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Coastal Zone
Information
Center

COASTAL ZONE MAPPING HANDBOOK

SECOND DRAFT

August 1, 1975

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

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COASTAL ZONE MAPPING HANDBOOK

National Oceanic and Atmospheric Administration Publication Number_____.
United States Geological Survey Publication Number_____.

PREFACE

(To be supplied by OCZM)

Anyone having knowledge of errors in this handbook, or anyone wishing to suggest changes is welcome to write to either of the following addresses:

. . .
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National Oceanic and Atmospheric Administration
. . .
Washington, D.C. _____

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MS 516 National Center
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INTRODUCTION

Passage of the Coastal Zone Management Act of 1972 focused attention on the lack of adequate maps of the nation's coastal zones and placed emphasis on a demonstrated widespread need for a handbook of this kind. The handbook has been prepared and issued with the requirements of the entire coastal zone community in mind, giving greatest attention given to the needs of coastal zone managers and planners and others having a concern with charting and mapping activities.

The principal objective of the handbook is to be informative. It is neither a textbook nor a technical manual; therefore, no attempt has been made to be instructive.

We have attempted to explain what charts and maps are, and how they are made without being too detailed; associated data have been described; sources of advice and assistance are provided; the various kinds and types of charts and maps are explained, some examples are described, and places listed where they are obtainable; a glossary of terms familiar to the charting and mapping community that may be strange to those concerned with coastal zone activities is included; and, finally, examples of many available products and services are provided.

PART I

GENERAL INFORMATION FOR USERS

I. Definitions of Coastal Zone (OCZM)

The Coastal Zone Management Act of 1972 (P.L. 92-583) defines the coastal zone as "the coastal waters" (including the lands therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal States, including transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in the great lakes waters, to the international boundary between the U.S. and Canada and, in other areas, seaward to the outer limit of the U.S. territorial sea. The zone extends inland from the shorelines only to the extent necessary to the control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal government, its officers, or agents.

The critical part of this definition lies in the sentence "the zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters." Delineation of boundaries following this definition is not an easy task. The definition would imply an inland boundary of the coastal zone which is basically delineated along natural features especially rivers, streams, marshes, and their accompanying drainage basins. In practice, however, many coastal States may define the landward boundaries

of their coastal zone along other than purely natural features. For example, a State may determine that the most feasible boundary could be based initially on an arbitrary line, say a 10 foot vertical distance above mean high water (MHW), which may roughly approximate a flood plain level, and then modify that line to correspond with the nearest township line or network of paved roads. This modification would greatly simplify the administration of such a coastal zone boundary. Another alternative approach a little further removed from a natural boundary could be an inland water of all the coastal damping of a State. Still another approach may be an arbitreary horizontal distance inland from MHW.

Other definitions of the coastal zone may include an extension of the seaward limit out to the edge of the continental shelf, this being defined as two hundred miles from shore or the two hundred metre depth curve. Geologically and biologically the seaward extent of the coastal zone terminating at the edge of the continental shelf rather than the outer limits of the territorial sea, in some senses, would be a more logical way to define the coastal zone if natural considerations and features are most important. By this same philosophy one could imagine the landward extension of the coastal zone extending to the crest of the coastal mountain range.

Another concept which could be considered would be those areas in which the water influences the land. This concept is just the reverse of that sited in the Coastal Zone Management Act. As a

practical concept, however, it might be much easier to delineatae, one could imagine, determining the extent of water influence on land by using the 50-year flood plain, or the 100-year flood plain, or the boundaries of coastal marshes, bogs, etc. Certainly other schemes could be used to define the coastal zone each with its advantages and disadvantages. For purposes of this handbook, however, we will use the definition as outlined in the Coastal Zone Management Act sited above.

I. Planning

The Coastal Zone Management Act of 1972 added another planning mechanism to be used in control of the coastal zone. Coastal planners at the Federal, State, and local level will need large scale maps of the coastal zone. Federal planners will need maps in range of 1:24,000 up to 1:100,000 or 1:250,000. A set of coastal maps for the entire coastal zone of the U.S. and the four territories including of course the Great Lakes is fundamental for an overview perspective. States will want maps of their own coastal zone. These maps could be expected to range approximately from 1:24,000 to 1:100,000. Local governments also would have a need for planning maps especially to relate their activities to other activities in other areas of the State. Such maps may be in the scale of 1:10,000 up to 1:24,000.

In planning for the management of the land and water resources of the coastal zone such maps would be useful in inventorying and designating areas of particular concern in the coastal zone. These could include marshes under threat of pollution and desecration, areas of the coastline subject to high erosion, and those subject to frequent and seevere flooding. Effective planning can be enhanced considerably if the results and data from inventories of coastal-zone resources are graphically displayed on such planning maps. These inventories would not only include natural resources, but also demographic trends, socio-economic factors, such as ..., environmental factors such as ..., cultural features such as historic buildings in need of preservation, archeological sites of historic significance, and coastal zone areas which could be preserved purely for their esthetic values.

Such planning maps also are used for graphically depicting land- and water-use classification systems.

Of further interest to the coastal planner and describable on small-scale charts would be coastal and estuarine circulation patterns including predominant coastal currents, areas of low water flow as well as fast water flow, within these and estuaries.

2. Managing

Maps for coastal-zone management would be larger in scale than maps for planning. Again such maps would be useful at the Federal, State, and local levels. However, these maps would be of greatest

practical concept, however, it might be much easier to delineatae, one could imagine, determining the extent of water influence on land by using the 50-year flood plain, or the 100-year flood plain, or the boundaries of coastal marshes, bogs, etc. Certainly other schemes could be used to define the coastal zone each with its advantages and disadvantages. For purposes of this handbook, however, we will use the definition as outlined in the Coastal Zone Management Act sited above.

2. Use of Maps and Charts in the Coastal Zone

1. Planning

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Maps for coastal-zone management would be larger in scale than maps for planning. Again such maps would be useful at the Federal, State, and local levels. However, these maps would be of greatest

concern to the State and local governments. Whereas the basic responsibility for producing the small scale maps mentioned above would be Federal, the basic responsibility for producing large-scale maps for management of the coastal zone would be State and local. One could envision State coastal zone maps in the range of 1:5,000 down to scales in the order of 1:24,000 depending on the geographic area of concern as well as the length of the coast line to be mapped. Local governments may need maps of an even larger scale for their regulation and management of coastal zone. One might expect a scale range of in the order of 1:2,000 up to 1:10,000. Such large-scale maps made for the entire coast line might be quite expensive. It is therefore anticipated that such large-scale maps would be produced for areas where concentrated management is necessary, while somewhat smaller scale maps and even perhaps the planning maps mentioned above might be sufficient for coastal areas in need of less rigorous managment.

The larger-scale management maps would be useful for finer detailed inventories, surveys, monitoring efforts, analysis, documentation, regulation and enforcement. Because many legal battles will ensue in administering coastal-zone regulation necessary for control of land- and water-use activities, large-scale maps, on which boundaries and surveys can be accurately delineated in a fashion admissible to local courts, will be needed by coastal-zone managers.

One of the best ways to depict the results of inventories of the resources and the boundaries of the coastal zone, as well as results

of surveys and land and water use classification, is to use overlays or overprints on existing maps whether Federally or locally produced. Since multi-plate maps produced by the Federal government can be reproduced using feature separation techniques (See II.9.2.) the use of overlays depicting certain data relating to the coastal zone and needed by coastal-zone managers is an easy and inexpensive way to graphically present the results of coastal inventories. Furthermore, the results of seasonal or annual monitoring efforts in the coastal zone could be depicted easily and inexpensively on overlays rather than having to print a completely new map. The photography resulting from monitoring overflights, be they annual, seasonal, or less frequent, could be analyzed and the results laid out on overlays or overprints.

Another concept along the same line would be to use the monitoring photography to produce new orthophoto information overwhich could be printed the topography, roads, land lines, and other such data which changes less frequently.

While charts of water areas have been used basically for navigation and for description of the physiography, we can expect many new uses for maps or charts of water areas as the management of the coastal zone becomes more intensive. For instance, water zoning, much the same as land zoning, can be expected to increase significantly over the next decade. Maps will have to be prepared for this purpose.

3. Criteria for Selection of Maps and Charts (USGS)

When choosing a working map or chart for use in a coastal zone managemnet program one must consider the size of the management area and the purpose for which the map or chart will be used. In conjunction with these considerations scale, content, and accuracy are major factors in selection.

It is convenient when a single map can be used for an entire management area. Generally, the small-scale products (1:250,000 and smaller) are most useful to planners because they cover a larger area and yet contain adequate information for defining a geographically extensive management zone. However, when the area is so large that an extremely small scale is required in order to fit onto one sheet of paper, other considerations must be made. If the scale is too small to provide the desired content, it may be better to use several sheets at a larger scale. Also, the accuracy with which features are plotted reduces with the scale. (See II.6.6 and II.7.5 for more information about scale.)

Up to 10 percent of the features on a small-scale map at 1:250,000, which conforms to the National Map Accuracy Standards (Appendix F), could have horizontal position errors exceeding the map equivalent of 417 feet (about 125 metres). The remaining 90 percent may be off by varying amounts within that figure. The corresponding values for a medium-scale map at 1:50,000, and for a large-scale map at 1:24,000 would be 83 feet (about 25 metres) and 40 feet (about

12 metres), respectively. Although the position errors for a given map may be far less than those quoted, the figures do show that one should at least consider accuracy when choosing a map or chart.

It is suggested that the upper portion of the small-scale range, 1:250,000 to 1:1,000,000 is most useful for general planning purposes. Maps and charts at those scales tend to have the capability of satisfying the majority of the requirements of content and accuracy. They cover a fairly large area and can provide adequate information with accuracy suitable for planning. More intense activities, such as boundary delineation and enforcement, require maps and charts at medium and large scales. Their greater accuracy gives them an advantage over small-scale maps when more detail is required.

Planimetric maps (See II.6.2) are frequently sufficient for planning of land and water resources in the coastal zone. They show the position of the major features including culture, transportation systems, wetlands, vegetation, and sometimes historical sites. Although planimetric maps show no continuous relief data they usually indicate the position of major physiographic features.

For recognition of locations where erosion and sedimentation are in progress, topographic and bathymetric maps (See II.6.2.) at medium or large scale are useful because they depict relief and provide some insight into the cycle of land-mass denudation within the coastal zone. The ideal product for this purpose is

the topographic-bathymetric series (See Appendix G) which is being produced jointly by the U.S. Geological Survey (USGS) and the NOAA National Ocean Survey (NOS). These maps will be published at scales of 1:250,000, 1:100,000, and 1:24,000 with 1 x 2 degree, 1 degree x 30 minute, and 7.5 x 7.5 minute formats, respectively.

The topographic map offers the greatest wealth of general information for land areas, but it is not all inclusive. The coastal zone manager should use supplemental data found on thematic maps covering fields such as geology, land-use, landownership, utilities, and population distribution. Selection and use of these maps would depend upon the goals of the user.

The greatest single source of data for water areas is the hydrographic chart. In addition to water depth, it shows channels, shoals, and aids to navigation. These charts may be subdivided into nautical, coast, harbor, Intracoastal Waterway, and small-craft charts. All of these contain essentially the same kinds of information. For the most part the differences lie in scale and intended use. Besides these charts there are a number of special purpose maps, charts, and diagrams (listed in 1.7.1) dealing with water areas.

Photographic products offer a wealth of information which is useful in coastal zone planning and management. Orthophotomaps are especially useful in ascertaining the extent of wetlands and for studying vegetation. Spacecraft imagery has been used in wetland delineation

and shallow-seas mapping. (See Appendix G for examples of imagery from space.)

Some management projects will require maps and charts at scales larger than 1:24,000. Normally these products are not available from the Federal government. However, USGS can provide technical assistance for those undertaking mapping projects to fill their own needs. For technical assistance, organizations or individuals may contact:

Chief, Office of Research and Technical Standards
Topographic Division
U.S. Geological Survey
MS 519 National Center
Reston, Virginia 22092
Telephone: 703-860-6291

Assistance also can be provided for those who are uncertain about choosing available products for use in a coastal zone management program. Help in selecting suitable maps, charts, and related data may be obtained from:

Chief, User Services Section
National Cartographic Information Center
U.S. Geological Survey
MS 507 National Center
Reston, Virginia 22092
Telephone: 703-860-6187

4. Special Problems (NOS)

Production of maps in any area almost always is accompanied by a host of problems, regardless of the kind of maps being published. Another group of problems arises in mapping the coastal zone. They are unique to that area and occur in addition to those of a routine nature. Perhaps most perplexing of all is the need to chart water areas as well as to map the terrain. Cartographic practices employed in the production of hypsographic maps vary little from those used to produce bathymetric and nautical charts. The major difference lies in the skills required to make sound judgments in preparation of navigational charts. Such decisions are critical to the safety of the navigator, his vessel or aircraft, cargo, crew, and passengers. Field surveys conducted to acquire essential data for hypsographic maps differ greatly from those made to obtain source data for nautical charts. Bathymetric and hydrographic surveys require different equipment, instruments, and techniques. They are conducted in an environment that, all too frequently, is more hostile than that found in topographic surveys.

Some of the more significant problems unique to the coastal zone are:

1. tidal datums
2. rapid changes in the shoreline and alongshore features
3. coastla boundaries
4. data acquisition procudures.

I. Tidal datums

Tidal datums are of critical importance in that part of the coastal zone affected by tidal fluctuations. They provide the base for establishing coastal boundaries, e.g., tidal datum lines form the boundary between private and sovereign (state-owned) property in the majority opf the 50 States; limits of the territorial sea and the contiguous zone are derived from a tiday datum line; water depths for bathymetric maps and nautical charts are referred to a tiday datum, and a tidal datum line depicts the junction of land and water on maps and charts; limits of various regulatory activities and responsibilities affecting coastal-zone management are defined by tidal datums; accurate and adequate knowledge of the tides and tidal datums is essential to promote and regulate safe navigation in an economical water transportation system, and for numerous engineering and scientific activities.

Lake levels in the Great Lakes area occupy a position similar to that of tidal datums along the oceanic coasts. Fluctuations of water levels in the Great Lakes result chiefly from meteorological forces. Neither the time nor the magnitude of changes is predictable consistently with any consistency or reliability. The periodicity of oceanic tides is absent. Lake level data is acquired by methods and equipment similar to that used to make tide observations, but the resulting data is processed differently.

2. Specific regional, State, or local problems

(This section is to be added by NOS upon receipt of information from State sources.)

3. Shoreline changes

Changes in the shoreline occur frequently, and often very quickly as a result of actions of both natural and artificial forces. Alongshore structures are subject to rapid change, principally through the activities of man, with the most significant changes occurring faster in the areas having the greatest development and congestion. Such changes soon make maps and charts obsolete and increase the workload required to conduct effective coastal-zone management programs.

4. Boundaries

Boundaries in the coastal zone range from the limits of private-sovereign property to the international boundary. All of them are affected to some degree by tidal datums along the Atlantic, Pacific, and Gulf Coasts, as well as along the shoreline of oceanic islands. Similar boundaries in the Great Lakes area are fixed by treaty by acts of Congress, or are controlled by a lake level. Of all these boundaries, that exist between private and sovereign lands, will create greater difficulty than any of the others. Recent maps, prepared by modern techniques, and related data, such as aerial photographs and tidal information, will be of inestimable value in resolving boundary problems.

5. Aerial photography

Acquisition of acceptable aerial photography can present some of the greatest difficulty in the coastal-zone mapping. Of special importance is the need to avoid loss of imagery within individual frames because of the reflection of the sun from the water's surface directly into the camera lens. This phenomenon is referred to as sun-glitter, sun-glint, and sunspot. Since the surface of the water can act as a very efficient mirror, detail usually is lost completely in the area illuminated directly by the sun. Effects of sun-glitter can be minimized through proper scheduling and by increasing the endlap (forward lap along the flight line). (See Reference 21, Chapter 3B3, for detailed information on flight planning.)

5. Existing Coastal Mapping Programs (NOS)

1. Federal programs

(This section will be written after receipt of information from coastal States.)

2. State programs

(This section will be written after receipt of information from coastal States.)

(1.5.2 continued)

6. Sources of Assistance and Advice (USGS)

I. General information centers

There are three centers where one can obtain general information on the availability of map and chart data produced by Federal agencies. They are the National Cartographic Information Center (NCIC), the National Geodetic Survey Information Center (NGSIC), and the EROS Data Center (EDC).

The primary role of NCIC is to develop and maintain a data base containing information on the location and availability of cartographic data. Generally mapping organizations will continue to store and distribute their own cartographic data. Users are encouraged to deal directly with the agency concerned if they know what they need and where it can be found. NCIC will provide assistance for those who need help in determining what is available and where it is located. For information on the availability of cartographic data contact:

User Services Section
National Cartographic Information Center
U.S. Geological Survey
MS 507 National Center
Reston, Virginia 22092
Telephone: 703-860-6045

The National Geodetic Survey, a part of the National Ocean Survey of the National Oceanic and Atmospheric Administration is responsible for establishing and maintaining the Nation's horizontal and vertical control networks. Control survey data is available from the NGS

Information Center. In addition to information on NGS control NGSIC is now receiving input on that of USGS. Eventually NGSIC will be able to provide information on control surveys performed by a number of different agencies. For assistance in obtaining control survey data contact:

The Director
National Geodetic Survey Information Center, C18
National Ocean Survey
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852
Telephone: 301-496-8631

The EROS Data Center, located a few miles north of Sioux Falls, South Dakota, is operated by the Earth Resources Observation Systems Program of the Department of the Interior and is managed by the Geological Survey's Land Information Analysis Office. Its purpose is to provide access to imagery from LANDSAT (ERTS), Skylab, USGS aerial photography, NASA aircraft data, and other remote sensing products. Facilities are available for storage, retrieval, reproduction, and dissemination, as well as for user assistance and training. The Data Center reproduces and distributes as sale items copies of imagery, photography, electronic data, and computer products collected by 16 different organizations.

For assistance in selecting imagery or to place an order contact:

User Services Unit
EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198
Telephone: 605-594-6511

Several EROS Applications Assistance Facilities have been established. They maintain microfilm copies of imagery held at the EROS Data Center and provide computer terminal inquiry and order capability through links with the computer complex at the Center. Scientific personnel are available for assistance in applying the data to a variety of resource and environmental problems and for assistance in ordering data from the Center.

The EROS Applications Assistance Facilities and other computer terminal locations, in or near the coastal zone, are listed below.

EROS Applications Assistance Facility
Room 202, Building 3
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025
Telephone: 415-323-2727

EROS Applications Assistance Facility
U.S. Geological Survey
Room 8-210, Building 1100
National Space Technology Laboratories
Bay St. Louis, Mississippi 39520
Telephone: 601-688-3472

EROS Applications Assistance Facility
University of Alaska
Geophysical Institute
College, Alaska 99701
Telephone: 907-479-7558

EROS Applications Assistance Facility
U.S. Geological Survey
1925 Newton Square East
Reston, Virginia 22090
Telephone: 703-860-7868

National Cartographic Information Center
U.S. Geological Survey
Room 1C-202 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092
Telephone: 703-860-6045

U.S. Army Engineer District, Chicago
Room 528
219 South Dearborn Street
Chicago, Illinois 60604
Telephone: 312-353-1275

EROS data reference files have been established to maintain microfilm copies of the data available from the Center and to provide guides to assist the visitor in reviewing and ordering data. This allows the user to view microfilm copies of the data before placing an order. Applications assistance by scientists is not provided at the offices where the data reference files are located. Data reference files may be viewed at the EROS Applications Assistance Facilities and at the following locations in or near the coastal zone:

Alaska

Public Inquiries Office
U.S. Geological Survey
108 Skyline Building
508 2nd Avenue
Anchorage, Alaska 99501
Telephone: 907-277-0577

American Samoa

EROS Coordinator
Office of the Governor
Pago Pago, American Samoa 96799
Telephone: 633-4116

Arizona

Water Resources Division
U.S. Geological Survey
5017 Federal Building
230 North First Avenue
Phoenix, Arizona 85025
Telephone: 602-261-3188

California

Public Inquiries Office
U.S. Geological Survey
7638 Federal Building
300 North Los Angeles Street
Los Angeles, California 90012
Telephone: 213-688-2850

EROS User Assistance Center
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025
Telephone: 415-323-8111

Department of Electrical Engineering
Sacramento State University
600 Jay Street
Sacramento, California 95819
Telephone: 916-454-6545

District of Columbia

Public Inquiries Office
Publications Division
U.S. Geological Survey
1036 General Services Building
18th and F Street, NW.
Washington, D.C. 20244
Telephone: 202-343-8073

Florida

State Topographic Office
Florida Department of Transportation
Lafayette Building
Koger Office Center
Tallahassee, Florida 32304
Telephone: 904-488-2168

Guam

University of Guam
Agana, Guam 96910
Telephone: 749-2921

Hawaii

Department of Geography
313C Physical Science Building
University of Hawaii
Honolulu, Hawaii 96825
Telephone: 808-944-8463

Massachusetts

U.S. Geological Survey
(5th Floor)
80 Broad Street
Boston, Massachusetts 02110
Telephone: 617-223-7202

New York

Water Resources Division
U.S. Geological Survey
343 Post Office and Court House Building
Albany, New York 12201
Telephone: 518-472-3107 or -6042

Ohio

Water Resources Division
U.S. Geological Survey
975 West 3rd Avenue
Columbus, Ohio 43212
Telephone: 614-469-5553

Oregon

Portland Service Center
Bureau of Land Management
710 NE Holladay
Portland, Oregon 97208
Telephone: 503-234-~~4100~~ 3361, X-4000

Virginia

National Cartographic Information Center
U.S. Geological Survey
Room 1C-202 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092
Telephone: 703-860-6045

Remote Sensors and Space Applications Team
U.S. Geological Survey
Room 2A-223 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092
Telephone: 703-860-6271

Washington

Public Inquiries Office
U.S. Geological Survey
678 U.S. Court House Building
West 920 Riverside Avenue
Spokane, Washington 99201
Telephone: 509-456-2524

The National Oceanic and Atmospheric Administration has established data reference files at the following locations: (Addresses and telephone numbers to be provided by NOAA.)

Anchorage, Alaska

La Jolla, California

Tiburon, California

Washington, D.C.

Miami, Florida

Honolulu, Hawaii

Hillcrest Heights, Maryland

Rockville, Maryland

Silver Spring, Maryland

Woods Hole, Massachusetts

Detroit, Michigan

Garden City, New York

Asheville, North Carolina

College Station, Texas

Fort Worth, Texas

Norfolk, Virginia

Seattle, Washington

Madison, Wisconsin

2. Major mapping and charting programs

The two major mapping and charting programs in the United States, which influence the coastal zone, are administered by the NOAA/National Ocean Survey, and the U.S. Geological Survey.

The National Ocean Survey...

(To be supplied by NOS)

(NOS programs continued)

The U.S. Geological Survey publishes several series of topographic maps of the United States as part of its National Mapping Program. The Topographic Division of USGS is the primary civilian producer of topographic maps of the United States, although the Defense Mapping Agency Topographic Center, National Ocean Survey, Tennessee Valley Authority, Forest Service, and the Mississippi River Commission sometimes prepare such maps in connection with their regular activities.

The principal USGS map series and their essential characteristics are given in the following table:

Series	Scale	1" Represents:	Standard Size
7.5-minute	1:24,000	2,000 feet	7.5 x 7.5 min
Puerto Rico 7.5-min	1:20,000	about 1,667 feet	7.5 x 7.5 min
Alaska 1:25,000	1:25,000	about 2,083 feet	7.5 x 7.5 min
1:50,000 County	1:50,000	about 4,167 feet	county format
15-minute	1:62,500	nearly 1 mile	15 x 15 min
Alaska 1:63,360	1:63,360	1 mile	15 x 20 to 36 min
1:100,000 County	1:100,000	about 8,333 feet	county format
U.S. 1:100,000	1:100,000	about 8,333 feet	30 min x 1 degree
U.S. 1:250,000	1:250,000	nearly 4 miles	1 degree x 2 degrees
U.S. 1:1,000,000	1:1,000,000	nearly 16 miles	4 degrees by 6 degrees

NOTE: In Alaska the size of the 1:250,000 and 1:1,000,000 quadrangles varies from the above figures.

In addition to the above products USGS produces a number of special items. Metropolitan Area Maps, at 1:24,000 scale, have been prepared for many cities and published in one or more sheets, according to the size of the area shown. The National Park Series, at various scales, covers national parks, monuments, and historic sites. Many of these maps are available with shaded-relief overprinting on which the topography is made to appear three dimensional by the use of shadow effects. State base maps at scales of 1:500,000 (1 inch represents approximately 8 miles) and 1:1,000,000 (1 inch represents approximately 16 miles) are available for all States except Alaska and Hawaii, which are covered by maps at other scales. For some States, topographic and shaded relief editions also are available. Maps of the United States are available in sizes and scales ranging from letter size, 1:16,500,000 scale, to a two-sheet wall map, 1:2,500,000 scale. Topographic maps of special format

are produced for many principal rivers and their flood plains. Land-use overlays are being prepared by the Topographic Division for the Geographic Applications Program of USGS's Land Information Analysis Office. Topographic-bathymetric maps are being produced and research in wetland mapping is being conducted.

The products mentioned in this section do not define the limits of the Topographic Division's functions. USGS is receptive to the needs of the map user and is prepared to undertake suitable new programs and special projects when they are needed. (See 1.6.3. for information on cooperative mapping programs.)

Detailed information on mapping programs in an area may be obtained from the following sources:

Alaska and Texas

Branch of Plans and Production
Rocky Mountain Mapping Center
U.S. Geological Survey
Denver Federal Center
Denver, Colorado 80225
Telephone: 303-234-3739

Atlantic Coast States, Alabama, Indiana, Ohio, Pennsylvania, Puerto Rico, and the Virgin Islands

Branch of Plans and Production
Eastern Mapping Center
U.S. Geological Survey
MS 559 National Center
Reston, Virginia 22092
Telephone: 703-860-6393

Illinois, Louisiana, Michigan, Minnesota, Mississippi, and Wisconsin

Branch of Plans and Production
Mid-Continent Mapping Center
U.S. Geological Survey
P.O. Box 133
Rolla, Missouri 65401
Telephone: 314-364-3680

Pacific Coast States, Hawaii, American Samoa, and Guam)

Branch of Plans and Production
Western Mapping Center
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025
Telephone: 415-323-2411

Entire Coastal Zone

Office of Plans and Program Development
U.S. Geological Survey
MS 514 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092
Telephone: 703-860-6706

National Cartographic Information Center
U.S. Geological Survey
MS 507 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092
Telephone: 703-860-6045

USGS has a revision program designed to update its standard products. Emphasis is given to the 7.5-minute topographic series because besides being the primary series it also is used to update other products. Each year a number of quadrangles are authorized for revision. The list of authorizations results from periodic review based on several categories.

The urbanized portions of the Standard Metropolitan Statistical Areas (SMSA) defined by the Bureau of the Census are considered first. It has been the practice to maintain maps in the urbanized portion of SMSA's on a five-year cycle.

The second category considered is that of quadrangles covering major airports. The Federal Aviation Administration (FAA) has expressed the need to maintain on a five-year cycle mapping within 10 nautical miles of approximately 600 selected airports.

Other categories considered (not necessarily in the order listed) are the following:

1. SMSA's extended (non-urban portion)
2. Coastal zone
3. A-16 multiple requests (quadrangles requested by other Federal agencies through Office of Management and Budget Circular A-16)
4. Cities and towns outside SMSA's
5. Energy areas
6. Parks and recreation areas
7. Transportation corridors

The Topographic Division is increasing emphasis on production and revision of map products in the coastal zone. The program is designed to provide users with accurate and up-to-date map products for the entire zone.

There are approximately 3,600 7.5-minute quadrangle areas that constitute the land portion of the coastal zone of the conterminous United States, Hawaii, and Puerto Rico. Of these, about 700 require new mapping and 2,000 need revision. Quick-respond products such as orthophotoquads and interim revisions will be provided for many coastal areas.

There are some exceptions to the normal review cycle. For example, a cooperative program may call for review of an area on a cycle which is shorter than the normal period based on the criteria mentioned. In such a case the area would not be subject to the usual consideration.

Plans call for maps in urban areas to be reviewed for revision on a five year cycle. Those in agricultural areas are to be reviewed every ten years. Maps of remote areas are to be reviewed every 20 years. This is not to say that all maps are revised upon review. Approximately 50 percent of those reviewed are found to warrant the expense of revision.

Research projects traditionally have played an important role in the overall mapping program of USGS. A cooperative effort between the Water Resources Division and the Topographic Division resulted in the mapping of the Wetlands on the Doboy Sound, Georgia, 7.5-minute quadrangle. The signature for the wetlands was derived by the Water Resources Division. Vegetation groupings were delineated using color infrared photographs. Orthophotoquad map bases (1:10,000 scale, format 2.50 min x 3.75 min) were prepared by the Topographic Division and the wetlands compilation was transferred. The experiment showed that remote sensing with field investigation to these bases can be used to delineate the defined wetlands. Two projects dealing with mapping and environmental assessments of wetlands are presently underway.

3. Cooperative programs with USGS and NOS

USGS performs work on cooperative projects which contribute to the National Mapping Program, including special products as well as the standard series. States (Commonwealths, or Territories), their political subdivisions, and their agencies may enter into cooperative agreements whereby map production is funded on a 50/50 basis between the State agency and the Federal Government. The cost of publication normally is borne by the Geological Survey. The effect of cooperative agreements is to expedite mapping of areas of particular interest to the cooperating agency, since these agreements enable the cooperators to participate in the selection of new projects. Present cooperators are listed in Appendix A. It should be noted that the list is by no means exclusive. Cooperative programs may be arranged with other organizations within the same jurisdictions.

On occasion other agencies enter into cost-sharing agreements with USGS for the purpose of completing only a portion of an operation. For example, an agency could agree to provide all or some of the funds necessary to produce a planimetric version of a topographic map, but it would not provide funds for the contouring of the standard map.

Where the work to be performed does not contribute directly to the National Mapping Program a repay program is possible. In these cases the work is performed by USGS, but the entire cost of the

project is paid by the requesting agency. The acceptance of a repay agreement would depend upon the nature of the work and the ability of USGS to fit it into its ongoing production schedule.

For information about applying for any of the above agreements one of the following offices should be contacted:

Alaska and Texas

Chief, Rocky Mountain Mapping Center
U.S. Geological Survey
Denver Federal Center
Denver, Colorado 80225
Telephone: 303-234-2351

Atlantic Coast States plus Alabama, Indiana, Pensylvania, Ohio, Puerto Rico, and the Virgin Islands

Chief, Eastern Mapping Center
U.S. Geological Survey
MS 567 National Center
Reston, Virginia 22092
Telephone: 703-860-6352

Illinois, Louisiana, Michigan, Minnesota, Mississippi, and Wisconsin

Chief, Mid-Continent Mapping Center
U.S. Geological Survey
P.O. Box 133
Rolla, Missouri 65401
Telephone: 314-364-3680

Pacific Coast (Includes Hawaii, American Samoa, and Guam)

Chief, Western Mapping Center
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94075
Telephone: 415-323-2411

Headquarters Office:

Chief, Topographic Division
U.S. Geological Survey
MS 516 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092
Telephone: 703-860-6231

USGS recognizes the need for providing technical assistance to other organizations, Federal, State, or private. Technical information in the form of mapping procedures and professional papers may be obtained from:

Technical Information Office
U.S. Geological Survey
MS 520 National Center
Reston, Virginia 22092
Telephone: 703-860-6275

The technical assistance program includes such services as providing technical instructions, accepting research projects on a repay basis, and training non-USGS personnel at the headquarters or at any of the five mapping centers across the country. Requests for arrangements such as these should be directed to:

Office of Research and Technical Standards
U.S. Geological Survey
MS 519 National Center
Reston, Virginia 22092
Telephone: 703-860-6291

(This section will be revised to include cooperative programs of NOS when input is received from that agency.)

In addition to publications such as the Coastal Zone Mapping Handbook, there are other cooperative programs between NOS and USGS. One of these projects is the topographic-bathymetric series. These maps will incorporate into one format and one edition the data previously shown separately on the USGS topographic map and the NOS bathymetric map of the area. The integrated product is designed to serve the cartographic needs of oceanographers, marine geologists, land-use planners, physical scientists, conservationists, and others having an interest in management of the coastal zone, the wetlands, and the off-shore environment.

A prototype of the topographic-bathymetric map was prepared of Beaufort, North Carolina at a scale of 1:250,000. Other maps have been authorized at that scale and at 1:100,000. Eventually such maps will be available at 1:24,000.

4. Sources of information about programs and activities in mapping and charting

The following offices are sources of information about the products of the particular agency which relate to the coastal zone:

Agricultural Stabilization and Conservation Service

Aerial Photography Field Office
Agricultural Stabilization and Conservation Service
2505 Parley's Way
Salt Lake City, Utah 84109
Telephone: 801-524-58567

Bonneville Power Administration

Information Office
Bonneville Power Administration
1002 NE Holliday Street
Portland, Oregon 97208
Telephone: 503-234-3361 X-5133

Bureau of Indian Affairs

Public Information Office
Bureau of Indian Affairs
1951 Constitution Avenue, NW.
Washington, D.C. 20245
Telephone: 202-343-7435

Bureau of Land Management

Cadastral Survey Division
Bureau of Land Management
1129 20th Street NW
Washington, D.C. 20240
Telephone: 202-343-5717

Bureau of Mines

Office of Technical Data Services
Bureau of Mines
Ballston Tower Number 3
4015 Wilson Boulevard
Arlington, Virginia 22209
Telephone: 703-557-1526

Bureau of Outdoor Recreation

Assistant Director - Federal Programs and Planning
Bureau of Outdoor Recreation
4415 Interior Building
18th and C Streets, NW.
Washington, D.C. 20040
Telephone: 202-343-7375

Bureau of Reclamation

Information Branch
Office of Public Affairs
Bureau of Reclamation
Room 7640 Interior Building
18th and C Streets NW
Washington, D.C. 20240
Telephone: 202-343-4662

Bureau of the Census

Geography Division
Bureau of the Census
Social and Economic Statistics Administration
Washington, D.C. 20233
Telephone: 301-763-2668

Defense Intelligence Agency

Maps and Charts Office
Central Reference Division
Defense Intelligence Agency
0040 B Building
Arlington Hall Station
Arlington Boulevard
Arlington, Virginia 22212

Defense Mapping Agency

Aerospace Center

Office of Information
Defense Mapping Agency, Aerospace Center
St. Louis Air Force Station
St. Louis, Missouri 63118
Telephone: 314-268-4142

Hydrographic Center

Public Information Officer
Defense Mapping Agency, Hydrographic Center
Suitland, Maryland 20390
Telephone: 202-763-1554

Topographic Center

Technical Director
Defense Mapping Agency, Topographic Center
124 Erskine Hall
6500 Brooks Lane
ATTN: 50000
Washington, D.C. 20315
Telephone: 301-227-2006

Delaware River Basin Commission

Executive Director
Delaware River Basin Commission
(25 State Police Drive)
Post Office Box 360
Trenton, New Jersey 08603
Telephone: 609-883-9500

Department of State

Office of the Geographer
Directorate for Research
Bureau of Intelligence and Research
8744 State Department Building
2201 C Street, NW.
Washington, D.C. 20520
Telephone: 202-632-1428

Energy Research and Development Administration

Public Affairs Director
Energy Research and Development Administration
7th and D Streets, __.
Washington, D.C. 20545
Telephone: 301-973-1000

Environmental Protection Agency

Communications Service Division
Office of Public Affairs
Environmental Protection Agency
401 M Street, SW.
Washington, D.C. 20460
Telephone: 202-755-0715

Federal Communications Commission

Public Information Officer
Federal Communications Commission
Room 202
1919 M Street, NW.
Washington, D.C. 20554
Telephone: 202-632-7260

Federal Highway Administration

Office of Public Affairs
Federal Highway Administration
Room 4208
400 7th Street, SW.
Washington, D.C. 20590
Telephone: 202-426-0677

Federal Power Commission

Office of Public Information
Federal Power Commission
825 North Capitol Street, NE.
Washington, D.C. 20426
Telephone: 202-386-6102

Federal Insurance Administration

Assistant Administrator for Flood Insurance
Federal Insurance Administration
Room 9240
451 7th Street, SW.
Washington, D.C. 20410
Telephone: 202-755-5581

Fish and Wildlife Service

Division of Realty
Fish and Wildlife Service
555 Matomic Building
1717 H Street, NW.
Washington, D.C. 20240
Telephone: 202-343-3193

Forest Service

Publications Office
Office of Information
Forest Service
U.S. Department of Agriculture
Washington, D.C. 20250
Telephone: 202-447-3957

International Boundary Commission

United States Commissioner
International Boundary Commission
United States and Canada
United States Section
Room 3810
441 G. Street, NW.
Washington, D.C. 20548
Telephone: 202-783-9151

International Boundary and Water Commission

United States Commissioner
International Boundary and Water Commission
United States and Mexico
United States Section
(4110 Rio Bravo, Executive Center)
P.O. Box 20003
El Passo, Texas 79998
Telephone: 915-543-7300

Mississippi River Commission

Executive Assistant
Mississippi River Commission
(Mississippi River Commission Building)
P.O. Box 80
Vicksburg, Mississippi 39180
Telephone: 601-636-1311 X-201

National Aeronatics and Space Administration

User Affairs Office
Office of Applications
National Aeronautics and Space Administration
236 Federal Office Building
600 Independence Avenue, SW.
Washington, D.C. 20546
Telephone: 202-755-8617

National Oceanic and Atmospheric Administration

Environmental Data Service

Director
Environmental Data Service
National Oceanic and Atmospheric Administration
2001 Wisconsin Avenue, NW
Washington, D.C. 20235
Telephone: 202-

Environmental Research Laboratories

Environmental Research Laboratories
National Oceanic and Atmospheric Administration
3100 Marine Avenue
Boulder, Colorado 80302
Telephone: 303-

National Ocean Survey

Public Information Officer
National Ocean Survey
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852
Telephone: 301-496-8708

National Park Service

Assistant to the Director-Public Affairs
National Park Service
3043 Interior Building
18th and C Streets, NW.
Washington, D.C. 20240
Telephone: 202-343-6843

Soil Conservation Service

Education and Publication Branch
Information Division
Soil Conservation Service
U.S. Department of Agriculture
Washington, D.C. 20250
Telephone: 202-447-5063

U.S. Army

Public Affairs Office
Office of the Chief of Engineers
Department of the Army
James Forrestal Building
Washington, D.C. 20314
Telephone: 202-693-6326

U.S. Air Force

Office of Information
Office of the Secretary
U.S. Air Force
The Pentagon
Washington, D.C. 20330
Telephone: 202-695-4602

U.S. Corps of Engineers

Maps and charts

Public Affairs Office
Office of the Chief of Engineers
Department of the Army
James Foresstal Building
Washington, D.C. 20314
Telephone: 202-693-6326

Photographs

Coastal Engineering Research Center
256 Kingman Building
Fort Belvoir, Virginia 22060
Telephone: 202-325-7000

U.S. Coast Guard

Public Affairs Division
Office of Public and International Affairs
U.S. Coast Guard
400 7th Street, SW
Washington, D.C. 20590
Telephone: 202-426-1587

U.S. Geological Survey

General Cartographic Information

Information Unit
National Cartographic Information Center
U.S. Geological Survey
MS 507 National Center
Reston, Virginia 22092

Map Information

Public Inquiries Office*
U.S. Geological Survey
108 Skyline Building
508 2nd Avenue
Anchorage, Alaska 99501
Telephone 907-277-0577

Public Inquiries Office**
U.S. Geological Survey
7638 Federal Building
300 North Los Angeles Street
Los Angeles, California 90012
Telephone: 213-688-2850

Public Inquiries Office**
U.S. Geological Survey
504 Custom House
555 Battery Street
San Francisco, California 94111
Telephone: 415-556-5627

Public Inquiries Office**
U.S. Geological Survey
602 Thomas Building
1314 Wood Street
Dallas, Texas 75202
Telephone: 214-749-3230

Public Inquiries Office
U.S. Geological Survey
1036 General Services Building
19th and F Streets, NW.
Washington, D.C.
Telephone: 202-343-8073

Public Inquiries Office
U.S. Geological Survey
MS 302 National Center
Reston, Virginia 22092
Telephone: 703-860-6167

Public Inquiries Office**
Publications Division
U.S. Geological Survey
678 U.S. Court House
West 920 Riverside Avenue
Spokane, Washington 99201
Telephone: 509-838-4611 X-111

* Area of concern is limited to Alaska
** Area of concern is limited to the States within the particular region of the country. The Los Angeles and San Francisco offices provide information on Hawaii.

