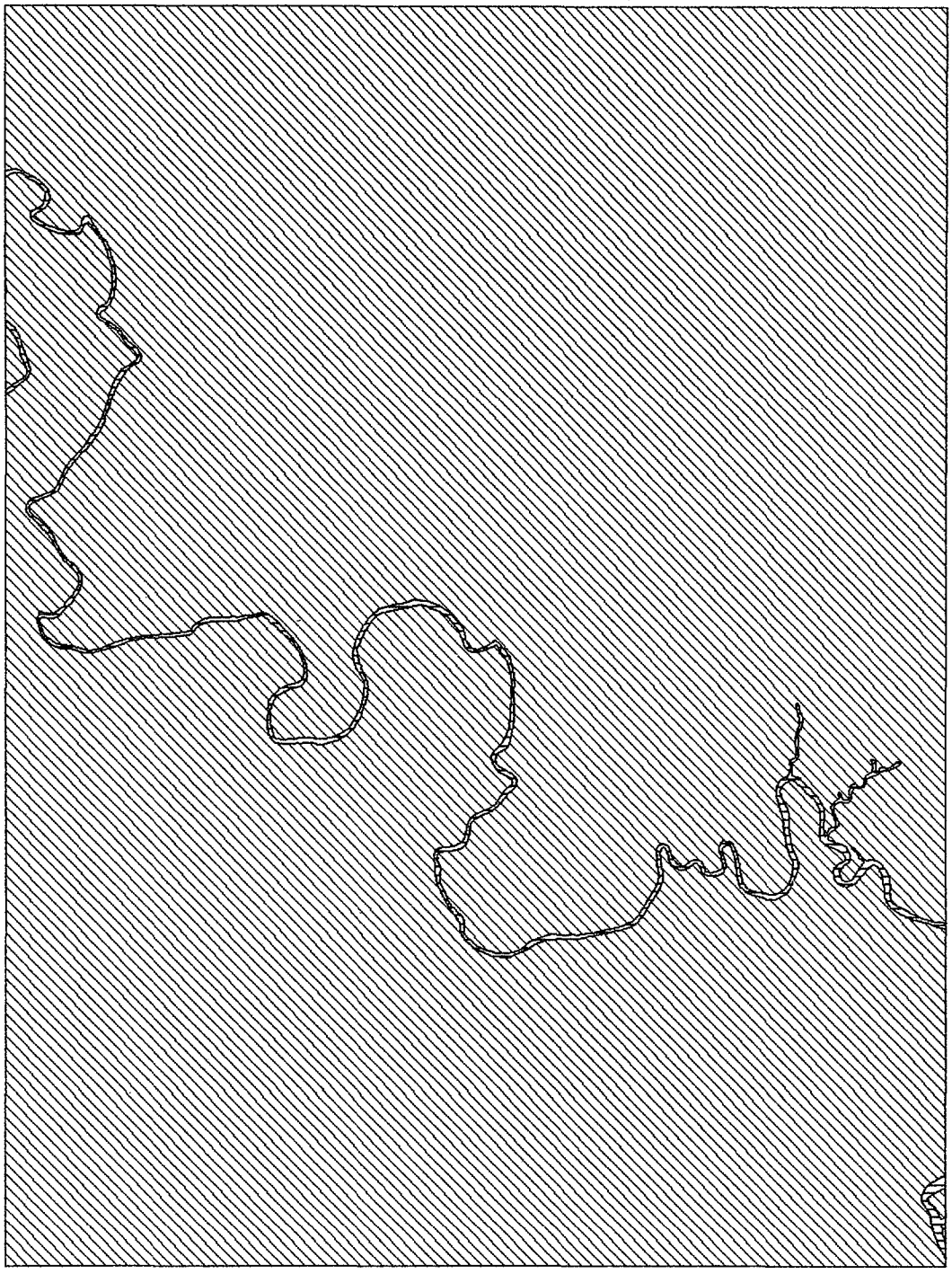
SHL5812

UPLAND
WATER



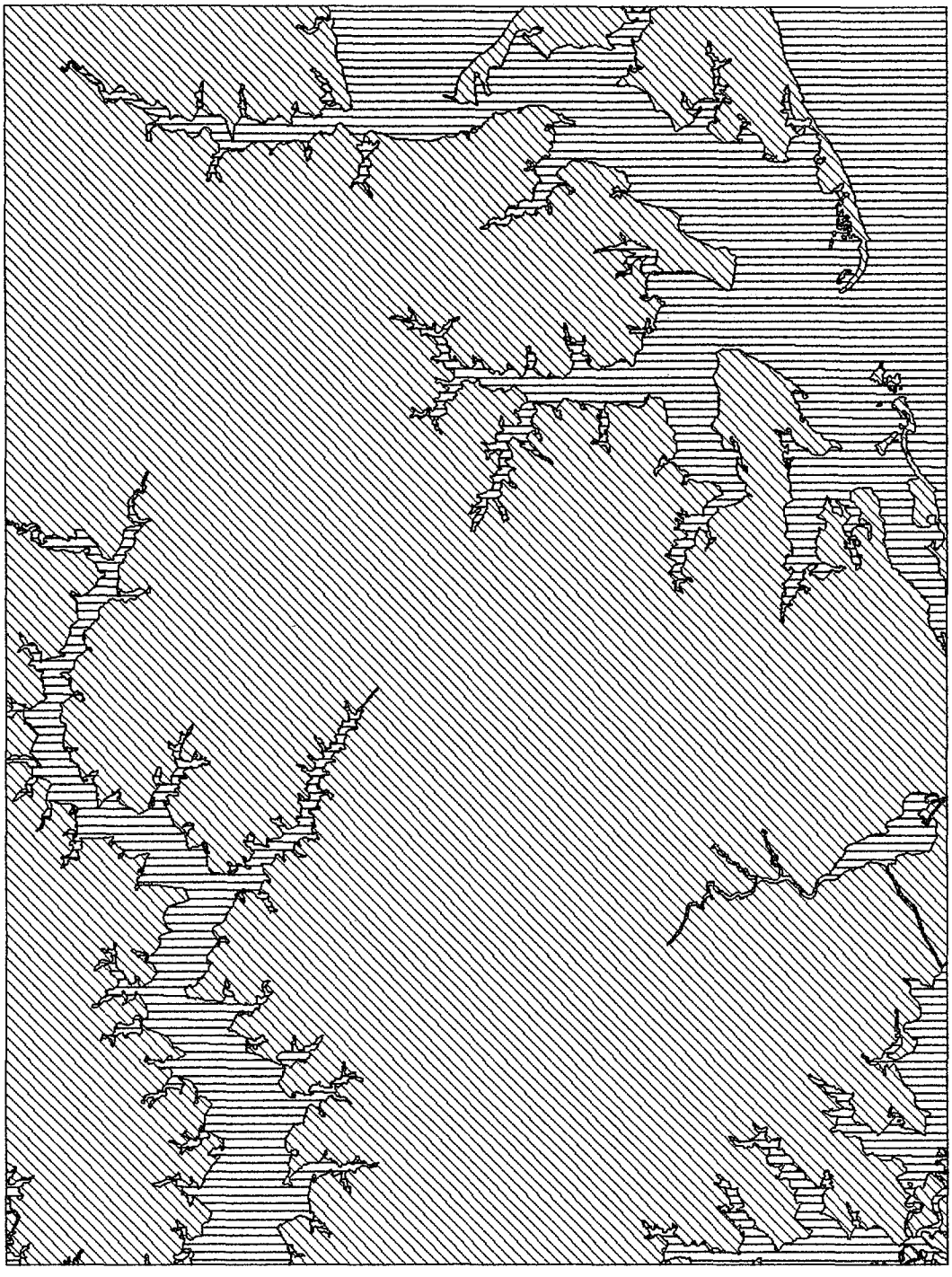
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
MACHODOC
WESTMORELAND CO

SHL5713
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
MANQUIN
KING WILLIAM CO

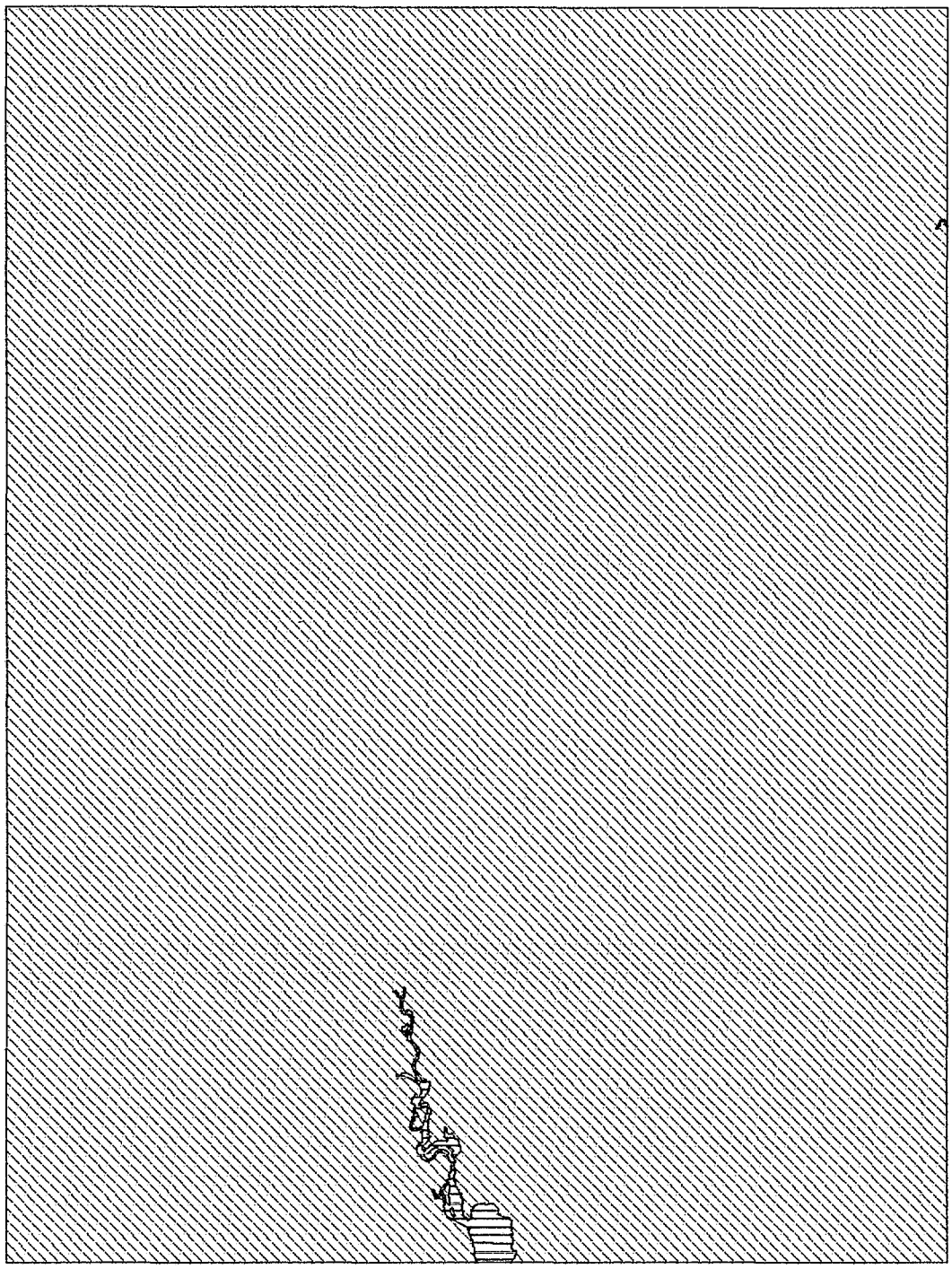
SHL5310
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
MATHEWS
MATHEWS CO

SHL6008

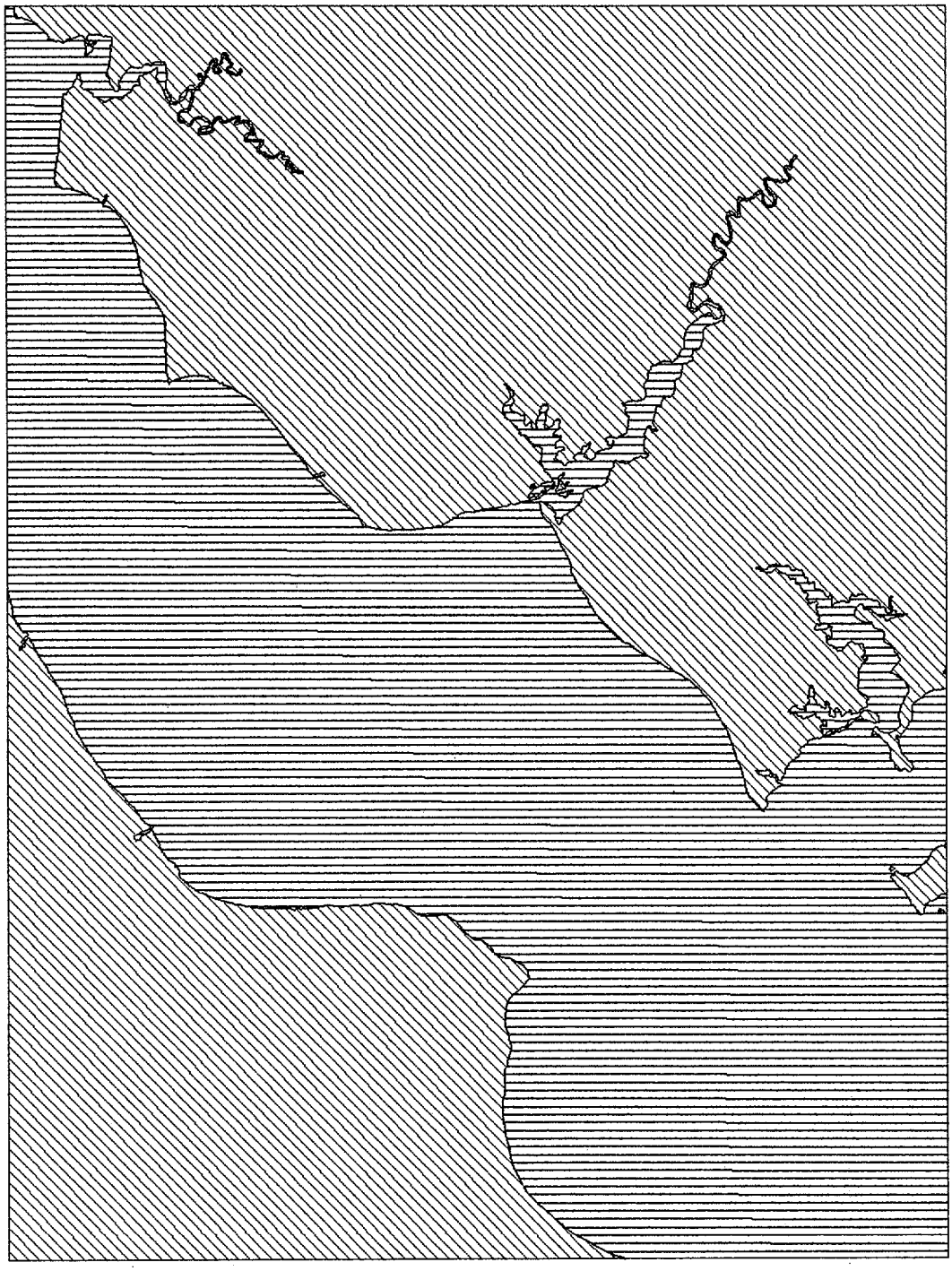
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
MONTROSS
WESTMORELAND CO

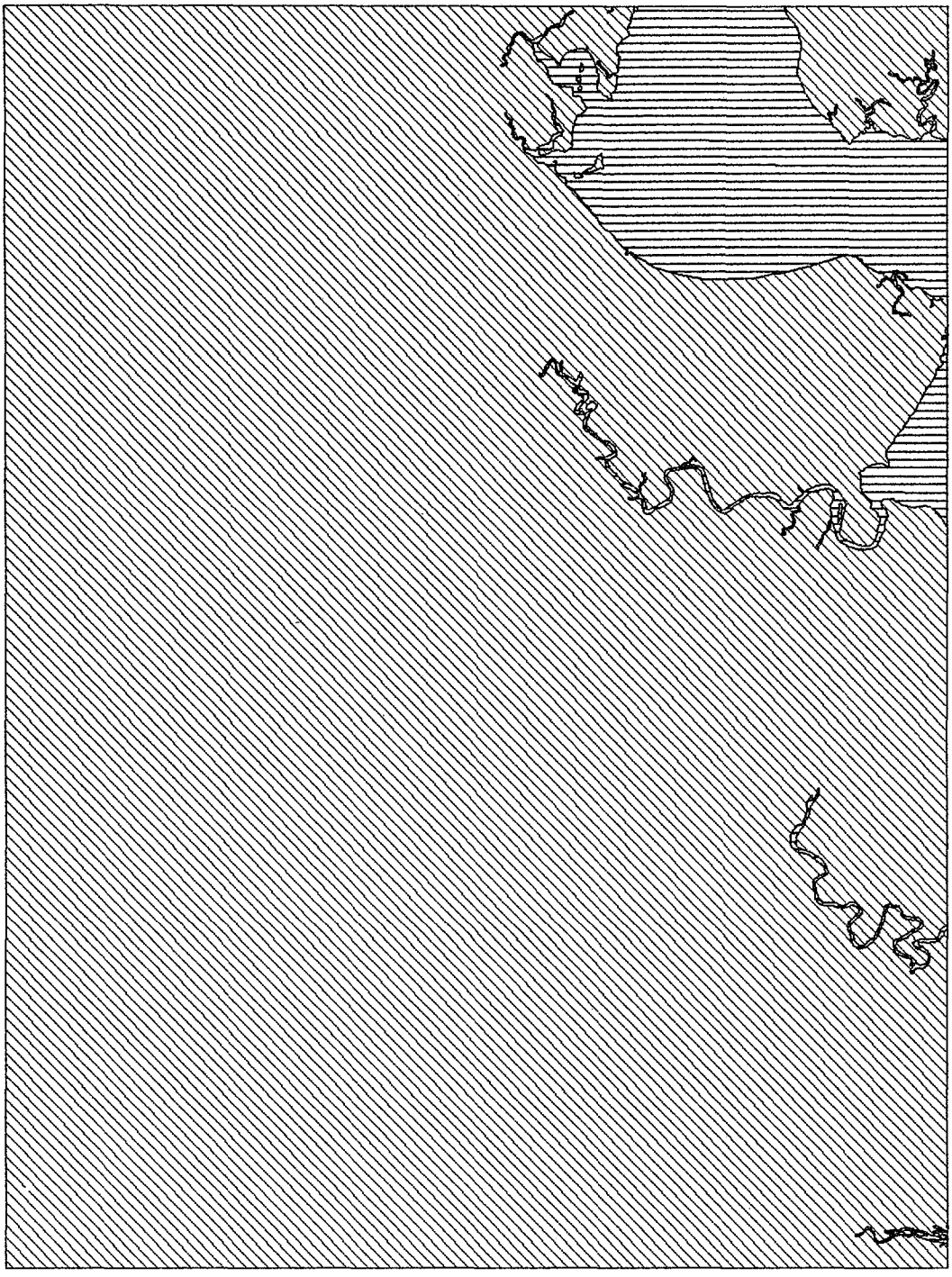
SHL5613

UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
MORATTICO
RICHMOND COUNTY

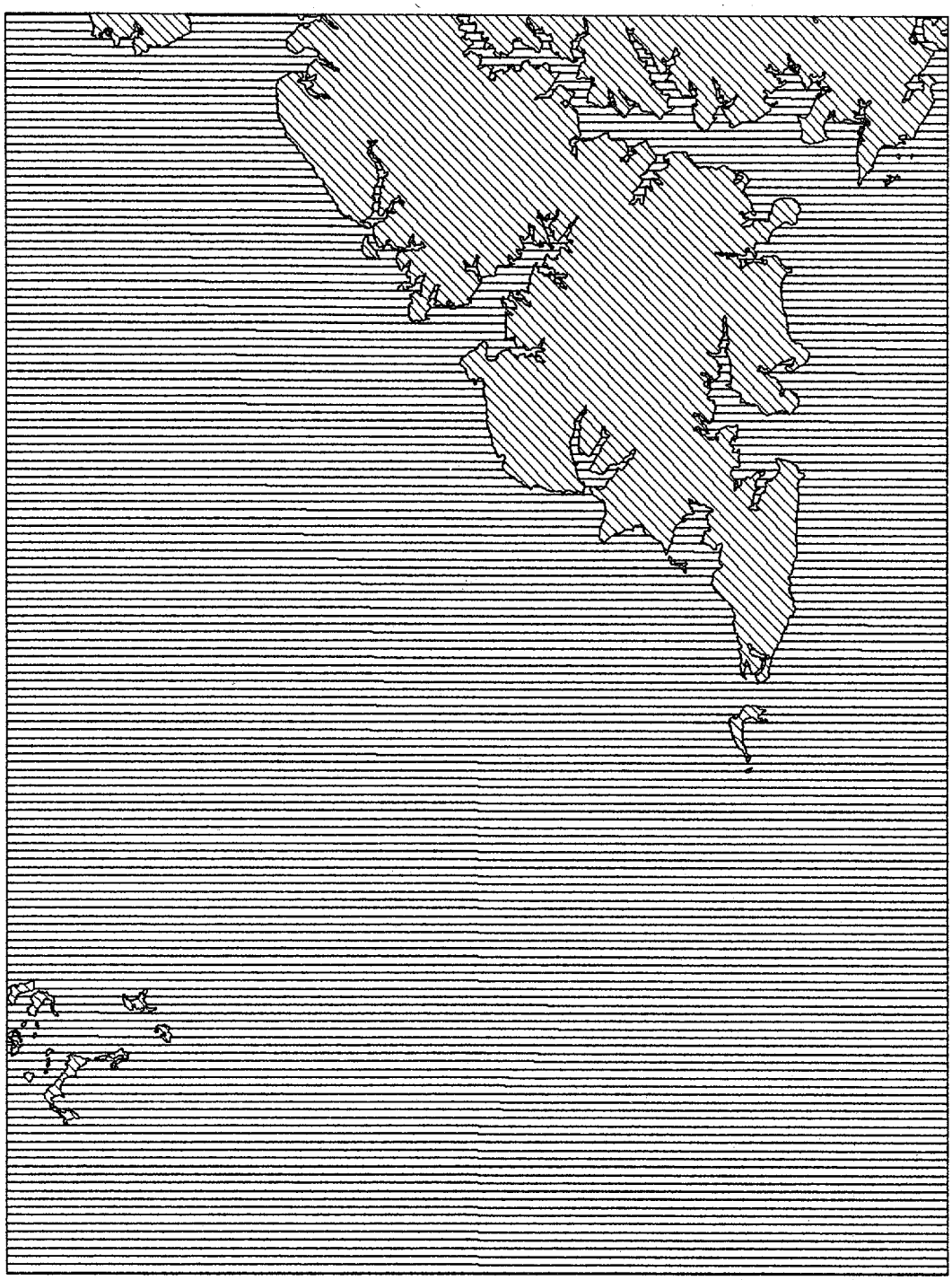
SHL5711
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
MT. LANDING
ESSEX CO

SHL5512

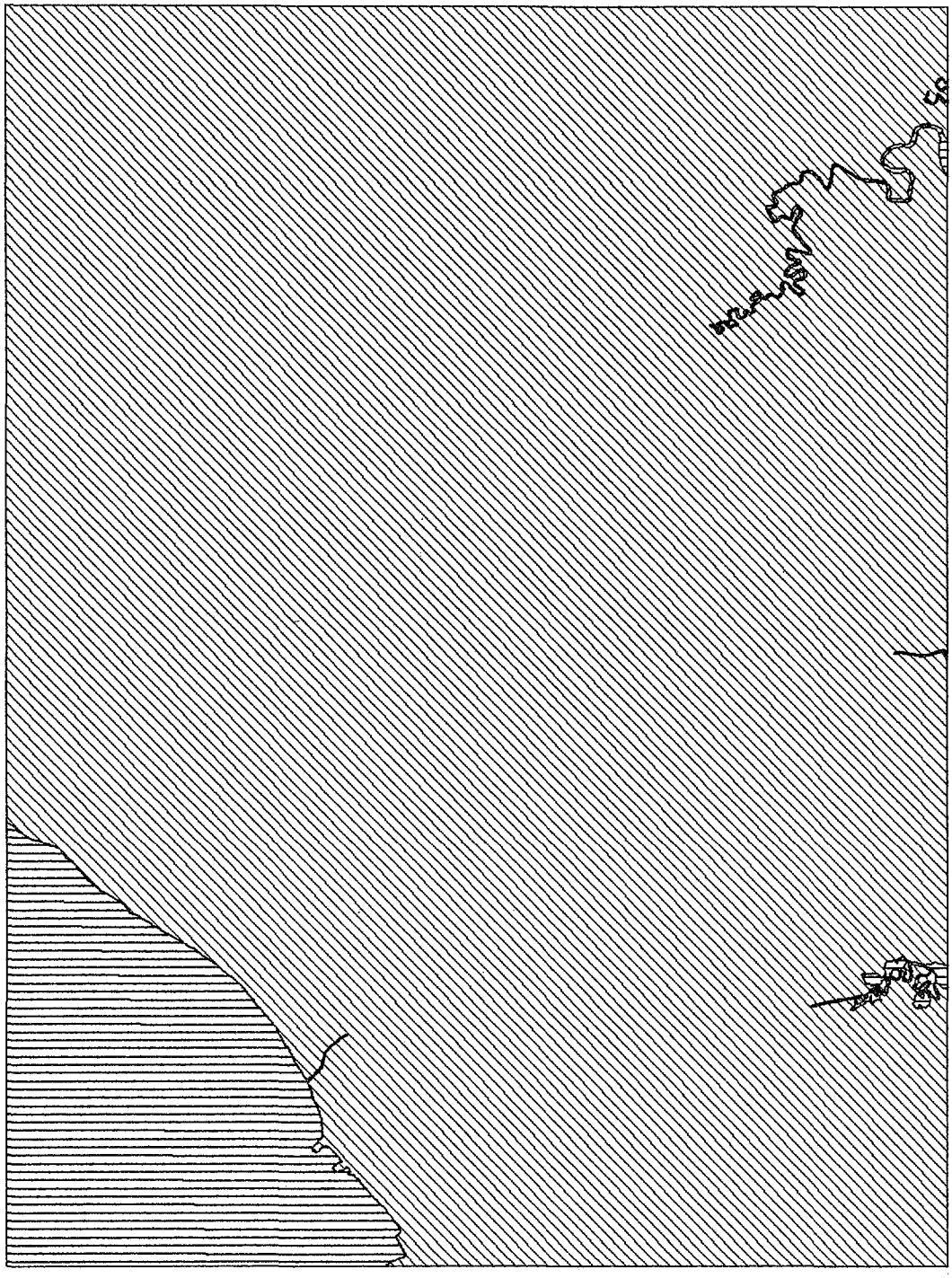
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
NEW POINT COMFORT
MATHEWS CO

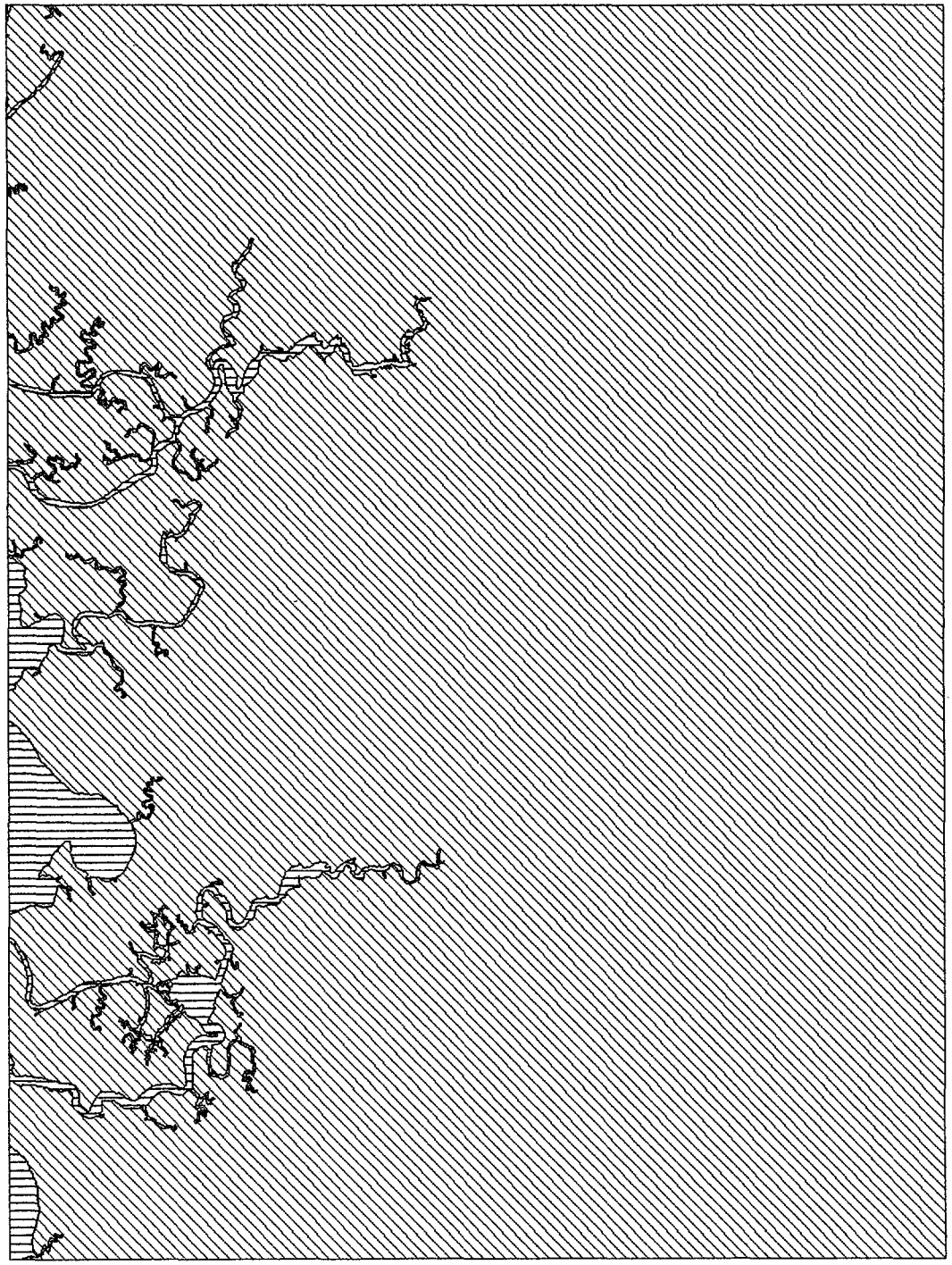
SHL6007

UPLAND
WATER



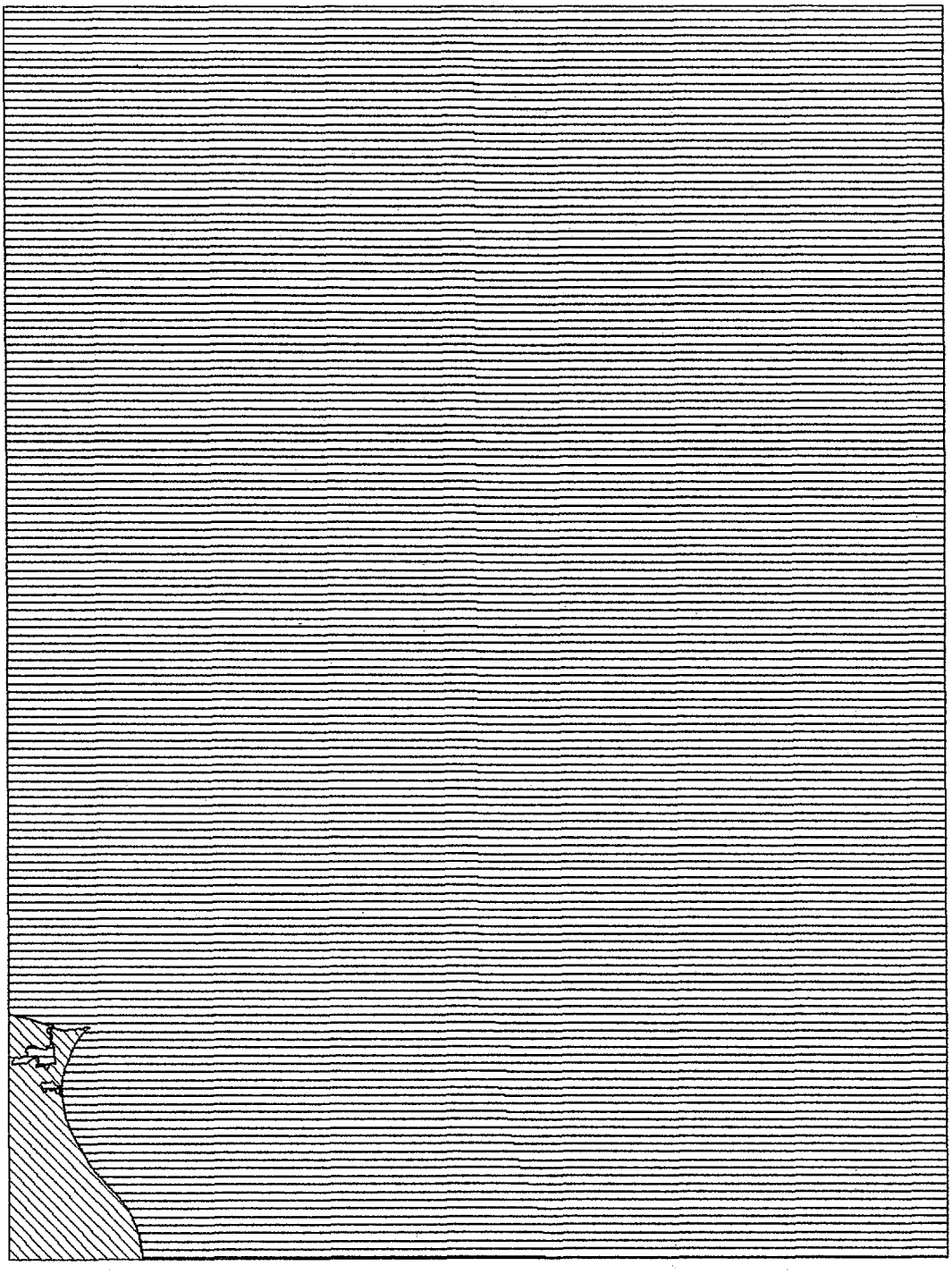
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
NEWPORT NEWS NORTH
CITY OF NEWPORT NEWS

SHL5905
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
NORGE
JAMES CITY COUNTY

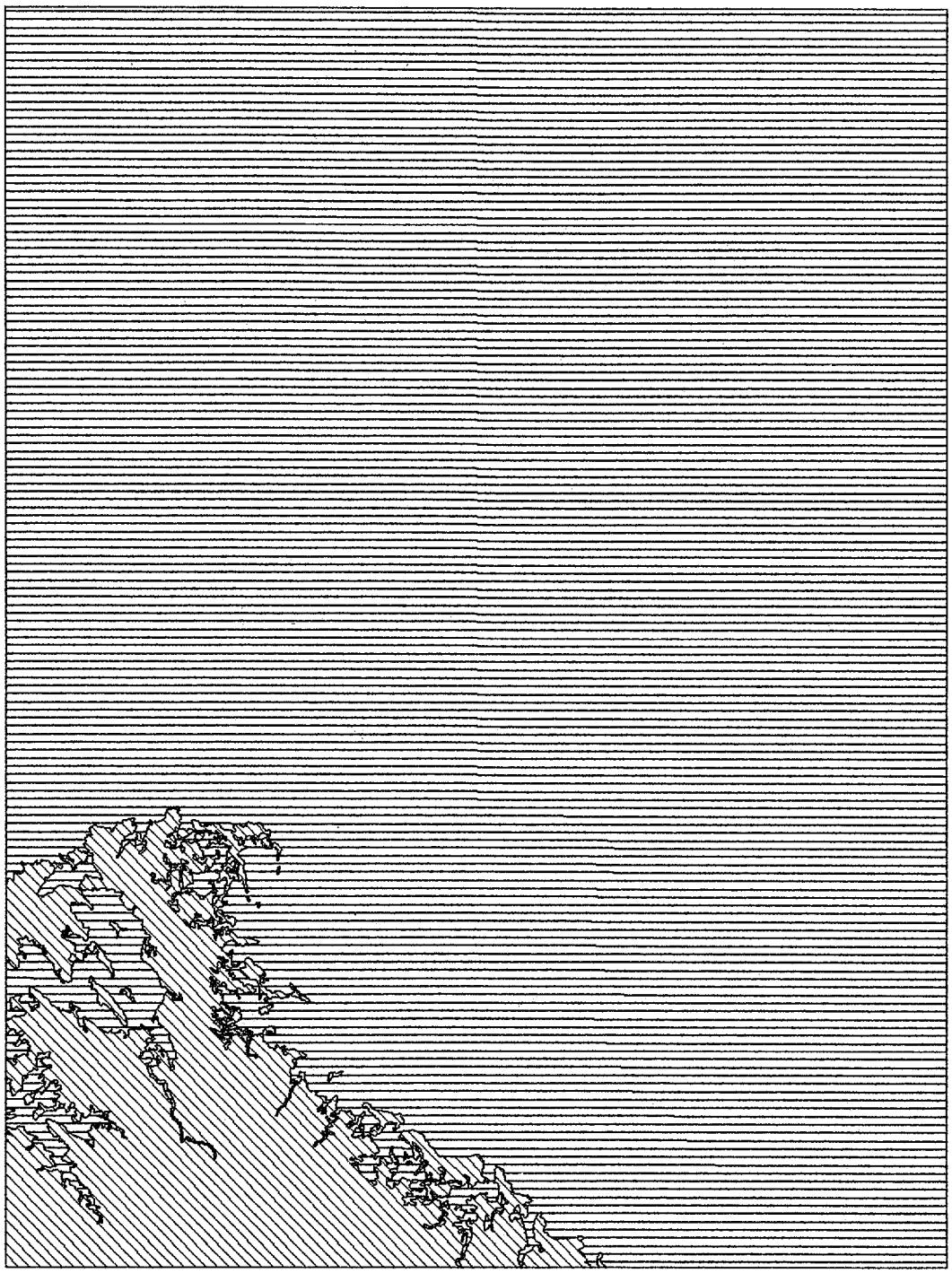
SHL5607
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
PINEY POINT
WESTMORELAND CO

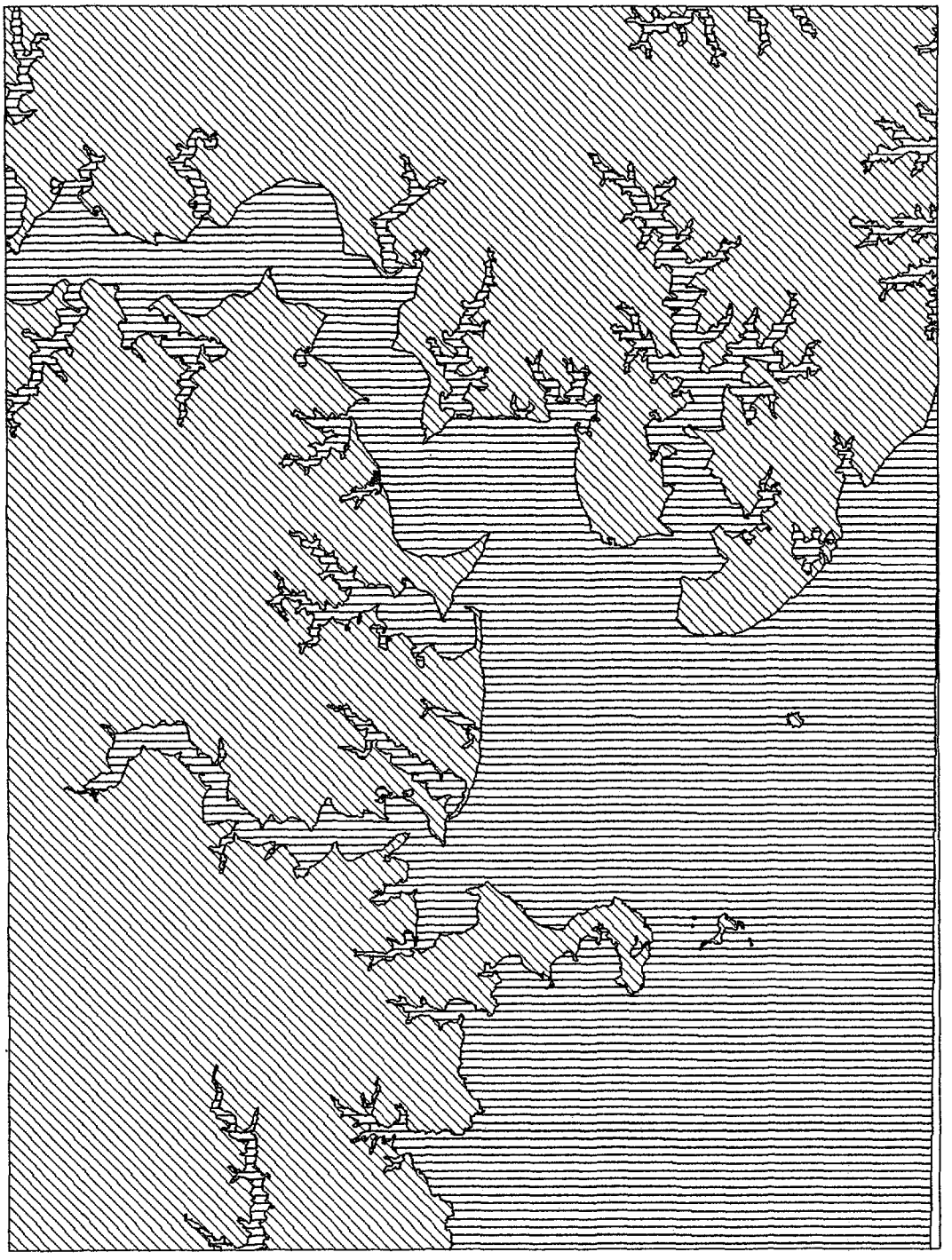
SHL5814

UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
POQUOSON EAST
YORK CO

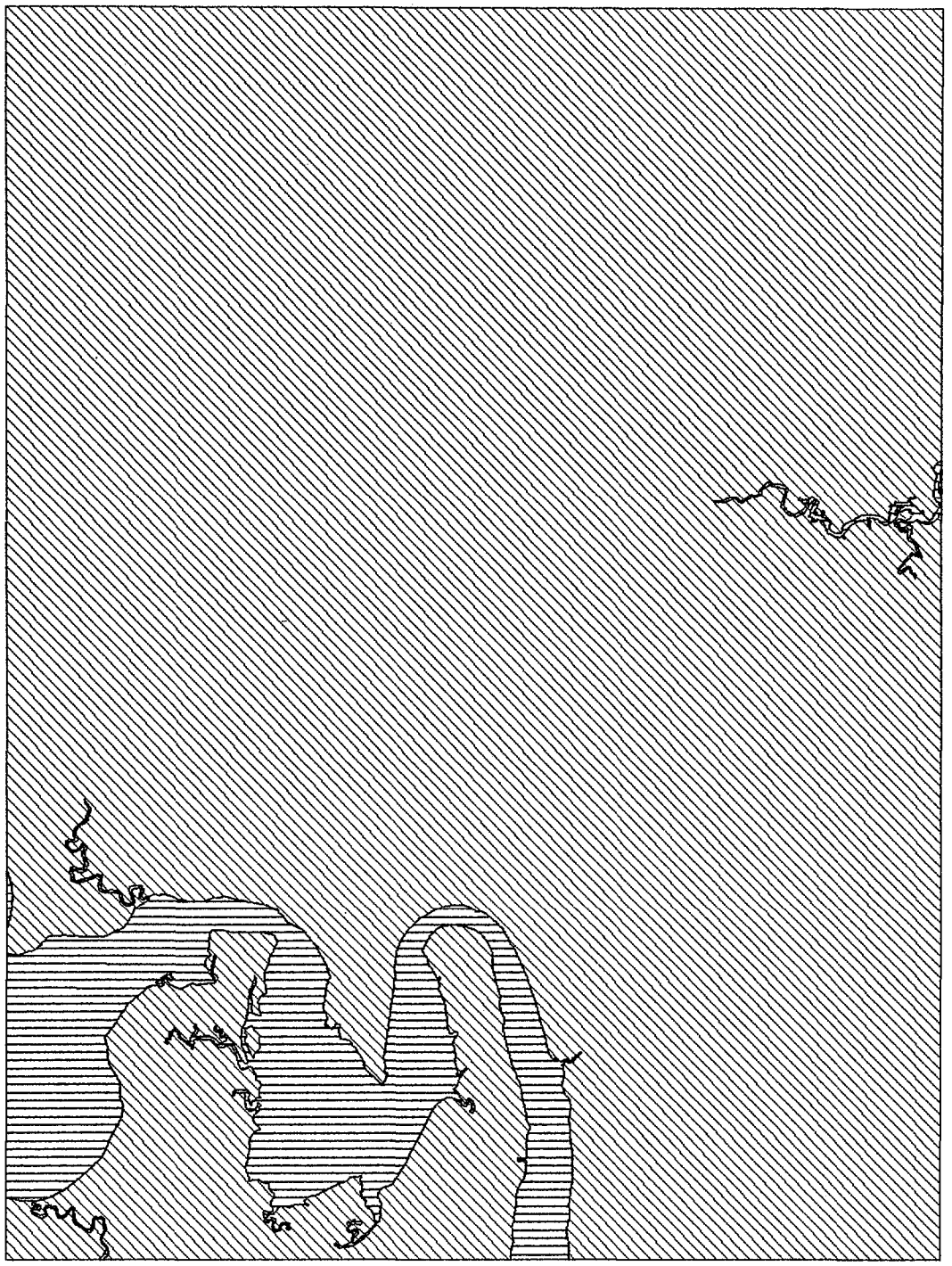
SHL6006
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
REEDVILLE
NORTHUMBERLAND CO

SHL6011

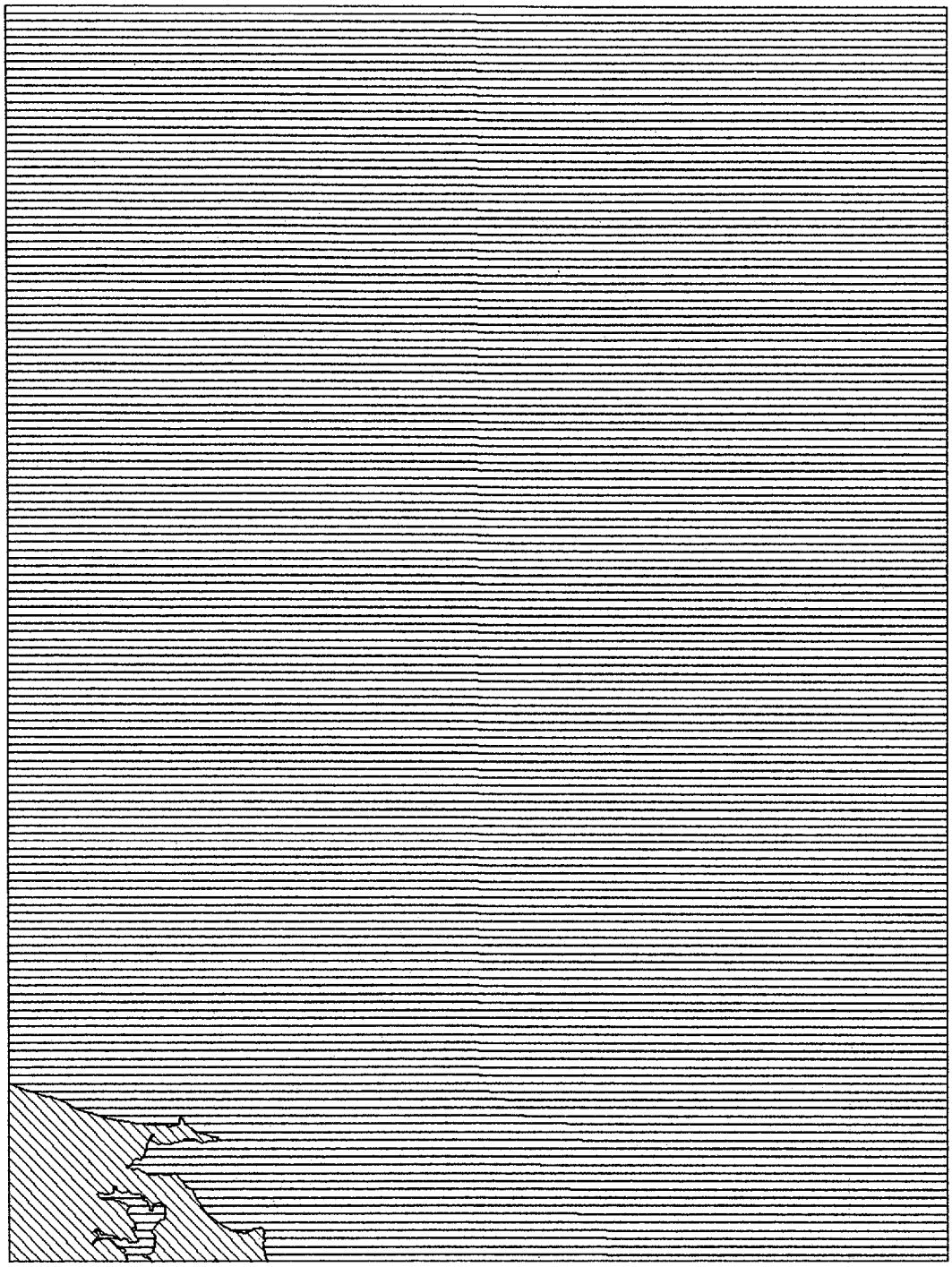
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
ROLLINS FORK
WESTMORELAND CO

SHL5414

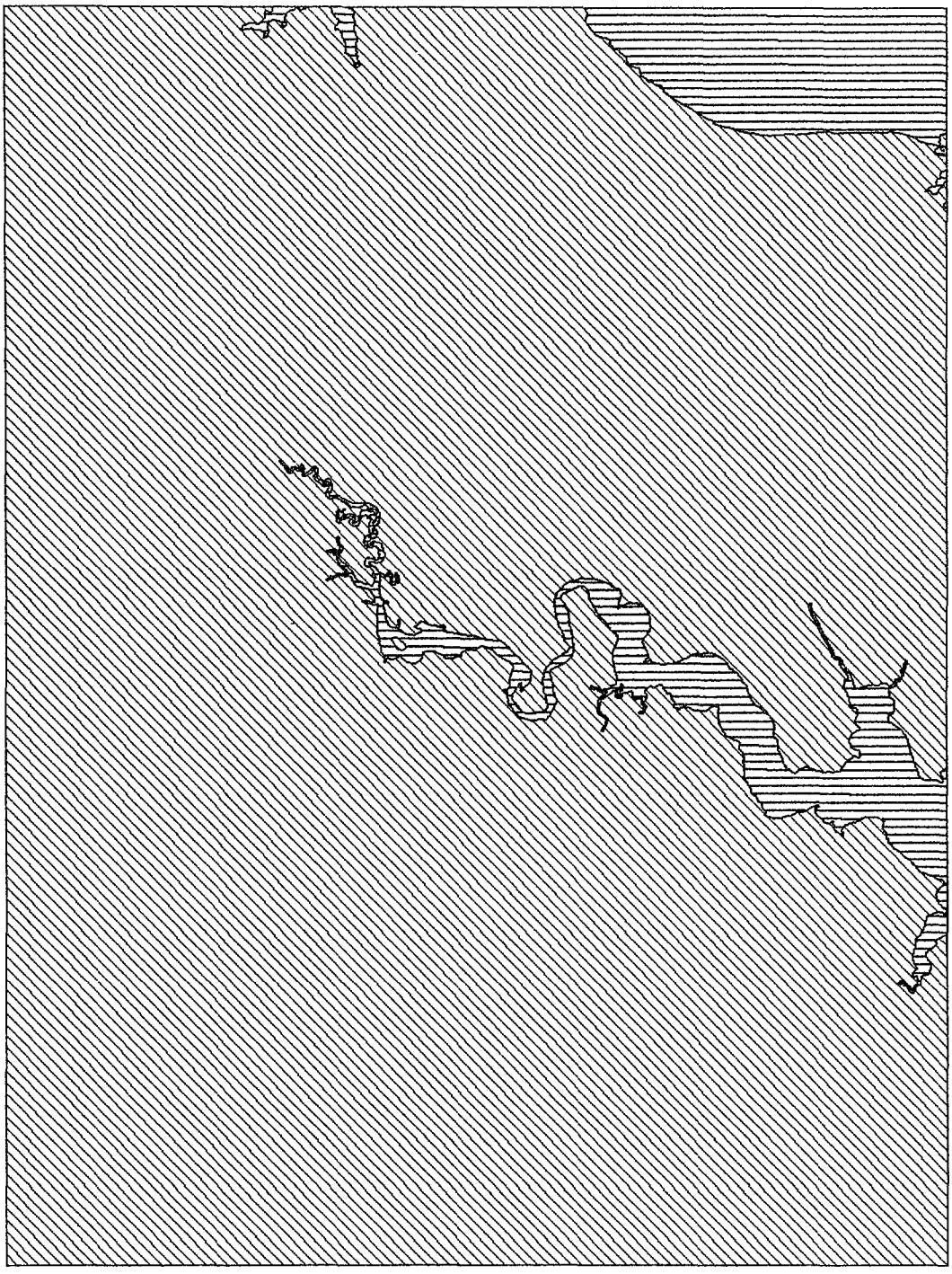
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
ST. GEORGE ISLAND
NORTHUMBERLAND CO

SHL5913

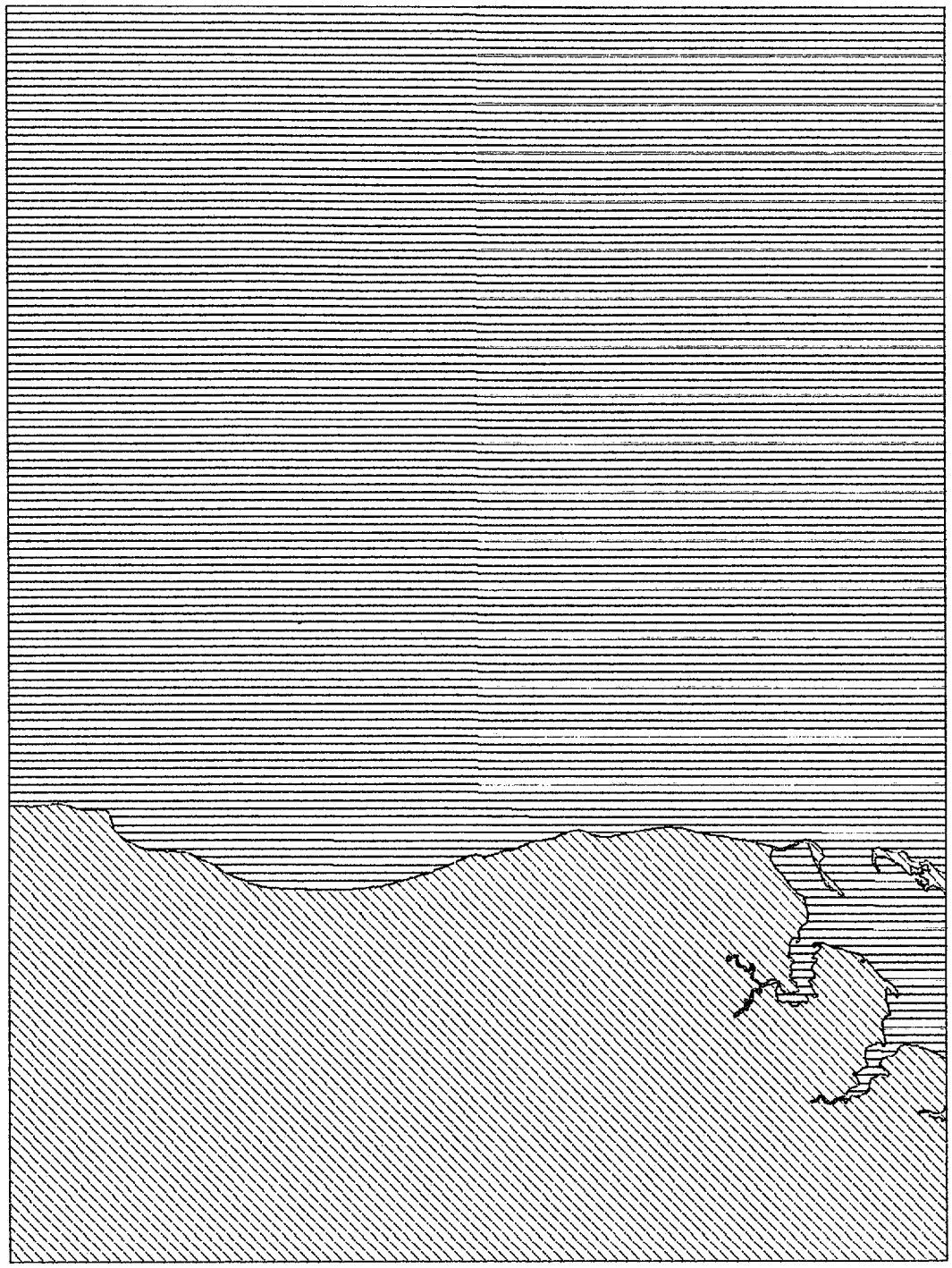
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
SALUDA
MIDDLESEX CO

SHL5809

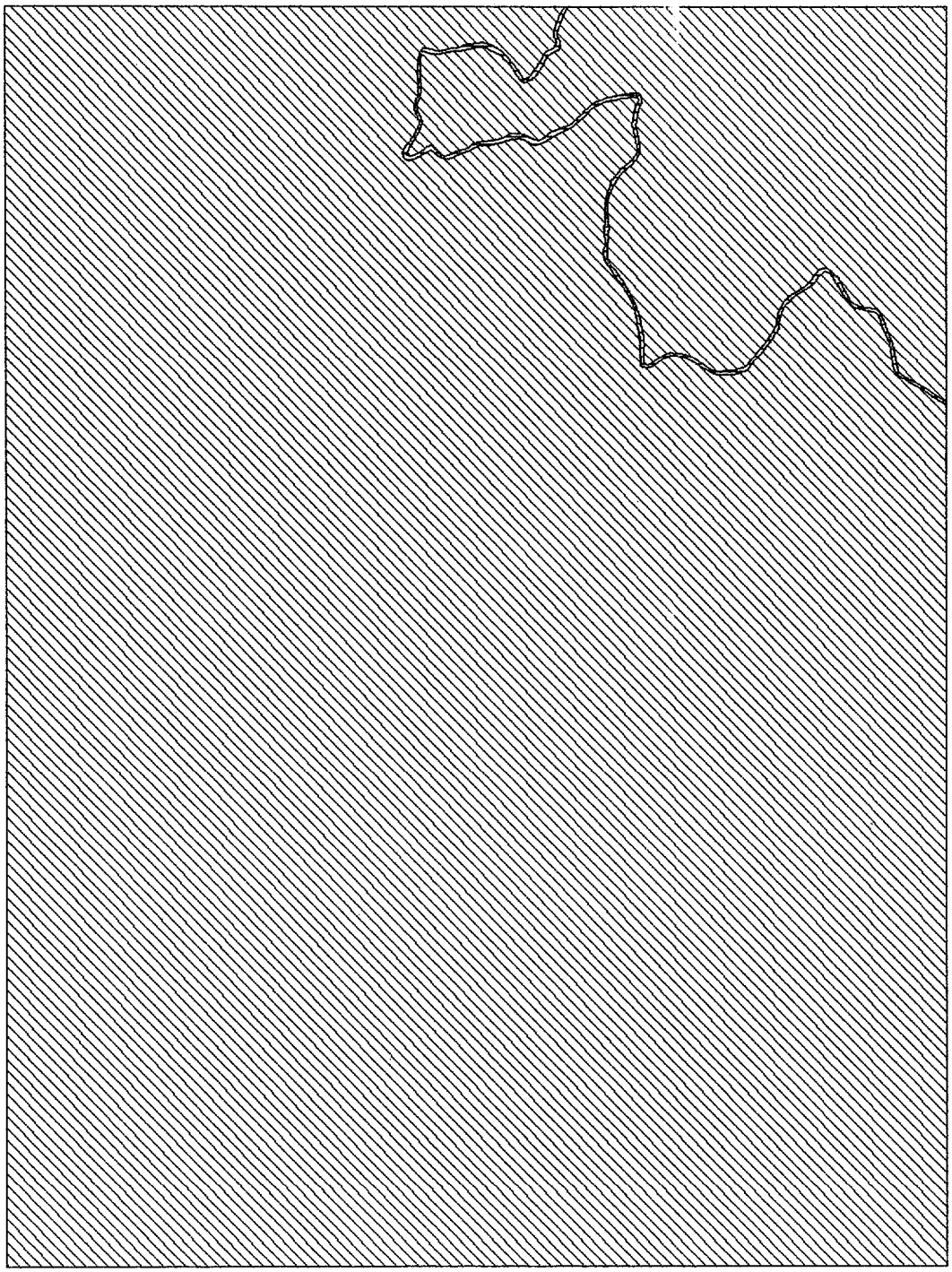
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
STRATFORD HALL
WESTMORELAND CO

