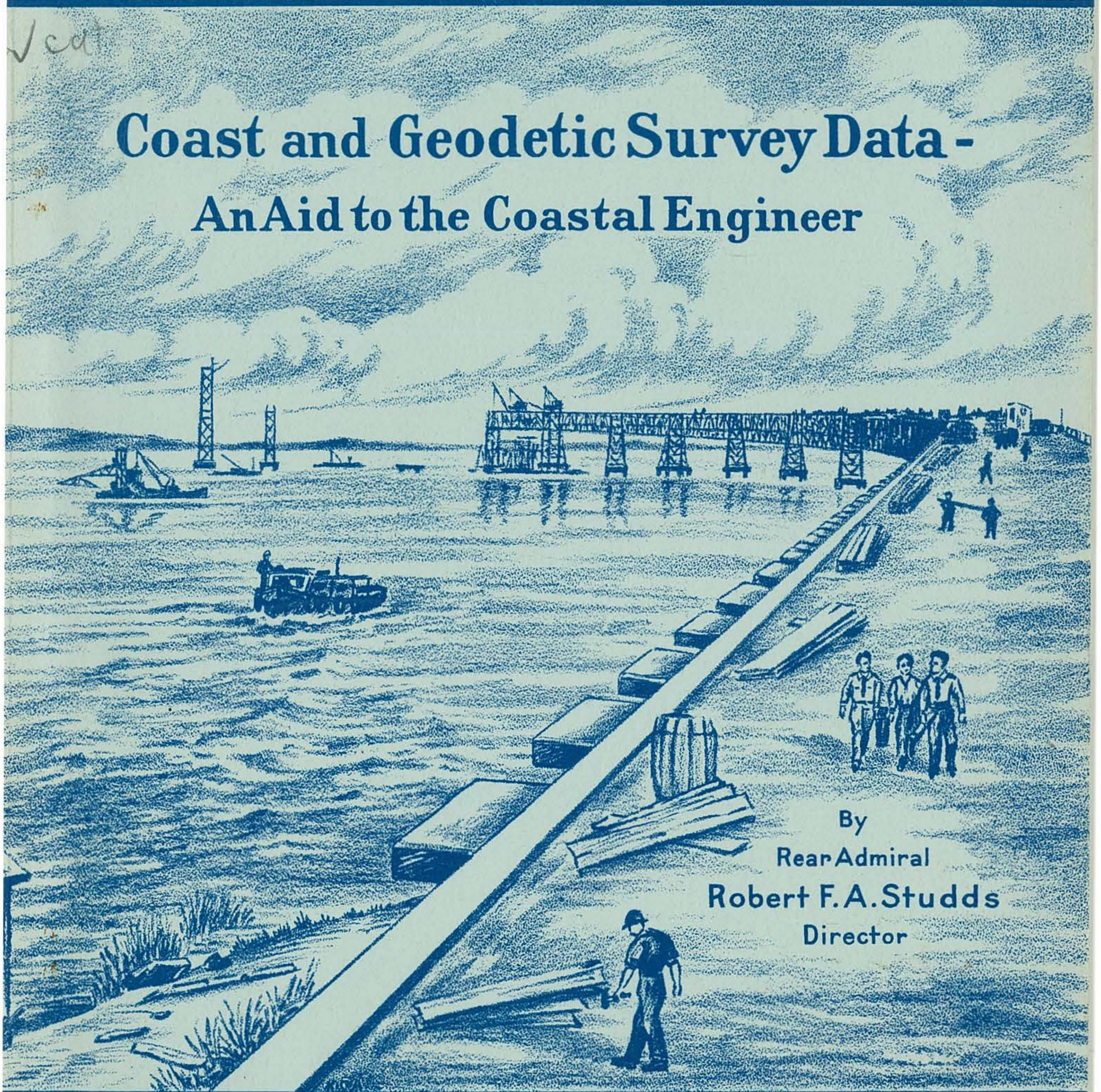
Coast and Geodetic Survey Data -
An Aid to the Coastal Engineer



By
Rear Admiral
Robert F. A. Studds
Director

U. S. Department of Commerce
Washington, D.C.

Coast and Geodetic Survey Data—An Aid to the Coastal Engineer

By REAR ADMIRAL ROBERT F. A. STUDDS
DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

Based on paper presented at Institute on Coastal Engineering,
University of California, Long Beach, October 11, 1950.