Technical Information

Technical Information Office
U.S. Geological Survey
MS 520 National Center
Reston, Virginia 22092
Telephone: 703-860-6275

Photographic Information

User Services Unit
EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198
Telephone: 605-594-6511

U.S. Marine Corps

See U.S. Navy

U.S. Navy

Research and Public Queries Office
Public Information Division
Office of Information
U.S. Navy
The Pentagon
Washington, D.C. 20350
Telephone: 202-695-0965

For assistance and advice on State mapping programs contact the State representatives listed in Appendixes A, B, and C. These sources should be able to provide some information about municipal and private mapping efforts within their respective States. Other sources of information about private mapping and aerial surveying companies are the professional societies listed in Appendix D.

7. Product and Data Sources (USGS)

1. Available products and data

Maps, charts and related data which may be helpful to coastal zone management personnel are listed in this section. The column headed "Agency" indicates the publishing agency or the organization which has compiled the data. The column headed "Available From" indicates the agency(ies) from which the data may be obtained. Addresses of information offices and distribution offices are found in 1.6.4. and 1.7.3, respectively. Abbreviations used in this section are explained in 1.7.2. Photocopies of published Federal maps may be obtained from the Geography and Map Division of The Library of Congress, 845 South Pickett Street, Alexandria, Virginia 22304.

Products	Agency	Available From
Aeronautical charts	DMAAC	NOS
	NOS	NOS
Boundary information		
U.S. and Canada	IBC	IBC
U.S. and Mexico	IBWC	IBWC
Boundary and annexation surveys of incorporated places with 2,500 or more inhabitants	BC	GPO
Civil subdivisions	BLM	BLM
State/Federal	DOS	DOS
Census data (social and economic statistics)	BC	GPO

Products	Agency	Available From
Federal property		
Bureau of Reclamation	BR	BR
Energy Research and Development Administration (Atomic Energy Commission)	ERDA	ERDA
Fish and Wildlife Service	FWS	FWS
National Aeronautics and Space Administration	NASA	NASA
National forests	FS	FS
National Park Service	NPS	NPS
Military reservations:		
Air Force	USAF	USAF
Army	USA	USA
Coast Guard	USCG	USCG
Marines	USMC	USMC
Navy	USN	USN
State map of lands administered by Bureau of Land Management	BLM	BLM
U.S. map of lands administered by Bureau of Land Management	BLM	GPO
Flood plain maps	DRBC	DRBC
	FIA	NFIA
	MRC	MRC
	SCS	SCS
	USCE	USCE
	USGS	USGS

Products	Agency	Available From
Geologic:		
Coal investigations	USGS	USGS
General Geologic	ERDA	ERDA
	SGA	SGA
	USGS	USGS
Geophysical investigations	USGS	USGS
Mineral investigations	USGS	USGS
Mines	BM	BM
Oil and gas investigations	USGS	USGS
Soils	SCS	SCS
Soils - substation quality	BPA	BPA
Geographic	DMAHC	DMAHC
	NOS	NOS
Land-use	USGS	USGS
Highways		
County	FHWA	FHWA
Indian lands	BIA	BIA
Federal lands	FHWA	FHWA
Federally funded roads	FHWA	FHWA
Federal primary and secondary	FHWA	FHWA
Interstate	FHWA	FHWA
Traffic flow	FHWA	FHWA

Products	Agency	Available From
Urban	FHWA	FHWA
Federal Highway Map of U.S.	FHWA	GPO
Historical	LC	LC
	All Federal	NA
Hydrographic		
Bathymetric	DMAHC	DMAHC
	NOS	NOS
	USCE	USCE
	USCG	USCG
	USGS	USGS
	USN	USN
Coastal data		
Beach erosion	USCE	USCE
Coastal boundary planimetric maps	NOS	NOS
Coastal U.S. shoreline survey maps	NOS	NOS
Delaware River Basin outline map	DRBC	DRBC
Estuarine coastline measurement maps	EPA	EPA
Outer continental shelf diagrams and resource management maps	BLM	BLM
Shellfish area mapping	EPA	EPA
Water quality - digital data	EPA	EPA
Great Lakes	NOS	NOS

Products	Agency	Available From
Hydrographic surveys	DMAHC	DMAHC
	USGS	USGS
Nautical charts	NOS	NOS
	USCE	USCE
	USCG	USCG
	USN	DMA/HC
Navigable waterways maps	USCE	USCE
Navigational charts	USCE	USCE
River and stream surveys	MRC	MRC
River basin watershed studies	FPC	FPC
River surveys	BR	BR
	USGS	USGS
Wildlife and scenic river jurisdiction	BLM	BLM
Geodetic control data	NGS	NGS
	USGS	NGS/NCIC
Hydrologic investigation atlases	USGS	USGS
Indian reservations		
Land surveys	BIA	BIA
U.S. map of Indian lands	BIA	GPO
Land plats	BLM	BLM/NA
	NPS	NPS
	USCE	USCE
National Atlas of U.S.	USGS	USGS

Products	Agency	Available From
Photographic Products		
Aerial Photos	ASCS	ASCS
	BLM	BLM/EDC
	BPA	BPA
	DIA	DIA
	NASA	EDC
	FHWA	FHWA
	FS	NCIC/EDC
	FWS	NCIC/EDC
	NOS	NOS
	NPS	NPS
	SCS	SCS
	USCE	USCE
	USGS	USGS
	USGS	NCIC/EDC
Orthophotomaps	BIA	BIA
	USGS	USGS
Space Photos		
LANDSAT (ERTS)	NASA	EDC/ASCS/EDS
NASA manned spacecraft	NASA	EDC
Skylab	NASA	EDC/ASCS
Recreation	BLM	BLM
	BOR	BOR

Products	Agency	Available From
Seismicity	ERL	ERL
Topographic maps	USGS	USGS
	DMATC	DMATC
	MRC	MRC
	NASA	NASA
	USCE	USCE
	USGS	USGS
Utilities		
Ground conductivity map of U.S.	FCC	GPO
Major natural-gas-pipelines map of U.S. 1:19,000,000	FPC	GPO
Principal electric-facilities map of U.S.	FPC	GPO
Principal natural-gas-pipelines map of U.S. 1:3,301,600	FPC	GPO
Water resources development	USGS	USGS
Miscellaneous data		
Gravity survey charts	USN	USN
Income distribution maps	BC	GPO
Isomagnetic charts	NOS	NOS
Magnetic charts	EDS	EDS
National-science-trail maps	SCS	SCS
Slope maps	USGS	USGS

Products	Agency	Available From
State indexes of fish hatcheries and national wildlife refuges	FWS	FWS
Storm evacuation maps	NOS	NOS
Tree danger (to power lines) detection map	BPA	BPA
U.S. location map of fish hatcheries and national wildlife refuges	FWS	FWS

2. Explanation of abbreviations used in I.6 and I.7

ASCS	Agricultural Stabilization and Conservation Service
BC	SESA/Bureau of the Census
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM	Bureau of Mines
BPA	Bonneville Power Administration
BOR	Bureau of Outdoor Recreation
BR	Bureau of Reclamation
DIA	Defense Intelligence Agency
DMAAC	Defense Mapping Agency Aerospace Center
DMAHC	Defense Mapping Agency Hydrographic Center
DMATC	Defense Mapping Agency Topographic Center
DOS	Department of State
DRBC	Delaware River Basin Commission
EDC	USGS/Earth Resources Observation Systems (EROS) Data Center
EDS	NOAA/Environmental Data Service
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ERL	NOAA/Environmental Research Laboratories
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FIA	Federal Insurance Administration
FPC	Federal Power Commission
FS	Forest Service
FWS	Fish and Wildlife Service
GPO	Government Printing Office
IBC	International Boundary Commission
IBWC	International Boundary and Water Commission
LC	Library of Congress
MRC	Mississippi River Commission
NA	National Archives
NASA	National Aeronautics and Space Administration
NCIC	USGS/National Cartographic Information Center
NFIA	National Flood Insurers Association
NGSIC	NOAA/NOS/National Geodetic Survey Information Center

NOS	NOAA/National Ocean Survey
NPS	National Park Service
SCS	Soil Conservation Service
SGA	State Geologic Agencies
USA	U.S. Army
USAF	U.S. Air Force
USCE	U.S. Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USMC	U.S. Marine Corps
USN	U.S. Navy

3. Distribution points for maps, charts, and related data

Agricultural Stabilization and Conservation Service

Aerial Photography Field Office
Agricultural Stabilization and Conservation Service
2505 Parley's Way
Salt Lake City, Utah 84109
Telephone: 801-524-5856

Bonneville Power Administration

Bonneville Power Administration
(1002 NE Holladay Street)
P.O. Box 3621
Portland, Oregon 97208
Telephone: 503-234-3361

Bureau of Indian Affairs

Bureau of Indian Affairs
1951 Constitution Avenue, NW
Washington, D.C. 20245
Telephone: 202-343-7435

Bureau of Land Management

Alaska State Office

Bureau of Land Management
555 Cordova Street
Anchorage, Alaska 99501
Telephone: 907-277-1561

California State Office

Bureau of Land Management
E-2841 Federal Office Building
2800 Cottage Way
Sacramento, California 95825
Telephone: 916-484-4724

Eastern States Office

Bureau of Land Management
7981 Eastern Avenue
Silver Spring, Maryland 20910
Telephone: 301-427-7440

Oregon State Office

Bureau of Land Management
729 Northeast Oregon Street
P.O. Box 2965
Portland, Oregon 97208
Telephone: 503-234-4024

Western States Office

Denver Services Center
Bureau of Land Management
Building 50
Denver Federal Center
Denver, Colorado 80225
Telephone: 303-234-2204

Outer Continental Shelf Offices:

Alaska Office

Outer Continental Shelf Office
Bureau of Land Management
121 West Fireweed Lane
Anchorage, Alaska 99510
Telephone: 907-279-4578

Atlantic Office

Outer Continental Shelf Office
Bureau of Land Management
90 Church Street
New York, New York 10007
Telephone: 212-264-2754

Gulf Office

Outer Continental Shelf Office
Bureau of Land Management
1001 Howard Avenue
New Orleans, Louisiana 70113
Telephone: 504-527-6541

Pacific Office

Outer Continental Shelf Office
Bureau of Land Management
300 North Los Angeles Street
Los Angeles, California 90012
Telephone: 213-688-7234

Bureau of Mines

Mine Map Repository
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4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213
Telephone: 412-621-4500

Mine Map Repository
Bureau of Mines
Denver Federal Center
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Telephone: 303-224-4119

Environmental Affairs Field Office
Bureau of Mines
Wilkes-Barre, Pennsylvania 18701
Telephone: 717-825-6811

Bureau of Outdoor Recreation

Federal Land Acquisition Division
Bureau of Outdoor Recreation
4223 Interior Building
18th and C Streets, NW
Washington, D.C. 20240
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Bureau of Reclamation

Chief, Publications and Photography Branch
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Bureau of Reclamation
7442 Interior Building
18th and C Streets, NW
Washington, D.C. 20240
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Bureau of the Census

Users Services Staff
Data Users Services Division
Bureau of the Census
Washington, D.C. 20233
Telephone: 301-763-5146

Defense Intelligence Agency

Maps and Charts Office
Central Reference Division
Defense Intelligence Agency
0040 B Building
Arlington Hall Station
4000 Arlington Boulevard
Arlington, Virginia 22212

Defense Mapping Agency

Hydrographic Center

Distribution Department
Defense Mapping Agency, Hydrographic Center
Suitland, Maryland 20390
Telephone: 202-763-1280

Topographic Center

Defense Mapping Agency, Topographic Center
ATTN: 55230
6500 Brooks Lane
Washington, D.C. 20315
Telephone: 301-227-2497

Delaware River Basin Commission

Office of the Executive Director
Delaware River Basin Commission
(25 State Police Drive)
Post Office Box 360
Trenton, New Jersey 08603
Telephone: 609-883-9500

Department of State

Office of the Geographer
Directorate for Research
Bureau of Intelligence and Research
8744 State Department Building
2201 C Street, NW.
Washington, D.C. 20520
Telephone: 202-632-1428

Energy Research and Development Administration

Public Affairs Director
Energy Research and Development Administration
7th and D Streets, SW.
Washington, D.C. 20545
Telephone: 301-973-1000

Environmental Protection Agency

Communications Services Division
Office of Public Affairs
Environmental Protection Agency
401 M Street, SW.
Washington, D.C. 20460
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Federal Communications Commission

Printing Branch
Administrative Services Division
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Office of Public Affairs
Federal Highway Administration
Room 4208
400 7th Street, SW.
Washington, D.C. 20590
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Aerial Surveys Branch
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Room 3130A
400 7th Street, SW.
Washington, D.C. 20590
Telephone: 202-426-0296

Federal Insurance Administration

Assistant Administrator for Flood Insurance
Federal Insurance Administration
Room 9240
451 7th Street, SW.
Washington, D.C. 20410
Telephone: 202-755-5581

Fish and Wildlife Service

Division of Realty
Fish and Wildlife Service
Washington, D.C. 20240
Telephone: 202-343-3193

Forest Service

Region 5 (California)

Headquarters, California Region
Forest Service
630 Sansome Street
San Francisco, California 94111
Telephone: 415-556-7739

Region 6 (Oregon and Washington)

Headquarters, Northwest Region
Forest Service
(319 SW Pine Street)
P.O. Box 3623
Portland, Oregon 97208
Telephone: 503-221-3614

Region 8 (Alabama, Georgia, Florida, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Texas, and Virginia)

Headquarters, Southern Region
Forest Service
1720 Peachtree Road, NW.
Atlanta, Georgia 30309
Telephone: 404-526-3749

Region 9 (Connecticut, Delaware, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, and Wisconsin)

Headquarters, Eastern Region
Forest Service
710 N. 6th Street
Milwaukee, Wisconsin 53203
Telephone: 414-224-3193

Region 10 (Alaska)

Headquarters, Alaska Region
Forest Service
(Federal Office Building)
P.O. Box 1628
Juneau, Alaska 99801
Telephone: 907-586-7266

Government Printing Office

Superintendent of Documents
U.S. Government Printing Office
North Capitol and H Streets, NW
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International Boundary Commission

U.S. Commissioner
International Boundary Commission
United States and Canada
United States Section
Room 3810
441 G Street, NW.
Washington, D.C. 20548
Telephone: 202-783-9151

International Boundary and Water Commission

United States Commissioner
International Boundary and Water Commission
United States and Mexico
United States Section
(4110 Rivo Bravo, Executive Center)
P.O. Box 20003
El Paso, Texas 79998
Telephone: 915-543-7300

Library of Congress

Geography and Map Division
Library of Congress
845 South Picket
Alexandria, Virginia 22304
Telephone: 202-370-1335

Mississippi River Commission

Executive Assistant
Mississippi River Commission
(Mississippi River Commission Building)
P.O. Box 80
Vicksburg, Mississippi 39180
Telephone: 601-636-1311 X-201

National Aeronautics and Space Administration

Contact the facility office of the installation concerned.

National Archives

Cartographic Archives Division
National Archives and Records Service
Archives Building
Pennsylvania Avenue at 8th Street, NW.
Washington, D.C. 20408
Telephone: 202-962-3181

National Flood Insurers Association (servicing companies)

Alabama and Georgia

The Hartford Insurance Group
Hartford Building
100 Edgewood Avenue
Atlanta, Georgia 30301
Telephone: 404-521-2059

Alaska

Industrial Indemnity Company of Alaska
P.O. Box 307
Anchorage, Alaska 99510
Telephone: 907-279-9441

California

Northern

Fireman's Fund American Insurance Companies
P.O. Box 3136
San Francisco, Califronia 94119
Telephone: 415-421-1676

Southern

Fireman's Fund American Insurance Companies
P.O. Box 2323
Los Angeles, California 90051
Telephone: 213-381-3141

Connecticut

Aetna Insurance Company
P.O. Box 1779
Hartford, Connecticut 06101
Telephone: 203-523-4861

Delaware

General Accident Fire and Life Assurance Corporation, Ltd.
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Philadelphia, Pennsylvania 19106
Telephone: 215-238-5000

Florida

The Travelers Indemnity Company
1516 East Colonial Drive
Orlando, Florida 32803
Telephone: 305-896-2001

Georgia

See Alabama

Hawaii

First Insurance Comapnay of Hawaii, Ltd.
P.O. Box 2866
Honolulu, Hawaii 96803
Telephone: 808-548-5115

Illinois

Illinois Regional Office
State Farm Fire and Casualty Company
2309 East Oakland Avenue
Bloomington, Illinois 61701
Telephone: 309-557-7211

Indiana

United Farm Bureau Mutual Insurance Company
130 East Washington Street
Indianapolis, Indiana 46204
Telephone: 317-263-7200

Louisiana

Aetna Technical Services, Inc.
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New Orleans, Louisiana 70160
Telephons: 504-821-1511

Maine

Commercial Union Insurance Company
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Box 527 Pearl Street Station
Portland, Maine 04116
Telephone: 207-774-1431

Maryland

United States Fidelity and Guaranty Company
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Baltimore, Maryland 21203
Telephone: 301-539-0380

Massachusetts and New Hampshire

Commercial Union Insurance Company
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Boston, Massachusetts 02108
Telephone: 617-725-6128

Michigan

Insurance Company of North America
300 Buhl Building
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Detroit, Michigan 48226
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Minnesota

The St. Paul Fire and Marine Insurance Company
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St. Paul, Minnesota 55165
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Mississippi

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Jackson, Mississippi 39205
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New Hampshire

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New Jersey and New York

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New York

See New Jersey

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San Juan, Puerto Rico 00902
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South Carolina

Maryland Casualty Company
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The Home Insurance Company
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Telephone: 713-225-0931

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Insurance Company of North America
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Washington, D.C. 20015
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Washington

Fireman's Fund American Insurance Companies
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6th and Stewart
Seattle, Washington 98101
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Wisconsin

Aetna Insurance Company
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Chicago, Illinois 60631
Telephone: 312-693-2500

National Oceanic and Atmospheric Administration

Environmental Data Service

National Climatic Center
Environmental Data Services
National Oceanic and Atmospheric Administration
Federal Building
Asheville, North Carolina 28801
Telephone: 704-

National Oceanographic Data Center
Environmental Data Service
National Oceanic and Atmospheric Administration
3300 Whitehaven Street, NW
Washington, D.C. 20235
Telephone: 202-655-4000

Environmental Research Laboratories

Environmental Research Laboratories
National Oceanic and Atmospheric Administration
3100 Marine Avenue
Boulder, Colorado 80302
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National Ocean Survey

Charts

Distribution Division, C-44
National Ocean Survey
National Oceanic and Atmospheric Administration
Riverside, Maryland 20840
Telephone: 301-436-6990

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Coastal Mapping Division, C3415
National Ocean Survey
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852
Telephone: 301-

Control Data

National Geodetic Survey Information Center, CI8
National Ocean Survey
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852
Telephone: 301-496-8631

National Park Service

Assistant to the Director--Public Affairs
National Park Service
3043 Interior Building
18th and C Streets, NW.
Washington, D.C. 20240
Telephone: 202-343-6843

Soil Conservation Service

Soil Geography Unit
Soil Survey Investigations Division
Soil Conservation Service
Washington, D.C. 20250
Telephone: 202-436-8587

Cartographic Division
Soil Conservation Service
Washingaton, D.C. 20250
Telephone: 202-447-6923

Publications Distribution Unit
Education and Publication Branch
Information Division
Soil Conservation Service
Washington, D.C. 20250
Telephone: 202-447-5157

State Geologic Agencies

Alabama

Geological Survey of Alabama
P.O. Drawer O
University, Alabama 35486
Telephone: 205-759-5721

Alaska

Division of Geological and Geophysical Sciences
Department of Natural Resources
3001 Porcupine Drive
Anchorage, Alaska 99504
Telephone: 927-586-6352

California

Division of Mines and Geology
California Department of Conservation
118 Resources Building
1416 9th Street
Sacramento, California 95814
Telephone: 916-445-1825

Connecticut

Department of Environmental Protection
561 State Office Building
Hartford, Connecticut 06115
Telephone: 203-566-3540

Delaware

Delaware Geological Survey
University of Delaware
101 Penny Hall
Newark, Delaware 19711
Telephone: 302-738-2833

Florida

Bureau of Geology
Department of Natural Resources
903 West Tennessee Street
Tallahassee, Florida 32302
Telephone: 904-488-4191

Georgia

Earth and Water Division
Georgia Department of Natural Resources
19 Hunter Street, SW.
Atlanta, Georgia 30334
Telephone: 404-656-3214

Hawaii

Division of Water and Land Development
Department of Land and Natural Resources
P.O. Box 373
Honolulu, Hawaii 96809
Telephone: 808-548-2211

Illinois

Illinois State Geological Survey
Natural Resources Building
Urbana, Illinois 61801
Telephone: 217-344-1481

Indiana

Geological Survey
Department of Natural Resources
611 North Walnut Grove
Bloomington, Indiana 47401
Telephone: 812-337-2862

Louisiana

Louisiana Geological Survey
Box G, University Station
Baton Rouge, Louisiana 70803
Telephone: 504-348-2201

Maine

Maine Geological Survey
Department of Forestry
State Office Building
Augusta, Maine 04330
Telephone: 207-289-2801

Maryland

Maryland Geological Survey
Latrobe Hall
Johns Hopkins University
Baltimore, Maryland 21218
Telephone: 301-235-0771

Massachusetts

State Geologist
Research and Materials Division
Massachusetts Department of Public Works
99 Worcester Street
Wellesley, Massachusetts 02181
Telephone: 617-237-9110

Michigan

Geological Survey Division
Michigan Department of Natural Resources
Stevens T. Mason Building
Lansing, Michigan 48926
Telephone: 517-373-1256

Minnesota

Minnesota Geological Survey
University of Minnesota
1633 Eustis Street
St. Paul, Minnesota 55108
Telephone: 612-373-3372

New Hampshire

Geologic Branch
Department of Geology
Department of Resources and Economic Development
James Hall
University of New Hampshire
Durham, New Hampshire 03824
Telephone: 603-862-1216

New Jersey

New Jersey Bureau of Geology and Topography
Division of Natural Resources
(709 John Fitch Plaza)
P.O. Box 1889
Trenton, New Jersey 08625
Telephone: 609-292-2576

New York

Geological Survey
New York State Museum and Science Service
973 New York State Education Building
Albany, New York 12224
Telephone: 518-474-5816

North Carolina

Office of Earth Resources
Department of Natural and Economic Resources
P.O. Box 27687
Raleigh, North Carolina 27611
Telephone: 919-829-3833

Ohio

Division of Geological Survey
Ohio Department of Natural Resources
Fountain Square
Columbus, Ohio 43224
Telephone: 614-469-5344

Oregon

State Department of Geology and Mineral Industries
1069 State Office Building
Portland, Oregon 97201
Telephone: 503-229-5580

Pennsylvania

Bureau of Topographic and Geological Survey
Department of Environmental Resources
Towne House Apartments
660 Boas Street
Harrisburg, Pennsylvania 17120
Telephone: 717-787-2169

South Carolina

Division of Geology
South Carolina State Development Board
Harbison Forest Road
Columbia, South Carolina 29210
Telephone: 803-758-6431

Texas

Bureau of Economic Geology
University of Texas at Austin
University Station, Box X
Austin, Texas 78712
Telephone: 512-471-1534

Virginia

Division of Mineral Resources
Department of Conservation and Economic Development
(Natural Resources Building)
P.O. Box 3667
Charlottesville, Virginia 22903
Telephone: 804-293-5121

Washington

Geologic and Earth Resources Division
Department of Natural Resources
Olympia, Washington 98504
Telephone: 206-753-7183

Wisconsin

Wisconsin Geological and Natural History Survey
University of Wisconsin
1815 University Avenue
Madison, Wisconsin 53706
Telephone: 608-262-1705

U.S. Army

Contact the Commander of the base concerned.

U.S. Air Force

Contact the information officer of the base concerned.

U.S. Corps of Engineers

Minnesota, Wisconsin (Lake Superior), and Michigan (Western half of Upper Peninsula)

U.S. Army Engineer District, St. Paul
1210 U.S. Post Office and Customs House
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Detroit, Michigan 48231
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Buffalo, New York 14207
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Long Island, New York City Area, and Northern New Jersey

U.S. Army Engineer District, New York
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Telephone: 212-264-0100

Southern New Jersey and Delaware

U.S. Army Engineer District, Philadelphia
U.S. Customs House
2nd and Chestnut Street
Philadelphia, Pennsylvania 19106
Telephone: 215-597-4848

Maryland

U.S. Army Engineer District, Baltimore
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P.O. Box 1715
Baltimore, Maryland 21203
Telephone: 301-962-4545

Virginia

U.S. Army Engineer District, Norfolk
803 Front Street
Norfolk, Virginia 23510
Telephone: 804-625-8201

North Carolina

U.S. Army Engineer District, Wilmington
(308 Federal Building)
P.O. Box 1890
Wilmington, North Carolina 28401
Telephone: 919-763-9971

South Carolina (Savannah River Basin Excluded)

U.S. Army Engineer District, Charleston
(Federal Building, 334 Meeting Street)
P.O. Box 919
Charleston, South Carolina 29402
Telephone: 803-577-4171

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U.S. Army Engineer District, Savannah
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P.O. Box 889
Savannah, Georgia 31402
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Florida Peninsula and Puerto Rico

U.S. Army Engineer District, Jacksonville
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Jacksonville, Florida 32201
Telephone: 904-791-2241

Mississippi, Alabama, and Florida Panhandle

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P.O. box 2288
Mobile, Alabama 36628
Telephone: 205-690-2511

Louisiana

U.S. Army Engineer District, New Orleans
(Foot of Prytania Street)
P.O. Box 60267
New Orleans, Louisiana 70160
Telephone: 504-865-1121

Texas

U.S. Army Engineer District, Galveston
(155A Essayons Building)
(400 Barracuda Avenue)
P.O. Box 1229
Galveston, Texas 77550
Telephone: 713-763-1211

Southern California

U.S. Army Engineer District, Los Angeles
(300 North Los Angeles Street)
P.O. Box 2711
Los Angeles, California 90053
Telephone: 213-688-5300

Northern and Central California

U.S. Army Engineer District, San Francisco
100 McAllister Street
San Francisco, California 94102
Telephone: 415-556-3660

Oregon and Columbia River Basin of Washington

U.S. Army Engineer District, Portland
(2850 S.E. 82nd Avenue)
P.O. Box 2946
Portland, Oregon 97208
Telephone: 503-777-4441

Washington (Columbia River Basin Excluded)

U.S. Army Engineer District, Seattle
4735 East Marginal Way South
Seattle, Washington 98134
Telephone: 206-764-3690

Alaska

U.S. Army Engineer District, Alaska
(Building 21-700)
(Elmendorf Air Force Base)
P.O. Box 7002
Anchorage, Alaska 99510
Telephone: 907-752-9114

Hawaii, American Samoa, Guam

From locations outside Hawaii

U.S. Army Engineer District, Honolulu
Pacific Ocean Division
APO San Francisco 96558
Telephone: 808-422-2711

From locations in Hawaii

U.S. Army Engineer Division, Pacific Ocean
(Building 230)
Fort Shafter
Honolulu, Hawaii 96823
Telephone: 808-422-2711

U.S. Coast Guard

Oceanographic Unit
U.S. Coast Guard
Building 159E, Washington Navy Yard Annex
Washington, D.C. 20390
Telephone: 202-426-4630

U.S. Geological Survey

Maps by mail

Alaska

Distribution Section
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Fairbanks, Alaska 99701
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Branch of Distribution
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Arlington, Virginia 22202
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Branch of Distribution
Publications Division
U.S. Geological Survey
Federal Center
Denver, Colorado 80225
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Public Inquiries Office
Publications Division
U.S. Geological Survey
108 Skyline Building
508 2nd Avenue
Anchorage, Alaska 99501
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Alaska (Selected)

Public Inquiries Office
Publications Division
U.S. Geological Survey
1012 Federal Building
1961 Stout Street
Denver, Colorado 80202
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Alaska, California, Washington, Oregon, and Hawaii

Public Inquiries Office
Publications Division
U.S. Geological Survey
7638 Federal Building
300 North Los Angeles Street
Los Angeles, California 90012
Telephone: 213-688-2850

Public Inquiries Office
Publications Division
U.S. Geological Survey
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San Francisco, California 94111
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Alaska (Selected), Oregon, and Washington

Public Inquiries Office
Publications Division
U.S. Geological Survey
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Spokane, Washington 99201
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Louisiana and Texas

Public Inquiries Office
Publications Division
U.S. Geological Survey
602 Thomas Building
1314 Wood Street
Dallas, Texas 75202
Telephone: 214-749-3230

Entire coastal zone

Public Inquiries Office
Publications Division
U.S. Geological Survey
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Washington, D.C. 20242
Telephone: 202-343-8073

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User Services Unit
EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198
Telephone: 605-594-6511

Photographs and control data

Information Unit
National Cartographic Information Center
U.S. Geological Survey
MS 507 National Center
(12201 Sunrise Valley Drive)
Reston, Virginia 22092
Telephone: 703-860-6045

U.S. Marine Corps

Contact the commander of the base concerned.

U.S. Navy

Contact the commander of the base concerned.

PART II

TECHNICAL PROCEDURES AND PRODUCTS

I. Datums (NOS)

A fundamental concept in surveying, charting, and mapping over a large area is the establishment of appropriate datums (Reference 19). To the professionals most intimately involved, i.e., cartographers, geodesists, hydrographers, photogrammetrists and topographers, there are few things as important as datums. Without datums, their work would be almost meaningless, somewhat similar to the gibberish mouthed by a child who has not yet learned to talk.

A datum is any numerical or geometrical quantity or set of such quantities which may serve as a reference or base for other quantities (Reference 14). The different kinds and types of datums are defined and described, and their applications briefly discussed, in this chapter. Datums and the subjects of the next two chapters, Control, and Projections and Grid Systems comprise the framing to which horizontal and vertical control attach the bathymetric, planimetric, topographic, and other detail, both natural and cultural.

1. Kinds of Datums

The two basic datums are horizontal and vertical. A horizontal datum is fundamental to an efficient and effective program of surveying, charting, and mapping in the coastal zone. Similarly, the appropriate vertical datum is fundamental to topographic maps, and bathymetric and nautical charts, and many coastal zone maps. Thematic maps which do not depict boundaries or other features

dependent upon tidal datums, are not affected by the availability, of vertical datums.

A horizontal datum is defined by five quantities: the latitude and longitude of an initial point; the azimuth of a line from that point; and the two constants needed to define the sphere of reference. In the conterminous United States and Alaska, the horizontal datum in current use is called the North American Datum of 1927; the sphere of reference is the Clarke Spheroid (1866). Various other datums are used for the State of Hawaii, the Commonwealth of Puerto Rico, and the island territories, all of them on the Clarke Spheroid (1866). They are:

Hawaii	Hawaii Datum and Old Hawaii Datum
Puerto Rico	Puerto Rican Datum
Virgin Islands	Puerto Rican Datum
Guam	Guam Datum

Although the terms "geodetic datum," "geographic datum," and "horizontal datum," are used the preferred terminology is geodetic horizontal datum. Geographic is technically correct as is horizontal but geodetic allows ambiguity to enter because a geodetic datum could be a vertical datum. "Geodetic horizontal datum" is specific and unambiguous.

Arrival of the space age emphasized the inaccuracies known to exist in the adopted spheroid of reference. At the same time,

however, the means became available to acquire, process, and utilize the data essential to make a more accurate determination of the dimensions of the Earth. The data has been acquired and is now being processed to create a new geodetic horizontal datum which will be based on dimensions that agree more closely with the real shape and size of the Earth. All geodetic horizontal control will be readjusted on the new datum. The new datum and associated data are expected to be available in the mid-1980's. There will be no immediate and significant effect on charting and mapping activities in the coastal zone.

A vertical datum is the surface to which heights, elevations, or depths are referred. It may be a geodetic datum, a leveling datum, or a tidal datum insofar as coastal zone charting and mapping are concerned. Contours depicting terrain relief on maps of the National Topographic Series in the conterminous States are referred to the National Geodetic Vertical Datum of 1929. Various other geodetic datums are used in the other States and territories, each usually based on a tidal datum at a nearby tide station. A leveling datum, the International Great Lakes Datum (1955) serves as the reference surface for operations required to meet charting and mapping responsibilities of the NOAA, National Ocean Survey in the Great Lakes region. Depths on bathymetric and nautical charts of tidal waters usually are referred to a tidal datum. Occasionally a special datum is more suitable because of conditions unique to a locality. These datums generally are based on a tidal datum.

All elevations in the National Vertical Control Network are referred to the National Geodetic Vertical Datum of 1929. These elevations are used in most topographic mapping, geodesy, engineering studies, construction work, and other similar activities. They have no direct application in any coastal-zone mapping function involving a boundary which is dependent upon a tidal datum in tidal water, or a lake level in the Great Lakes regions. The result of the 1929 general adjustment of the United States and Canadian leveling networks, was formerly called the Sea Level Datum of 1929. Engineers, scientists, surveyors, and many other professionals developed the erroneous practice of considering the datum as mean sea level. It is not. This datum is based on mean sea level at 26 tide stations in the United States and Canada, and represents the best fit over a broad area. The relationship between the Sea Level Datum and local mean sea level is not consistent from one place to another because of the many variables which affect the atter. Under no circumstances should the National Geodetic Vertical Datum be confused with mean sea level. Both the National Geodetic Vertical Datum of 1929 and the National Vertical Control Network are applicable only to the conterminous United States. Various geodetic datums are used in Alaska, Puerto Rico, the Virgin Islands, Hawaii, Guam, and other oceanic islands. Wherever practical a tidal datum, usually local mean sea level, is adopted.