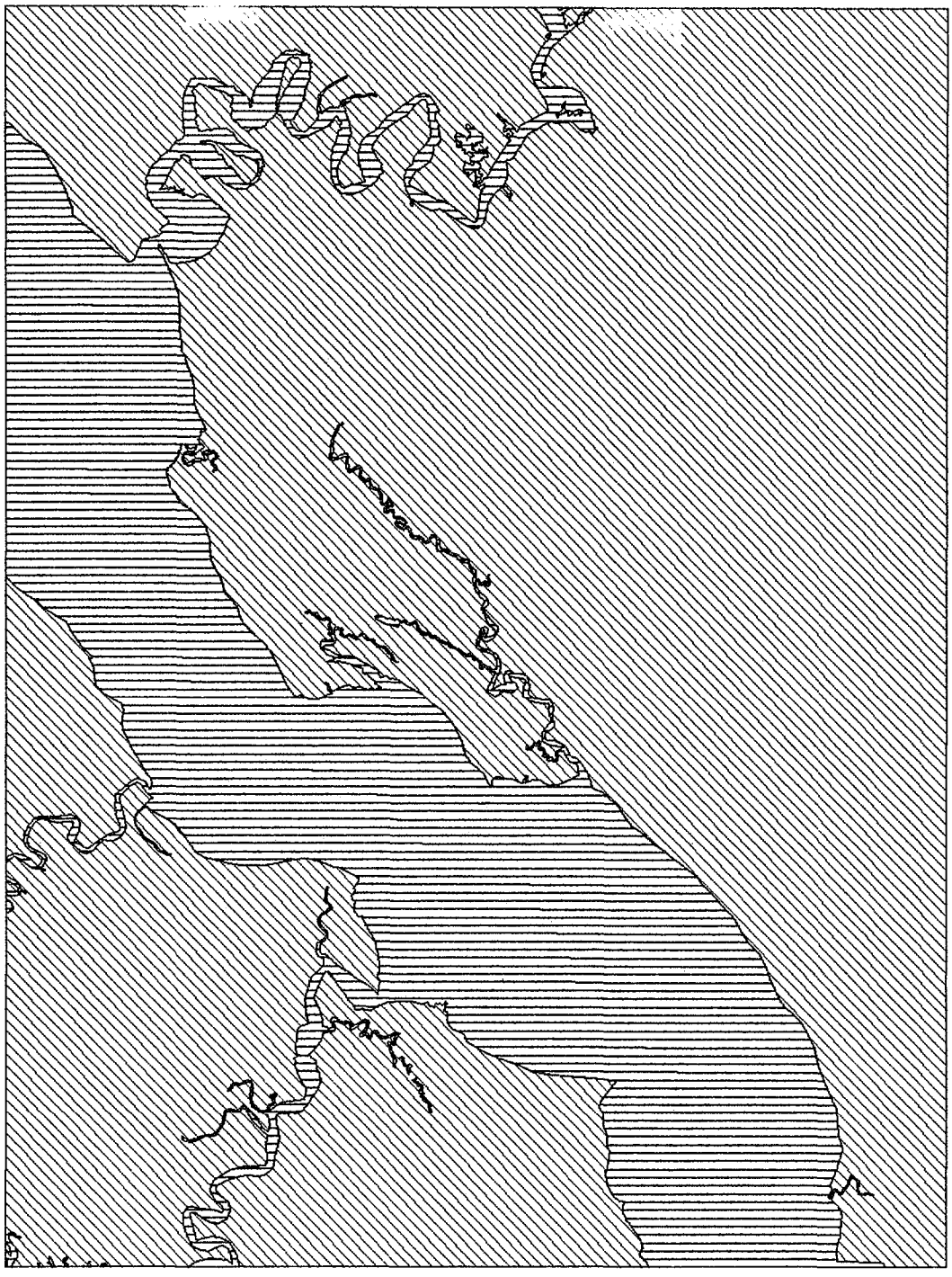
SHL5614

UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
STUDLEY
HANOVER CO

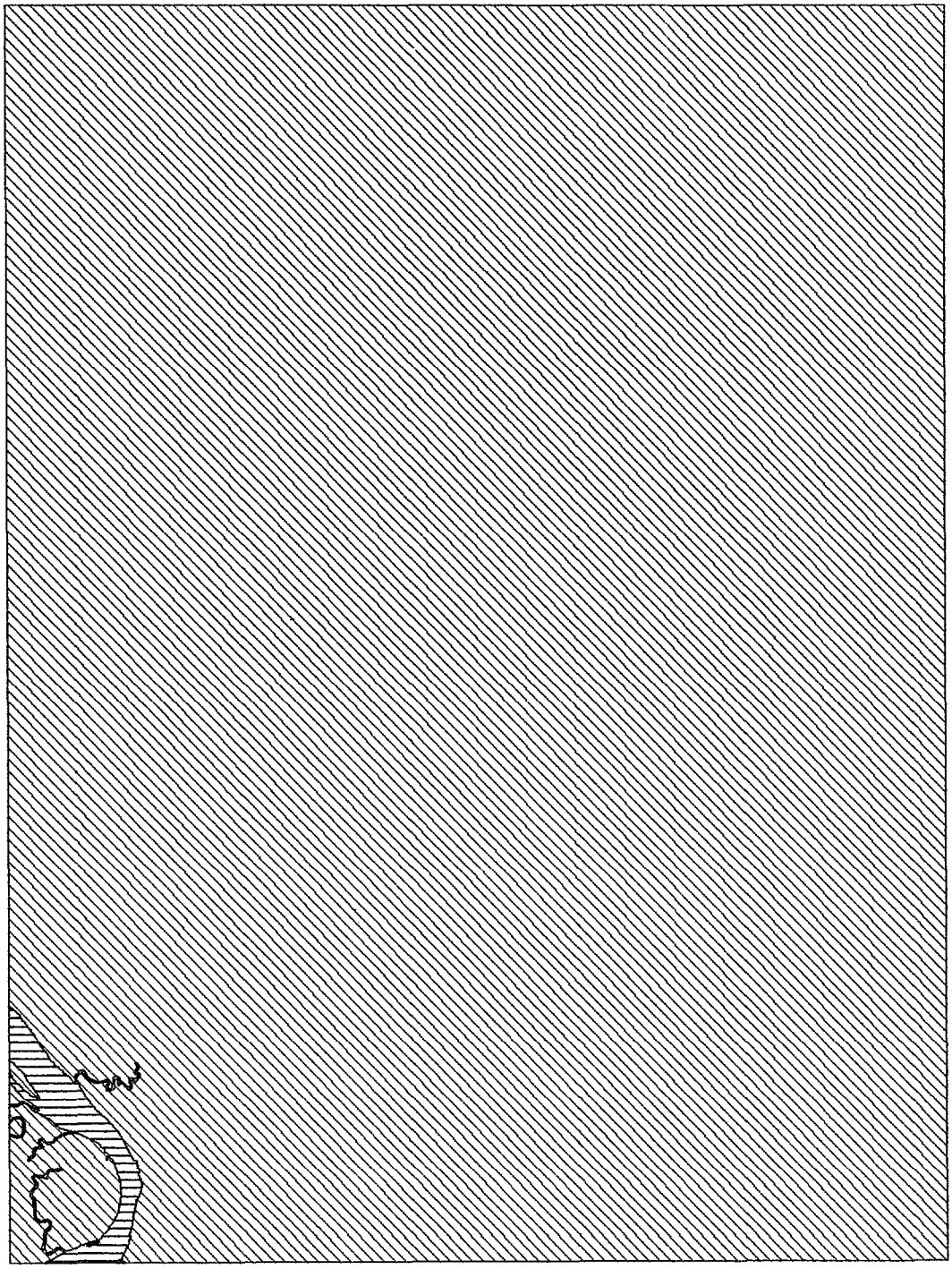
SHL5210
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
TAPPAHANNOCK
RICHMOND CO

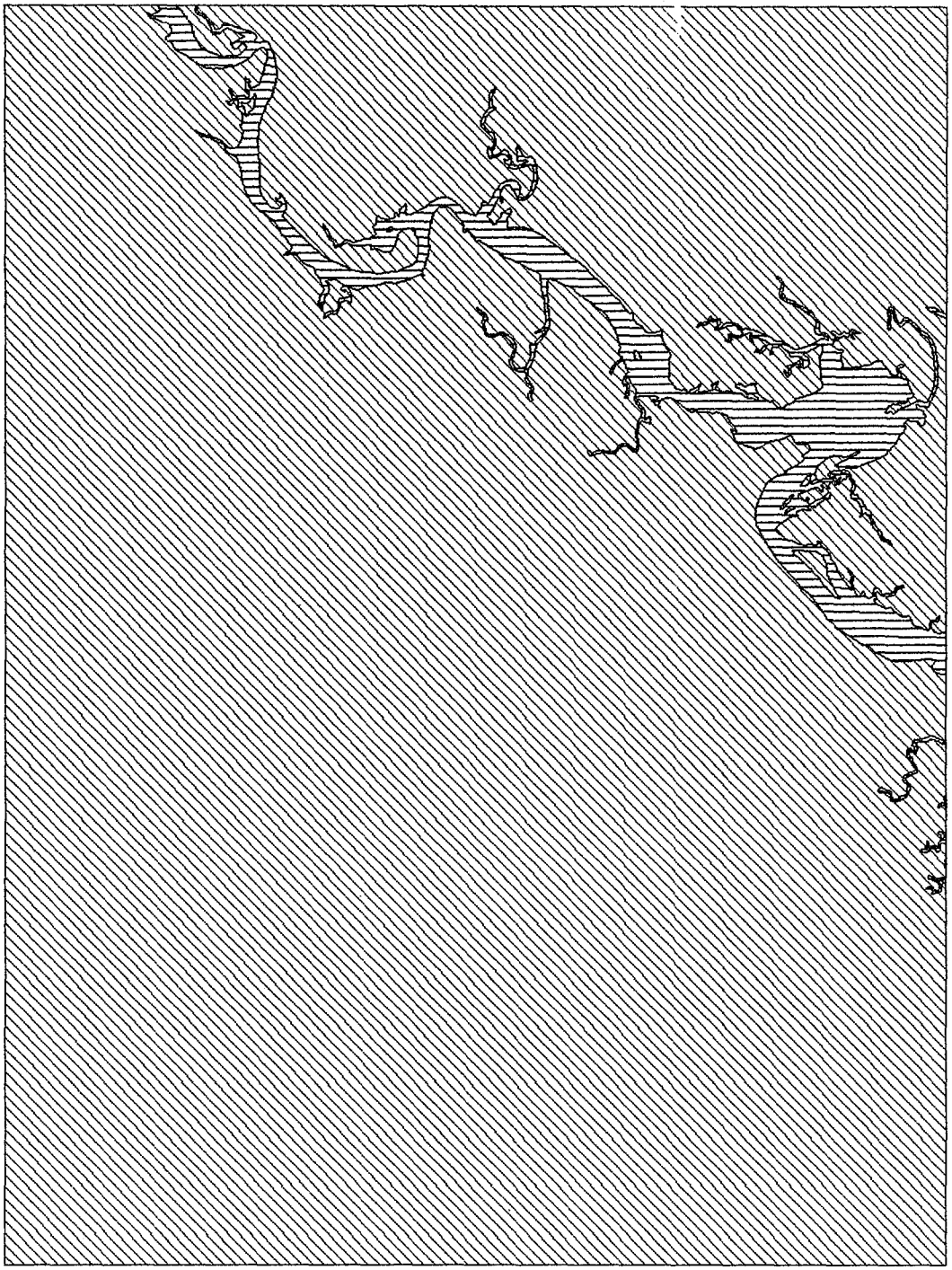
SHL5612

UPLAND
WATER



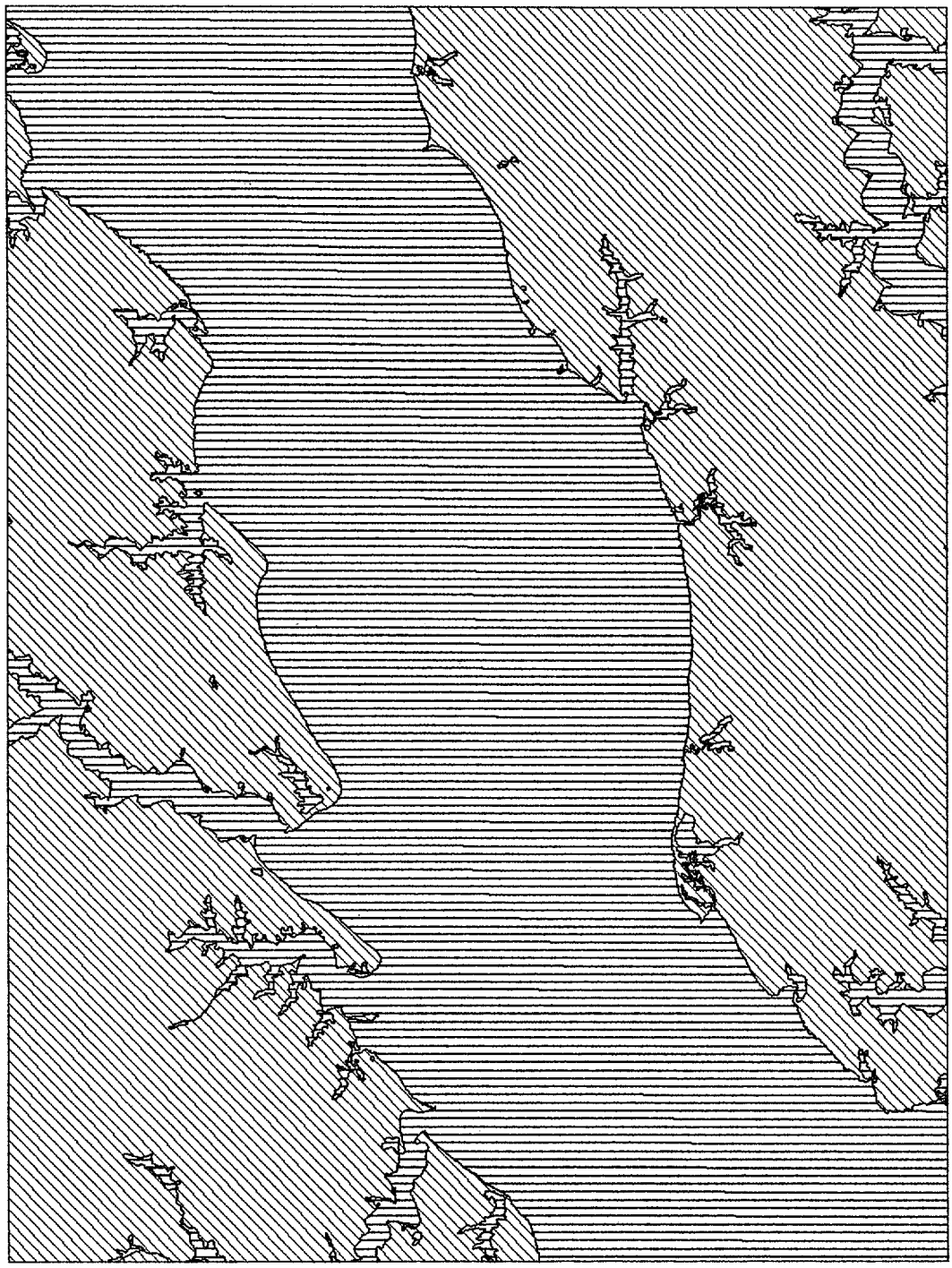
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
TRUHART
KING AND QUEEN CO

SHL5610
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
TUNSTALL
NEW KENT COUNTY

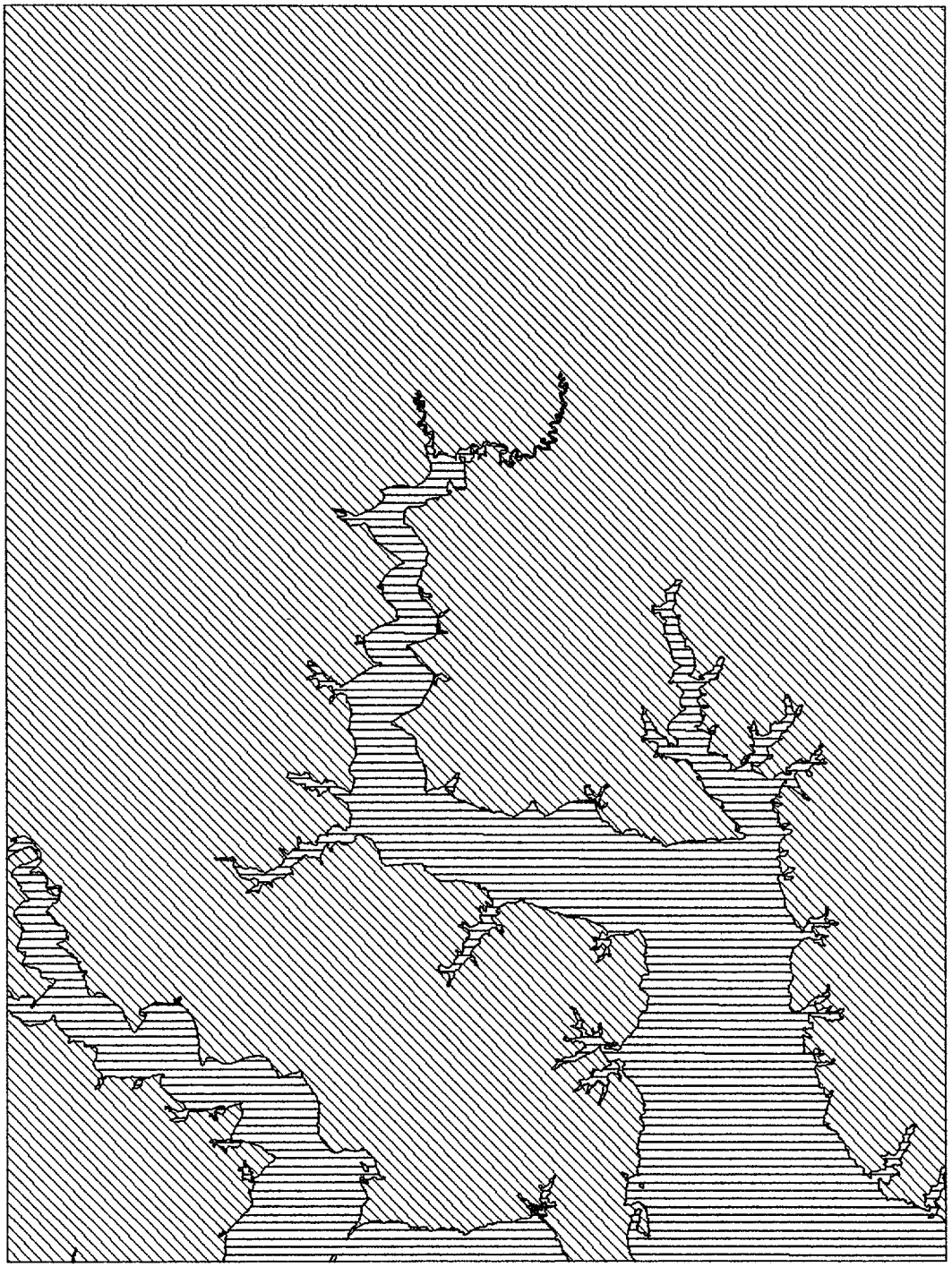
SHL5409
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
URBANNA
LANCASTER CO

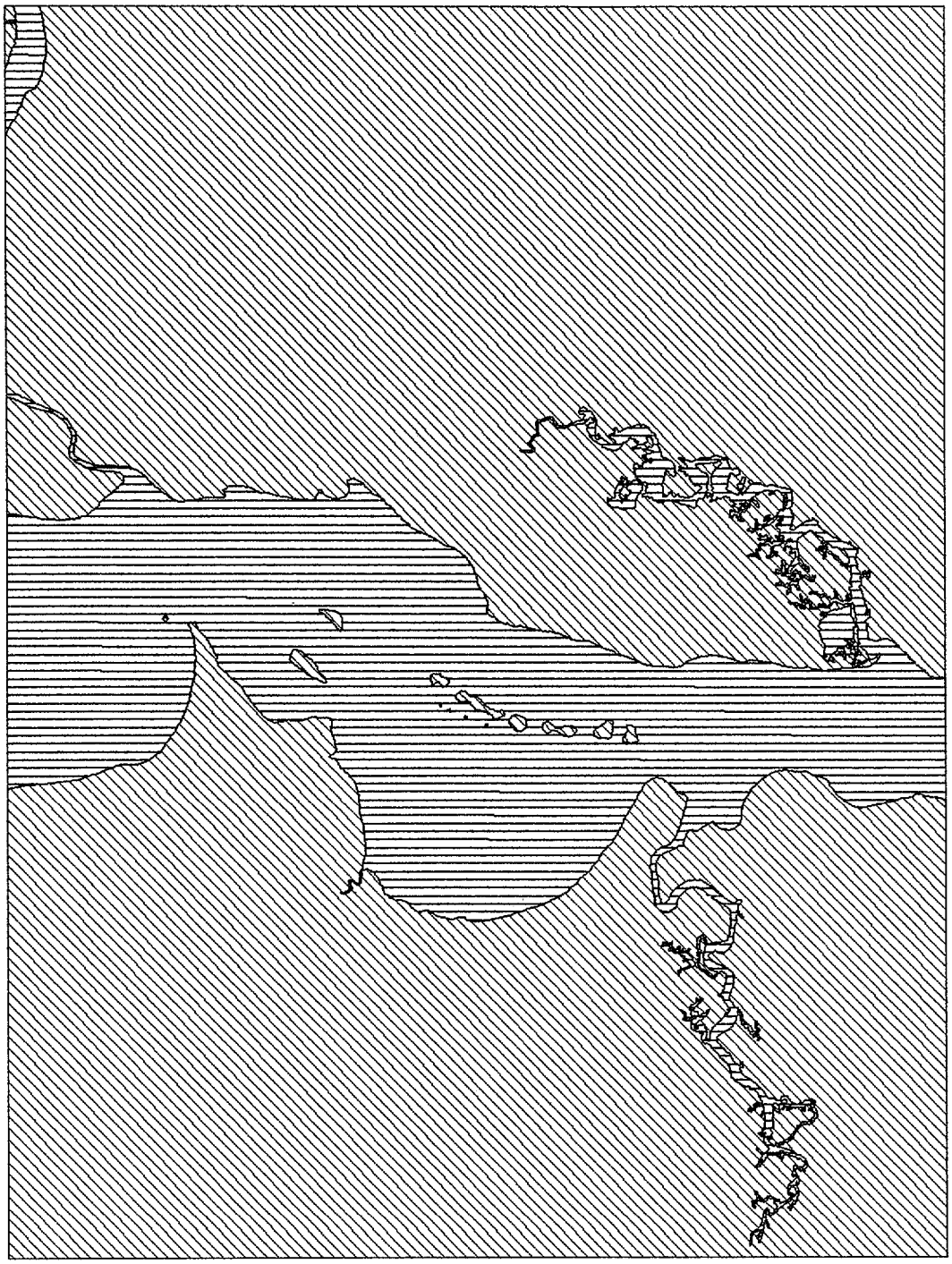
SHL5810

UPLAND
WATER



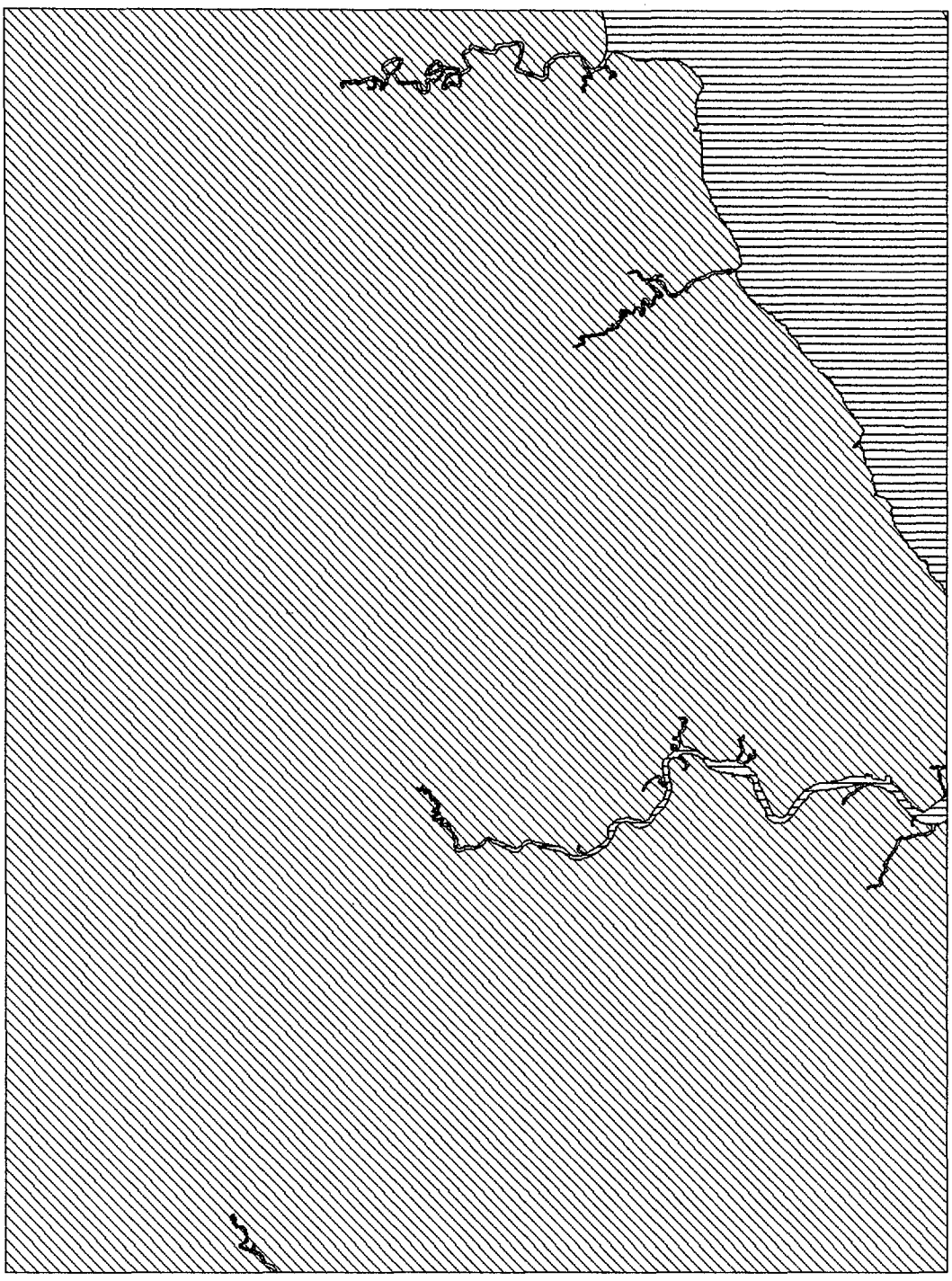
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
WARE NECK
GLOUCESTER CO

SHL5908
UPLAND
WATER



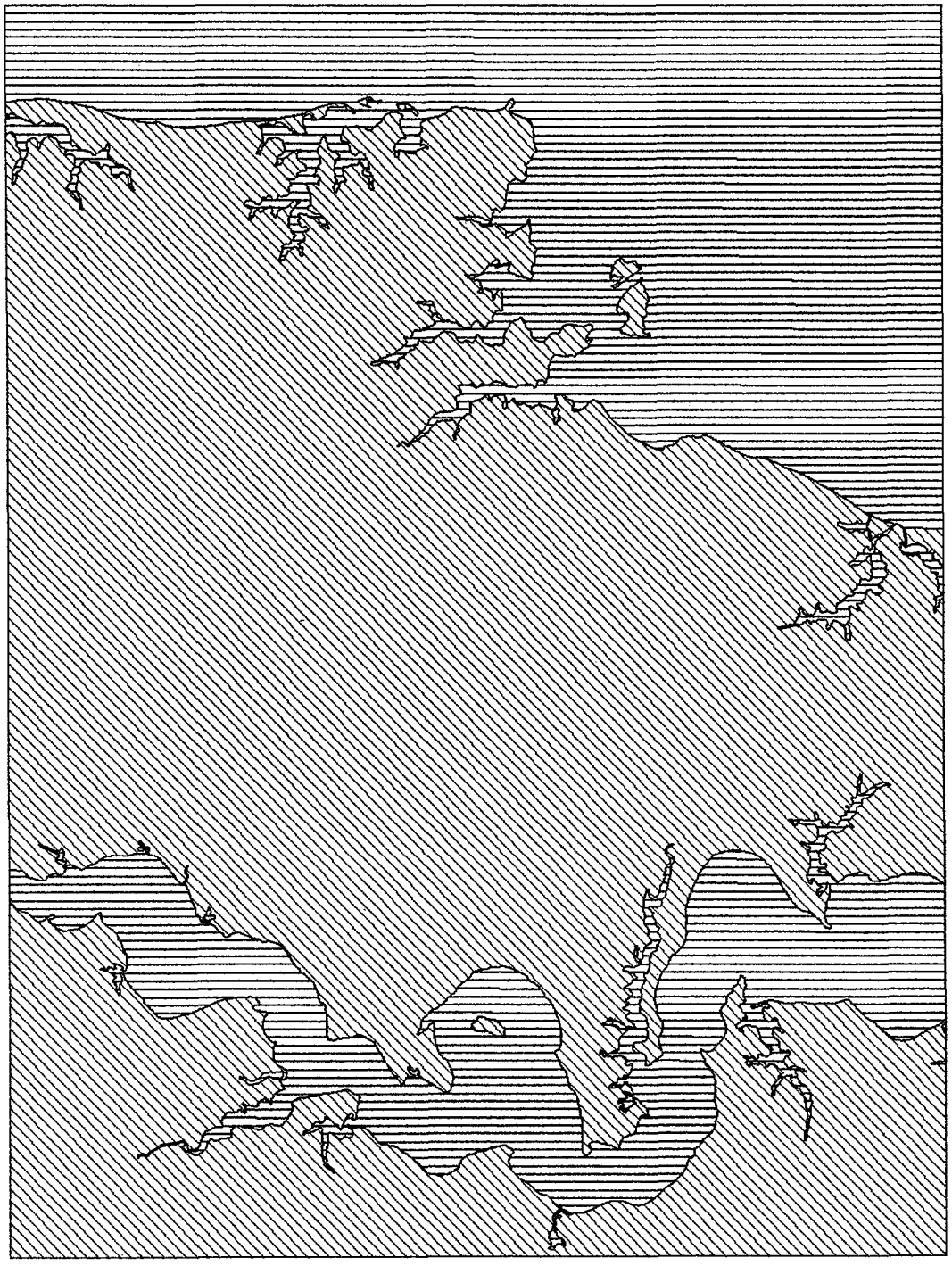
VIMS COASTAL INVENTORIES
1:24000 SHORELINE
WESTOVER
CHARLES CITY COUNTY

SHL5307
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
WILLIAMSBURG
YORK COUNTY

SHL5707
UPLAND
WATER



VIMS COASTAL INVENTORIES
1:24000 SHORELINE
WILTON
MIDDLESEX CO

SHL5909

UPLAND
WATER

CHAPTER III. VMRC SHORELINE COVERAGE

III. VMRC SHORELINE COVERAGE

Introduction.

A GIS-based coastal inventory is absolutely dependent on one critical element: a high-resolution, accurate baseline shoreline position. All data layers collected subsequently and all historical information will be referenced to this GIS-defined datum. Because a database is only as accurate as its coarsest layer, the baseline establishes the maximum resolution to which all other data sets aspire. The salient characteristics of the baseline shoreline are:

* Highest resolution (largest scale) of all expected data

* Most accurate of available data sets, as established by extensive ground-truthing and verification

* High precision levels; can be replicated

* Well-documented

Virginia Marine Resources Commission (VMRC) Shoreline Maps.

An extensive research effort was undertaken to determine the most accurate and most extensive shoreline database available for the State of Virginia. After reviewing existing information at federal and state repositories, including the U.S. Geological Survey, National Ocean Service, various Office of Coastal Resource Management contractors, and extant digital shoreline databases at the University of Virginia, it was determined that the Virginia Marine Resources Commission (VMRC) had produced the most accurate, recent, and extensive shoreline maps.

The VMRC maps were produced at a 1:5000 scale from a 1976 aerial survey of selected portions of Virginia's tidal shorelines (Figure 1) undertaken to delineate oyster ground lease boundaries. Double precision mapping techniques were employed throughout. In addition, extensive ground surveying and reconnaissance checks were undertaken by VMRC staff to assure map accuracy. The relatively large scale of these maps (1:5000, or 1" = 416') permits these data to be used to address local as well as regional environmental planning issues.

Shoreline Data Entry.

Original stable-base drafts of the 1976 VMRC shoreline maps were reproduced on double matte mylar by a local engineering service agent. The original map drafts are stored at the VMRC office in Newport News, Virginia. The mylar copies and the digital record are housed at the Coastal Inventory Facility, College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, Virginia. Public access to the information may be achieved through the Council on the Environment, ECOMAPS Program, Richmond, Virginia, which retains digital files of all data collected in the Comprehensive Coastal Inventory.

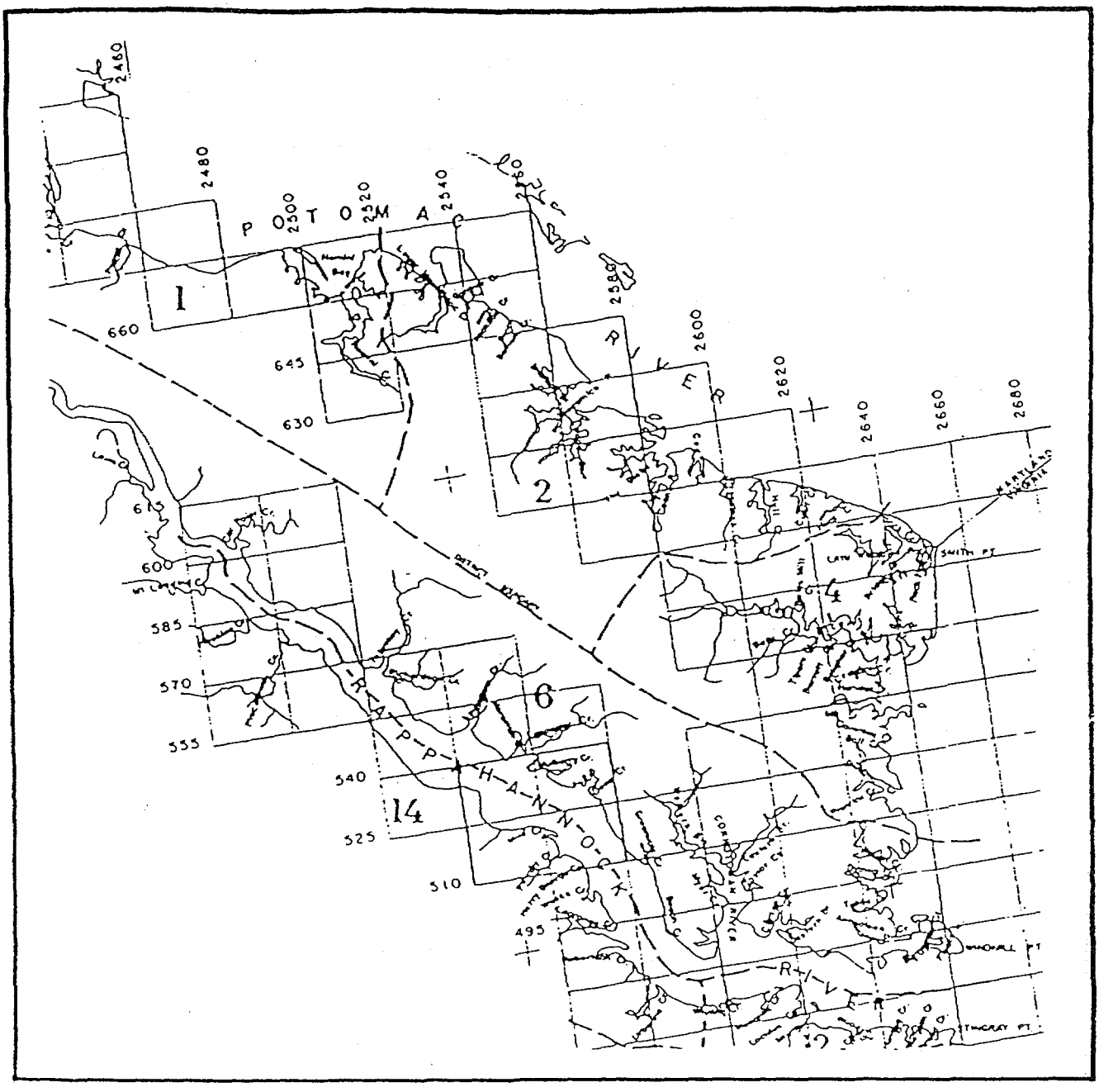


FIGURE 1. Virginia Marine Resources Commission Shoreline Map Index.

The VMRC shoreline maps were digitized using a Numonics 2200 Digitablet[1] interfaced with a Dell 386 personal computer. Data is stored and manipulated through the PC version of the ARCInfo® software package. ARCInfo® is a vector-based GIS that allows the user to store, superimpose, and transform geographic data layers.

Data are entered directly from the tablet in inches relative to the Digitablet grid. Corners of the mapped section are identified by actual geographic positions related to a network of surveyed benchmarks. A transformation procedure is performed to translate digital inches into state plane coordinates. Map features are entered and stored at the map scale of 1:5,000; however, they can be retrieved and plotted at any scale.

Use of tradenames is for descriptive purposes only and does not imply endorsement of this product.[2]

---

[1] Use of tradenames is for descriptive purposes only and does not imply endorsement of the product.

[2] Use of tradenames is for descriptive purposes only and does not imply endorsement of the product.

GEOGRAPHIC DATA SET DESCRIPTION

VIMS GIS Lab Prefix MRC

Data Layer Name MARINE RESOURCES SHORELINE

Description SHORELINE SURVEYED BY MARINE RESOURCES COMMISSION TO DELINEATE OYSTER GROUND LEASES

Year(s) Collected 1976

Base Maps used for Digitizing SHORELINE MAP (MYLAR MEDIUM)

Digitizing Scale 1:5000

Geographic Extent COASTAL VIRGINIA

How Collected (Describe):

SHORELINE MAPS WERE FROM AERIAL IMAGERY AND DOUBLE PRECISION FIELD RECONNAISSANCE SURVEYS.

Actual/Intended Use or Purpose:

THIS SHORELINE WILL SERVE AS AN HISTORIC REFERENCE TO SUBSEQUENT SHORELINE COVERAGES NOW BEING CREATED.

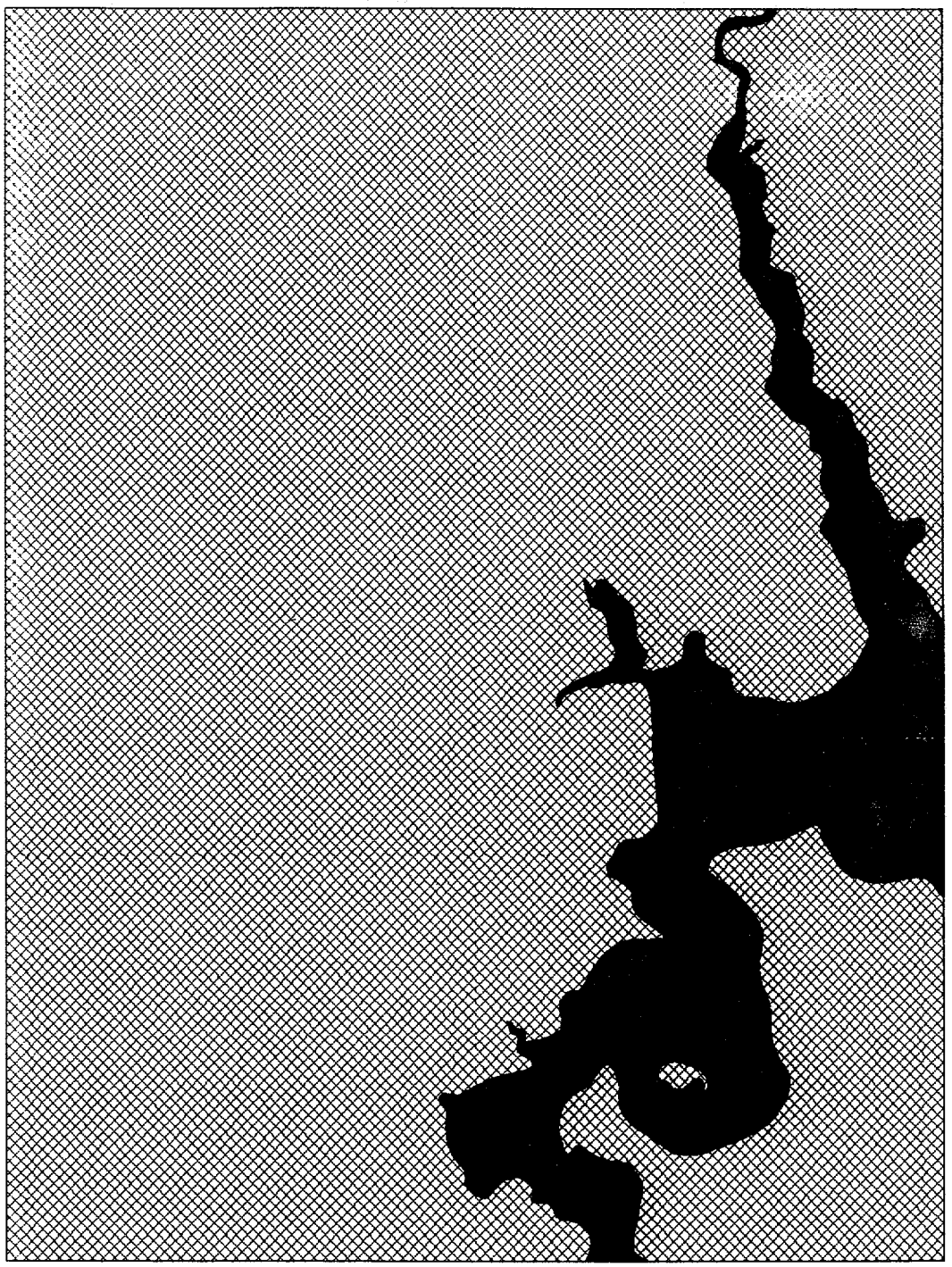
COASTAL INVENTORY

AVERAGE TIME AND DISC SPACE USED*

MARINE RESOURCES COMMISSION SHORELINE
WESTMORELAND COUNTY

MAP NUMBER	TIME	DISC SPACE
7202400	2.75	833536
7202420	1.75	808960
7052400	4.75	837632
7052420	4.75	839680
7052440	2.5	798720
6902420	2.25	823296
6902440	3.25	823296
6752420	5.75	841728
6752440	7.5	843776
6752460	2.5	798720
6602460	5.25	804864
6602480	4.25	908101
6602500	3.5	942080
6602520	3.5	2250752
6602540	5.75	833536
6452500	6.25	882688
6452520	4.75	907264
6452540	7.5	856064
6452560	4.25	908101
6302500	3.5	841728
6302540	5.0	835584
6302560	4.25	849920
6152540	4.25	908101
6152560	4.25	908101
6002540	2.5	819200
6002560	3.25	905216
AVERAGE	4.25	908102