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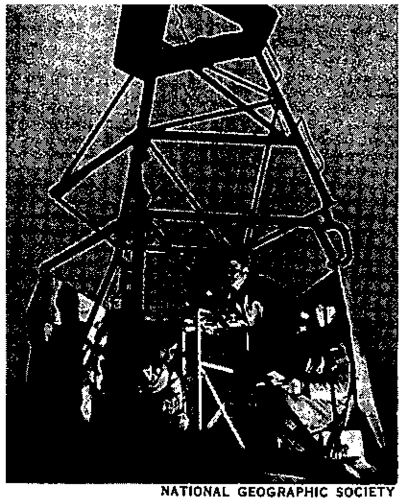

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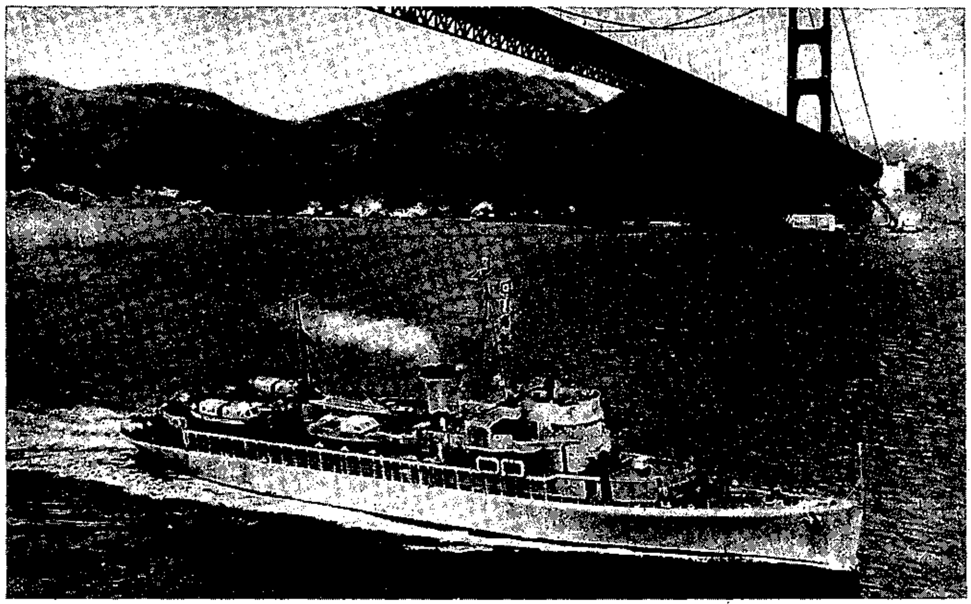

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Coast and Geodetic Survey Data-An Aid to the Coastal Engineer

REAR ADMIRAL ROBERT F. A. STUDDS
Director, U. S. Coast and Geodetic Survey

I am grateful for the opportunity to participate in this timely Institute and to present to this distinguished group of engineers and scientists something of the work of the Bureau, which I am privileged to head, insofar as that work relates to the problems of coastal engineering.

In its long career of surveying and charting the coastal waters of the United States and possessions, a career which dates back to the early part of the nineteenth century, the work of the Coast and Geodetic Survey has been associated with the problems of the coastal engineer. Its successive hydrographic and topographic surveys of the coastal regions furnish basic data for the study of changes in the coastline and adjacent underwater topography and the means to arrest these changes; its tide and current surveys provide the fundamental data necessary in the design of waterfront structures and in harbor improvement; and its geodetic control surveys provide an accurate base for the preliminary study and final construction plans for large-scale improvement projects. To a lesser extent the geomagnetic and seismologic data of the Bureau have also been used by the coastal engineer.

These and other data comprise a vast reservoir of precise facts concerning the coastal regions of our country. We are constantly adding to this storehouse of knowledge, both qualitatively and quantitatively, through improvements in instruments and techniques. In the field of hydrographic surveying, for example, the development of electronic methods for depth measurement and position fixing has made it feasible to survey large sections of our coastal waters with a completeness of detail and position accuracy comparable to that usually obtainable on a ground topographic survey. This was not possible with the older methods of wire sounding and celestial observation.