Established jointly with the Dominion of Canada, the International Great Lakes Datum (1955) is the basic datum for charting water

depths of the Great Lakes and connecting waterways. The datum is utilized by the NOS/Lake Survey Center in nearly all other operations, related to the Great Lakes, for which a vertical datum is required. Although there are bench marks common to the International Great Lakes Datum and the National Geodetic Vertical Datum of 1929, the two datums are not entirely the same. The International Great Lakes Datum is a leveling base, but not a geodetic foundation.

Tidal datums are base elevations defined by a certain phase of the tide and used as a reference from which heights and depths are reckoned. They are local datums that should not be extended into adjacent areas due to the changes in tidal datums, which can be caused by differences in basin topography. Mean high water, mean low water, and mean lower low water are the tidal datums most significant to charting and mapping activities in the coastal zone. Local mean sea level, i.e., mean sea level at a tide station, is the basic datum for a harmonic analysis of observations at that station. It does not have a direct impact on either charting or mapping. Half tide level is extracted from the analyzed data and its value published for each station. However, it also has no direct effect on charting and mapping. Mean sea level and half tide level are too frequently assumed to be the same. Although they sometimes are the same at some places, the assumption most often is false and should not be made. Local mean sea level should

never be confused with, or assumed to be, the National Geodetic Vertical Datum of 1929.

The surface to which depths are referred on bathymetric and nautical charts is called a chart datum. It is a tidal datum in tidal waters, i.e., mean low water in the Atlantic Ocean and the Gulf of Mexico and mean lower low water in the Pacific and Arctic Oceans. Special datums sometimes are used for a body of coastal water where tidal characteristics are significantly altered by the physiography of the basin. They generally are based on a selected tidal datum. Chart datums for the Great Lakes are low lake levels at elevations above the International Great Lakes Datum (1955) as determined from water level observations made at appropriately located gaging stations. Sloping datums are necessary for some connecting waterways because of the natural gradient of the waterway bed.

Soundings, or measurements of water depth, made during bathymetric and hydrographic surveys must be referred to the appropriate vertical datum. The preferred datum, especially in hydrographic surveying, is the chart datum. However, it usually is neither possible nor practical in such surveys to have the final datum available while the survey is in progress. The tide observations which will establish the datum are being made during the course of the survey. In most cases several weeks pass before harmonic analysis, which establishes the final values of the various datums at a tide station, is completed. Therefore, the correct value

of the chart datum may not be available during the survey. For that reason, the hydrographer refers to the datum he uses as the sounding datum. The final datum is available for smooth sheet processing, review, and verification.

2. Tidal Datums and Local Boundaries

The mean high water line forms the boundary between sovereign and private property in all except two States which border on tidal waters. The same line is compiled as the shoreline on nautical charts of the NOS and topographic maps of USGS. Publication scales of these products are too small in almost all instances to be of practical benefit to boundary affairs in the coastal zone. Also, tidal datums at many places, where such data exist, were established to meet requirements for hydrographic surveys and are not adequate for boundary applications.

In the two exceptions noted in the preceding paragraph, the mean los water line forms the boundary between sovereign and private property. That line is compiled on NOS nautical charts when scale permits. It is not compiled on most small-scale charts or on any topographic maps published by USGS.

Coastal-zone management officials, engineers, surveyors, attorneys, property owners, and others concerned with local boundaries based on tidal datums, should assure themselves that the maps and datums which they are using, or intend to use, are adequate for the

purpose. Advice, assistance, and products can be obtained from the sources listed in I.6.

3. Lake Levels and Local Boundaries

This section will be completed after receipt of pertinent information from the Lake Survey Center.

11.1.3. Continued.----------

2. Horizontal and Vertical Control (NOS)

1. Definitions

Control in general may be defined as coordinated and correlated elevation or position of data forming a framework to which detailed surveys are adjusted. Basic control may be either horizontal or vertical; it is usually executed with greater precision and accuracy than is required for dependent surveys. Both horizontal and vertical control are fundamental to charting and mapping. Except for those operations which involve details referred to tidal datums, both horizontal and vertical control used for coastal-zone mapping must be established by geodetic surveying methods. The shape and size of the Earth are therby taken into account, avoiding the accumulation of errors caused by distortion which results from plane surveying techniques.

There are two geodetic control networks in the United States. They are the National Horizontal Control Network and the National Vertical Control Network. Both are maintained by the NOAA, National Ocean Survey through its Office of the National Geodetic Survey. Other Federal agencies such as the Geological Survey, Bureau of Reclamation, and the United States Corps of Engineers, as well as State agencies, establish geodetic control in the accomplishment of their missions. Instruments, methods, and techniques used to establish such control meet the criteria set by the National Ocean Survey whenever a specific mission dictates a requirement for second

or higher order accuracy. Records and observations acquired by the establishing agency are accepted by the NGS and adjusted to the appropriate national network. The National Horizontal Control Network covers the conterminous United States and Alaska. The State of Hawaii and the oceanic islands are covered by independent networks. The National Vertical Control Network covers the conterminous United States only. Independent networks cover Alaska, Hawaii, and the oceanic islands.

2. Horizontal Contrl

Horizontal control makes it possible for the cartographer to orient and scale his map accurately, to position it properly on the Earth and to datum, and to compile details on the map in their correct positions and relationship. Basic horizontal control may be of first, second, or third order accuracy. The network maintained by the NGS usually will provide sufficient control for charting and mapping. The few hiatuses which always exist in the basic schemes can, in most instances, be circumvented by use of modern phoptogrammetric techniques. Establishing geodetic horizontal control by conventional field methods is expensive, causing a significant increase in overall costs.

3. Geodetic Vertical Control

The aerotriangulation phase of photogrammetric mapping is the first instance where vertical control enters the overall coastal zone mapping process except in planning. Aerotriangulation requirements

for vertical control do not necessarily dictate the use of a geodetic datum. Normally in the National Ocean Survey, coastal-zone mapping is conducted without reference to the geodetic datum at all. However, if representation of relief (topographic mapping) is to be included as a phase of the mapping program, then a common datum must be used. The National Geodetic Vertical Datum of 1929 is the one most suitable for this purpose in the coastal zone of the conterminous United States. Adequate data to permit extension of this datum to the State of Alaska is not available. The same situation exists in the Pacific Islands, the State of Hawaii, Puerto Rico, and the Virgin Islands. As a result, local datums are used in these areas, each based upon tidal datums established at selected tide stations. The datum involved is specified in the geodetic control data provided for each of these areas.

4. Other control

Vertical control of the greatest significance to coastal-zone mapping is that provided by tidal observations. This control is in the form of elevations of tidal bench marks above mean low water along the Atlantic Coast and above mean lower low water in the Gulf of Mexico and the Pacific Ocean areas. For tide stations along the Atlantic Coast, data is provided for mean high water, half-tide level, mean sea level, and mean low water. Through special arrangements, data for the mean higher high water and mean lower low water datums can also be provided. For tide stations in the Gulf of Mexico, along the Pacific Coast, Alaska, Hawaii, and the

Pacific Islands, data is provided for mean higher high water, mean high water, half-tide level, mean low water, and mean lower low water. Differences in the tidal datums for which data is provided result from the variation in the types of tides. The tide along the Atlantic Coast is classified as semidiurnal with very little difference in the heights of one high water and the following high water, or a low water and the following low water. In the Gulf of Mexico and the Pacific Ocean, the tide is either classified as diurnal (one high water and one low water each day) or as mixed. The mixed tide is similar to the semidiurnal except that there is a marked difference in the height of a high water and the following high water or a low water and the following low water (called diurnal inequality). Mean sea level at a tide station, of which data is always provided, is local mean sea level and valid only at that locality. It should not be confused with the general term, mean sea level. Mean sea level at any point may be defined simply as the mean level of the sea at that point. It is the primary tidal datum plane, all the other tidal datum planes are derived with reference to it. Mean sea level at each tide station is derived as the average of the tabulated hourly heights of the observed tide.

3. Map Projections and Grid Systems (NOS)

1. Introduction

It is indeed unfortunate that globes cannot be used instead of charts

and maps to depict and study the Earth and its component parts. Because they are both spheres, a globe can be made an accurate model of the Earth, with constant scale and with areas, shapes, distances, and directions held in the same relationship as on the Earth. But the large physical size of globes constructed at useful scales would be impractical. For example, the diameter of a 1:10,000 scale globe would be greater than 4,000 feet and the diameter of one at 1:2,400 scale would exceed 17,000 feet.

Because a sphere, or a portion of one, cannot be flattened into a plane without causing distortion, the cartographer resorts to a process known as "map projecting." This process lets the cartographer represent all or a part of the curved surface of the Earth on a plane surface while limiting distortion to an acceptable level.

The Greek astronomer, Hipparchus, is credited with dividing the Earth in a system of parallels of latitude and meridians of longitude to provide the means by which the locations of features, objects, and places can be stated uniquely (Reference 19). Uniqueness is essential because only one feature, object, or place can occupy a given location. However, that system is the source of the main difficulty in map projections, i.e., transferring the imaginary lines representing meridians and parallels from a curved surface to the flat surface of a chart or map. They must be drawn with conformity to avoid confusion and to be of scientific value. A map projection map be defined as a systematic network of lines, representing imaginary meridians and parallels on a plane surface,

either for all of the Earth or for some portion thereof (Reference 10). That network is called the graticule.

Plane rectangular coordinate systems are less complex and easier to apply, for both the cartographer and surveyor. Each is based on a map projection and is satisfactory for only a relatively small area. Errors caused by distortion increase to an unacceptable magnitude when attempts are made to cover too large an area.

Lines drawn on maps to represent the plane coordinate system cross each other at right angles and are spaced at an interval compatible with the mapping scale. The X ordinate is represented by north-south lines (similar to meridians), while east-west lines represent the Y ordinate (similar to parallels). This network is called a grid system.

Large-scale maps usually carry the graticule as solid lines with the plane coordinate system shown by ticks, however in some instances the practice is to reverse the procedure with the grid system shown as solid lines and the graticule with ticks. Intervals selected for both the rectangular coordinate system and the graticule are compatible with the scale of the map. Grid systems are not shown on small-scale maps because the area covered introduces excessive distortion.

The grid system should not be confused with the military grid which appears on many small-scale maps. The latter is a quadrillage, or system of squares, determined by rectangular

coordinates on a spherical map projection referred to one origin and extended over the whole area of the original map projection. The military grid is designed to make map data more readily usable for military purposes. The military grid is basically a map reference system designed for the user and has no relation at all to the plane coordinate systems which have been discussed in this section.

2. Map projections in common use

No single map projection is capable of meeting the requirements of all map users. The projection may be selected because it is easy to construct, or because it is conformal, which means that the actual shapes of very small areas are preserved. On the other hand, the desired projection might be one which retains accuracy of scale in all directions, or one in which all directions or azimuths are depicted accurately. In preparing a map projection, and the map itself, the cartographer is projecting from the curved surface of the Earth to a flat, or plane surface (a sheet of paper), an area which is infinitesimal in size compared to the actual area of the Earth's surface. All map projections whether planar, cylindrical, or conic, are projections of a curved surface to one type or other of the geometric figures mentioned. Complex mathematical operations are required to derive the elements of these projections.

Until the advent of sophisticated electronic computers and peripheral equipment, which permit rapid manipulation of highly complex problems,

the availability of tables providing the cartographer with data for the various elements was a major factor in selecting a projection.

Fortunately, the modern electronic computer and the automatic plotter which it is capable of controlling, make it possible to construct practically any projection that might be selected. The number and variety of projections available is far more than adequate to meet the needs of most coastal-zone activities.

Maps at very large scale, i.e., 1:2,400, usually omit this graticule. Instead, they are constructed on a grid system, generally the appropriate State Plane Coordinate System.

The polyconic projection is commonly used on most modern, medium- to large-scale maps of the coastal zone. This projection has been in use for so many years and has received such wide application because of the availability of tables for its elements and because it is relatively easy to construct accurately. These factors make it well suited for preparation of large-scale maps. State plane coordinate systems can be shown on this projection without introducing significant errors due to distortion.

Coastal-zone maps of intermediate-scale (1:100,000 to 1:250,000) are constructed on the Transverse Mercator Projection. Various other projections are used for maps of even smaller scale, but, on the whole, the Lambert Conformal Conic Projection with two standard parallels offers the most advantages.

3. Projections commonly used for charts

Basically charts are special versions of maps meeting a specific need of one or more type of user. There are two types of charts produced by the Federal government covering the coastal zone. Of the two kinds, neither is specifically designed to meet the requirements for coastal-zone-management operations. The National Ocean Survey uses the Mercator Projection for all of its nautical charts except those of the Great Lakes which are on the polyconic. A Lambert conformal conic projection with two standard parallels is used for the sectional aeronautical charts that cover the coastal zone. All of these charts are a t a scale of 1:500,000. In a smaller-scale series of charts which cover the coastal zone is the world aeronautical charts at a scale of 1:1,000,000; the same projection is used for that series.

4. Commonly used coordinate systems

The majority of large-scale maps in the coastal zone carry the appropriate State Plane Coordinate System. These systems were devised by the Coast and Geodetic Survey and are based on either the Transverse Mercator or Lambert conformal conic projection with two standard parallels. The tranverse Mercator is applied to States, or zones of States, in which the greatest dimension is north and south. The Lambert conformal conic projection is applied to States, or zones of States, with the greatest dimension in the east and west direction. The system for each State, or each zone

within the State, was designed in such a way that no part of the area covered by the system will be in error more than one part in 10,000. Two of the 10 zones of the State of Alaska required special treatment of the projection selected. Zone 1, covering Southeast Alaska, is an oblique Mercator projection of the spheroid. The curve used for the center of the projection is a geodetic line passing through an arbitrary central point of the area and roughly bisecting the strip. Zone 10 covers the Aleutian Islands, the center line of that zone is a parallel of the spheroid near the center of the zone; the resulting projection is the Lambert conformal. Zones 2 to 9 all have the same set of plane coordinates and are based on the transverse Mercator projection.

4. Remote Sensing (NOS)

1. Introduction

There are many different definitions of remote sensing. The literal definition, perceive from a distance, perhaps, would be an over-simplification. For the purposes of this handbook, remote sensing is defined as being the application of any technique, in which direct physical contact with the emitter or reflector is not required, to observe, measure, and record emitted and/or reflected energy, in order to produce useful data.

Remote sensing gained widespread recognition as a consequence of achievements in space activities. Many view it as a product of the space age when, in reality, it is not new-comer to many professions

and trades; photography is an old and familiar example. Near vertical aerial photography obtained properly with the correct camera-film-filter combination is the very foundation of modern mapping procedures. Measuring and recording water depths with echo sounders has long been the keystone operation in bathymetric and hydrographic surveying. Satisfactory operational uses and procedures must be developed for the great majority of the new sensors before they can be profitably applied to coastal-zone activities.

2. Kinds and types

Remote sensors known to have, or which may have, practical operational applications to coastal zone activities range from scintillometers to echo sounders and geological echo profilers. All can be classified as being either active or passive, imaging or nonimaging, analog or digital, and scanning or nonscanning.

There are numerous types of sensors either in operational use or in developmental or testing stages. Because of the variety and number of kinds and types, narrative explanations would be lengthy and inconvenient. Instead, pertinent information is presented in the matrixes and tabulations immediately following.

(Two and/or three dimension matrixes and approximate tables are being prepared for inclusion in the ~~2nd~~ next draft).

Diagram

Diagram

Diagram

Diagram?

Text?

5. Photogrammetric Mapping Techniques (USGS)

Photogrammetry is the science of making accurate measurements by means of photography. Today maps are produced largely from aerial photographs with a minimum of field work.

A photogrammetric mapping project begins with carefully executed techical planning. After the boundaries of the project area have been determined, decisions are made concerning the following:

1. Method of compilation
2. Compilation and publication scales
3. Contour interval
4. Nature, extent, adequacy, and location of existing control.

1. Aerial Surveys

The planning of the aerial photography is based on the above determinations and involves the following additional considerations:

1. Season of the year as it affects
   a. sun angle (shadows, reflections, glare)
   b. ground cover (snow, leaves, crops, floods)
   c. local weather conditions
2. Type of photography (vertical, convergent, angle of coverage, focal length, format, emulsion, exposure)
3. Direction of flights (designed for minimum number of aircraft passes.

4. Flight height
    a. capabilities of stereoplotter
    b. desired contour interval; C-factor
    c. visibility and interpretability of planimetric detail
    d. relation of flight height to stereomodel scale
    e. capability of the pantograph to convert model scale to compilation scale

5. Number and spacing of flight lines; width-height ratio

6. Spacing of photographs along flight lines; base-height ratio

Once the flight design is completed a flight plan diagram is made using the best available map of the area. The center line of each flight path is drawn on the flight map.

The photographs are obtained within a time frame specified in the contract. Weather largely determines the actual day and time chosen for the flight.

After a project area has been photographed the film is processed by the contractor. The traditional steps in photographic processing are developing, fixing, washing, and drying. These steps may be performed by hand, but modern automatic processors are now available, making the job easier and less time consuming. With automation has come the ability to exercise greater quality control.

Fig. 6 from Photogrammetry
in The National Ocean Survey

(Photograph to be provided by NOS)

Fig. ___. Wild B-8 aerial
camera mounted in an aircraft

Fig. 8 from Photogrammetry
in the NOS

(Photograph to be provided by NOS)

Fig. ___. The Color Automat
for chemically processing
color photographic prints

When processing is complete proof prints are made. They are stapled together in relative position and the composite is examined to determine if all areas are covered and whether the required overlapping has been achieved. If the contract requirements have been met, contact prints are produced. Each print is marked with the date of photography, the frame number, and a project code. Also a mosaic-like photographic index is prepared to aid subsequent operations.

2. Field Operations

Accurate photogrammetric operations require adequate ground control. Control surveys are needed in order to present map features in correct relationship to each other and to the Earth's surface. Two kinds of control are required: horizontal and vertical. Horizontal control is needed to develop and maintain correct scale, position, and orientation of the map. For this purpose, latitude and longitude of selected points within the project area must be determined from field surveys.

Horizontal control points often are marked in the field before the photographs are taken. The marking consists of fastening three or four strips of cloth or plastic material to the ground in such a way that they converge at the control monument, or at some precisely surveyed, nearby point which is visible from the air. The color of the marking material is selected so that it will

contrast with that of the ground when photographed. This marking process is called paneling or targeting.

The required frequency of horizontal control points is determined by the desired accuracy and by the limitations of the photogrammetric techniques to be used. For example, in 7.5-minute topographic mapping, an effort is made to establish horizontal control stations at 7.5-minute spacing on the perimeter of the project. Horizontal positioning within the project area is obtained through the process of aerotriangulation (See II.5.3).

Similarly, vertical control is needed for the correct delineation of the contours. To provide vertical control, the elevation of selected points must also be determined in the field. As a rule, more vertical stations are required than horizontal. A minimum of four vertical control points are desired for each stereomodel. These points need not be (and seldom are) monumented control stations. Many of them may be image points whose position has been determined by photogrammetric methods. The important condition is that they be photoidentifiable points such as a road intersection or fence corner. Therefore, one of the major field operations is running level lines (plane tables and alidades often are used) between known vertical control stations and the photoidentifiable points, often referred to as picture points.

Horizontal and vertical control points located as described above become the framework upon which map detail is assembled. This framework

determines the accuracy with which the position and elevation of map features can be shown.

A third important field operation is classification of map detail. Although the stereocompiler can interpret much of the map detail from the stereomodel, he often needs help in interpreting some features and in distinguishing between others.

The classification operation usually is a pen-and-ink annotation made directly on the aerial photograph or the photoindex before photogrammetric compilation. Annotations include such items as the following:

1. Classification of buildings according to use
2. Classification of roads and trails according to use and capacity
3. Delineation of boundaries
4. Identification of culture
5. Location and labeling of control stations
6. Delineation of streams and classification as intermittent or perennial
7. Delineation of wetlands
8. Delineation of U.S. land lines and labeling of townships/sections
9. Classification of sample woodland areas
10. Name investigation

Classification may be performed after compilation of the map manuscript. However, it has been found that since the control operation must be completed prior to the compilation phase, time and money can be saved by completing the classification in advance along with the control.

3. Map Compilation

Once aerial photography of a project area is obtained, contact paper prints are made for each scene. These prints are used in field classification and to aid the photogrammetric compiler in interpretation of detail. In many cases transparencies are made of each scene. They are useful for checking and editing purposes.

Diapositives, which are positive prints on glass plates or on film made from the aerial negatives, are required for the various types of stereoscopic plotting instruments. In some stereoplotters the diapositives are placed in projectors and the photographic image is projected upon a tracing table. In other plotters the diapositives are observed directly through a viewing system. Diapositives are used in pairs and are viewed stereoscopically to form three-dimensional models from overlapping imagery. The stereovision effect is produced by the operator's viewing the same area from two perspectives, one for each eye, at the same time. The different perspectives are made possible by the movement of the aircraft, resulting in a series of scientifically spaced perspective centers for successive photographic exposures.

Fig. 2 from Photogrammetry in the NOS

(Photograph to be provided by NOS)

Fig. __. Stereoscopic viewing

Fig. 3 from Photogrammetry in the NOS

(Photograph to be provided by NOS)

Fig. __. A Stereopair of aerial photographs

Before compilation can take place the stereomodel must be scaled (all points made to conform to proper horizontal position) and leveled (all points adjusted to proper vertical position). Scaling is achieved by adjusting the stereomodel so that when the plotter reference mark is moved a given distance the drawing pencil will move a corresponding distance on the compilation manuscript. Leveling is achieved by making a series of adjustments according to a prescribed sequence to result in proper vertical relationship for all known elevations in a model. If all known points are in correct relative position (horizontal and vertical) every other point in the model will likewise be in position and the elevation of any point can be measured.

In order to scale the stereomodel a base sheet is used. The sheet contains points representing specific images from the aerial photographs. The points are properly positioned on the base sheet by coordinates derived from a process known as aerotriangulation, an extension of horizontal and/or vertical control by means of aerial photographs.

Aerotriangulation, sometimes called aerialtriangulation, can be accomplished by either of two general computational methods. Both methods involve the selection and identification of a pattern of image points on the overlapping photographs that serve the double purpose of relating the photographs one to another and of relating the photoimage to the ground--and thus to the map to be

Figure GS-1

Fig. __. Kelsh stereoplotting instrument

Fig. __. A Wild Stereocomparator. This instrument is used to measure the coordinates of photoimages for computerized aerotriangulation.

compiled. Some of these points will necessarily be points whose horizontal positions and/or elevations are already known, generally as the result of ground surveys. In semianalytical methods, the computations involve adjustments of coordinates of the points read in a stereomode. The adjustments involve the use of polynomial equations for adjusting the models to each other to form a block and for fitting the block to the known control points. In fully analytical methods, plane coordinate data rather than stereomodel data are used as input to the computations, and the adjustments involve simultaneous adjustmens of the cones of perspective rays defined by the points in the photographs to a best fit to the control and to each other. The output in both cases, are the coordinates in a ground or map system, of all the points.

The points may then be plotted on an automated coordinate plotter, using a computer-prepared set of plotting instructions on magnetic tape. The resulting plot is the base sheet upon which the map is compiled.

Once the base sheet has been prepared and oriented on the stereoplotter and the stereomodel has been scaled and leveled, the drawing of the map can begin drawing. Stereoplotters are equipped with an index point (reference mark), usually a small dot of light. As the index is moved along photographic images in the stereomodel, a drawing pencil is put through similar motions at compilation scale by the use of a pantograph. Contouring is done by

moving the index along the ground at a preset elevation. Planimetric (culture) features are compiled first directly on the base sheet. Other features such as woodland and contours, usually are compiled on separate manuscripts. Drainage often is combined with either culture or relief. The deciding factor usually is whether a drainage feature is to be shown by a single line or a tint.

The data compiled directly on the base sheet is scribed immediately. Then, by photomechanics the information is printed on the successive manuscript sheets and is used as a positioning guide in the compilation of the other types of features.

Most maps are produced either from ink drawings or scribed (engraved) compilation plates. Before inking is undertaken a light pencil drawing is constructed on tracing paper. A light table is used to prepare the fine ink drawing on quality paper overlaid on the pencil drawing. The disadvantage of using ink is the difficulty in making corrections.

In a sense, scribing is the reverse of inking because the inker adds material (ink) to the base sheet while the scriber removes material. The scriber creates a negative image; the inker, a positive image. Scribing is performed on transparent plastic sheets which have been covered on one side by a photographically opaque coating. The map symbols are cut into the coating using special engraving tools.

KEY

1	Field scribing kit (large)	6	Register studes	14	Straight fineline graver
2	Instructions for use of plastic templet and for sharpening points	7	Scribing points	15	Correction fluid brush
3	Thinner	8	Straightedge-curve	16	Sharpening stone
4	Correction fluid	9	Swivel graver	17	Allen wrench for rigid graver
5	Allen wrenches for swivel graver	10	Rigid graver	18	Plastic symbol templet
		11	Building graver		
		12	Screwdriver		
		13	Angle fineline graver		

Figure ___. A complete field scribing kit.

Fig. __A. Right-reading positive.

Fig. __B. Right-reading negative.

Fig. __C. Wrong-reading positive.

Fig. __D. Wrong-reading negative.

Then light can pass through the cuts making photographic reproduction possible. The scribing normally is done wrong-reading (left and right reversed) so that reproductions will appear in the correct mode. Corrections may be made easily by covering unwanted cuts with opaquing fluid or by additional scribing.

The effect of hand scribing may also be obtained photomechanically. The scribecoat material is sensitized and mated with a line drawing or film positive to obtain a contact print. After exposure the scribecoat sheet is developed with an etching solution which removes the coating wherever light was prevented from striking the sheet during contact printing.

This photoscribing process is used when a finished positive copy exists, particularly if the reproduction involves a large quantity of numbers and symbols. Often contours are reproduced in this manner when a map is being revised. Generally, contours do not need revision as much as other map features, so contour guides frequently may be reused. The photoscribing process is a quick and easy way to prepare reproduction copy. Its greatest disadvantage is that the lines sometimes are less clear cut than desired. However, minor repair work can be accomplished with a simple scribing needle in much less time than it would take to hand scribe or ink the entire map.

Fig. ___. Stickup

Solid tint areas, which are used to symbolize water, woodland, and urban areas, or to signify areas of equal distribution in thematic maps, usually are produced photomechanically through a process known as stripping. An outline of the area to be tinted is compiled and contact printed onto a transparency which has been coated with a special stripping material. The line image then is etched into the strip coat. Using the etched lines as a boundary, the required areas may easily be peeled away with the aid of a small knife, leaving open windows.

Sometimes lettering and symbolization are prepared on transparent, adhesive material called stickup. The information is placed in proper position on the appropriate manuscript. On the other hand, lettering may be done manually or with the aid of an electronic lettering machine.

If a map is to be multicolored it is necessary to produce color-separation guides (not to be confused with feature separation guides, II.9.2). The normal separation of colors is as follows.

Black--culture, control, grids and coordinates, labels
Blue--drainage
Green--vegetation
Brown--relief
Red--highway numbers and classification, land lines, and fence lines.

At least one "color separation guide" must be prepared for each color. These guides may be scribed sheets, film negatives, or

Fig. ___. Open-window guide.

open window plates. Each contains data to be printed in only one color. For good registration, they are prepared on a printed image reproduced from the compilation manuscripts. The important difference between compilation manuscripts and guides is that the manuscripts are drawn in right-reading form while guides must be drawn wrong-reading because they are used in pressplate processing.

The color-separation guides may be successively contact printed in the representative color on a white material to create a composite for checking purposes. The editor then can easily identify errors and indicate necessary changes to be made on the guides. In a complex, multicolored map, such as a topographic map, corrections sometimes can create other errors which previously were nonexistent. Therefore, the editing-correcting-editing cycle should be repeated once or twice before publication.

4. Map Reproduction

Although there are several methods of printing, most maps are reproduced by offset lithography. Lithography means "stone writing," but modern techniques employ aluminum press plates. Lithography works on the principle that water and grease do not mix.

Sensitized press plates are photographically prepared from the color-separation guides by contact printing. One plate is prepared for each color. Different shades may be produced during plate exposure by using screens in conjunction with open-window guides. The screens are lined patterns which block out specific percentages

of light, creating dotted patterns of color which give the appearance of a variation in shade. The plate processing procedures result in a right-reading, positive, image which is receptive to ink while the remainder of the plate repels ink.

The term "offset" comes from the fact that the image is not transferred directly to the paper. Instead it is first printed (wrong-reading) on a "blanket" which in turn transfers the image to the paper, creating the printed map. Use of the blanket allows for more evenly controlled inking and better quality.

Multicolored maps may require several passes through a press in order to print all of the colors. After each pass the presses must be cleaned of ink. This a job requires about an hour of conscientious cleaning. This time-consuming work may be avoided by the use of a multicolor press which has several printing systems in tandem, each of which is devoted to a different color. The paper passes through one system after another and the finished product is made in one press run. Sometimes multicolored maps are printed by using the three basic colors, yellow, magenta, and cyan in various combinations to make other colors.

For information on other types of printing such as letterpress and gravure see Reference 12.

6. Maps (USGS)

1. Definition

A map is a graphic representation of selected natural and manmade features on or below the surface of the Earth or other celestial body. Usually maps are prepared at an established scale and on a plane surface. They make use of symbolization to eliminate certain details and emphasize others in accordance with their intended purpose.

2. Types

The types of maps available to the user encompass a wide range of products. Generally speaking maps may be classified under one or more of the following headings:

Planimetric

Topographic

Thematic

Digital

Line

Photographic.

Planimetric maps represent the horizontal positions for selected natural and/or manmade features. The natural features usually include rivers, lakes, and seas; mountains, valleys, and plains; and forests, prairies, marshes, and deserts. The manmade features include such things as political and private boundary lines, cities, transportation

systems, and public-utility facilities. The foremost characteristic of a planimetric map is its failure to depict relief in any measurable form such as the practice of describing physiography by the use of contours.

Examples of planimetric maps are base, boundary, cadastral, line-route, and outline maps. Base Maps are used to plan or to compile data for the production of specialized maps. Cadastral maps show the boundaries of subdivisions of land, usually stating their bearing and length. They also show the area of individual tracts for purposes of describing and recording ownership. One type of cadastral map is the plat which often constitutes a legal description of a parcel of land. A major producer of plats is the Bureau of Land Management. Line-route maps are used by utility companies such as suppliers of electricity, gas, water, and telephone services. They show the routes and type of construction of pipelines or wire circuits plus the locations of facilities such as switchboards and telegraph stations. An outline map represents only that information needed to provide a basis for the compilation of additional data. Outline maps often show only national and State boundaries plus major drainage systems.

The second major map group is topographic. Topographic maps represent selected natural and manmade features of a part of the surface of the Earth plotted to a definite scale. They are distinguished from planimetric maps because of their portrayal of the shape and elevation of the terrain. Topographic maps show the location and shape of the mountains, valleys, and plains; the network of streams and rivers,

Contours

Shading

Form lines

Hachures

Fig. ___. Methods of portraying relief.

and principal works of man.

There are several methods of portraying relief. Although most topographic maps portray relief with contours, some use other methods, namely form lines, hill work (shading), color gradients, and hachures. Any map portraying relief using one of these conventions may be called a hypsometric map. A map on which the elevations are referred to a sea-level datum is called a hypsographic map. A standard topographic map falls into both of these categories.

Most topographic maps are published at a scale of 1:250,000 or larger. In the United States the best known type of topographic map is the quadrangle series (See Section II.6.3). Topographic quadrangle maps are used for development purposes such as selection of industrial sites, highway planning, routing of utility lines, selection of dam sites, and location of communication facilities. They also are useful for recreation purposes including hunting, fishing, and camping. Topographic quadrangle maps usually range in scale from 1:20,000 to 1:250,000.

Other types of topographic maps include engineering, flood control, and landscape maps. Engineering maps are used for planning and cost estimation of engineering projects. Flood control and storm evacuation maps are special purpose topographic maps designed for use in studying areas subject to inundation and for use in flood control planning. Landscape maps are used by architects to plan buildings which conform to the topography of the site. Landscape gardeners use them in the maintenance of parks, playgrounds, and private estates.

A bathymetric map portrays water depth through the use of depth curves. Usually, significant degrees of depth are indicated by a system of different colors or tints. Bathymetric maps are designed especially for geophysical studies. Often they are combined with navigational information to create a nautical chart.

Thematic maps also are called "geographic," "special purpose," or "distribution" maps. They emphasize a single topic such as geology, climatology, crop distribution, etc. and the entire map is related to the specific topic.

Geographers make wide use of thematic maps to show the geographical distribution of such subjects as population, languages, crop production, soil, climate, vegetation, land-use, and industry. Distributions of this sort are graphed by several different methods. The most popular of these employ dots, choropleths, or isopleths.

Dots are used to represent quantities such as 1,000 people, or 500 acres of corn. The size and value of dots are selected so that the dots coalesce in areas of densest distribution. Sometimes dots of different size are used for different quantities.

Choropleth maps are thematic maps which make use of civil boundaries or other arbitrary sectional division of an area. The sections are colored, shaded, dotted, or hatched to create darker or lighter areas in proportion to the density of distribution. Choropleth maps may be somewhat misleading because of the use of arbitrary sections. The map

may show an abrupt change between sections where in fact the change is quite gradual.

Isopleths are lines which connect places of equal value of distribution. They have the same inherent virtues and deficiencies as contour lines. They provide exact information throughout their entirety. However, they do not show what happens in the intervals. Isopleth maps are used by those who are interested in numerical values and wish to observe these values directly. Isopleths always are used for continuous distribution such as rainfall and temperature which involve values rather than numbers of units. Tinting or shading between isopleths is sometimes employed.

Thematic maps include a number of maps directly related to the natural sciences, including geologic, vegetation, and soil maps. Geologic maps may be directed toward portraying a number of different geological conditions. Forestry maps are prepared principally to show the size, density, kind, and values of trees in a given area. Soil maps are produced by soil conservation agencies to help with the management of that natural resource. Land-use maps use colors, letters, or numbers to show the land use activities within small areas. (See Section 11.10. for a discussion of land use classification systems.)

Maps showing areas of critical ranges of slope are particularly useful in studies related to land-use. They are called slope maps and use different colors to graphically represent different degrees of slope. Slopes are determined either manually or mechanically according to

the distance between contours as represented on a relief map.

Thematic maps which are dedicated to the explanation of the past are called historical maps. They tend to be political in emphasis, showing battlefields, military routes, and boundary changes. Virtually all maps are historical in a sense because of the time interval between compilation and publication or use. However, not all historical maps are thematic. Only those historical maps which were originally intended to illustrate statistics may be classified thematic.

A recent addition to the list of map classifications is the digital map. Actually a digital map is not a map in the physical sense of the word. Instead it is a computer bank loaded with map data. The user can retrieve selected information automatically, either in map or list form. (See III.1. Automation.)

Any map produced from scribed, inked, or paste-on line copy is considered a line drawing, or line map. (See II.5.3 for details about scribing, inking, stickup, and open-window guides.)

An alternative to the line map is the photomap (II.6.2). It is far less selective in its subject matter, and requires photointerpretation by the user. Any aerial photographic image may be considered a photomap in the broad sense of the word. A simple aerial photograph has some use as a map substitute because it does show surface features, but it has scale distortions. Most photomaps include some cartographic enhancement to assist the user. This enhancement may be only marginal information or may include an overprinted line drawing or name placement.

Certain image distortions and displacements are created by relief and by the tilt and tip of the aircraft (and thus the camera). Distortions due to lack of verticality of the camera may be removed in a process known as simple rectification. An orthophotoscope or other differential-rectification system is used to remove displacement due to relief. The resulting orthophotographs possess imagery which is correct in scale and relative position.

Two distinct products have developed from these techniques, the orthophotoquad and the orthophotomap. Both products are made from either orthophotograph or an orthophotomosaic and both contain marginal information including grid ticks and projection lines.

Orthophotoquads are black-and-white other photographic images in quadrangle format with a minimum of cartographic enhancement. For general orientation, the major highways and a few principal places or features are labeled on the photoimagery. The orthophotoquad requires the user to employ a greater amount of photointerpretation than the corresponding line map.

An orthophotomap is a color-enhanced version of the orthophotoquad. By applying color to the photoimagery, using appropriate ink colors and masking techniques, ground features can often be enhanced in more recognizable colors than nature provides. A variety of tones of green, blue, and brown accentuate such detail as salt-water encroachment, marshland limits, fault lines, and the physical character of prominent geologic features. The orthophotomap also is enhanced by additional cartographic representation, including contours, elevations, boundaries,

and labels. The orthophotomap represents approximately the same production effort as the line map, but the photoimagery is a decided advantage in the study of areas of special interest to hydrologists and geologists.

3. Format

Maps usually are rectangular in format and may include the entire area of a political division such as a country, State, county, or municipality. Generally, some map detail is shown beyond the political boundary to fill in the entire sheet of paper. However, on occasion compilation ends at the boundary and the format takes on the shape of the political entity.