*TIME IN HOURS, DISC SPACE IN BYTES



MARINE RESOURCES SHORELINE

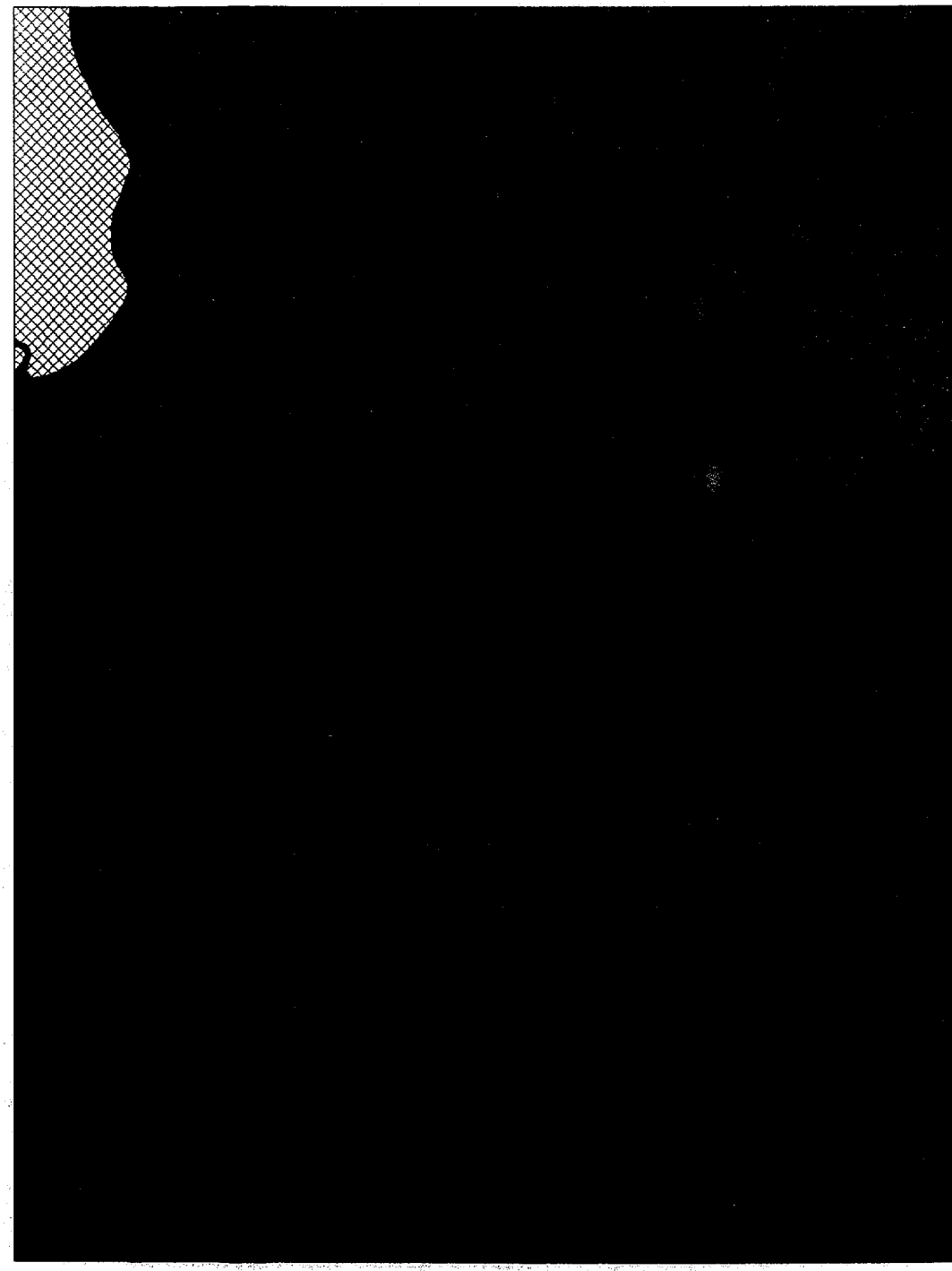
7202400

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

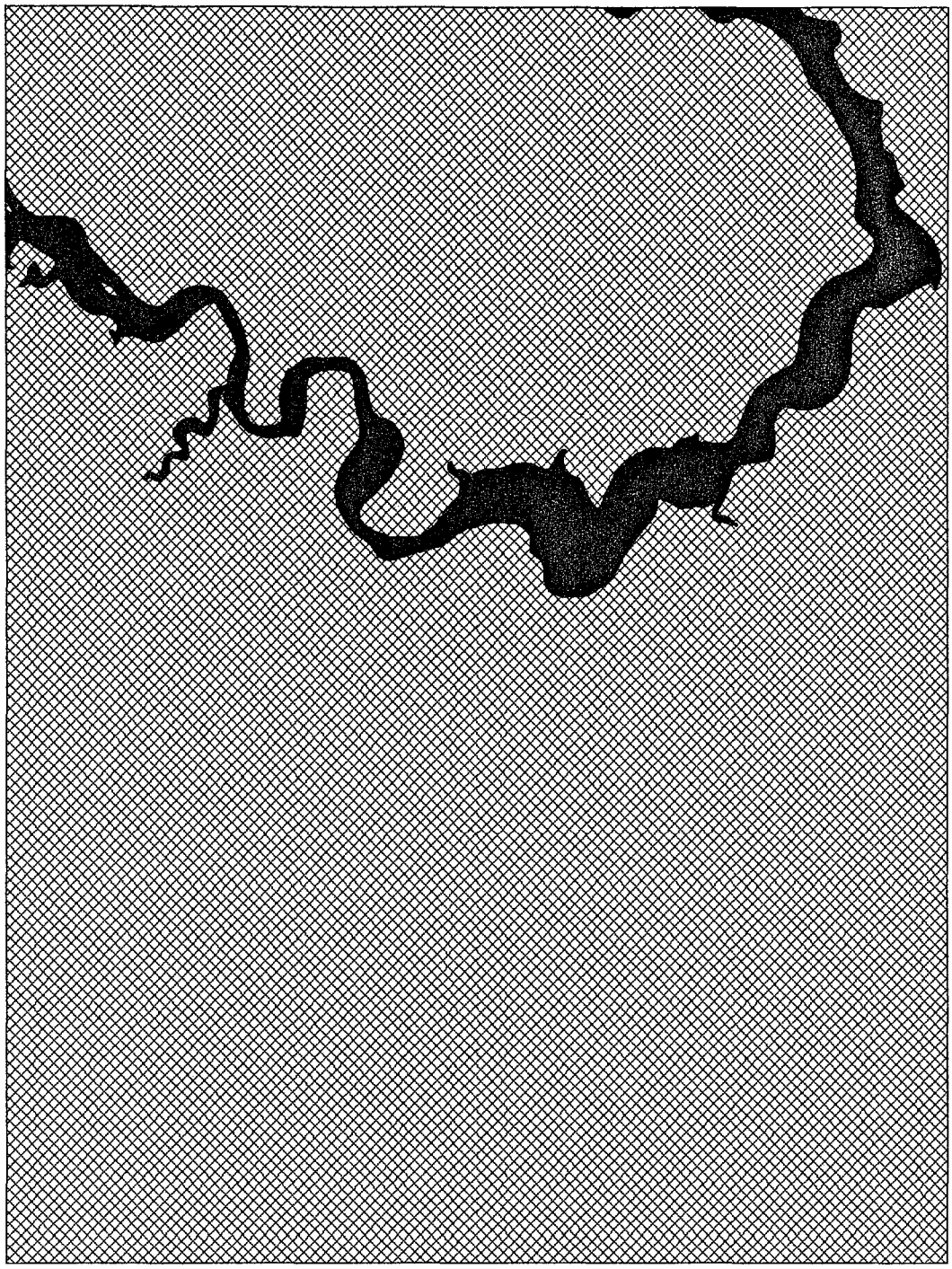
7202420

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

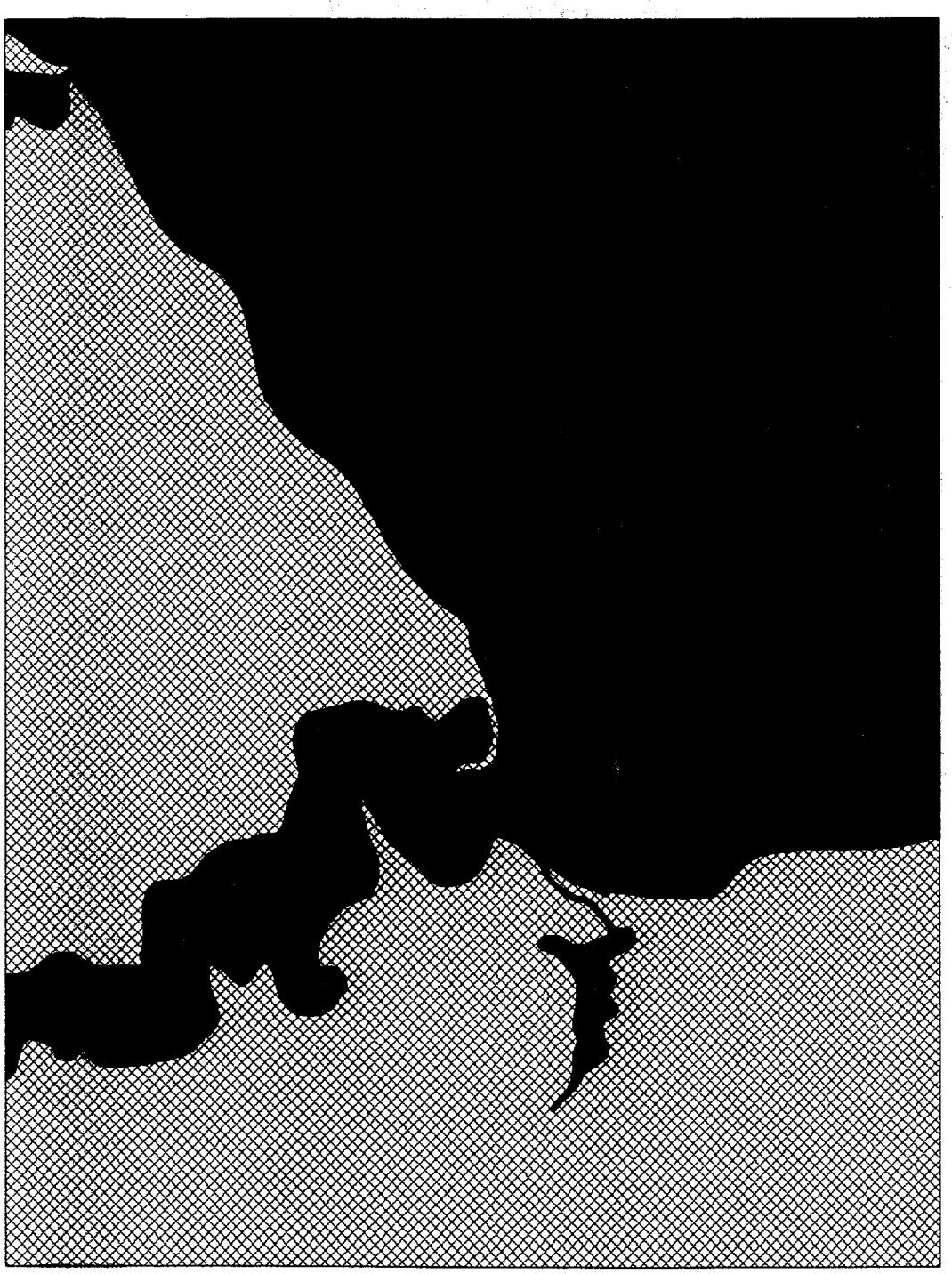
7052400

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

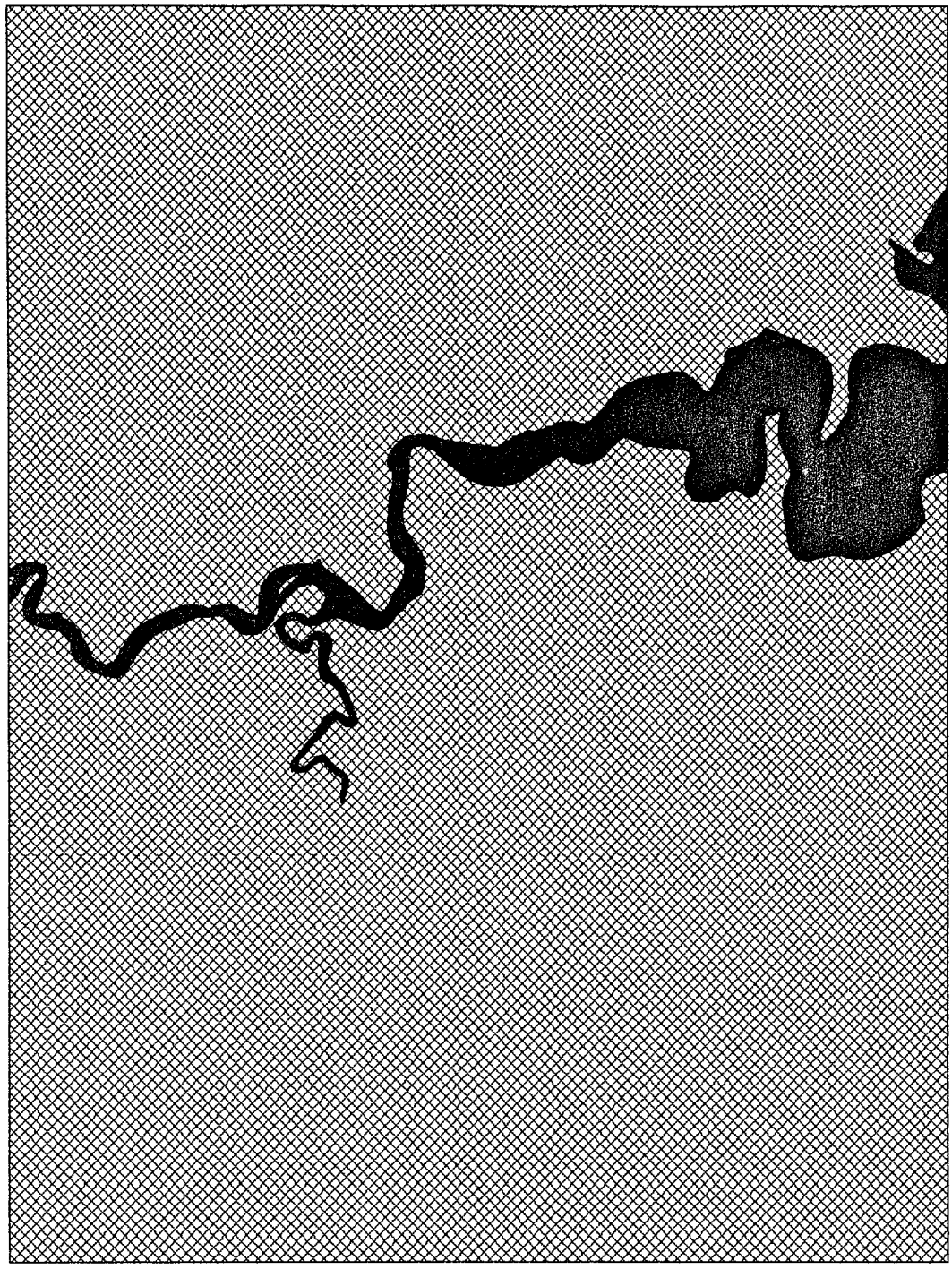
7052420

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

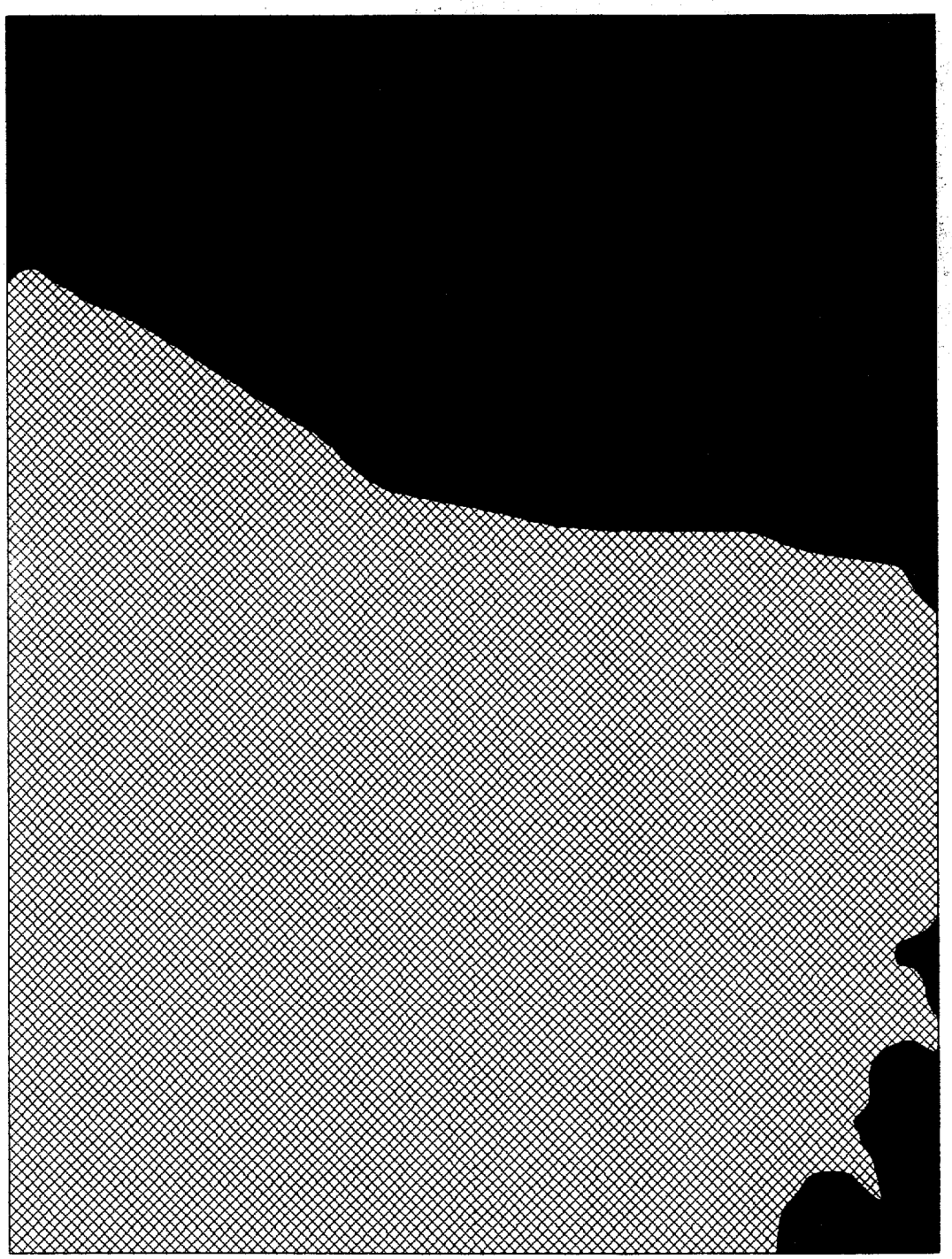
6752420

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

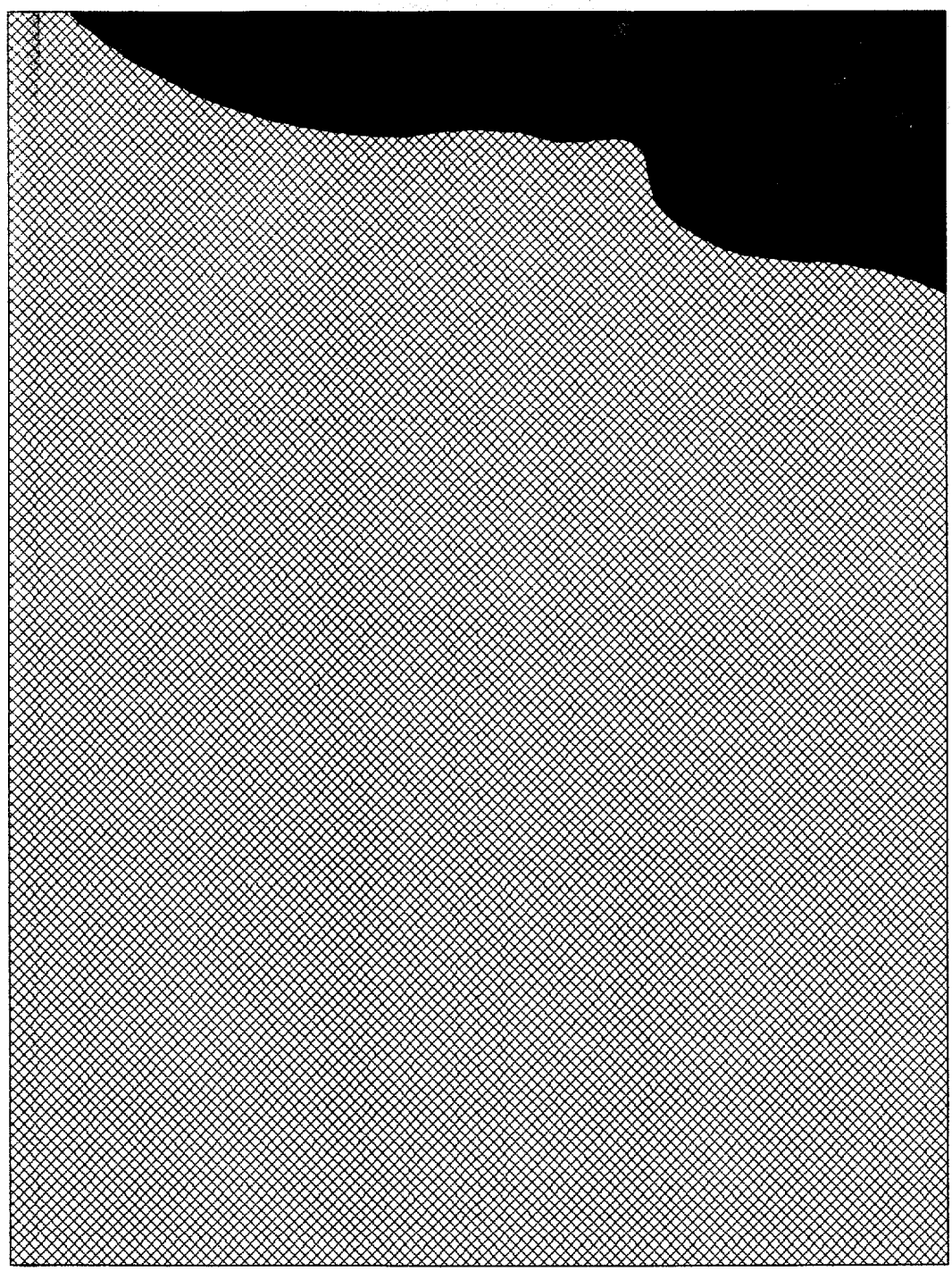
6752440

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

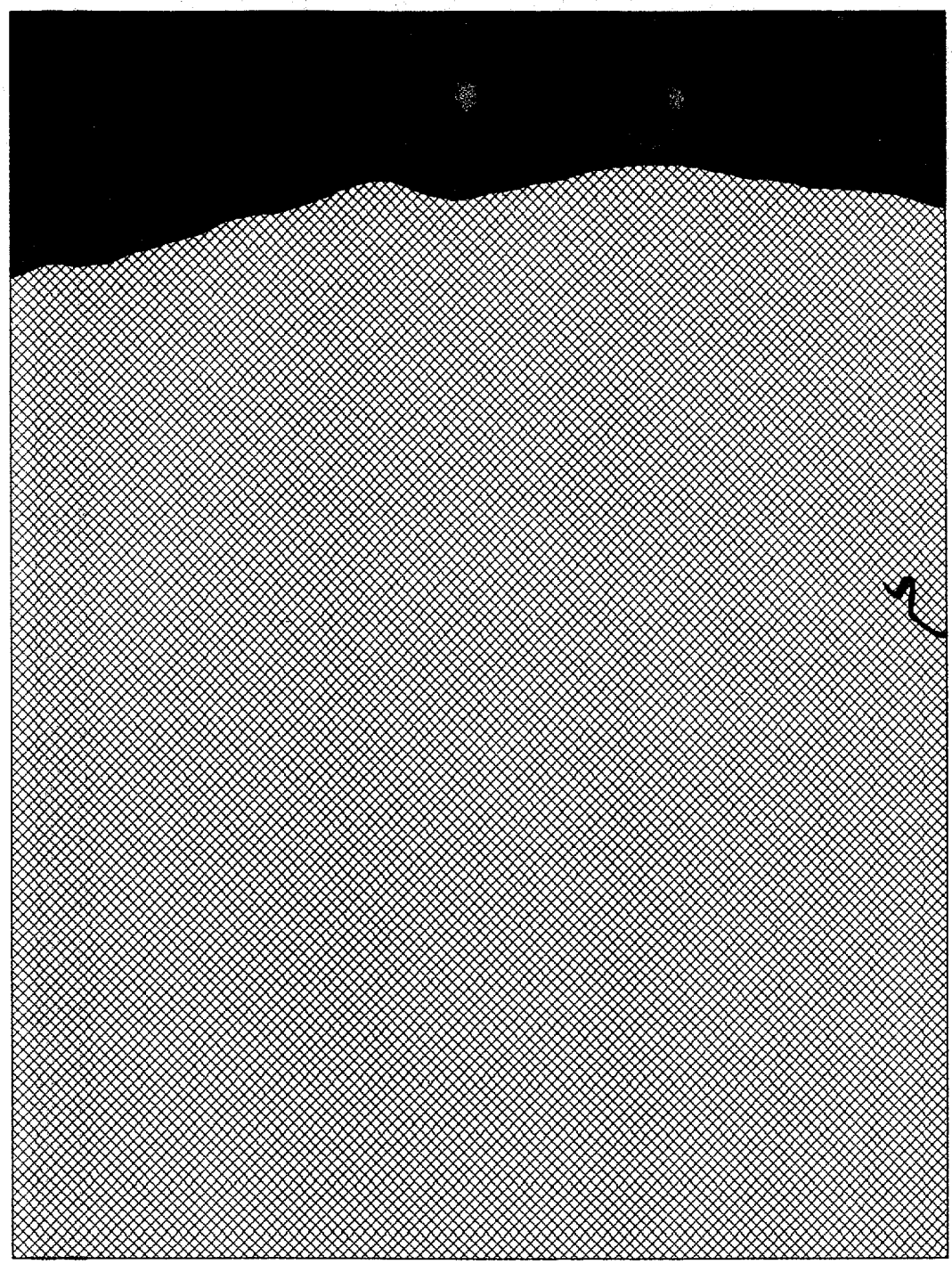
6602460

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

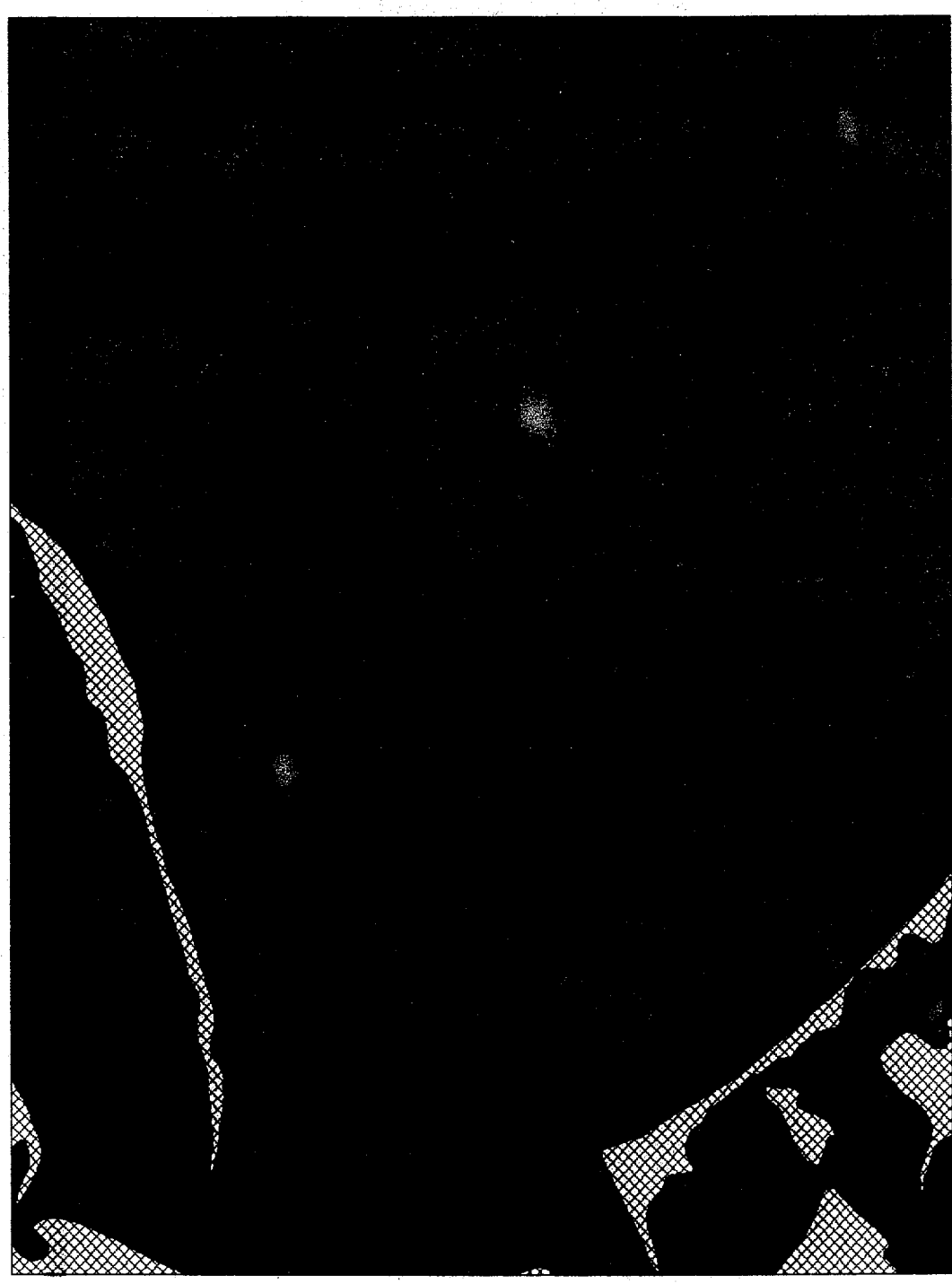
6602480

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

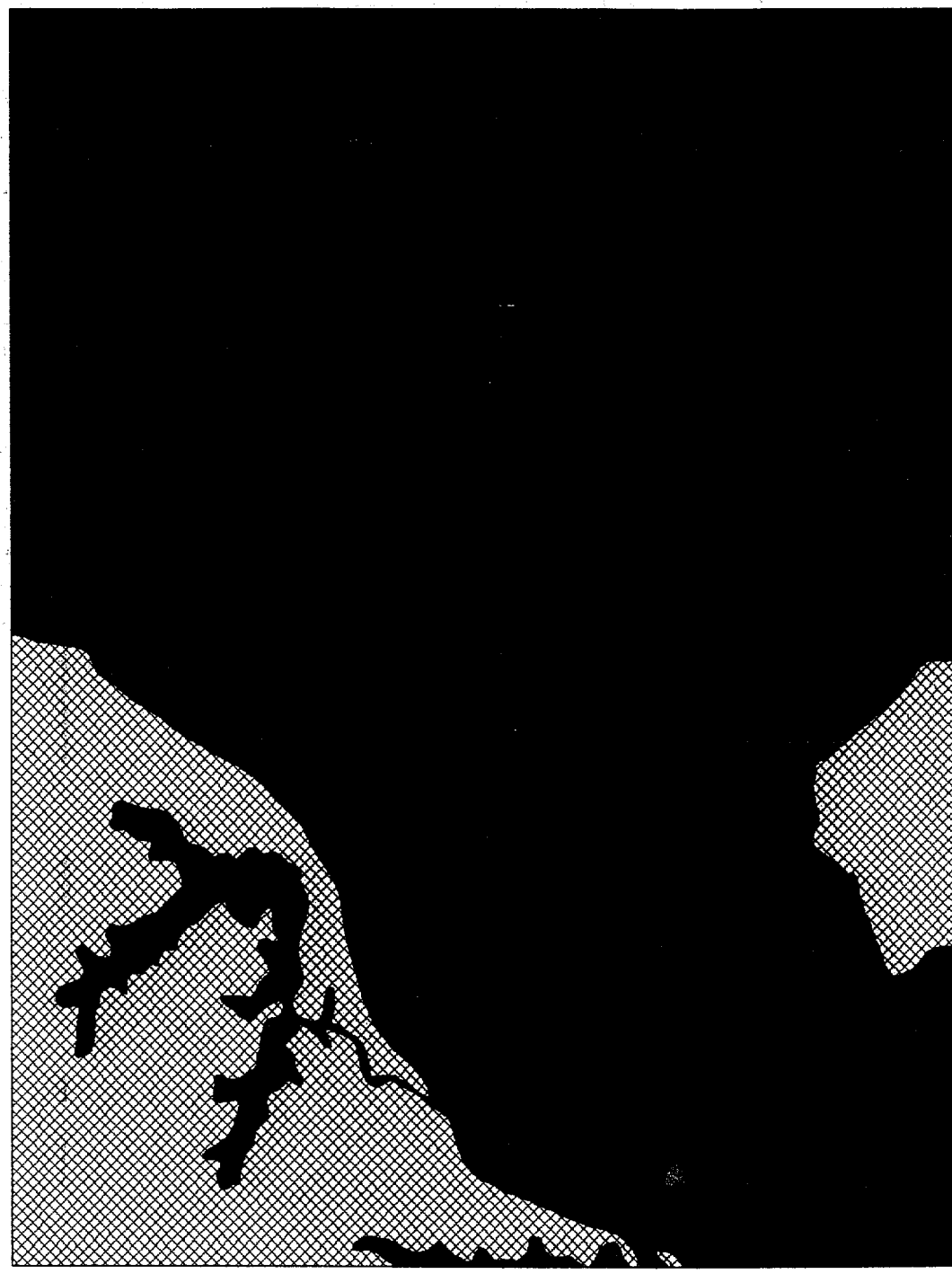
6602500

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

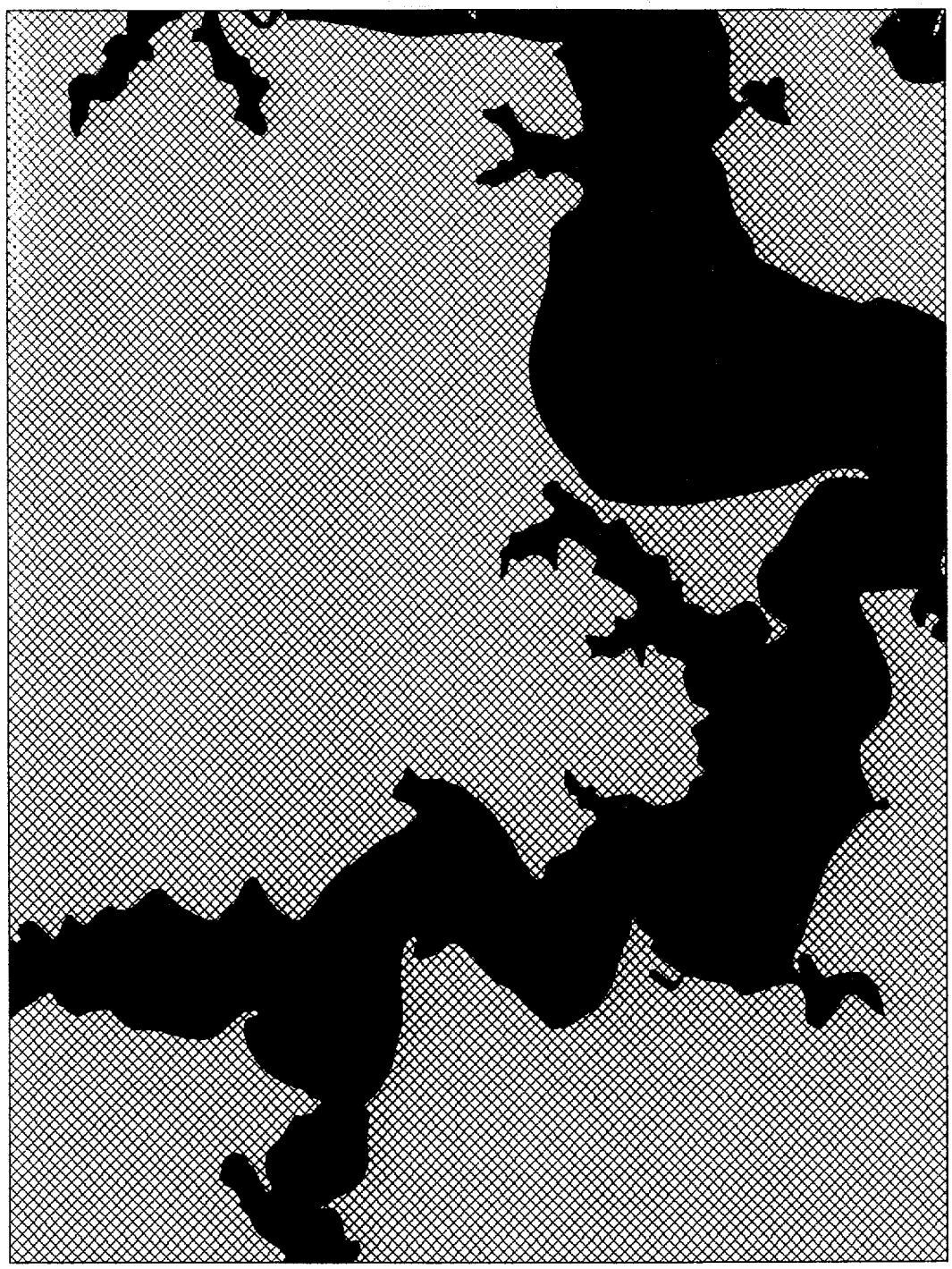
6602520

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

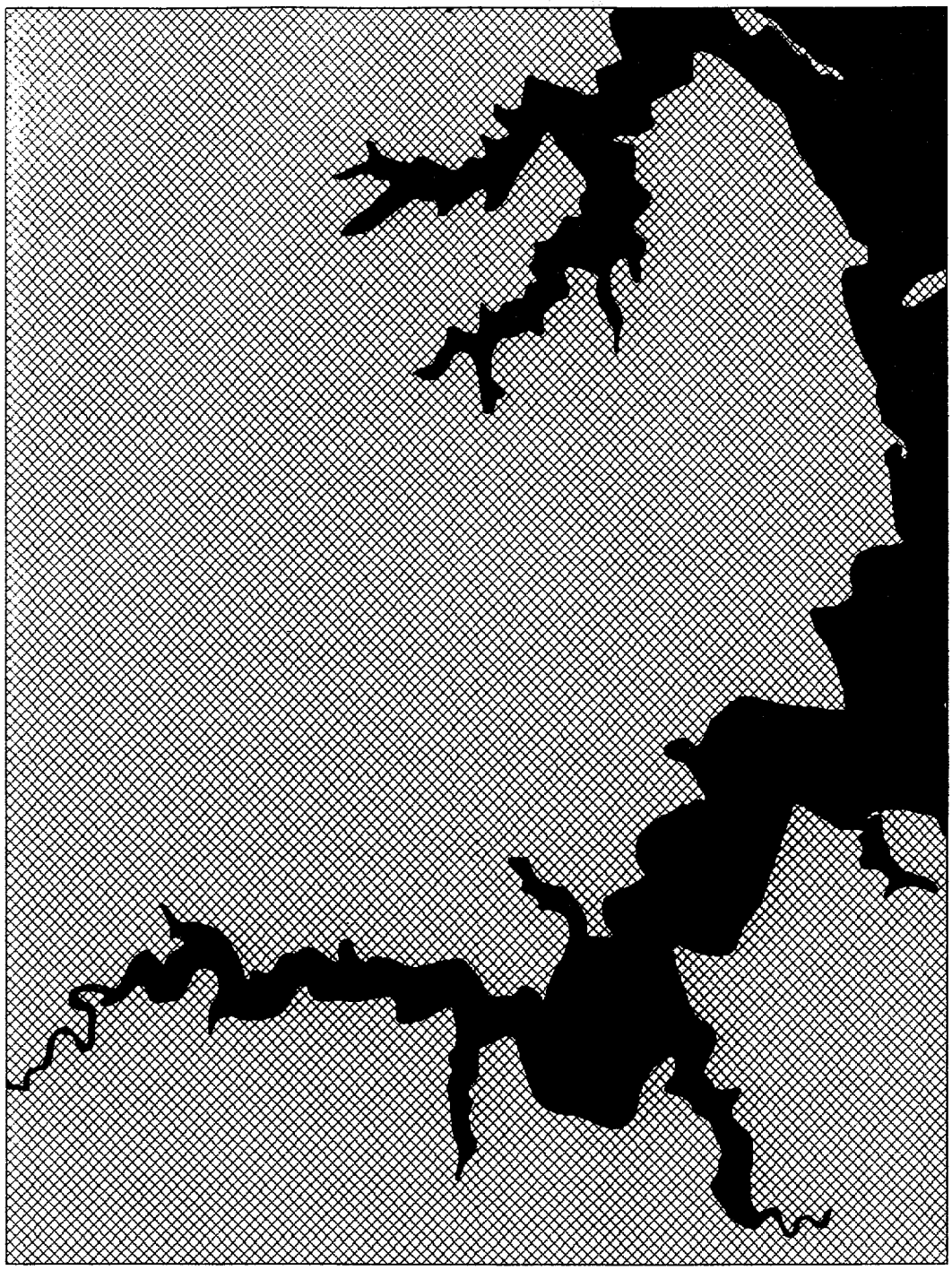
6452500

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

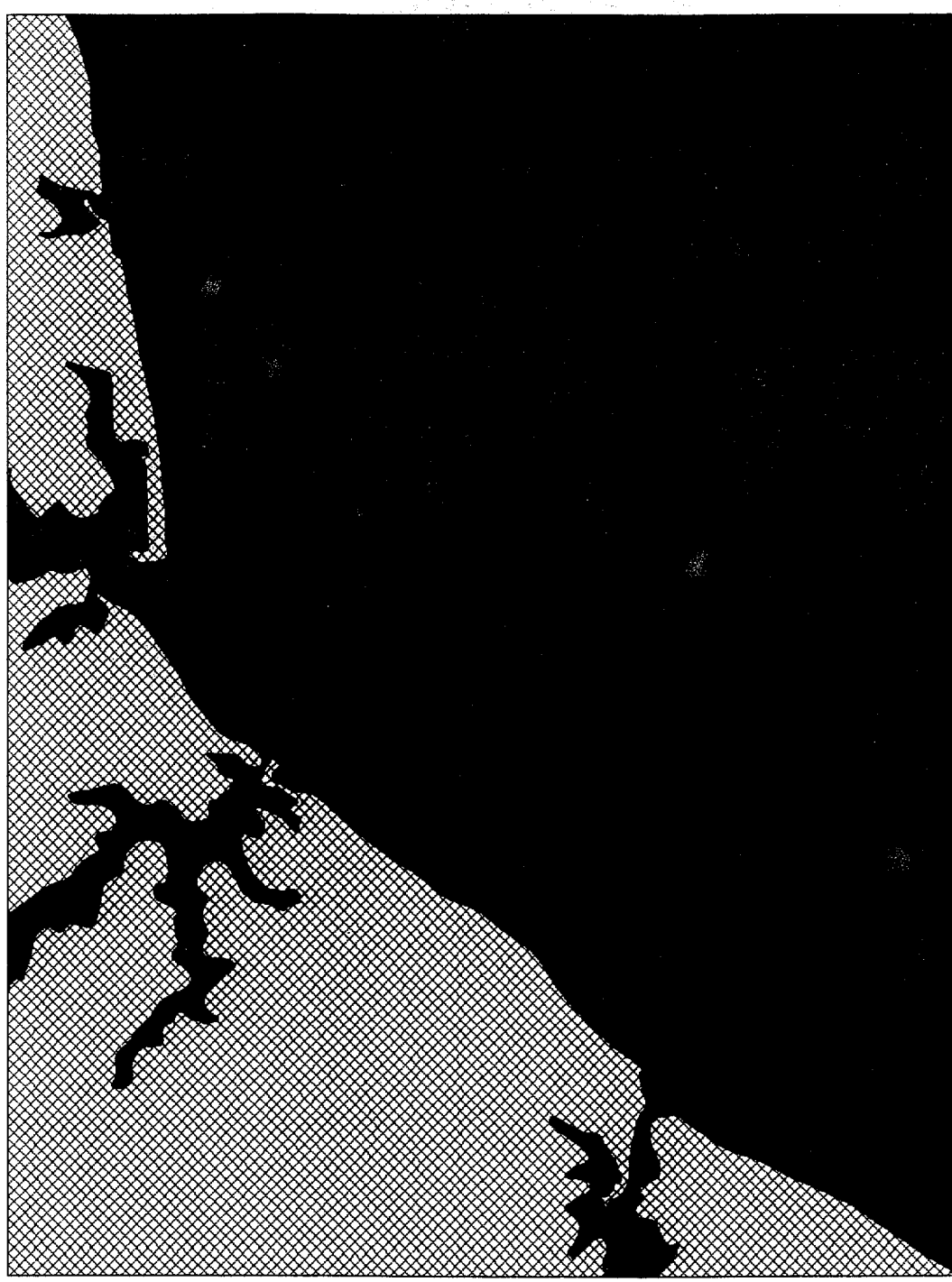
6452520

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

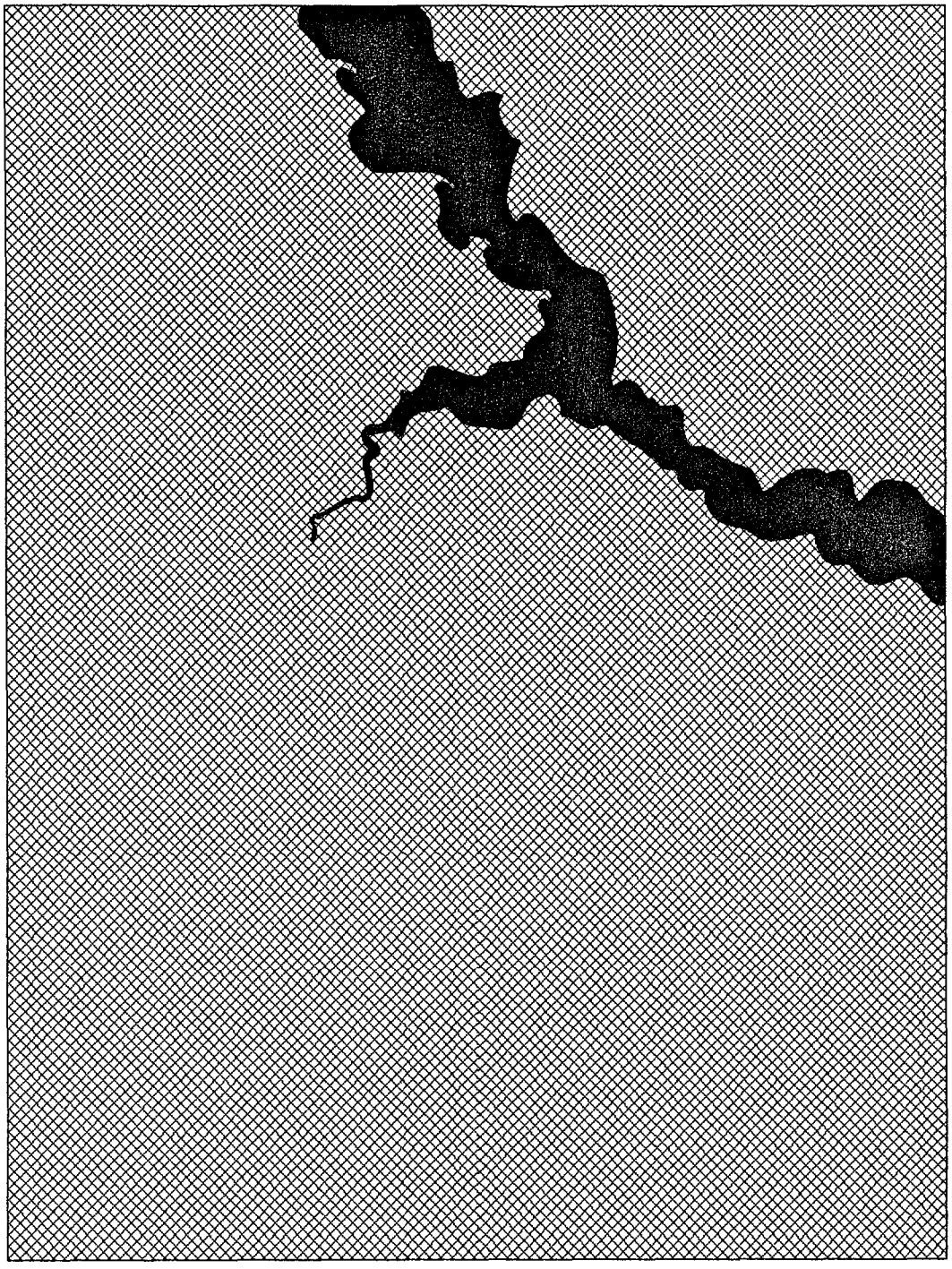
6452540

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

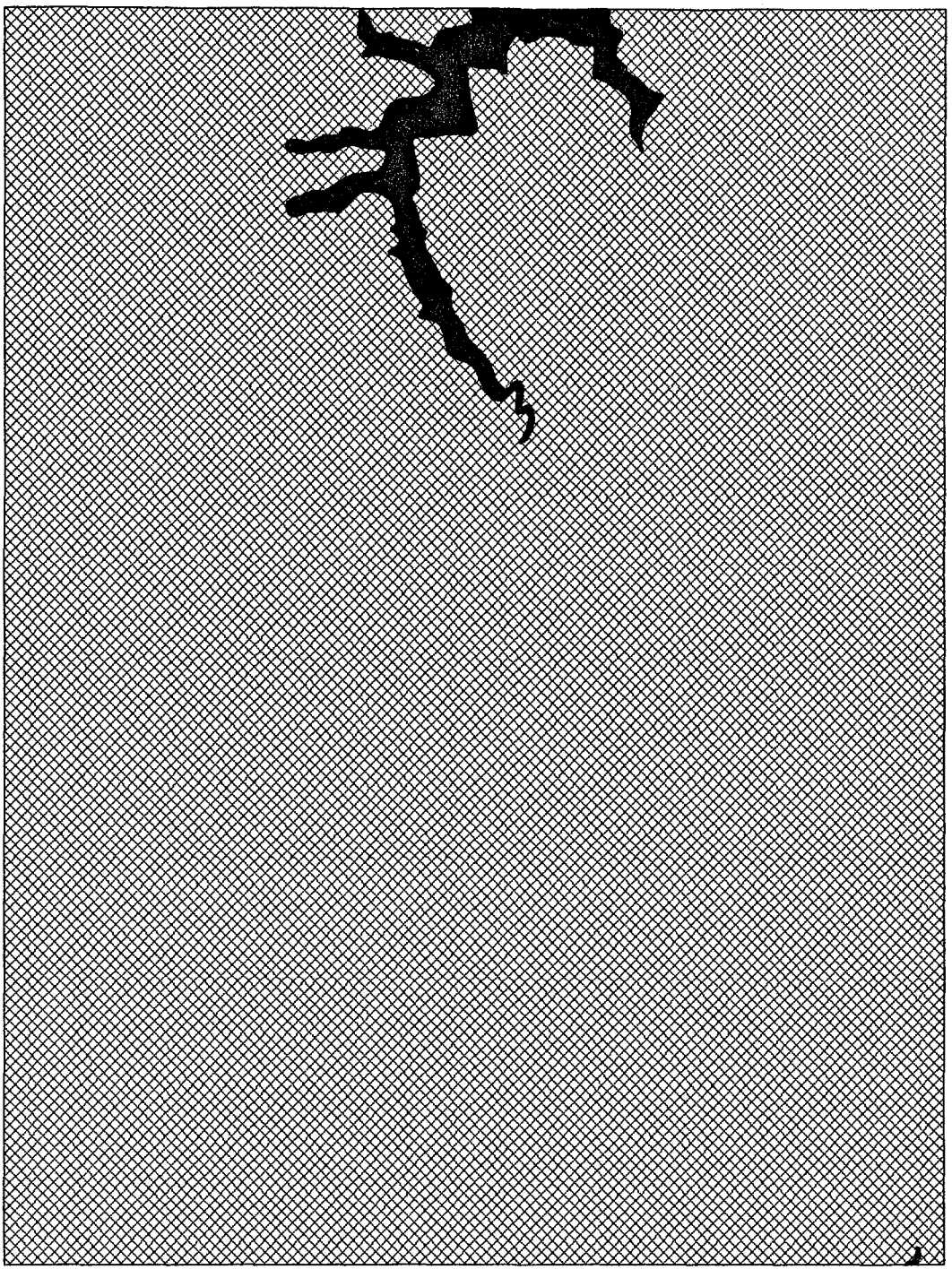
6302500

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

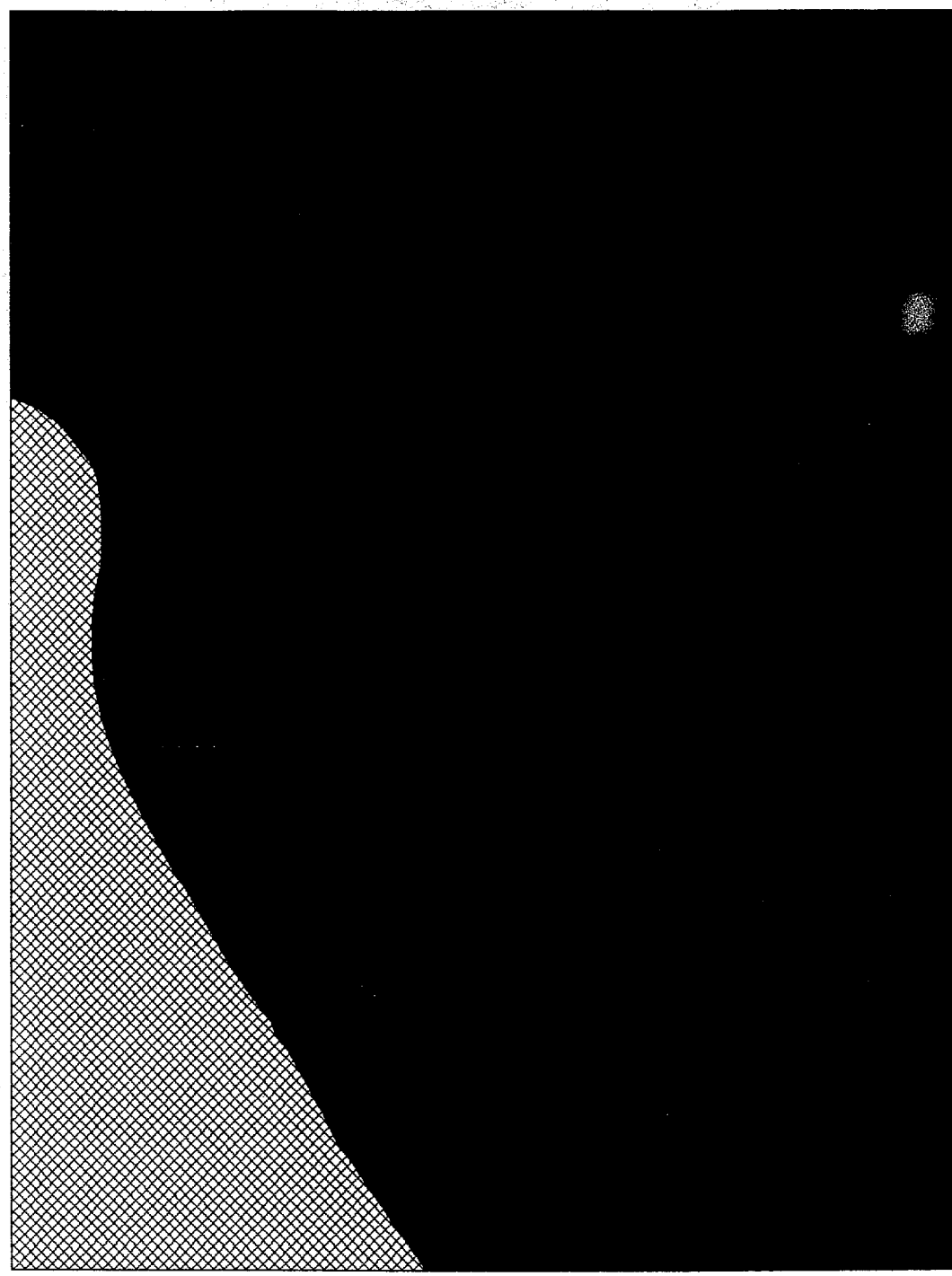
6302540

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

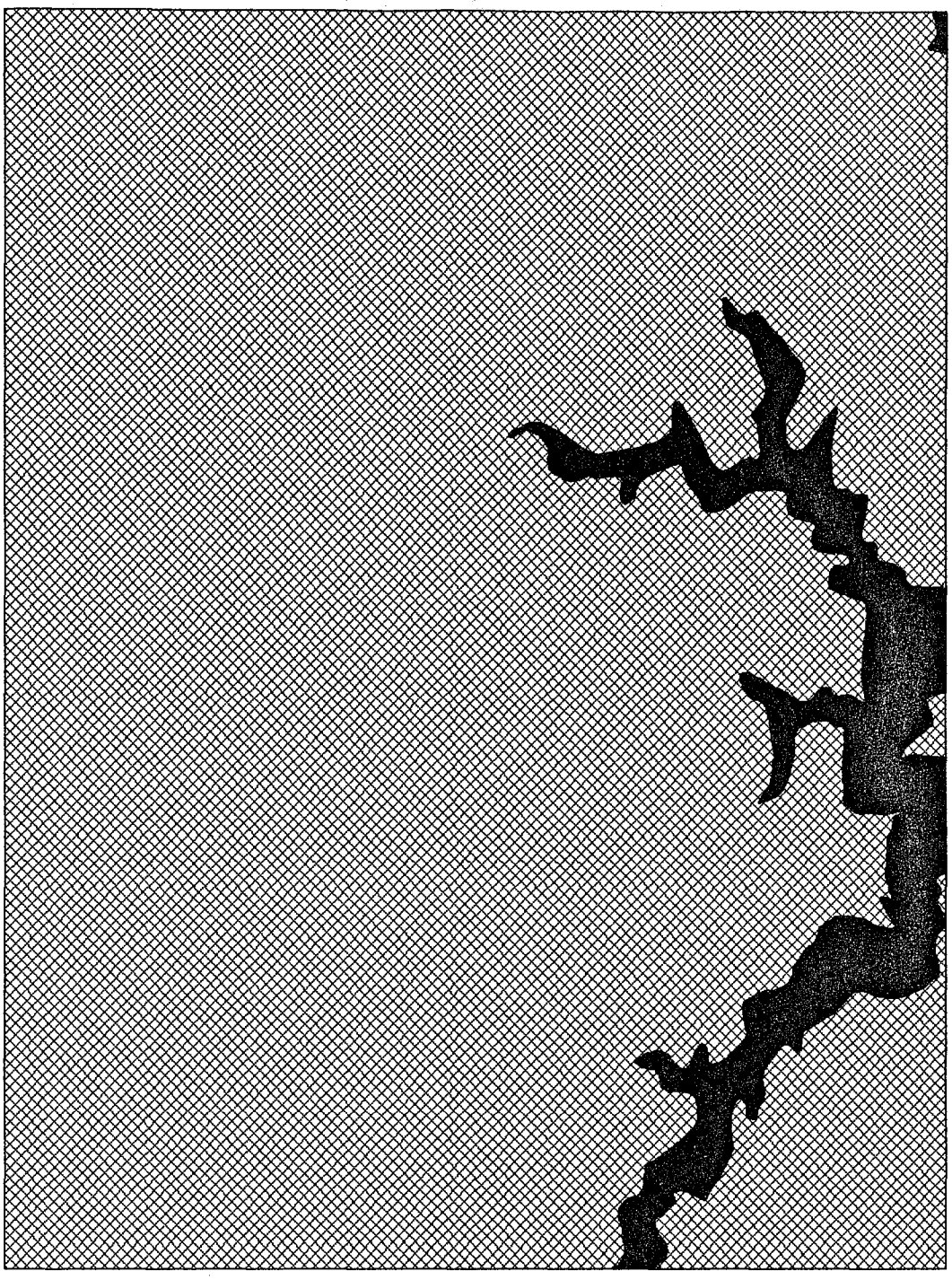
6302560

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

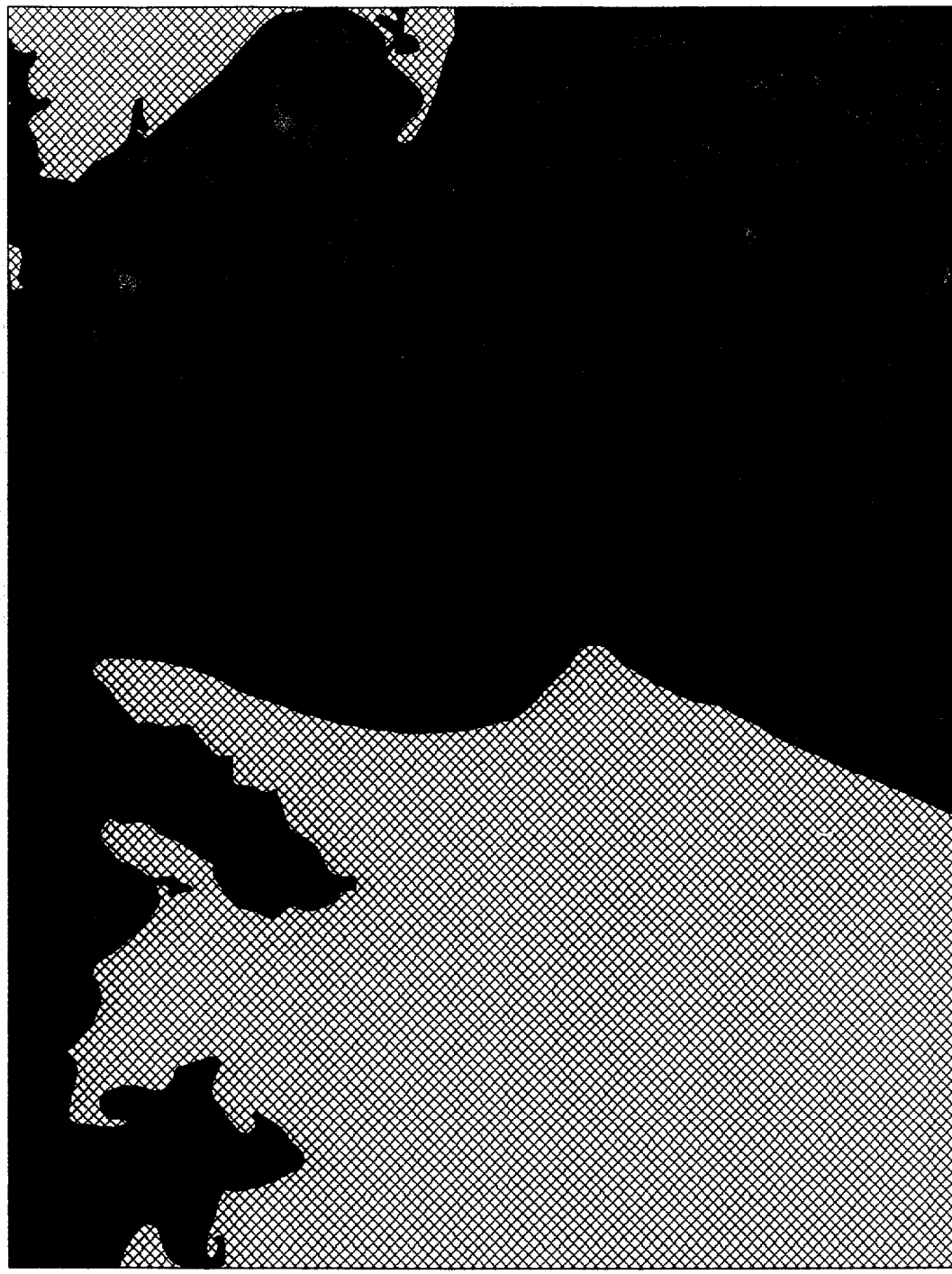
6152540

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

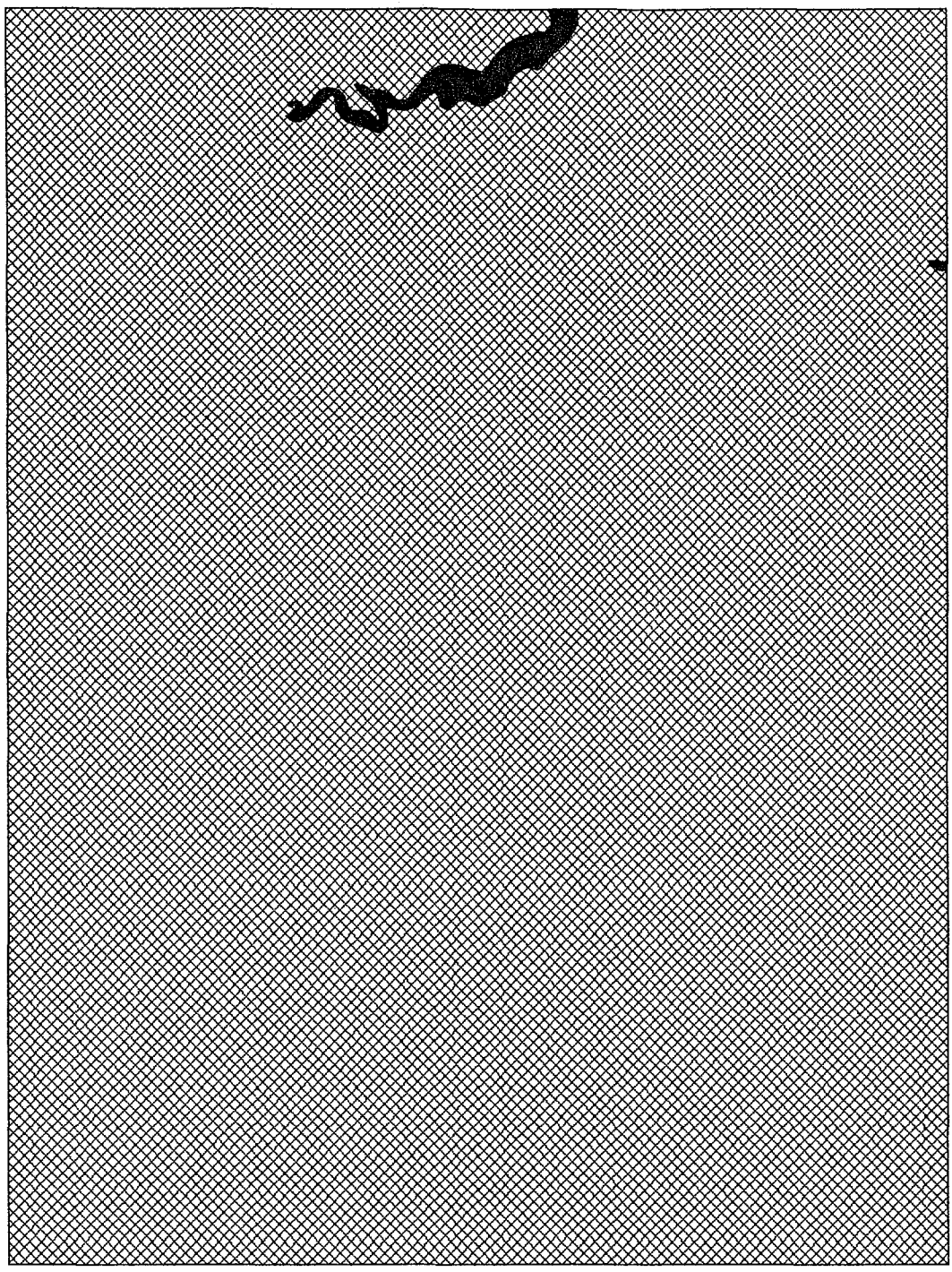
6152560

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

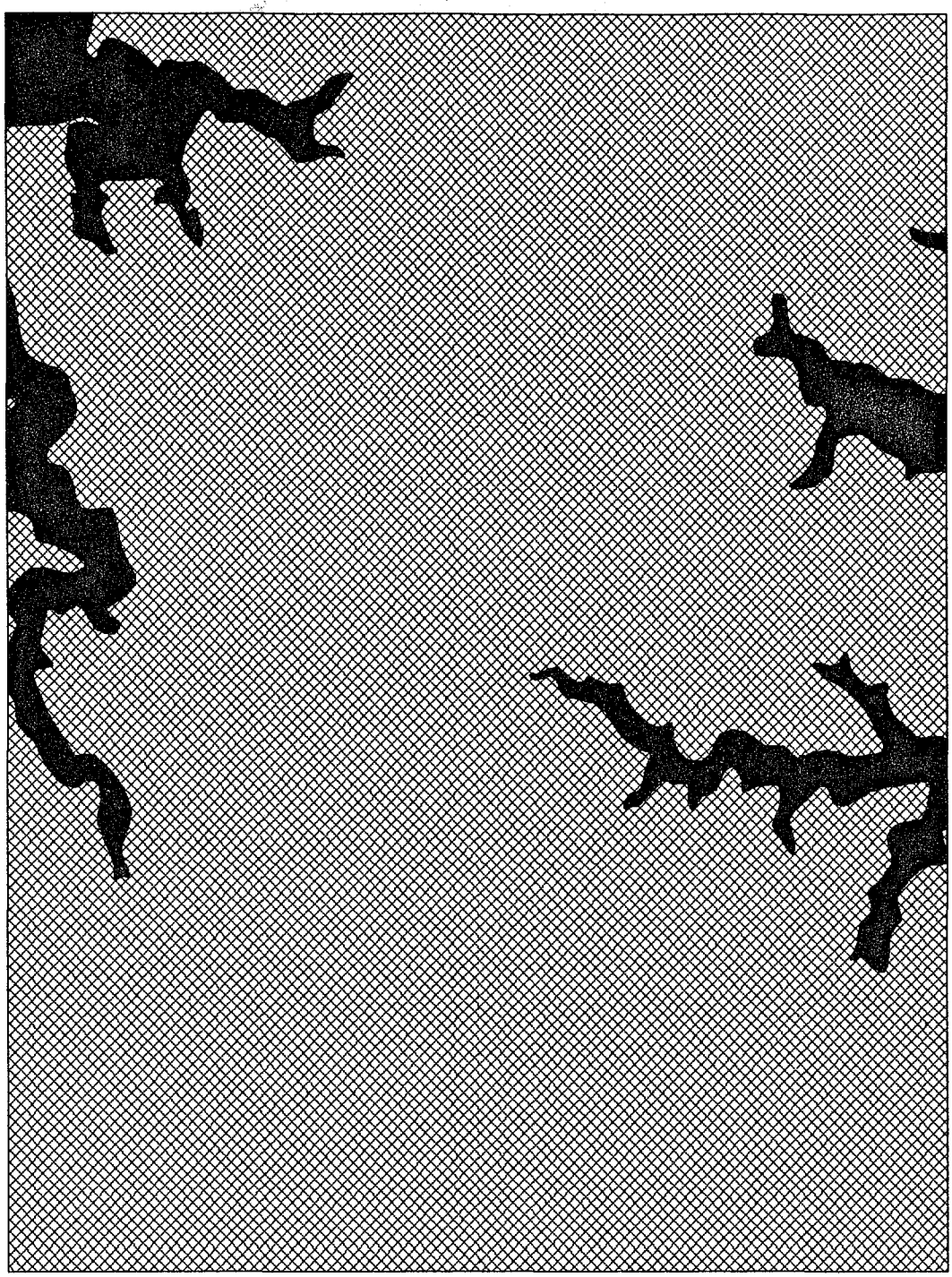
6002540

WESTMORELAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

6002560

WESTMORELAND CO

LEGEND

UPLAND

WATER

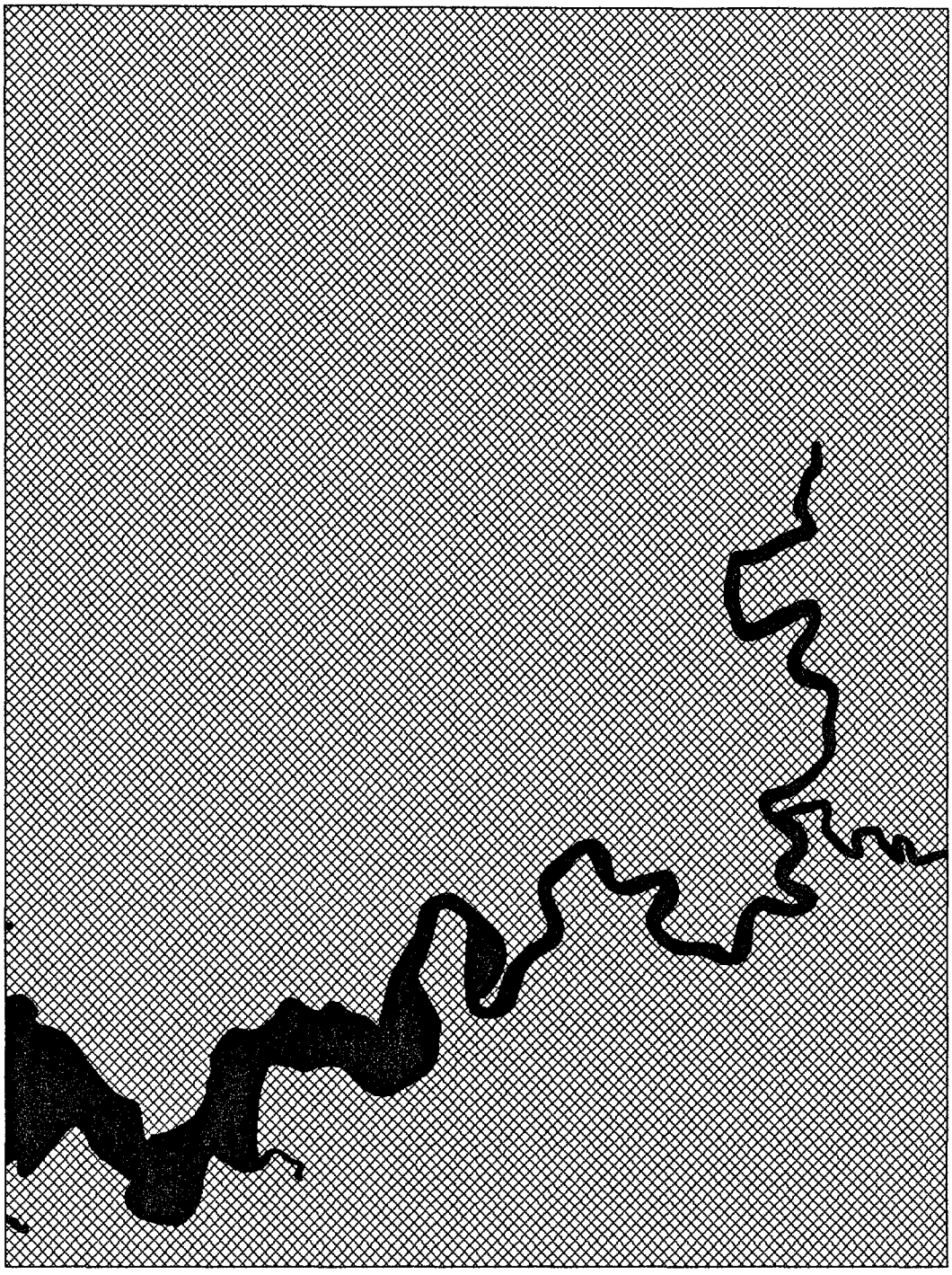
COASTAL INVENTORY

AVERAGE TIME AND DISC SPACE USED*

MARINE RESOURCES COMMISSION SHORELINE
LANCASTER COUNTY

MAP NUMBER	TIME	DISC SPACE
5402520	5.75	868352
5402540	4.5	847872
5252520	4.25	806912
5252540	6.25	868352
5252580	1.75	811008
5102540	3.25	835584
5102560	3.25	864256
5102580	3.75	856064
5102600	2.5	823296
4952560	3.5	849920
4952580	4.75	929792
4952600	3.5	825344
4952620	15.75	950272
4802560	3.25	854016
4802580	5.25	860160
4802600	2.5	816544
4802620	4.0	888832
4802640	1.75	798720
4652600	3.5	835584
4652620	3.5	872448
4652640	1.25	798720
AVERAGE	4.25	850573