In this discussion, I should like to describe briefly the nature of our activities, the kind of data we accumulate, and the criteria by which such data should be evaluated.

I. Bureau Activities Related to Coastal Engineering

A. TOPOGRAPHIC SURVEYS

Of perhaps primary importance in problems involving coastal engineering is a knowledge of the location, nature, and form of our sea coasts. Topographic surveys provide this information. Since land features are an essential part of marine charts, the Bureau has been making topographic surveys almost from the very beginning of its work. Scales of topographic surveys are usually 1-20,000 or larger (1-10,000 or 1-5,000), depending upon

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tide. On gently sloping beaches, the estimation of the high-water line is necessarily approximate, and the line is seldom located with greater accuracy than within 10 feet of its true position. The many predetermined triangulation points within the area of a topographic survey provide a constant check on the work and no large errors can accumulate.

High-Water Line in Tidal Marshes

In areas of marsh grass, mangrove, or other similar marine vegetation, where the shoreline is generally obscured, the surveyor makes no attempt to locate the actual mean high-water line, but rather a line that marks the outer or seaward edge of the marsh or marine vegetation, because to the navigator this is the visible shoreline. The true mean high-water line in such areas is generally a meandering line located somewhere between the outer edge of the vegetation and the fast land inshore. Under certain stages of marsh development, the whole of the marsh area may be precisely at mean high water, but from the topographic survey alone, no inference can be drawn regarding the position of the mean high-water line. Other collateral information is usually necessary, such as the contemporary hydrographic survey of the area.

THE LOW-WATER LINE

Another feature on coastal topographic surveys that is important to the coastal engineer is the low-water line--symbolized by a series of dots. A word of caution is necessary regarding the use of this line from topographic surveys. From the survey alone, there is no evidence that the line is the true low-water line. During a large part of the time when the topographer is at work the low-water line is covered and it is impossible for him to locate it by measurement. The low-water line on our topographic surveys is a sketched line and does not represent a definite plane of reference. For charting purposes, the line is developed from the hydrographic survey, supplemented wherever necessary with information from the topographic survey.

B. HYDROGRAPHIC SURVEYS

Hydrographic surveying, as applied to the work of the Coast Survey, consists essentially of measuring depths--that is, taking soundings--and determining the definite locations of the depths even though their positions may be out of sight of land. Besides their value for charting, hydrographic surveys provide the coastal engineer with information on the underwater slope immediately adjacent to the shore. Successive surveys reveal whether there has been a steepening or flattening of the shore and throw light on probable future changes.

In the offshore areas the measurement of great depths can now be obtained in a matter of seconds, making it possible to take thousands of soundings in areas where formerly only a few scattered ones were economically feasible. This is greatly augmenting our knowledge of the ocean floor which not only contributes to the safety of navigation but provides important data for use in several of the earth sciences.

MODERN METHODS

During the century and a quarter that we have been engaged in charting work, many changes have taken place in the methods of hydrographic surveying, each change resulting in an accumulation of more accurate and more detailed information. The most significant of these changes occurred during the periods following the two World Wars. The measurement of ocean depths by handlead and wire gave way to echo sounding, which is a measurement of the time a sound echo takes to return from the bottom beneath the vessel. The uncertain meth-