Not all maps conform to political designations. A quadrangle map is bounded by meridians of longitude and parallels of latitude. Examples of standard quadrangle formats are 7.5 x 7.5 minutes, 15 x 15 minutes, and 1 x 2 degrees. Adjacent quadrangles can be fitted together to form one continuous map.

4. Content

In addition to relief, general purpose maps contain some or all of the following data:

1. Control
    a. Horizontal and vertical stations
    b. Spot elevations

2. Reference systems

   a. Geographic (latitude and longitude)

   b. Universal Transverse Mercator grid

   c. State plane coordinate systems

   d. Public land system (township and section lines)

3. Culture--roads, buildings, dams, utility lines, etc.

4. Drainage--swamps, rivers, streams, ponds, lakes, oceans

5. Vegetation--woodland, scrub, orchards, vineyards.

5. Contour interval

Contour interval is the difference in elevation between adjacent contours on a map. The selection of the optimum interval is one of the most important considerations in topographic mapping. The intended purpose of the map is the most significant factor. A large interval may be acceptable for reconnaissance. On the other hand, development of natural resources usually requires a comparatively small interval.

Too small an interval may result in crowding of contours or showing of insignificant details; too large an interval may prevent adequate representation of the terrain. An interval appropriate at one scale may not be satisfactory at another scale.

Occasionally, the selection is difficult because certain portions of the terrain warrent greater recognition than others. For example, use of a 5,000-foot interval on a large-scale map may result overlooking a 3,000-foot mountain range sticking out of a 6,000-foot-high basin.

It may be necessary to subdivide the interval in parts of such maps by using supplementary contours. Usually, supplementary contours are given different symbols to distinguish them from the primary contours. Normally, dashed or dotted patterns are used.

The U.S. Geological Survey has established standards for the use of contour intervals in its topographic map series. The standard contour intervals for the large- and intermediate-scales are 5, 10, 20, and 40 feet. The 80-foot interval sometimes is used in the intermediate range for very steep terrain. The standard intervals used for the 1:250,000. large-scale, series are 25, 50, 100, or 200 feet. Other intervals are in use for large scales and for maps of Alaska. (See III.2 for the effect on these intervals of conversion to the metric system.)

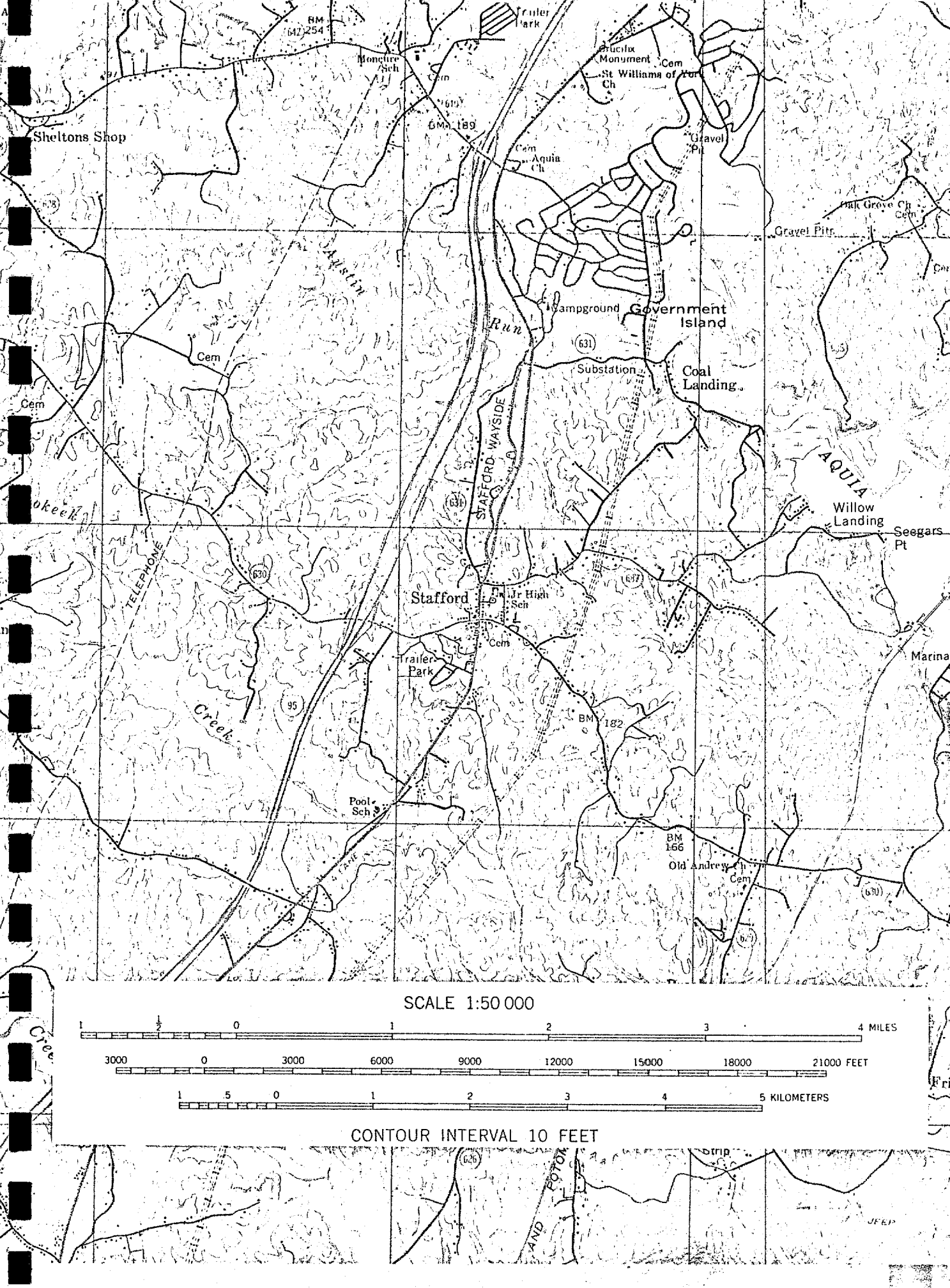
6. Scale

One of the most important considerations in planning any mapping project is scale. The scale of a map is a mathematical relationship between the ground and the map. It can be expressed as a representative fraction in either of the following ways:

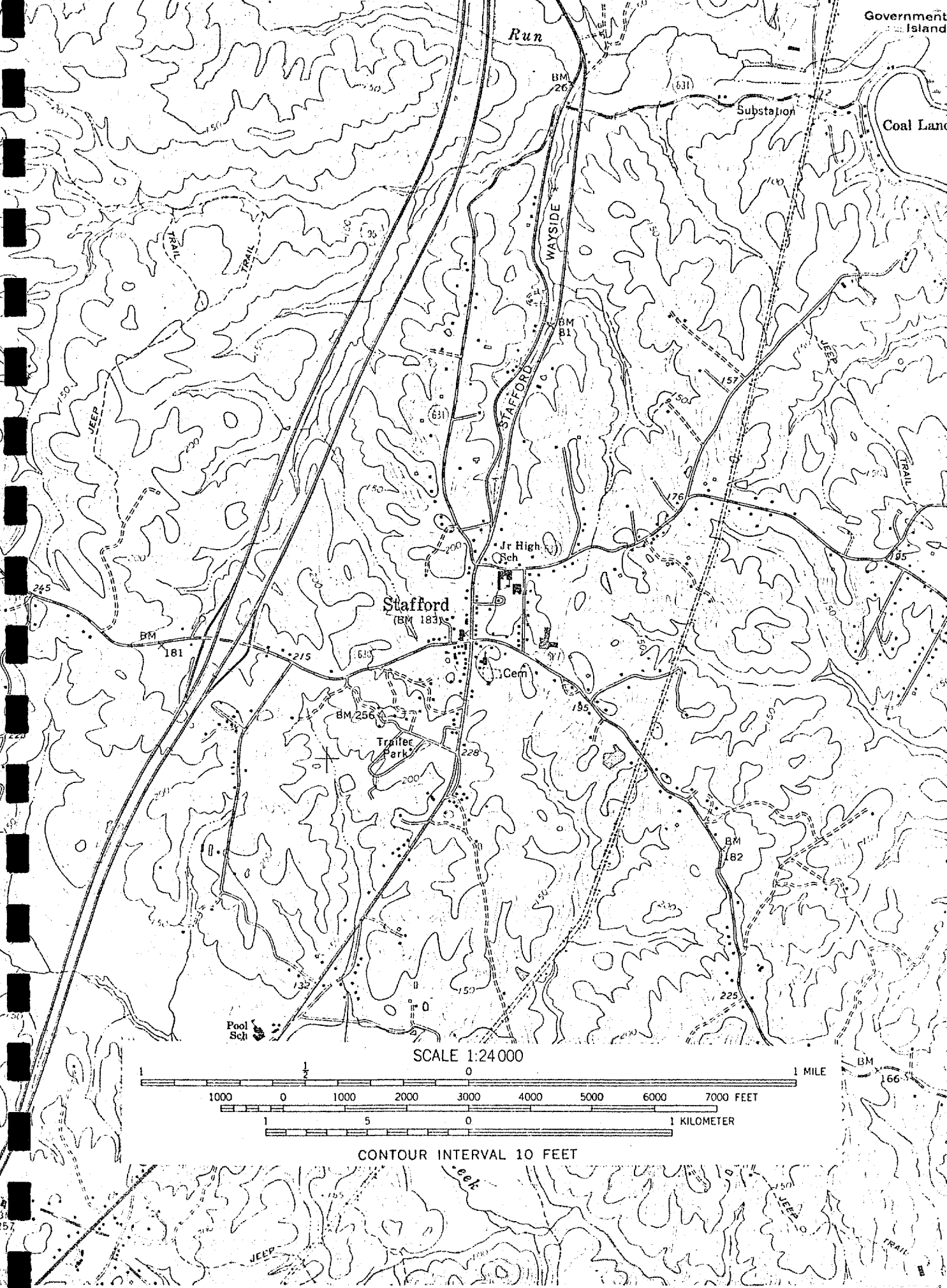
$$\frac{1}{24{,}000} \qquad 1{:}24{,}000$$

Either way these representative fractions indicate that any unit of linear measurement on the map represents 24,000 times its length on the ground. This same scale could be shown using different units of measure such as 1 inch (on the map) = 2,000 feet (on the ground).

Woodbridge
Occoquan Bay
Numerous uncharted rocks
VIRGINIA
MARYLAND
Potomac Heights
Indian Head
Dale City
Aden
Camp Upshur
Bristersburg
Elk Run
US NAVAL ORDNANCE STATION INDIAN HEAD
Cherry Hill
Dumfries
QUANTICO MARINE BASE AND MARINE SCHOOLS
Triangle
Water
Power plant
Quantico
MCAS Quantico
Buds Ferry
Chicamuxen
DONCASTER STATE FOREST
Doncaster
Ironsides
Cromwell
Lookout Tower
Lake Arrowhead
Flat Run
Beaverdam Run
Camp Barrett
Midway Island
Rectory
Mountjoy Store
Roseville
Widewater
Nanjemoy
Stafford
Widewater Beach
Brent Pt
Storck
Harlwood
Glendie
Accokeek Creek
Brooke
Potomac Cr
Hotty Corner
Leeland
Marlboro Pt
Maryland Pt
Maryland Point
Falmouth
Chatham Heights
Fairview Beach
Chancellorsville
Fredericksburg
Ferry Farm
White Oak
Five Mile Fork
Concord Heights
Hop Yard Landing
King George
FREDERICKSBURG AND SPOTSYLVANIA COUNTY
Scale 1:250,000
5 0 5 10 15 20 Statute Miles
5 0 5 10 15 20 25 30 Kilometers
0 5 10 15 Nautical Miles
CONTOUR INTERVAL 50 FEET
Dalton Millpond
Mica AAF No 4
Port Royal



Trailer Park
BM 254
Moncure Sch
Cem
Crucifix Monument
Cem
St Williams of York Ch
BM 189
Sheltons Shop
Cem
Aquia Ch
Gravel Pit
Oak Grove Ch
Cem
Gravel Pits
Austin
Run
Campground
Government Island
631
Substation
Coal Landing
Cem
Cem
STAFFORD WAYSIDE
AQUIA
Willow Landing
Seegars Pt
TELEPHONE
630
Stafford
Jr High Sch
Cem
Trailer Park
Marina
95
Creek
BM 182
Pool Sch
BM 166
Old Andrew Ch
Cem
630
SCALE 1:50 000
1 ½ 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 10 FEET
626
Strip
JEEP


Government Island
Run
BM 26
Substation
Coal Land
WAYSIDE
STAFFORD
BM 81
TRAIL
JEEP
Jr High Sch
Stafford
(BM 183)
BM 181
Cem
BM 256
Trailer Park
BM 182
Pool Sch
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 10 FEET

It should be remembered that the terms "small scale" and "large scale" refer to representative fractions with large and small denominators, respectively. For example, of the two scales 1:24,000 and 1:250,000, 1:24,000 is the larger.

Map detail increases or decreases with scale. One cannot expect to find the same degree of detail on every map. Sometimes maps may be photographically enlarged or reduced for special purposes. Care must be taken to see that these changes do not create problems.

Enlargements may make symbolization too large and defeat the purpose of enlargement. Reduction may make the map hard or even impossible to read. Enlargements which are made with a pantograph, rather than photographically, allow for changes in symbol size. Some problems resulting from reduction of a map could be solved by removal of feature separation plates (See II.9). The map user must consider the effect that changes in scale has upon detail.

Bar scales are placed on a map to help the user make linear measurements between points. On large-scale maps such as the topographic quadrangles the scale is generally consistent throughout. However, on small-scale maps, especially those drawn on certain projections, there may be scale distortions at the map extremities. Sometimes the scale shown is that for the center of the map; sometimes it applies along one or two lines within the map. Most frequently, such as with a quadrangle series, the scale applies to points or lines outside the individual map but within the confines of a block of adjacent maps, such as along standard parallels of the State plane coordinate system.

7. Accuracy

Along with scale, the user must consider the accuracy of a map. If it is to be used for precise measurements, a map showing accurately positioned features must be selected. The National Map Accuracy Standards (Appendix F) have been devised to assure the user that any map bearing the statement, "This map complies with National Map Accuracy Standards," meets the necessary requirements.

The standards for horizontal accuracy require that at least 90 percent of the well-defined map points shall be plotted correctly within 1/50 of an inch on the published map. This tolerance corresponds to 40 feet on the ground for 1:24,000-scale maps and about 100 feet on the ground for 1:62,500-scale maps. The standards for vertical accuracy require that at least 90 percent of the elevations interpolated from the contour lines shall be correct within one-half the contour interval.

8. Revision

In a sense, "accuracy" involves "currentness." The user should note the compilation date of a map to determine whether its content is up-to-date. Certain types of maps require little revision, especially those concerned with geology, or relief. The major revisions are brought about by the works of man and for the most part affect only manmade features. Although minor revisions are necessary on nearly all map plates, revision is needed most where there have been changes in manmade features, such as new roads, buildings and reservoirs, and changes in

the shape of the terrain. The rate and amount of change varies greatly from urban to remote areas, therefore maps are not all revised at definite intervals and to the same extent. The needs of map users for up-to-date maps that meet modern standards are considered in selecting maps for revision.

7. Charts (NOS)

I. Introduction

For the purposes of this handbook, a map has been defined as a representation on a flat surface of a portion of the surface of the Earth, indicating a specific group of features, at a definite scale, with colors, dots, lines, and symbols, in a manner which meets established criteria for positional accuracy. A chart is defined, again for the purposes of this handbook, as a map designed specifically as an aid to aerial or marine navigation, by stressing features and hazards of, and/or to present a set of facts for, the area depicted.

Various kinds and types of charts are prepared, published and issued by the NOAA/National Ocean Survey. They have the common objective of promoting safety in either aerial or marine navigation. Because of their importance to the safety of life and property, accuracy compatible with the intended purpose is a basic factor in the design, acquisition of source data, and construction of these charts, expecially those to be used in marine navigation.

Information and data invaluable to coastal zone activities are available as byproducts from the source material acquired and assembled for the production of these charts.

2. Types

Aeronautical and nautical are the two principal kinds of charts that are valuable to coastal-zone activities, the latter possesses far greater value because of scale and content. Airport obstruction, isogonic, isopach, and tidal current charts are other kinds that present data of value in the coastal zone.

Aeronautical charts are designed, constructed, produced, and issued for use in aerial navigation. In the design and preparation of these charts, emphasis is placed on features that are considered to be most essential to the aircraft pilot and navigator. Scale must be relatively small because of the speed of movement. Terminal Control Area (TCA) Charts, Sectional Aeronautical and World Aeronautical Charts are the most likely to contain coastal zone information of any value, having scales of 1:250,000, 1:500,000, and 1:1,000,000 respectively.

Nautical charts are designed, constructed, produced, and issued for use in marine navigation; they are classified in accordance with the specific navigational phase each is intended to serve. For example, a sailing chart is appropriate for a ship on an ocean crossing, but a coast chart is needed as land is approached or for a voyage generally parallel to the coast where land or

objects useful in navigation are visible from the ship's bridge. Harbor charts replace the coast charts as vessels approach harbors and enter restricted waterways with congested traffic and increased navigational hazards. Another series, the small-craft chart, is issued for convenience of use aboard small craft and other vessels where space is at a premium. The primary differences in these classifications are scale and the features emphasized.

Airport obstruction charts are designed to provide information regarding obstructions in the vicinity of airports where commercial flight operations are conducted. These charts will provide little data of value to coastal zone activities.

Isogonic charts provide the engineer, surveyor, and cartographer with the variation of the magnetic direction and the annual rate of change of that variation. Isogonic lines, or lines of equal variation of the magnetic compass, are compiled on a suitable base map, usually at a small scale. Field observations provide the basic data from which the variation and rate of change are determined.

Isopach charts present information regarding deposition of sediments on the sea bottom. Isopachs, or lines which pass through all points where the depth of sediment is equal, are drawn on a chart of appropriate scqale. These charts have somewhat limited value in coastal zone activities.

Tidal current charts probably are second to nautical charts in value to the coastal-zone. Tidal current charts provide essential information about the direction and speed of the current in a specific area at intervals through the entire tidal cycle. Presently limited to major harbors, coverage is being extended to important coastal waters.

With few exceptions these charts are basically line drawings, relying on the use of colors and symbols to provide emphasis on significant features. On aeronautical and nautical charts, significant features are those essential for safe navigation. The first of a series utilizing an orthophoto mosaic base to present plaimetry usually shown by the traditional line method. Landmarks and similar features important to the navigator are accentuated by color or symbolization.

3. Format

The different charts are issued in various formats, each one the result of compromises in the many factors affecting format design and selection. The intended use of the chart, and the environment in which it will be used, are the two factors which generally receive the most attention in selection of a format.

Aeronautical charts which may have some value to coastal activities cover differing areas and are issued normally in accordion-folded format.

Terminal control area (TCA) charts, available only for selected major airports, cover a geographic area in the immediate vicinity of an airport. They vary little in physical size.

Sectional aeronautical charts are compiled, published, and issued to cover an area defined by geographic coordinates. These charts also vary little in physical size. Each is printed on both sides, each side covers 2° in latitude and from 6° to 8° in longitude (convergence of the meridians permits an increase in longitudinal coverage at higher latitudes without changing the physical dimensions of the chart).

World aeronautic charts differ from the sectional charts only in the area covered because of the smaller scale (1,000,000 compared to 1:500,000). Each side covers an area 4° in latitude and from 12° to 16° in longitude.

Nautical charts vary widely in physical dimensions. They are designed to cover a portion, or an entire body of water, or a section of coast between major ports or salient geographic features.

Uniformity of coverage and dimensions of individual charts within each series is maintained when practical; usefulness and convenience to the mariner are paramount.

Airport obstruction charts are planned to cover an area approximately circular in shape, extended to include runway approach and departure zones. They are fairly uniform in physical dimensions.

They are not printed, but ozalid copies are produced as needed.

Isogonic charts . . .

Isopach charts . . .

Tidal current charts are in bound volumes consisting of 12 or 13 individual current diagrams prepared on the same base.

4. Accuracy

Navigational charts are relied on for safety of life and property in two major segments of the nation's transportation system. Therefore, accuracy is a factor of major concern throughout the numerous operations required to produce a chart for use in navigation. Emphasis on accuracy shifts from operation to operation, depending on the kind of chart, affecting more operations and reaching the highest intensity in nautical charting.

Base maps which meet United States National Map Accuracy Standards provide terrain data required for aeronautical and nautical chart bases. Base maps for nautical charts, except in rare instances, are prepared by the National Ocean Survey. The scale for such mapping is never smaller than twice the scale of the affected chart. Chart base topography is prepared directly at charting

scale on occasion when a contemporary hydrographic survey is not scheduled. Certain features critical to safe marine navigation are mapped to stricter accuracy criteria than the national standards. For example, the shoreline (usually the mean high water line) and the mean low water line, must be within 0.5 mm (at mapping scale) of the true position. This is about 16 feet at 1:10,000 scale compared to 28 feet under the national standards. Fixed aids to navigation and objects to be charted as landmarks must be within 0.3 mm (about 10 feet) at 1:10,000 scale of true position as compared to 28 feet. Similar accuracy criteria are not applied to the preparation of aeronautical charts but radio navigational facilities and obstructions to safe operation of aircraft are located and charted with an accuracy commensurate to the charting scale. Bases for all the other types of charts usually are prepared from existing aeronautical or nautical charts, whichever is most suitable.

5. Scale and Content

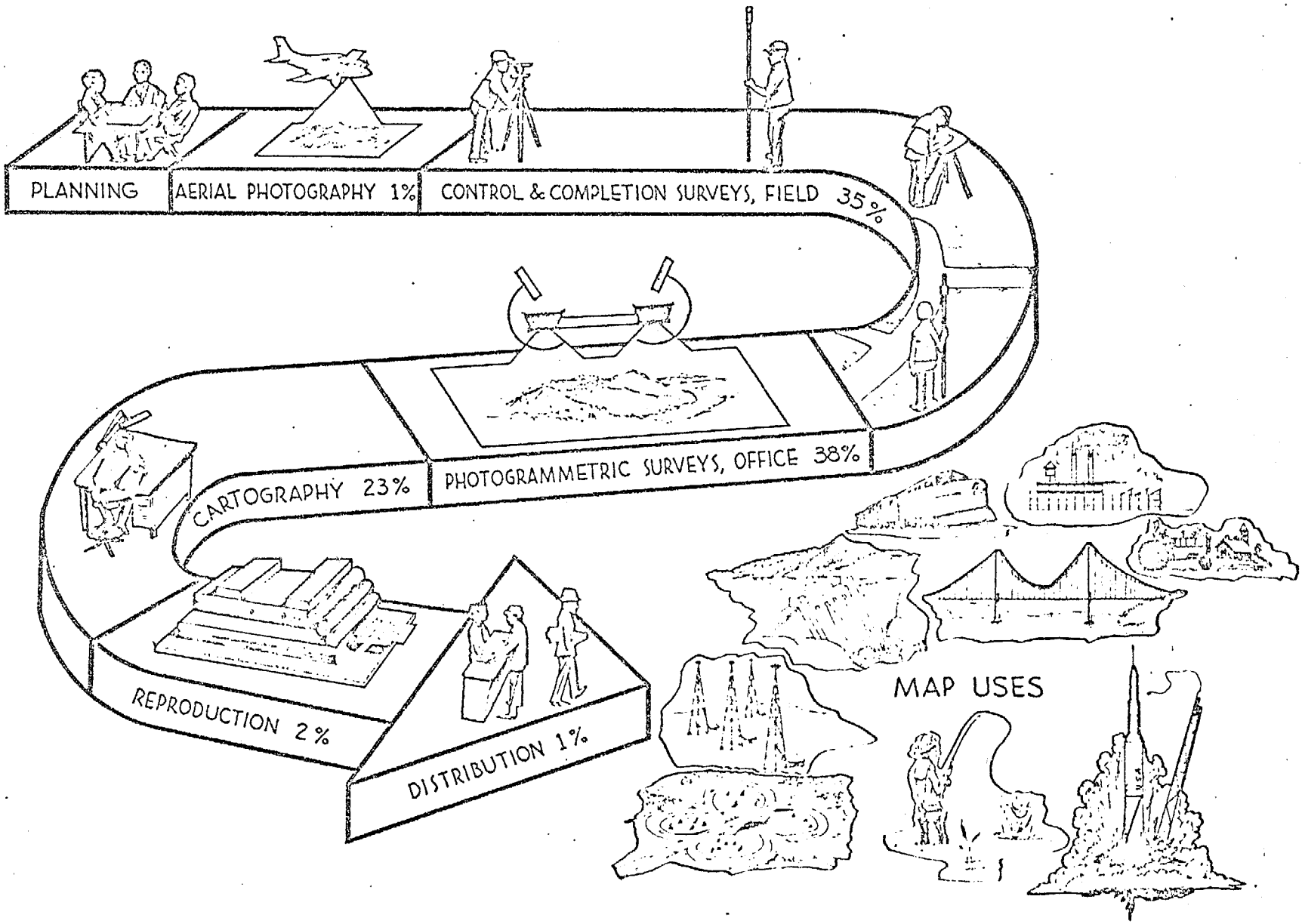
Chart content is governed by the intended use of the chart and its publication scale. The affect of scale on charts is the same as on maps; more detail can be shown without congestion, or legibility can be increased with larger symbols and type at large mapping scales but at the expense of areal coverage. Small mapping scales permit coverage of larger geographic areas but detail must be sacrificed to avoid congestion. Chart content of value in coastal-zone activities varies with the kind of chart, and certain detail

is emphasized to achieve prominence to benefit the intended user.

In general, small-scale charts are suitable for planning or, perhaps, gross inventory purposes, depending upon charted detail. For example, sectional aeronautical charts can be used for planning purposes in the emerged areas of the coastal zone. Like large-scale maps, large-scale charts are of the greatest value to users. Scale can be changed by either enlargement or reduction through the use of photographic and mechanical techniques. However, scale enlargement is not a recommended procedure, except as an expedient, because all errors accumulated in producing the chart are enlarged by the same factor. Too, photographic enlargement can result in reduced legibility, or, even in its complete loss.

Details shown or indicated on a chart comprise the contents of that chart. Certain details may be common to several different kinds of charts. Some examples are the graticule and the shoreline. Both are of critical importance on nautical charts and are invariably indicated in a prominent manner. The shoreline is not as important to an aircraft navigator as it is to a ship's navigator and is indicated less prominently on aeronautical charts; it is of even less significance to users of isogonic charts, where it is indicated with even less prominence.

SEQUENCE OF TOPOGRAPHIC MAPPING OPERATIONS
AND % OF TOTAL COST INVOLVED IN EACH MAJOR PHASE



6. Revision

Obsolescence of contents can make a chart worthless in an exceedingly short period of time. Like maps, charts are made obsolete by the acts of man and nature; most often by the former. The majority of aeronautical charts are revised semiannually; those of remote areas at a less frequent interval. Changes to this kind of chart usually affect airways data and navigational facilities and have very little significance to the coastal zone. Nautical charts are generally revised on an annual schedule if the area covered is congested, subject to frequent change, or bears heavy marine traffic. Charts covering remote areas, relatively free from the works of man, and supporting little traffic are revised at much longer intervals. Isogonic charts are not revised. They are recompiled and reissued periodically to conform with an established epoch (every 5 years). There is no established revision schedule for isopach charts. Airport obsturction charts are revised on a 3-year basis when resources permit. Obstruction charts of some smaller airports, where traffic is light, are revised less frequently.

8. Overprints and Overlays (USGS)

1. Definitions

Overprinting is the practice of printing additional information on a map. An overlay is a printing, photograph, or drawing on a transparent or translucent medium at the same scale as the base map. The information added by using either an overprint or an overlay is designed to show details not appearing on the original or to give special emphasis to details which do appear on the original.

2. Uses

Overprints may be used for revision purposes. New roads, buildings, dams, reservoirs, etc., can be added to original maps with an additional press run. Revised copies of published maps can be made by adding a revision plate to the original map guides rather than having to correct the original copy. Sometimes an extra color is used for the revision data. This makes it possible to evaluate the changes which have taken place during the time interval between the initial publication and the revision issue. Overprints also direct the users' attention to certain specialized data. Examples of this use are an arrow pointing to a particular feature or perhaps a shading delineating the best route between two cities.

Overlays are used in conjunction with the original base map. They do not become a permanent part of the map as does an overprint.

Overlays can provide the same information as can an overprint. Sometimes several overlays are used in combination to display changes over a period of time or to reveal data to an audience in a piecemeal fashion.

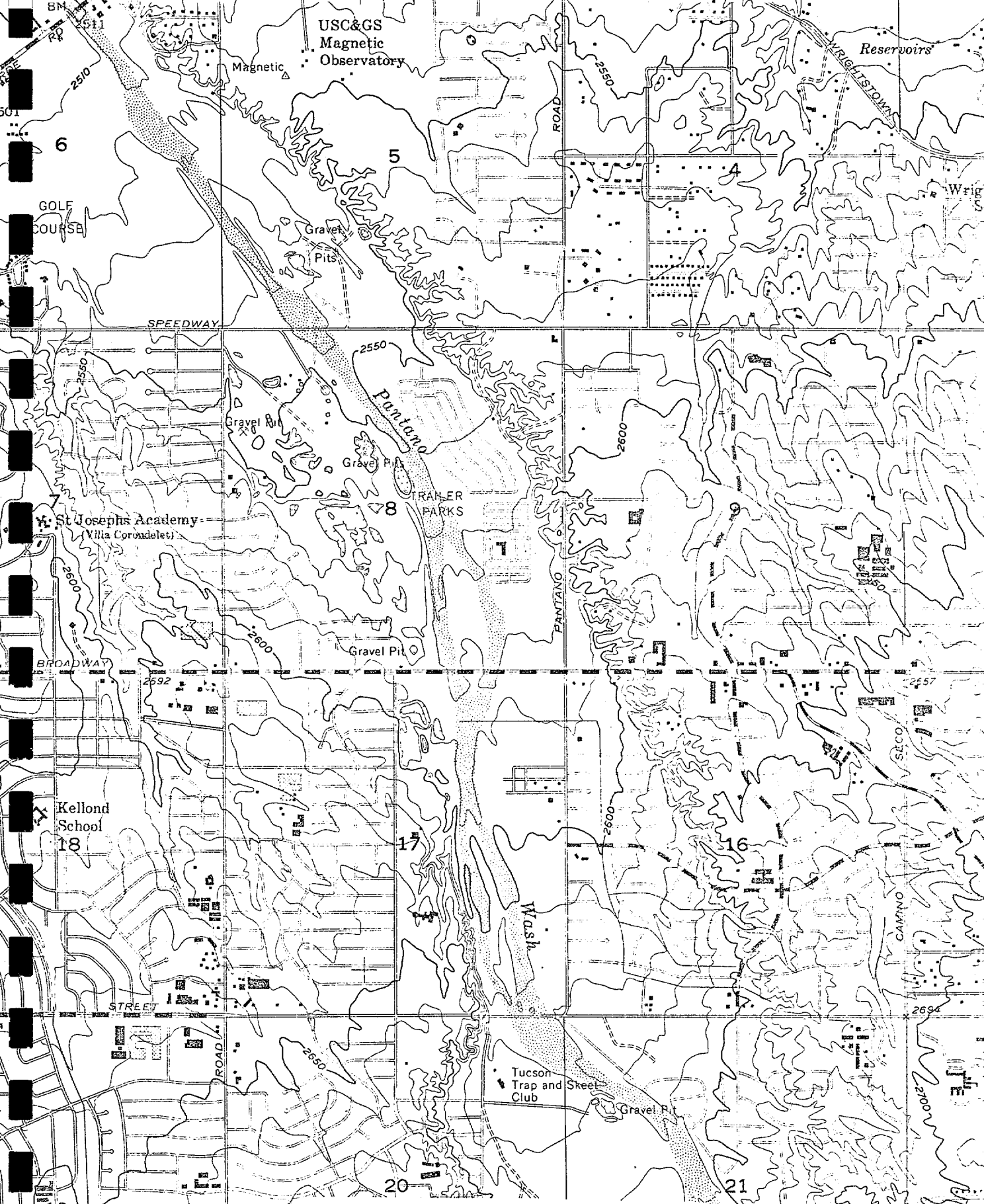
Cartographers use overlays in the planning and production of maps. Examples of these uses include the following:

1. Administrative data; cost, priorities, location of field parties.
2. Planning and surveying for control
3. Planning, procurement, and annotation of photographs
4. Editing of compilation manuscripts
4. Classification guide for draftsmen
4. Layout of contour numbers or soundings
7. Name placement and type style.

The U.S. Geological Survey's Land Use Data and Analysis (LUDA) Program is an example of the effective use of overlays. The 1:250,000 topographic map series is being used as the basis for the production of overlays (film positives) showing classification of land uses throughout the country. These film positives may be used in conjunction with the base map or they may be combined with selected plates from the base map and published as land use maps.

3. Examples of overlays for coastal zone management

Although overprints may be of use in a coastal zone mapping effort, overlays are more suitable. A high percentage of these overlays



TUCSON EAST QUADRANGLE

ARIZONA—PIMA CO.

7.5 MINUTE SERIES (TOPOGRAPHIC)

Portion of Henderson, Texas, Land-use overlay.

would fall into an area of interest to both the Federal and the State governments.

Examples of overlays appropriate for Coastal Zone Management are:

1. 100 year flood plain
2. Soils
3. Geology
4. Population
5. Estuarine studies
    a. discharge
    b. run-off
    c. physical characteristics
        (1) salinity
        (2) slope analysis
6. Oceanography
    a. hydrodynamics
    b. sediments
        (1) bottom
        (2) near surface
    c. currents
        (1) surface
        (2) sub-surface
    d. tidal
        (1) location of station
        (2) data
        (3) bench marks

7. Climatic studies
    a. temperature
    b. rain fall
        (1) seasonal
        (2) annual
8. Resources
    a. living
    b. non-living
9. Land use
10. Wetlands
    a. vegetation
    b. limits
11. Sanctuaries and refuges
    a. public
    b. private
12. Historical and archeological sites
13. Land ownership
14. Recreation
    a. parks
    b. marinas
15. Pollution
    a. sewage outfalls, ocean dumping, etc.
    b. air
    c. noise

16. Support services

a. primary

(1) sewage disposal

(2) fresh water

(3) solid waste disposal

(4) electricity

(5) transportation

b. secondary

(1) schools

(2) hospitals

(3) fire stations

(4) police stations

4. Advantages and limitations

An overprint becomes a permanent part of a map. This permanency may be undesirable at a later date and the entire map probably would then have to be revised. Overprints do have an advantage over overlays where the latter require the use of one or more additional sheets which may be cumbersome to the user. However, overprinting requires at least one press run which can be quite costly. On the other hand overlays may be produced photographically or even by hand. The cost of production of small quantities of overlays would be less than that for overprinting.

The greatest advantage of overlays is the fact that their use makes it possible to avoid the crowding of map detail. The use of

overprinting should be limited by the amount of data that can be placed on a single map without causing confusion. By using overlays in keeping with the feature separation concept (See II.9.2), an unlimited number of different types of information can be related to the same base map and to each other in whatever combinations are desired.

9. Data Extraction Techniques (USGS)

A map user may not be interested in all of the information on a map. He may be concerned with a single subject or with several kinds of information on an individual basis. It is impractical for cartographers to attempt to produce a map for individual interests. Likewise, it is not feasible to produce maps using every conceivable combination of plates to satisfy every requirement. Therefore, it is necessary for the user to extract from a map the specific data which he needs, and he may have to be content with less than the total information desired.

1. Visual-extraction method

Whenever one reads a map he is extracting data. A map reader, whether or not he is conscious of the fact, selects certain information and disregards the rest. When a person reads a map to find his way he makes a visual interpretation of the data and reacts to it by choosing his route. Others may be interested in interpreting every aspect of specific map features. This task may be accomplished visually by mental calculation or with the use of map reading aids such as

scales, protractors, compasses, and cartometers. Data collection by this method is time consuming and is vulnerable to human error.

2. Feature-separation concept

As explained in II.5., press plates for multicolored maps are produced from color separation guides. Each color may be broken down farther. For example, several blue guides may be combined to produce one blue press plate. There could be a guide for lakes and ponds, one for streams, another for swamps, etc.

There can be even greater separation. The following list is an example of some of the possibilities:

I. Black
   a. Transportation systems
      (1) Major highways
      (2) Secondary roads
      (3) Tertiary roads
      (4) Unimproved roads
      (5) Trails
      (6) Railroads
      (7) Airports
   b. Control
   c. Labels (names)
   d. Culture
      (1) Buildings
      (2) Schools, churches, or cemeteries, etc.

(3) Wells: oil, gas, water

(4) Mines

(5) Recreation areas

(6) Marinas

(7) Military reservations

(8) Boundaries

(9) Utilities

(a) Power transmission lines

(b) Pipelines

(c) Telephone lines

2. Brown

a. Contours

(1) Index contours

(2) Intermediate contours

(3) Supplemental contours

b. Sand

(1) Beach

(2) Dunes

c. Tailings

d. Levees

e. Strip mines

3. Blue

a. Streams.