*TIME IN HOURS, DISC SPACE IN BYTES



MARINE RESOURCES SHORELINE

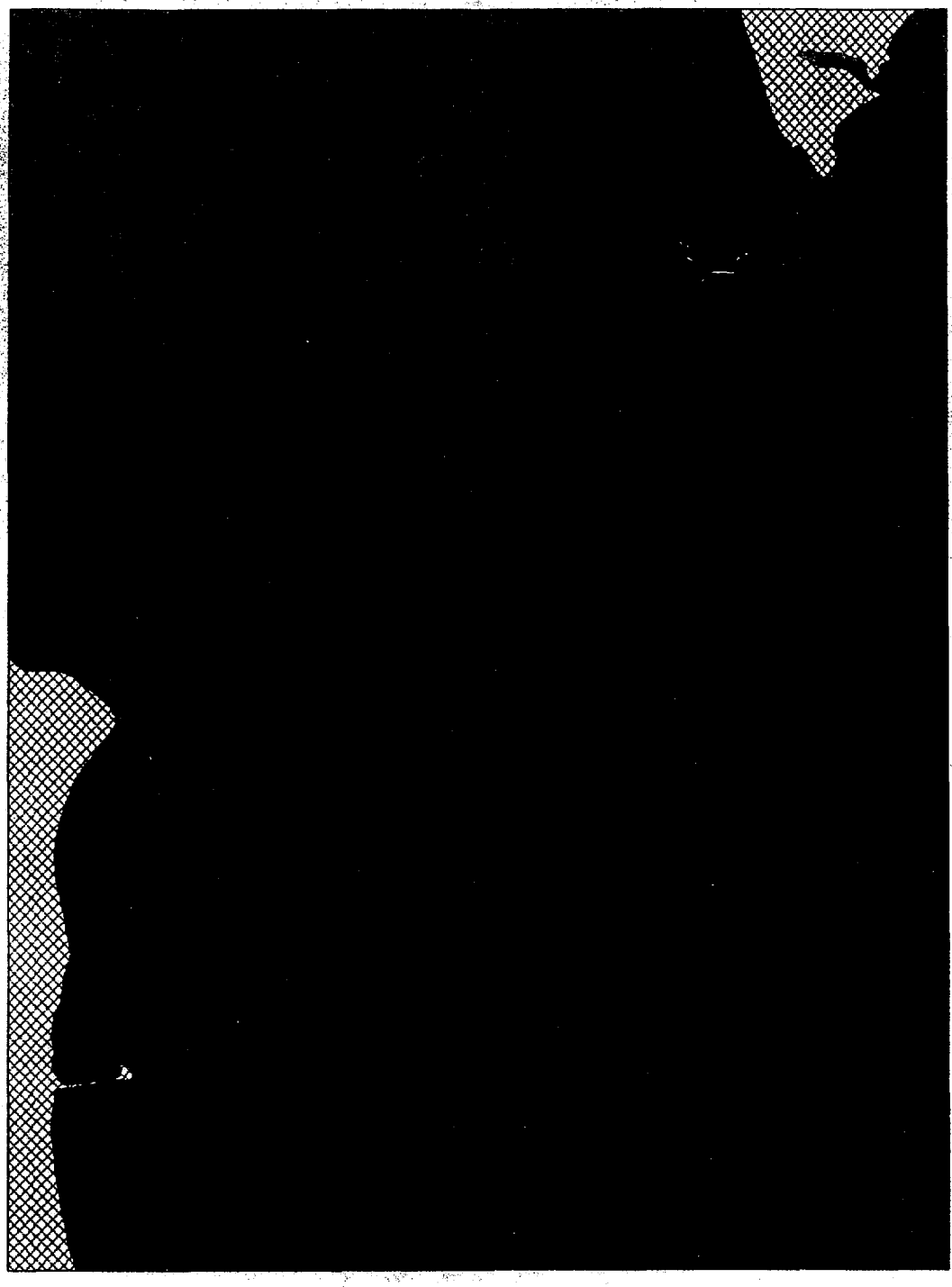
5402540

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

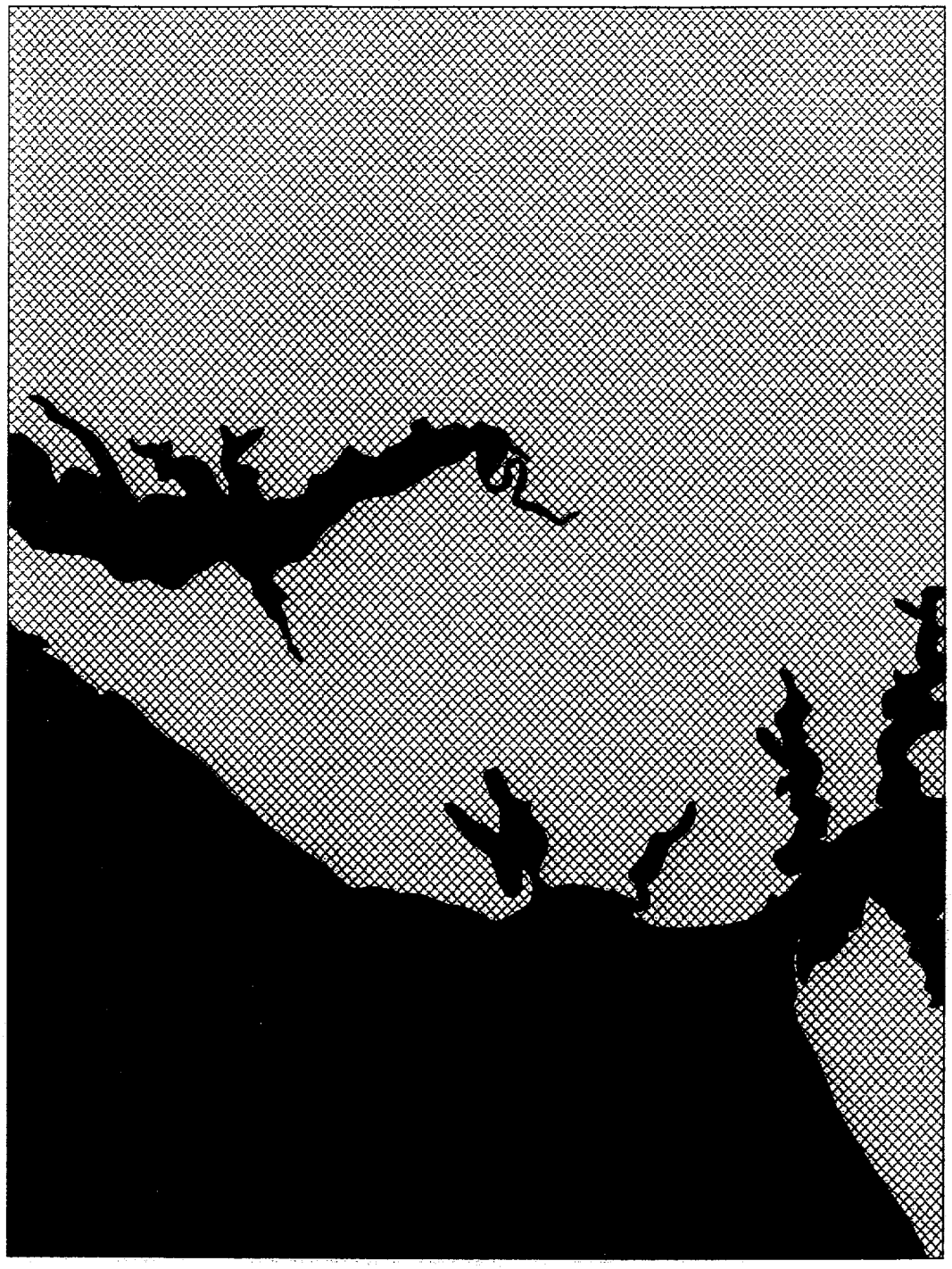
5252520

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

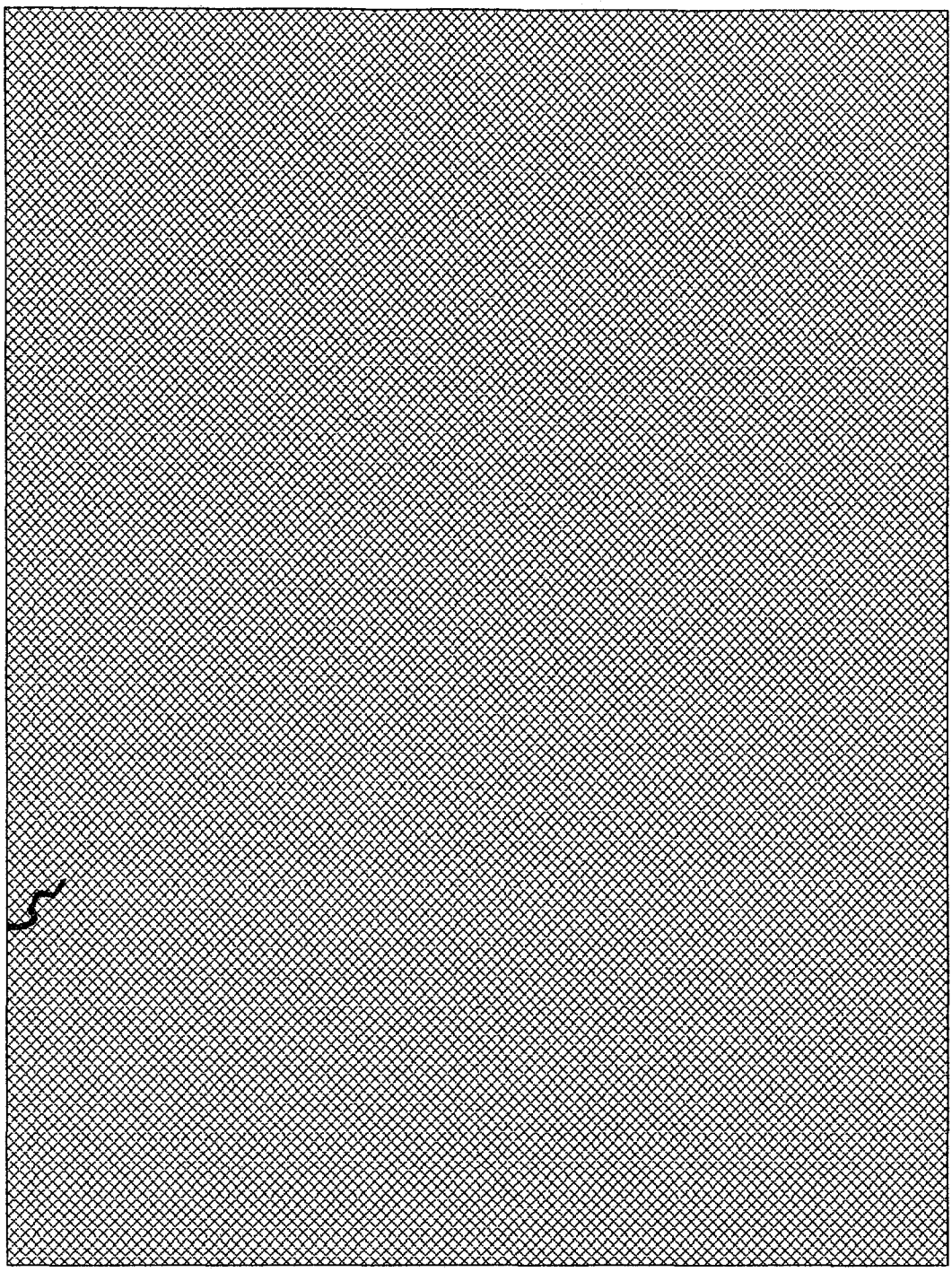
5252540

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

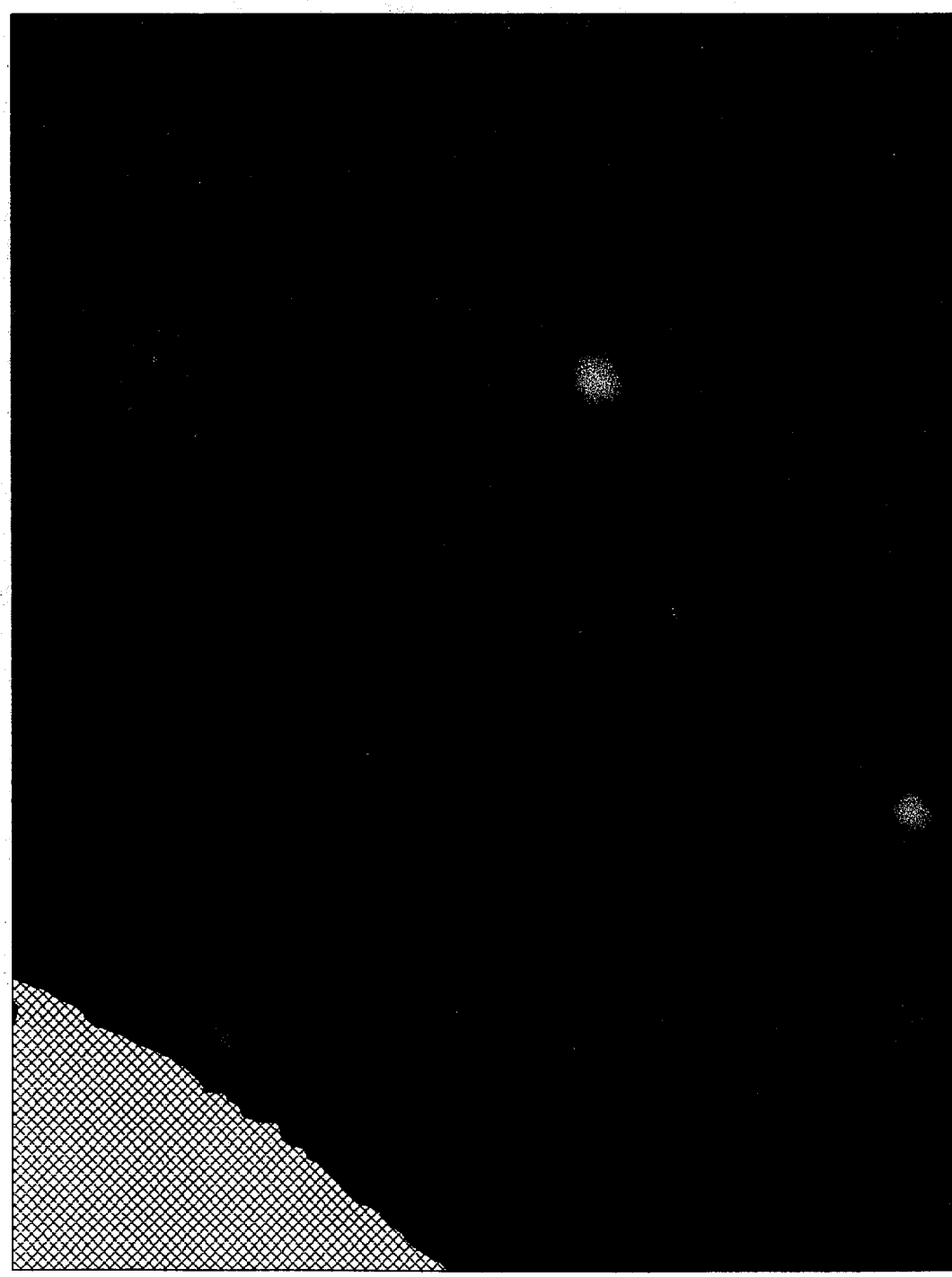
5252580

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

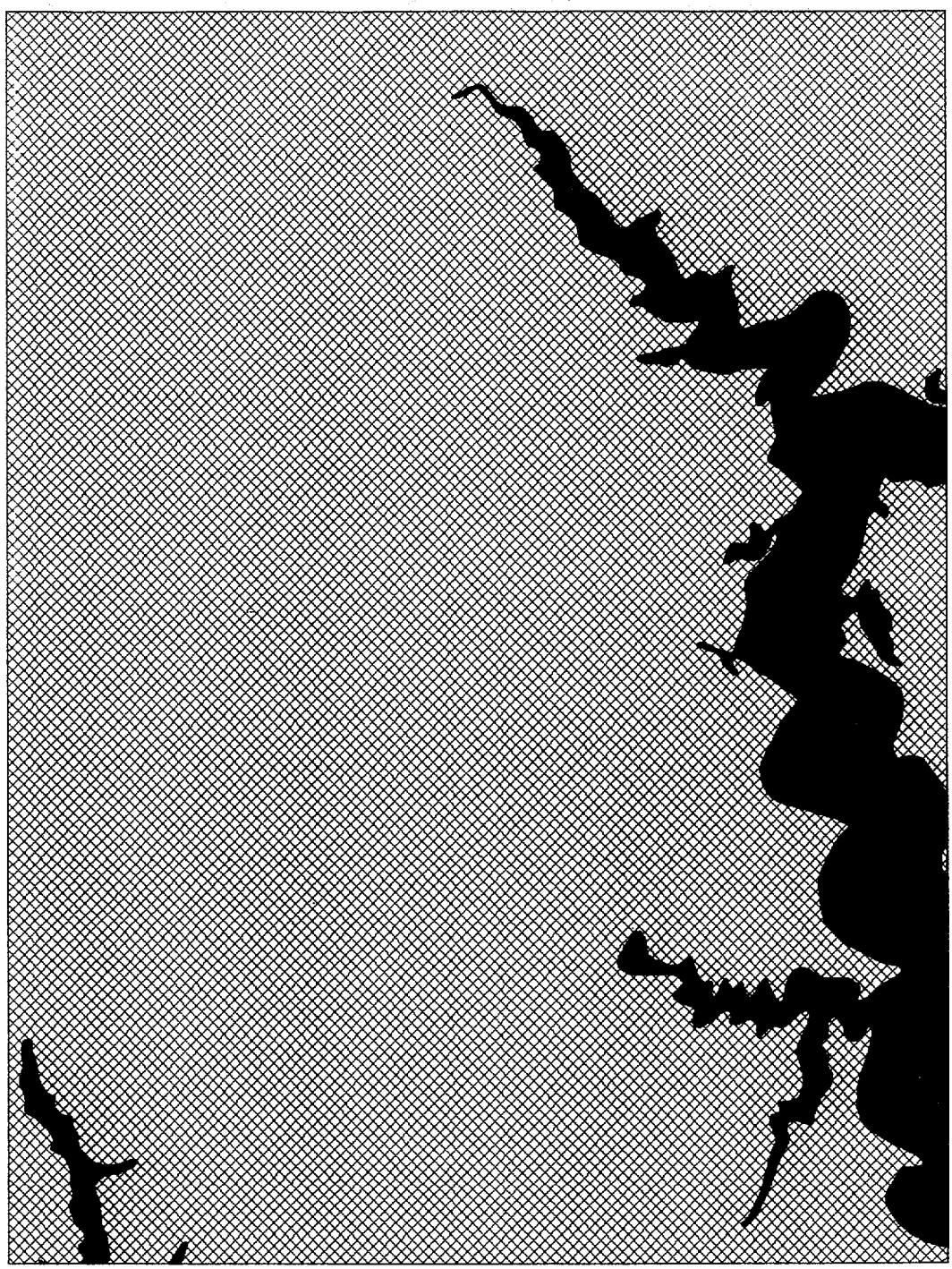
5102540

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

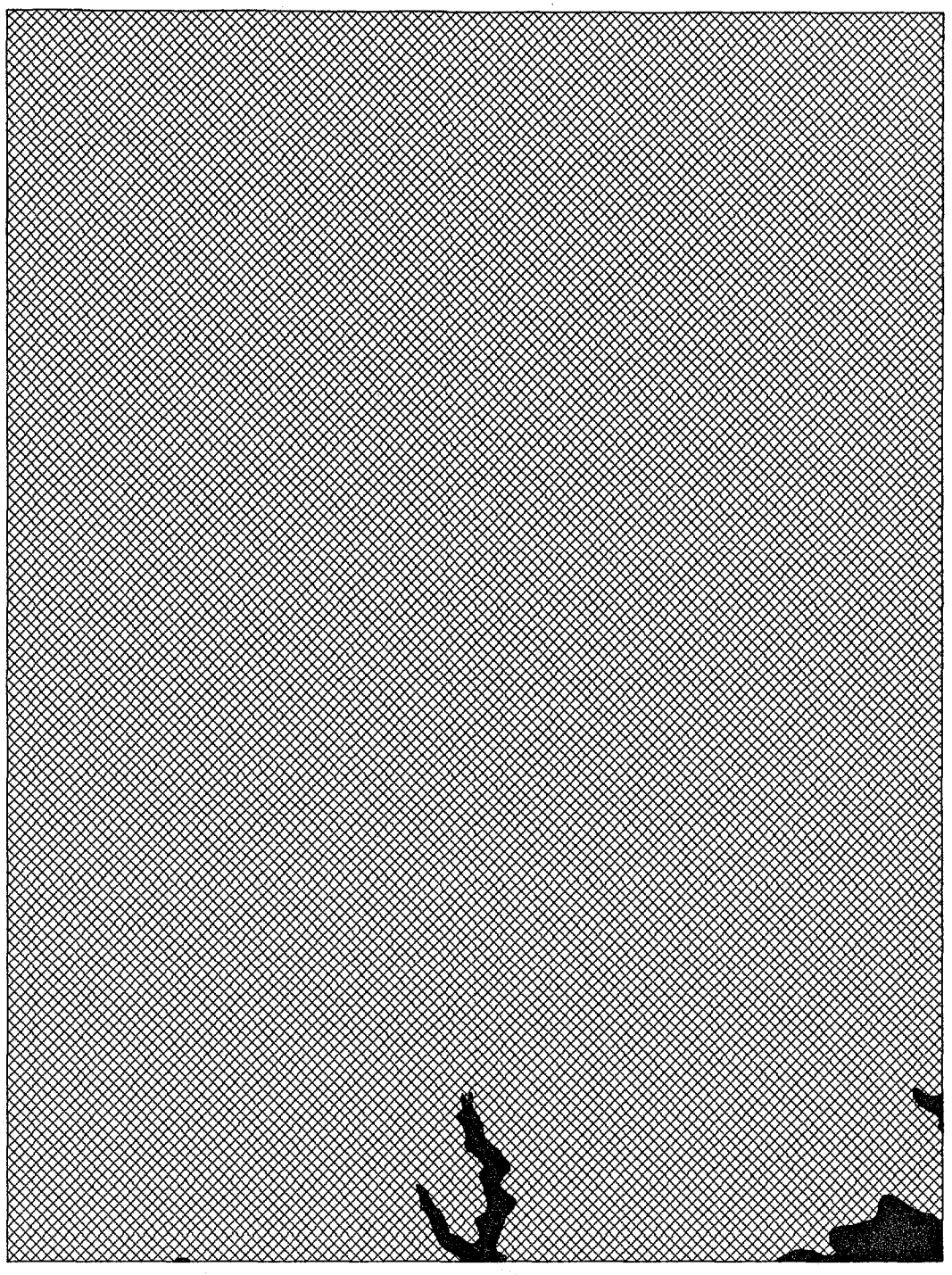
5102560

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

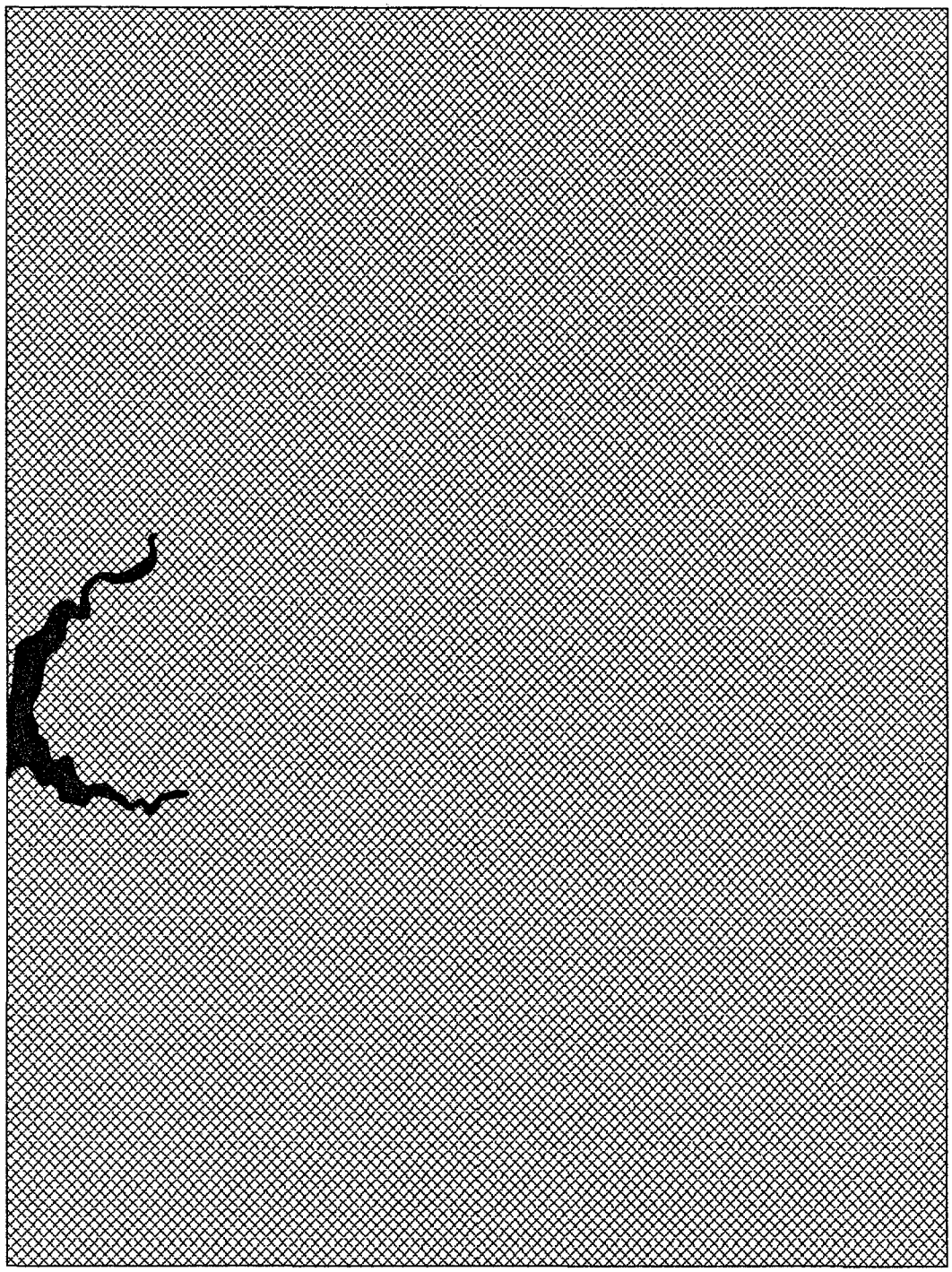
5102580

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

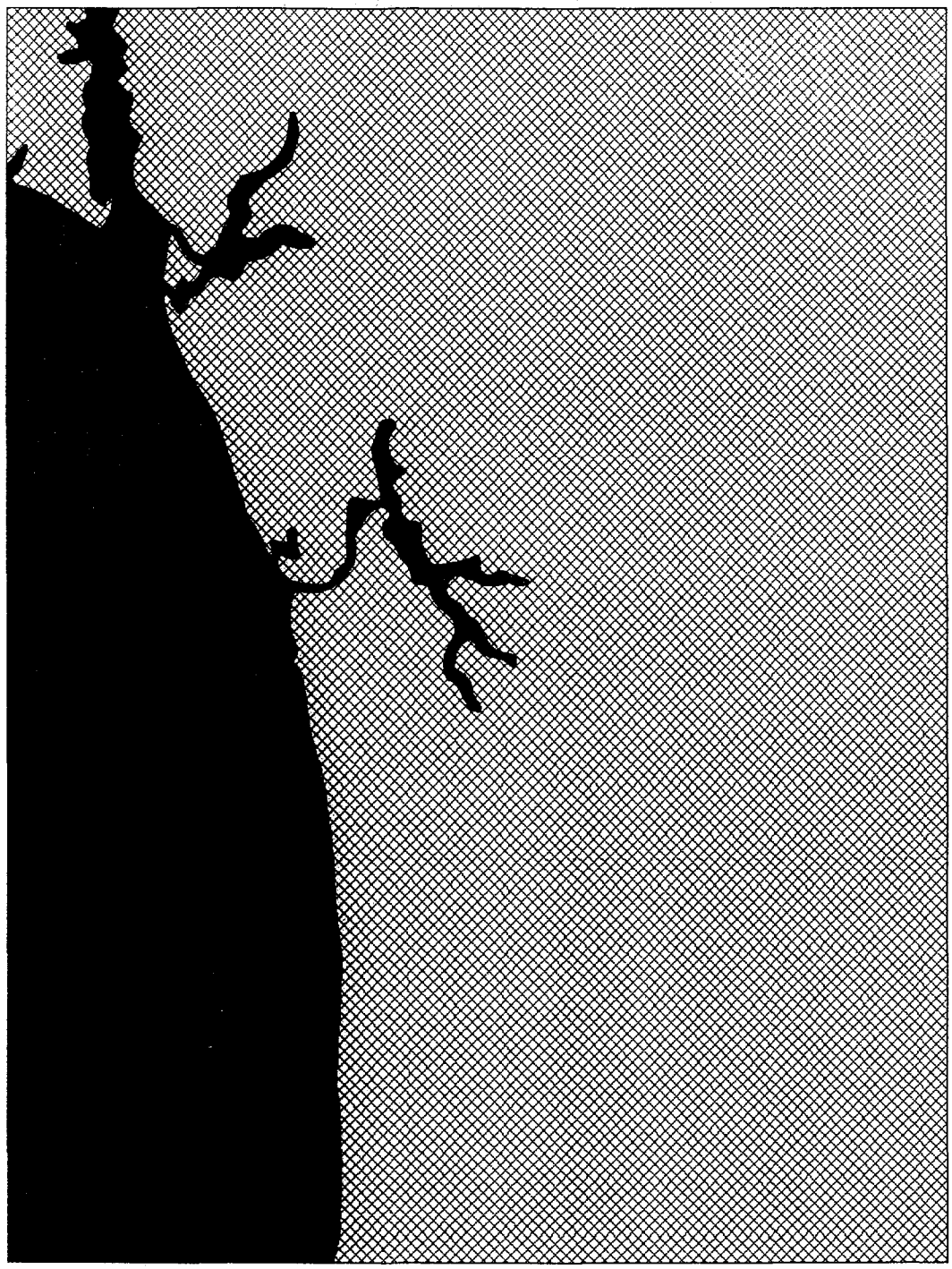
5102600

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

4952560

LANCASTER CO

LEGEND

UPLAND

WATER

MARINE RESOURCES SHORELINE

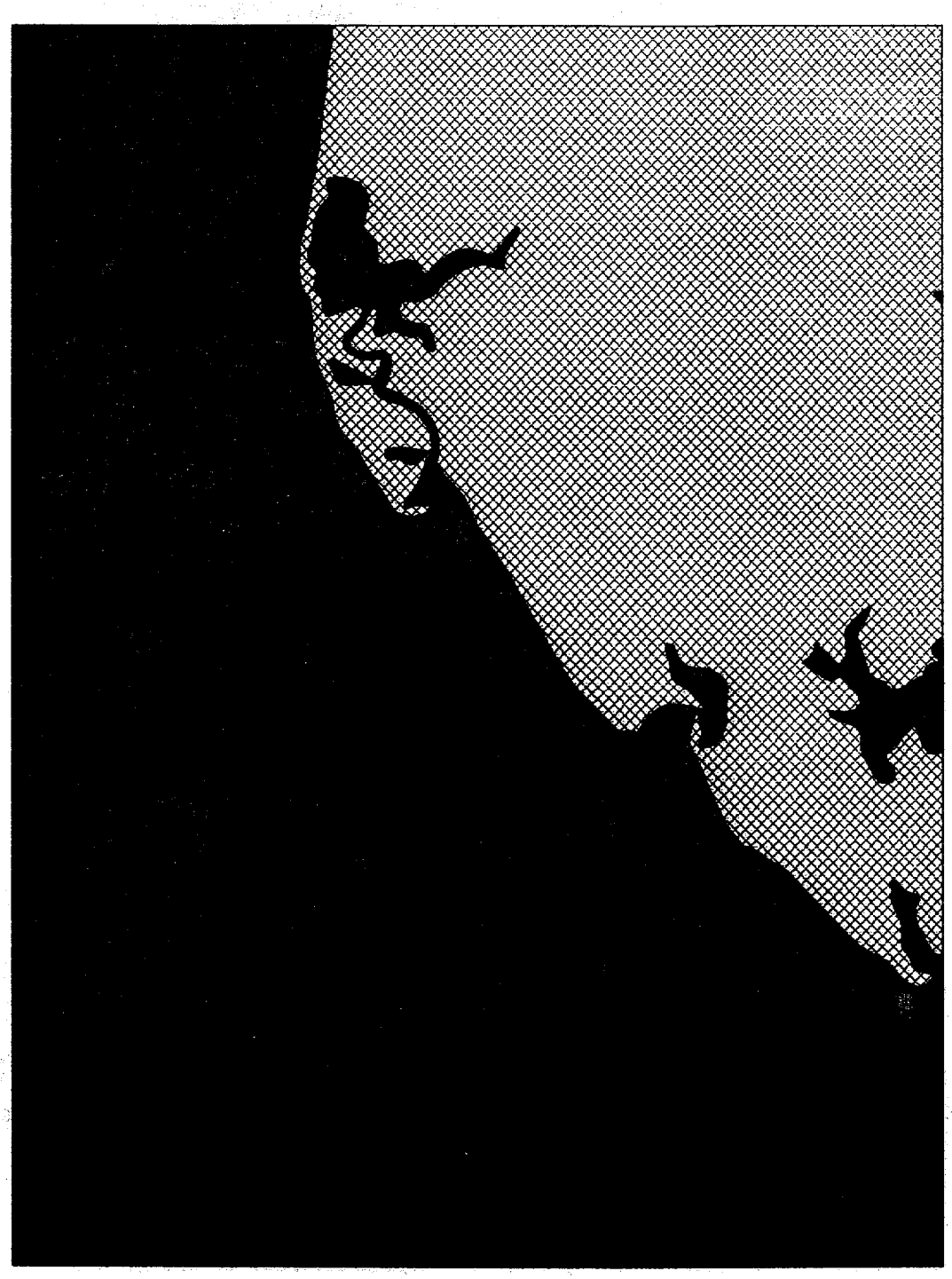
4952580

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

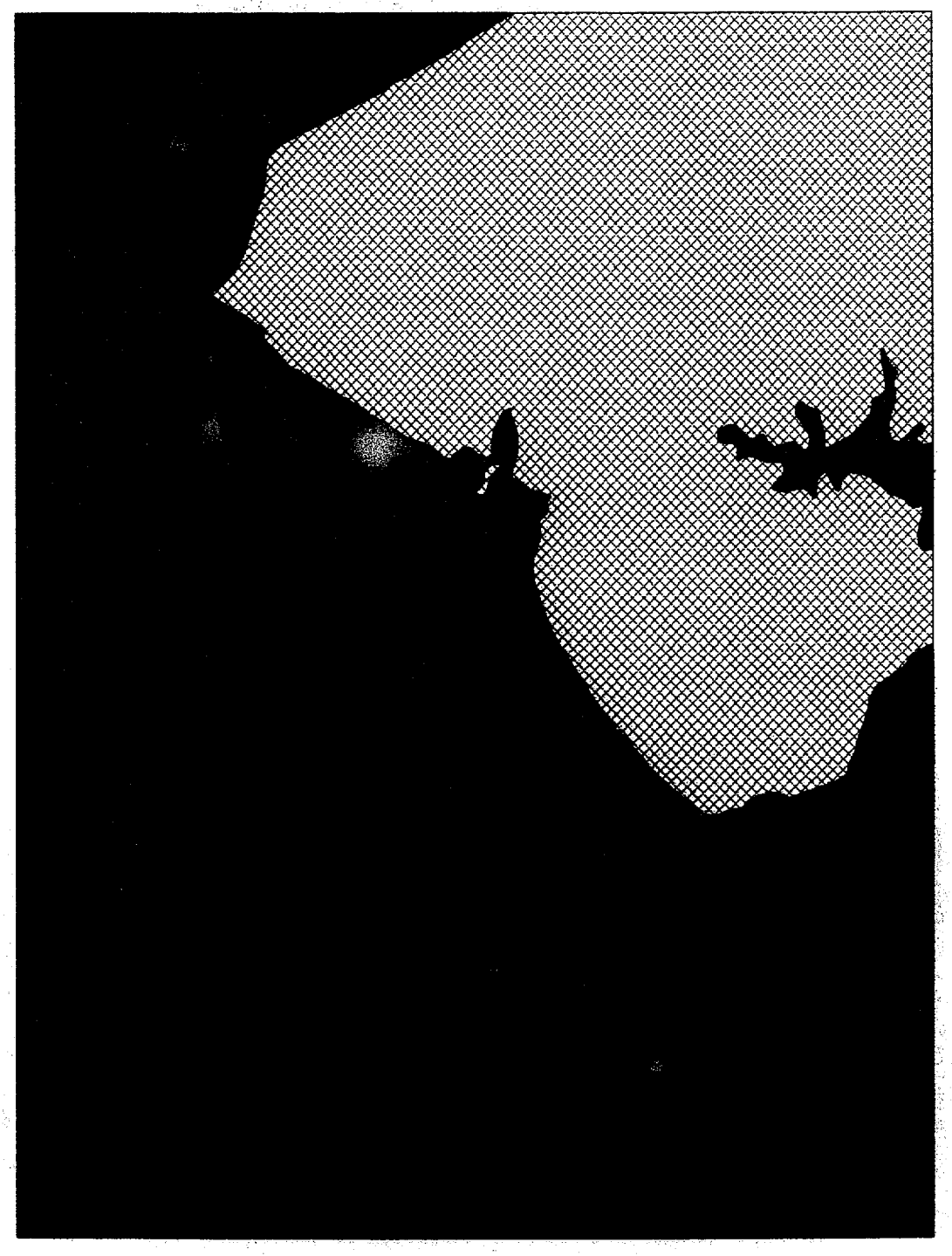
4802560

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

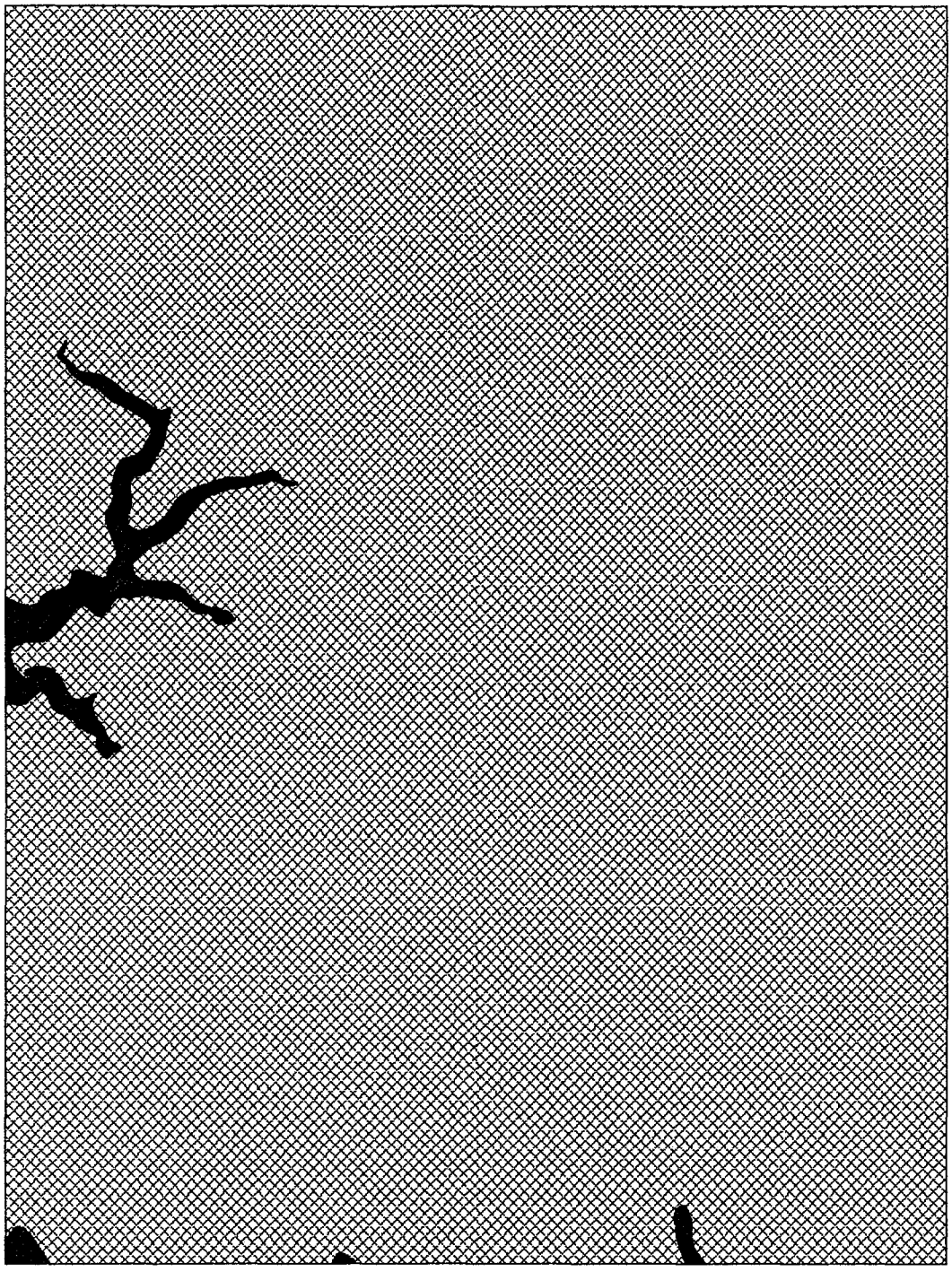
4802580

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

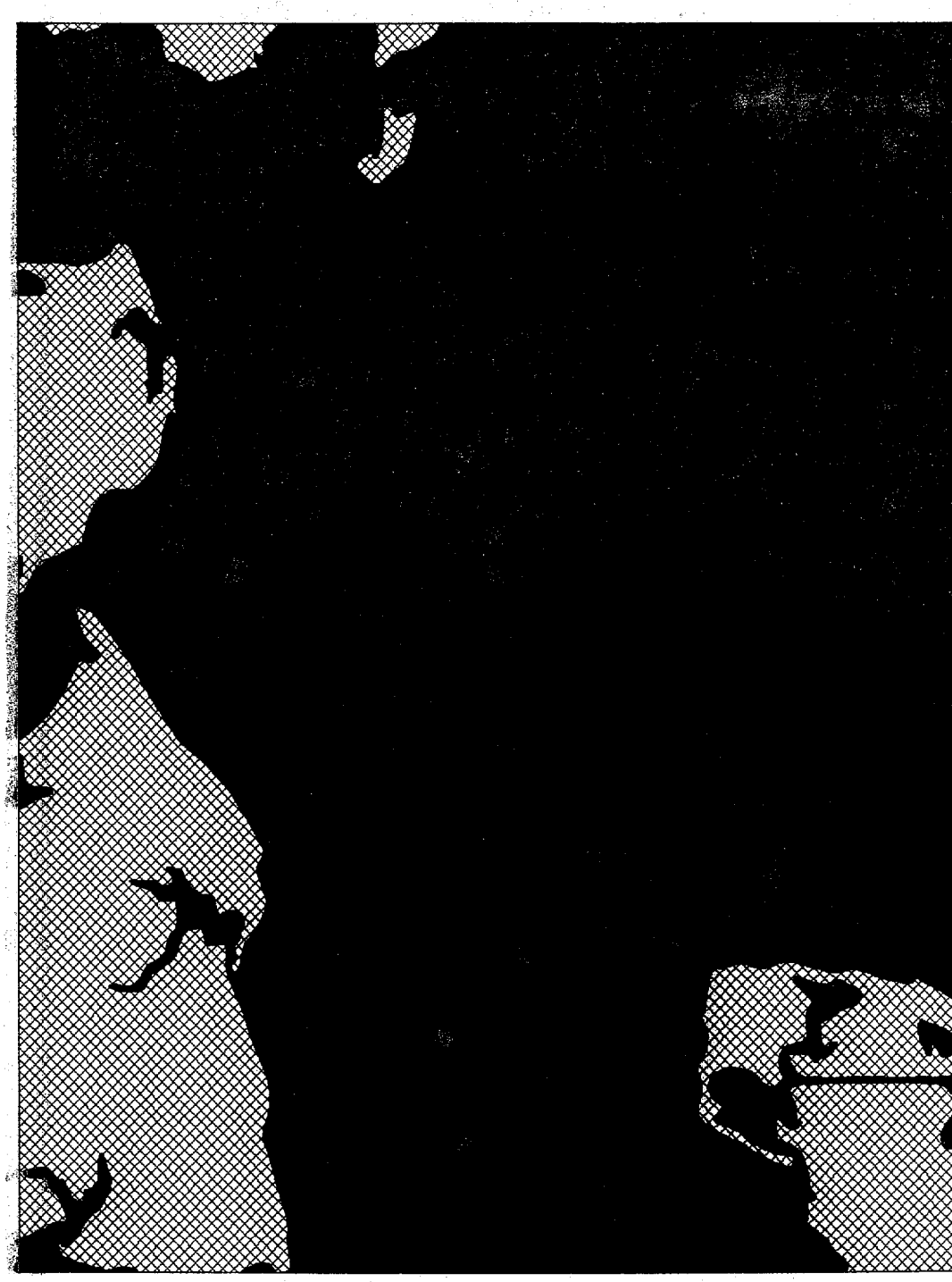
4802600

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

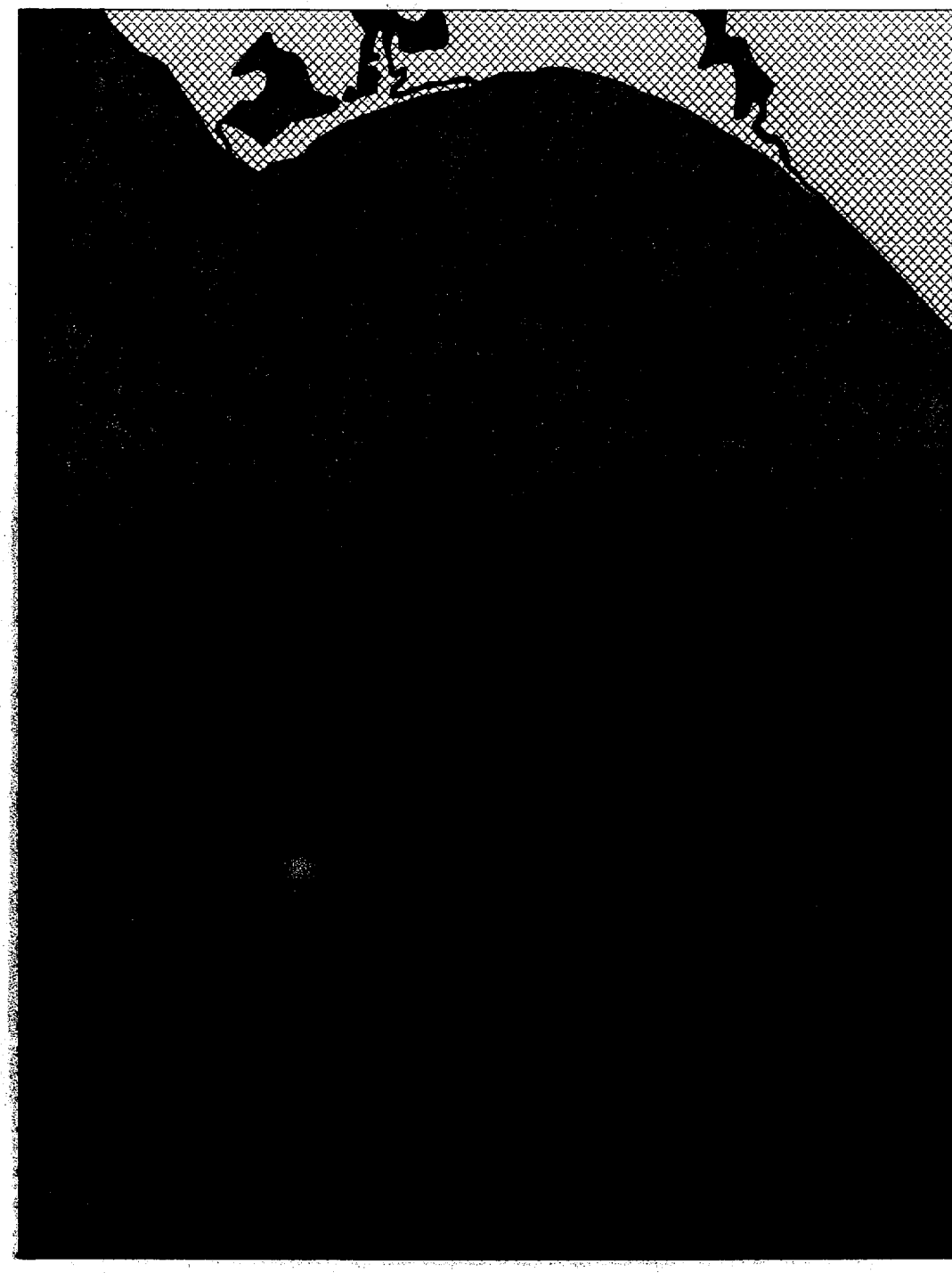
4802620

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

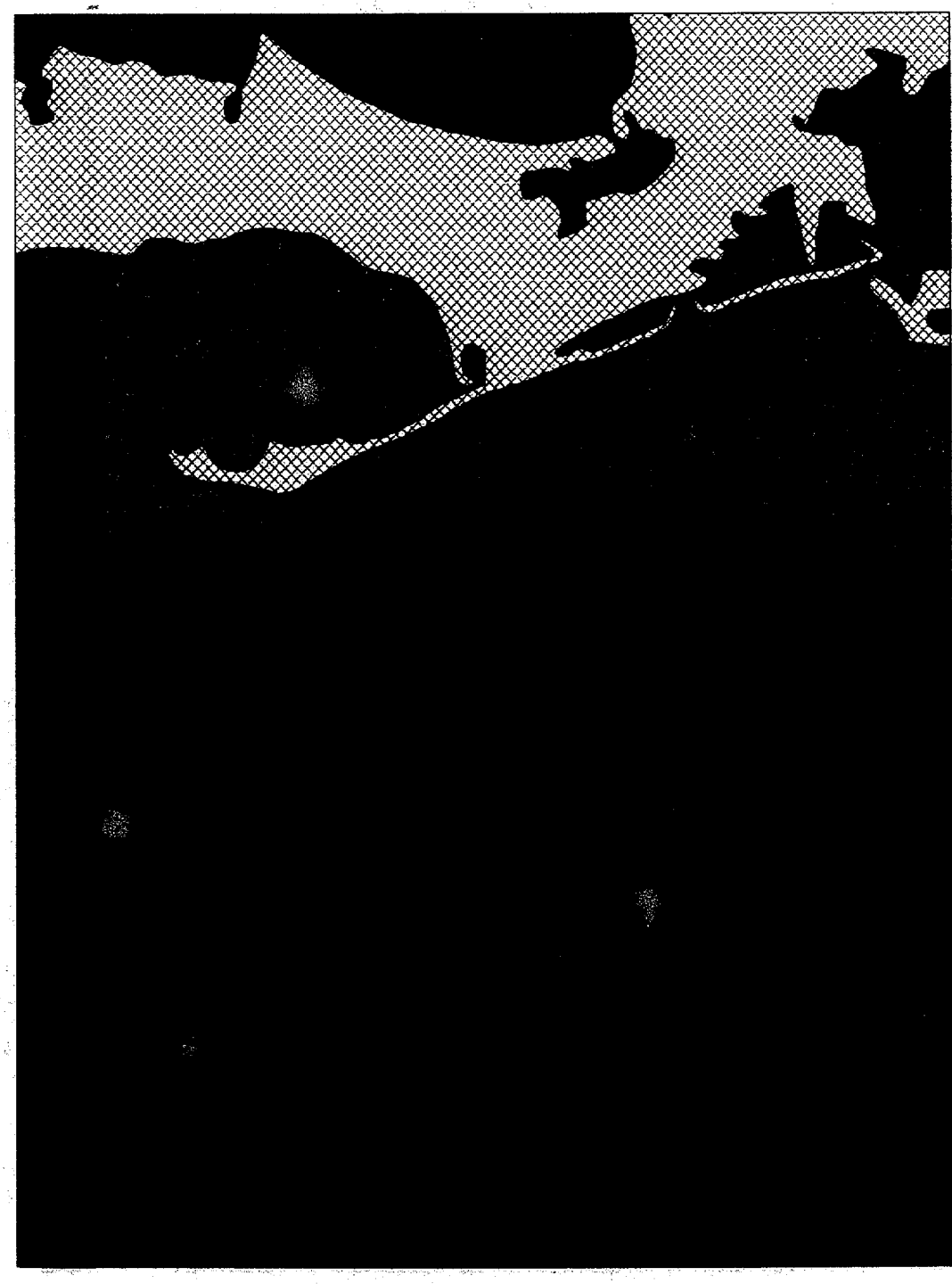
4652600

LANCASTER CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

4652620

LANCASTER CO

LEGEND

UPLAND

WATER

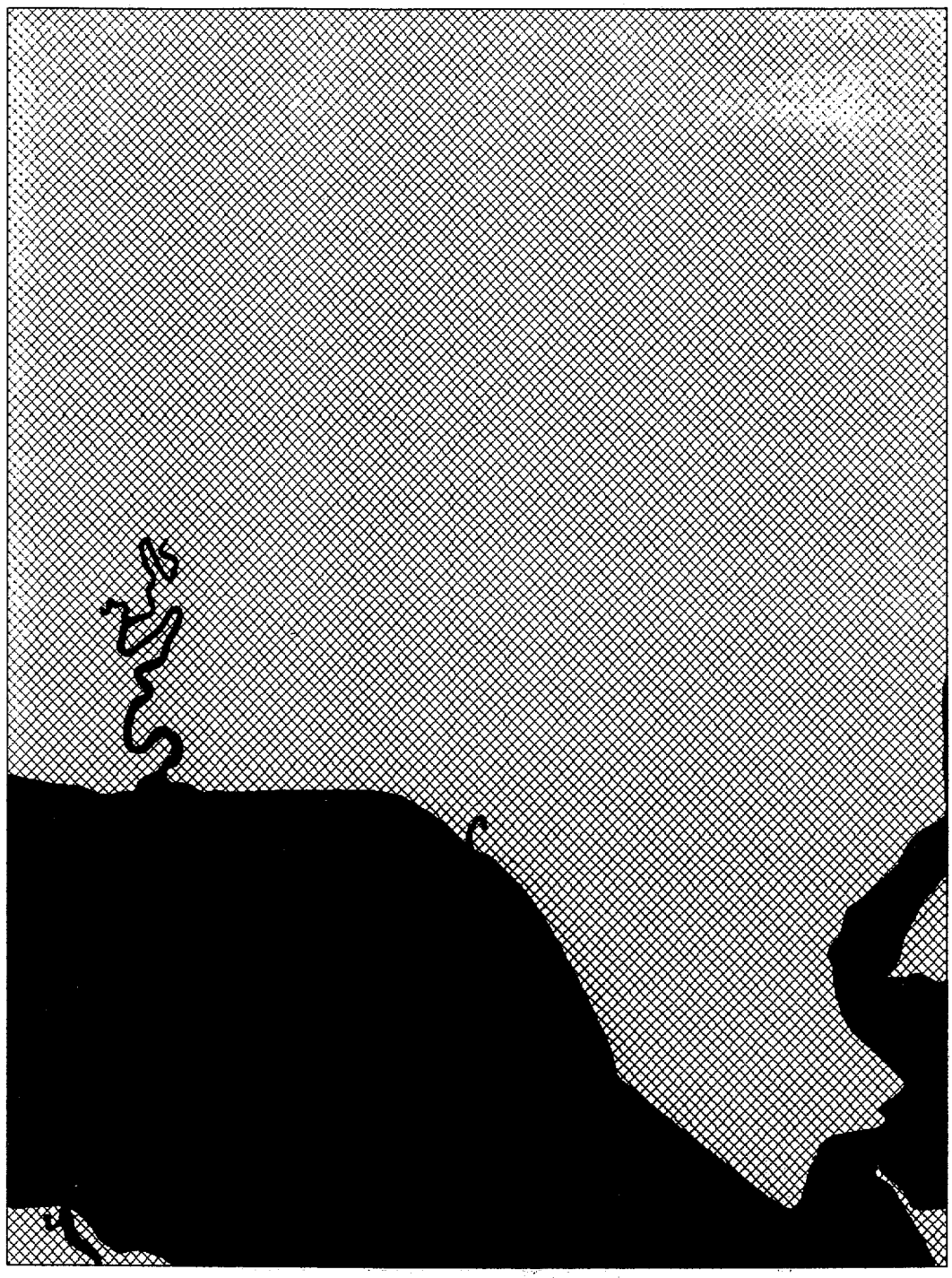
COASTAL INVENTORY

AVERAGE TIME AND DISC SPACE USED*

MARINE RESOURCES COMMISSION SHORELINE
RICHMOND COUNTY

MAP NUMBER	TIME	DISC SPACE
6002460	9.0	862208
6002480	3.25	858112
5852460	3.75	843776
5852480	3.5	849920
5702460	5.0	846029
5702480	5.75	874496
5552460	5.0	846029
5552480	5.0	846029
5552500	5.75	839680
5552520	2.0	808960
5402500	5.5	806912
5402520	5.75	868352
5402540	4.5	847872
5252520	5.0	846029
AVERAGE	5.0	846029