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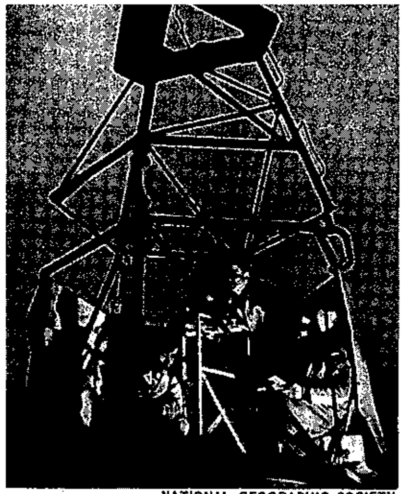
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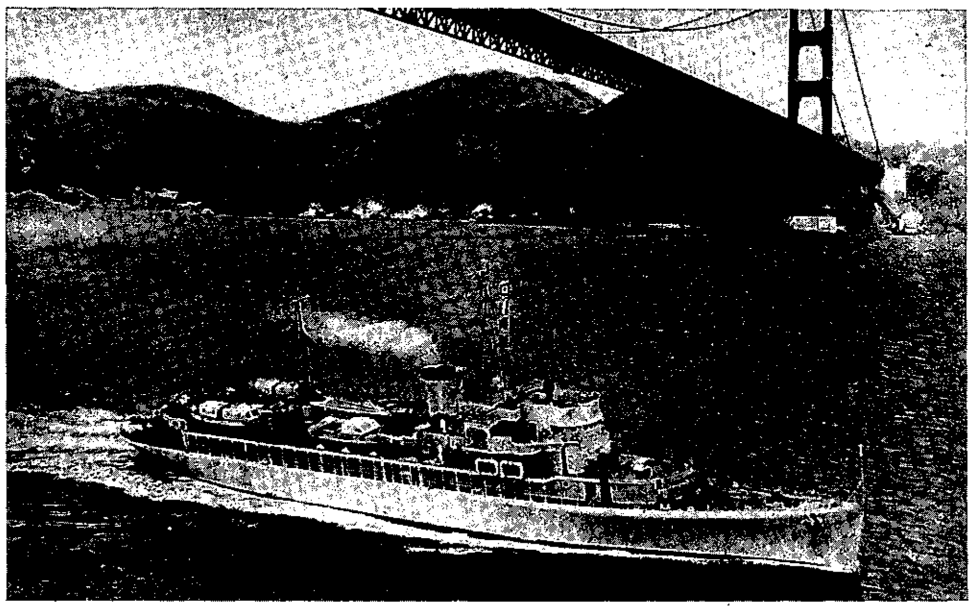