(1) Perennial

(2) Intermittent

b. Ponds

c. Swamps

d. Inundated areas

e. Depth curves

f. Rice paddies

4. Green

a. Woodland

b. Orchards

c. Scrub

d. Mangrove (symbol often requires a blue overprint)

e. Vineyards

5. Red

a. Major highway classification

b. Highway route numbers

c. Land lines

d. Urban tint

Feature separation makes it possible for a map user to delete extraneous information and to compile a data collection with greater ease. Also, one can select from the available plates and combine them in different ways to produce thematic maps. Changes in color combinations can be used in conjunction with feature separation to emphasize certain features.

Using feature-separation techniques maps of different scale can be produced using the same basic data. As explained in II.6.6, the effect of decreasing the scale of a map could be the crowding of data.

(Figure __. Feature separation of San Juan Experimental Map.)

By removing a number of plates from the original map materials before reduction takes place one can avoid the problem of crowding. For example, the primary and secondary road guides from several 1:24,000 scale feature-separated maps could be separated from the other materials and could be reduced and combined to compile a map at at 1:50:000 or 1:100,000 scale. Only the final map data would be reduced, thus facilitating compilation of the newly generated map.

3. Automation

Computers and related machinery have helped to ease the task of preparing maps and extracting map data. Although automated cartography still is in its infancy, great steps have been taken toward the goal of full automation of cartographic processes.

One approach to automation is to use of an automated coordinatograph, an instrument by which the X and Y coordinates of points and/or lines can be plotted or determined. Map data arranged according to location can be stored on punch cards and/or tapes. One can recall the information at a later date and have the coordinatograph create a graphic from the stored information. The data thus recalled and plotted may be edited, by correcting, deleting, or adding to the data, and the edited data then may be returned to storage. Some of this editing can be done automatically.

The usefulness of map data can be enhanced by feature separation (II.9.2). Cartographic information can be stored in a data bank in such a way that the user can be selective in recalling data.

(Figure __. USGS Research: Automation in Cartography.)

For example, one can select the set of all towns with a population greater than x number of people, or the set of all contours resulting from an interval of y. The user can make his own feature separation from the total available information and can combine separate features as he chooses. In some cases he may be able to select the scale(s) or even the projection at which the graphical output is drawn.

If the user's ultimate goal is to compile statistics he can extract the data from published maps and manually compile his lists. However, digitized map data can be retrieved in list form, eliminating the need for map interpretation and saving the time needed to compile a list by hand.

10. Land-Use Classification Systems (USGS)

1. Importance of land-use information

Every economic and social activity in the United States requires some use of land or water. According to Clawson (Reference 5), in 1970 the average person in the United States used or derived products from about eleven acres of land.

Unfortunately, the supply of desirable land in choice locations is no longer plentiful. There are serious problems of land misuse and degradation. Careful management of our resources is essential and any management program requires tools such as land-use maps. For the purpose of this discussion the term "land use" will refer to use of both land and water.

Land use is one of the most important subjects in thematic mapping. Nevertheless, the availability of land-use maps has not reached the level of that of topographic and geologic maps. Although several classification systems have been developed, none has met the needs of every project or investigator.

The advent of remote-sensing techniques has brought about changes in the procedures surrounding land-use classification. Although the use of photographs allows for faster compilation, the new problems of image identification and interpretation are introduced.

2. Considerations in land-use classification

Before developing a land-use classification system one must define the term "land-use." A system can be designed to classify such things as improvements, historical considerations, aesthetic attributes, and human activity. Clawson and Stewart (Reference 6) prefer the purity of a system which deals exclusively with the human aspect. They offer the following additional characteristics of a good classification of man's activities:

1. The system should be flexible. It should be usable either in great detail, or in summary form. The user should be able to recombine data in different ways to meet his particular needs, but without modifying the activity classification as such.

2. The system should be based, as far as possible, upon what the field observer actually sees on the ground or on aerial photographs, with a minimum of classification or grouping at that point. Field enumeration should be based on the smallest recognizable and geographically identifiable unit of land.

3. Data should be readily susceptible to machine processing and should be computer compatible.

Land-use classification systems developed to date have been unable to escape an element of arbitrary decision making. Some land uses have arbitrary boundaries, e.g., hunting or recreation may be confined within property boundaries although adjacent land may be equally suited for these activities. It is difficult to draw divisions between some classes if their extent is vague or if their influence diminishes gradually. The human-judgment factor almost assures disagreement among different compilers. Decisions have to be made about how to classify areas where there are mixtures of equally significant land uses, and in cases of subsurface land use where, for example, mining takes place below a residential area.

The traditional problem with classification systems has been standardization. But the fact that systems differ in format is not the whole problem. Problems in terminology compound the difficulty. Nunnally and Witmer (Reference 16) explain:

> Problems in terminology appear to be two kinds--those associated with the incompatibility of terms used in different systems, and

those where the same term may be used differently in several systems. A good example of the former is the use of such words as arable, cultivated, and cropland; all of which are similar but do not necessarily mean exactly the same thing. The latter problem is illustrated by the varying meanings that are attached to a word like "idle" in agricultural land use. This category may or may not include fallow cropland, abandoned land and land in conservation reserve programs.

Remote-sensing applications bring with them problems of image identification. The image forming devices do not record activity directly. The sensors acquire data which primarily are based on the characteristics of the ground cover. Seasonal changes may effect those characteristics. Therefore, a certain amount of ground investigation is desirable.

A land use classification system which can effectively employ orbital and high-altitude imagery should meet the following criteria (Anderson, Reference 3):

1. The minimum level of accuracy in image interpretation should be at least 85 percent.

2. The accuracy of interpretation for the several categories should be about equal.

3. Repeatable or repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.

4. The classification system should be applicable over extensive areas.

5. The categorization should permit vegetation and other types of land cover to be used as surrogates for activity.

6. The classification system should be suitable for use with imagery obtained at different times of year.

7. Effective use of subcategories that can be obtained from ground surveys or from the use of larger-scale or enhanced imagery should be possible.

8. Aggregation of categories must be possible.

9. Comparison with past and future land use should be possible.

10. Multiple uses of land should be recognized when possible.

For a discussion of the accuracies obtained from orbital imagery the reader is directed to Reference 12. This is a report on the use of LANDSAT (ERTS) and SKYLAB/EREP imagery to investigate coastal zone land use and vegetation in the Delaware Bay area. Automatic classification of LANDSAT data yielded classification accuracies of over 80 percent for all categories tested. Visual interpretation of EREP Earth terrain photographs resulted in classification accuracies ranging from 75 to 99 percent.

3. Classification Systems

The land-use classification concept has been known for centruies. Originally land classification was confined to very small areas with each system being entirely independent of others. In 1930 Prof. L. Dudley Stamp made the important achievement of developing a uniform classification system for an entire country, Great Britain. Maps were distributed to interested citizens including students and teachers. Working in their own local area they classified each field, accordint to the table below, resulting in complete coverage of the country.

STAMP'S SYSTEM OF 1930

F - Forest
M - Meadow
H - Heath and rough pasture
G - Gardens and orchards
W - Wasteland, cities, yards, cemeteries, etc.
P - Water

Obviously, a system such as Stamp's does not go into as great detail as some users require. More detailed study of land use calls for greater breakdown of the general categories.

Nevertheless, Stamp's system was a step toward standardization because a large area was classified under a single system. The professor later was involved in an attempt to standardize on a worldwide basis. He played a major role with the World Land Use Survey Commission of the International Geographical Union. In 1949 the Commission published a report that presented the following classification system for use on a worldwide basis.

CATEGORIES OF THE INTERNATIONAL GEOGRAPHICAL UNION

1. Settlements and associated nonagricultural lands
2. Horticulture
3. Tree and other perennial crops
4. Cropland
   a. Continual and rotation cropping
   b. Land rotation
5. Improved permanent pasture
6. Unimproved grazing land
   a. Used
   b. Not used
7. Woodlands
   a. Dense
   b. Open
   c. Scrub
   d. Swamp
   e. Cut-over or burnt-over forest areas
   f. Forest with subsidiary cultivation
8. Swamp and marshes
9. Unproductive land

The U.S. Department of Agriculture, Soil Conservation Service developed the following categories for land use and ground cover.

1. Urban and built-up
   1.1 Roads and railroads
   1.2 Residential, commercial industrial, mixed, and other
2. Agricultural land
   2.1 Non-irrigated cropland
      2.11 Row crops
      2.12 Close grown crops
      2.13 Summer fallow
      2.14 Rotation hay and pasture
      2.15 Hayland
      2.16 In conservation use
      2.17 Temporarily idle
   2.2 Irrigated cropland
      2.21 Row crops
      2.22 Close grown crops
      2.23 Summer fallow
      2.24 Rotation hay and pasture
      2.25 Hayland
      2.26 In conservation use
      2.27 Temporarily idle
   2.3 Non-irrigated pasture
   2.4 Irrigated pasture

2.5 Non-irrigated orchards, groves, vineyards, nurseries, and ornamental hort. areas
2.6 Irrigated orchards, groves, vineyards, nurseries, and ornamental horticultural areas
2.7 Confined feeding operations
2.8 Other agricultural land

3. Rangeland
   3.1 Herbaceous range
   3.2 Shrub-brushland range
   3.3 Mixed range

4. Forest land
   4.1 Deciduous forest
      4.11 Grazed commercial forestland
      4.12 Not grazed commercial forestland
      4.13 Grazed noncommercial forestland
      4.14 Not grazed noncommercial forestland
   4.2 Evergreen forest
      4.21 Grazed commercial forestland
      4.22 Not grazed commercial forestland
      4.23 Grazed noncommercial forestland
      4.24 Not grazed noncommercial forestland
   4.3 Mixed forest
      4.31 Grazed commercial forestland
      4.32 Not grazed commercial forestland
      4.33 Grazed noncommercial forestland
      4.34 Not grazed noncommercial forestland

5. Water
   5.1 Ponds, lakes, reservoirs, 2.5 to 40 acres in size
   5.2 Ponds, lakes, and reservoirs more than 40 acres in size
   5.3 Canals, streams and rivers 165 to 660 feet wide
   5.4 Canals, streams and rivers more that 660 feet wide

6. Wetlands
   6.1 Deciduous forest wetlands
   6.2 Evergreen forest wetlands
   6.3 Mixed forest wetlands
   6.4 Non-forested wetlands

7. Barren land
   7.1 Salt flats
   7.2 Beaches and mudflats
   7.3 Non-beach sandy areas
   7.4 Exposed rock
   7.5 Stripmines, quarries, sand and gravel pits
   7.6 Mixed
   7.7 Other

8. Tundra
   8.1 Shrub and bush tundra
   8.2 Herbaceous tundra
   8.3 Bareground tundra
   8.4 Wet tundra
   8.5 Mixed tundra

9. Permanent snow and icefields
   9.1 Permanent snow fields
   9.2 Glaciers

In January 1965, the Urban Renewal Administration, Housing and Home Finance Agency (Now Department of Housing and Urban Development), and the Bureau of Public Roads, Department of Commerce (Now Federal Highway Administration, Department of Transportation), published the Standard Land Use Coding Manual. The Manual provides a four-digit categorization of land use developed mainly for use in urban and adjacent situations in the United States. This classification scheme was not designed specifically for use with air photointerpretation or other remote-sensing techniques. Ground observation and enumeration obviously must provide much of the information necessary to classify land use with this scheme when used in urban areas.

Since it would require several pages to reproduce this system in its entirety, only the first two levels are shown below. As an example of the complete four-level system, the category, Transportation, Communication, and Utilities, has been expanded to the fourth level. For the complete coding system the reader is referred to Reference 6.

A STANDARD SYSTEM FOR IDENTIFYING AND CODING LAND USE ACTIVITIES

1. Residential
   11. Household units
   12. Group quarters
   13. Residential hotels
   14. Mobile home parks or courts
   15. Transient lodging
   19. Other residential

2. Manufacturing
   21. Food and kindred products
   22. Textile mill products
   23. Apparel and other finished products made from fabrics, leather, and similar materials
   24. Lumber and wood products (except furniture)
   25. Furniture and fixtures
   26. Paper and allied products
   27. Printing, publishing, and allied industries
   28. Chemicals and allied products
   29. Petroleum refining and related industries
3. Manufacturing (continued)
   31. Ruber and miscellaneous plastic products
   32. Stone, clay, and glass products
   33. Primary metal industries
   34. Fabricated metal products
   35. Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks
   39. Miscellaneous manufacturing
4. Transportation, communication, and utilities
   41. Railroad, rapid rail transit, and street railway transportation
      411. Railroad transportation
         4111. Railroad right-of-way (excluding switching and marshaling yards)
         4112. Railroad switching and marshaling yards.
         4113. Railroad terminals (passenger)
         4114. Railroad terminals (freight)
         4115. Railroad terminals (passenger and freight)
         4116. Railroad equipment and maintenance
         4119. Other railroad transportation
      412. Rapid rail transit and street railway transportation
         4121. Rapid rail transit and street railway passenger termin
         4123. Rapid rail transit and street railway equipment mainte
         4129 Other rapid rail transit and street railway transportat
   42. Motor vehicle transportation
      421. Bus transportation
         4211. Passenger terminals (intercity)
         4212. Passenger terminals (local)
         4213. Passenger terminals (intercity and local)
         4214. Garaging and equipment maintenance.
         4219. Other bus transportation
      422. Motor freight transportation
         4221. Terminals
         4222. Garaging and equipment maintenance
         4229. Other motor freight transportation
      429. Other motor vehicle transportation
         4291 Taxicab transportation
         4299. Other motor vehicle transportation

43. Aircraft transportation
    - 431. Airports and flying fields
        - 4311. Landing/takeoff fields
        - 4312. Terminals (passenger)
        - 4313. Terminals (freight)
        - 4314. Terminals (passenger and freight)
        - 4315. Aircraft storage and equipment maintenance
        - 4319. Other airports and flying fields
    - 439. Other aircraft transportation
        - 4391. Heliport landing/takeoff pads
        - 4399. Other aircraft transportation

44. Marine craft transportation
    - 441. Marine terminals
        - 4411. Terminals (passenger)
        - 4412. Terminals (freight)
        - 4413. Terminals (passenger and freight)
        - 4414. Terminals (commercial fishing)
        - 4419. Other marine terminals
    - 449. Other marine craft transportation

45. Highway and street right-of-way
    - 451. Freeways
    - 452. Expressways
    - 453. Parkways
    - 454. Arterial streets
    - 455. Collector/distributor streets
    - 456. Local access streets
    - 457. Alleys
    - 459. Other highway and street right-of-way

46. Automobile parking

47. Communication
    - 471. Telephone communication
        - 4711. Exchange stations
        - 4712. Relay towers (microwave)
        - 4719. Other telephone communication
    - 472. Telegraph communication
        - 4721. Message centers
        - 4722. Transmitting and receiving stations
        - 4729. Other telegraph communication
    - 473. Radio communication
        - 4731. Broadcasting studios (only)
        - 4732. Transmitting stations and towers
        - 4739. Other radio communication
    - 474. Television communication
        - 4741. Broadcasting studios (only)
        - 4742. Transmitting stations and relay towers
        - 4749. Other television communication
    - 475. Radio and television communication (combined systems)
        - 4751. Broadcasting studios, only
        - 4759. Other combined radio and television communication.

479. Other communication
48. Utilities
481. Electric utility
4811. Transmission right-of-way
4812. Generation plants
4813. Regulating substations
4819. Other electric utility
482. Gas utility
4821. Pipeline right-of-way
4822. Production plants
4823. Natural or manufactured gas storage and distribution points
4824. Pressure control stations
4829. Other gas utilities
483. Water utilities and irrigation
4831. Pipeline right-of-way
4832. Treatment plants (purification)
4833. Storage
4834. Irrigation distribution channels
4835. Pressure control stations
4839. Other water utilities and irrigation
484. Sewage disposal
4841. Treatment plants
4842. Sludge drying beds
4843. Pressure control stations
4849. Other sewage disposal
485. Solid waste disposal
4851. Refuse incineration
4852. Central garbage grinding stations
4853. Compositing plants
4854. Sanitary land fills
4855. Refuse disposals
4856. Industrial waste disposals
4857. Active slag dumps and mineral waste disposals
4859. Other solid waste disposal
489. Other utilities
49. Other transportation, communication, and utilities
491. Other pipeline right-of-way and pressure control stations
4911. Petroleum pipeline right-of-way
4912. Petroleum pressure control stations
4919. Other pipeline right-of-way and pressure control stati
492. Transportation services and arrangements
4921. Freight forwarding services
4922. Packing and crating services
4923. Travel arranging services
4924. Transportation ticket services
4929. Other transportation services and arrangements
499. Other transportation, communication, and utilities
5. Trade
51. Wholesale
52. Retail building materials, hardware, and farm equipment

53. Retail general merchandise
54. Retail food
55. Retail automotive, marine craft, aircraft, and accessories
56. Retail apparel and accessories
57. Retail furniture, home furnishings, and equipment
58. Retail eating and drinking
59. Other retail trade

6. Services
   61. Finance, insurance, and real estate services
   62. Personal services
   63. Business services
   64. Repair services
   65. Professional services
   66. Contract construction services
   67. Governmental services
   68. Educational services
   69. Micellaneous services
7. Cultural, entertainment, and recreational
   71. Cultural activities and nature exhibitions
   72. Public assembly
   73. Amusements
   74. Recreational activities
   75. Resorts and group camps
   76. Parks
   79. Other cultural, entertainment, and recreational
8. Resource production and extraction
   81. Agriculture
   82. Agricultural related activities
   83. Forestry activities and related services
   84. Fishing activities and related services
   85. Mining activities and related services
   89. Other resource production and extraction
9. Undeveloped land and water areas
   91. Undeveloped and unused land area (excluding noncommercial forest development)
   92. Noncommercial forest development
   93. Water areas
   94. Vacant floor areas
   95. Under construction
   99. Other undeveloped land and water areas.

Another system is that which was the product of a study carried out by the Commission on Geographic Applications of Remote Sensing of the Association of American Geographers. The scale of 1:250,000 was used for a study in the Phoenix, Arizona, area to test the

capabilities of the system for use mainly with conventional color and color infrared imagery taken from Apollo 9 and from high-altitude aircraft.

I. Resource production and extraction
   A. Agricultural
      1. Crop production (cropland)
      2. Fruit (orchards, groves, and vineyards)
   B. Grazing
      1. Rangeland grazing (rangeland)
      2. Livestock pasturing (pasture)
   C. Forestry
      1. Commercial
      2. Non-commercial
   D. Mining
   E. Quarrying
II. Transportation, communication, and utilities
   A. Transportation
      1. Motoring (highways, parking, terminals, etc.)
      2. Railroading (rights-of-way, yards, terminals, etc.)
      3. Flying (airports)
      4. Shipping (inland waterway & marine docks & related facilities)
   B. Communications
      1. Telephone lines and facilities
      2. Telegraph lines and facilities
      3. Radio stations and facilities
      4. Television stations and facilities
   C. Utilities
      1. Electric
      2. Gas
      3. Water (including irrigation)
      4. Sewage disposal
      5. Solid waste disposal
III. Urban activities
   A. Urbanized livelihood areas (urbanized areas defined by the Bureau of the Census)
      1. Industrial
      2. Commercial
      3. Services
      4. Residential
      5. Recreational

B. Other urban livelihood (places of more than 2,500 population but not including urbanized areas)
   1. Industrial
   2. Commercial
   3. Services
   4. Residential
   5. Recreational

IV. Towns and other built-up livelihood areas
   A. Industrial
   B. Commercial
   C. Services
   D. Residential
   E. Recreational

V. Recreational activities (other than those in urban areas and towns)
   A. Mountain oriented
   B. Water oriented
   C. Desert oriented
   D. Forest oriented
   E. Other (including combinations of above)

VI. Low-Activity Areas
   A. Marshland oriented
   B. Tundra oriented
   C. Barren land oriented (including lava flows, dunes, salt flats, mountain peaks above timber line, etc.)

VII. Water-using activities
   A. Lakes
   B. Reservoirs
   C. Streams
   D. Ponds

The USGS Circular 671, A Land-Use/Land-Cover Classification System for Use With Remote-Sensor Data, presents a two-level coding, shown in the following table. More detailed levels are left to the user's ingenuity, allowing for tailoring of the system to individual needs.

LAND-USE CLASSIFICATION SYSTEM FOR USE
WITH REMOTE SENSOR DATA

Level I	Level II
1. Urban and built-up Land	11. Residential
	12. Commercial and services
	13. Industrial
	14. Transportation, communications, and utilities
	15. Industrial and commercial complexes
	16. Mixed
	17. Other
2. Agricultural land	
	21. Cropland and pasture
	22. Orchards, groves, vineyards, nurseries, and ornamental horticultural areas
	23. Confined feeding operations
	24. Other
3. Rangeland	
	31. Herbaceous range
	32. Shrub-brushland range
	33. Mixed
4. Forest land	
	41. Deciduous
	42. Evergreen
	43. Mixed
5. Water	
	51. Streams and canals
	52. Lakes
	53. Reservoirs
	54. Bays and estuaries
	55. Other
6. Wetland	
	61. Forested
	62. Nonforested
7. Barren land	
	71. Salt flats
	72. Beaches and mudflats
	73. Sandy areas other than beaches
	74. Bare exposed rock
	75. Strip mines, quarries, and gravel pits
	76. Transitional areas
	77. Mixed

Level I	Level II
8. Tundra	81. Shrub and brush tundra
	82. Herbaceous tundra
	83. Bare ground tundra
	84. Wet tundra
	85. Mixed
9. Permanent snow and ice	91. Permanent snowfields
	92. Glaciers

Only a few classification systems have been shown here. Several more exist. Some States have developed their own systems according to their individual needs. In some cases the State systems are entirely independent. Others are an expansion of a previously developed system. A few of the States which have developed their own system are Alabama, California, and Maryland. For more information on State systems it is suggested that the reader contact the appropriate sources to be found in Appendixes A, B, and C.

PART III

FUTURE OUTLOOK FOR MAPPING AND CHARTING

I. Automation (USGS)

1. Influence of Data Gathering by Remote Sensing

There is a high potential for the application of remote sensing techniques for inventorying and managing the Nation's Earth resources and monitoring the environment. For example, LANDSAT (ERTS) imagery, because of its synoptic coverage, has identified previously unmapped geologic structures as targets for exploration for oil, gas, copper, and other minerals, and is being used to inventory water impoundment areas.

The repetitive coverage of satellite data provides information for land-use planning with a timeliness not previously possible. The capability of detecting changes in land and water use has proved effective in the monitoring and reclamation of strip mines. It will be useful in identifying beach erosion and for gaging the environmental impact of projects such as the construction of the Alaskan pipeline.

Satellite-collected data in addition to that of LANDSAT (ERTS) includes the monitoring capability of SKYLAB, manned orbital flights, and environmentally oriented spacecraft such as weather satellites. In the cartographic field this data may be used to identify and locate newly constructed features, such as Interstate Highways, and to monitor the spread of urbanization. Revision of small-scale maps from ~~dots~~ data obtained by satellite remote sensing is a reality.

For example, the maps of the Amazon Basin were changed drastically after space imagery resolved old misconceptions concerning the drainage pattern.

The field of satellite geodesy has proved itself in remote parts of the world including Antarctica. By using U.S. Navy Navigation Satellites and applying the principles of the Doppler effect, X, Y, and Z coordinates of ground stations may be obtained via a Geoceiver. Applications of this system may become useful in places like the Florida Everglades or the vast coastline of Alaska.

2. Computer Stored Data

The demand for charts and maps in all branches of cartography has increased during the past few decades. Therefore, the workload has increased. In the future cartographers will be better equipped to cope with the increased demand because of research in the field of map digitization.

By storing cartographic information in digital form one acquires the ability to retrieve and manipulate the data at a later date by automatic means. The most important advantage of the digital form is the capability of automatic access. It is important to make the most efficient and flexible storage system possible.

Digital map data falls into three basic categories; point data, linear data, and area data. Point data includes such features as control stations, boundary monuments, and wells. Data of this

type are recorded by coordinates and include any features which can be located by a pinpoint. An expansion of the point concept leads to linear data which include roads, railroads, streams, etc. Linear features constitute sequences of closely spaced point coordinates. Area data are those which require a tint or pattern such as woodland, swamp, and urban tint. Although the boundaries of areas can be defined by lines, use of a pixel array approach simplifies the task of digitizing area data.

The larger the amount of stored data, the greater will be the accuracy and the flexibility in selective retrieval. However, one may encounter both a storage problem and high costs in an attempt to record a plethora of data. Consideration should be given to compacting the digital information and to developing a less costly storage system in the future.

Some data which would be included in a digital map data bank are directly available in digital form. These data can be input with relative ease. However, most of the data would come from line drawings and published maps. For the purpose of digitizing drawings automatic line-following devices are being developed. Similar scanning devices for area data are being researched as well as the practice of digitizing map data during compilation.

Computer stored cartographic data can be retrieved automatically either as a printout or in the form of a line drawing depending upon whether the user is interested in statistical data or a graphical analysis.

The statistics derived from a single data base may vary according to the judgments of the statisticians. Because the original source data is retained, a digital map allows each user to make his own judgments without the prejudices that a printed map has incorporated from its compilers. Because the basic data is somewhat permanent, the user is free to make his own interpretation.

3. Updating

Often a map is out-of-date before it is published because of the time needed for compilation and publication. A major benefit of the computerized map is the fact that it can be corrected on a continuous basis. Erroneous and/or obsolete information can be changed by issuing a correction instruction. Actual additions or deletions to map copy will not be necessary. The initial task of digitizing existing maps is monumental, but, because of this digitization maps of the future will be produced and revised more easily.

For detailed information about current methods of automated cartography and research in this field the reader is referred to the journals and information services of the technical sources listed in Appendix D.

2. The Metric System (USGS)

Adoption of the metric system in the United States will have marked effect upon mapping procedures. For the most part cartographers will deal with the length of measure, the metre. Fortunately the ground control used in mapping generally is extended from

the National Geodetic Network which has always been in the metric system. Many of the electronic distance measuring devices used for horizontal control measurements are designed for use with the metric system. Vertical control by leveling may be measured in feet or metres depending on the equipment used. The trend is toward the use of metric rods and compatible instruments. In cases where elevations have already been obtained in terms of feet a simple conversion to the metric system is practical for operational purposes. However, rewriting station descriptions which have been recorded in feet, yards, and miles would be a monumental task.

Manufacturers of photogrammetric instruments usually design their products in the metric system. Most stereocompilation instruments provide for direct elevation readout in either system. With instruments whose elevation readout is in the English system a conversion to metric probably can be effected by a minor change in equipment.

Because of the conversion to the metric system, changes in format, scale, contour intervals, and drafting specifications will be necessary. To facilitate metric scaling there will be greater use of publication scales such as 1:20,000 and 1:100,000. The scales of previously published maps may be changed upon revision. That can be accomplished photomechanically with a minimum of cartographic work. Scale changes may require a change in format to reduce sheet size. For example, a series with a 7.5-minute quadrangle format could be replaced by one with a metric grid format. Drafting

specifications for symbol size and line weight usually are stated as fractions of an inch. The specifications will have to be rewritten to incorporate metric units. Some tools will have to be replaced.

Probably the greatest problem of metric conversion will lie with the contours. Present intervals of 80, 40, 20, and 10 feet will have to be replaced by intervals such as 20, 10, 5, and 2 (or 2.5) metres. This change will necessitate the interpolation and/or redrawing of thousands of contour manuscripts.

USGS plans to have the capability of making a complete change to metric products by July 1976. All new series will be metric as of now. Beginning with the effective date of the complete change, all maps entering into production will be metric. Any maps in progress on that date will be completed in the old system.

3. A View Toward the Future (USGS)

The following has been extracted from Reference 22:

Land surveys--The land surveyor will discard his transit and EDM equipment and replace them with an inertial package weighing 2 to 4 kilos which can be hand-carried or mounted on a land vehicle, boat, or aircraft. Starting at a point of known position and elevation, and with azimuth indicated by an automatic north-seeking gyroscope, the surveyor indexes the equipment to the known parameters of the point; he then proceeds in the vehicle to the first point whose position and elevation are required. By means of the gyro,

accelerometers, elevation meter, and computer contained in the inertial package, changes in powition and elevation are continuously recorded and integrated in the computer and displayed digitally. When the vehicle reaches the desired point, the surveyor presses a key and the computer prints out the three coordinates of that point in the required coordinate system. In the same manner, he proceeds from point to point of the survey project, determining the coordinates of each point. Lengths and bearings of courses can then be determined from the coordinates by simple computation.

Small- and medium-scale maps--The principal data-gathering machinery for small- and medium-scale mapping (including special-purpose thematic maps) will be a cartographic satellite. This satellite will be so equipped that it can simultaneously produce data for basic control, generate high-resolution imagery for topographic image-based mapping and extension of control by analytical techniques, and produce imagery for thematic maps through an array of high-resolution sensors recording in the special portions of the spectrum giving optimum information for each desired theme. New sensors will be able to penetrate both cloud cover and vegetation so that clear images of the terrain surface will become available.

Basic control will be obtained by means of ground-based Doppler measurements on radio signals from the satellite. The basic control will then be extended by combining recorded spacecraft position, altitude, and attitude data with analytical aerotriangulation of

the imagery which records both the basic control stations and the area to be mapped. Plate coordinates of model control points will be read and correlated from plate to plate by an automatic image correlator.

Once the model control is established the best imagery for producing orthophotographs will be selected; it is likely that this will be the same imagery that is used for aerotriangulation. This imagery will then be processed in a universal automatic map compilation machine which requires only that the plates be oriented to control; the machine automatically produces a contoured orthophotograph. The orthophotographs can then be mosaicked to give the desired map format which will be an image base rather than a line map. The map will bear new symbols, compatible with automation. A byproduct of the automatic map compilation will be complete digitization of the terrain surface in terms of x-y-z coordinates at closely spaced intervals. The digital map data base will provide a ready means of accomplishing such operations as series conversion by computer and slope mapping. It will also provide a powerful means for rapid distribution of map data through local computer terminals.

Large-scale maps--For large-scale maps, such as maps of urban areas, the procedure will be somewhat different. The same kinds of imagery will, in general, be obtained as for small- and medium-scale maps, but the lower-flying vehicle will be an automated unmanned aircraft operated by remote control instead of a satellite at an orbital altitude.

Basic control for large-scale mapping will be obtained in the same manner as described above for determining positions and elevations of points for land surveys. This control will then be extended by analytical aerotriangulation to obtain model control. Map compilation will then be performed automatically in the same manner as for small- and medium-scale maps.

PART IV

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1A3	Contour Intervals	1966
1B5	Summary of Topographic Mapping Procedures	1956
2A1	Triangulation Standards and Datums	1956
2A2	Triangulation Planning and Reconnaissance	1955
2A3	Triangulation Stations and Signals	1955
2A4	Equipment for Triangulation	1955
2A5	Observing and Recording Horizontal Angles in Triangulation	1956
2A7	Preparing Triangulation Data for Computation	1953
2B3	Solution of Geodetic Triangles	1956
2B4	Computing Geodetic Positions from Triangulation	1957
2B7	Triangulation Adjustment by Variation of Coordinates	1966
2C1	Standards and Planning for Transit Traverse	1955
2C2	Equipment for Transit Traverse	1955
2C3	Permanent Marks for Transit Traverse	1954
2C4	Taping for Transit Traverse	1955
2C5	Instrumentman's Work in Transit Traverse	1955
2C6	Field Records fore Transit Traverse	1953
2C7	Polaris Observations for Azimuth	1954
2C8	Solar Observations for Transit Traverse	1953
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2D3	Computing Latitude and Departure	1952
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3D3	Autoplot Procedures	1968
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3F4	Multiplex Plotter Procedures	1960
3F5	Kelsh Plotter Procedures	1960
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PART V

GLOSSARY

accuracy--The degree of conformity with a standard, or the degree of perfection attained in a measurement. Accuracy relates to the quality of a result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained.

aerial photography--The art, science, or process of taking aerial photographs.

aerial triangulation--See aerotriangulation.

aerotriangulation--Triangulation for the extension of horizontal and/or vertical control accomplished by means of aerial photographs.

airport obstruction chart--See chart, airport obstruction.

angle of coverage--The apex angle of the cone of rays passing through the front nodal point of a lens. Wide-angle lens--A lens whose focal length is equal approximately to one half the diagonal of the format. Normal-angle lens--A lens whose focal length is equal approximately to the diagonal of the format. Narrow-angle lens--A lens whose focal length is equal approximately to twice the diagonal of the format.

bar scale--See scale, bar.

base map--See map, base.

bathymetric map--See map, bathymetric.

bathymetry--The art or science of determining ocean depths.

bench mark--A relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known.

bench mark, tidal--A bench mark set to reference a tide staff at a tidal station and the elevation of which is determined with relation to the local tidal station.

cadastral map--See map, cadastral.

cartometer--A device consisting of a small wheel and a calibrated dial used to measure distances on a map by following the desired route.

C-factor--An empirical evaluation which expresses the vertical (elevation) measuring capability of a stereoscopic system; generally defined as the smallest contour interval which can be plotted to required accuracy. The C-factor is not a fixed constant. It varies over a considerable range, according to the conditions of the photogrammetric system and the precision of use. The C-factor is often used to determine the flight height from which aerial photographs should be taken for photogrammetrically accomplishing topographic mapping, at the smallest contour interval accurately plottable from using a particular aerial camera and instrument system. The practicable flight height is the contour interval multiplied by the C-factor.

chart--A special-purpose map generally designed for nautical or aeronautical navigation or other particular purposes, in which essential map information is combined with various other data critical to the intended use.

chart, airport obsturction--TO BE DEFINED BY NOS.

chart, coastal--A nautical chart intended for inshore coastwise navigation when a vessel's course may carry her inside outlying reefs and shoals, for use in entering or leaving bays and harbors of considerable size, or for use in navigating larger inland waterways.

chart, datum--See datum, chart.

chart, harbor--A nautical chart intended for navigatgion and anchorage in harbors and smaller waterways.

chart, hydrographic--See chart, nautical.

chart, Intracoastal Waterway--A nautical chart intended for navigation of the Intracoastal Waterway which stretches from Boston, Massachusetts to Brownsville, Texas.

chart, isogonic--A chart of which the chief feature is a system of isogonic lines which join points of equal magnetic variation.

chart, isopach--TO BE DEFINED BY NOS.

chart, nautical--A chart showing depths of water, nature of the bottom, contours of the bottom and coastline, and tides and currents in a given sea or sea and land area.

chart, sectional aeronautical--A series of aeronautical charts at a 1:500,000 scale covering the entire United States, suitable for contact or visual flying.

chart, small-craft--A nautical chart intended for navigation of smaller vessels usually in shallow water areas.

chart, terminal control area--TO BE DEFINED BY NOS.

chart, tidal current--A chart showing, by arrows and numbers, the average direction and speed of tidal currents at a particular part of the current cycle. A number of such charts, one for each hour of the current cycle, usually are published together.

chart, world aeronautical--NOS to clarify. (Series being replaced by Operational Navigation Chart ?)

choropleth map--See map, choropleth.

coastal chart--See chart, coastal.

coastal zone--(TO BE DEFINED BY OCZM)

color separation--The process of preparing a separate drawing, engraving or negative for each color required in the production of a lithographic map or chart.

compilation--The production of a new or revised map or chart, or portion thereof, from existing maps, aerial photographs, field surveys, and other sources.

continuous tone--An image which has not been screened and contains unbroken, gradient tones from black to white, and may be either in negative or positive form. Aerial photographs are examples of continuous-tone prints. Contrasted with halftone (screened); line copy.

contour--An imaginary line on the ground, all points of which are at the same elevation above a specified datum surface, usually mean sea level.

contour interval--The difference in elevation between adjacent contours on a map.

control--The coordinated and correlated dimensional data used in geodesy and cartography to determine the positions and elevations of points on the Earth's surface or on a cartographic representation of that surface. Also a collective term for a system of marks or objects on the Earth or on a map or a photograph, whose positions or elevation, or both, have been or will be determined.

control, horizontal--Control with horizontal positions only. The positions may be referred to the geographic grid or to other lines of reference, such as plane coordinate systems.

control, vertical--The measurements taken by surveying methods for the determination of elevation only with respect to an imaginary level surface, usually mean sea level.

convergent photography--Aerial photography using an assembly of two cameras which take simultaneous photographs and are mounted so as to maintain a fixed angle between their optical axes. The effect is to increase the angular coverage in one direction, usually along the longitudinal axis of the aircraft.

coordinatograph--An instrument used to plot in terms of plane coordinates. It may be an integral part of a stereoscopic plotting instrument whereby the planimetric motions (x and y) of the index mark are plotted directly.

culture--Those features that are under, on, and above the ground which are delineated on the map and which were constructed by man, such as roads, trails, buildings, canals, sewer systems, andd the like; and boundary lines. In a broad sense, the term also applies to all names, other identification, and legends on a map.

data base--A package of formatted data developed at the end of specific production phases in a form which can be further processed to achieve multiple end products.

datum--Any numerical or geometrical quantity or set of such quantities which may serve as a reference or base for other quantities.

datum, chart--The plane of reference of soundings, depth curves, and elevations of foreshore and offshore features.

datum, international Great Lakes (1955)---TO BE DEFINED BY NOS.

datum, national geodetic vertical, of 1929--See datum, sea level, of 1929.

datum, North American Datum of 1927--The geodetic datum, adopted in 1927, which is defined by the following geographic position of triangulation station Meades Ranch and the azimuth from that station Waldo, on the Clarke spheroid of 1866:

Latitude of Meades Ranch	39 13′26.686"N
Longitude of Meades Ranch	98 32′30.506"W
Azimuth, Meades Ranch	75 28′09.64"

datum, sea level, 1929--A determination of mean sea level that has been adopted as a standard datum for heights, last adjusted in 1929. The sea level is subject to some variations from year to year,

but, as the permanency of any datum is of prime importance in engineering work, a sea-level datum after adoption should, in general, be maintained indefinitely even though differing slightly from later determinations of mean sea level based on longer series of observations. The datum itself can be considered to be an adjustment based on the tide observations taken at various tide stations along the coasts of the United States over a number of years.

datum, sounding--The plane to which soundings are referred.

datum, tidal--Specific tide levels which are used as surfaces of reference for depth measurements in the sea and as a base for the determination of elevation on land.

depth curve--A line on a map or chart con necting points of equal depth below the hydrographic datum.

diapositive--A photographic positive print on glass or film often used in photogrammetry.

digital map--See map, digital.

displacement--The horizontal shift of the plotted positions of a topographic feature from its true position, caused by required adherence to prescribed line weights and symbol sizes. Any shift in the position of an image on a photograph which does not alter the perspective characteristics of the photograph, i.e., shift due to tilt of the photograph, scale changes in the photograph, and relief of the objects photographed.

distortions--Lens aberrations affecting the positions of images from their true relative positions.

echo sounder--An instrument used for depth measurements in water by recording the time interval required for sound waves to go from a source of sound near the surface to the bottom and back again.

electronic distance measurin g (EDM) devices--Instruments that measure the phase difference between transmitted and reflected or retransmitted electromagnetic waves of known frequency and speed, or the round-trip transit time of a pulsed signal, from which distance is computed.

emulsion--A suspension of a light-sensitive silver salt (especially silver shloride or silver bromide) in a colloidal medium (usually gelatin), which is used for coating photographic films, plates, and papers. Types of photographic emulsions currently in common usage are panchromatic (black and white), color negative, color positive, infrared color, and in frared black and white.

engineering map--See map, engineering.

etch--To remove selected areas of the emulsion either chemically or manually. Chemical treatment of a lithographic plate to make non-printing areas grease-repellent and water-receptive or to produce the image on deep-etch plates. An acid solution mixed with the dampening fountain water on an offset press to help control ink on the pressplate.

erosion--Removal of weathered rock material by the forces of wind, water, or gravity.

exposure--The total quantity of light received per unit area on a sensitized plate or film; may be expressed as the product of the light intensity and the exposure time. The act of exposing a light-sensitive material to a light source. One individual picture of a strip of photographs.

feature separation--The process of preparing a separate drawing, engraving, or negative for selected types of data in the preparation of a map or chart.

flood control map--See map, flood control.

flood plain--A belt of low, flat ground bordering the channel on one or both sides inundated by stream waters when the supply of runoff exceeds the capacity of the stream channel.

focal length--A general term for the distance between the center, vertex, or rear node of a lens (or the vertex of a mirror) and the point at which the image of an infinitely distant object comes into critical focus.

forestry map--See map, forestry.