*TIME IN HOURS, DISC SPACE IN BYTES



MARINE RESOURCES SHORELINE

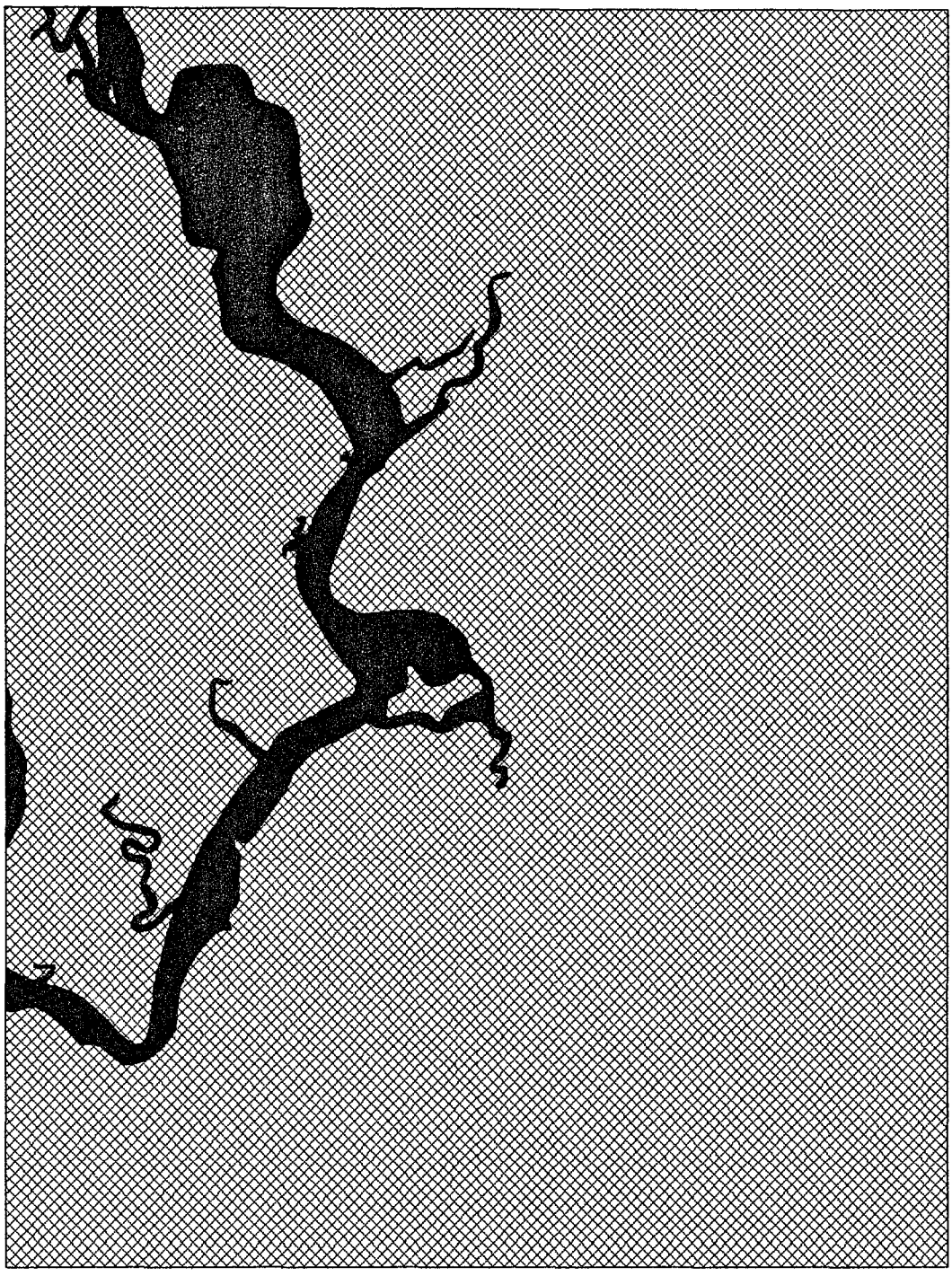
6002460

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

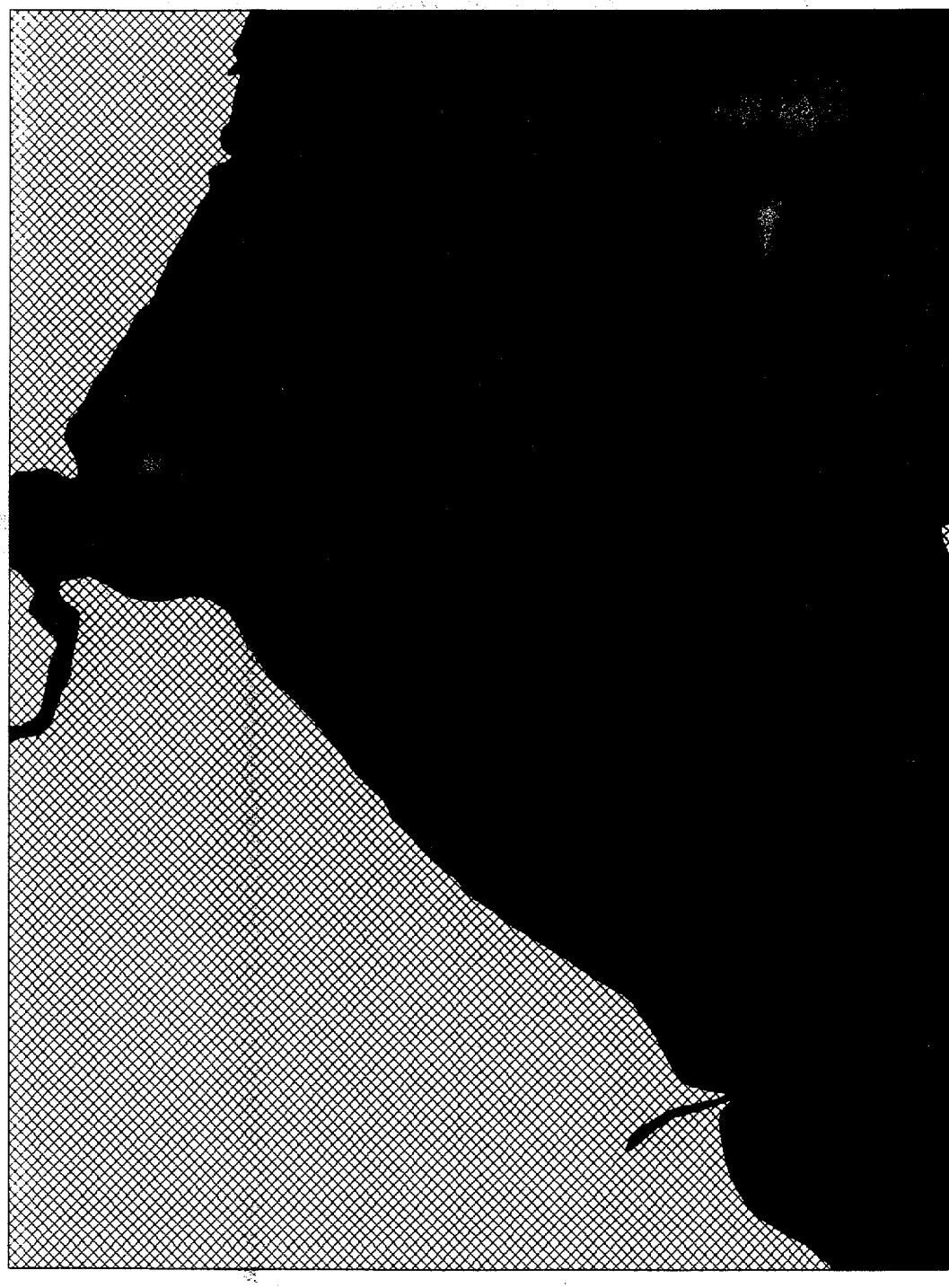
6002480

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

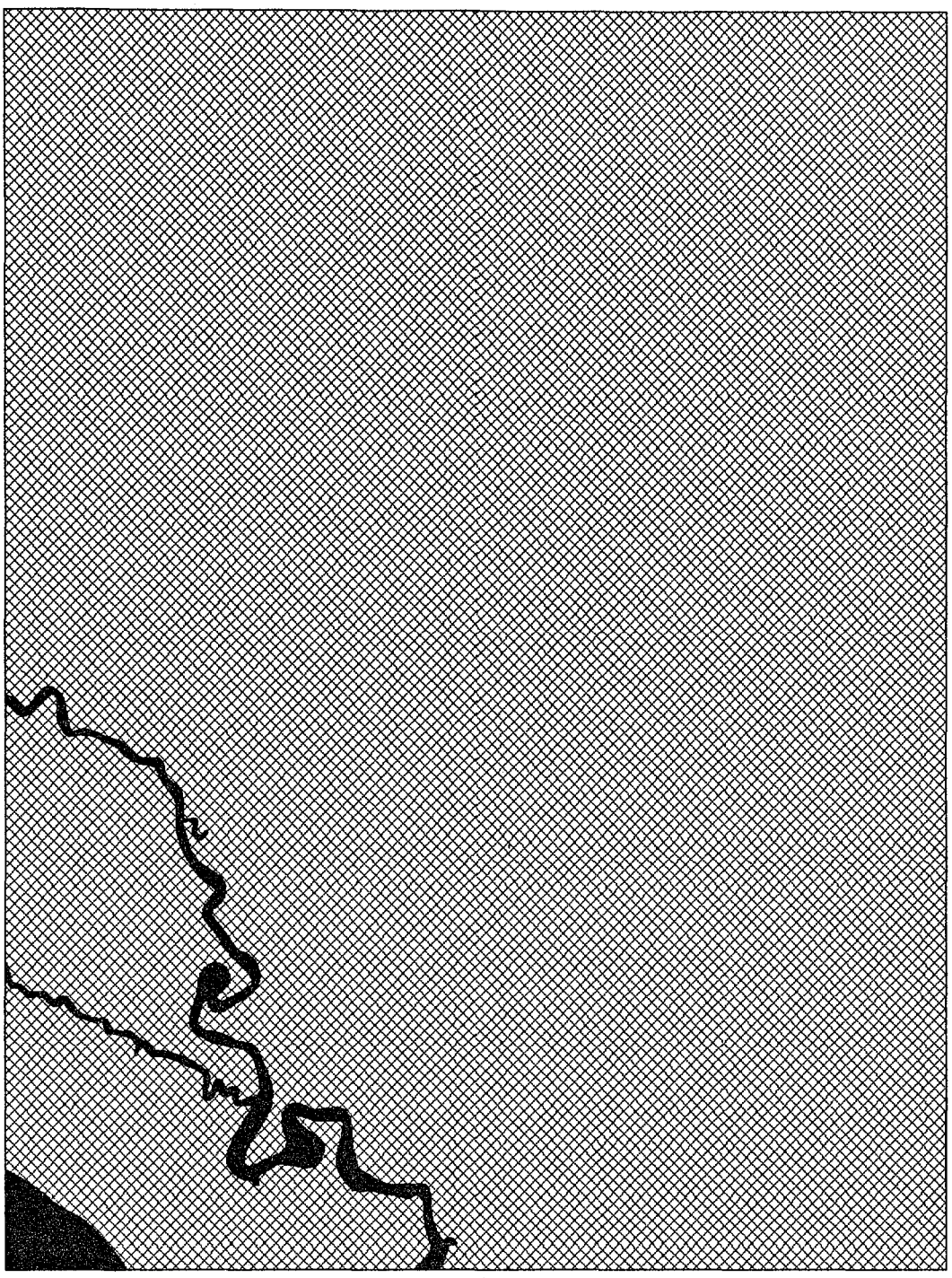
5852460

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

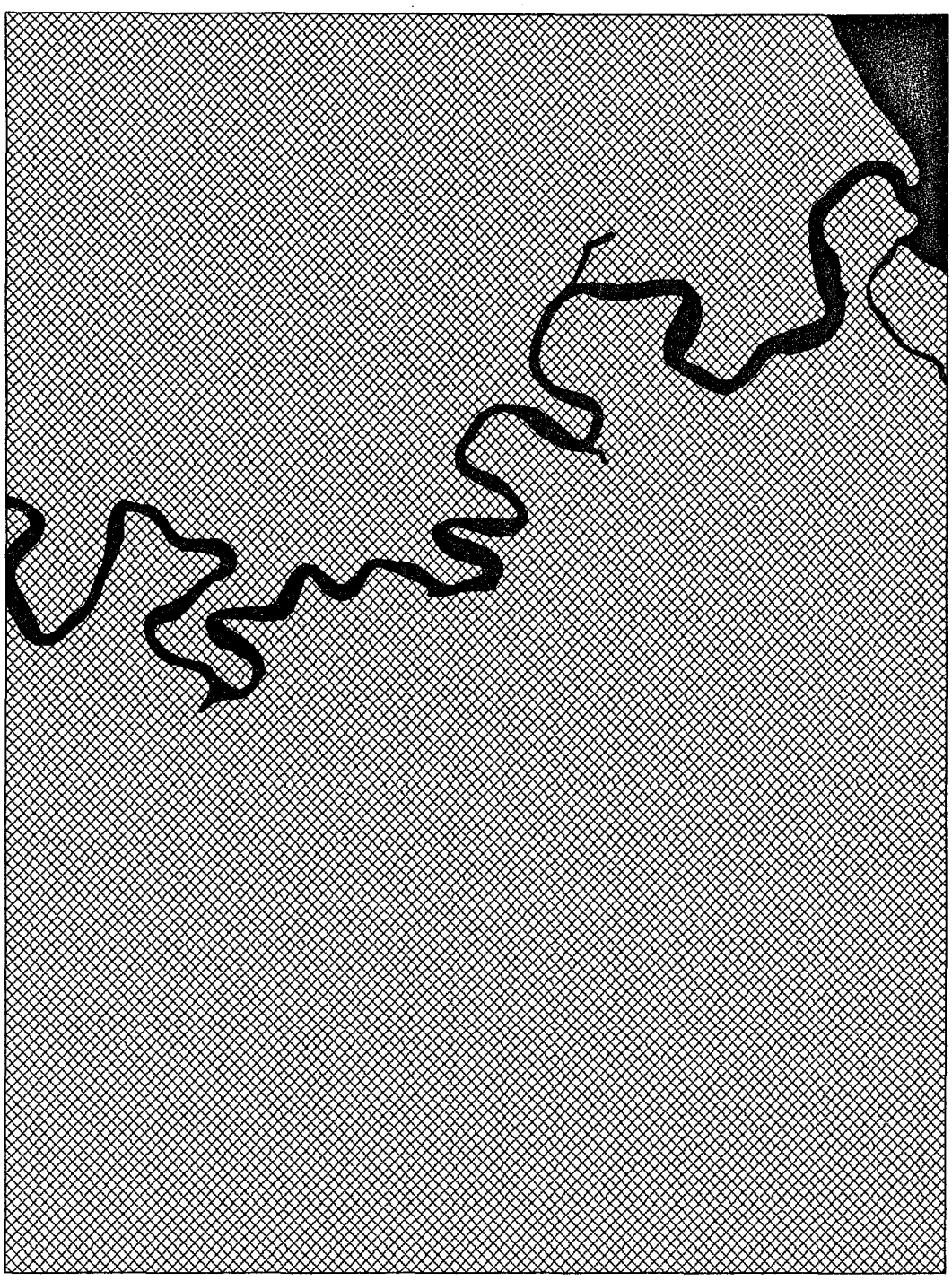
5852480

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

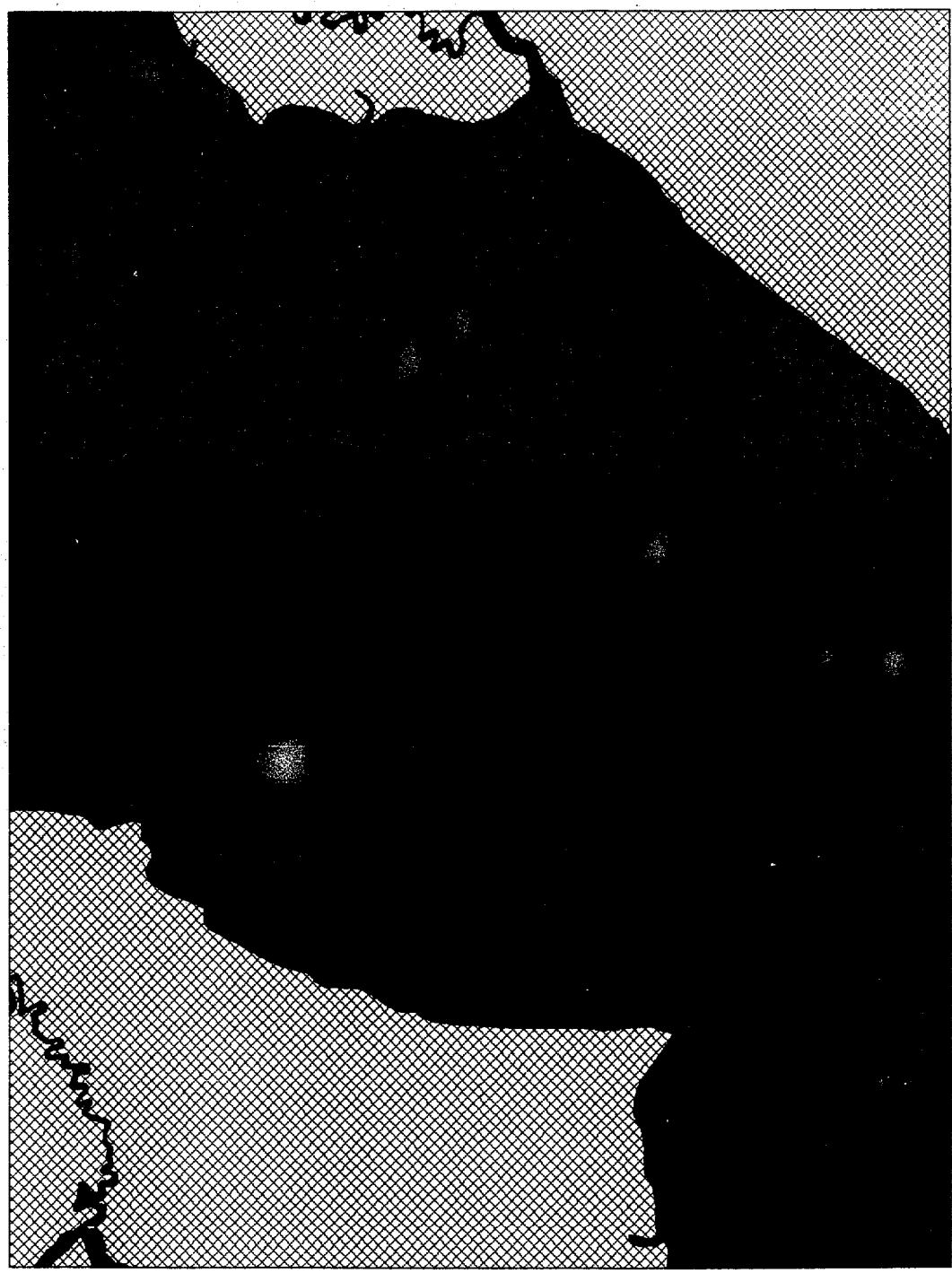
5702460

ESSEX CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

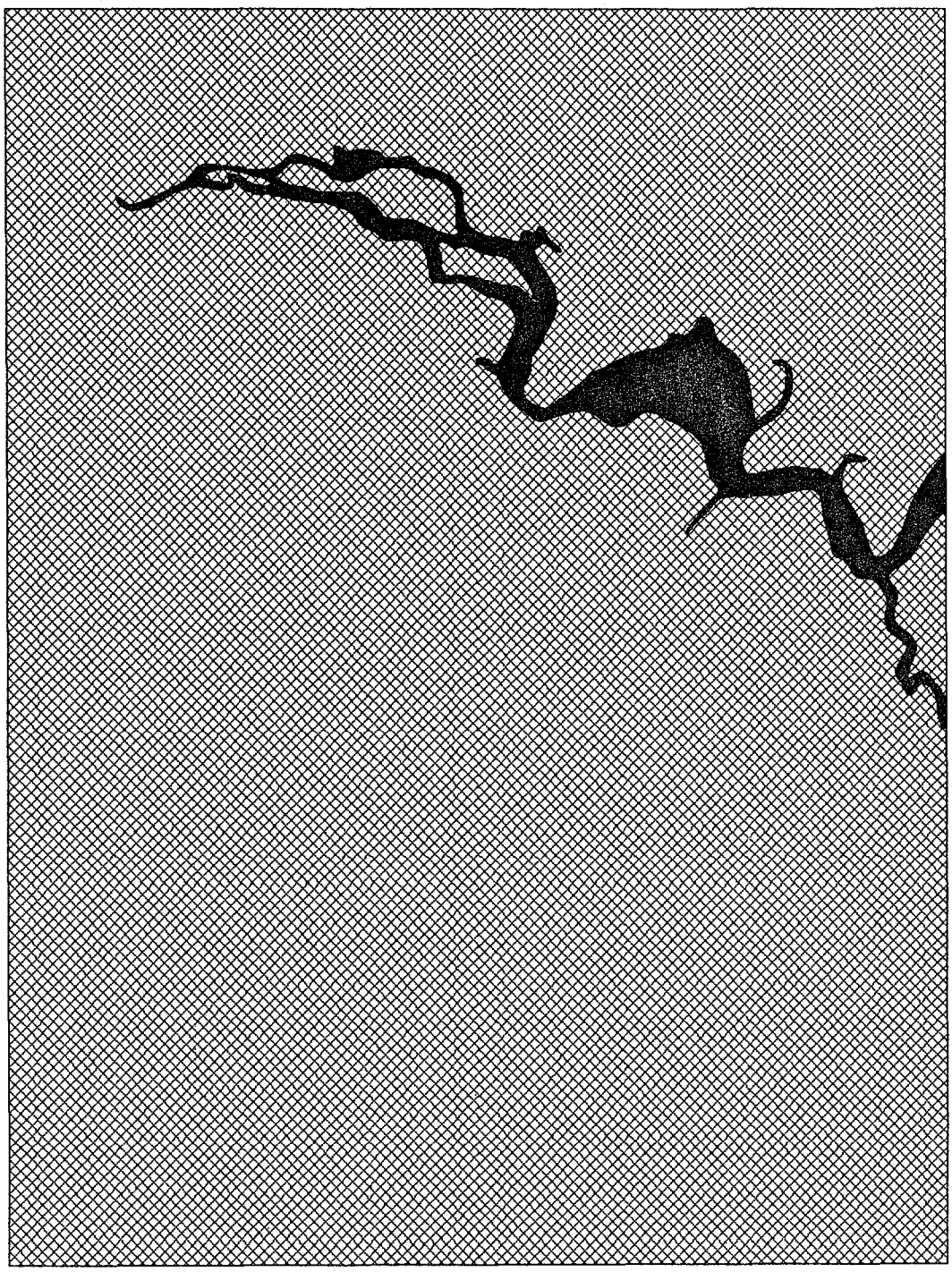
5702480

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

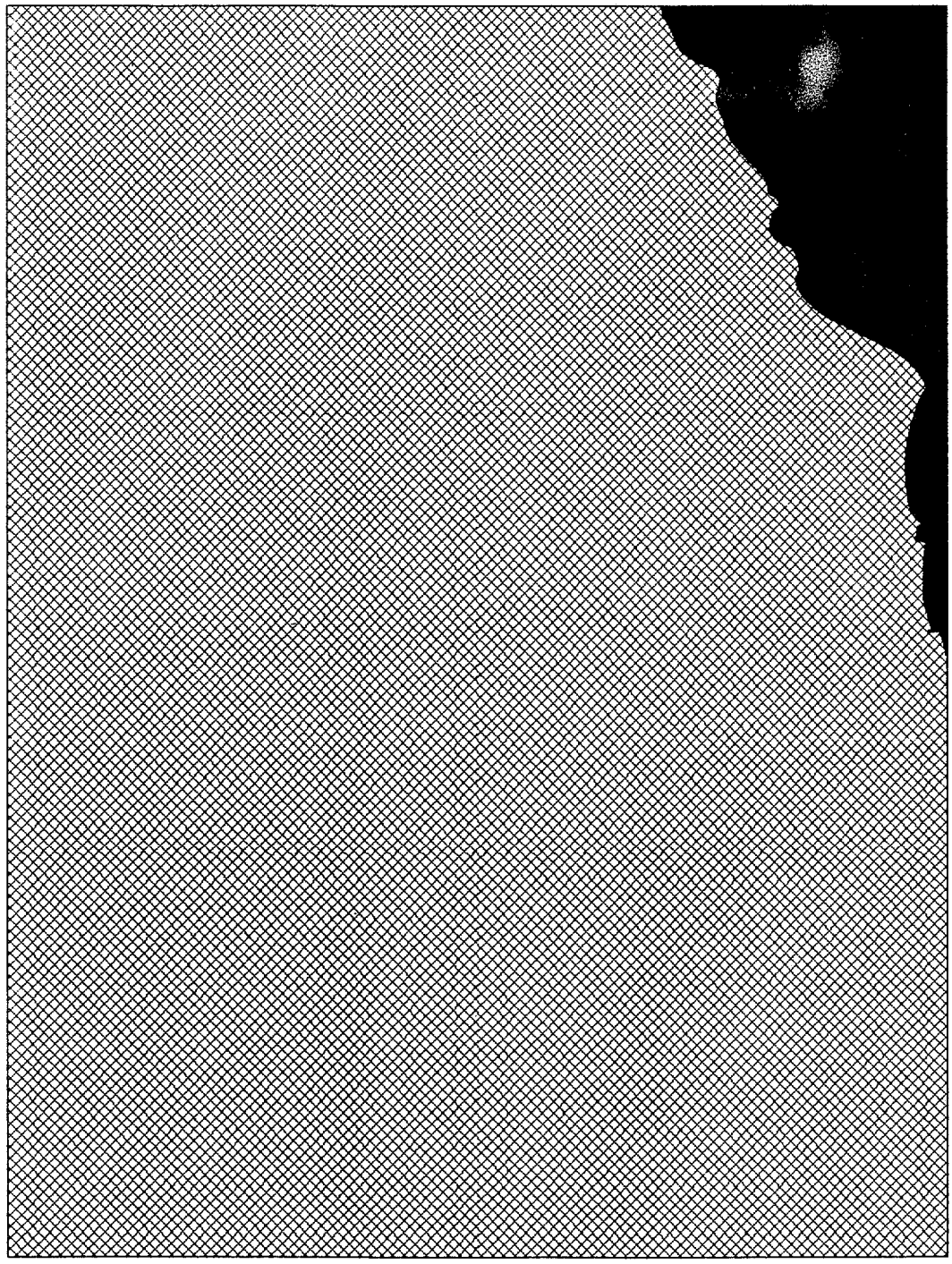
5552460

ESSEX CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

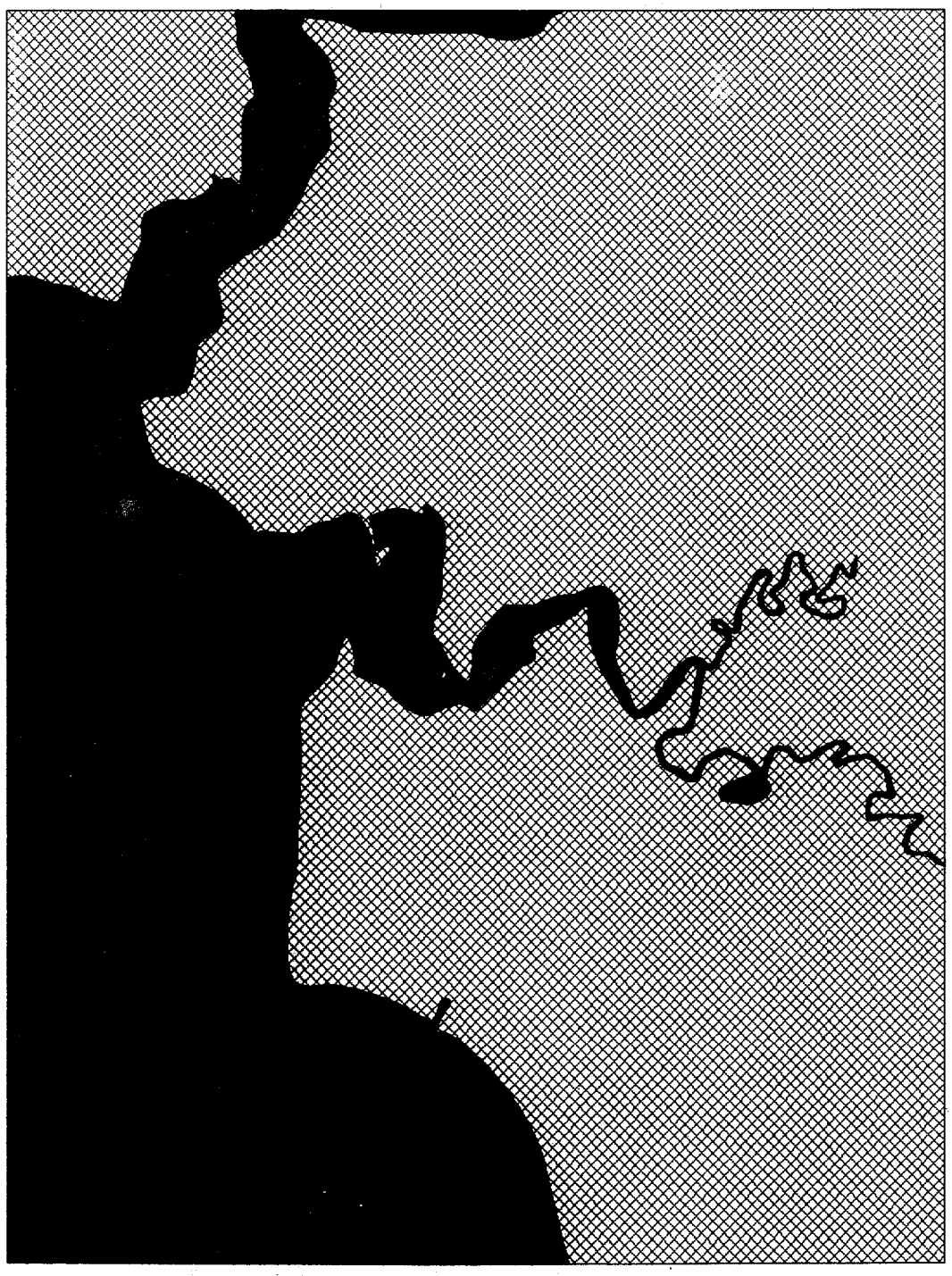
5552480

ESSEX CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

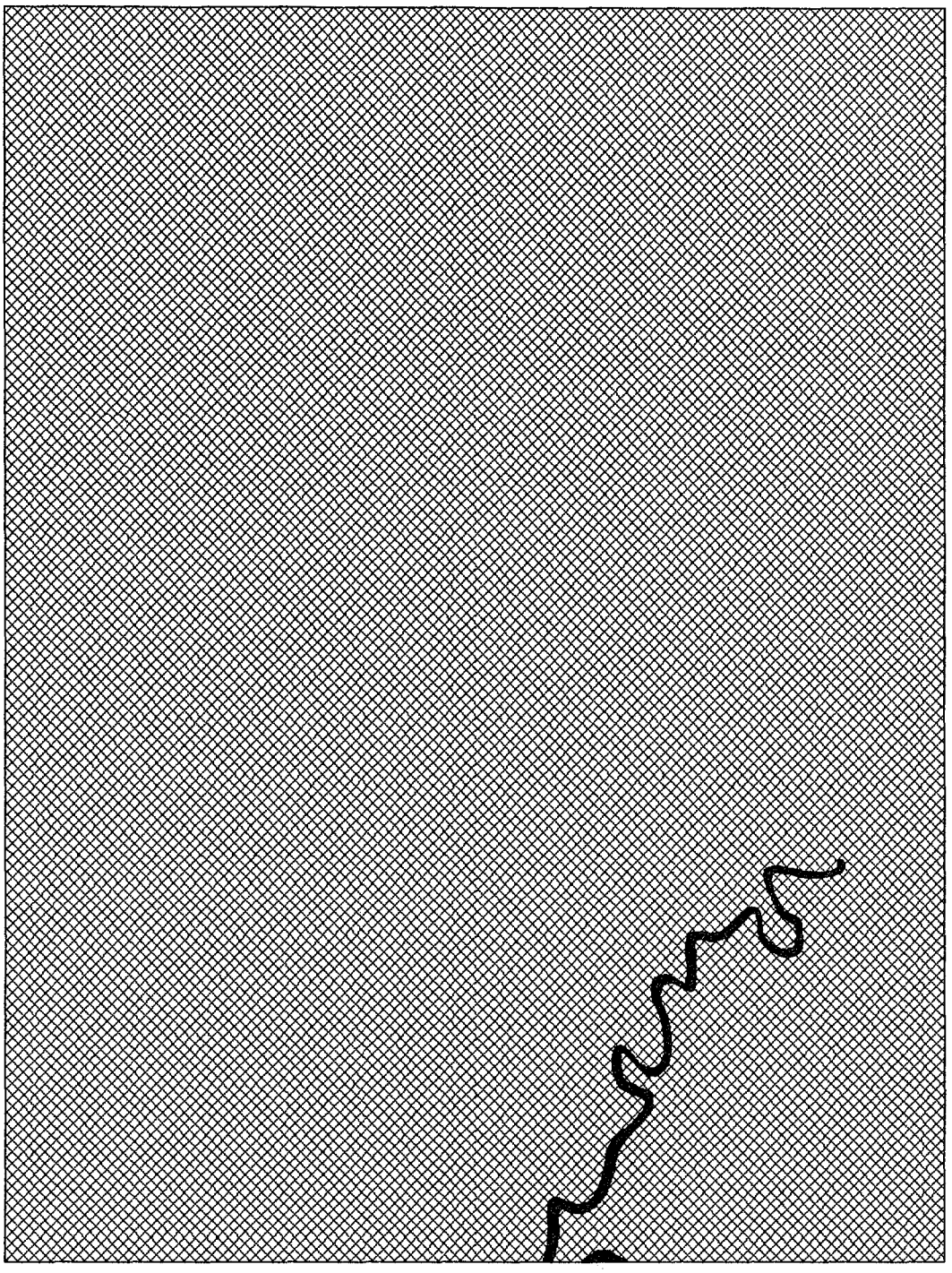
5552500

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

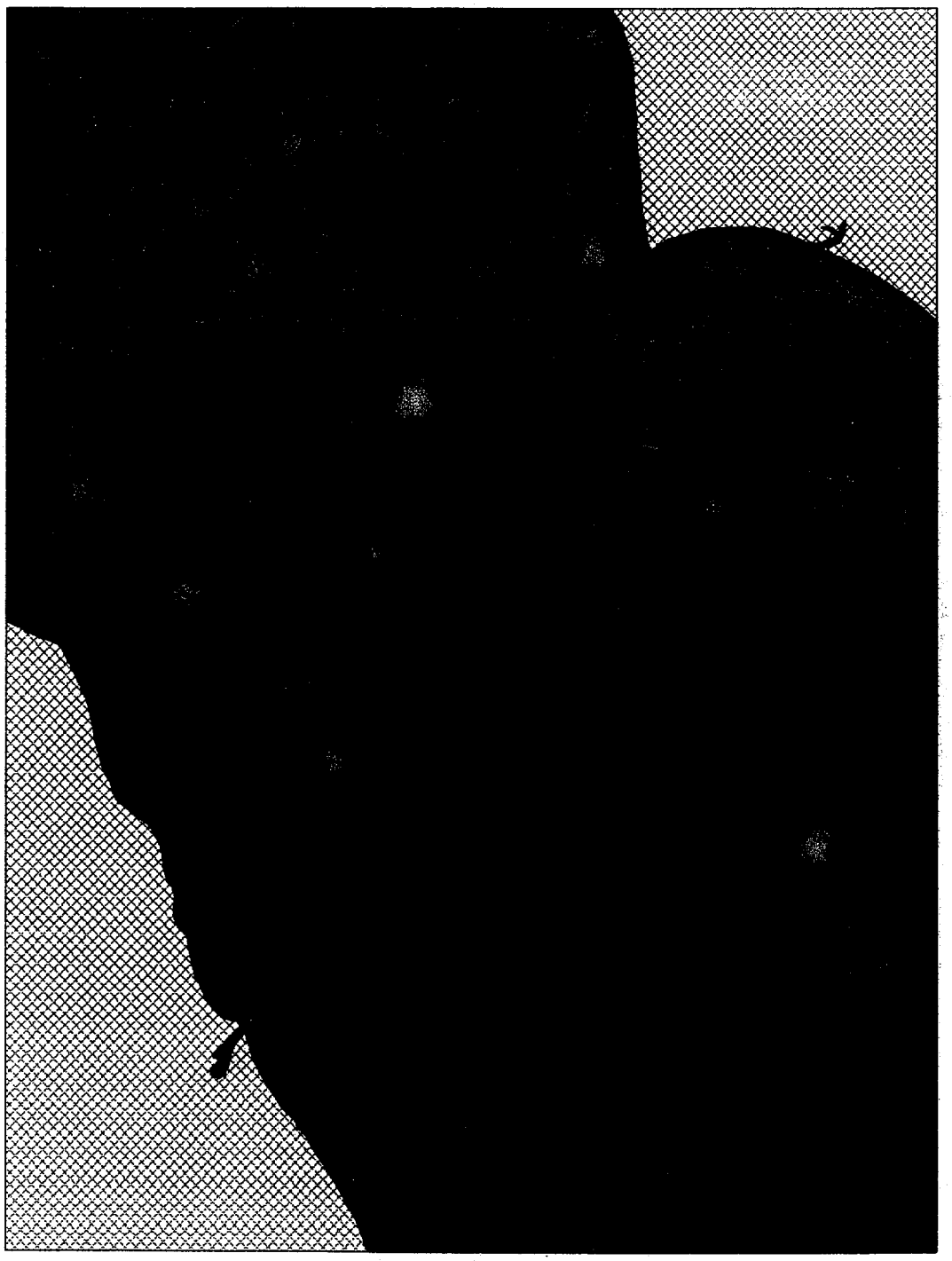
5552520

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

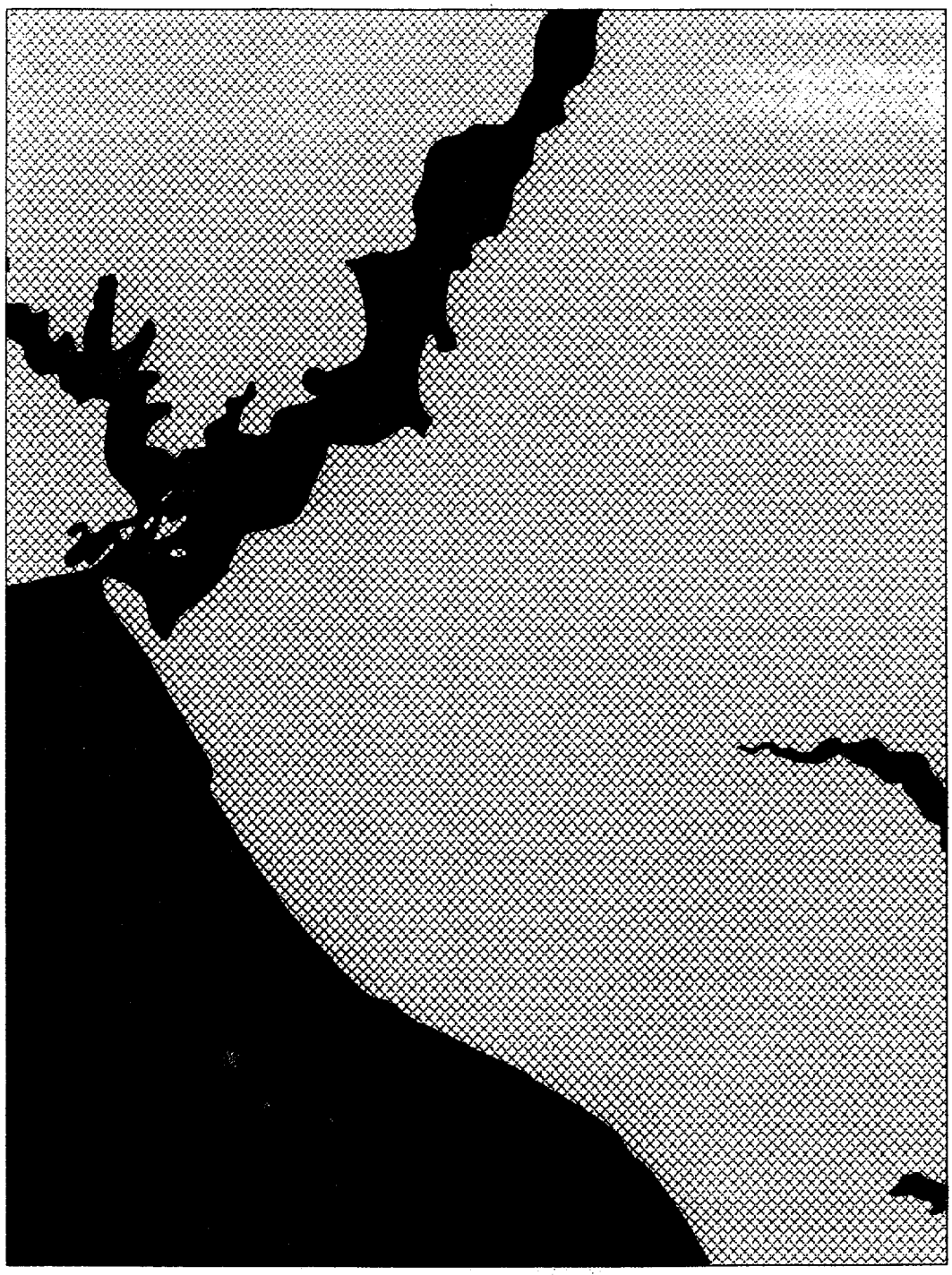
5402500

RICHMOND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

5402520

RICHMOND CO

LEGEND

UPLAND

WATER

COASTAL INVENTORY

AVERAGE TIME AND DISC SPACE USED*

MARINE RESOURCES COMMISSION SHORELINE
NORTHUMBERLAND COUNTY

MAP NUMBER	TIME	DISC SPACE
6152540	3.75	858112
6152560	3.5	866304
6152580	2.25	811008
6002540	4.75	858282
6002560	4.75	858282
6002580	7.75	905216
6002600	4.0	804864
5852560	2.75	813056
5852580	4.0	841728
5852600	5.0	890880
5852620	3.5	839680
5702580	2.0	798720
5702600	1.75	800768
5702620	6.0	874496
5702640	8.75	897024
5552580	2.0	819200
5552600	3.5	899072
5552620	15.5	917504
5552640	8.75	915456
5402600	2.25	808960
5402620	5.25	911360
5402640	6.0	839680
5252600	1.25	804864
5252620	10.5	978944
5252640	1.5	798720
5102620	4.25	903168
4952600	4.75	858282
4952620	4.75	858282
AVERAGE	4.75	858282

*TIME IN HOURS, DISC SPACE IN BYTES

MARINE RESOURCES SHORELINE

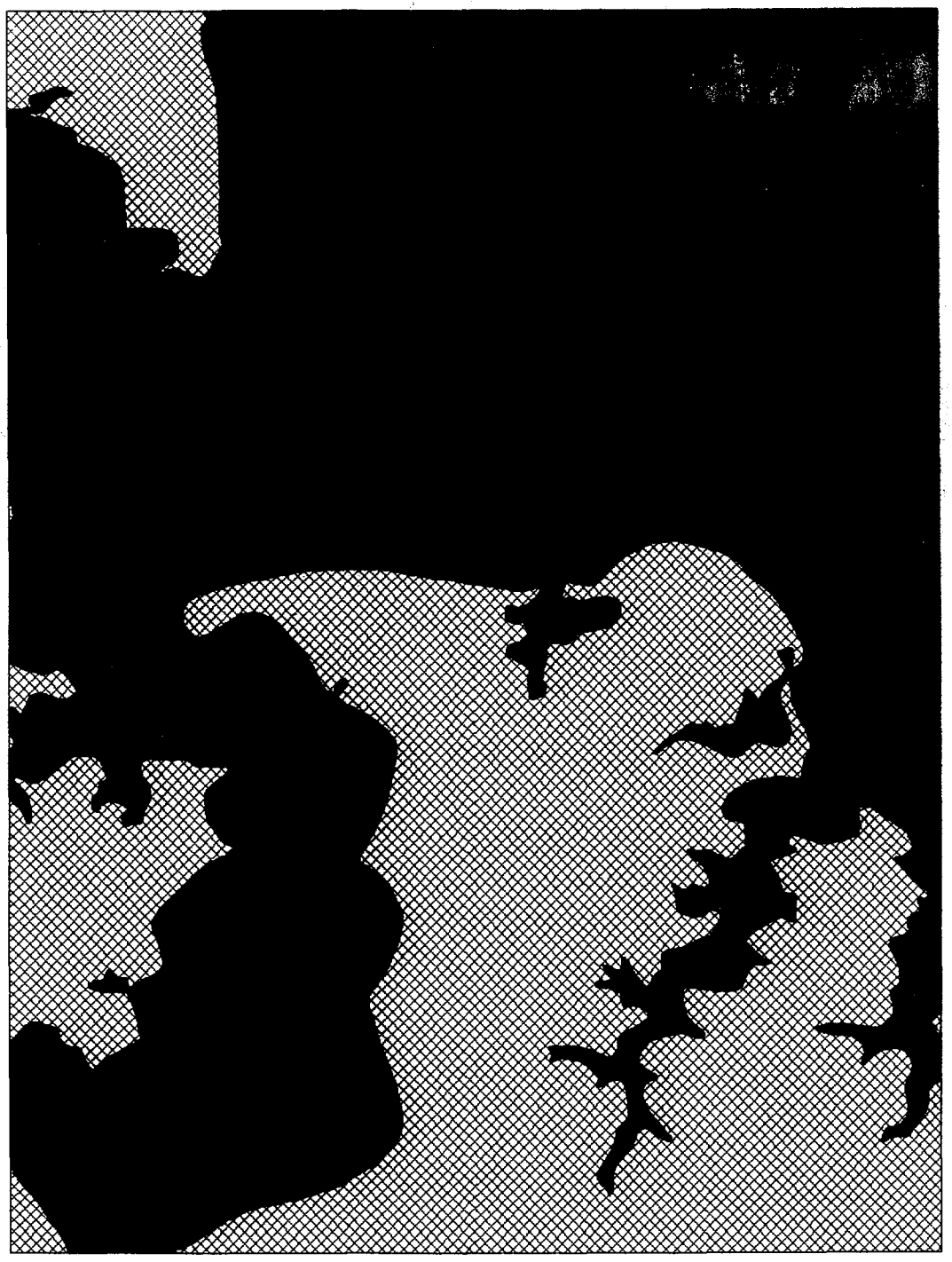
6152580

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

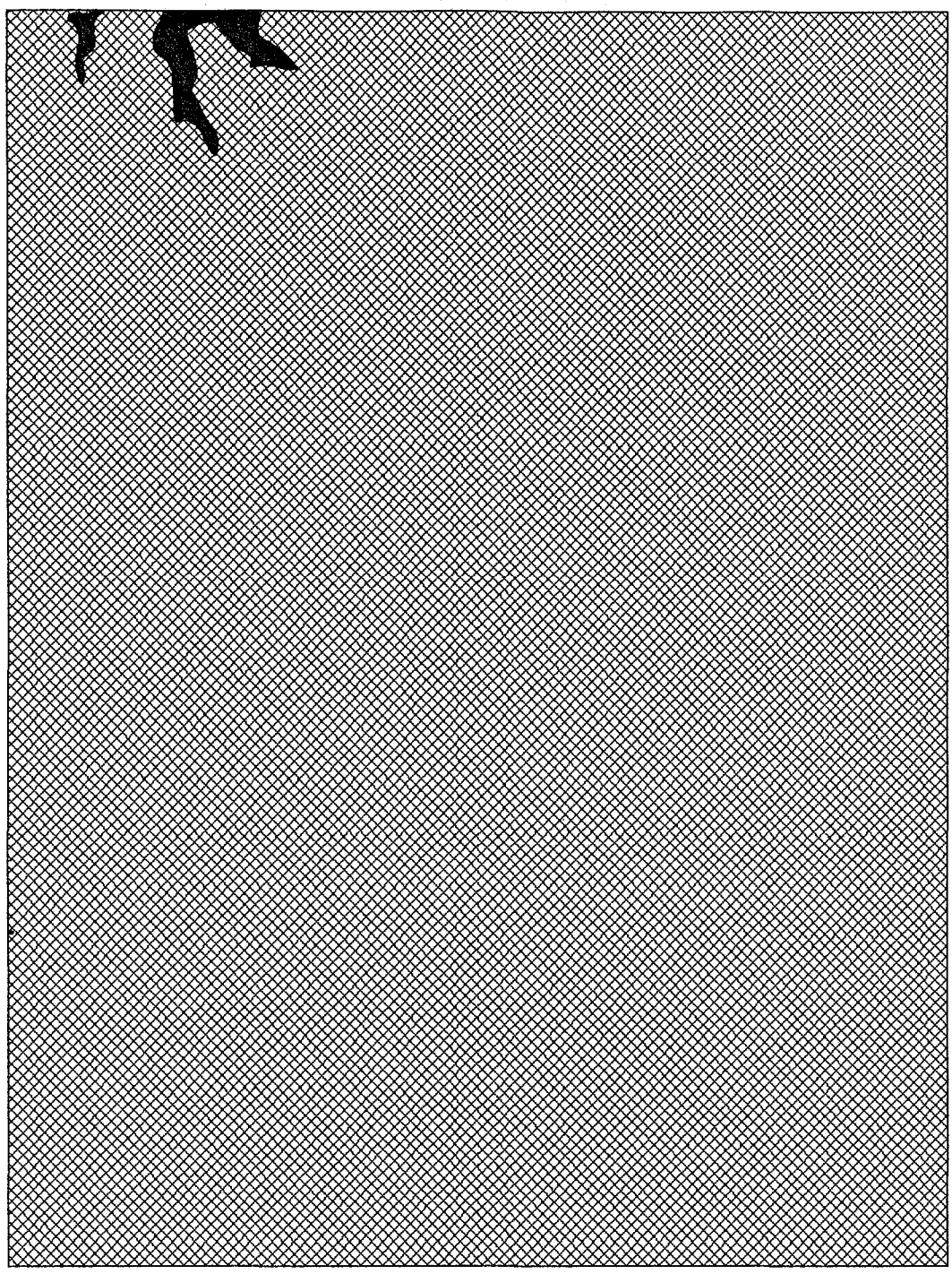
6002580

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

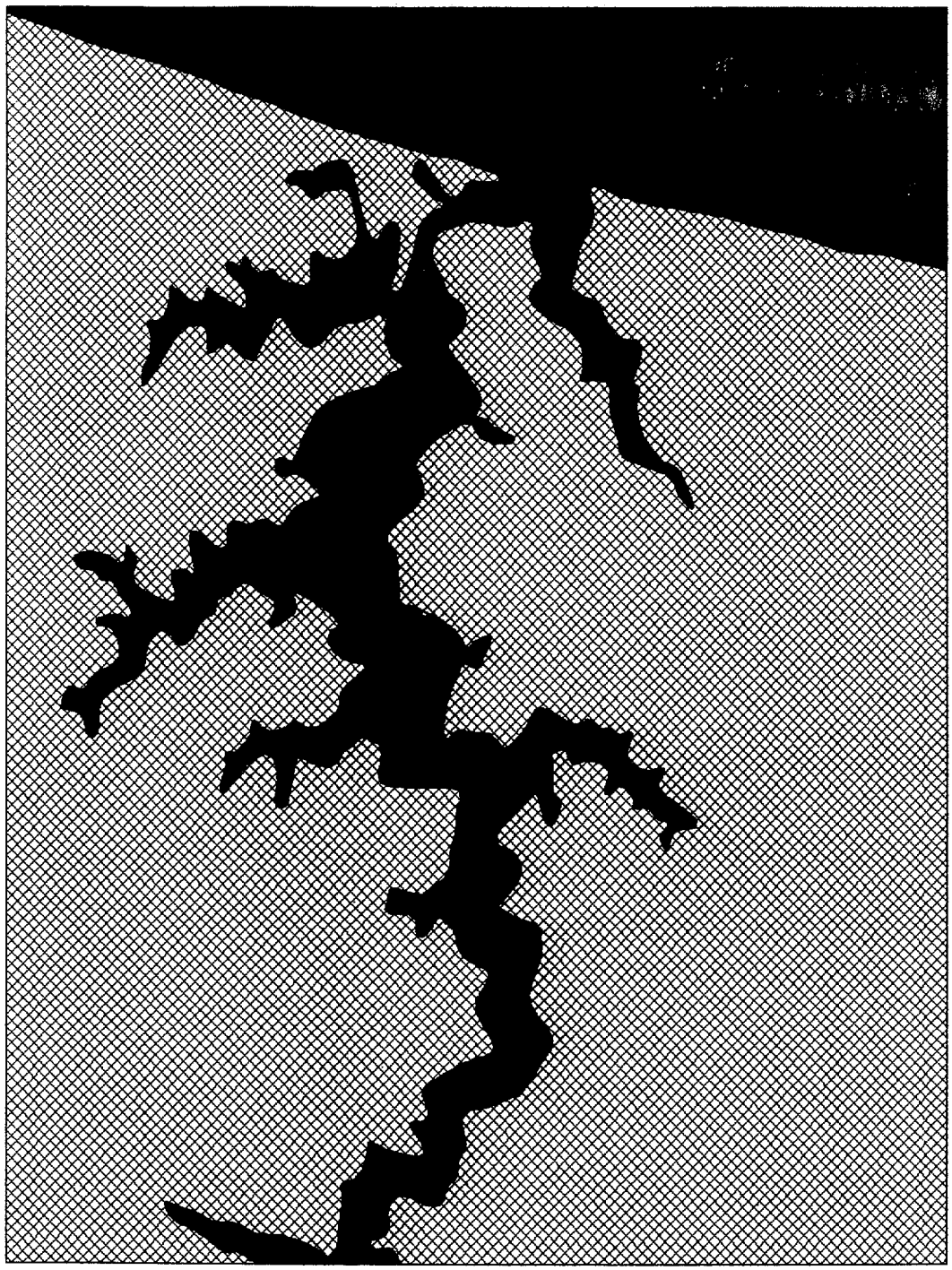
5852580

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

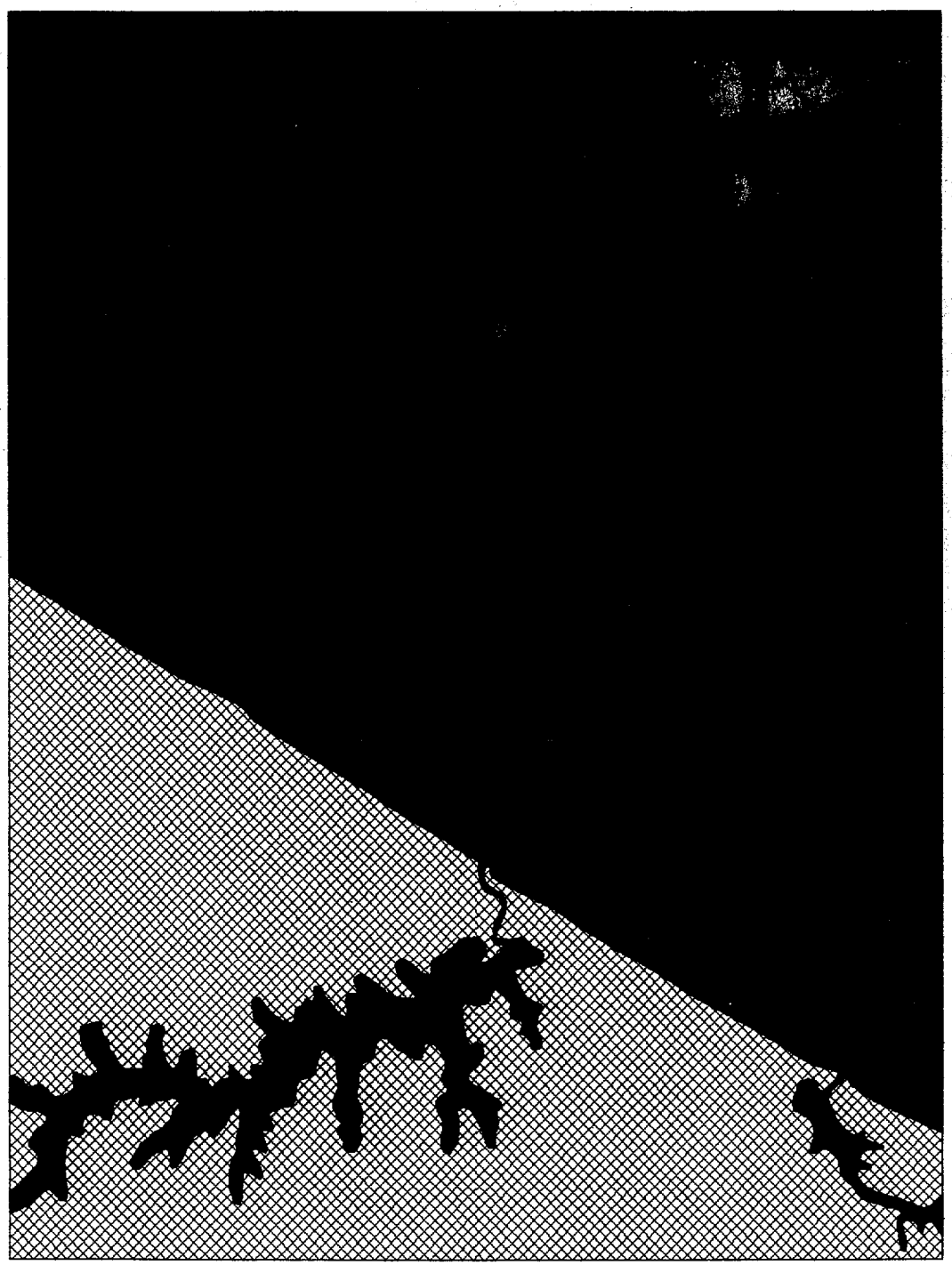
5852600

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

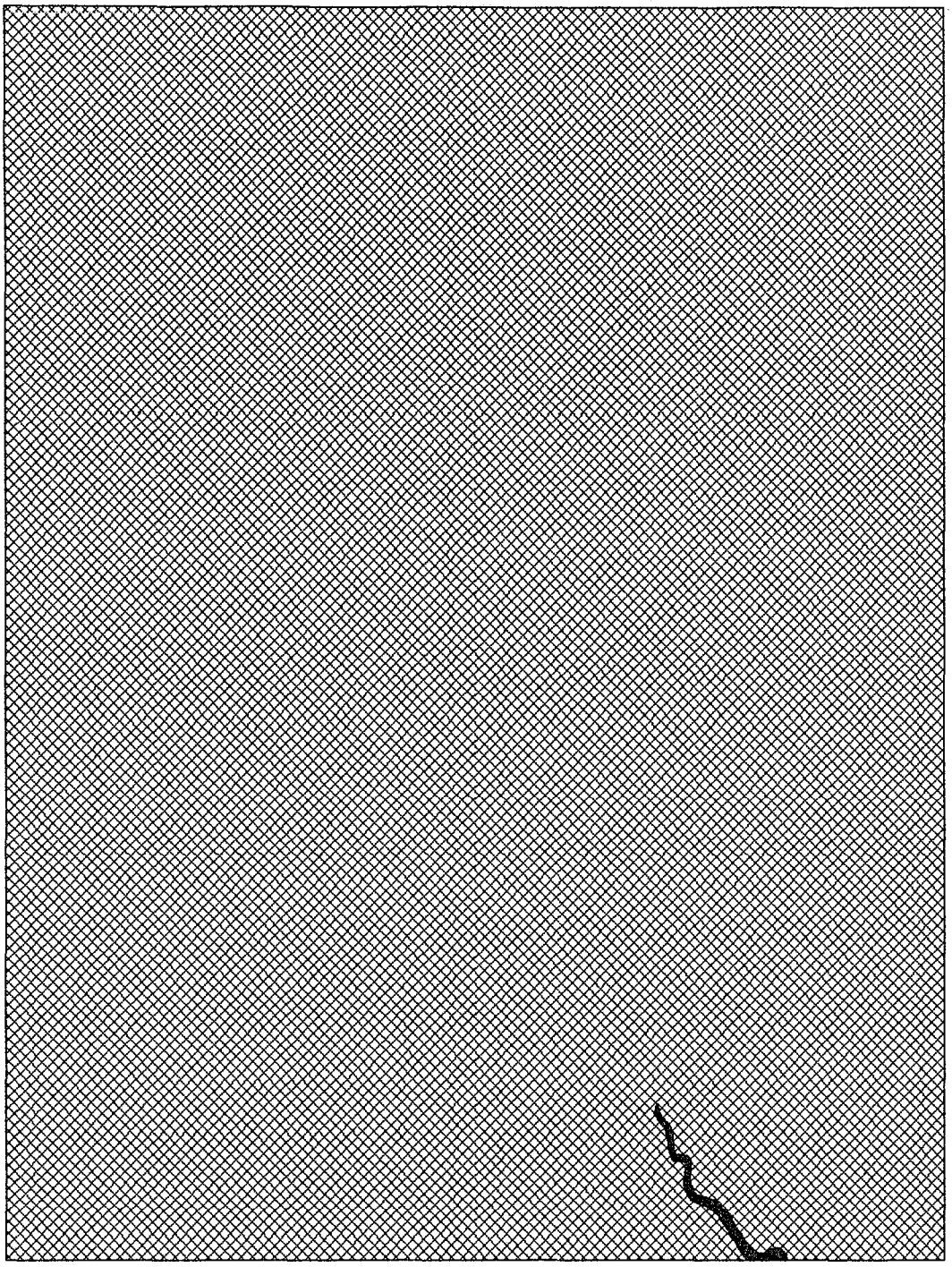
5852620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

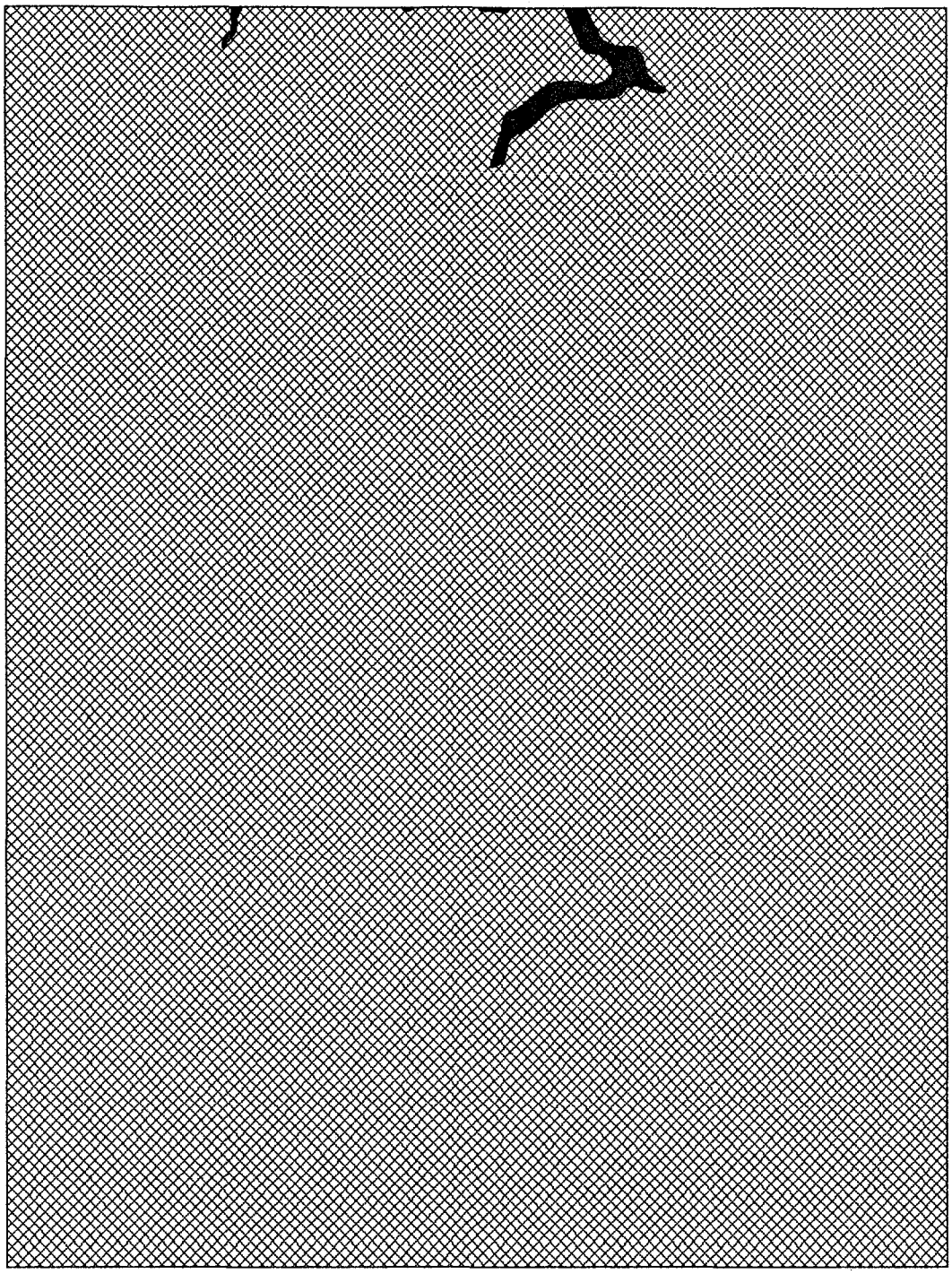
5702580

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

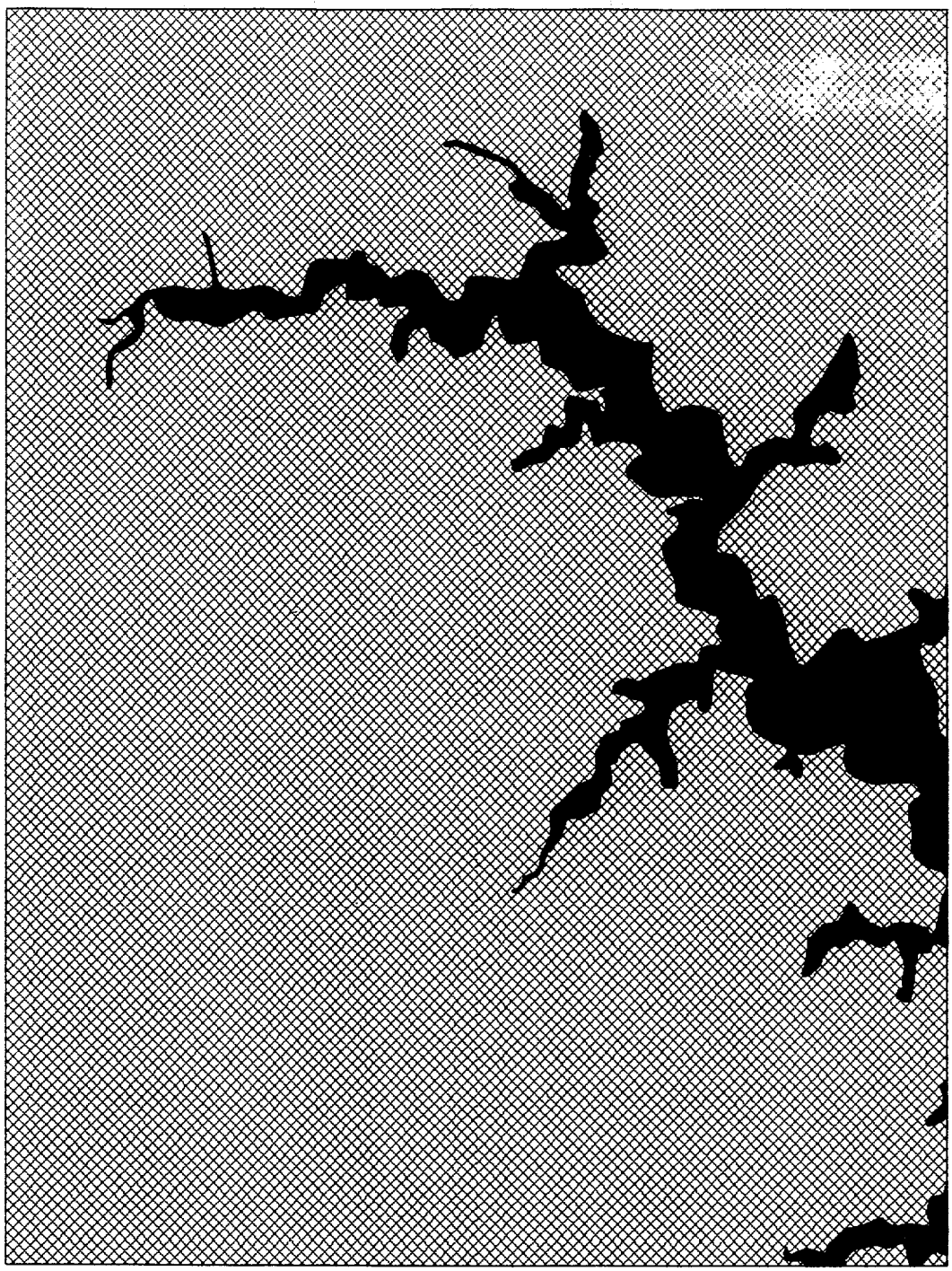
5702600

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

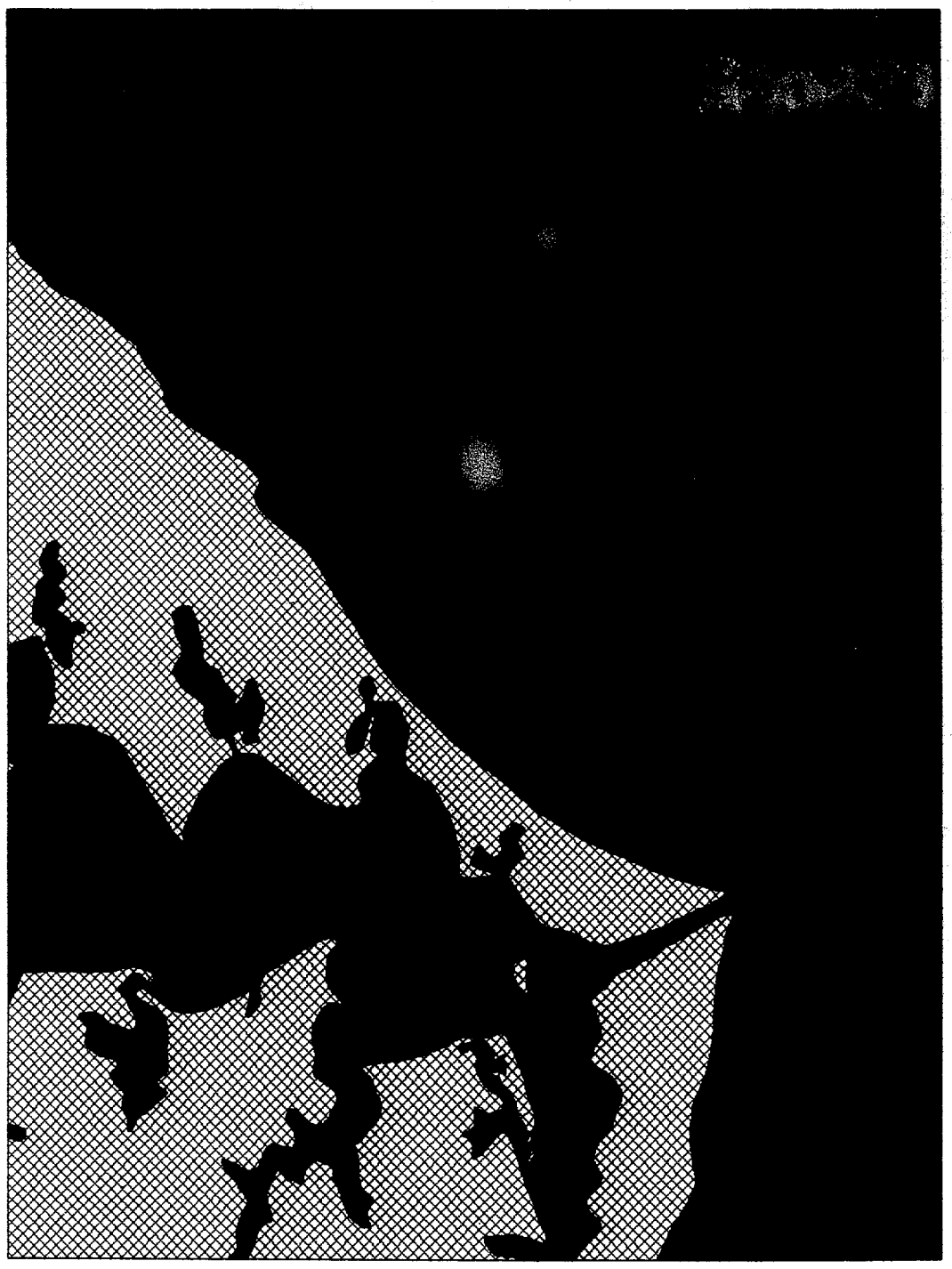
5702620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