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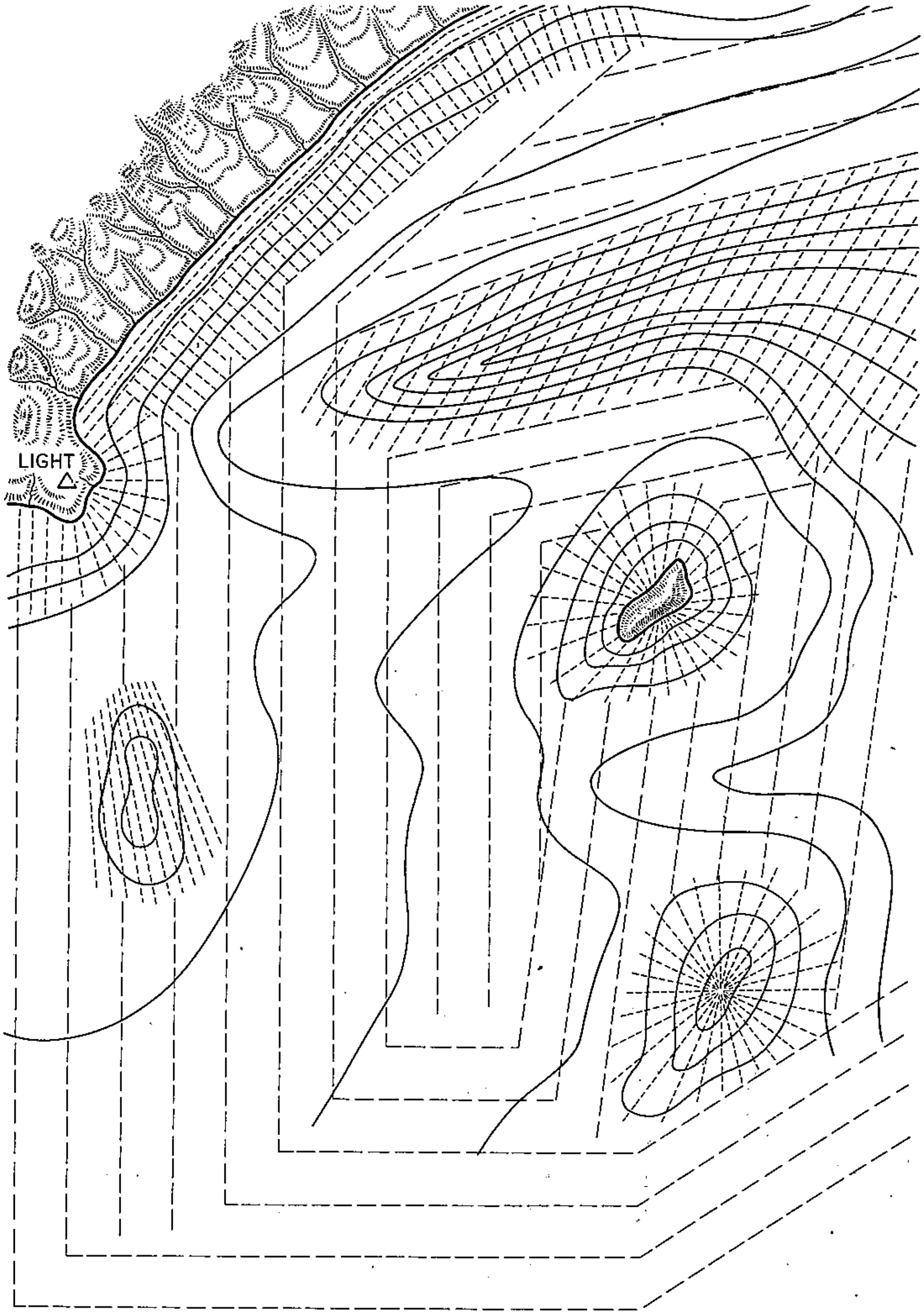
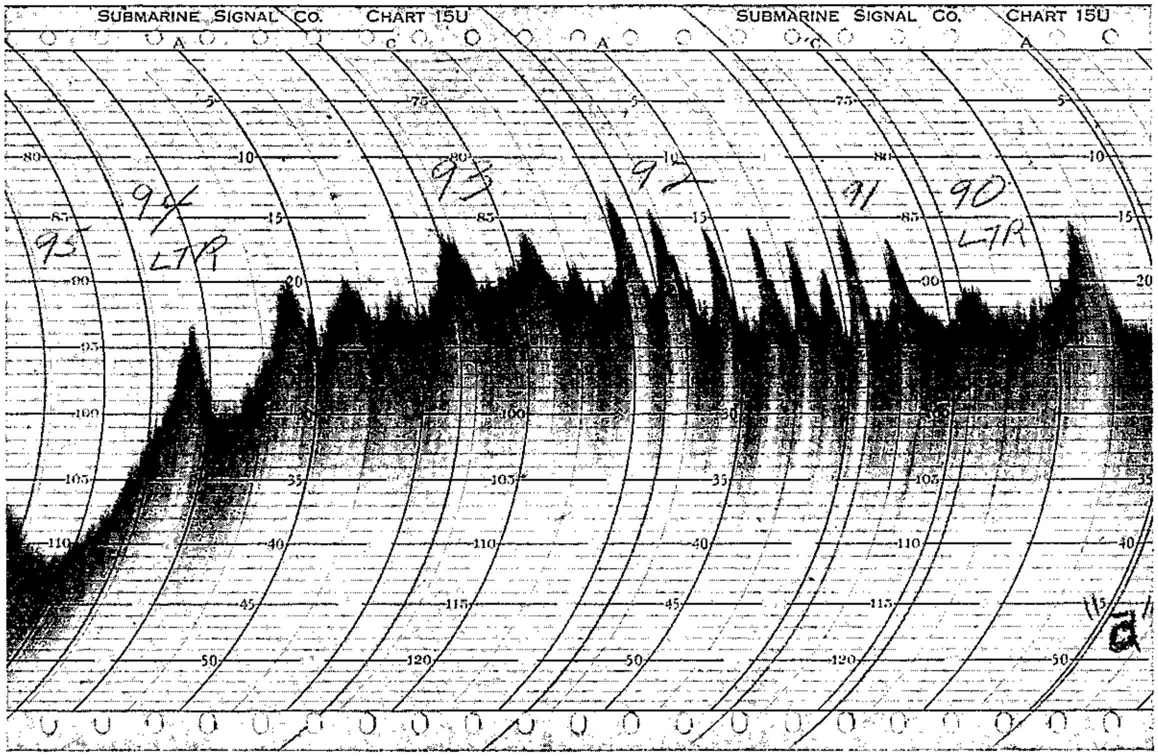


SYSTEMS OF SOUNDING LINES FOR DEVELOPING UNDERWATER FEATURES



DISTINCTIVE "SAW-TOOTH" PATTERN FATHOGRAM RECORD

ods of position determination, such as dead reckoning and celestial observation, have been supplanted by accurate electronic methods.