Geoceiver--Doppler Geodetic Receiver, AN/PRR-14, a lightweight, portable radio receiver used to acquire and record the output signal from navigational satellites for the purpose of computing horizontal and vertical control on the Earth's surface. The set consists of a receiver, a 5-level paper tape recorder, and an antenna-preamp assembly.

geographic grid--A system of coordinates of latitude and longitude, which is used to define the position of a point on the surface of the Earth with respect to the reference spheroid.

goelogical map--See map, geological.

geophysics--The science of the Earth with respect to its structure, composition, and development.

guide--A wrong-reading negative of map copy in the color separation stage used in the preparation of a press plate. It may be either a scribed sheet or a film.

half tide level--See mean tide level.

halftone--Any photomechanical printing surface or the impression therefrom in which detail and tone values are represented by a series of evenly spaced dots of varying size and shape, varying in direct proportion to the intensity of the tones they represent.

harbor chart--See chart, harbor.

historical map--See map, historical.

horizontal control--See control, horizontal.

hydrographic chart--See chart, hydrographic.

hypsographic map--See map, hypsographic.

hypsometric map--See map, hypsometric.

imgery--The recording on photographic film (or display on a cathode ray tube) of the electric signals from a sensor (amplified and/or modified electronically) so the images produced thereby bear a spacial relationship in pattern and detail to the direction of the phenomenon sensed.

infrared photography--Pertaining to or designating the portion of the electromagnetic spectrum with wavelengths just beyond the red end of the visible spectrum, such as radiation emitted by a hot body. Infrared rays are invisible to the eye and are detected by their thermal and photographic effects. Their wavelengths are longer than those of visible light and shorter than those of radio waves.

inking--The drawing of map copy in positive form using pen and ink on high-quality paper.

international Great Lakes datum (1955)--See datum, international Great Lakes, (1955).

Intracoastal Waterway chart--See chart, Intracoastal Waterway.

isogonic chart--See chart, isogonic.

isopach chart--See chart, isopach.

isopleth--A line of equal or constant value of a given quantity, with respect to either space or time.

isopleth map--See map, isopleth.

landscape map--See map, landscape.

land-use classification system--A coding system of categories and subcategories designed for use on a map to show how land or water areas are being used by man.

land-use map--See map, land-use.

land-mass denudation--The evolution of a large region, such as the Eastern United States, through the stages of youth, maturity, and old age as the result of the influence of the forces of weathering and erosion.

line drawing--Any map copy suitable for reproduction without the use of a screen; a drawing composed of lines as distinguished from continuous-tone copy.

line map--See map, line.

line-route map--See map, line-route.

lithography--A planographic method of printing based on the chemical repulsion between grease and water to separate the printing from nonprinting areas.

manuscript--The original drawing of a map as compiled or constructed from various data, such as ground surveys and photographs.

map--A graphic representation, usually on a plane surface at an established scale, of natural and manmade features on or under the surface of the Earth or other planetary body. The features are positioned accurately according to a coordinate reference system.

map, bathymetric--A map showing the physiographic conditions of the bottom of the ocean by the use of depth curves.

map, cadastral--A map showing the boundaries of subdivisions of land, usually with the bearings and lengths thereof and the areas of individual tracts, for purposes of describing and recording ownership. It may also show culture, drainage, and other features relating to the value and use of land.

map, choropleth--A map showing statistical data by means of shading, dotting, hatching, coloring, or otherwise identifying a range of distribution within an area determined by political boundaries.

map, digital--A computer-stored data bank containin g geographically oriented information which can be retrieved either in list or graphical form.

map digitization--Conversion of map data from graphical form to digital form.

map, engineering--A map showing information that is essential for planning an engineering project or development and for estimating its cost. It usually is a large-scale map of a small area or of a route. It may be entirely the product of an engineering survey, or reliable information may be collected from various sources for the purpose, and assembled on a base map.

map, flood control--A map designed for study and planning the control of areas subject to inundation.

map, forestry--A map prepared principally to show the size, density, kind, and value of trees in a designated area.

map, geological--A map showing the structure and composition of the Earth's crust.

map, historical--A map showing data of historical significance or one which has been replaced by a more recent publication.

map, hypsographic--A map showing relief with elevations which are referred to a sea level datum.

map, hypsometric--A map showing relief by any convention, such as contours, hachures, shading, or tinting.

map, isopleth--A map showing statistical data by use of isopleths.

map, landscape--A topographic map made to a relatively large scale and showing all details. Such maps are required by architects and landscape gardeners for use in planning buildings to fit the natural topographic features and for landscaping parks, playgrounds, and private estates.

map, land-use--A map showing by means of a coding system the various purposes for which parcels of land are being used by man.

map, line--A map composed of lines as distinguished from continuous-tone copy. In the strict sense of the term the map material may consist only of copy suitable for reproduction without use of a screen. In the broad sense the term may be applied to maps composed of open-window copy which requires screening.

map, line-route--A map showing the routes and types of construction of wire circuits. It also gives the locations of switchboards and telegraph stations.

map, outline--A map which presents just sufficient geographic information to permit the correlation of additional data placed upon it.

map, slope--A map showing the degree of steepness of the Earth's surface by the use of various colors or shading for critical ranges of slope.

map, soil--A map showing the constitution, structure, texture of the soil and identifies ongoing erosion.

map, storm evacuation--A special-purpose map designed to identify areas subject to inundation and recommended areas of refuge.

map, thematic--A map designed to provide information on a single topic, such as geology, rainfall, population, etc.

map, topogrpahic--A map which presents the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form.

mean higher high water--The average height of all the daily higher high waters recorded over a 19-year period or a computed equivalent period. Higher high water is the higher of two high waters occurring during a tidal day where the tide exhibits mixed characteristics.

mean high water--The average height of all of the high waters recorded over a 19-year period, or a computed equivalent period. High water is the highest limit of the surface water level reached by the rising tide.

mean lower low water--The average height of all the lower low waters recorded over a 19-year period. It is usually associated with a mixed tide. Lower low water is the lower of two waters of any tidal day where the tide exhibits mixed characteristics.

mean low water--The average height of all low waters recorded over a 19-year period, or a computed equivalent period. Low water is the lowest limit of the surface water level reached by the lowering tide.

mean sea level--The average height of the surface of the sea for all stages of the tide, usually determined by averaging height readings observed hourly over a minimum period of 19 years.

mean tide level--The reference plane midway between mean high water and mean low water.

meridian--A north-south reference line, particularly a great circle through the geographical poles of the Earth, from which longitudes and azimuths are determined; or a plane, normal to the geoid or spheroid, defining such a line.

metric system--A decimal system of weights and measures based on the meter as a unit length and the kilogram as a unit mass.

military grid--Two sets of parallel lines intersecting at right angles and forming squares; the grid is superimposed on maps, charts, and other similar representations of the Earth's surface in an accurate and consistent manner to permit identification of ground locations with respect to other locations and the computation of direction and distance to other points.

mixed tide--A range of tides where there is marked inequality in height between successive high or low tides.

mosaic--An assembly of aerial photographs whose edges usually have been torn or cut and matched to form a continuous photographic representation of a protion off the Earth's surface.

national geodetic network--The two control survey nets being extended over the United States by the National Geodetic Survey for the control of nautical charts and topographic maps, comprising the horizontal-control survey net, which is referred to the North American datum of 1927, and the vertical-control survey net, which is referred to mean sea level.

national geodetic vertical datum of 1929--See datum, sea level, of 1929.

National Map Accuracy Standards--See Appendix F.

nautical chart--See chart, nautical.

negative--A photographic image on film, plate, or paper, in which the subject tones to which the emulsion is sensitive are reversed or complementary. Also, in cartography, any drawing or film on which map copy is either white or transparent against a black or opaque background.

North American datum of 1927--See datum, North American, of 1927.

offset lithography--An indirect method of printing whereby the ink image is transferred from the press plate to an intermediate surface of a rubber blanket, and from that to the paper.

orders of accuracy--The orders of accuracy are known as first (meaning the most accurate), second, and third (the least accurate).

The orders of accuracy for unadjusted horizontal distances, expressing the closure error as a fraction of the overall distance measured between points of known higher order of accuracy, are: first 1:250,000; second 1:10,000, and third, 1:5,000. For the unadjusted

angles in traverses, the orders of accuracy are the following number of seconds of arc times the square root of the number of horizontal angles measured: first, 2; second, 10; and third, 30. For triangle closure in triangulation, the seconds of arc in maximum and average error for each order of accuracy are: first, 3 and 1; second, 5 and 3; and third, 10 and 5. The unadjusted closure error in vertical distances are the following values times the square root of the length of the level circuit in miles or kilometers, respectively: first, 0.017 feet and 4.0 mm; second, 0.035 feet and 8.4 mm, and third, 0.05 feet and 12.0 mm.

Any survey in which the closure error is larger than third-order is known as fourth-order. Also, in supplemental control for the photogrammetric compilation of topographic and other maps, fourth-order control could have errors of closre as large as 1:2,500 in the horizontal, 60 seconds times the square root of the number of angles measured in a traverse, maximum of 30 seconds and average of 15 seconds in triangle closures in triangulation, and in the vertical of 0.50 feet or 120 mm, respectively, times the length of the level circuit in miles or kilometers.

orthophotograph--A photographic copy, prepared from a perspective photograph, in which the displacements of images due to tilt and relief have been removed.

orthophotomap--A photomap made from an assembly of orthophotographs. It may incorporate special cartographic treatment, photographic edge enhancement, color separation, or a combination of these.

orthophotomosaic--An assembly of orthophotographs forming a uniform-scale mosaic.

orthophotoscope--A photomechanical device, used in conjunction with a double-projection stereoplotter, for producing orthophotographs.

orthophotoquad--An orthophotograph presented in quadrangle format with marginal data but with little or no cartographic enhancement.

outline map--See map, outline.

overlay--A printing or drawing on a transparent or translucent medium at the same scale as a map, chart, or other graphic, to show details not appearing, or requiring special emphasis, on the original.

overprint--New material printed or stamped upon a map or chart to show data of importance or special use, in addition to that originally printed.

paneling--The distinctive marking or instrumentation of a ground point to aid in its identification on a photograph. Panels constitute a material marking so arranged and placed on the ground as to

form a distinctive pattern over a geodetic or other control-point marker, on a property corner or line, or at the position of an identifying point above an underground facility or feature.

pantograph--An instrument for copying maps, drawings, or the like at a predetermined reduction or enlargement. It generally consists of four bars hinged to form a parallelogram linkage, so designed and proportioned that when the frame is pinned to a base at one point, the motion of an attached pencil is proportional to the motion of a tracing stylus; the pivot, pencil, nd stylus always being maintained on line by the linkage arrangement. When used as an instrument for compiling maps at a scale equal to, or larger or smaller than the stereoscopic model.

parellel--A circle on the surface of the Earth, parallel to the plane of the equator and connecting all points of equal latitude, or a circle parallel to the primary great circle of a sphere or spheroid; also, a closed curve approximately such a circle.

pixel--Smallest resolvable element in a cathode ray tube. Picture element of a television picture; i.e., the smallest area of a television picture that can be delineated by an electric signal passed through part or all of the television system. Element of a picture or other area display, produced by scanning.

photogrammetry--The science or art of obtaining reliable measurements by photography.

photography--The art or process of producing images on sensitized material through the action of light.

photoidentification--The detection, identification, and marking of ground survey stations on aerial photographs.

photoindex--An index map made by assembling individual aerial photographs into their proper relative positions and copying the assembly photographically at a reduced scale. Also, an overlay, keyed to a base map, indicating the location and area covered by individual photographs and/or flight strips.

photomap--A map substitute or supplement that consists wholly, or in part, of a printed aerial photographic image of the terrain.

photomechanics--A combination of photographic and mechanical operations used to reproduce cartographic materials.

physiography--The field of geography which specializes in physical aspects of the Earth's surface.

planimetric map--See map, planimetric.

planimetry--The science of measuring plane surfaces; horizontal measurements. Also, parts of a map which represent everything except relief.

plat--A diagram drawn to scale showing all essential data pertaining to the boundaries and subdivisions of a tract of land, as determined by survey or protraction.

positive--A photographic image on film, plate, or paper having approximately the same rendition of tones as the original subject; i.e., light for light and dark for dark.

pressplate--A thin, metal, plastic, or paper sheet, that carries the printing image and who surface is treated to make only the image areas ink-receptive.

projection, map--A systematic drawing of lines on a plane surface to represent the parallels of latitude and the meridians of longitude of the Earth or a section of the Earth.

projection, conformal--A map projection by which any small piece of the Earth's surface has the same shape on the map as it does on a globe. Examples of conformal projections are the stereographic, the Lambert conformal conic, the Mercator, and the transverse Mercator.

projection, equal-area--A map projection by which equal areas of the Earth's surface are represented by equal areas on the map. The shapes of the areas usually differ. Examples of equal-area projections are the azimuthal equal-area, the Mollweide homolographic, the sinusoidal, and the homolosine.

Public land system--Public lands are subdivided by a rectangular system of surveys established and regulated by the Bureau of Land Management, the agency responsible for administration of public lands. The standard format for subdivision is by townships measuring about six miles (480 chains) on a side. Townships are further subdivided into 36 numbered sections of one square mile (640 acres) each.

quadrangle--A four-sided figure, bounded by parallels of latitude and meridians of longitude, used as an area unit in mapping. The dimensions are not necessarily the same in both directions.

rectification--The process of projecting an aerial photograph (mathematically, graphically, or photographically) from its plane onto a horizontal plane by translation, rotation, and/or scale change to remove displacement due to tilt of the aircraft.

registration--Correct positioning of one component of a composite map image in relation to the other components. This usually is achieved by punching holes, having a fixed horizontal relationship to each

other, in each component sheet and then attaching the components together using specially designed fasteners.

relief--Variations in the elevation of the ground surface, also features of height above a plain or reference datum.

remote sensing--The process of detecting and/or monitoring the chemical or physical properties of an object without physically contacting the object.

representative fraction--The scale of a map or chart expressed as a fraction or ratio which relates unit distance on the map to distance measured in the same unit on the ground.

reproduction--The summation of all the processes involved in printing copies from an original drawing. A printed copy of an original drawing made by the processes of reproduction.

resolution--The minimum distance between two adjacent features, or the minimum size of a feature, which can be detected by a photographic system or a radar system.

right-reading copy--A printed or drawn page on which the lettering and/or images are presented in their normal order, reading from left to right. See wrong-reading copy.

scale--The relationship existing between a distance on a map and the corresponding distance on the Earth.

scale, bar--A line on a map subdivided and marked with the distance which each of its parts represents on the Earth.

scribing--The act of marking material with a pointed instrument. Removal of portions of a photographically opaque coating from a transparent base with engraving tools.

screen--A grating of opaque lines on glass or film, crossing at right angles, producing transparent apertures between intersections. Screens are used to break up a solid or continuous tone image into a pattern of small dots.

sea level datum--See datum, sea level.

sectional aeronautical chart--See chart, sectional aeronautical.

sedimentation--Deposition of eroded particles by hydraulic action.

semidiurnal tide--A range of tides consisting of two high tides and two low tides daily, each reaching approximately the same level as its previous counterpart.

small craft chart--See chart, small craft.

smooth sheet--A final plot or field control and hydrographic development such as soundings, fathom curves, wire drag areas, etc., to be used in chart construction.

spheroid--Any figure differing slightly from a sphere. Also, a mathematical figure closely approaching the geoid in form and size and used as a surface of reference for geodetic surveys.

sounding datum--See datum, sounding.

spot elevation--A point on a map or chart whose height above a specified reference datum is noted, usually by a dot or a small sawbuck and elevation value. Elevations are shown, wherever practicable, for road forks and intersections, grade crossings, summits of hills, mountains and mountain passes, water surfaces of lakes and ponds, stream forks, bottom elevations in depressions, and large flat areas.

standard metropolitan statistical areas--An integrated economic and social unit with a recognized large population nucleus of at least 50,000. A standard metropolitan statistical area (SMSA) always includes a city (cities) of specified population which constitutes the central city and the county (counties) in which it is located. It also includes contiguous counties when the economic and social relationships between the central and contiguous counties meet specified criteria of metropolitan character and integration. SMSA's may cross State lines. In New England, they are composed of cities and towns instead of counties.

State plane coordinate systems--The plane-rectangular coordinate systems established by the National ocean Survey, one for each State in the United States, for use in defining positions of geodetic stations in terms of plane-rectangulation (x and y) coordinates.

stereocompilation--The production of a map or chart manuscript from aerial photographs and geodetic control data, by means of photogrammetric instruments.

stereo model--The mental impression of a three-dimensional model which results from two perspective overlapping views.

stereoplotter--An instrument for plotting a map or obtaining spatial solutions by observation of stereo models formed by pairs of photographs.

stereoscopic vision--The particular application of binocular vision which enables the observer to obtain the impression of depth, usually by means of two different perspectives of an object (as two photographs taken from different camera stations).

stick-up--Adhesive-backed or wax-backed film or paper on which map names, symbols, descriptive terms, etc., have been printed, for application in map and chart production.

storm evacuation map--See map, storm evacuation.

targeting--See paneling.

terminal control area chart--See chart, terminal control area.

thematic map--See map, thematic.

tidal bench mark--See bench mark, tidal.

tidal current chart--See Chart, tidal current.

tidal datum--See datum, tidal.

tide station--A place at which tide observations are made.

topographic map--See map, topographic.

transparency--A photographic print on a clear base, especially adaptable for viewing by transmitted light. Also, the light-transmitting capability of a material.

Universal Transverse Mercator grid--A military grid system based on the transverse Mercator projection, applied to maps of the Earth's surface extending to 84° N and 80° S latitudes.

wrong reading copy--A cartographic image which is a reverted or mirror image of the original.

PART VI

APPENDIXES

APPENDIX A

COOPERATING AGENCIES IN THE COASTAL ZONE

Alabama

Assistant State Geologist

Geological Survey of Alabama

P.O. Drawer O

University, Alabama 35486

California

Director

Department of Water Resources

P.O. Box 388

Sacramento, California 95802

Connecticut

Chief Cartographer

Bureau of Planning and Research

Department of Transportation

P.O. Drawer A

Wethersfield, Connecticut 06109

Director

Connecticut Geological and Natural History Survey

Box 128, Wesleyan Station

Middletown, Connecticut 06457

Delaware

State Geologist

Delaware Geological Survey

University of Delaware

101 Penny Hall

Newark, Delaware 19711

Florida

State Topographic Engineer

Department of Transportation

Burns Building, 605 Suwannee Street

Tallahassee, Florida 32304

Administrative Assistant

Department of Natural Resources

Larson Building

Tallahassee, Florida 32304

Georgia

Director and State Geologist

Georgia Department of Natural Resources

Earth and Water Division

19 Hunter Street, NW.

Atlanta, Georgia 30334

Illinois

Chief

Illinois Geological Survey

121 Natural Resources Building

Urbana, Illinois 61801

Indiana

Assistant Chief

Division of Water

Department of Natural Resources

606 State Office Building

Indianapolis, Indiana 46204

Attn: Head, Surveying and Mapping Section

Louisiana

Office Engineer

Department of Public Works

P.O. Box 44155, Capitol Station

Baton Rouge, Louisiana 70804

Maine

State Geologist

Maine Geological Survey

Department of Forestry

211 State Office Building

Augusta, Maine 04330

Maryland

Director

Maryland Geological Survey

214 Latrobe Hall

The Johns Hopkins University

Baltimore, Maryland 21218

Massachusetts

Deputy Chief Engineer for Highway Engineering

Department of Public Works

100 Nashua Street

Boston, Massachusetts 02114

Michigan

State Geologist Geological Survey Division

Department of Natural Resources

Stevens T. Mason Building

Lansing, Michigan 48926

Minnesota

Commissioner

Department of Administration

114 Administration Building

St. Paul, Minnesota 55101

New York

Director

Data Services Bureau

New York State Department of Transportation

1220 Washington Avenue

Albany, New York 12226

North Carolina

Director

Office of Earth Resources

Department of Natural and Economic Resources

P.O. Box 27687

Ohio

Chief Engineer

Aerial Engineering Section

Ohio Department of Transportation

Box 899

Columbus, Ohio 43216

Oregon

State Engineer

Water Resources Division

516 Public Service Building

Salem, Oregon 97310

Pennsylvania

Director and State Geologist

Department of Environmental Resources

Bureau of Topographic and Geological Survey

660 Boas Street

Harrisburg, Pennsylvania 17120

Puerto Rico

Head

Topographic Mapping and Photogrammetry Services Division

P.O. Box 8218

Santurce, Puerto Rico 00910

Texas

Principal Engineer

Texas Water Development Board

P.O. Box 13087, Capitol Station

Austin, Texas 78711

Virginia

Geologist

Division of Mineral Resources

Department of Conservation and Economic Development

P.O. Box 3667

Charlottesville, Virginia 22903

Washington

State Geologist

Geologic and Earth Resources Division

Department of Natural Resources

Olympia, Washington 98501

Wisconsin

State Geologist and Director

Wisconsin Geological and Natural History Survey

1815 University Avenue

Madison, Wisconsin 53706

APPENDIX B

STATE MAPPING ADVISORY COMMITTEES IN THE COASTAL ZONE

Alaska

Chairman

State Mapping Advisory Committee

Department of Natural Resources

Juneau, Alaska 99801

Maine

Chairman

State Mapping Advisory Committee

Maine Geological Survey

Augusta, Maine 04330

Michigan

Chairman

State Mapping Advisory Committee

Michigan Department of Natural Resources

515 West Michigan

Lansing, Michigan 48926

Minnesota

Chairman

State Mapping Advisory Committee

Environmental Quality Control State Planning Agency

550 Cedar Street

St. Paul, Minnesota 55101

Texas

Chairman

State Mapping Advisory Committee

Texas Water Development Board

Austin, Texas 78701

APPENDIX C

CONTACTS FOR COASTAL ZONE MANAGEMENT

Alabama

Technical Advisor

Alabama Coastal Area Board

Alabama Development Office

State Office Building

Montgomery, Alabama 36104

Alaska

Director

Division of Marine and Coastal Zone Management

Department of Environmental Conservation

Pouch 0

Juneau, Alaska 99801

American Samoa

Executive Secretary

Environmental Quality Commission

Office of the Governor

Pago Pago, American Samoa 96799

California

Secretary for Resources

Resources Agency

1416 Ninth Street

Sacramento, California 95814

Chairman

California Coastal Zone Conservation Commission

1540 Market Street

San Francisco, California 94102

Connecticut

Coastal Zone Management Representative

Department of Environmental Protection

118 State Office Building

Hartford, Connecticut 06115

Delaware

Director, State Planning Office

Thomas Collins Building

Dover, Delaware 19901

Florida

Coordinator

Coastal Coordinating Council

309 Magnolia Office Plaza

Tallahassee, Florida 32301

Georgia

Director

Office of Planning and Budget

Room 611

270 Washington Street, SW.

Atlanta, Georgia 30334

Guam

Director

Bureau of Budget and Management

Office of the Governor

Agana, Guam 96910

Hawaii

Director

Department of Planning and Economic Development

Executive Chambers

P.O. Box 2359

Honolulu, Hawaii 96804

Illinois

Director of Conservation

Room 602

State Office Building

Springfield, Illinois 62706

Indiana

Deputy Director

Department of Natural Resources

608 State Office Building

Indianapolis, Indiana 46204

Louisianna

Executive Director

State Planning Office

P.O. Box 44425

Baton Rouge, Louisiana 70804

Maine

State Planning Director

State Planning Office

184 State Street

Augusta, Maine 04330

Maryland

Chief

Coastal Zone Management Program

Water Resources Administration

Department of Natural Resources

Tawes State Office Building

Annapolis, Maryland 21401

Massachusetts

Secretary

Executive Office of Environmental Affairs

18 Tremont Street

Boston, Massachusetts 02108

Michigan

Director

Department of Natural Resources

Stevens T. Mason Building

Lansing, Michigan 48926

Minnesota

Director of Environmental Planning

State Planning Agency

801 Capitol Square Building

St. Paul, Minnesota 55155

Mississippi

Executive Director

Mississippi Marine Resources Council

P.O. Box 497

Long Beach, Mississippi 39560

New Hampshire

Director

Division of State Planning

State House

Concord, New Hampshire 03301

New Jersey

Assistant Chief

Office of Environmental Analysis

Department of Environmental Protection

P.O. Box 1889

Trenton, New Jersey 08625

New York

Deputy Director

Office of Planning Services

Executive Department

488 Broadway

Albany, New York 12207

North Carolina

Secretary

Department of Natural and Economic Resources

116 West Jones Street

Raleigh, North Carolina 27611

Ohio

Director

Department of Natural Resources

1930 Belcher Drive

Columbus, Ohio 43224

Oregon

Director

Department of Land Conservation and Development

Room 660

1600 SW Fourth Avenue

Portland, Oregon 97201

Executive Director

Oregon Coastal Conservation and Development Commission

P.O. Box N

Florence, Oregon 97439

Pennsylvania

Deputy Secretary

Resources Management

Department of Environmental Resources

P.O. Box 1467

Harrisburg, Pennsylvania 17120

Puerto Rico

Secretary

Department of Natural Resources

P.O. Box 5887

Puerto de Tierra, Puerto Rico 00906

Rhode Island

Chief

Statewide Planning Program

Department of Administration

265 Melrose Street

Providence, Rhode Island 02907

South Carolina

Chairman

Coastal Zone Management Council

P.O. Box 547

Beaufort, South Carolina 29902

Texas

State Land Commissioner

General Land Office

P.O. Box 12428

Capitol Station

Austin, Texas 78711

Virgin Islands

Director of Planning

Office of the Governor

P.O. Box 2606

Charlotte Amalie

St. Thomas, U.S. Virgin Islands 00801

Virginia

Associate Director

Commerce and Resources Section

Division of State Planning and Community Affairs

1010 James Madison Building

109 Governor Street

Richmond, Virginia 23219

Washington

Director

Department of Ecology

State of Washington

Olympia, Washington 98504

Wisconsin

Director

State Planning Office

Room B-130

1 West Wilson Street

Madison, Wisconsin 53702

APPENDIX D

SOURCES FOR LISTS OF QUALIFIED PRIVATE CONTRACTORS

for mapping information and services

American Congress on Surveying and Mapping

430 Woodward Building

733 15th Street, NW.

Washington, D.C. 20005

American Society of Cartographers

( )

P.O. Box 1493

Louisville, Kentucky 40201

American Society of Civil Engineers

345 East 47th Street

New York, New York 10017

American Society of Photogrammetry

105 N. Virginia Avenue

Falls Church, Virginia 22046

Association of American Geographers

1710 16th Street, NW.

Washington, D.C. 20009

Engineers Joint Council

2029 K Street, NW.

Washington, D.C. 20006

International Remote Sensing Institute

6151 Freeport Boulevard

Sacramento, California 95822

COASTAL ZONE MANAGEMENT ACT

Public Law 92-583
92nd Congress, S. 3507
October 27, 1972

An Act

86 STAT. 1280

To establish a national policy and develop a national program for the management, beneficial use, protection, and development of the land and water resources of the Nation's coastal zones, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act entitled "An Act to provide for a comprehensive, long-range, and coordinated national program in marine science, to establish a National Council on Marine Resources and Engineering Development, and a Commission on Marine Science, Engineering and Resources, and for other purposes", approved June 17, 1966 (80 Stat. 203), as amended (33 U.S.C. 1101-1124), is further amended by adding at the end thereof the following new title:

Marine Resources and Engineering Development Act of 1966, amendment.

80 Stat. 998; 84 Stat. 865.

TITLE III—MANAGEMENT OF THE COASTAL ZONE

SHORT TITLE

SEC. 301. This title may be cited as the "Coastal Zone Management Act of 1972".

CONGRESSIONAL FINDINGS

SEC. 302. The Congress finds that—

(a) There is a national interest in the effective management, beneficial use, protection, and development of the coastal zone;

(b) The coastal zone is rich in a variety of natural, commercial, recreational, industrial, and esthetic resources of immediate and potential value to the present and future well-being of the Nation;

(c) The increasing and competing demands upon the lands and waters of our coastal zone occasioned by population growth and economic development, including requirements for industry, commerce, residential development, recreation, extraction of mineral resources and fossil fuels, transportation and navigation, waste disposal, and harvesting of fish, shellfish, and other living marine resources, have resulted in the loss of living marine resources, wildlife, nutrient-rich areas, permanent and adverse changes to ecological systems, decreasing open space for public use, and shoreline erosion;

(d) The coastal zone, and the fish, shellfish, other living marine resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alterations;

(e) Important ecological, cultural, historic, and esthetic values in the coastal zone which are essential to the well-being of all citizens are being irretrievably damaged or lost;

(f) Special natural and scenic characteristics are being damaged by ill-planned development that threatens these values;

(g) In light of competing demands and the urgent need to protect and to give high priority to natural systems in the coastal zone, present state and local institutional arrangements for planning and regulating land and water uses in such areas are inadequate; and

(h) The key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over the lands and waters in the coastal zone by assisting the states, in cooperation with Federal and local governments and other vitally affected interests, in developing land and water use programs for the coastal zone, including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance.

DECLARATION OF POLICY

SEC. 303. The Congress finds and declares that it is the national policy (a) to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations, (b) to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone giving full consideration to ecological, cultural, historic, and esthetic values as well as to needs for economic development, (c) for all Federal agencies engaged in programs affecting the coastal zone to cooperate and participate with state and local governments and regional agencies in effectuating the purposes of this title, and (d) to encourage the participation of the public, of Federal, state, and local governments and of regional agencies in the development of coastal zone management programs. With respect to implementation of such managament programs, it is the national policy to encourage cooperation among the various state and regional agencies including establishment of interstate and regional agreements, cooperative procedures, and joint action particularly regarding environmental problems.

DEFINITIONS

SEC. 304. For the purposes of this title—

(a) "Coastal zone" means the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in Great Lakes waters, to the international boundary between the United States and Canada and, in other areas, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents.

(b) "Coastal waters" means (1) in the Great Lakes area, the waters within the territorial jurisdiction of the United States consisting of the Great Lakes, their connecting waters, harbors, roadsteads, and estuary-type areas, such as bays, shallows, and marshes and (2) in other areas, those waters, adjacent to the shorelines, which contain a measurable quantity or percentage of sea water, including, but not limited to, sounds, bays, lagoons, bayous, ponds, and estuaries.

(c) "Coastal state" means a state of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes. For the purposes of this title, the term also includes Puerto Rico, the Virgin Islands, Guam, and American Samoa.

(d) "Estuary" means that part of a river or stream or other body of water having unimpaired connection with the open sea, where the sea water is measurably diluted with fresh water derived from land drainage. The term includes estuary-type areas of the Great Lakes.

(e) "Estuarine sanctuary" means a research area which may include any part or all of an estuary, adjoining transitional areas, and adjacent uplands, constituting to the extent feasible a natural unit, set

aside to provide scientists and students the opportunity to examine over a period of time the ecological relationships within the area.

(f) "Secretary" means the Secretary of Commerce.

(g) "Management program" includes, but is not limited to, a comprehensive statement in words, maps, illustrations, or other media of communication, prepared and adopted by the state in accordance with the provisions of this title, setting forth objectives, policies, and standards to guide public and private uses of lands and waters in the coastal zone.

(h) "Water use" means activities which are conducted in or on the water; but does not mean or include the establishment of any water quality standard or criteria or the regulation of the discharge or runoff of water pollutants except the standards, criteria, or regulations which are incorporated in any program as required by the provisions of section 307(f).

(i) "Land use" means activities which are conducted in or on the shorelands within the coastal zone, subject to the requirements outlined in section 307(g).

MANAGEMENT PROGRAM DEVELOPMENT GRANTS

SEC. 305. (a) The Secretary is authorized to make annual grants to any coastal state for the purpose of assisting in the development of a management program for the land and water resources of its coastal zone.

(b) Such management program shall include:

(1) an identification of the boundaries of the coastal zone subject to the management program;

(2) a definition of what shall constitute permissible land and water uses within the coastal zone which have a direct and significant impact on the coastal waters;

(3) an inventory and designation of areas of particular concern within the coastal zone;

(4) an identification of the means by which the state proposes to exert control over the land and water uses referred to in paragraph (2) of this subsection, including a listing of relevant constitutional provisions, legislative enactments, regulations, and judicial decisions;

(5) broad guidelines on priority of uses in particular areas, including specifically those uses of lowest priority;

(6) a description of the organizational structure proposed to implement the management program, including the responsibilities and interrelationships of local, areawide, state, regional, and interstate agencies in the management process.

(c) The grants shall not exceed 66⅔ per centum of the costs of the program in any one year and no state shall be eligible to receive more than three annual grants pursuant to this section. Federal funds received from other sources shall not be used to match such grants. In order to qualify for grants under this section, the state must reasonably demonstrate to the satisfaction of the Secretary that such grants will be used to develop a management program consistent with the requirements set forth in section 306 of this title. After making the initial grant to a coastal state, no subsequent grant shall be made under this section unless the Secretary finds that the state is satisfactorily developing such management program. Limitation.

(d) Upon completion of the development of the state's management program, the state shall submit such program to the Secretary for

review and approval pursuant to the provisions of section 306 of this title, or such other action as he deems necessary. On final approval of such program by the Secretary, the state's eligibility for further grants under this section shall terminate, and the state shall be eligible for grants under section 306 of this title.

Grants, allocation.

(e) Grants under this section shall be allocated to the states based on rules and regulations promulgated by the Secretary: *Provided, however*, That no management program development grant under this section shall be made in excess of 10 per centum nor less than 1 per centum of the total amount appropriated to carry out the purposes of this section.