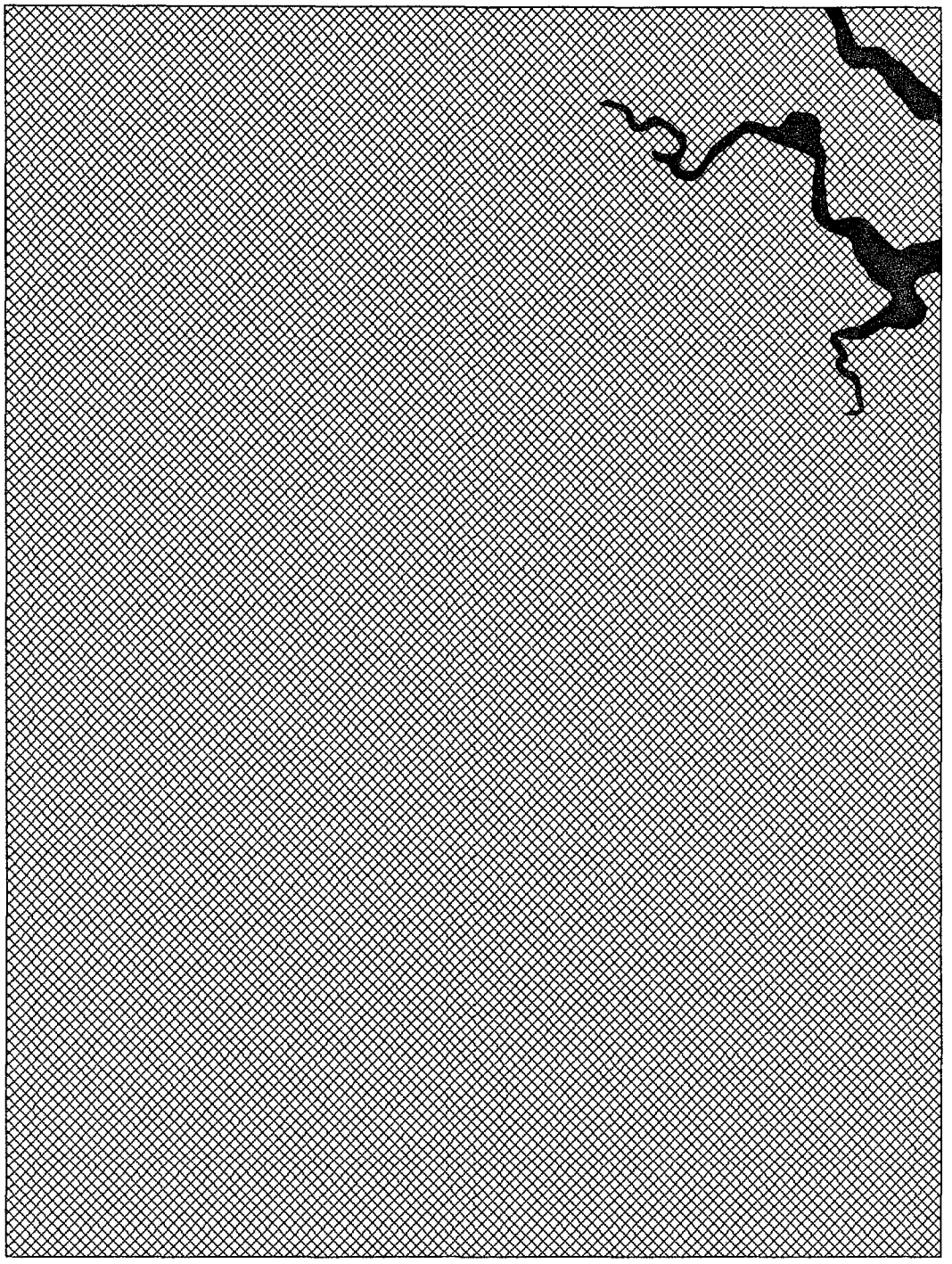
5702640

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

5552580

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER

MARINE RESOURCES SHORELINE

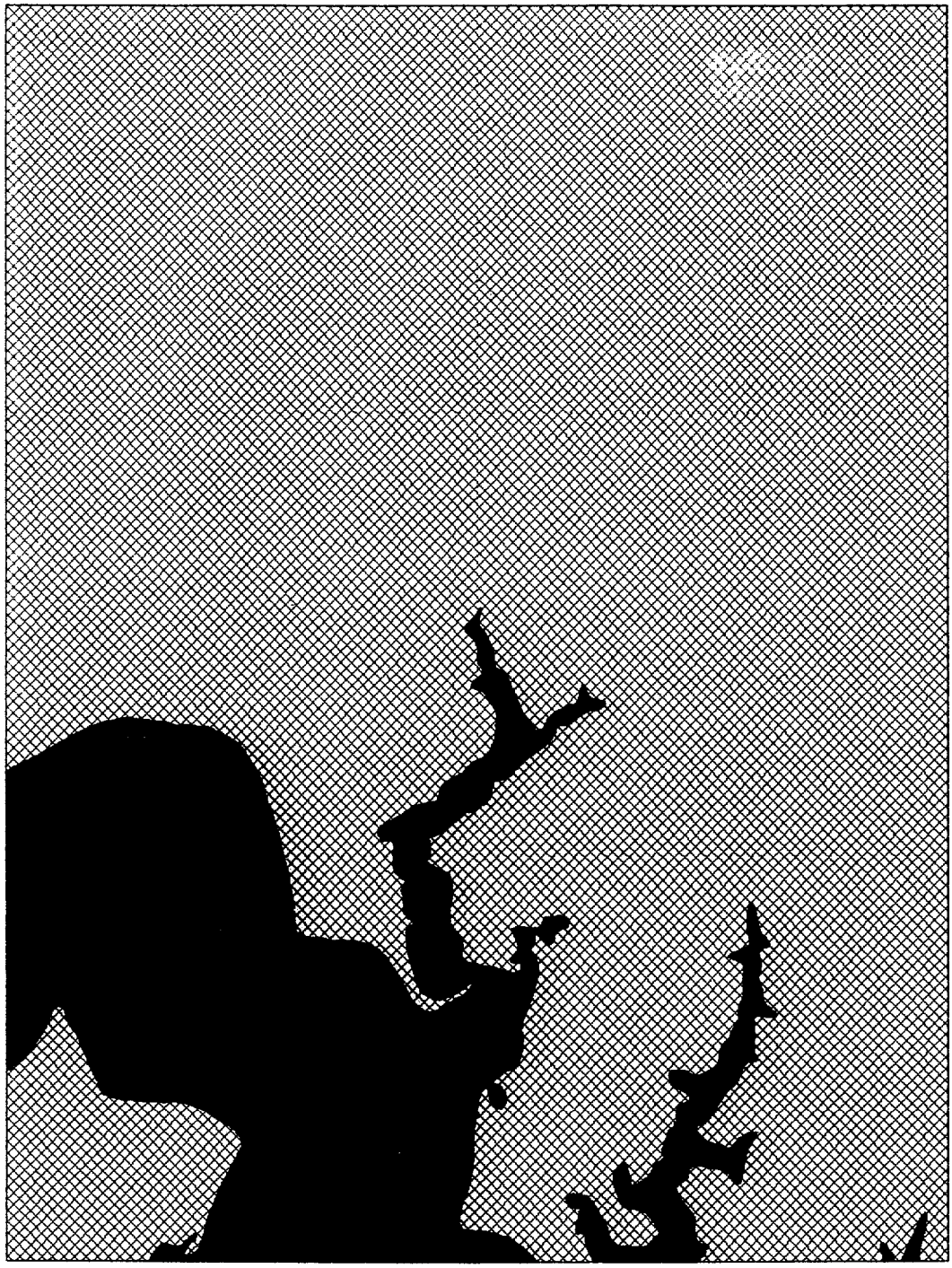
5552600

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

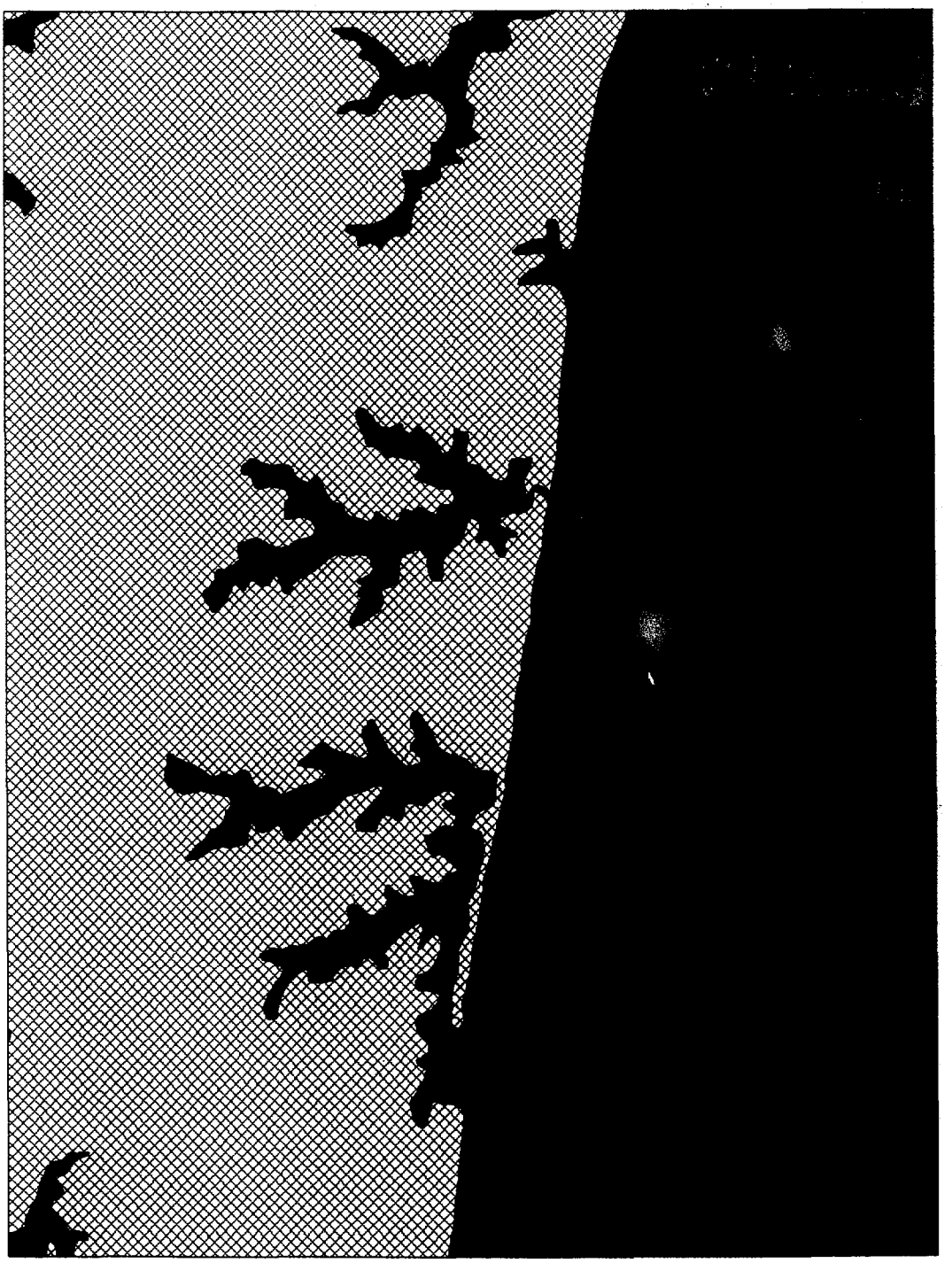
5552620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

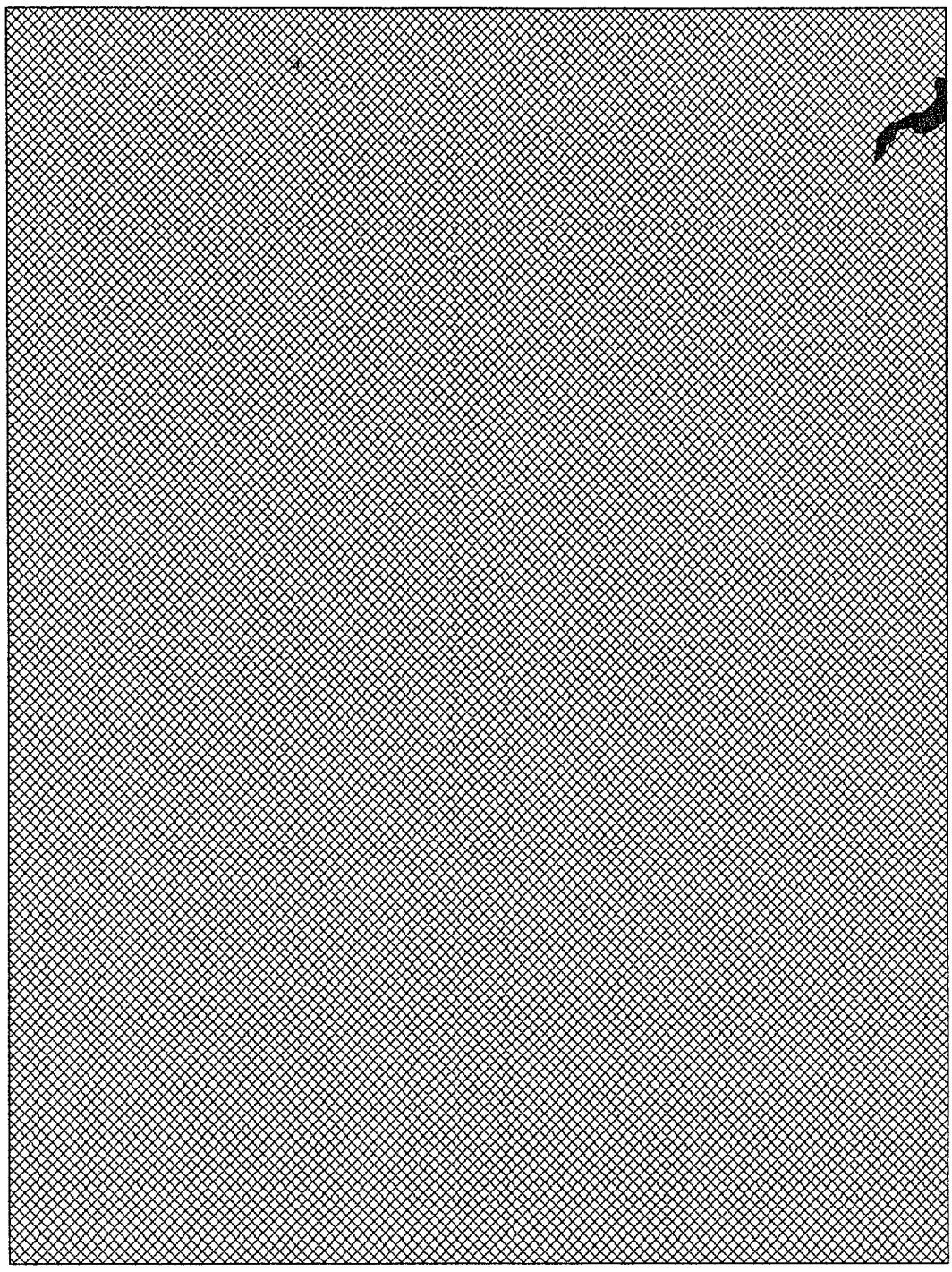
5552640

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

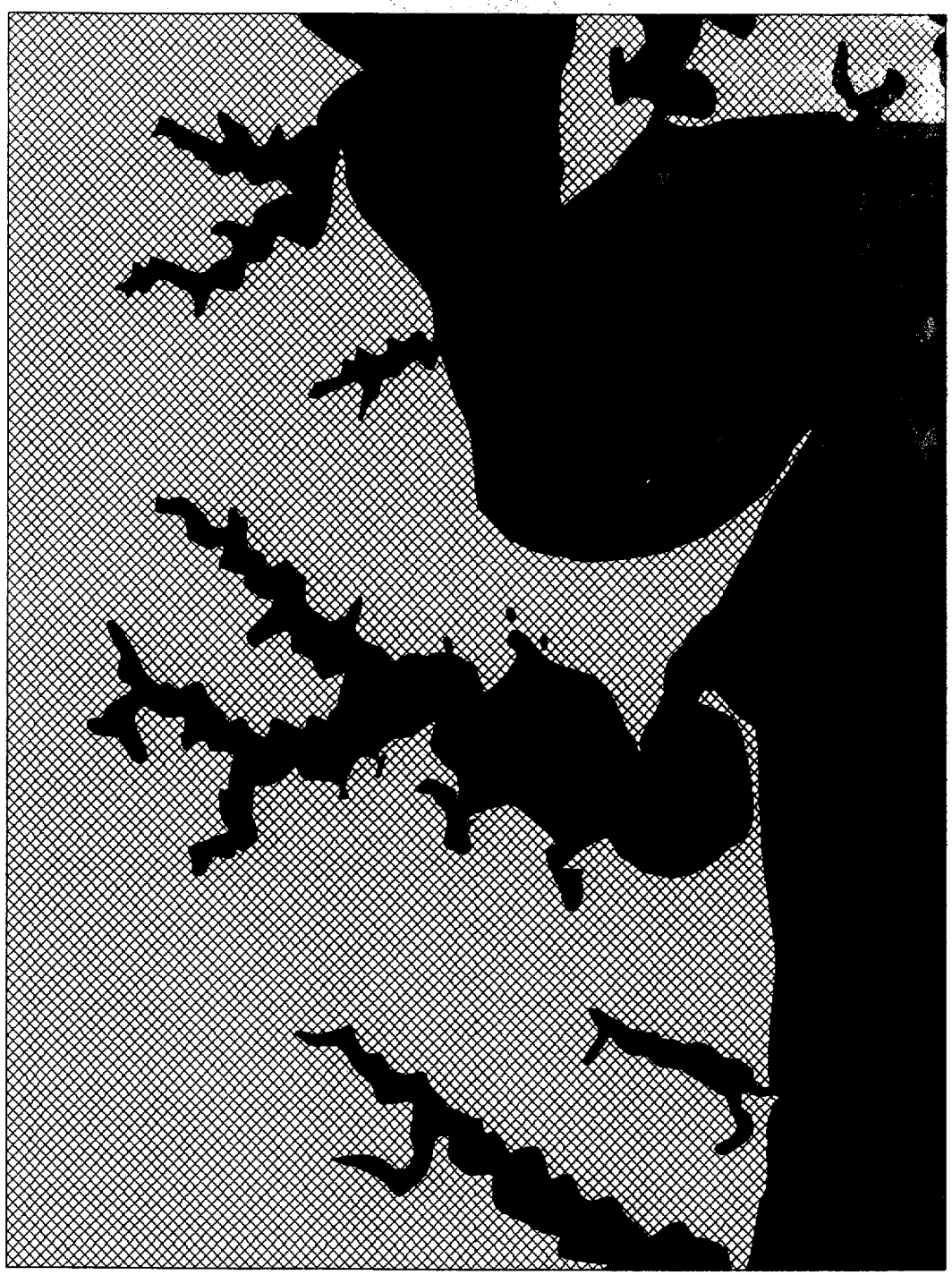
5402600

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

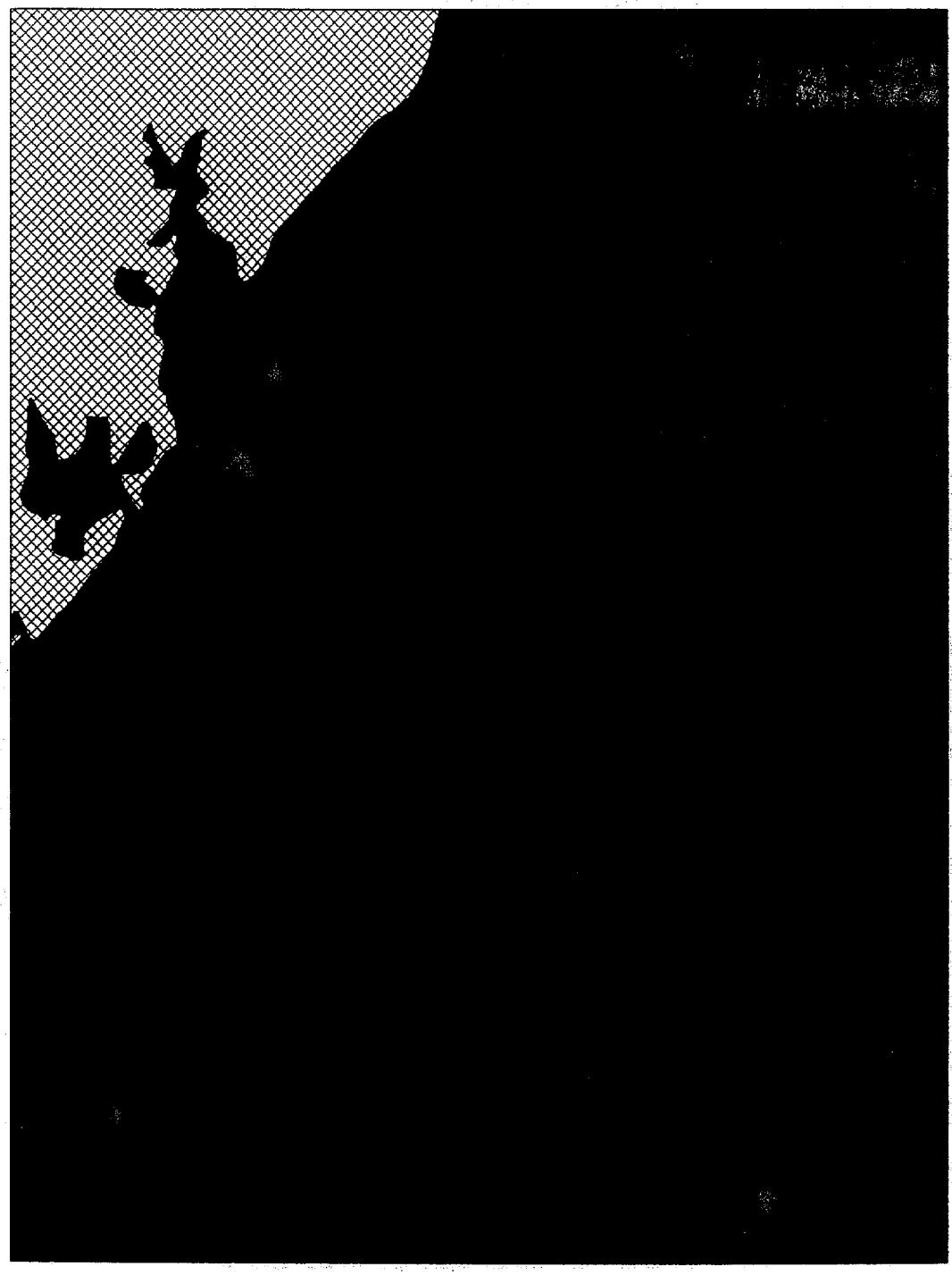
5402620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

5402640

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER

MARINE RESOURCES SHORELINE

5252620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER

MARINE RESOURCES SHORELINE

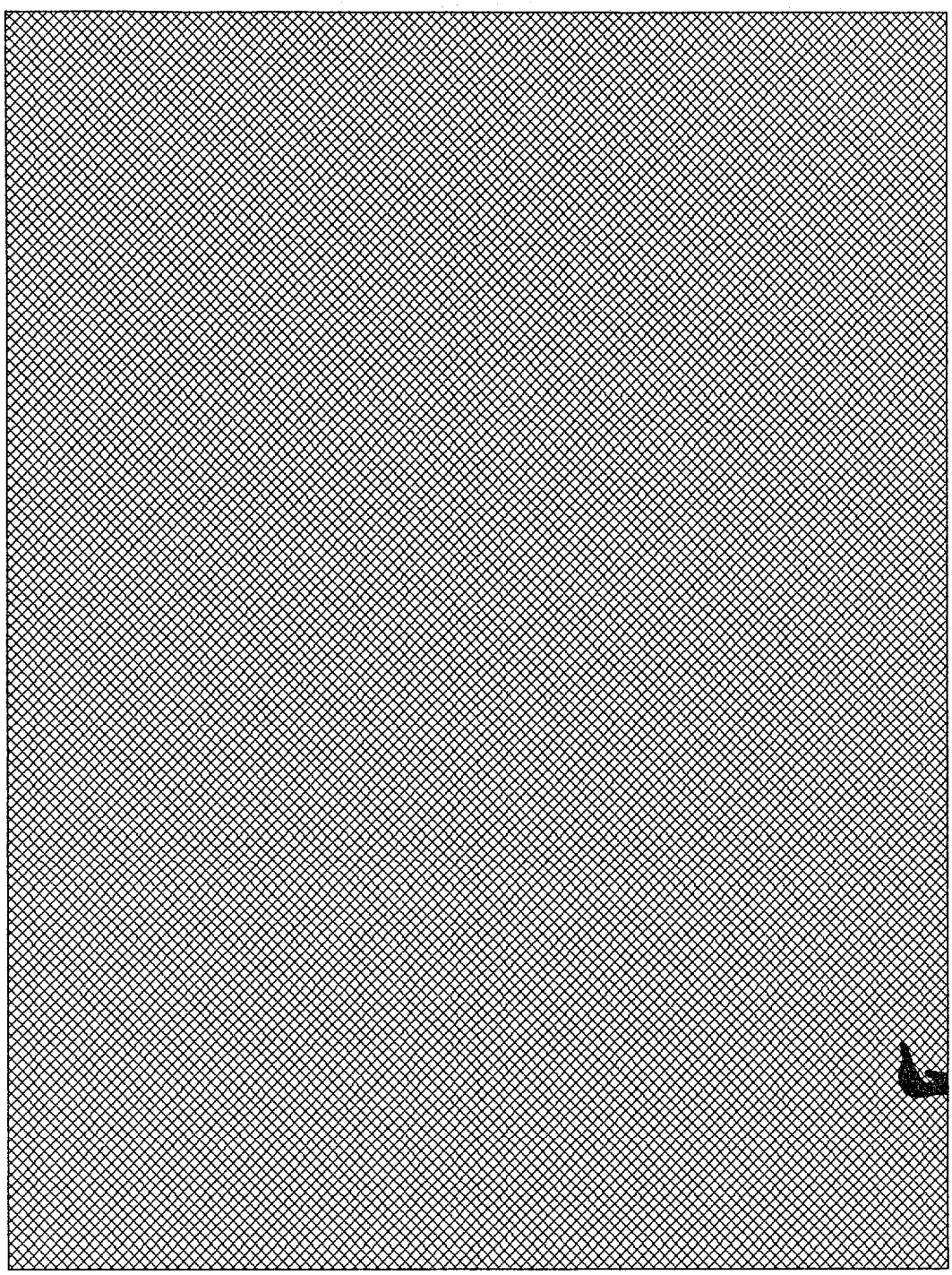
5102620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER



MARINE RESOURCES SHORELINE

4952600

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER

MARINE RESOURCES SHORELINE

4952620

NORTHUMBERLAND CO

LEGEND

UPLAND

WATER

CHAPTER IV. MAPPING SCALES

IV. MAPPING SCALES

The development and utility of a computer-based GIS system is critically dependent on the accuracy and precision of primary data layers like shoreline coverages to which all subsequent coverages are superimposed. The elements of accuracy and precision define the quality of the database. Accuracy is a measure of exactness or correctutude: that is, how well does the line on the map that represents the land/water interface correspond to the actual geographic location of that interface. Precision is a meausre of the degree of refinement with which a measurement can be made. It is usually associated with the operational limits of a particular technique or instrument. For example, a particular reach of shoreline may be digitized from an aerial photograph. The operator may digitize a line that he interprets as the land/water interface. Subsequent ground surveys establish that the actual position of the shoreline varies by as much as 30 meters from the mapped line. The accuracy of the shoreline database, therefore, can only be verified within an error bar of +/- 15 meters. The digitizer used may be capable of recognizing a measurement to .001 cm. At a scale of 1:5,000, the ground distance represented by the measurement limits is +/- .05 m. This value places precision limits on the mapping operation. The total amount of error associated with both methodology and instrumentation must be assessed to establish the quality of any particular data coverge.

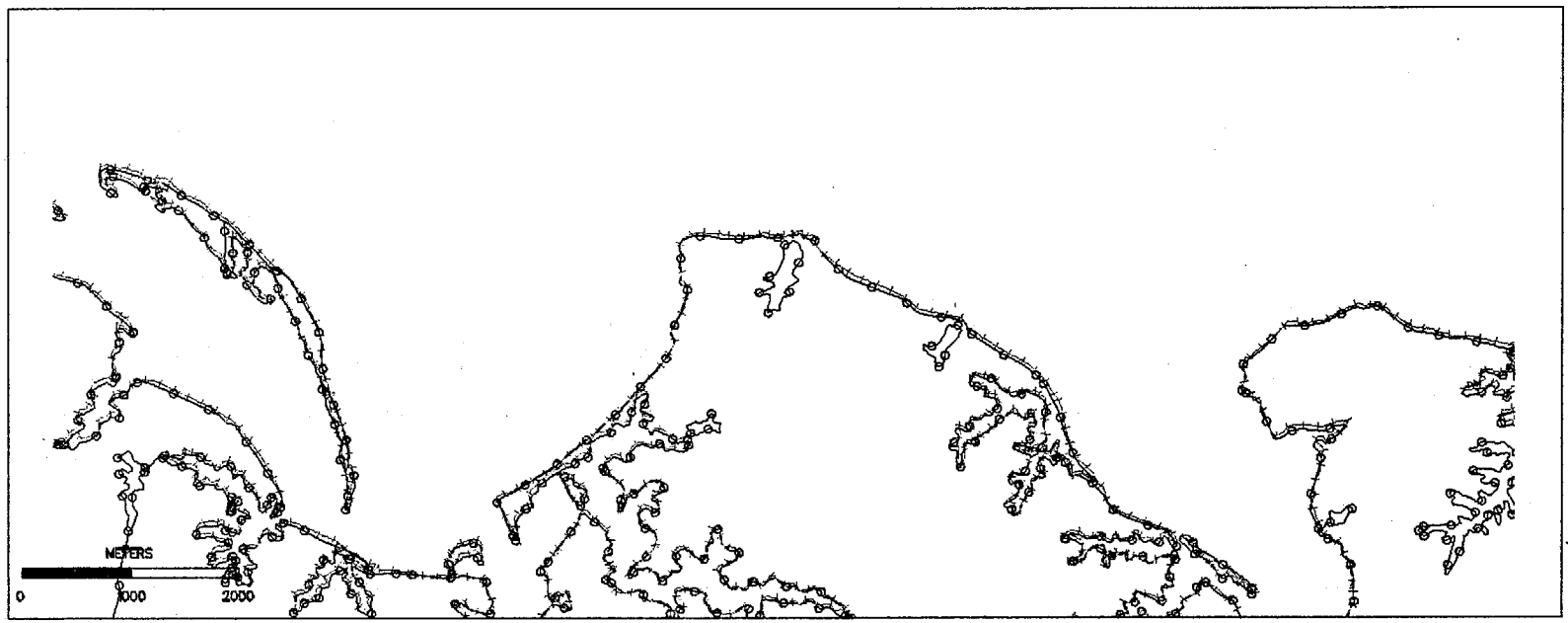
To maintain accuracy and precision standards it is essential that geographic data be represented at scales no finer than those at which the data was originally mapped. Since several data coverages included in the Comprehensive Coastal Inventory were originally mapped at coarse scales, the acquisition or creation of low resolution shoreline data was necessary. The 1:100,000 scale shoreline record (ref. Chapter 12) created by the U.S. Geological Survey was incorporated into the GIS to allow for primary and secondary transportation networks, mapped at a scale of 1:100,000, to be accurately plotted within the constraints that the scale itself permits. To map this data at finer scales like 1:24,000 would have introduced error beyond the standards of this project. The tidal marsh coverage (ref. Chapter 11) was originally delineated at a scale of 1:24,000. Therefore, a 1:24,000 shoreline coverage was created in-house to serve as the base coverage for the tidal marsh records. Updates to the tidal marsh inventory can be made at finer scales (e.g. 1:5,000), but a first run comparsion of this data to the existing inventories must be made at a scale of 1:24,000. The VMRC shoreline maps were produced at a scale of 1:5,000 (ref. Chapter 3). This is the highest resolution shoreline base in the Inventory to date.It serves as the baseline coverage to plot all newly acquired shoreline data.

The 1989 shoreline coverage is developed from the interpretation of geographically registered vertical photographs (ref. Chapter 8). These images (ref. Chapter 6) were photographed at an altitude of 4400 feet, yielding a scale of 1:7200 or 1 inch on the photograph is equivalent to 605 feet on the ground. Once completed, a high resolution shoreline coverage at 1:7200 will be incorporated into the GIS.

The relatively large scale of the VMRC maps (1:5,000 or 1" = 416') and the GIS 1989 shoreline maps (1:7,200 or 1" = 605') permits data at these scales to be used to address local as well as regional environmental planning issues. The small scale alternative sources such as the U.S. Geological Survey Digital Line Graph (DLG) database (1:100,000), and the National Wetlands Inventory and Tidal Marsh Inventory digital shoreline databases (1:24,000) establish a resolution level that is unacceptably low for most management uses. In addition, accuracy (+/- 10 m at 1:24,000), and precision limits (line width = 2.4 m ground distance at 1:24,000) are undesirable for the anticipated applications of the Comprehensive Coastal Inventory.

A folio of shoreline comparisions, each digitized at different scales, is included to illustrate the potential variations in map interpretation and geographic data analysis which can result from superimposing coverages digitized at different scales. The following shoreline comparisions were made for a portion of the St. Clements Island Quadrangle sheet in Westmoreland County:

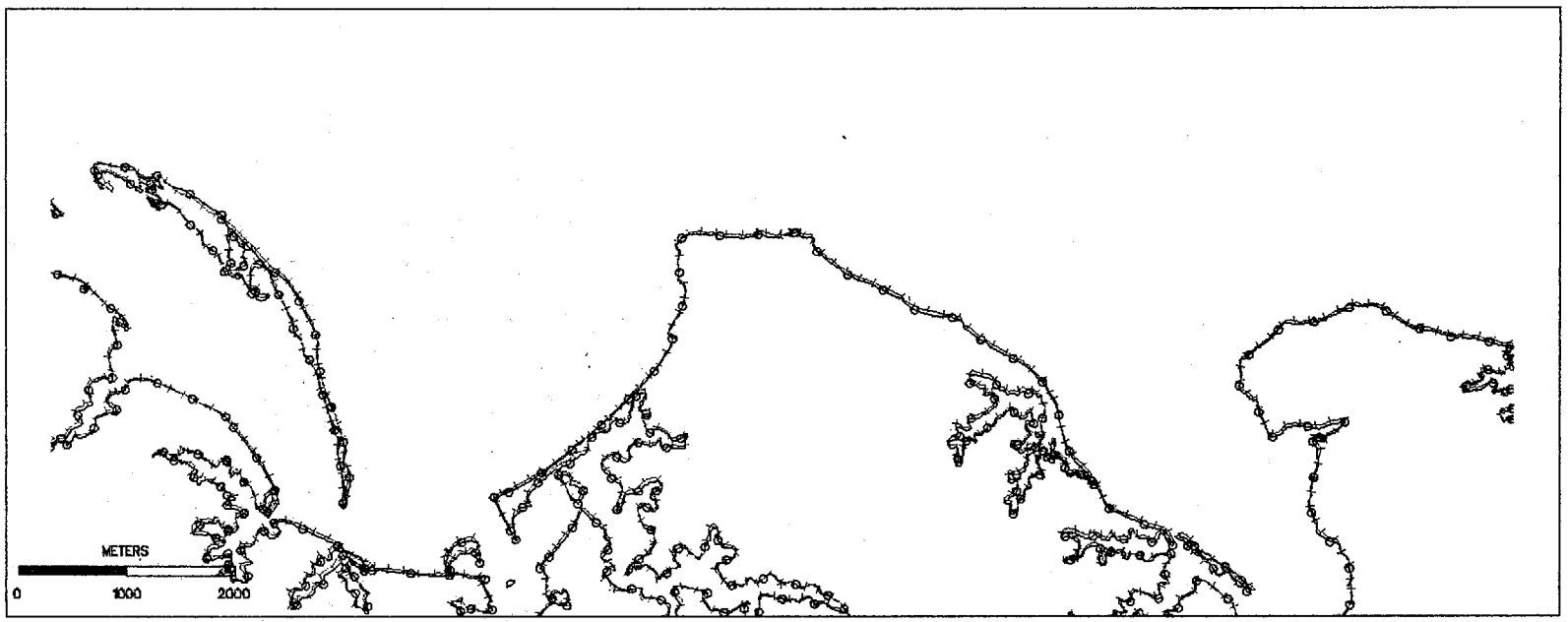
* 1:100,000 vs. 1:5,000
* 1:24,000 vs. 1:5,000
* 1:7,200 vs. 1:5,000



SHORELINE COMPARISON

St. Clements Island Quadrangle

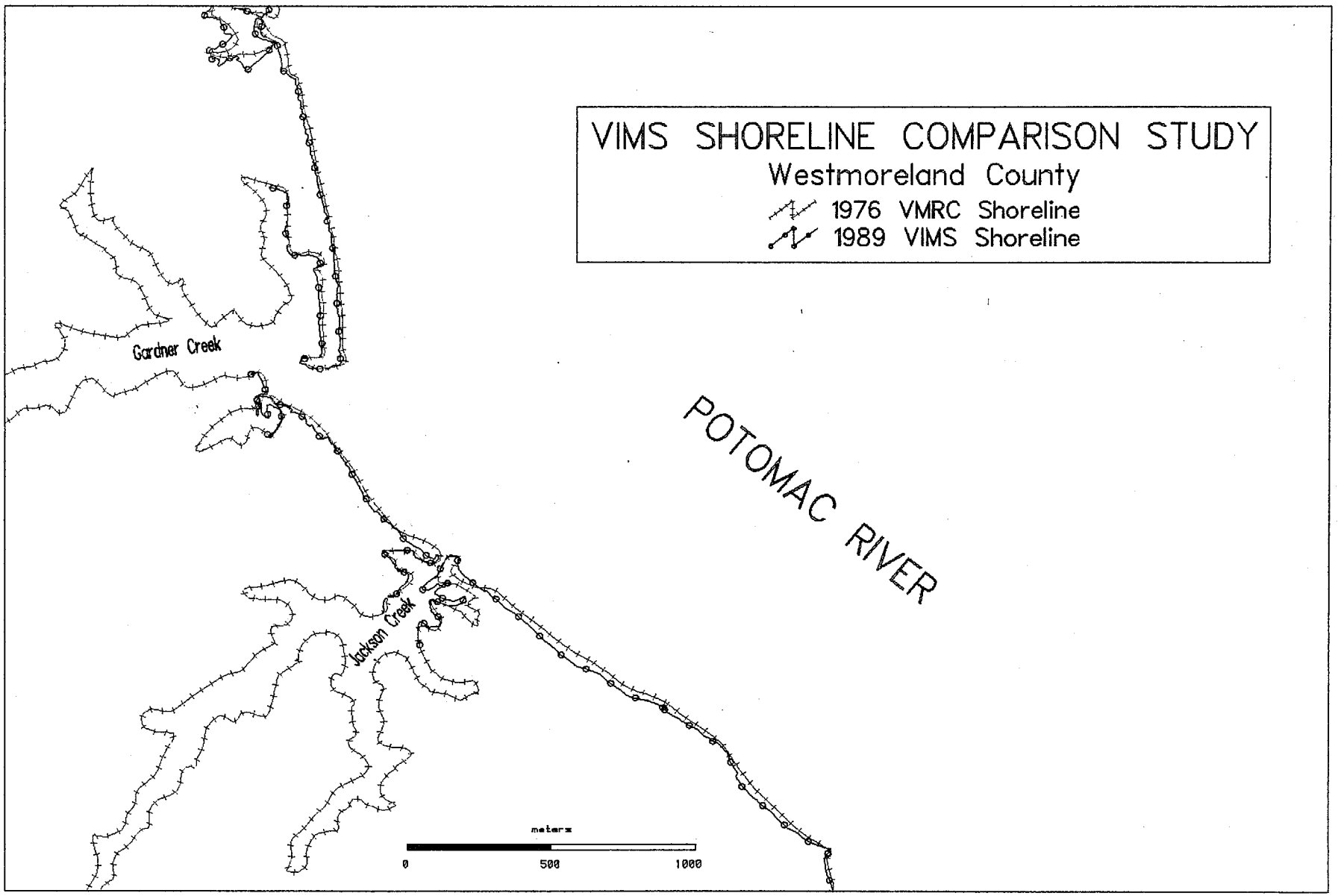
1:5000 VMRC Shoreline
1:100000 USGS Shoreline

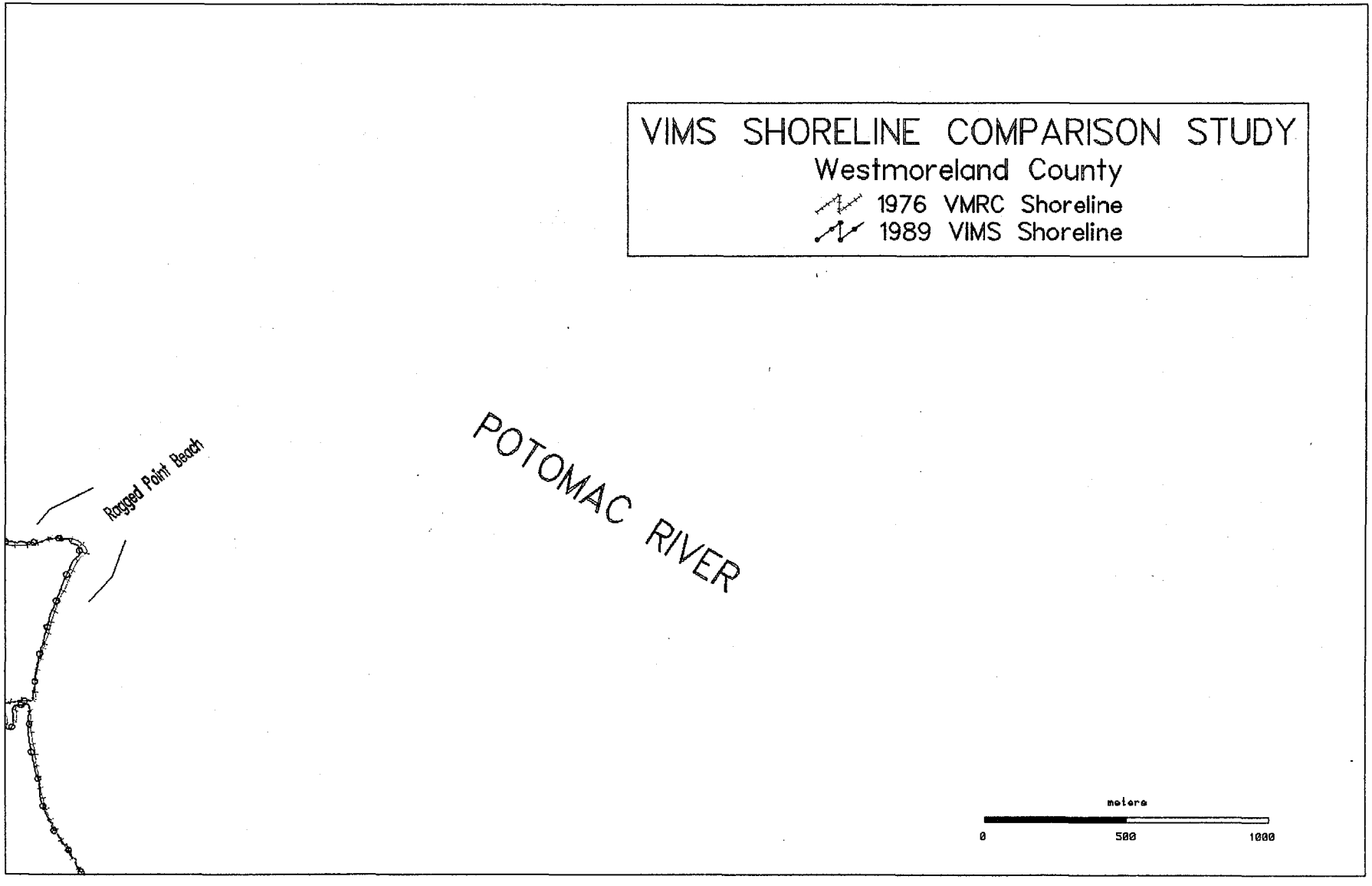


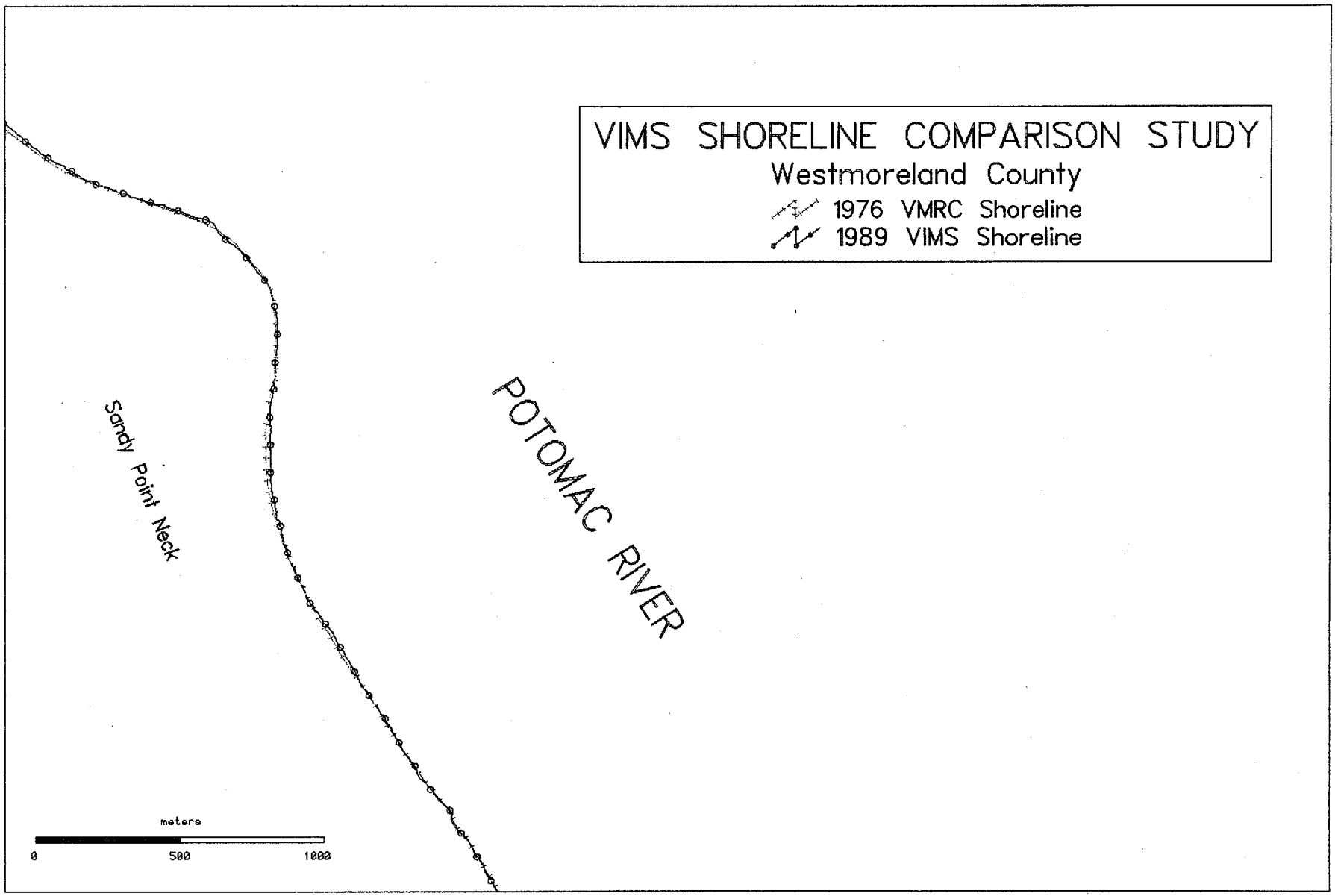
SHORELINE COMPARISON

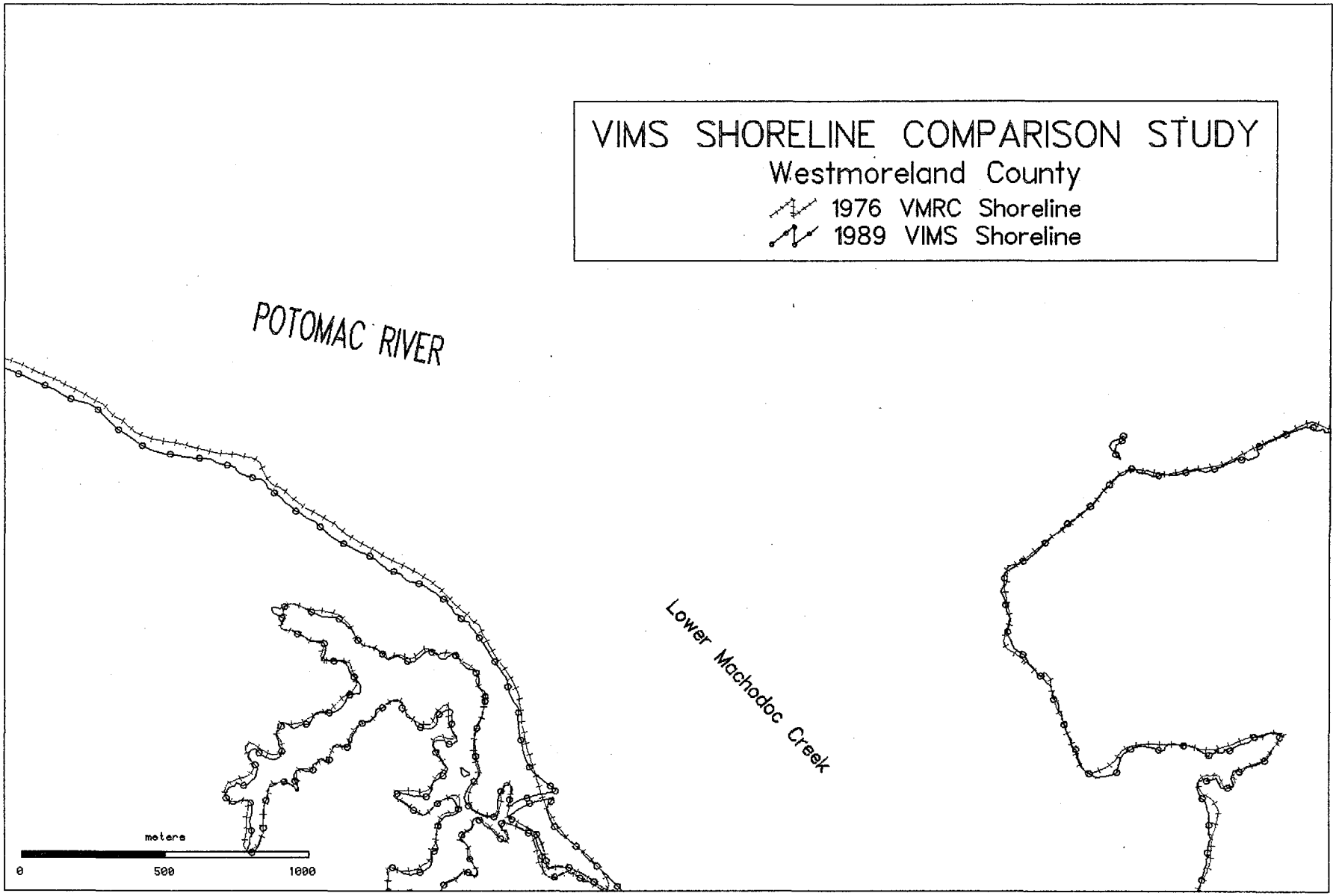
St. Clements Island Quadrangle

1:5000 VMRC Shoreline
1:24000 USGS Shoreline


VIMS SHORELINE COMPARISON STUDY
Westmoreland County
1976 VMRC Shoreline
1989 VIMS Shoreline
Gardner Creek
Jackson Creek
POTOMAC RIVER
meters
0
500
1000


VIMS SHORELINE COMPARISON STUDY
Westmoreland County
1976 VMRC Shoreline
1989 VIMS Shoreline
POTOMAC RIVER
Ragged Point Beach
meters
0
500
1000


VIMS SHORELINE COMPARISON STUDY
Westmoreland County
1976 VMRC Shoreline
1989 VIMS Shoreline
POTOMAC RIVER
Sandy Point Neck
meters
0
500
1000


VIMS SHORELINE COMPARISON STUDY
Westmoreland County
1976 VMRC Shoreline
1989 VIMS Shoreline
POTOMAC RIVER
Lower Machodoc Creek
meters
0
500
1000

CHAPTER V. VIDEO COVERAGE

V. VIDEO COVERAGE

An aerial video coverage was produced for each of the four Northern Neck counties to assess general shore use and condition. Flights were flown at an altitude of 500 feet from a 1953 de Haviland Beaver. Videos were filmed on 3/4 inch, broadcast quality video cassettes using a JVC video camera. Optimal filming conditions required high visibility, low turbulence, and a cloud ceiling greater than 600 feet above ground level (AGL). A general flight path was determined prior to take-off to ensure continuity in filming the shoreline. This would ultimately limit editing requirements in the laboratory later. The field crew consisted of a pilot, photographer, and a staff marine scientist who was responsible for documenting film location and noting general shoreline conditions observed during flight. Approximately thirty hours of flight time were required to complete the coverage.

In laboratory facilities at the Virginia Institute of Marine Science, Gloucester Point, Virginia, two 3/4 inch tape decks were used to preview and "rough" edit the original master tape. Acetate overlays of regional 7.5 minute U.S. Geological Survey topographic maps were drafted for insertion into the final film product to provide the viewer with flight path and area location information. Maps were inserted, and the final product spliced and cleaned at the Educational Media Center (EMC) at the College of William and Mary, Williamsburg, Virginia.

A narrative was prepared and synchronized to the final product. Information relating to shore condition, stabilization, land ownership and use was stressed. Data reported in existing publications provided information on shoreline erosion and accretion rates, sediment volume inputs, tidal marsh vegetation and nearshore bathymetry.

CHAPTER VI. AERIAL IMAGERY

VI. AERIAL IMAGERY

Vertical aerial imagery was collected during the period between May and November, 1989, for each of four counties in the Northern Neck: Westmoreland, Lancaster, Richmond, and Northumberland. Coverage included all tidal shorelines, to the head of each tidal creek.

Imagery was photographed by VIMS photographers through a floor mount in the VIMS research aircraft (1953 de Haviland Beaver) at an altitude of 4400 ft above ground level (AGL), resulting in an approximate image scale of 1:7,200. A bubble level was used to level the camera relative to the ground during flight, thus minimizing tilt distortion in the photograph. Minimum flight conditions were established at three miles visibility and a ceiling of 4500 ft AGL. Aircraft speed was held at approximately 100 knots with incidental variations due to weather conditions.

A Hasselblad 500EL, 70-mm camera equipped with a 50-mm lens and loaded with Kodak VPS 2106-S film was used for all vertical imagery. A shutter speed of 1/250 sec and an ASA setting of 125 resulted in the best image quality. A 35-mm camera was carried for light metering.

Flight lines were determined in the laboratory using a coverage area chart derived from the ground projection of the photo image at a standard 4400 ft AGL flight altitude. Using the VIMS camera and mount, the coverage ratio at this altitude is 1:1.1, where one foot of altitude allows 1.1 ft^2 of ground coverage in a single photo frame. Along the flight path, image overlap ranges between 20% and 60%. Lateral overlap varies between 10% and 25%. Flight lines wre plotted on U.S. Geological Survey 7.5 minute series topographic maps. Subsequent to flight verification, flight lines were digitized and entered into the ARCInfo@ format (ref. Chapter 7).

Film was developed by an independent photographic service using a C-41 developing process. Eight inch square color prints were processed to include the full negative frame. Given the flight conditions and photographic procedures, each 8"x8" print is scaled at 1:7,200, where one inch on the image represents 605 linear feet ground distance.

Distortions inherent in the photographs can be attributed to the developing process, pitch and roll of the aircraft, and radial lens distortion where the level of distortion increases towards the edges of the images. Some of these distortions are corrected in the mapping process (ref. Chapter 8).

The 1989 aerial imagery was organized into annotated reference notebooks for each county that explained methodology, flight lines, reference locations, and other information pertinent to the interpretation of the photography. Five sets of each county coverage were printed and compiled. These sets were distributed as follows:

1 - Council on the Environment
1 - Local Planning District Commission
1 - Field notebook
2 - VIMS working copy and archive

The imagery was used to update shoreline positions for calculations of erosion and accretion and to update the wetlands inventories. The copies of the notebooks that were delivered to the Northern Neck Planning District Commission were distributed to the appropriate county officials. The notebooks are being used to assist in local planning and zoning decisions.

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: **Westmoreland**

FLIGHT DATE: 9 May 1989, Tuesday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: A-Q (see associated topographic maps)

Location	Time Flown	Flight Line	# of photos
Rosier Creek	10:50	A	4
Colonial Beach	10:45	B	8
Goldman Creek	10:55	C	3
Col. Bch./Monroe Bay	11:00	D	5
Monroe Creek	11:00	E	3
Mattox Creek	11:05	F	7
Mattox Creek	11:15	G	7
Washington's Birthplace	11:25	H	6
Pope's Creek	11:25	I	3
Pope's Creek	11:35	J	5
Pope's Creek to Haulover Inlet	11:40-11:45	K	13
Hollis Marsh Island	11:50	L	6
Cold Harbor Creek area	11:50	M	3
Currioman Bay shore	11:55	N	6
Currioman Creek to Nomini Creek	12:00	O	8
Barnes Creek	12:05	P	3
Pierce Creek	12:10	Q	5
Haulover Point	12:15	Altitude: 500 ft.	2 photos

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: **Westmoreland**

FLIGHT DATE: 22 May 1989, Monday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: R-KK (see associated topographic maps)

Location	Time Flown	Flight Line	# of photos
Nomini Creek (from Nomini Bridge to Beales Mill Run)	12:05	R	7
Templeman Run	12:10	S	2
Nomini Creek (from Nomini Bridge to mouth, east shore)	12:15-12:25	T	7
Buckner Creek	12:30	U	4
Nomini Bay east shore	12:35	V	3
Lower Machodoc Creek west shore	12:40	W	9
Lower Machodoc Creek (west shore area)	12:40	X (overlaps W)	4
Head of Lower Machodoc Creek	12:45	Y	7
Lower Machodoc Creek east shore	12:50	Z	7
Potomac River (Lower Machodoc Creek to Ragged Point)	12:50	AA	2
Potomac River (Long Pond area to Jackson Creek)	12:55	BB	6
Gardner Creek head	13:00	CC	2
Jackson Creek	13:00	DD	2
Potomac River (Jackson Ck. to Yeocomico R.)	13:05-13:10	EE	10

Bonum Creek	13:05	FF	3
NW Yeocomico River	13:10	GG	2
NW Yeocomico River	13:15	HH	3
NW Yeocomico River (White Point Creek)	13:15	II	2
West Yeocomico River	13:20	JJ	5
West Yeocomico River (Hampton Hall Br.)	13:25	KK	4

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: **Westmoreland**

FLIGHT DATE: 25 May 1989, Thursday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: LL-QQ (see associated topographic maps)

Location	Time Flown	Flight Line	# of photos
Brockenbrough Creek to Peedee Creek (Rappahannock R.)	12:05	LL	6
Peedee Ck. Head	12:10	MM	3
Rappahannock River (Peedee Creek to Drakes Marsh)	12:15-12:20	NN	10
Drakes Marsh	12:20	OO	2
Rappahannock River (Drakes Marsh to Owl Hollow)	12:25	PP	8
Rappahannock River (Owl Hollow to Bristol Mine Run)	12:30	QQ (last flight line in Westmoreland County)	3

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Lancaster

FLIGHT DATE: 14 June 1989, Wednesday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: A-H (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Indian Creek	14:10	A	5
Pittman's Cove	14:10	B	2
Dymer Creek (north shore)	14:15	C	5
Dymer Creek (south shore)	14:20	D	6
Tabb's Creek (north side)	14:25	E	4
Tabb's Creek (south side)	14:25	F	3
Antipoison Creek (north shore)	14:30	G	4
Antipoison Creek (south shore to Little Bay)	14:35	H	5

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Lancaster

FLIGHT DATE: 2 July 1989, Sunday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: I-BB(partial) (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Fleets Island	10:40	I	5
Fleets Island	10:45	J	3
Mouth of Rappahannock Riv. (Windmill Point Creek to Mosquito Point)	10:50	K	7
Rappahannock River shore (Mosquito Point to Cherry Point)	10:55	L	5
Rappahannock River shore (Cherry Pt. to Carter Ck. Norris Bridge area)	11:00	M	5
Eastern Branch of Carter Ck.	11:10	N	4
Carter Creek (east shore)	11:05	O	3
Carter Creek (west shore)	11:05	P	4
Corrotoman River east shore (Orchard Pt to Taylor Ck)	11:35	Q	4
Taylor Creek	11:30	R	2
Moran Creek	11:25	S	2
Eastern Branch of Corrotoman River	11:15	T	6
Eastern Branch of Corrotoman River (Brown's Ck/Quarter Cove)	11:20	U	4
Eastern Branch of Corrotoman River (Hill's Ck./Bell's Ck.)	11:20	V	4

Western Branch of Corrotoman River (West Point-Little Branch)	13:15-13:20	W	9
Western Branch of Corrotoman River (Upper)	13:05-13:10	X	7
Western Branch of Corrotoman River (Senior Ck.-Bar Pt. Light)	13:25	Y	5
Myer Creek	13:30	Z	5
Corrotoman River west shore (Town Ck.-Whitehouse Ck.)	13:35	AA	4
Rappahannock River shore (Towles Point-Rocky Neck)	13:40-13:50	BB (photo 1-14)	14 (23total)

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Lancaster

FLIGHT DATE: 31 August 1989, Thursday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: BB(partial)-EE (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Rocky Neck area to Deep Creek	12:30	BB (photo 15-23)	9 (23 total)
Belle Isle	12:35	CC	4
Mulberry Creek/Morattico	12:40	DD	6
Lancaster Creek	12:45-12:50	EE (last FL)	9

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Richmond

FLIGHT DATE: 25 August 1989, Friday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: A-O, Q(partial)-R (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Brockenbrough Creek to Mulberry Island (Rappahannock Shore)	11:45-12:00	A	11
Mulberry Island to Cat Point Creek mouth	12:05	B	7
Cat Point Creek (Lower)	12:15	C	2
Cat Point Creek (Lower)	12:15	D	2
Cat Point Creek	12:20	E	2
Cat Point Creek	12:20	F	3
Cat Point Creek	12:25	G	3
Cat Point Creek	12:25	H	2
Cat Point Creek (Upper)	12:10	I	7
Cat Point Creek mouth to Tappahannock Bridge	12:30	J	7
McGuire Creek Marsh	12:35	K	4
Little Carter Creek and McGuire Marsh	12:40	L	3
Little Carter Creek	12:45	M	6
Rappahannock Shore (Little Carter Ck. to Accaceek Pt)	12:50	N	12
Accaceek Point area	12:55	O	2
Little Totuskey Creek	13:05	Q (photo 8-11)	4
Totuskey Creek (Upper)	13:20	R	7

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Richmond

FLIGHT DATE: 31 August 1989, Thursday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: P-Q(partial), S-AA (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Totuskey Creek (west shore)	13:30	P	6
Totuskey Creek (east shore)	13:35	Q (photo 1-7)	7
Richardson Creek (Waverly Pt. to North Fork)	13:25	S	4
Richardson Creek	13:25	T	4
Rappahannock Shore (Neals Pt. to Farnham Ck. mouth)	13:20	U	10
Farnham Creek branch	13:15	V	2
Farnham Creek (west shore)	13:10	W	2
Farnham Creek (upper and east shore)	13:05	X	8
Rappahannock shore (Farnham Ck. to Tarpley Point)	13:00	Y	4
Morattico Creek and Perch Creek	13:00	Z	5
Lancaster Creek	12:55	AA (last FL)	9

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Northumberland

FLIGHT DATE: 23 October 1989, Monday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: A-AA, except X (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Hampton Hall Branch of West Yeocomico River	11:45	A	5
Wilkins Creek	11:50	B	2
Mill Creek of South Yeocomico River	11:50	C	8
Lodge Creek	11:55	D	6
Dungan Cove/Lodge Creek	11:55	E	4
Cornish Ck.to Palmer Cove	12:00	F	2
Potomac shore (Thicket Pt. Bay to Judith Sound)	12:05	G	8
Lewisetta to Garners Creek	12:05	H	5
The Glebe (northshore-Lewisetta to Wrights Co.)	12:10	I	5
Glebe Creek	12:15	J	7
The Glebe (southshore-Killneck Creek)	12:20	K	3
Mill Creek and Coan River (northwest shore)	12:25	L	8
Coan River (east shore)	12:40	M	10
Coan River headwaters	12:30	N	4
Potomac shore	12:50-12:55	O	25
Cod Creek (west branch)	13:25	P	2
Cod Creek (east branch)	13:25	Q	2
Presley Creek	13:20	R	4

COUNTY: Northumberland (continued)

DATE: 23 October 1989

Location	Time	Flight Line	# of Photos
Hull Creek (west shore)	13:10	S	7
Hull Creek (east shore)	13:15	T	7
Cubitt Creek	13:05	U	4
Hack Creek	13:00	V	5
Little Wicomico River	13:35	W	7
Bridgeman's Back Creek	13:40	Y	1
Ellyson Creek	13:00	Z	3
Cod Creek of Little Wicomico River	13:40	AA	2

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Northumberland

FLIGHT DATE: 26 October 1989, Thursday & * 10 November 1989, Friday *

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: X, BB-ZZ (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Spences Creek	11:45	X (1 frame)	1
* Little Wicomico R. (upper)	09:50	X (7 frames)	7 *
Bridge Creek	11:50-11:55	BB	4
Little Wicomico River (south shore)	11:50	CC	6
Chesapeake Bay shore (Smith Pt. to Fleet Pt.)	12:00	DD	13
Cockrell Creek (east side)	12:15	EE	4
Cockrell Creek (Reedville)	12:10	FF	5
Cockrell Creek (west side)	12:15	GG	5
Reason Creek/Whay's Creek	12:20	HH	4
Warehouse Creek	12:25	II	3
Horn Harbor/Coles Creek	12:25	JJ	6
Glebe Pt./Betts Mill Creek	12:35	KK	4
upper Great Wicomico River (north shore)	12:40-12:45	LL	10
Great Wicomico River (south shore)	12:50-12:55	MM	14
Knight Run	12:50	NN	3
Balls Creek of Great Wicomico River	12:25	OO	3
Bogey Neck/Mila Neck	13:00	PP	5

COUNTY: Northumberland (continued)

DATE: 26 October 1989

Location	Time	Flight Line	# of Photos
Bailey Prong/Cranes Creek	13:05	QQ	3
Ingram Bay shore (Gougher (Creek to Harveys Creek)	13:00-13:05	RR	7
Harveys Creek	13:10	SS	2
Mill Creek	13:20	TT	8
Damerson Marsh	13:25	UU	4
Ball Creek	13:25	VV	3
Chesapeake Bay shore (Ball Ck. to Hughlett Pt)	13:30	WW	4
Dividing Creek (northshore)	13:35	XX	3
Dividing Creek headwaters	13:40	YY	5
Dividing Creek (southshore)	13:45	ZZ	4

* - Flight Line X (frames 2-8) were photographed on 10 November 1989

AERIAL PHOTOGRAPHY DATA
NORTHERN NECK PROJECT

COUNTY: Northumberland

FLIGHT DATE: 6 November 1989, Monday

ALTITUDE: 4400 ft. ASL

FLIGHT LINES: AAA-GGG (see associated topographic maps)

Location	Time Flown	Flight Line	# of Photos
Prentice Creek	13:45	AAA	3
Jarvis Creek	13:50	BBB	3
Chesapeake Bay shore (Kent Pt. to Bluff Pt.)	13:50	CCC	5
Barnes Creek	13:55	DDD	3
Indian Creek (northshore)	13:55	EEE	5
upper Indian Creek	14:00	FFF	4
Indian Creek (Warehouse Pt. branch - county border)	13:55	GGG	2

CHAPTER VII. FLIGHT LINE COVERAGE

VII. FLIGHT LINE COVERAGE

The Flight Line Coverage (FFL) is a record illustrating the general flight paths followed during the vertical photography field efforts in the Northern Neck. The flight lines were plotted on topographic maps and digitized at 1:24,000. The arrows indicate the direction of the flight path. Reference to the photographic inventories associated with these flight paths can be found in Chapter 6. Plots included in this report are represented at a scale of 1:68,000.

GEOGRAPHIC DATA SET DESCRIPTION

VIMS GIS Lab Prefix FLL

Data Layer Name FLIGHT LINE TRAJECTORIES

Description FLIGHT PATHS FLOWN FOR THE AERIAL PHOTOGRAHPY WORK.

Year(s) Collected 1989

Base Maps used for Digitizing USGS TOPOGRAPHIC MAPS (PAPER)

Digitizing Scale 1:24000

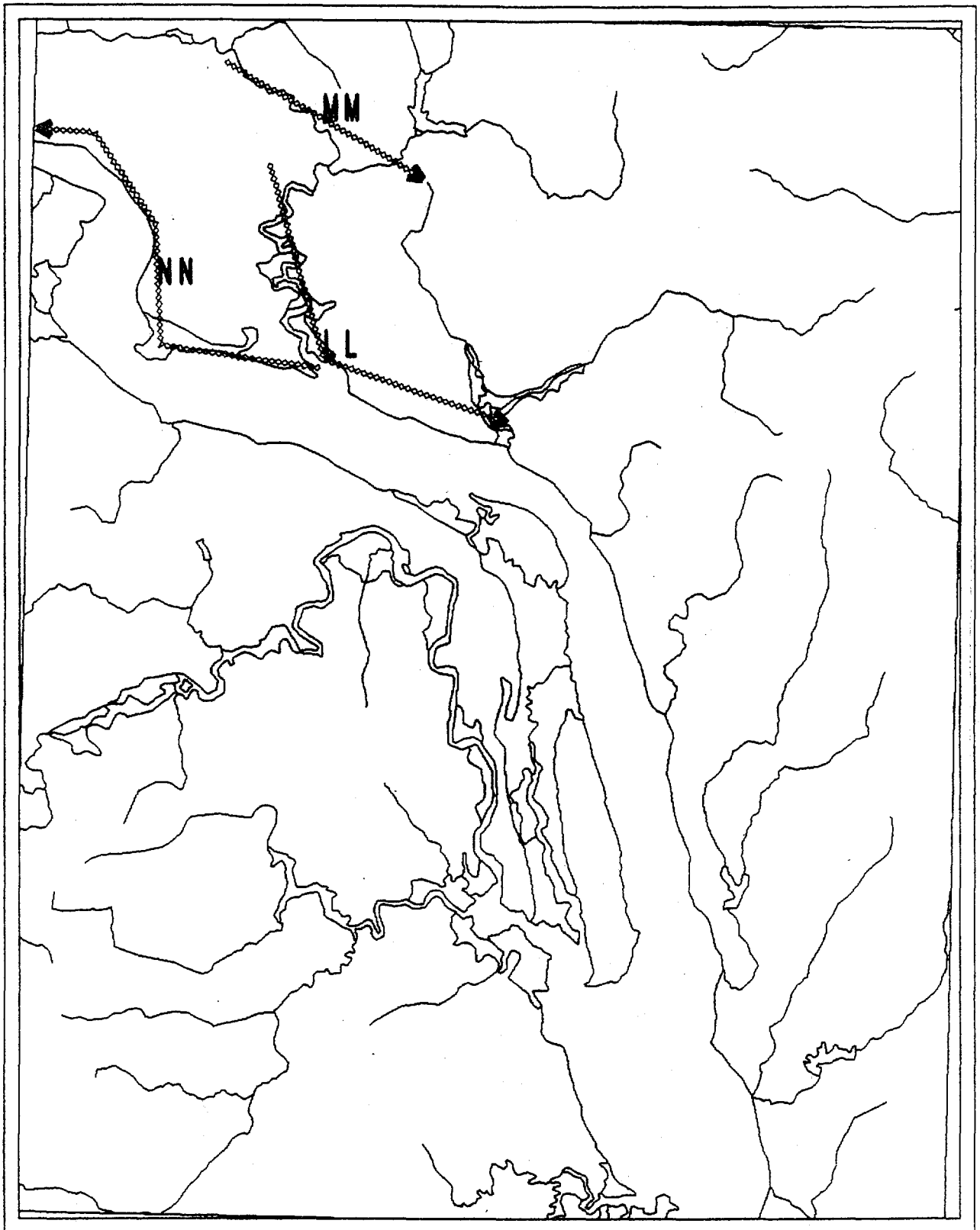
Geographic Extent SELECTED AREAS OF COASTAL VIRGINIA (NORTHERN NECK)

How Collected (Describe):

FLIGHT LINES ARE DRAWN ON TOPOGRAPHIC MAPS AND DIGITIZED.

Actual/Intended Use or Purpose:

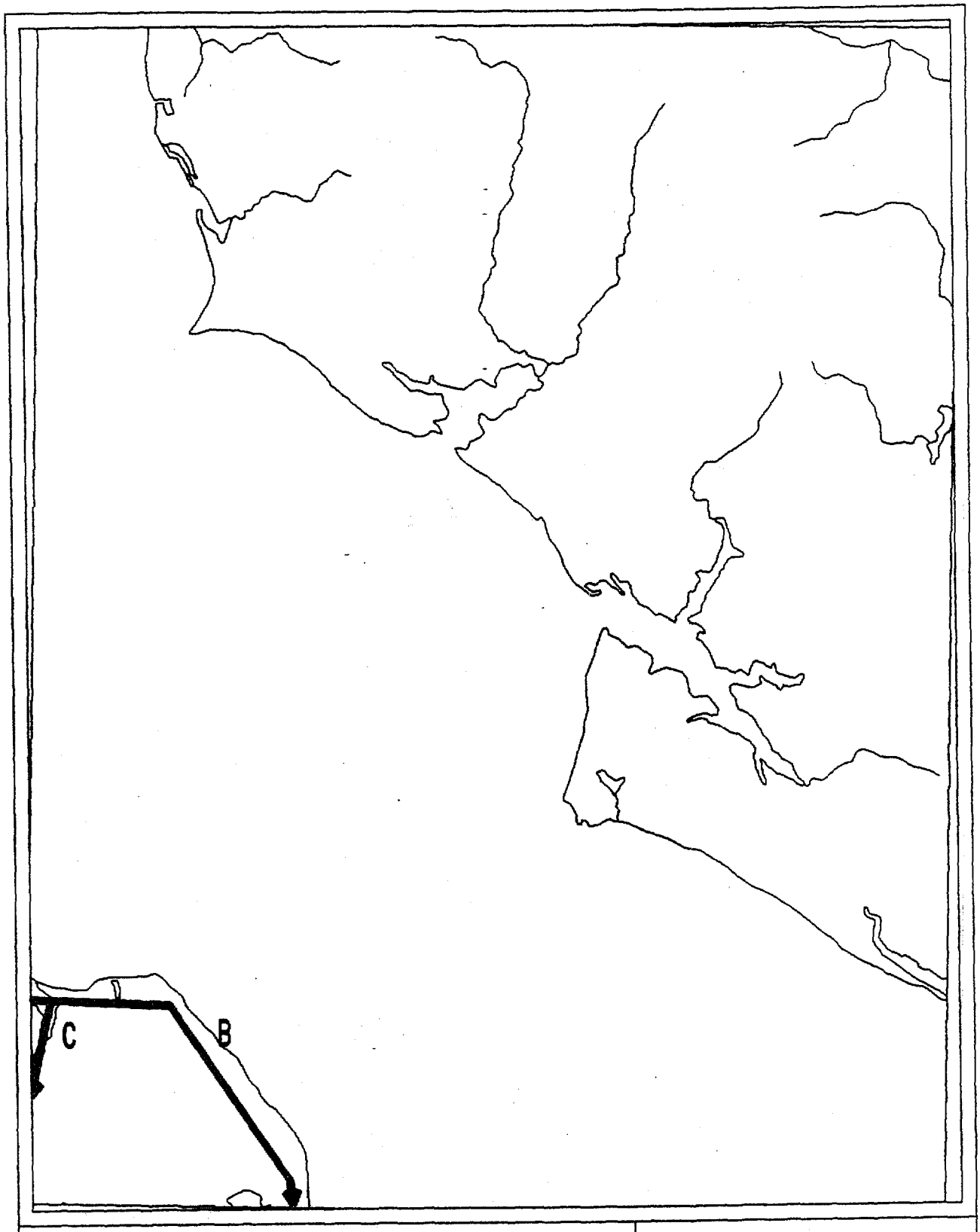
USED AS REFERENCE TO CATALOGUE AERIAL PHOTOGRAPHS.



Flightline Trajectories
VIMS Coastal Inventory
CHAMPLAIN
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

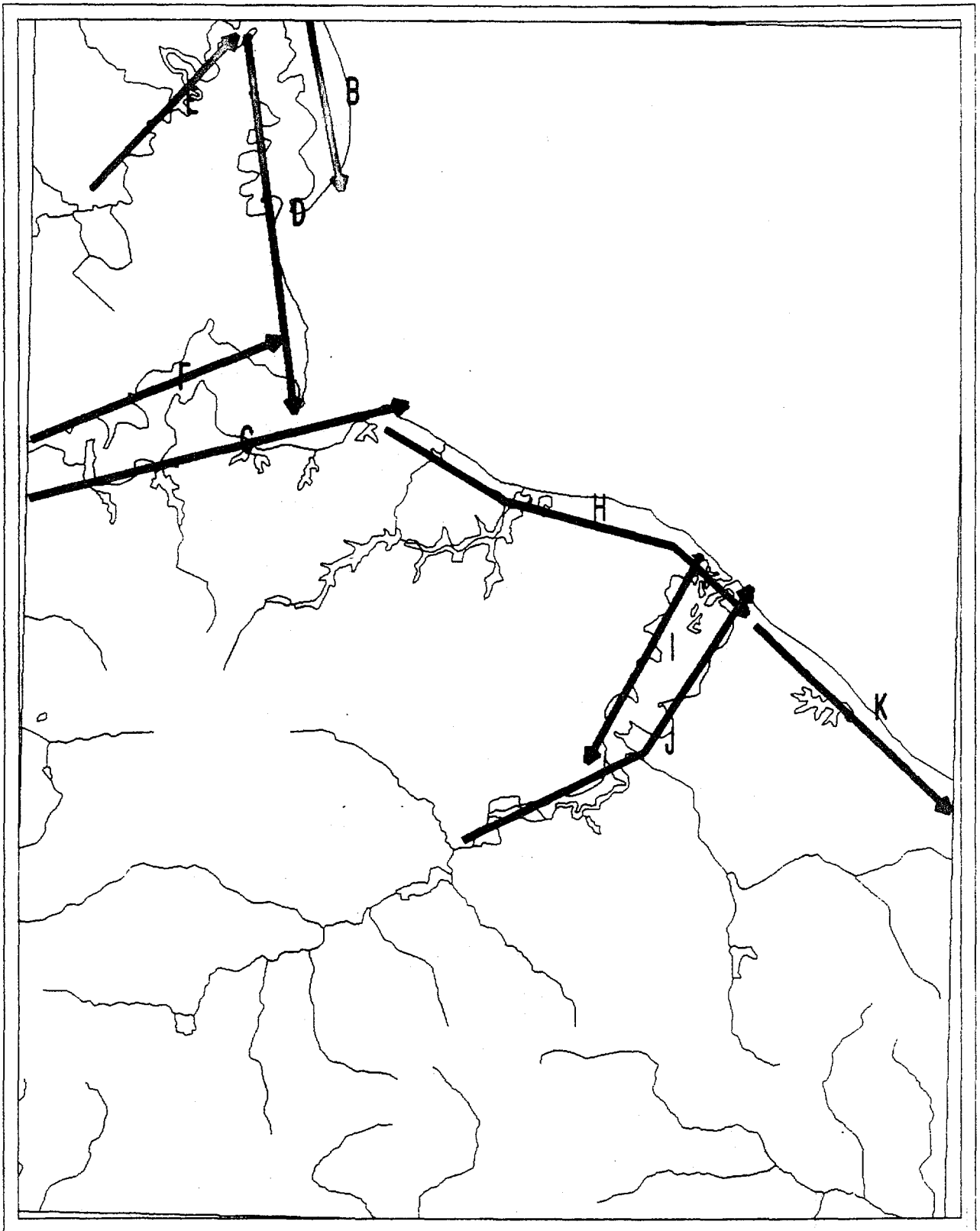
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
COLONIAL BEACH NORTH
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
COLONIAL BEACH SOUTH
Westmoreland County

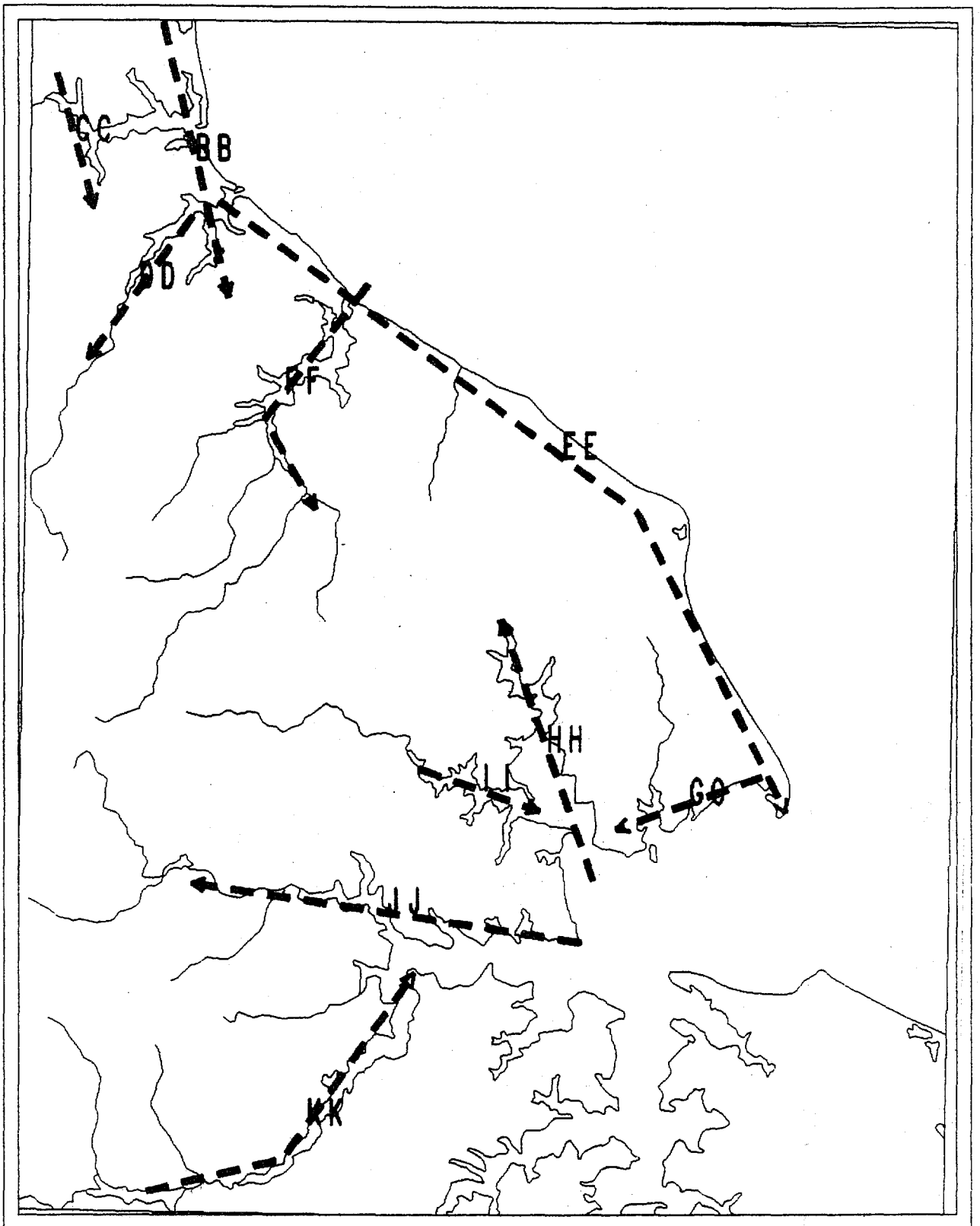
May 9, 1989
May 22, 1989
May 25, 1989

Scale - 1 65,000

Flightline Trajectories
VIMS Coastal Inventory
DAHLGREN
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

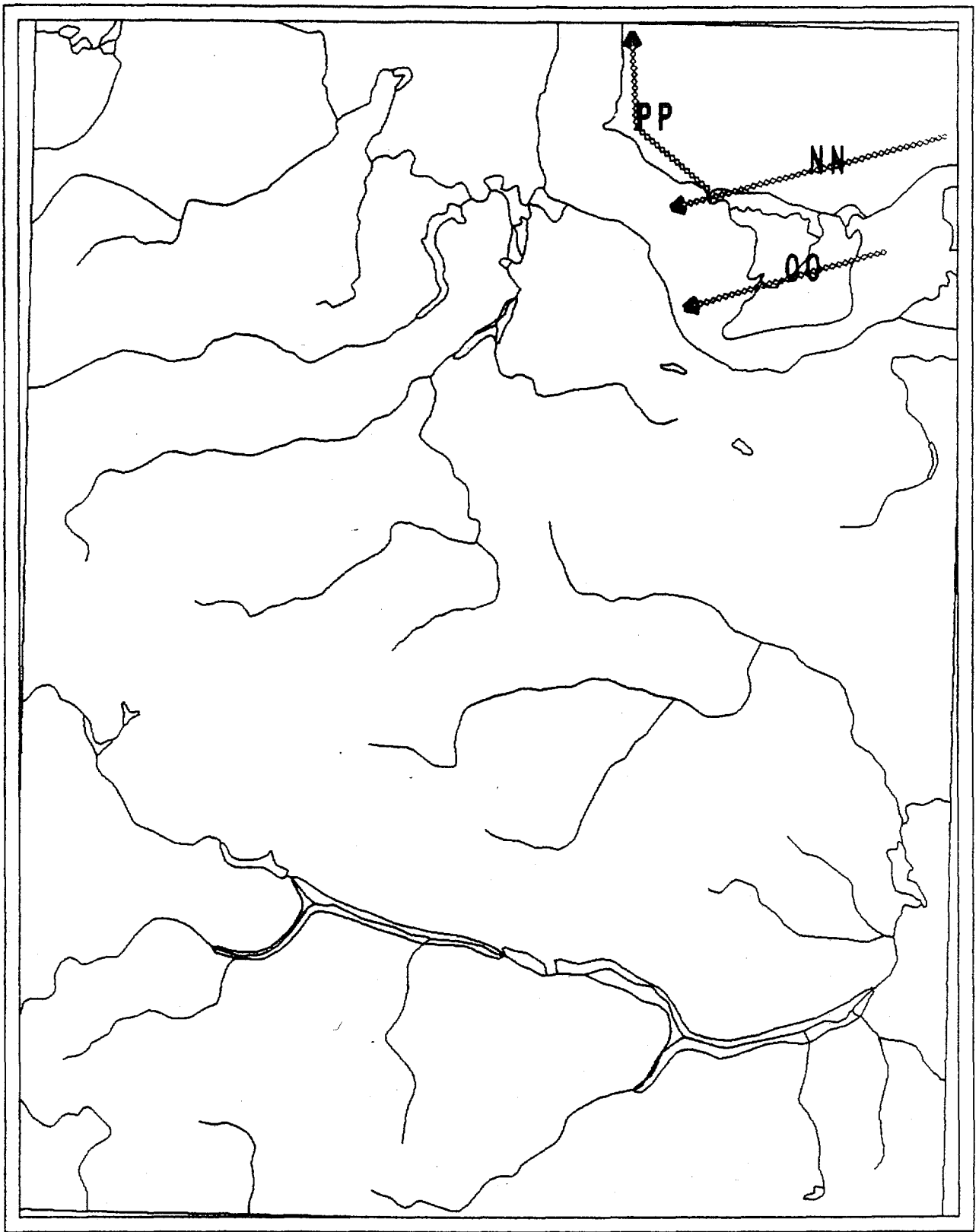
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
KINSALE
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

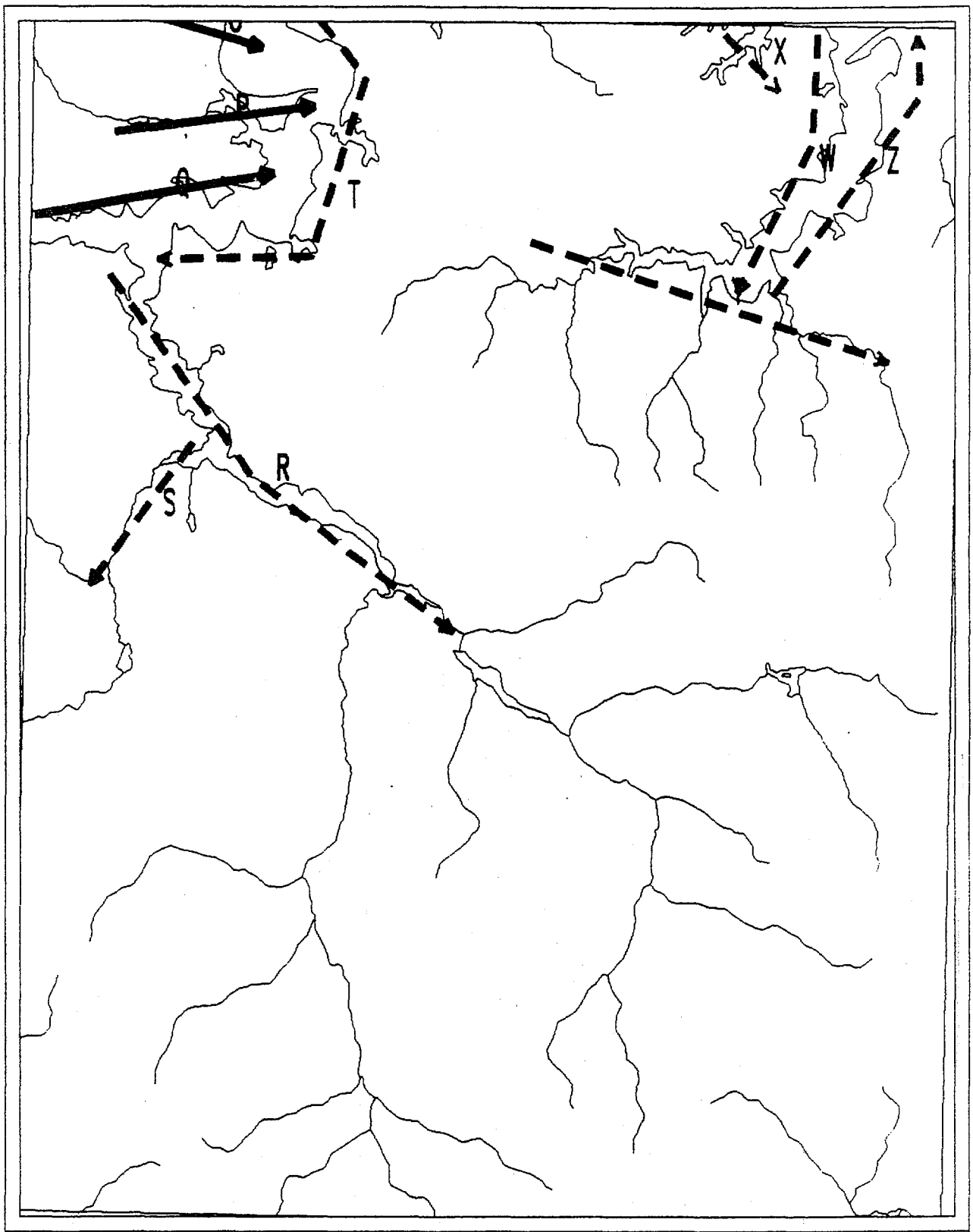
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
LORETTO
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

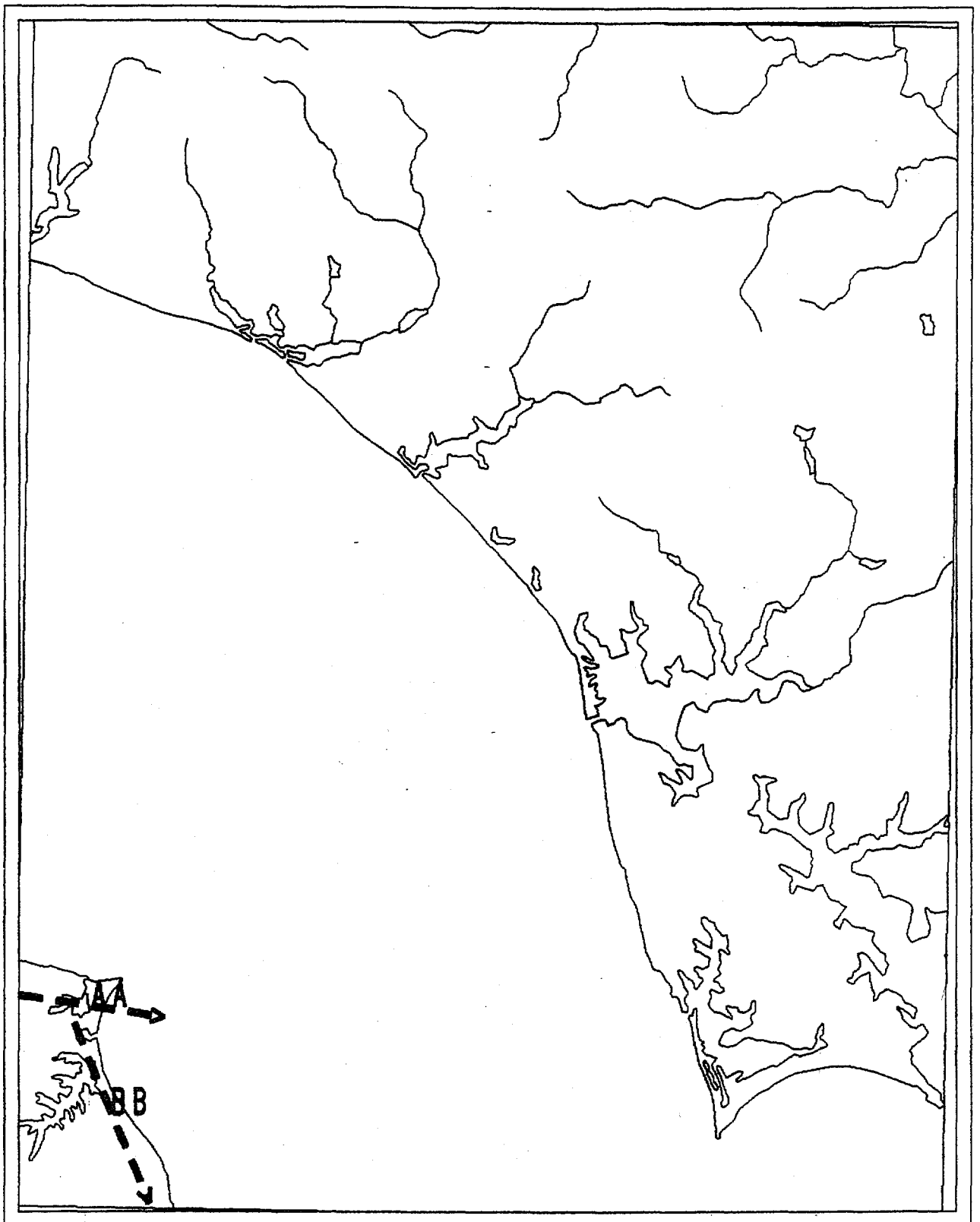
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
MACHODOC
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

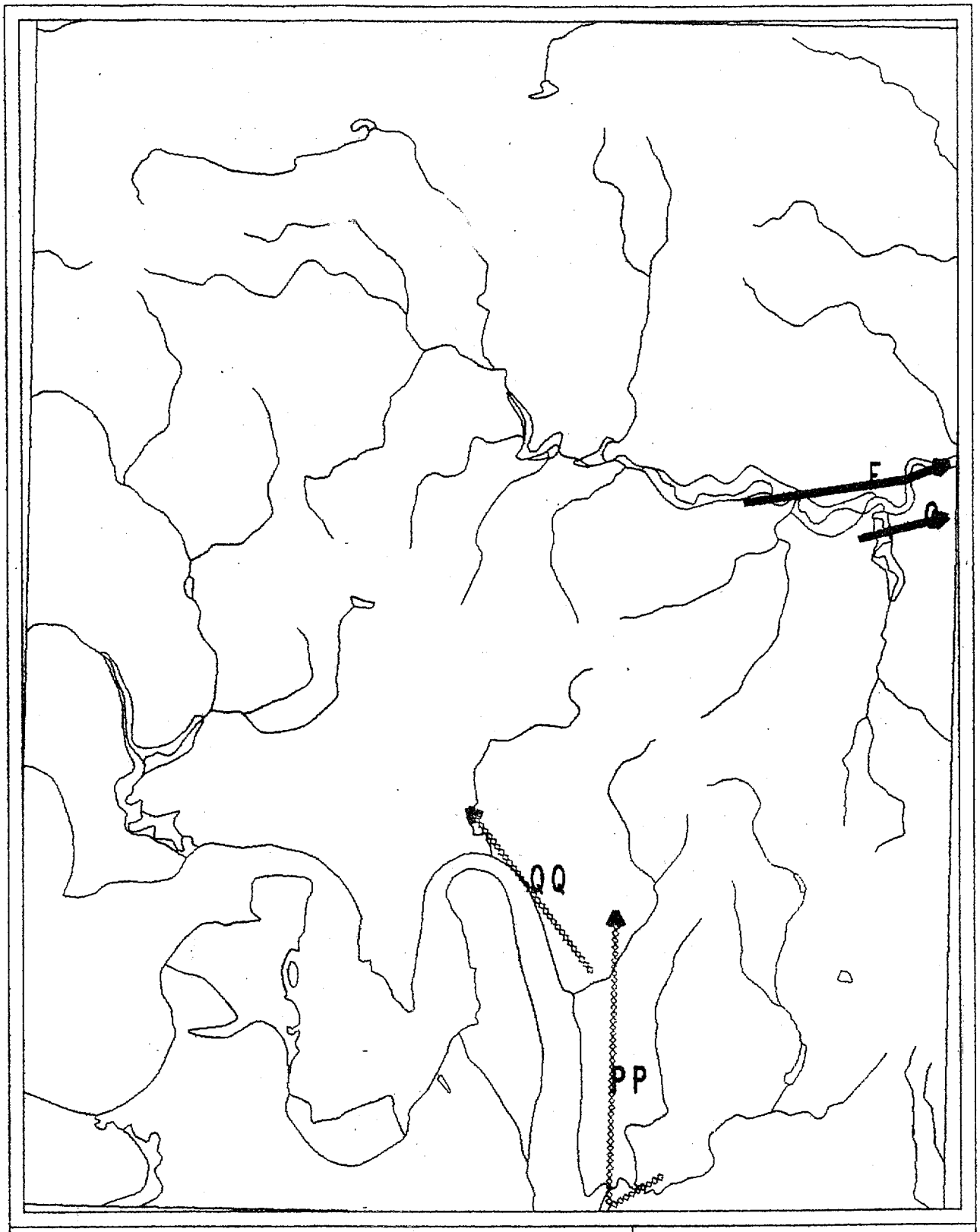
Scale - 1 65,000



Flightline Trajectories
VIMS Coastal Inventory
PINEY POINT
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

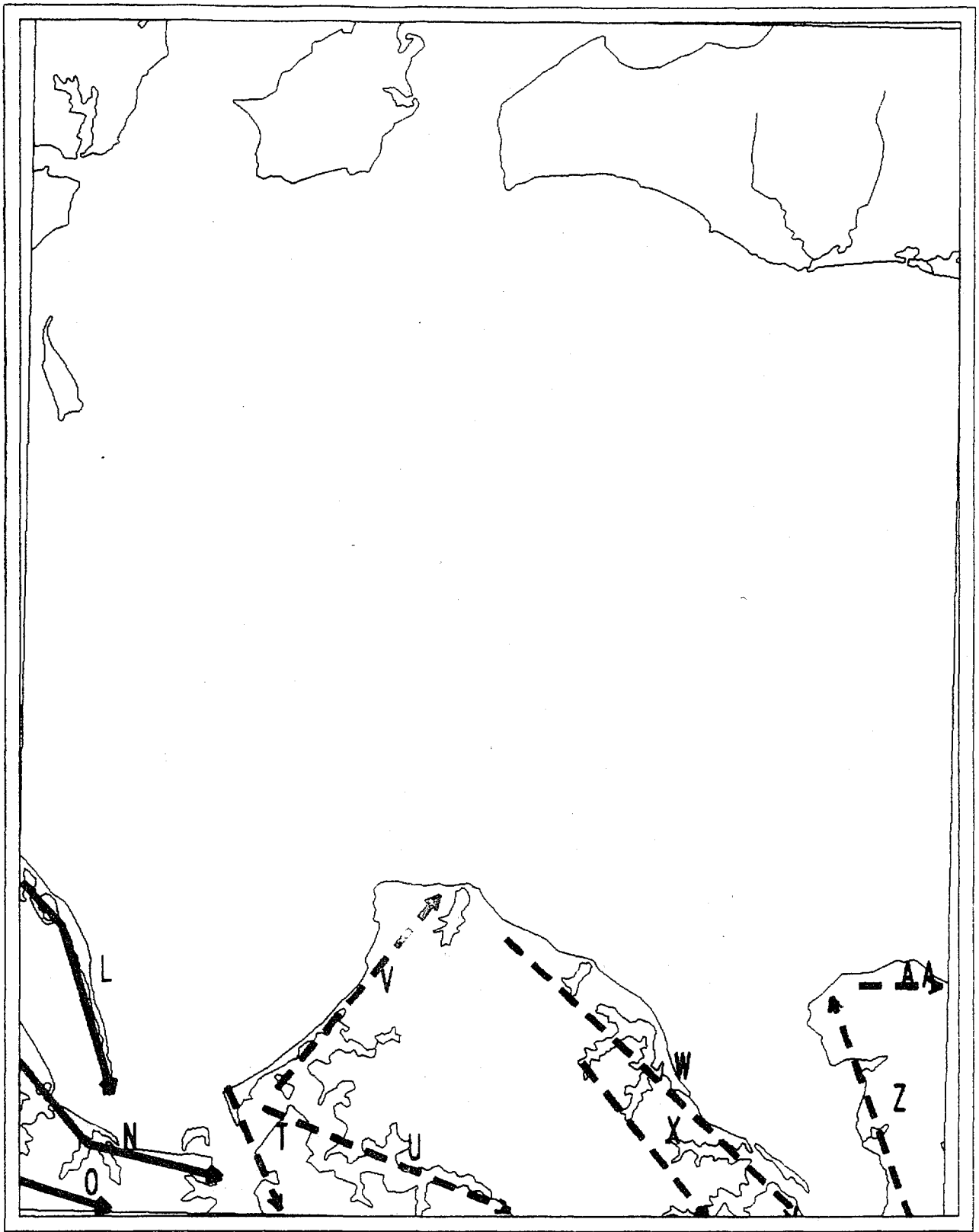
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
ROLLINS FORK
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
ST CLEMENTS ISLAND
Westmoreland County

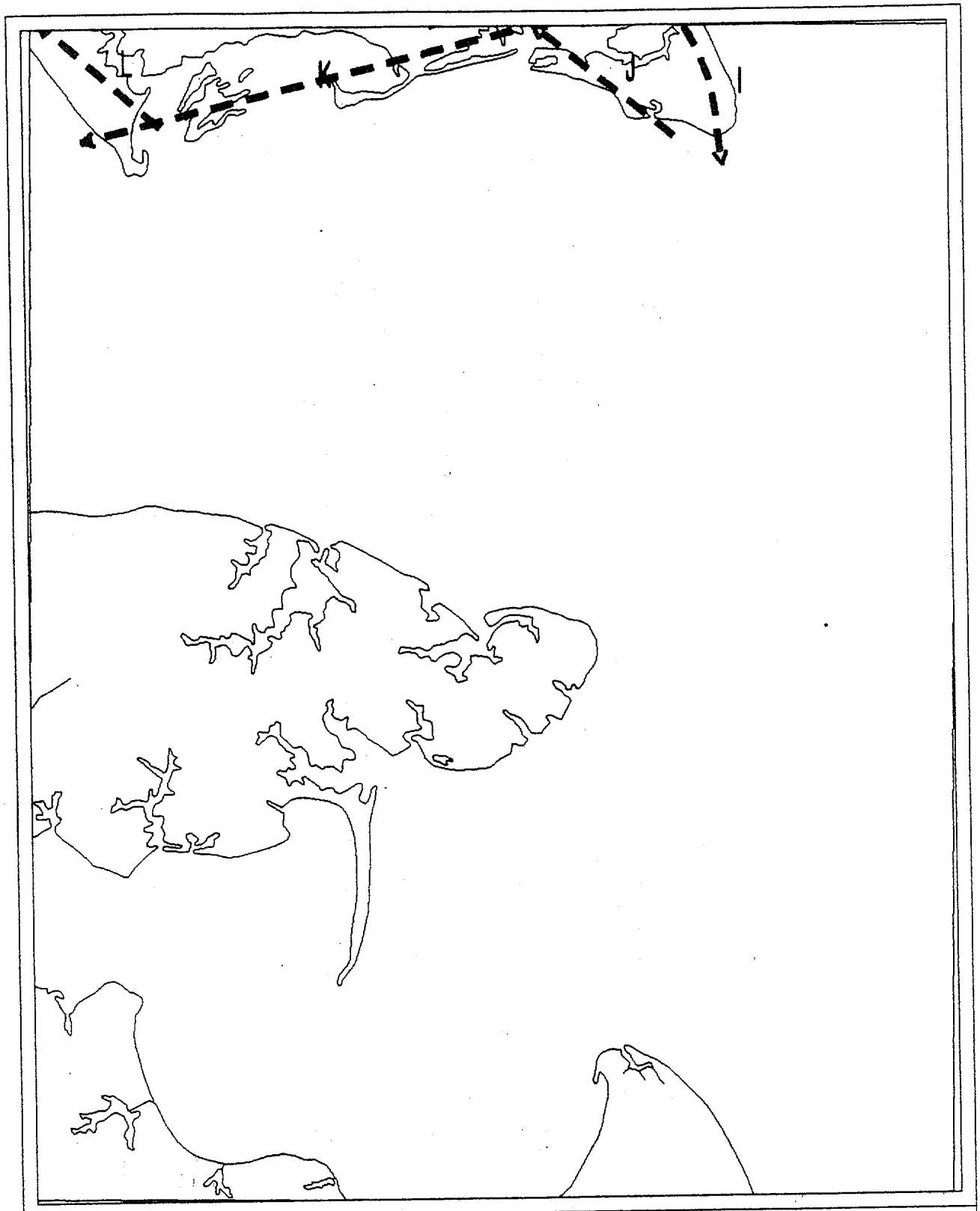
May 9, 1989
May 22, 1989
May 25, 1989

Scale - 1:65,000

Flightline Trajectories
VIMS Coastal Inventory
STRATFORD HALL
Westmoreland County

May 9, 1989
May 22, 1989
May 25, 1989

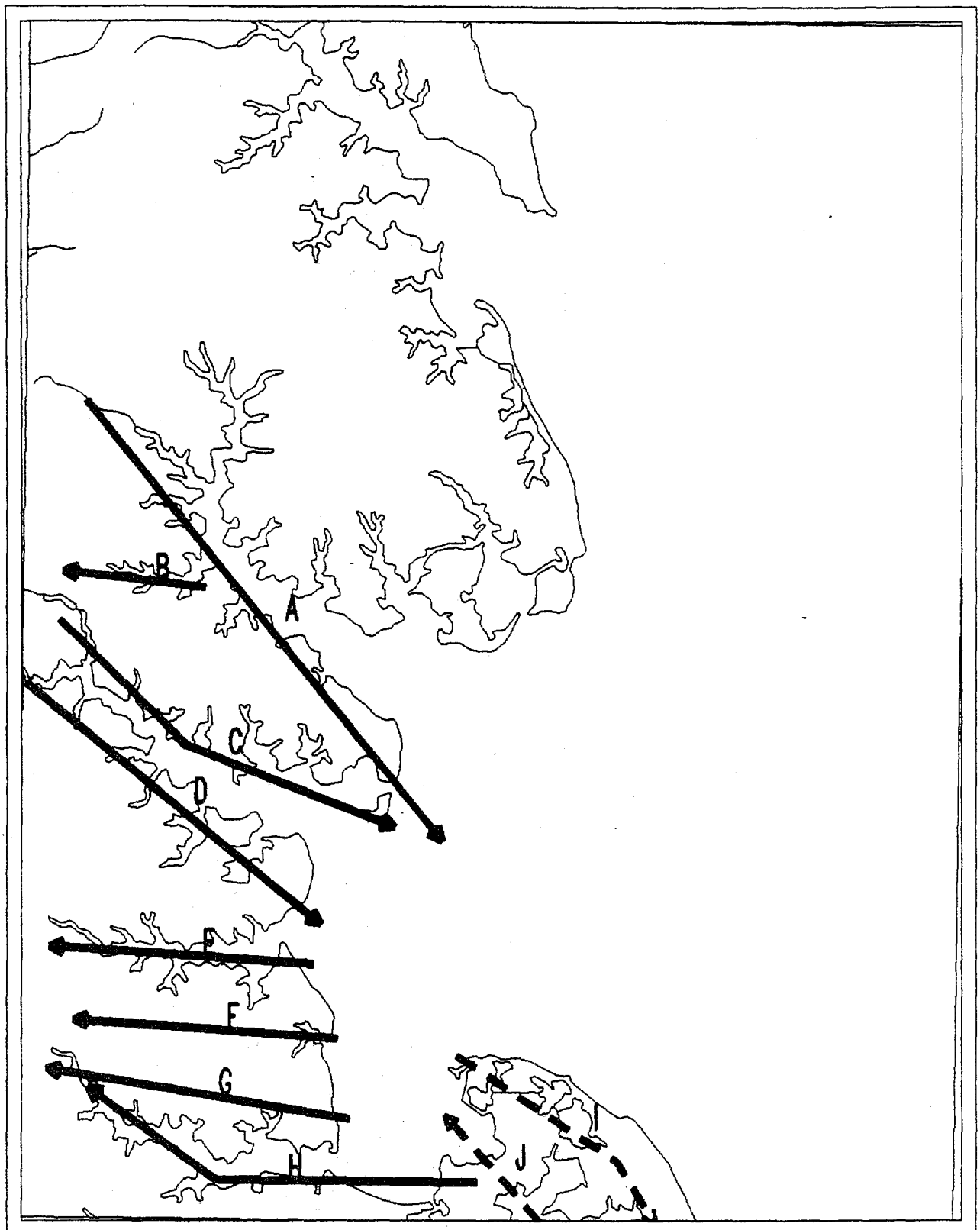
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
DELTAVILLE
Lancaster County

June 14, 1989
July 2, 1989
August 31, 1989

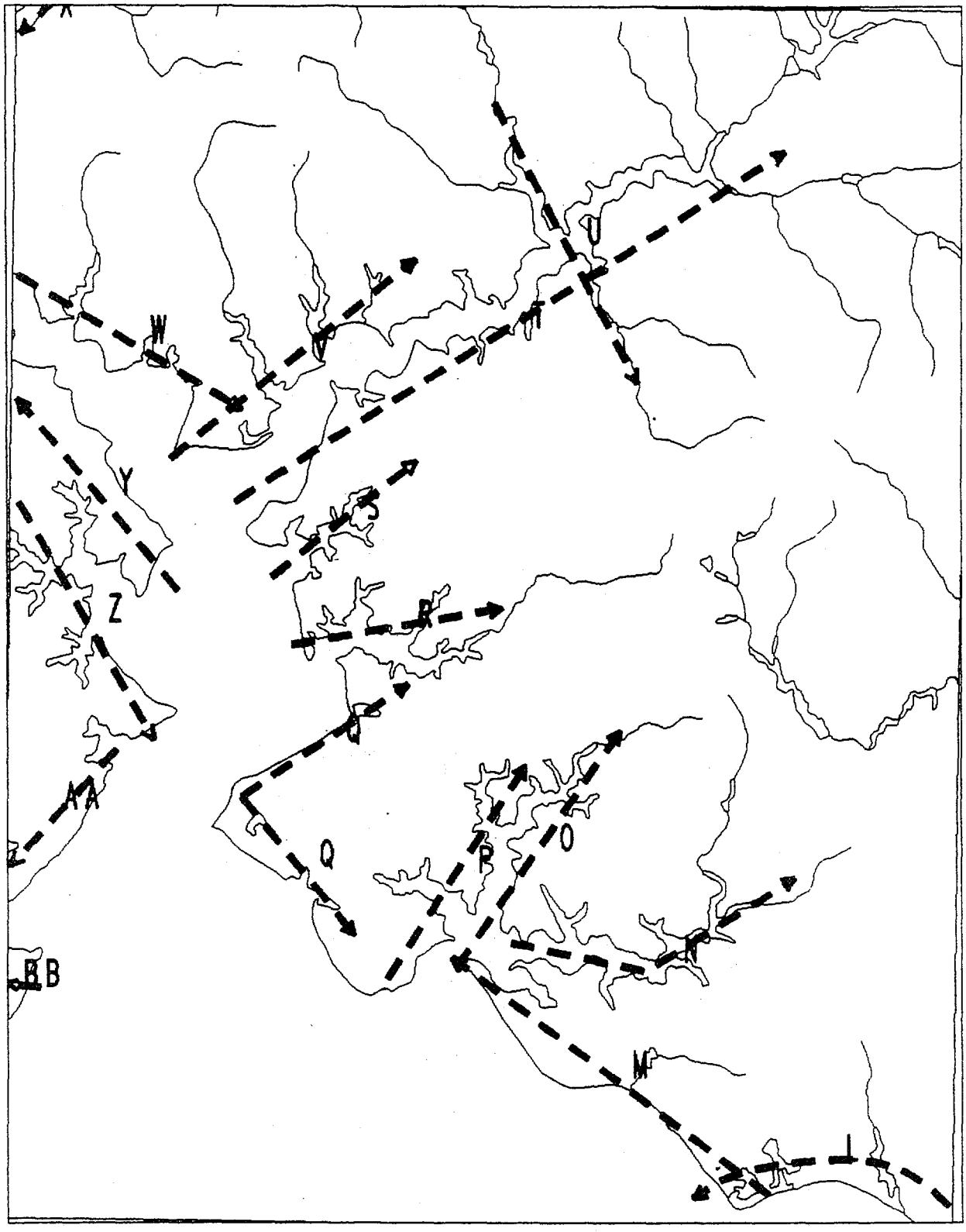
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
FLEETS BAY
Lancaster County

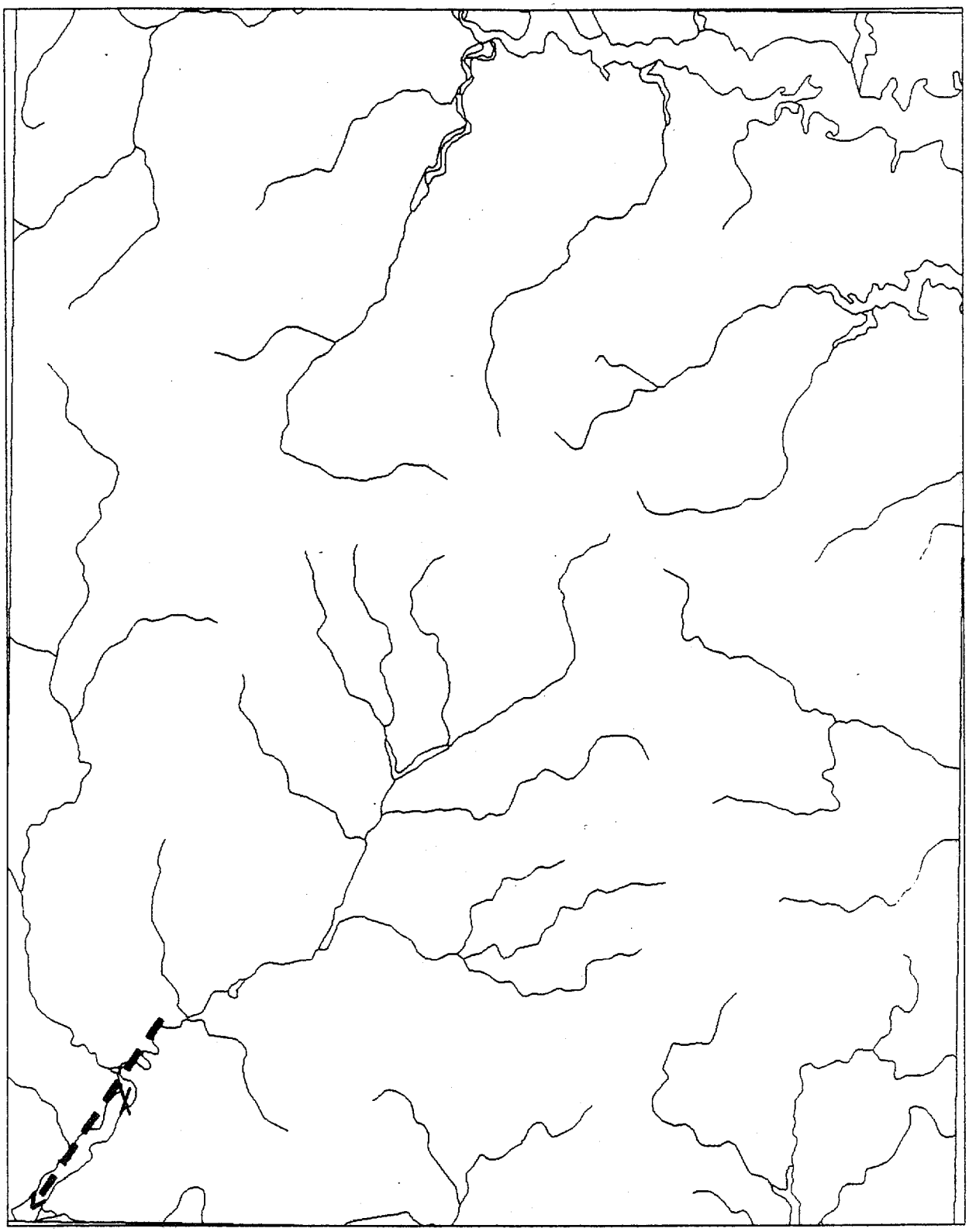
June 14, 1989
July 2, 1989
August 31, 1989

Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
IRVINGTON
Lancaster County

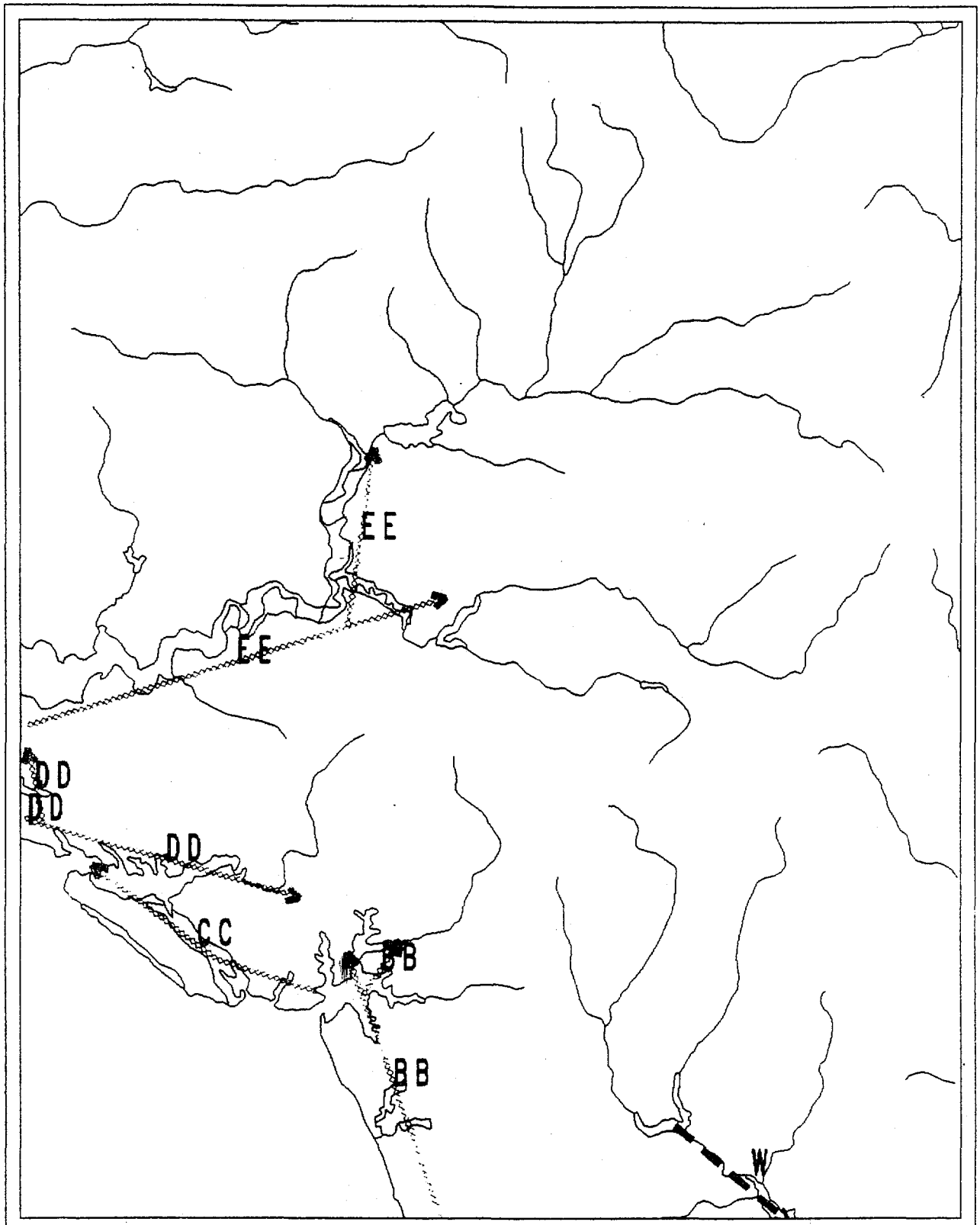
June 14, 1989
July 2, 1989
August 31, 1989
Scale - 1 65,000