(f) Grants or portions thereof not obligated by a state during the fiscal year for which they were first authorized to be obligated by the state, or during the fiscal year immediately following, shall revert to the Secretary, and shall be added by him to the funds available for grants under this section.

(g) With the approval of the Secretary, the state may allocate to a local government, to an areawide agency designated under section 204 of the Demonstration Cities and Metropolitan Development Act of 1966, to a regional agency, or to an interstate agency, a portion of the grant under this section, for the purpose of carrying out the provisions of this section.

80 Stat. 1262; 82 Stat. 208. 42 USC 3334.

Expiration date.

(h) The authority to make grants under this section shall expire on June 30, 1977.

ADMINISTRATIVE GRANTS

Limitation.

SEC. 306. (a) The Secretary is authorized to make annual grants to any coastal state for not more than 66⅔ per centum of the costs of administering the state's management program, if he approves such program in accordance with subsection (c) hereof. Federal funds received from other sources shall not be used to pay the state's share of costs.

Allocation.

(b) Such grants shall be allocated to the states with approved programs based on rules and regulations promulgated by the Secretary which shall take into account the extent and nature of the shoreline and area covered by the plan, population of the area, and other relevant factors: *Provided, however*, That no annual administrative grant under this section shall be made in excess of 10 per centum nor less than 1 per centum of the total amount appropriated to carry out the purposes of this section.

Program requirements.

(c) Prior to granting approval of a management program submitted by a coastal state, the Secretary shall find that:

(1) The state has developed and adopted a management program for its coastal zone in accordance with rules and regulations promulgated by the Secretary, after notice, and with the opportunity of full participation by relevant Federal agencies, state agencies, local governments, regional organizations, port authorities, and other interested parties, public and private, which is adequate to carry out the purposes of this title and is consistent with the policy declared in section 303 of this title.

(2) The state has:

(A) coordinated its program with local, areawide, and interstate plans applicable to areas within the coastal zone existing on January 1 of the year in which the state's management program is submitted to the Secretary, which plans have been developed by a local government, an areawide agency designated pursuant to regulations established under section 204 of the Demonstration

Cities and Metropolitan Development Act of 1966, a regional agency, or an interstate agency; and 80 Stat. 1262; 82 Stat. 208, 42 USC 3334.

(B) established an effective mechanism for continuing consultation and coordination between the management agency designated pursuant to paragraph (5) of this subsection and with local governments, interstate agencies, regional agencies, and areawide agencies within the coastal zone to assure the full participation of such local governments and agencies in carrying out the purposes of this title.

(3) The state has held public hearings in the development of the management program.

(4) The management program and any changes thereto have been reviewed and approved by the Governor.

(5) The Governor of the state has designated a single agency to receive and administer the grants for implementing the management program required under paragraph (1) of this subsection.

(6) The state is organized to implement the management program required under paragraph (1) of this subsection.

(7) The state has the authorities necessary to implement the program, including the authority required under subsection (d) of this section.

(8) The management program provides for adequate consideration of the national interest involved in the siting of facilities necessary to meet requirements which are other than local in nature.

(9) The management program makes provision for procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, or esthetic values.

(d) Prior to granting approval of the management program, the Secretary shall find that the state, acting through its chosen agency or agencies, including local governments, areawide agencies designated under section 204 of the Demonstration Cities and Metropolitan Development Act of 1966, regional agencies, or interstate agencies, has authority for the management of the coastal zone in accordance with the management program. Such authority shall include power—

(1) to administer land and water use regulations, control development in order to ensure compliance with the management program, and to resolve conflicts among competing uses; and

(2) to acquire fee simple and less than fee simple interests in lands, waters, and other property through condemnation or other means when necessary to achieve conformance with the management program.

(e) Prior to granting approval, the Secretary shall also find that the program provides:

(1) for any one or a combination of the following general techniques for control of land and water uses within the coastal zone;

(A) State establishment of criteria and standards for local implementation, subject to administrative review and enforcement of compliance;

(B) Direct state land and water use planning and regulation; or

(C) State administrative review for consistency with the management program of all development plans, projects, or land and water use regulations, including exceptions and variances thereto, proposed by any state or local authority or private developer, with power to approve or disapprove after public notice and an opportunity for hearings.

(2) for a method of assuring that local land and water use regulations within the coastal zone do not unreasonably restrict or exclude land and water uses of regional benefit.

(f) With the approval of the Secretary, a state may allocate to a local government, an areawide agency designated under section 204 of the Demonstration Cities and Metropolitan Development Act of 1966, a regional agency, or an interstate agency, a portion of the grant under this section for the purpose of carrying out the provisions of this section: *Provided*, That such allocation shall not relieve the state of the responsibility for ensuring that any funds so allocated are applied in furtherance of such state's approved management program.

80 Stat. 1262; 82 Stat. 208. 42 USC 3334.

Program modification.

(g) The state shall be authorized to amend the management program. The modification shall be in accordance with the procedures required under subsection (c) of this section. Any amendment or modification of the program must be approved by the Secretary before additional administrative grants are made to the state under the program as amended.

Segmental development.

(h) At the discretion of the state and with the approval of the Secretary, a management program may be developed and adopted in segments so that immediate attention may be devoted to those areas within the coastal zone which most urgently need management programs: *Provided*, That the state adequately provides for the ultimate coordination of the various segments of the management program into a single unified program and that the unified program will be completed as soon as is reasonably practicable.

INTERAGENCY COORDINATION AND COOPERATION

SEC. 307. (a) In carrying out his functions and responsibilities under this title, the Secretary shall consult with, cooperate with, and, to the maximum extent practicable, coordinate his activities with other interested Federal agencies.

(b) The Secretary shall not approve the management program submitted by a state pursuant to section 306 unless the views of Federal agencies principally affected by such program have been adequately considered. In case of serious disagreement between any Federal agency and the state in the development of the program the Secretary, in cooperation with the Executive Office of the President, shall seek to mediate the differences.

(c)(1) Each Federal agency conducting or supporting activities directly affecting the coastal zone shall conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved state management programs.

(2) Any Federal agency which shall undertake any development project in the coastal zone of a state shall insure that the project is, to the maximum extent practicable, consistent with approved state management programs.

Certification.

(3) After final approval by the Secretary of a state's management program, any applicant for a required Federal license or permit to conduct an activity affecting land or water uses in the coastal zone of that state shall provide in the application to the licensing or permitting agency a certification that the proposed activity complies with the state's approved program and that such activity will be conducted in a manner consistent with the program. At the same time, the applicant shall furnish to the state or its designated agency a copy of the certification, with all necessary information and data. Each coastal state shall establish procedures for public notice in the case of all such

certifications and, to the extent it deems appropriate, procedures for public hearings in connection therewith. At the earliest practicable time, the state or its designated agency shall notify the Federal agency concerned that the state concurs with or objects to the applicant's certification. If the state or its designated agency fails to furnish the required notification within six months after receipt of its copy of the applicant's certification, the state's concurrence with the certification shall be conclusively presumed. No license or permit shall be granted by the Federal agency until the state or its designated agency has concurred with the applicant's certification or until, by the state's failure to act, the concurrence is conclusively presumed, unless the Secretary, on his own initiative or upon appeal by the applicant, finds, after providing a reasonable opportunity for detailed comments from the Federal agency involved and from the state, that the activity is consistent with the objectives of this title or is otherwise necessary in the interest of national security. Notification.

(d) State and local governments submitting applications for Federal assistance under other Federal programs affecting the coastal zone shall indicate the views of the appropriate state or local agency as to the relationship of such activities to the approved management program for the coastal zone. Such applications shall be submitted and coordinated in accordance with the provisions of title IV of the Intergovernmental Coordination Act of 1968 (82 Stat. 1098). Federal agencies shall not approve proposed projects that are inconsistent with a coastal state's management program, except upon a finding by the Secretary that such project is consistent with the purposes of this title or necessary in the interest of national security. 42 USC 4231.

(e) Nothing in this title shall be construed—

(1) to diminish either Federal or state jurisdiction, responsibility, or rights in the field of planning, development, or control of water resources, submerged lands, or navigable waters; nor to displace, supersede, limit, or modify any interstate compact or the jurisdiction or responsibility of any legally established joint or common agency of two or more states or of two or more states and the Federal Government; nor to limit the authority of Congress to authorize and fund projects;

(2) as superseding, modifying, or repealing existing laws applicable to the various Federal agencies; nor to affect the jurisdiction, powers, or prerogatives of the International Joint Commission, United States and Canada, the Permanent Engineering Board, and the United States operating entity or entities established pursuant to the Columbia River Basin Treaty, signed at Washington, January 17, 1961, or the International Boundary and Water Commission, United States and Mexico.

(f) Notwithstanding any other provision of this title, nothing in this title shall in any way affect any requirement (1) established by the Federal Water Pollution Control Act, as amended, or the Clean Air Act, as amended, or (2) established by the Federal Government or by any state or local government pursuant to such Acts. Such requirements shall be incorporated in any program developed pursuant to this title and shall be the water pollution control and air pollution control requirements applicable to such program. Ante, p. 816. 81 Stat. 485; 84 Stat. 1678. 42 USC 1857 note.

(g) When any state's coastal zone management program, submitted for approval or proposed for modification pursuant to section 306 of this title, includes requirements as to shorelands which also would be subject to any Federally supported national land use program which may be hereafter enacted, the Secretary, prior to approving such pro-

gram, shall obtain the concurrence of the Secretary of the Interior, or such other Federal official as may be designated to administer the national land use program, with respect to that portion of the coastal zone management program affecting such inland areas.

PUBLIC HEARINGS

SEC. 308. All public hearings required under this title must be announced at least thirty days prior to the hearing date. At the time of the announcement, all agency materials pertinent to the hearings, including documents, studies, and other data, must be made available to the public for review and study. As similar materials are subsequently developed, they shall be made available to the public as they become available to the agency.

REVIEW OF PERFORMANCE

SEC. 309. (a) The Secretary shall conduct a continuing review of the management programs of the coastal states and of the performance of each state.

Financial assistance, termination.

(b) The Secretary shall have the authority to terminate any financial assistance extended under section 306 and to withdraw any unexpended portion of such assistance if (1) he determines that the state is failing to adhere to and is not justified in deviating from the program approved by the Secretary; and (2) the state has been given notice of the proposed termination and withdrawal and given an opportunity to present evidence of adherence or justification for altering its program.

RECORDS

SEC. 310. (a) Each recipient of a grant under this title shall keep such records as the Secretary shall prescribe, including records which fully disclose the amount and disposition of the funds received under the grant, the total cost of the project or undertaking supplied by other sources, and such other records as will facilitate an effective audit.

Audit.

(b) The Secretary and the Comptroller General of the United States, or any of their duly authorized representatives, shall have access for the purpose of audit and examination to any books, documents, papers, and records of the recipient of the grant that are pertinent to the determination that funds granted are used in accordance with this title.

ADVISORY COMMITTEE

Costal Zone Management Advisory Committee, establishment; membership.

SEC. 311. (a) The Secretary is authorized and directed to establish a Coastal Zone Management Advisory Committee to advise, consult with, and make recommendations to the Secretary on matters of policy concerning the coastal zone. Such committee shall be composed of not more than fifteen persons designated by the Secretary and shall perform such functions and operate in such a manner as the Secretary may direct. The Secretary shall insure that the committee membership as a group possesses a broad range of experience and knowledge relating to problems involving management, use, conservation, protection, and development of coastal zone resources.

Compensation, travel expenses.

(b) Members of the committee who are not regular full-time employees of the United States, while serving on the business of the committee, including traveltime, may receive compensation at rates not exceeding $100 per diem; and while so serving away from their

homes or regular places of business may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5, United States Code, for individuals in the Government service employed intermittently. 80 Stat. 499; 83 Stat. 190.

ESTUARINE SANCTUARIES

SEC. 312. The Secretary, in accordance with rules and regulations promulgated by him, is authorized to make available to a coastal state grants of up to 50 per centum of the costs of acquisition, development, and operation of estuarine sanctuaries for the purpose of creating natural field laboratories to gather data and make studies of the natural and human processes occurring within the estuaries of the coastal zone. The Federal share of the cost for each such sanctuary shall not exceed $2,000,000. No Federal funds received pursuant to section 305 or section 306 shall be used for the purpose of this section. Grants. Federal share.

ANNUAL REPORT

SEC. 313. (a) The Secretary shall prepare and submit to the President for transmittal to the Congress not later than November 1 of each year a report on the administration of this title for the preceding fiscal year. The report shall include but not be restricted to (1) an identification of the state programs approved pursuant to this title during the preceding Federal fiscal year and a description of those programs; (2) a listing of the states participating in the provisions of this title and a description of the status of each state's programs and its accomplishments during the preceding Federal fiscal year; (3) an itemization of the allocation of funds to the various coastal states and a breakdown of the major projects and areas on which these funds were expended; (4) an identification of any state programs which have been reviewed and disapproved or with respect to which grants have been terminated under this title, and a statement of the reasons for such action; (5) a listing of all activities and projects which, pursuant to the provisions of subsection (c) or subsection (d) of section 307, are not consistent with an applicable approved state management program; (6) a summary of the regulations issued by the Secretary or in effect during the preceding Federal fiscal year; (7) a summary of a coordinated national strategy and program for the Nation's coastal zone including identification and discussion of Federal, regional, state, and local responsibilities and functions therein; (8) a summary of outstanding problems arising in the administration of this title in order of priority; and (9) such other information as may be appropriate.

(b) The report required by subsection (a) shall contain such recommendations for additional legislation as the Secretary deems necessary to achieve the objectives of this title and enhance its effective operation.

RULES AND REGULATIONS

SEC. 314. The Secretary shall develop and promulgate, pursuant to section 553 of title 5, United States Code, after notice and opportunity for full participation by relevant Federal agencies, state agencies, local governments, regional organizations, port authorities, and other interested parties, both public and private, such rules and regulations as may be necessary to carry out the provisions of this title. 80 Stat. 383.

AUTHORIZATION OF APPROPRIATIONS

SEC. 315. (a) There are authorized to be appropriated—

(1) the sum of $9,000,000 for the fiscal year ending June 30, 1973, and for each of the fiscal years 1974 through 1977 for grants under section 305, to remain available until expended;

(2) such sums, not to exceed $30,000,000, for the fiscal year ending June 30, 1974, and for each of the fiscal years 1975 through 1977, as may be necessary, for grants under section 306 to remain available until expended; and

(3) such sums, not to exceed $6,000,000 for the fiscal year ending June 30, 1974, as may be necessary, for grants under section 312, to remain available until expended.

(b) There are also authorized to be appropriated such sums, not to exceed $3,000,000, for fiscal year 1973 and for each of the four succeeding fiscal years, as may be necessary for administrative expenses incident to the administration of this title.

Approved October 27, 1972.

LEGISLATIVE HISTORY:

HOUSE REPORTS: No. 92-1049 accompanying H.R. 14146 (Comm. on Merchant Marine and Fisheries) and No. 92-1544 (Comm. of Conference).

SENATE REPORT No. 92-753 (Comm. on Commerce).

CONGRESSIONAL RECORD, Vol. 118 (1972):

Apr. 25, considered and passed Senate.

Aug. 2, considered and passed House, amended, in lieu of H.R. 14146.

Oct. 12, House and Senate agreed to conference report.

WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 8, No. 44:

Oct. 28, Presidential statement.

O

APPENDIX F

UNITED STATES NATIONAL MAP ACCURACY STANDARDS

With a view to the utmost economy and expedition in producing maps which fulfill not only the broad needs for standard or principal maps, but also the reasonable particular needs of individual agencies, standards of accuracy for published maps are defined as follows:

1. Horizontal accuracy. For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or center points of small buildings); etc. In general what is well defined will also be determined by what is plottable on the scale of the map within 1/100 inch. Thus while the intersection of two road or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. In this class would come timber lines, soil boundaries, etc.

2. Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

3. The accuracy of any map may be tested by comparing the positions of points whose locations or elevations are shown upon it with corresponding positions as determined by surveys of a higher accuracy. Tests shall be made by the producing agency, which shall also determine which of its maps are to be tested, and the extent of such testing.

4. Published maps meeting these accuracy requirements shall note this fact on their legends, as follows: "This map complies with National Map Accuracy Standards."

5. Published maps whose errors exceed those aforestated shall omit from their legends all mention of standard accuracy.

6. When a published map is a considerable enlargement of a map drawing (manuscript) or of a published map, that fact shall be stated in the legend. For example, "This map is an enlargement of a 1:20,000-scale map drawing", or "This map is an enlargement of a 1:24,000-scale published map".

7. To facilitate ready interchange and use of basic information for map construction among all Federal mapmaking agencies, manuscript maps and published maps, wherever economically feasible and consistent with the uses to which the map is to be put, shall conform to latitude and longitude boundaries, being 15 minutes of latitude and longitude, or 7.5 minutes, or 3-3/4 minutes in size.

U.S. BUREAU OF THE BUDGET

Issued June 10, 1941
Revised April 26, 1943
Revised June 17, 1947

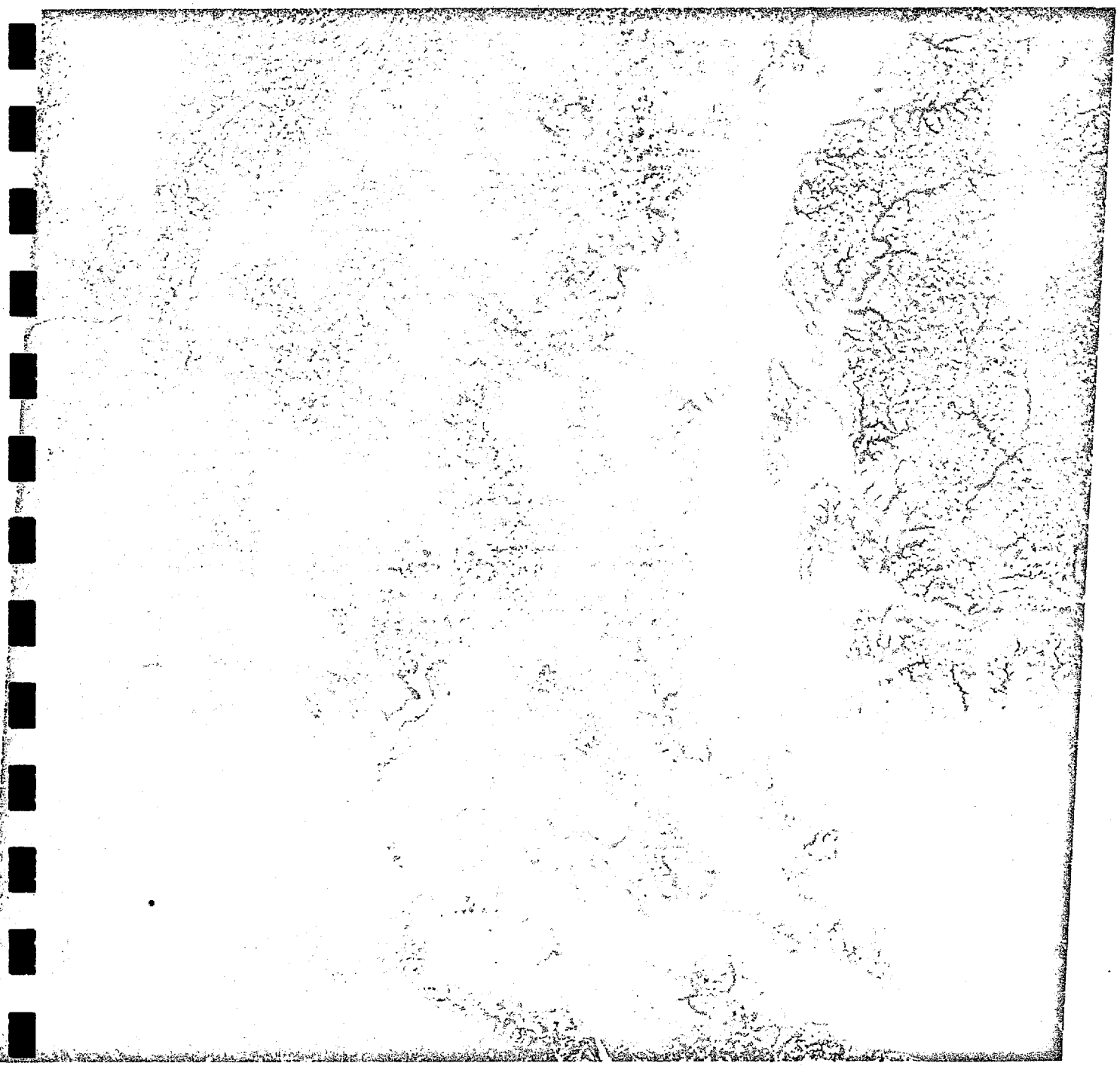
APPENDIX G

EXAMPLES OF PRODUCTS

1. Landsat image
2. USGS aerial photograph
3. USGS 7 1/2-minute orthophotomap/line map combination
4. USGS 7 1/2-minute orthophotoquad
5. USGS 7 1/2-minute topographic quadrangle
6. USGS slope map
7. USGS 7 1/2-minute geologic quadrangle
8. USGS flood plain map
9. USGS/NOS Topographic-bathymetric map
10. NOS storm evacuation map
11. USGS/NOS geodetic control diagram
12. NOS coast chart
13. NOS lake chart
14. NOS aeronautical chart
15. BLM plot
16. National Forest map
17. National Park map
18. Federal highway map of the United States
19. (Census map)

NASA LANDSAT-1

NATION'S CAPITAL AREA



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION IMAGE

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1972

W077-301 W076-3011 N038-00

110CT72 C N38-54/W076-48 N N38-52/W076-43 MSS 4 5 7 D SUN EL38 AZ149 191-1114-N-I-N-D-IL NASA ERTS E-1080-15192-7 01

5 0 10 20 30 40 MILE

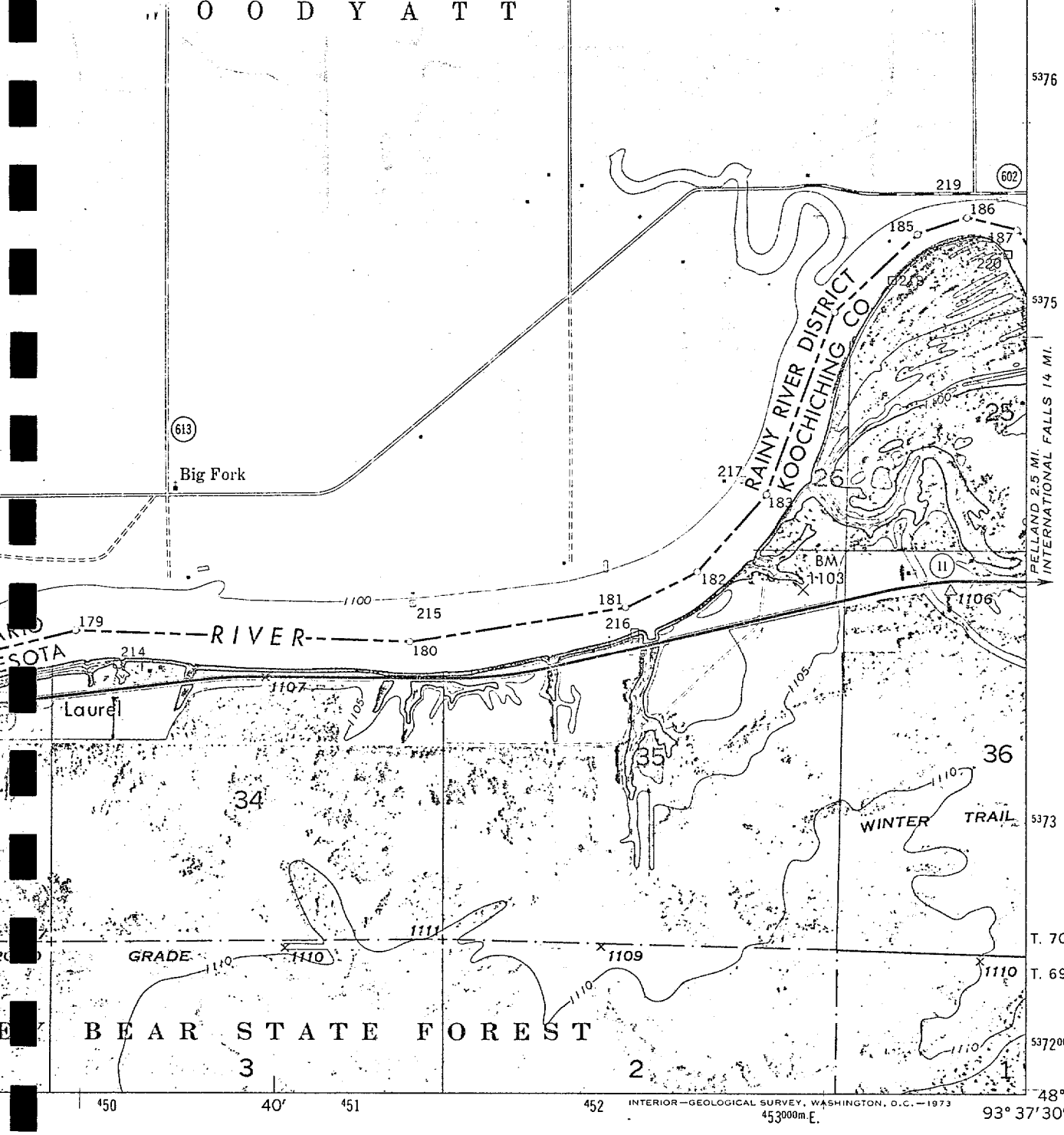
Scale approximately 1:1,000,000

EROS EARTH RESOURCES OBSERVATION SYSTEMS PROGRAM
In cooperation with NASA and other agencies

imental printed image produced from a color-separated color transparency.
S. Geological Survey

Aerial photograph

USGS



INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973

1 MILE

6000 7000 FEET

1 KILOMETER

ND 50 FEET IN CANADA

ROAD CLASSIFICATION

Primary highway, hard surface

Secondary highway, hard surface

Light-duty road, hard or improved surface

Unimproved road

Interstate Route U. S. Route State Route

MINN.

QUADRANGLE LOCATION

AL MAP ACCURACY STANDARDS
O 80225, OR WASHINGTON, D.C. 20242
S AVAILABLE ON REQUEST

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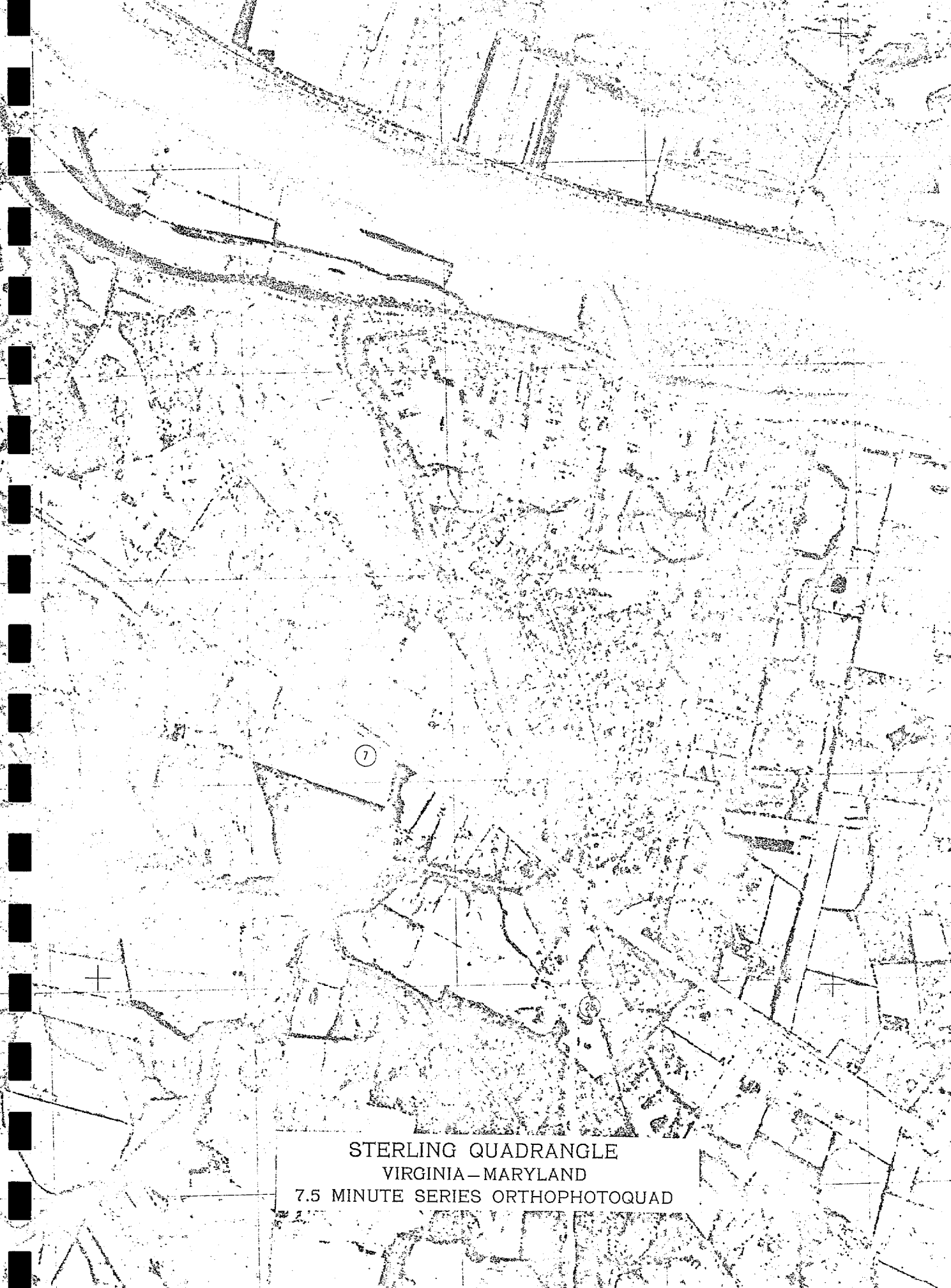
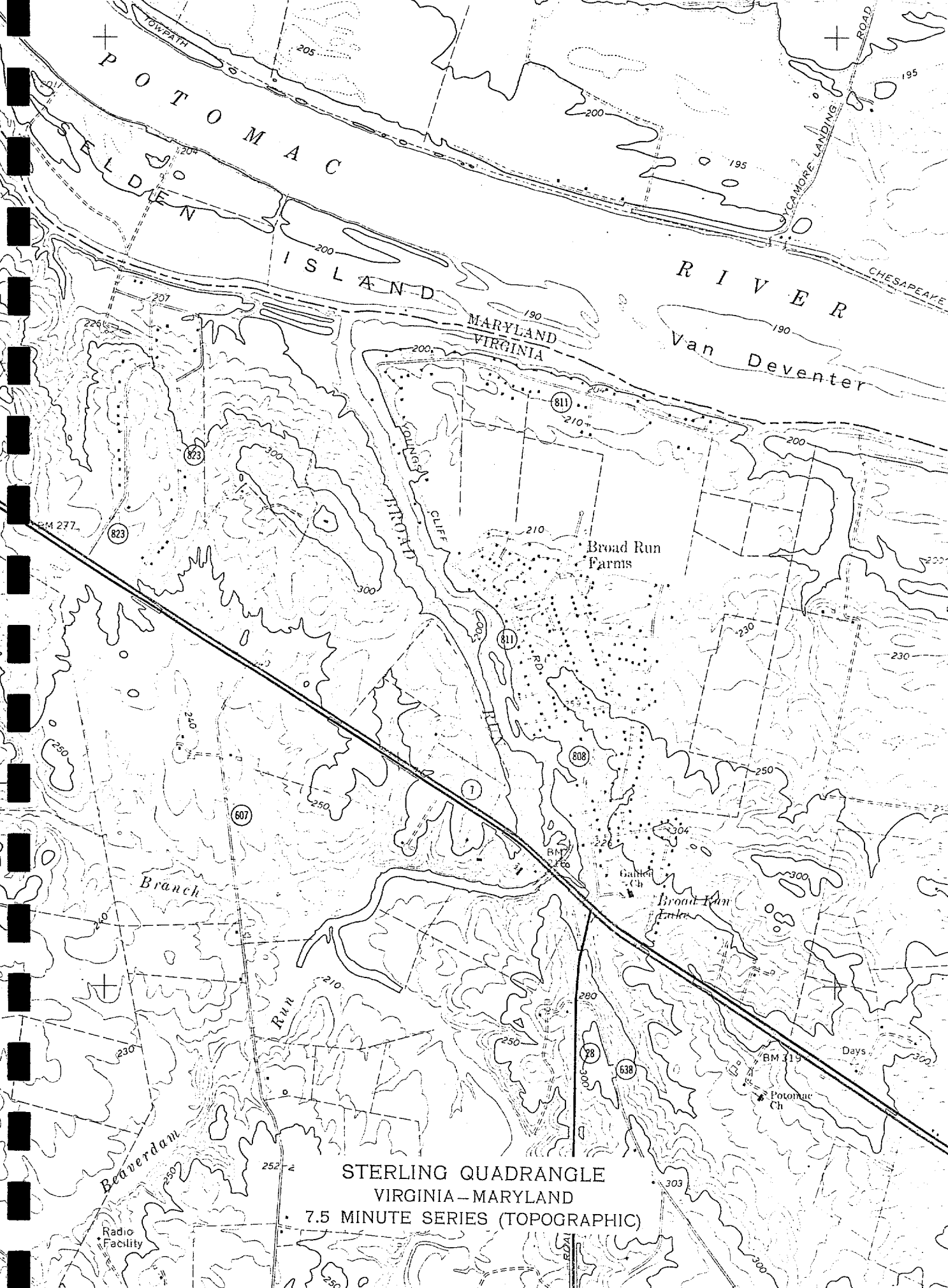
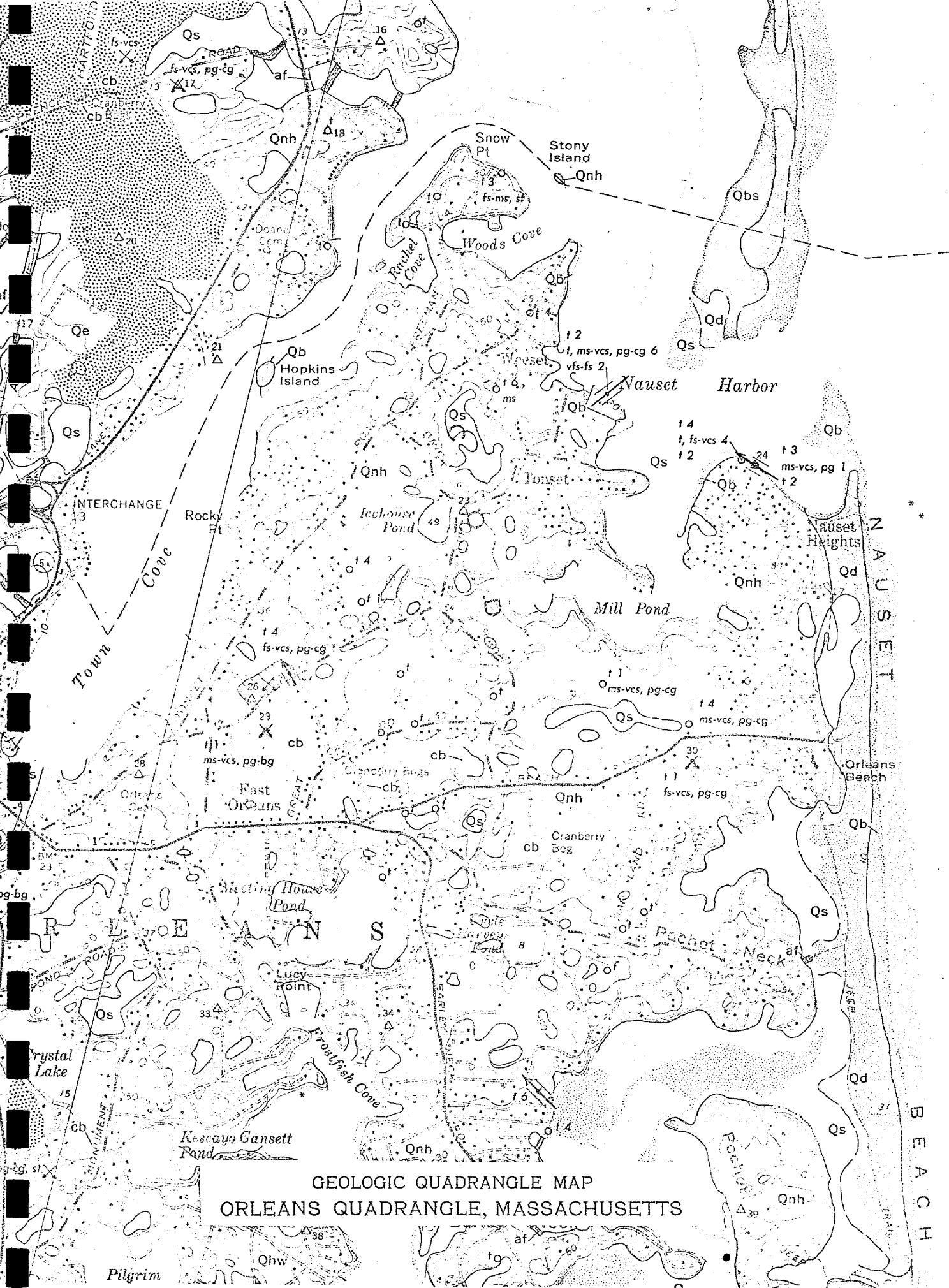