Flightline Trajectories
VIMS Coastal Inventory
LANCASTER
Lancaster County

June 14, 1989
July 2, 1989
August 31, 1989

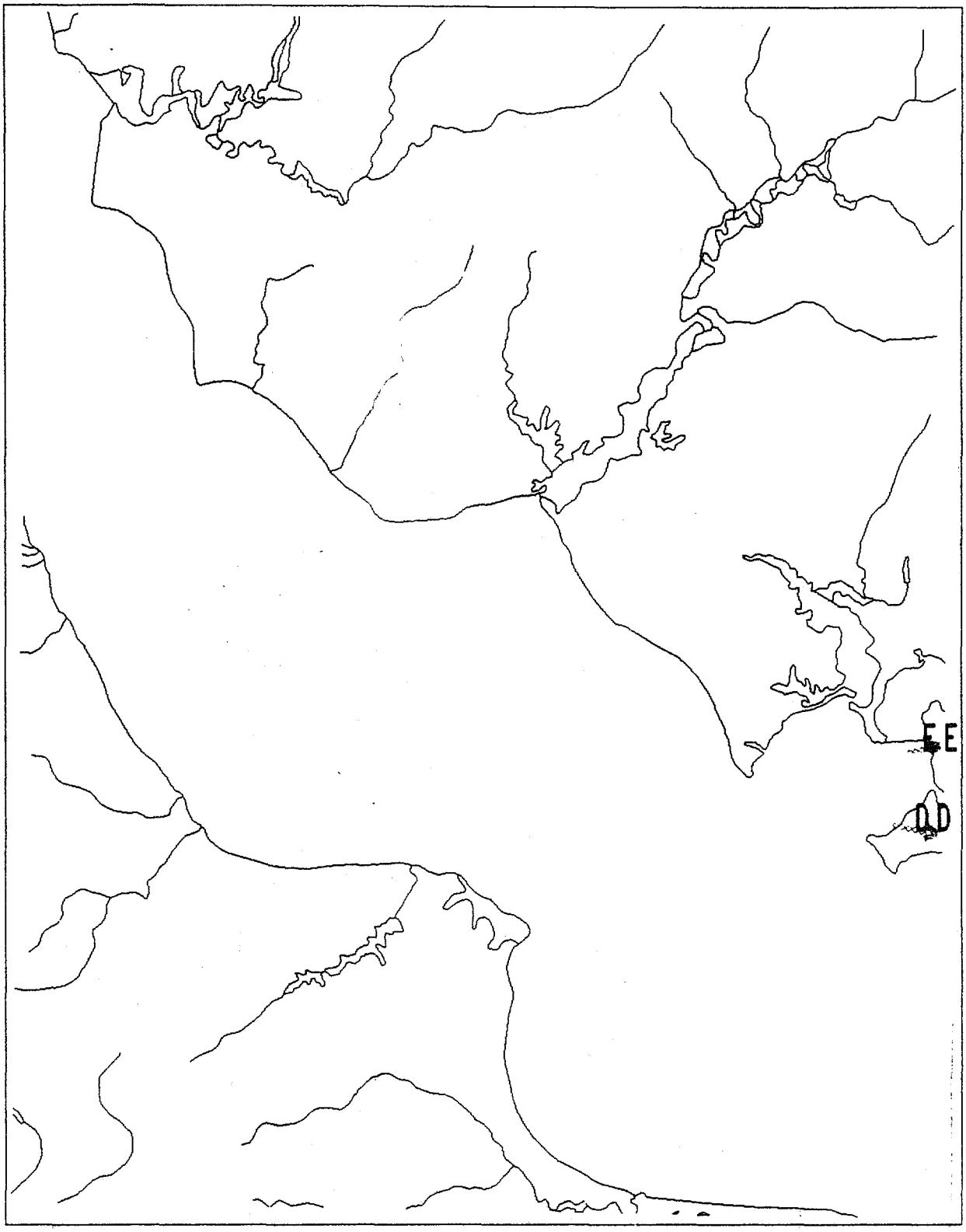
Scale - 1 65,000



Flightline Trajectories
VIMS Coastal Inventory
LIVELY
Lancaster County

June 14, 1989
July 2, 1989
August 31, 1989

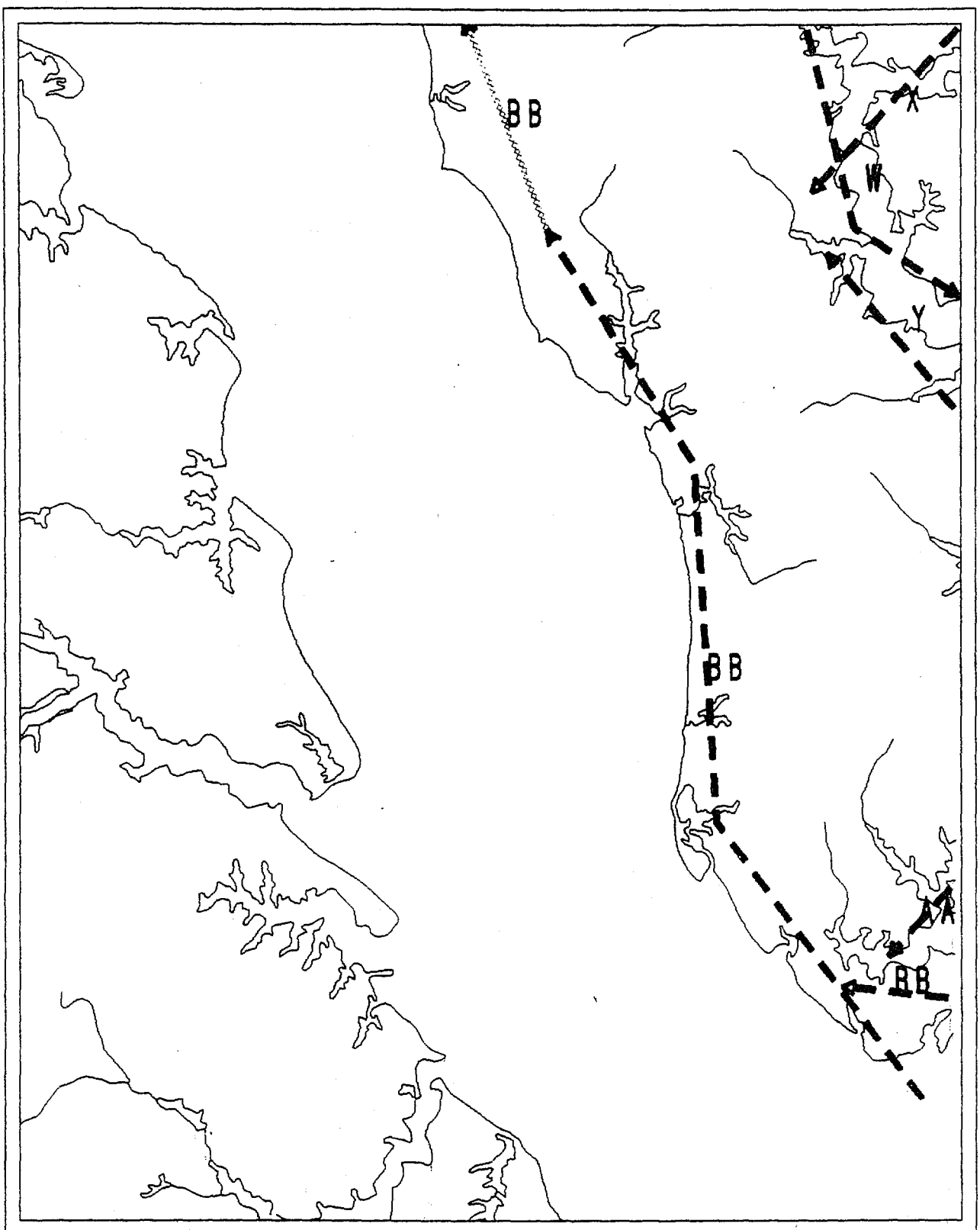
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
MORATTICO
Lancaster County

June 14, 1989
July 2, 1989
August 31, 1989

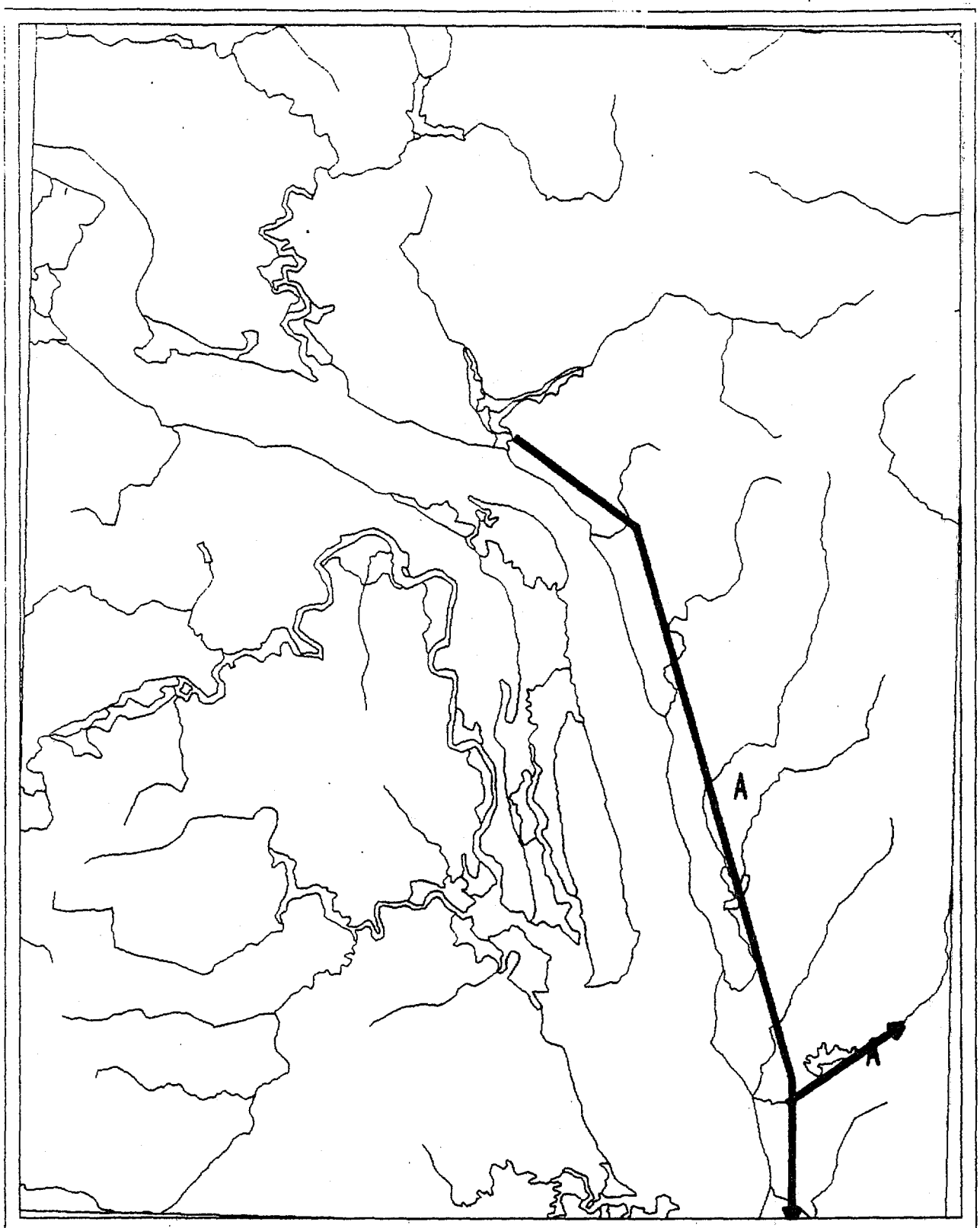
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
URBANA
Lancaster County

June 14, 1989
July 2, 1989
August 31, 1989

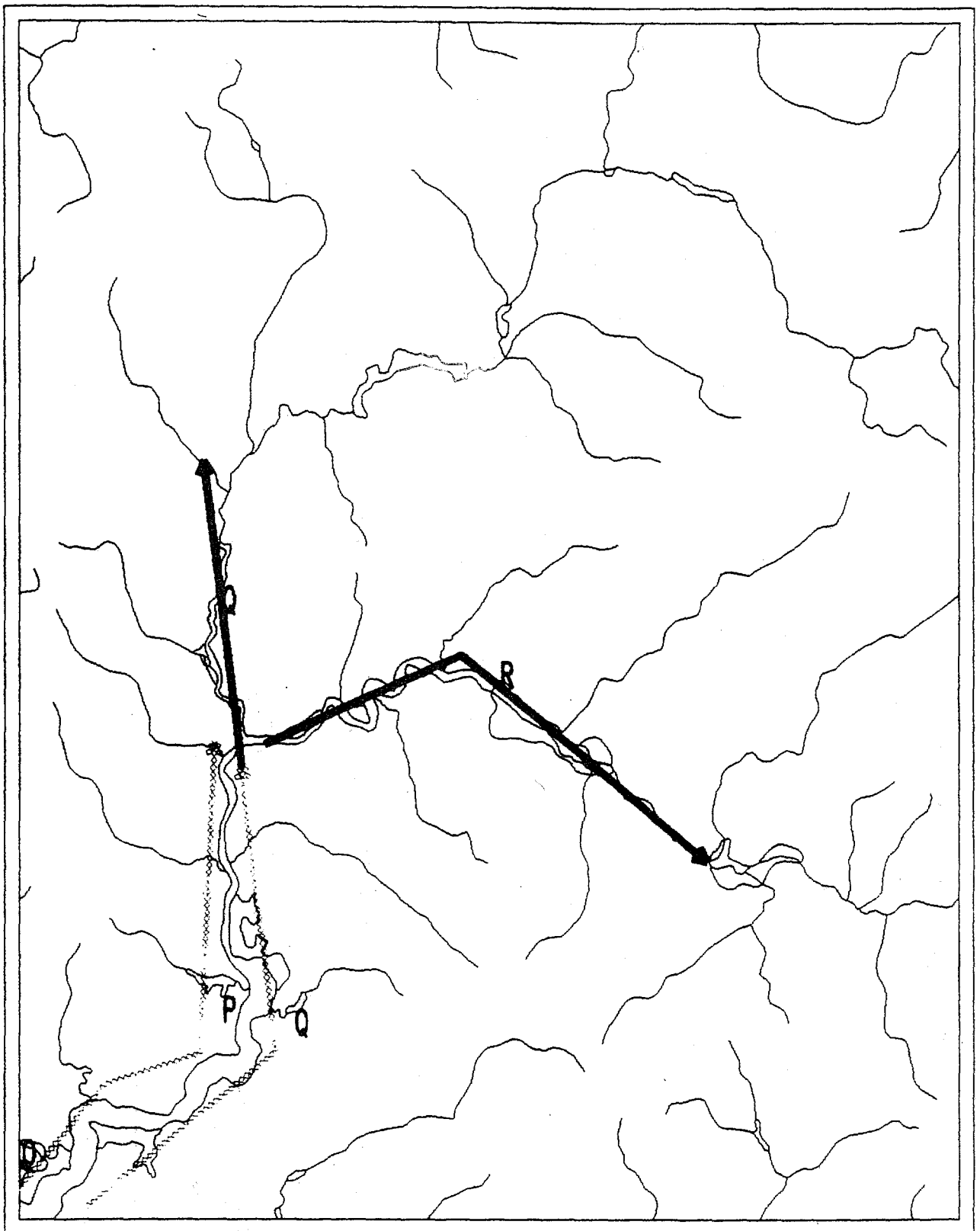
Scale - 1 65,000



Flightline Trajectories
VIMS Coastal Inventory
CHAMPLAIN Quadrangle
Richmond County

August 25, 1989

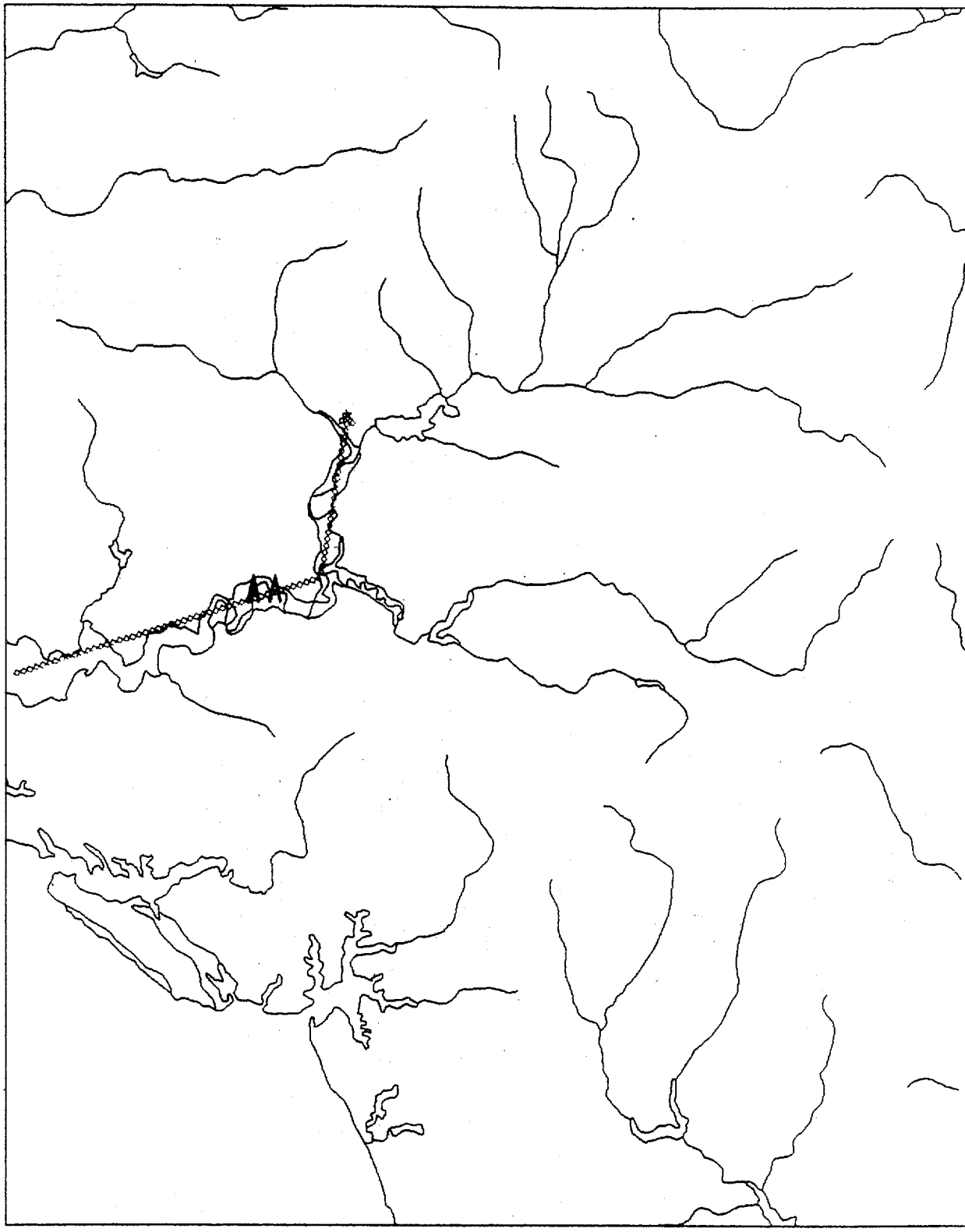
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
HAYNESVILLE Quadrangle
Richmond County

August 25, 1989
August 31, 1989

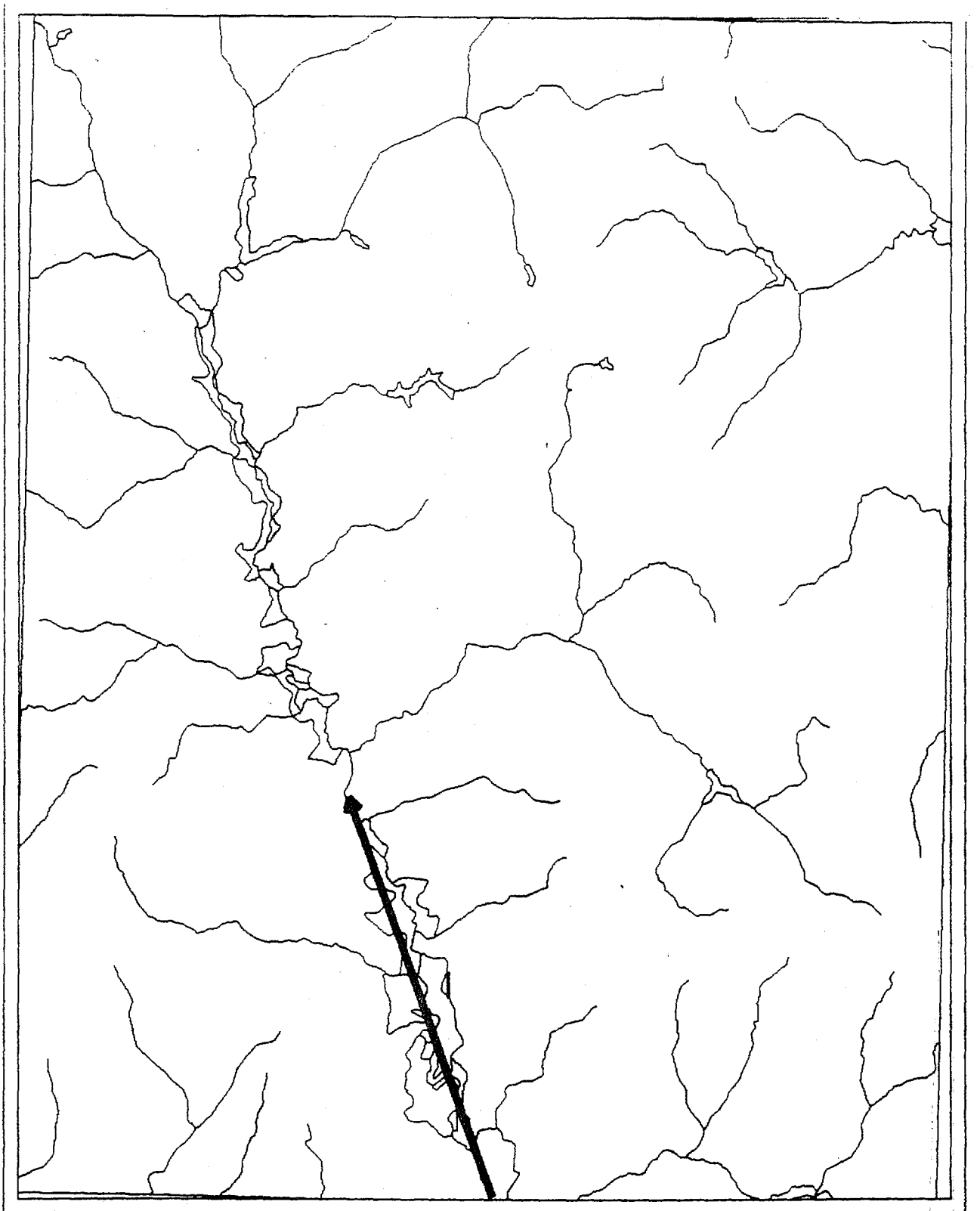
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
LIVELY Quadrangle
Richmond County

August 31, 1989

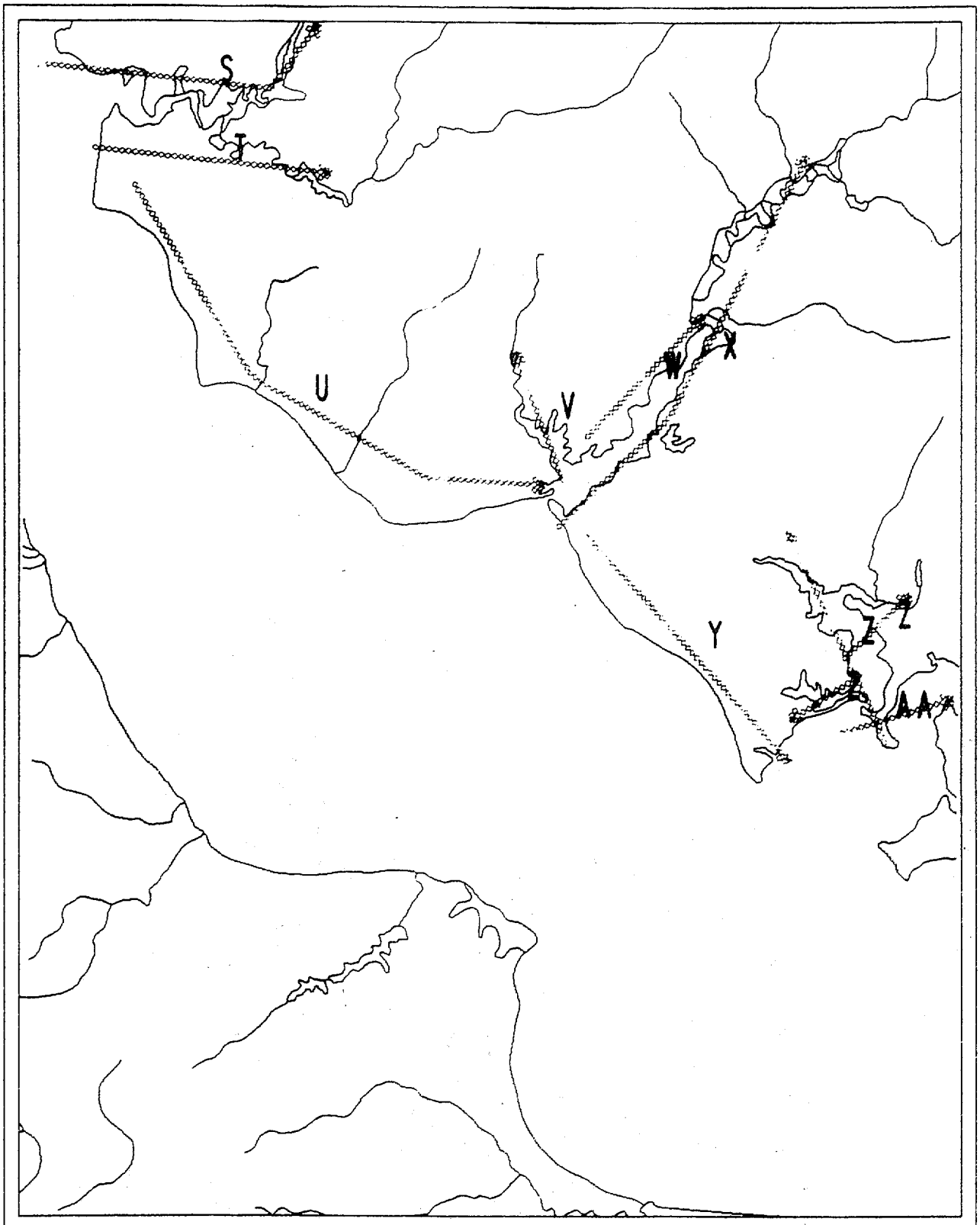
Scale - 1 65,000



Flightline Trajectories
VIMS Coastal Inventory
MONTROSS Quadrangle
Richmond County

August 25, 1989

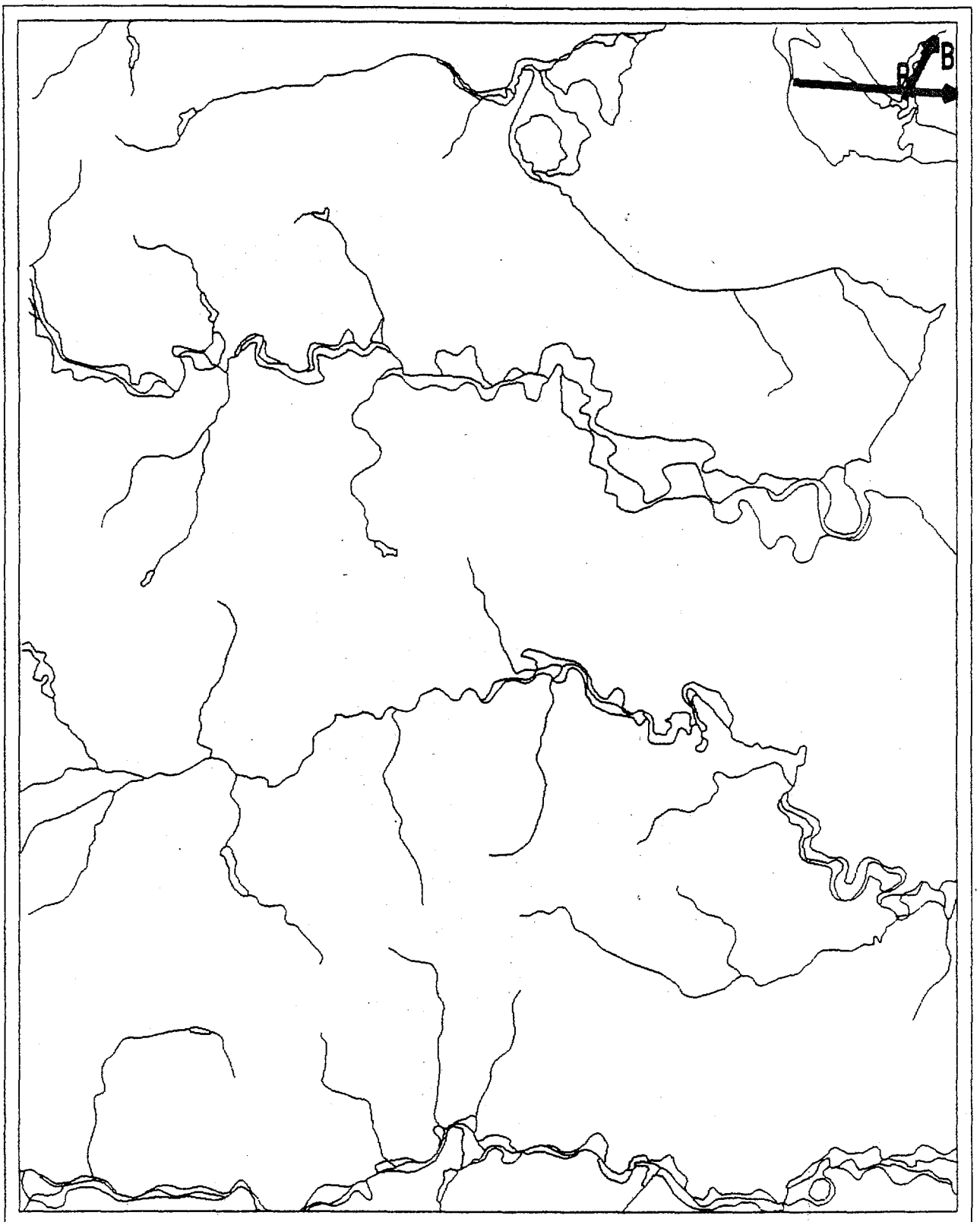
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
MORATTICO Quadrangle
Richmond County

August 31, 1989

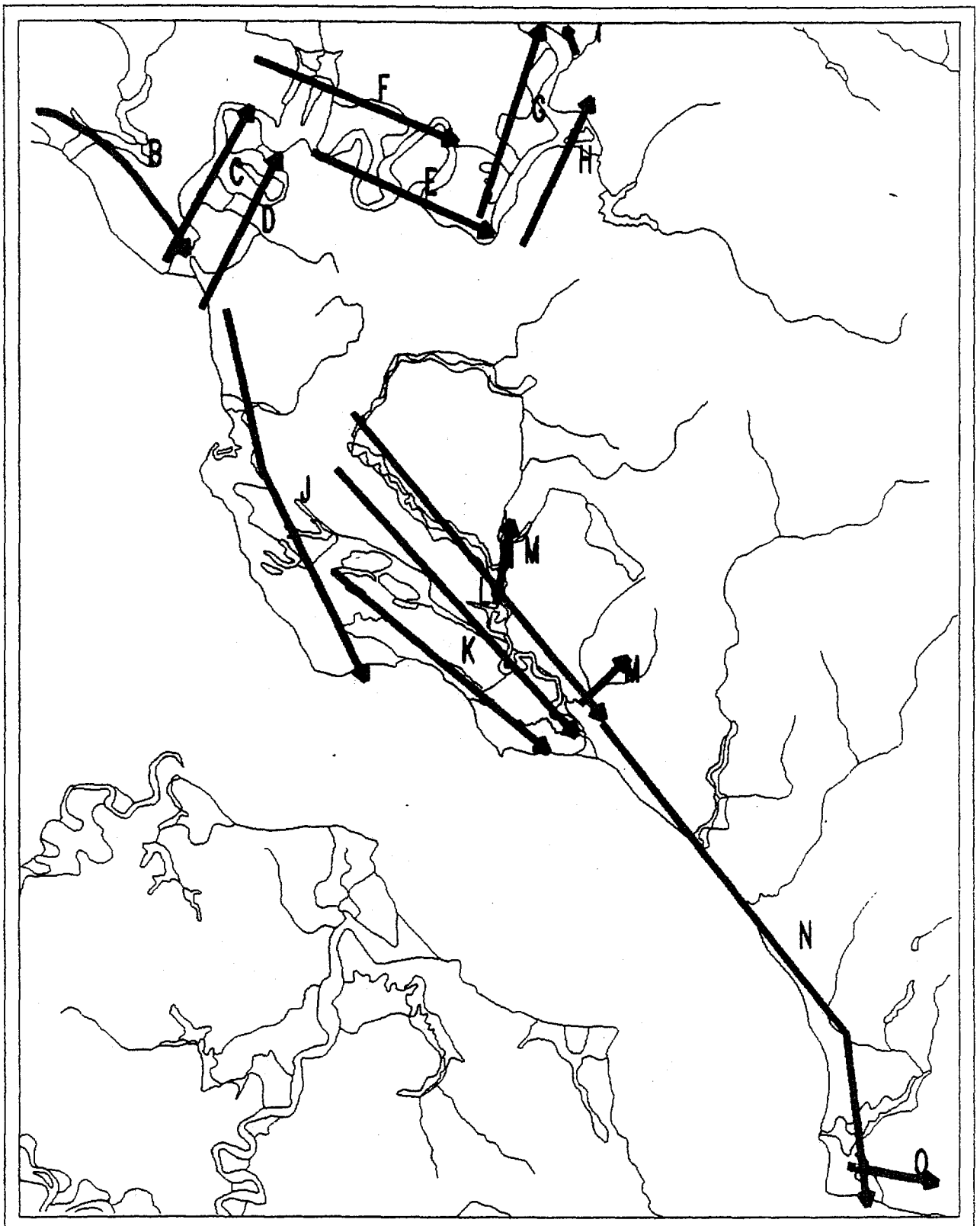
Scale - 1 65,000



Flightline Trajectories
VIMS Coastal Inventory
MT _LANDING Quadrangle
Richmond County

August 25, 1989

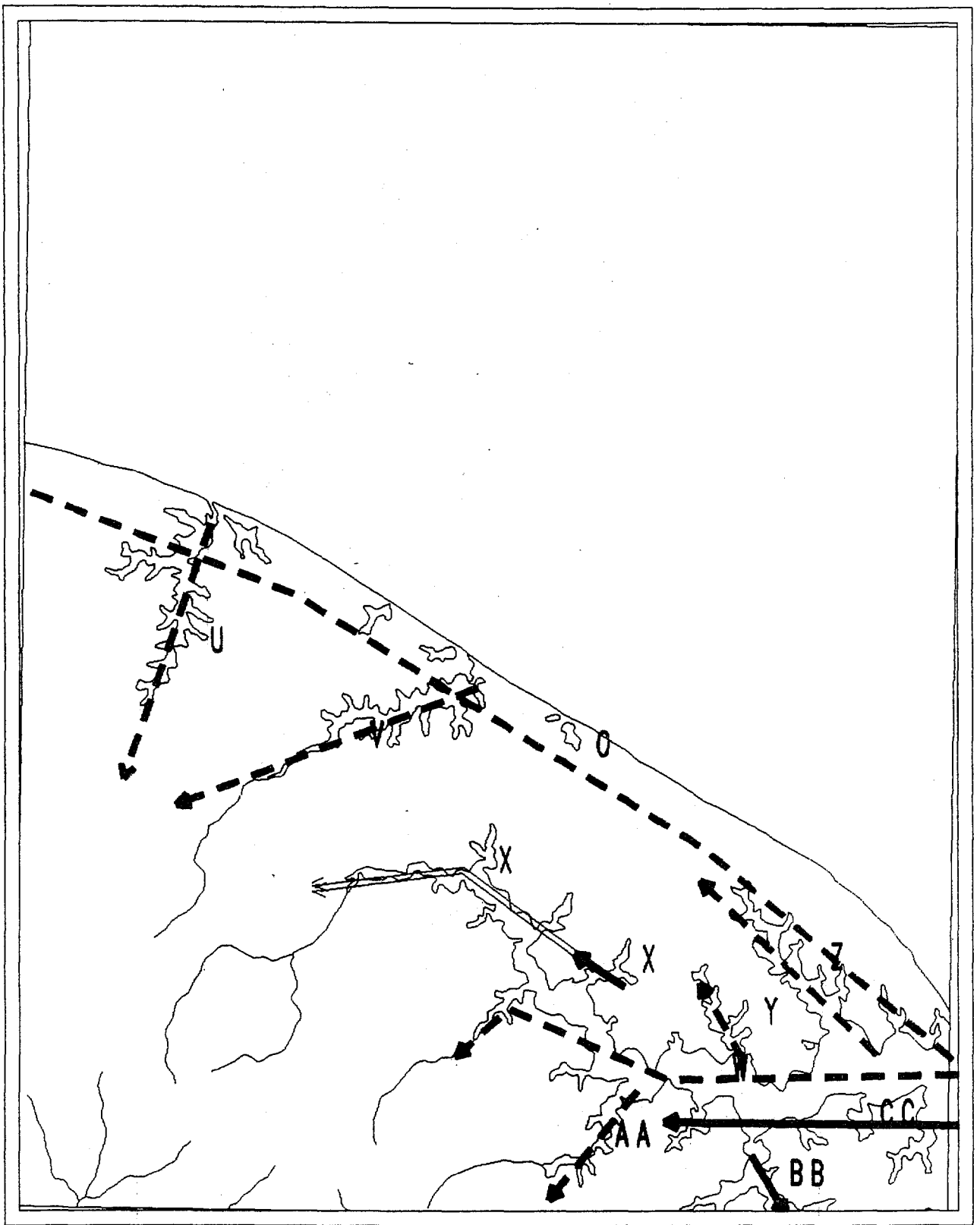
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
TAPPAHANNOCK Quadrangle
Richmond County

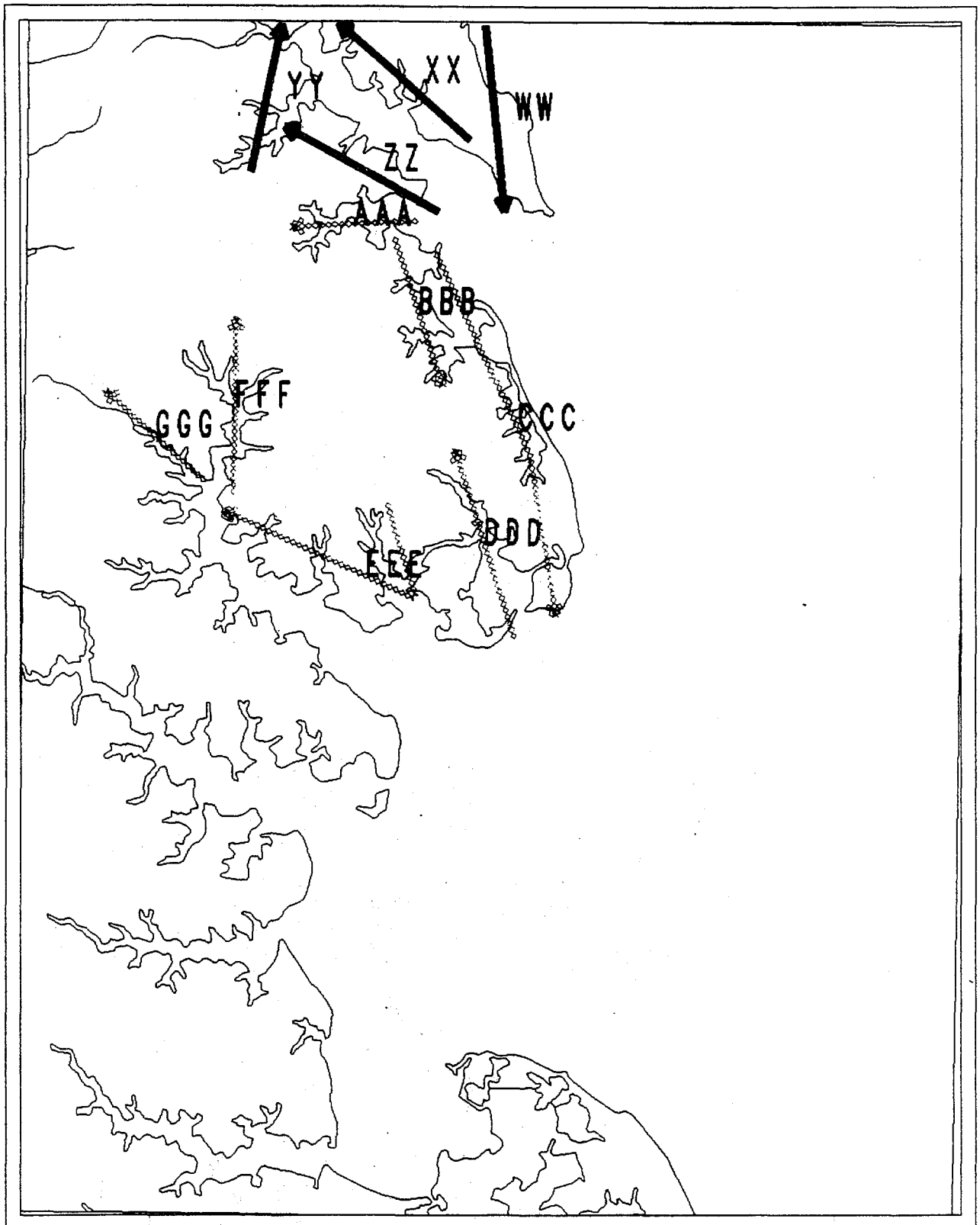
August 25, 1989

Scale - 1:65,000



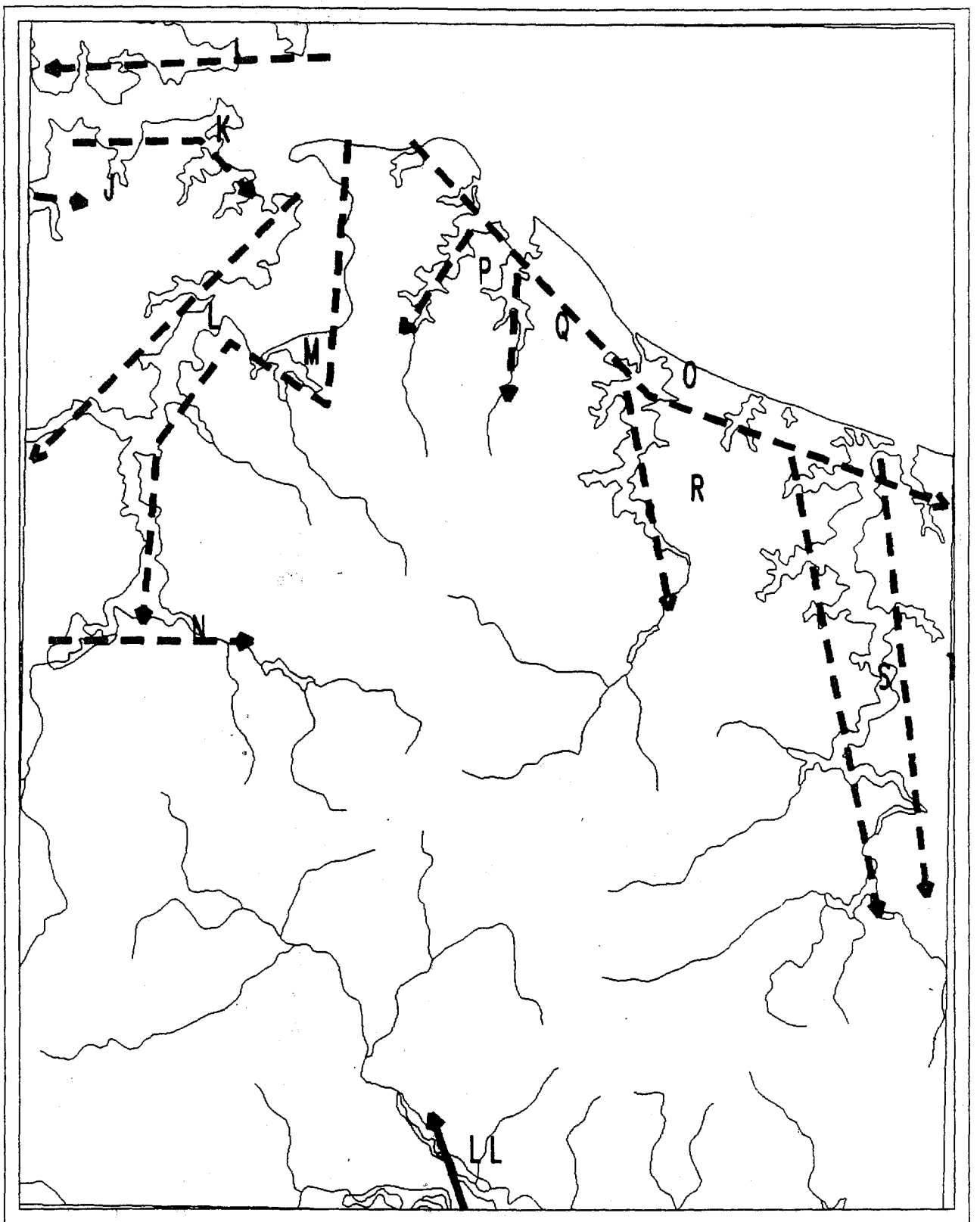
Flightline Trajectories
VIMS Coastal Inventory
BURGESS Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000



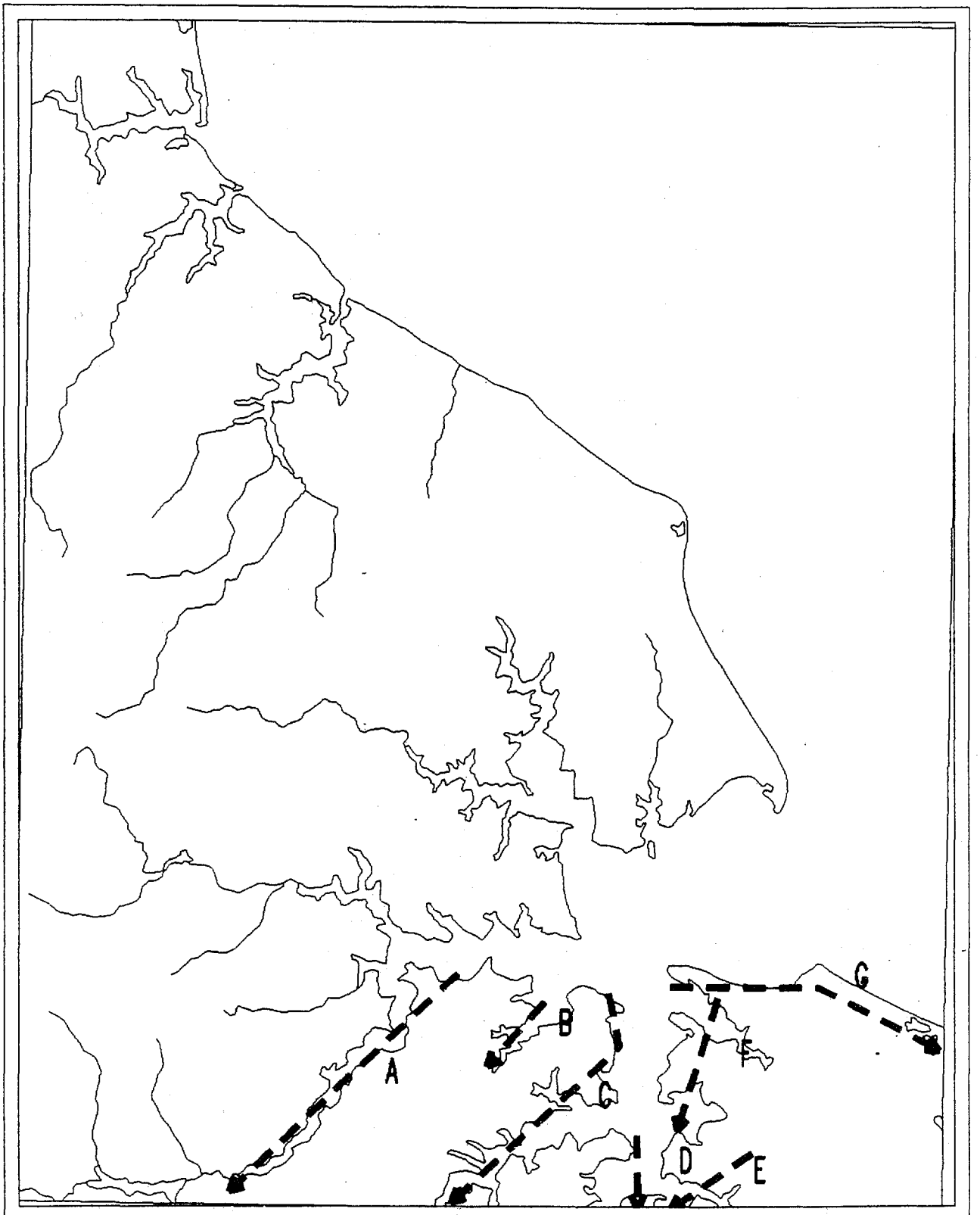
Flightline Trajectories
VIMS Coastal Inventory
FLEETS_BAY Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000



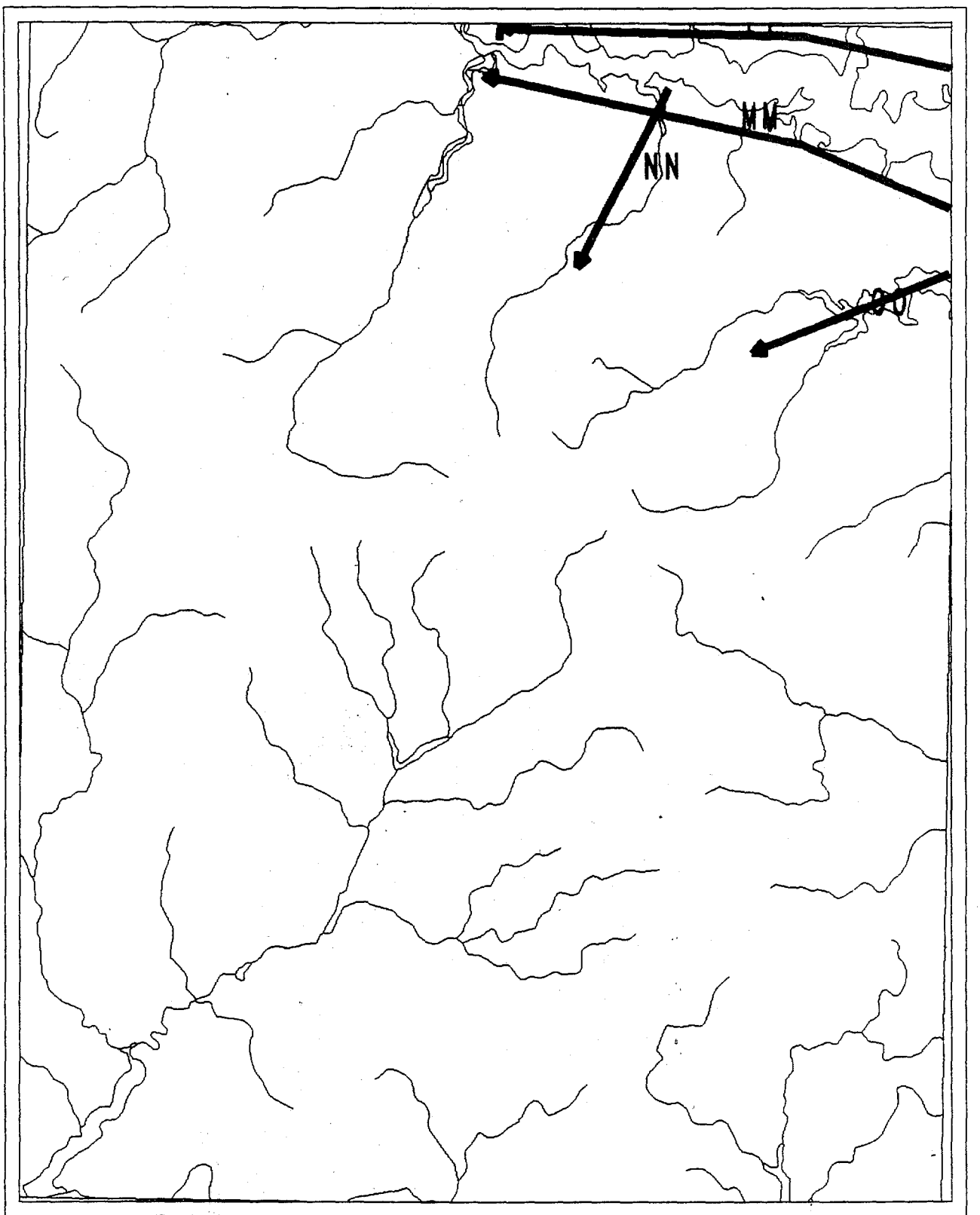
Flightline Trajectories
VIMS Coastal Inventory
HEATHSVILLE Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000



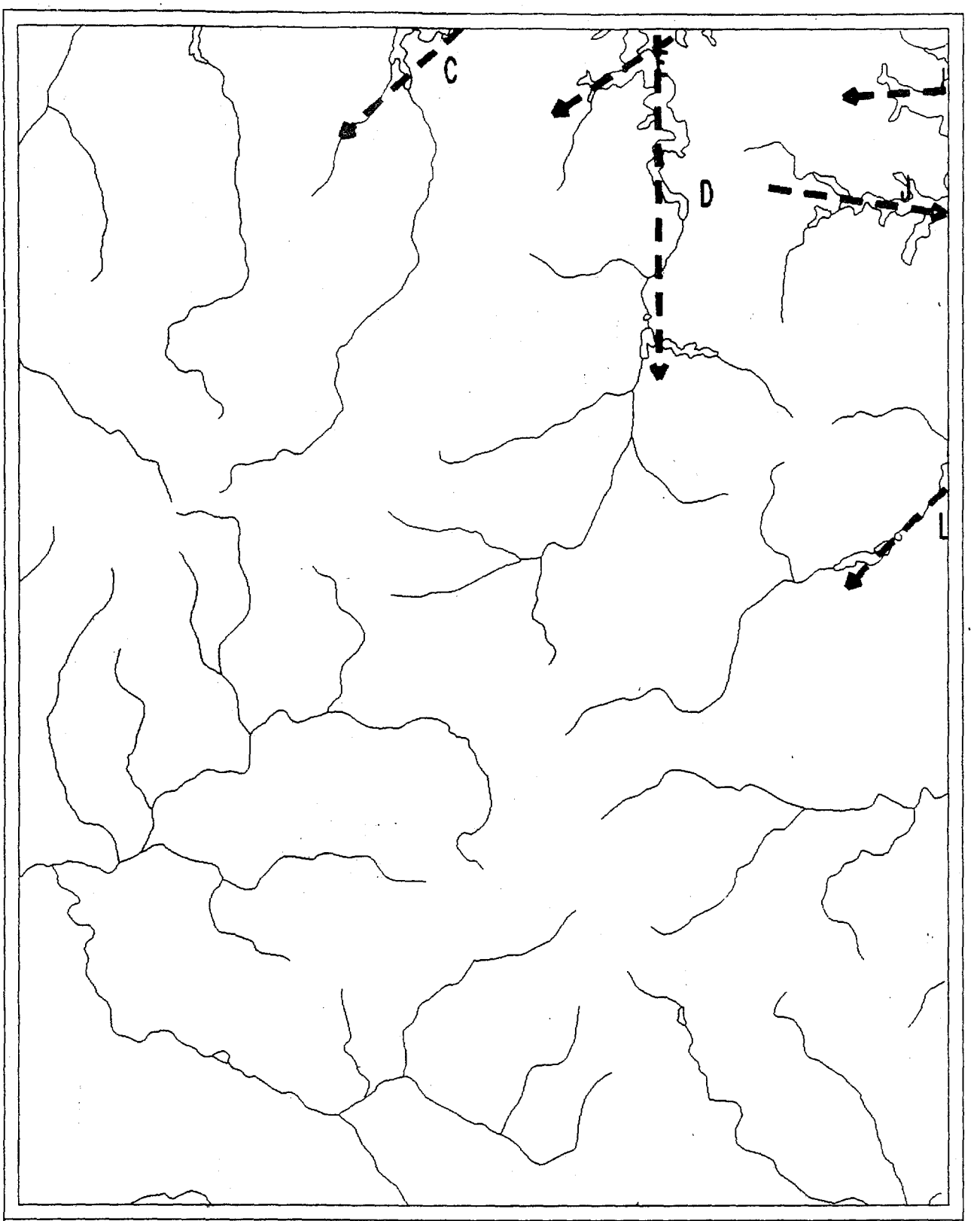
Flightline Trajectories
VIMS Coastal Inventory
KINSALE Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1 65,000



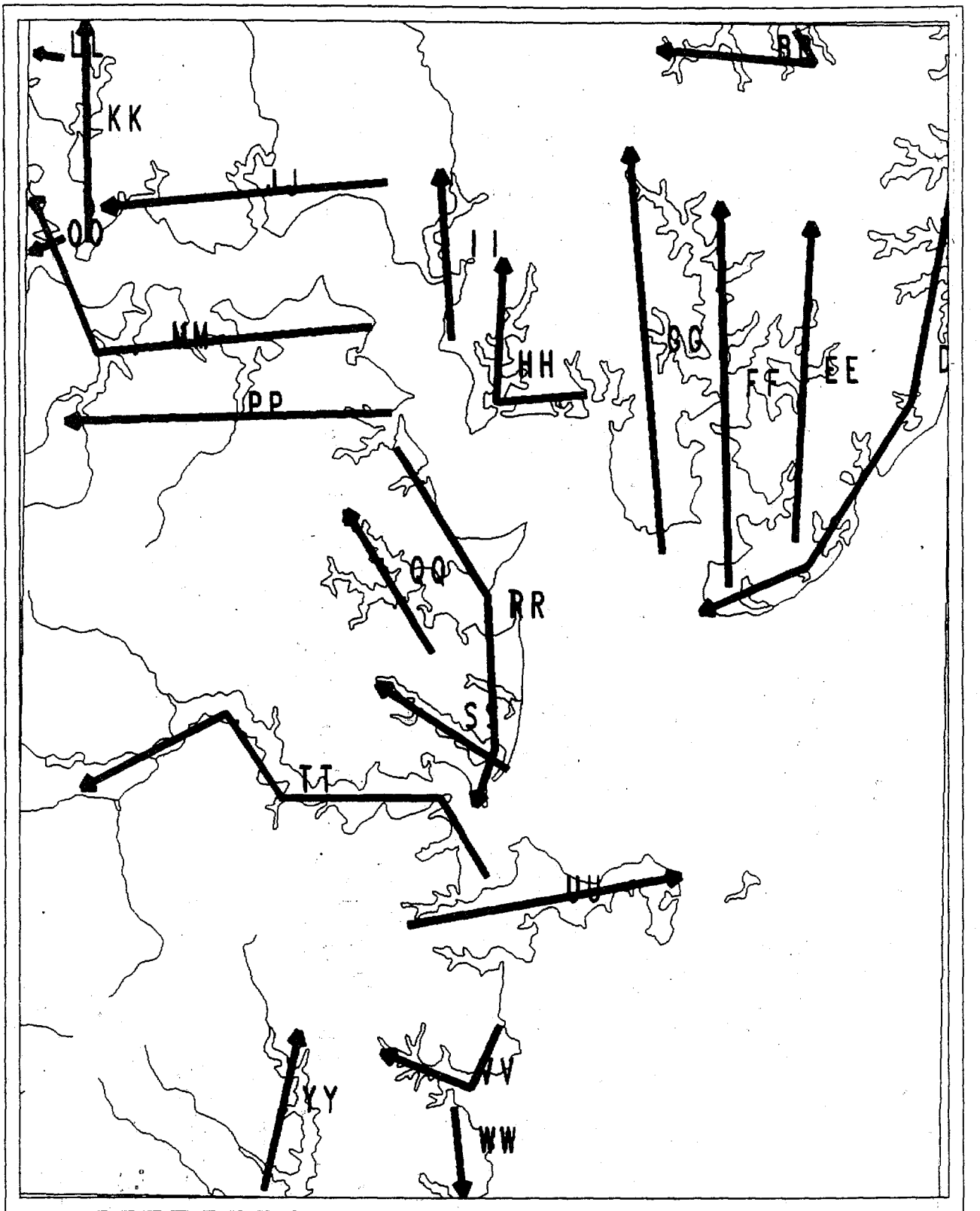
Flightline Trajectories
VIMS Coastal Inventory
LANCASTER Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000



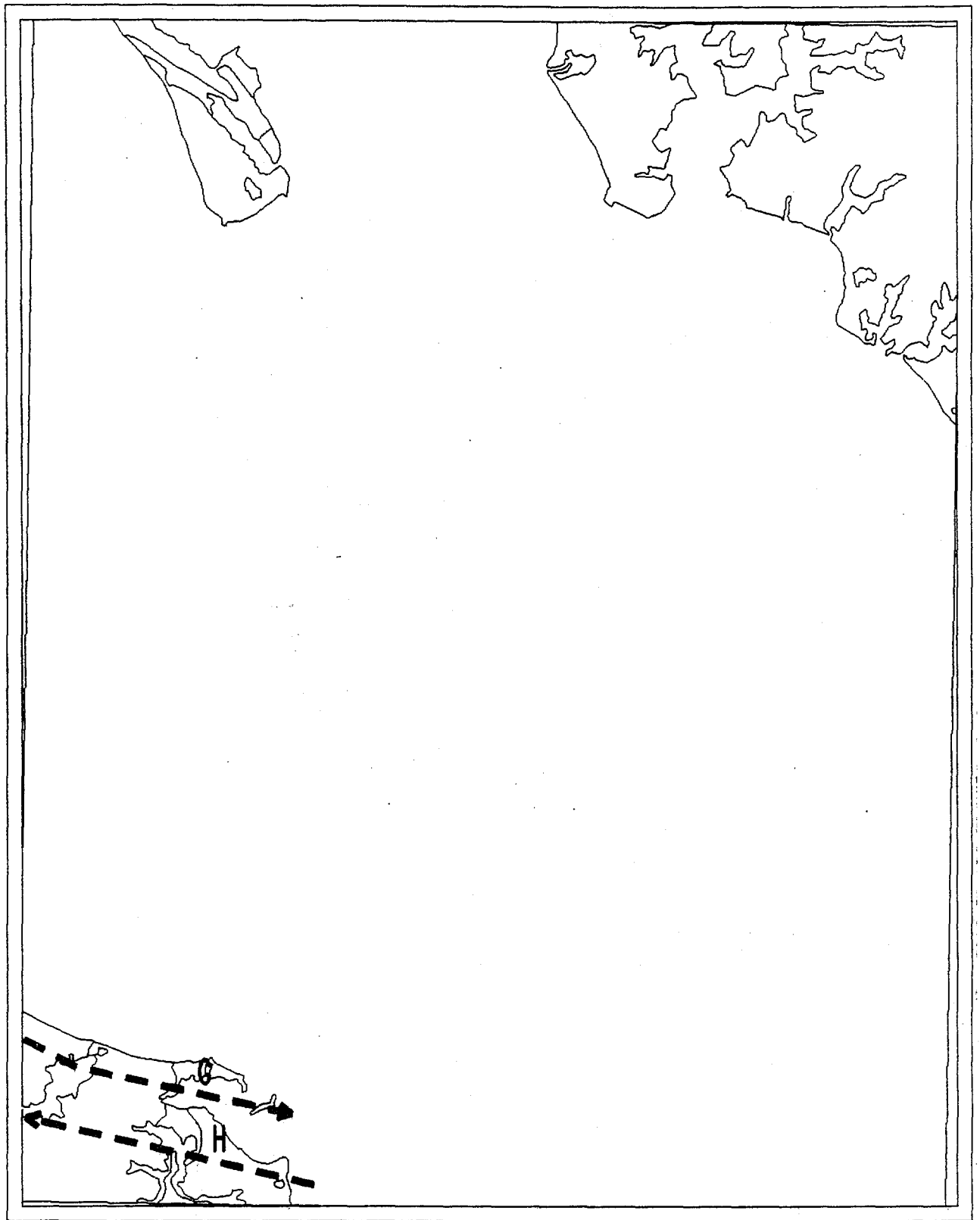
Flightline Trajectories
VIMS Coastal Inventory
LOTTSBURG Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
REEDVILLE Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000



Flightline Trajectories
VIMS Coastal Inventory
ST_GEORGE_ISLAND Quadrangle
Northumberland County

Oct 23, 1989
Oct 26, 1989
Nov 06, 1989
Nov 10, 1989
Scale - 1:65,000