STERLING QUADRANGLE
VIRGINIA—MARYLAND
7.5 MINUTE SERIES ORTHOPHOTOQUAD



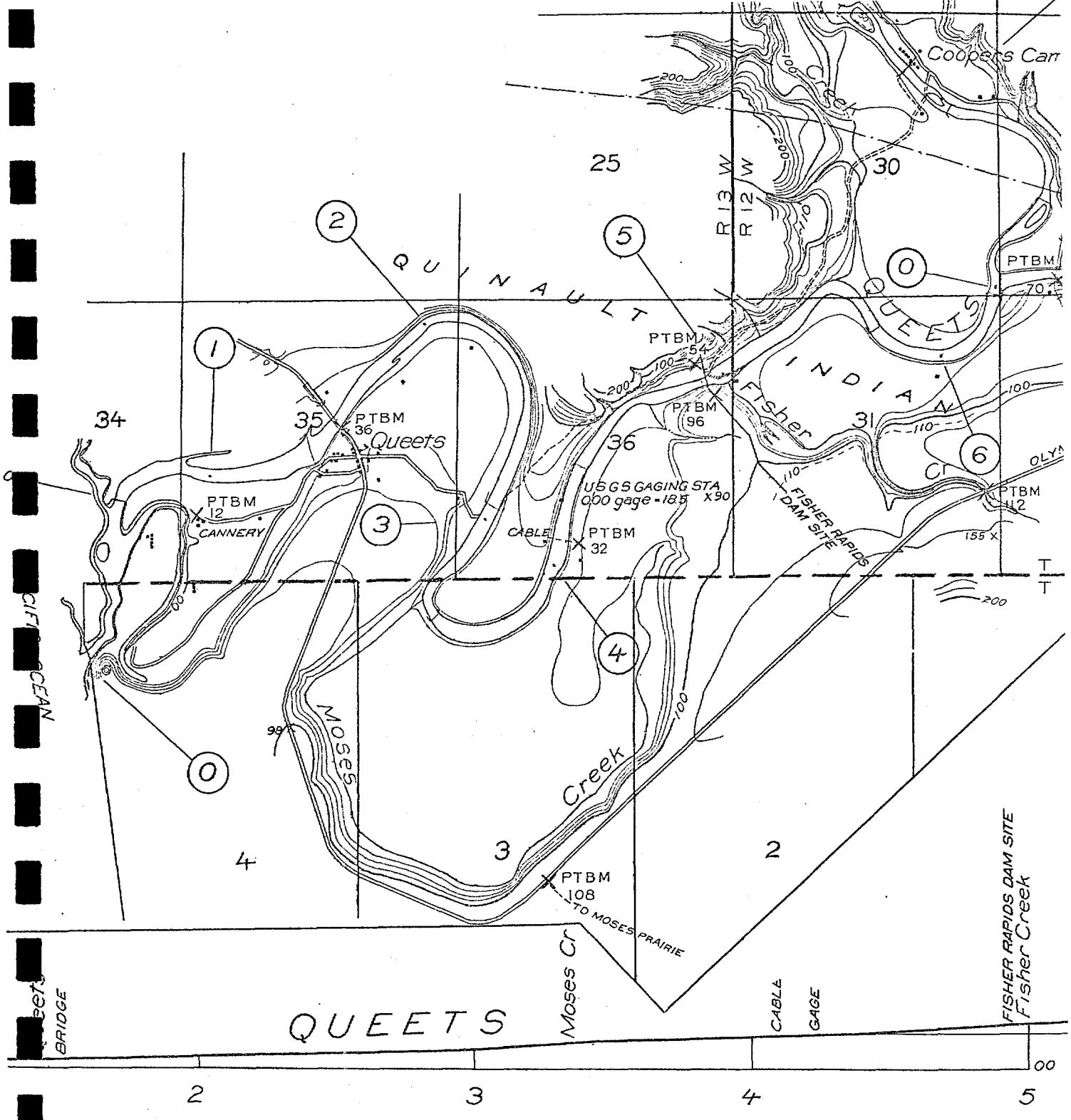
STERLING QUADRANGLE
VIRGINIA—MARYLAND
7.5 MINUTE SERIES (TOPOGRAPHIC)

USGS slope map



GEOLOGIC QUADRANGLE MAP

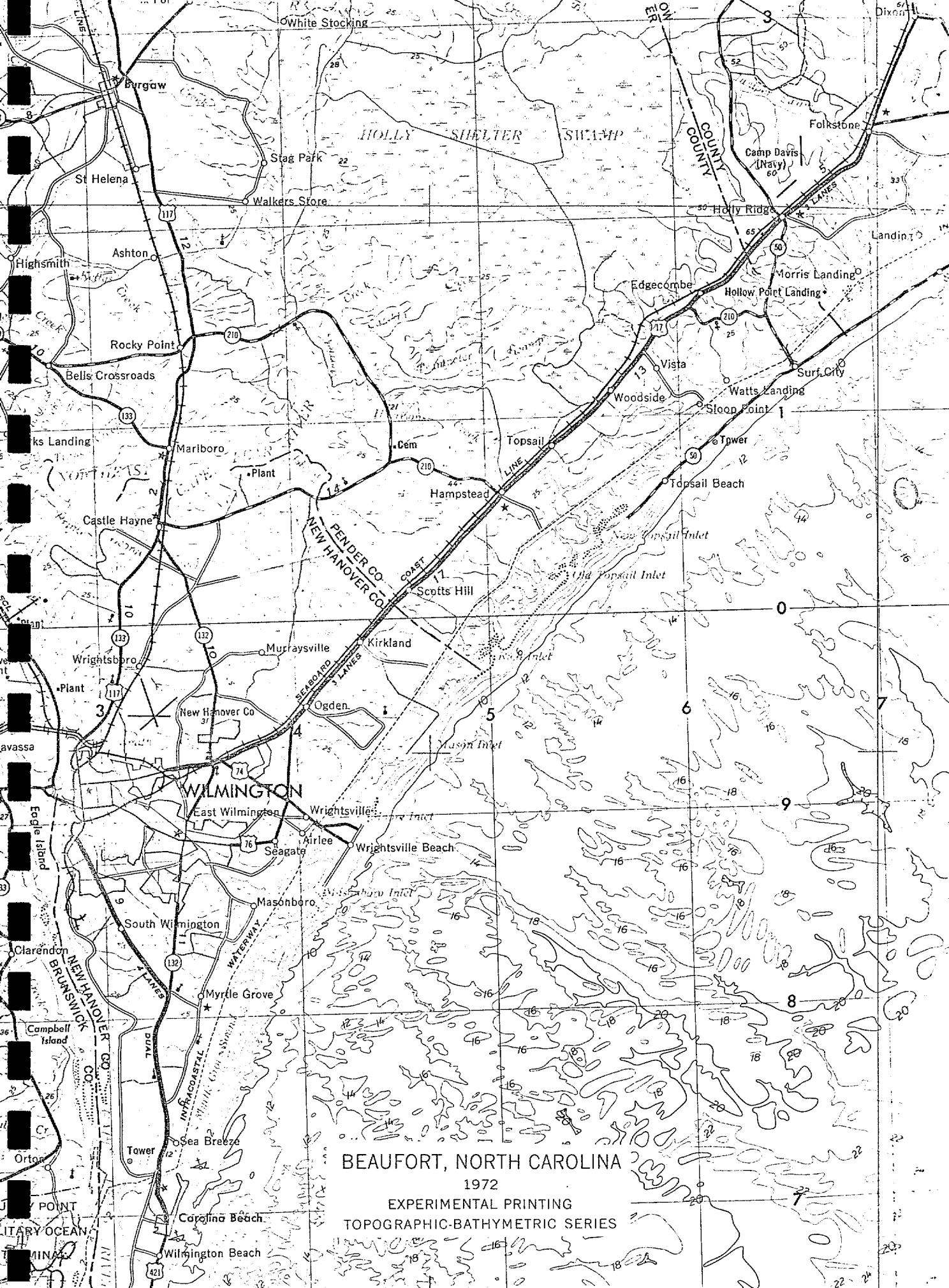
ORLEANS QUADRANGLE, MASSACHUSETTS



PLAN AND PROFILE OF

QUEETS RIVER, WASHINGTON, AND TRIBUTARIES
MISCELLANEOUS DAM SITES

(3 plan sheets, 2 profile sheets)



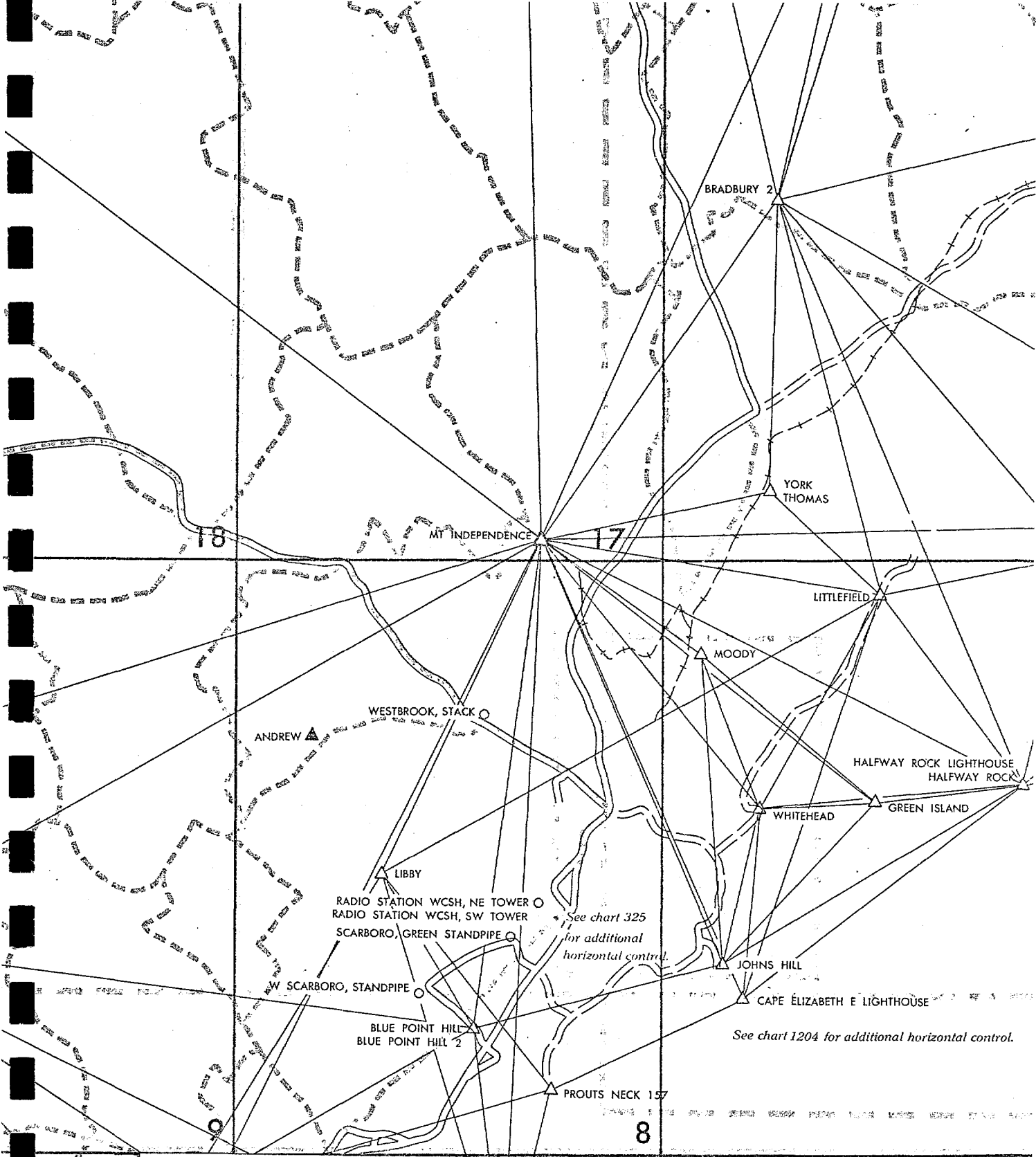
BEAUFORT, NORTH CAROLINA

1972

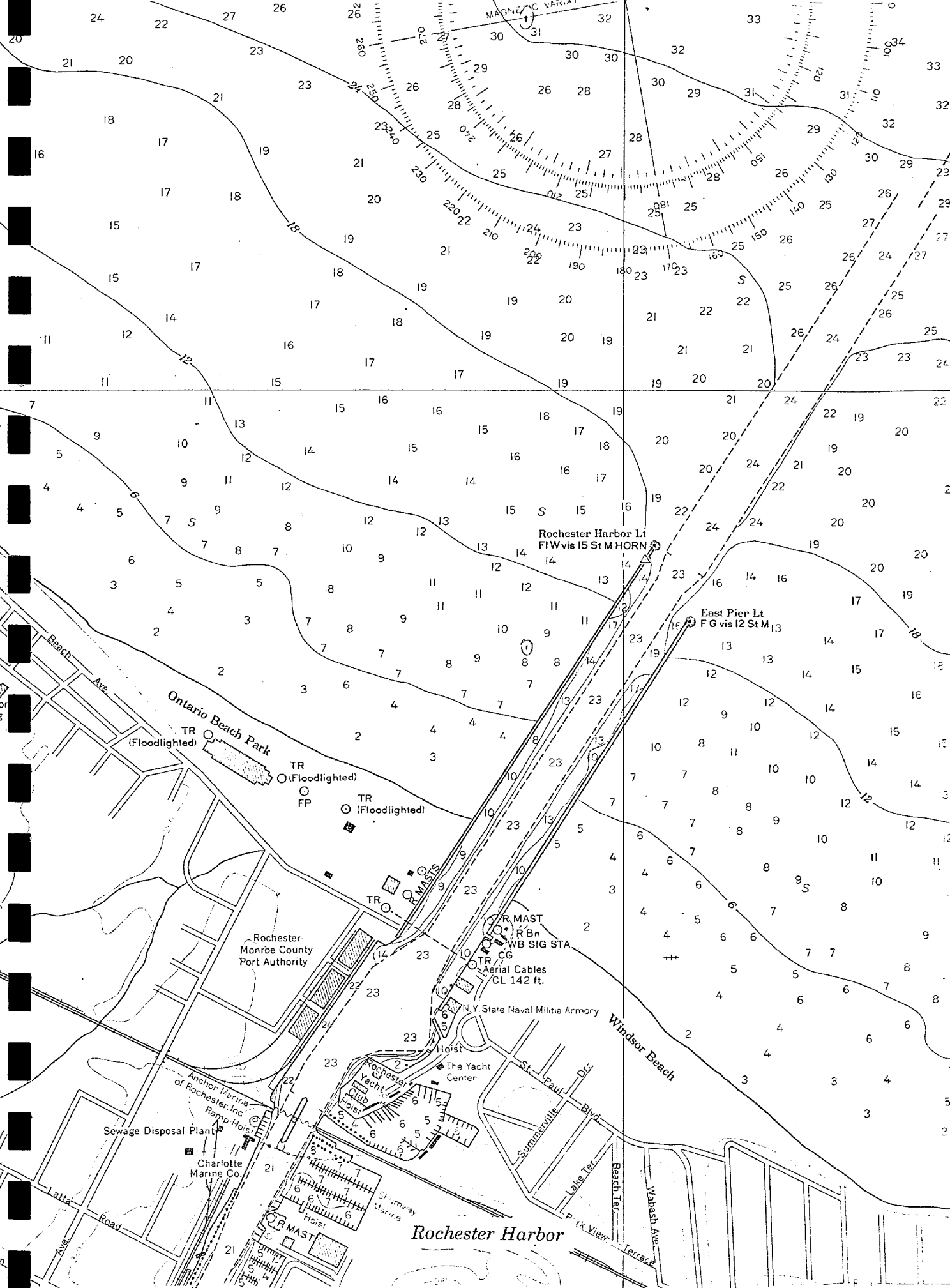
EXPERIMENTAL PRINTING

TOPOGRAPHIC-BATHYMETRIC SERIES

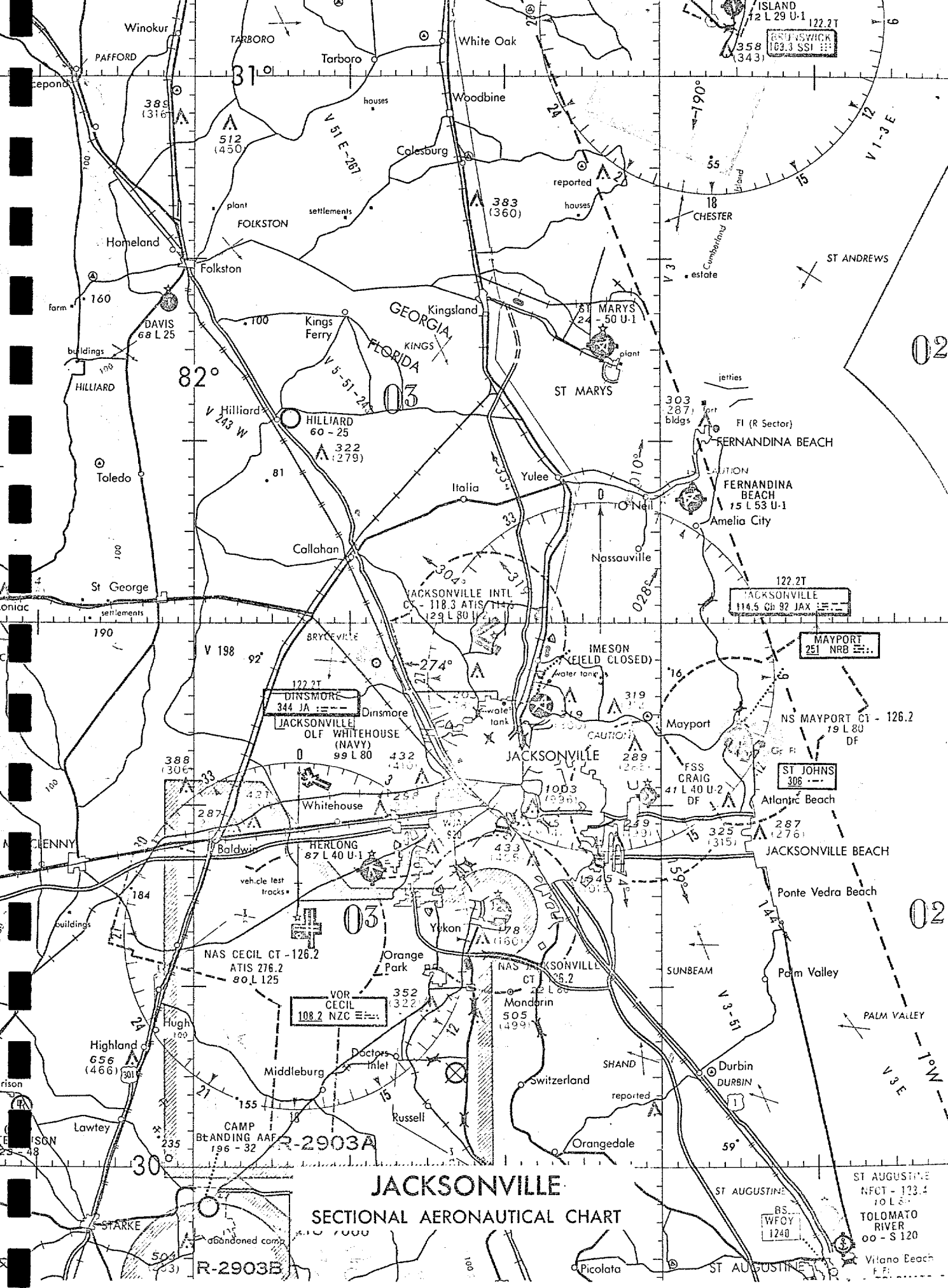
NOS storm evacuation map


BRADBURY 2
YORK
THOMAS
MT INDEPENDENCE
18
17
LITTLEFIELD
MOODY
WESTBROOK, STACK
ANDREW
HALFWAY ROCK LIGHTHOUSE
HALFWAY ROCK
WHITEHEAD
GREEN ISLAND
LIBBY
RADIO STATION WCSH, NE TOWER
RADIO STATION WCSH, SW TOWER
SCARBORO, GREEN STANDPIPE
See chart 325 for additional horizontal control.
JOHNS HILL
W SCARBORO, STANDPIPE
CAPE ELIZABETH E LIGHTHOUSE
BLUE POINT HILL
BLUE POINT HILL 2
See chart 1204 for additional horizontal control.
PROUTS NECK 157
9
8
HC
GEODETIC CONTROL DIAGRAM
NASON
FLETCHERS NECK
FLETCHERS NECK 156
See chart 1205 for additional horizontal control.

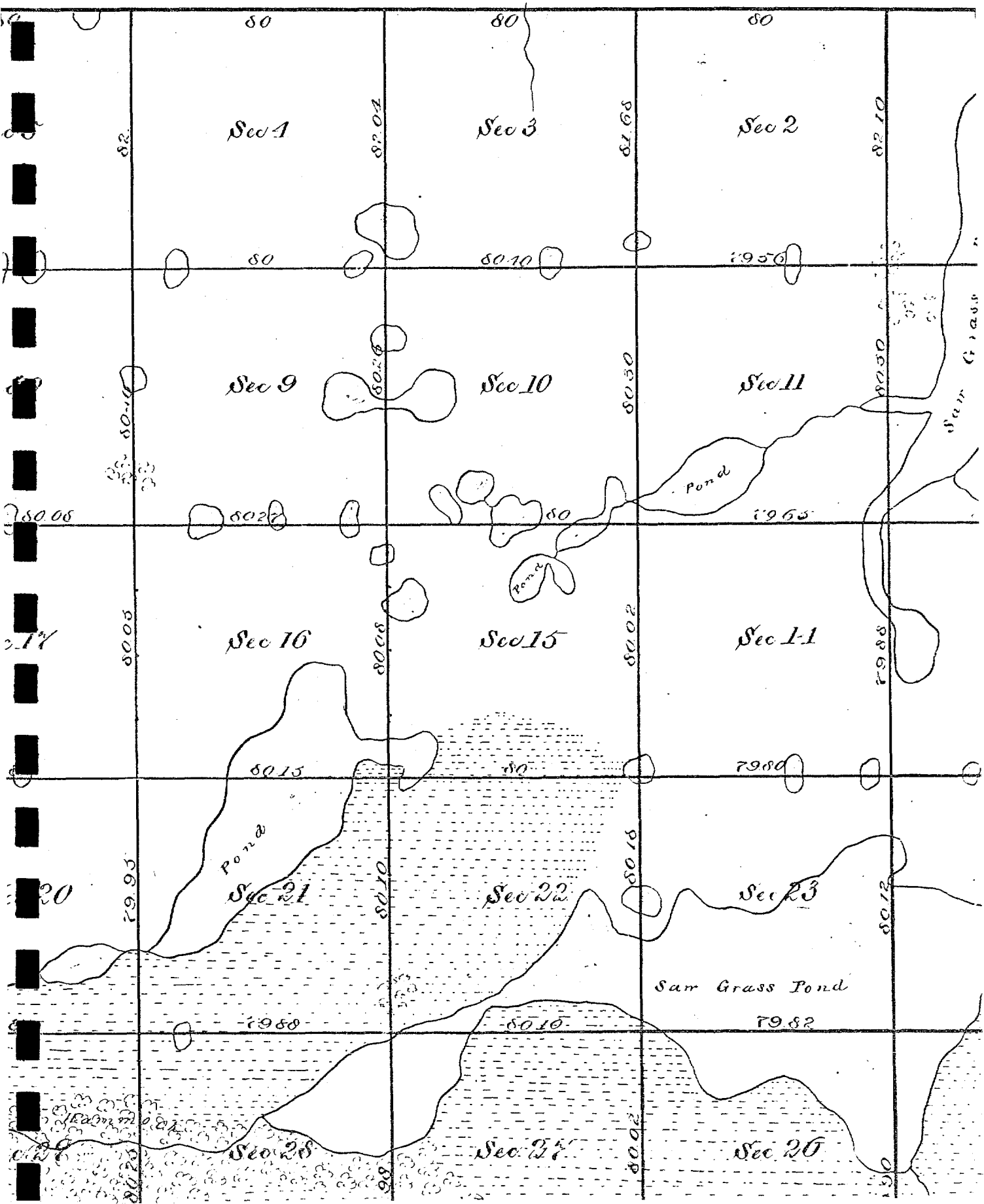
NOS coast chart

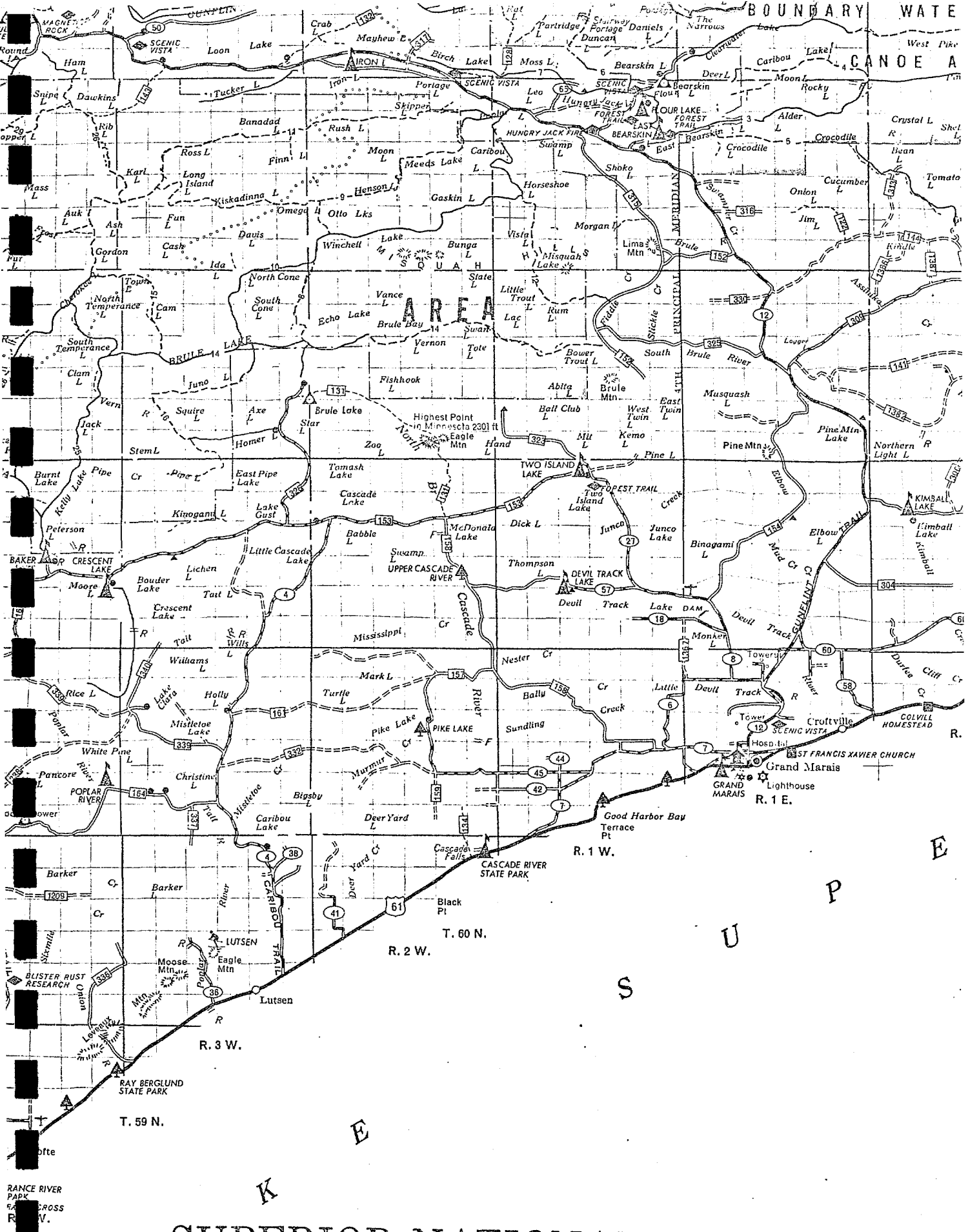


MAGNETIC VARIAT
Rochester Harbor Lt
Fl W vis 15 St M HORN
East Pier Lt
F G vis 12 St M
Beach Ave.
Ontario Beach Park
TR (Floodlighted)
TR (Floodlighted)
FP
TR (Floodlighted)
TR
R MASTS
R MAST
R Bn
WB SIG STA
CG
TR
Aerial Cables
CL 142 ft.
N.Y. State Naval Militia Armory
Rochester-Monroe County Port Authority
Windsor Beach
Hoist
The Yacht Center
Rochester Yacht Club Hoist
St. Paul Blvd.
Summerville Dr.
Lake Ter.
Beach Ter.
Wabash Ave.
Park View Terrace
Anchor Marine of Rochester, Inc.
Ramp Hoist
Sewage Disposal Plant
Charlotte Marine Co.
Latta Road
Ave.
Shimway Marine
Hoist
R MAST
Rochester Harbor


JACKSONVILLE
SECTIONAL AERONAUTICAL CHART
Winokur
PAFFORD
TARBORO
Tarboro
White Oak
Woodbine
Colesburg
FOLKSTON
Homeland
Folkston
Kingsland
GEORGIA
FLORIDA
KINGS
Kings Ferry
DAVIS
68 L 25
HILLIARD
HILLIARD
60 - 25
Toledo
Italia
Yulee
O'Neil
Amelia City
Callahan
Nassauville
St George
BRYCEVILLE
Dinsmore
DINSMORE
344 JA
JACKSONVILLE OLF WHITEHOUSE (NAVY)
99 L 80
Whitehouse
JACKSONVILLE
IMESON (FIELD CLOSED)
Mayport
MAYPORT
251 NRB
NS MAYPORT CT - 126.2
19 L 80
DF
ST JOHNS
306
FSS CRAIG
41 L 40 U-2
DF
Atlantic Beach
JACKSONVILLE BEACH
Ponte Vedra Beach
Baldwin
HERLONG
87 L 40 U-1
vehicle test tracks
Yukon
NAS CECIL CT - 126.2
ATIS 276.2
80 L 125
Orange Park
VOR
CECIL
108.2 NZC
NAS JACKSONVILLE
CT
Mandarin
SUNBEAM
Palm Valley
PALM VALLEY
Hugh
Highland
656
(466)
Middleburg
Doctors Inlet
Switzerland
Durbin
DURBIN
Lawtey
CAMP BLANDING AAF
196 - 32
R-2903A
R-2903B
Russell
Orangedale
STARKE
abandoned comp
Picolata
ST AUGUSTINE
WFOY
1240
TOLOMATO RIVER
00 - S 120
Vilano Beach
ST ANDREWS
CHESTER
ISLAND
12 L 29 U-1
122.2T
BRUNSWICK
109.3 SSI
ST MARYS
24 - 50 U-1
ST MARYS
FERNANDINA BEACH
FERNANDINA BEACH
15 L 53 U-1
JACKSONVILLE
INTL CT - 118.3
ATIS 114.6
29 L 80
JACKSONVILLE
114.6 Ch 92 JAX
122.2T
V 51 E - 267
V 5 - 51 - 24
V 243 W
V 198
V 1 - 3 E
V 3 - 51
V 3
V 3E
190°
274°
286°
310°
304°
303
287
bldgs
jetties
FI (R Sector)
reported
houses
plant
settlements
farm
buildings
water tank
estate
Cumberland Island
SHAND
CAUTION
GP FI
82°
30°
02
03
1°W

TXXIIIS. RXVIIIE.




BOUNDARY WATE
CANOE A
SQUAW LAKE AREA
BRULE LAKE
Highest Point in Minnesota 2301 ft
Eagle Mtn
TWO ISLAND LAKE
FOUR LAKE
EAST BEARSKIN
HUNGRY JACK FOREST TRAIL
SCENIC VISTA
IRON L
Mayhew L
Birch Lake
Moss L
Bearskin L
Deer L
Caribou L
Moon L
Rocky L
Alder L
Crystal L
Crocodile
Bean L
Tomato L
Cucumber L
Onion L
Jim L
Kimball Lake
Northern Light L
Pine Mtn Lake
Musquash L
Brule Mtn
Lima Mtn
Misquah Lake
Vista L
Morgan L
Horseshoe L
Shoko L
Swamp L
Meeds Lake
Caribou L
Moon L
Rush L
Banadad L
Rib L
Ross L
Finn L
Karl L
Long Island L
Mass L
Kiskadinna L
Henson L
Gaskin L
Omega
Otto Lks
Fun L
Ash L
Auk L
Davis L
Gordon L
Cash L
Ida L
Winchell Lake
Bunga L
North Cone
South Cone
Echo Lake
Brule Bay
Vance L
Vernon L
Tote L
Swan L
Lac L
Rum L
Little Trout L
State L
Bower Trout L
South Brule River
Fishhook L
Abita L
Ball Club
West Twin L
East Twin
Kemo L
Mit L
Hand L
Zoo L
Star L
Brule Lake
Homer L
Stem L
Squire L
Axe L
Juno L
Vern
Jack L
Clam L
South Temperance L
North Temperance L
Cam L
Town L
Cherokee
Burnt Lake
Kelly Lake
Pipe
Pine L
East Pipe Lake
Tomash Lake
Cascade Lake
Lake Gust
Kinogami L
Peterson L
Baker
Crescent Lake
Little Cascade Lake
Lichen L
Bouder Lake
Moore L
Tait L
Crescent Lake
Williams L
Rice L
Lake Clara
Holly L
Mistletoe Lake
White Pine L
Pancore L
Poplar River
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Mississippi
Wills L
Mark L
Turtle L
Pike Lake
PIKE LAKE
Sundling
Bigsby L
Caribou Lake
Deer Yard L
Murmur Cr
Nester Cr
Ballu Creek
Little Devil Track River
Devil Track Lake DAM
DEVIL TRACK LAKE
Devil Track
Thompson L
UPPER CASCADE RIVER
Swamp L
Babble L
McDonald Lake
Dick L
Junco L
Junco Lake
Binagami L
Elbow L
Mud Cr
SUNFLINT CO
Elbow TRAIL
Two Island Lake
FOREST TRAIL
Creek
Tomash Lake
Cascade River
Cascade Falls
CASCADE RIVER STATE PARK
Good Harbor Bay
Terrace Pt
Black Pt
Grand Marais
GRAND MARAIS
Lighthouse
R. 1 E.
R. 1 W.
T. 60 N.
R. 2 W.
R. 3 W.
T. 59 N.
Croftville
COLVILL HOMESTEAD
ST FRANCIS XAVIER CHURCH
Hospital
Tower
Durfee Cliff Cr
Lutsen
LUTSEN
Moose Mtn
Eagle Mtn
Poplar
Onion
Sixmile
BLISTER RUST RESEARCH
Barker Cr
Barker
Deer Yard Cr
CARIBOU TRAIL
RAY BERGLUND STATE PARK
Levaque Mtn
Mountain
RANCE RIVER PARK
Lofte
Cascade River
Brule River
Louger
Assiniboine Cr
Stickle Cr
Riddle Cr
PRINCIPAL 4TH MERIDIAN
Swamper Cr
Lima Mtn
Brule
Eagle Mtn
Hand
Mit
Pine L
Pine Mtn
Kimball Lake
Kimball
Binagami L
Junco
Junco Lake
Dick L
Babble L
McDonald Lake
Swamp
Thompson L
Devil Track
Devil Track Lake DAM
Monker L
Nester Cr
Ballu Creek
Little Devil Track River
Sundling
Pike Lake
PIKE LAKE
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Turtle L
Mississippi
Wills L
Williams L
Rice L
Lake Clara
Holly L
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East Twin
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Louger
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Banadad L
Rib L
Ross L
Finn L
Karl L
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Henson L
Gaskin L
Omega
Otto Lks
Fun L
Ash L
Auk L
Davis L
Gordon L
Cash L
Ida L
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Bearskin L
East
Four Lake
Bearskin L
Deer L
Caribou L
Moon L
Rocky L
Alder L
Crystal L
Crocodile
Bean L
Tomato L
Cucumber L
Onion L
Jim L
HUNGRY JACK FOREST TRAIL
HUNGRY JACK FIRE
Swamp L
Leo L
Portage L
Skipper L
Tucker L
Iron L
Ham L
Snipe L
Dawkins L
Round L
Magnetic Rock
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Mayhew L
Crab L
Partridge L
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Duncan L
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Rib L
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Finn L
Karl L
Long Island L
Mass L
Kiskadinna L
Henson L
Gaskin L
Omega
Otto Lks
Fun L
Ash L
Auk L
Davis L
Gordon L
Cash L
Ida L
SUPERIOR NATIONAL FOREST

National Park map

Federal highway map of the United States

Census map

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FINIS