Echo Sounding

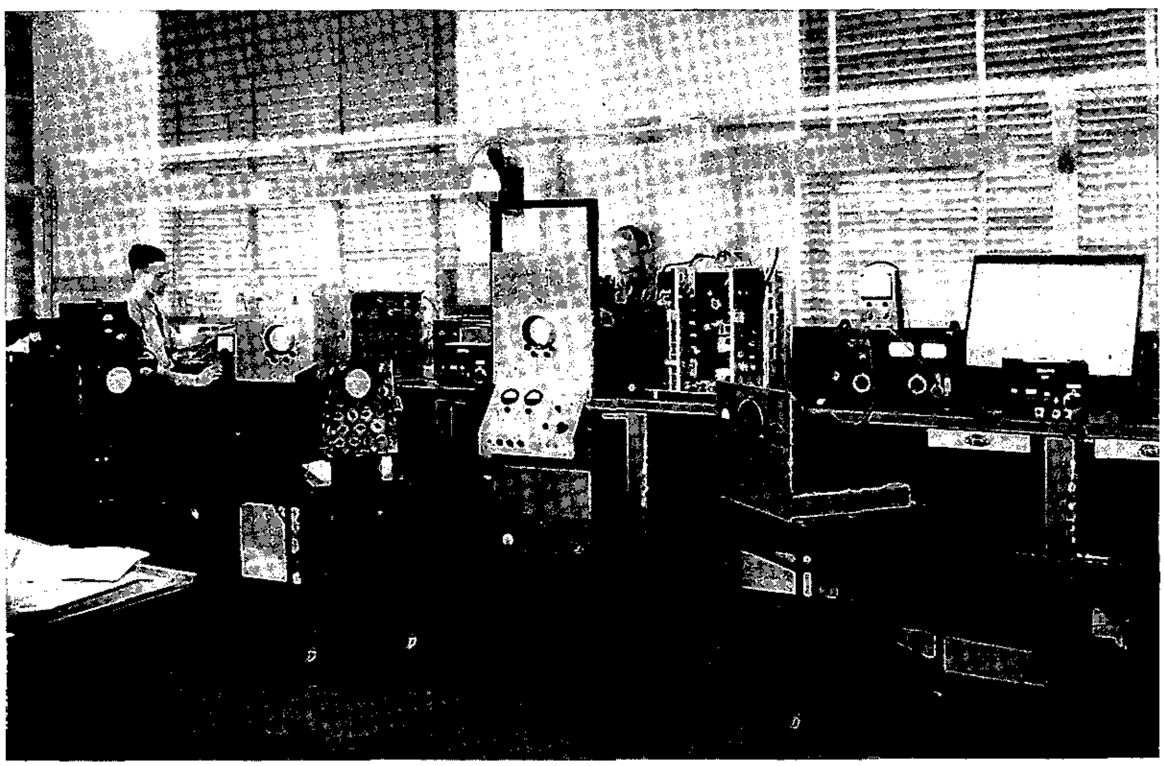
Modern echo-sounding equipment, designed for use in small launches, furnishes detailed information on depths of water close to the beach. The continuous profiles traced by graphic recorders show characteristic patterns of the underwater topography and details which were frequently missed by the older handlead-and-line method of sounding. An interesting example of underwater topography was disclosed recently in a hydrographic survey in San Francisco Bay off one of the beaches. A distinctive saw-tooth pattern closely resembling sand wave forms was disclosed by the fathogram. Another fathogram survey of an inshore area in the Gulf of Mexico revealed a narrow along-shore ridge with a depth of 6 feet of water over it. This hitherto unknown ridge occurred between inshore and offshore depths of 12 feet.

The fathograms of echo-sounding equipment also show quite clearly, under certain conditions, layers of silt or other loosely distributed sediment overlaying the substrata, such as are commonly found in bays, lakes, or estuaries.

Experience has shown that the most effective method of surveying an inshore area, where the bottom slopes gradually, is by a system of sounding lines parallel to the beach, with an occasional cross check line. The first line of soundings is run as close to the high-water line as practicable. The next lines are closely spaced and do not exceed 50 meters. This interval is increased as the survey progresses offshore. Our operations are planned to take advantage of periods of high tide and calm weather which afford the best conditions for inshore sounding.

Shoran and E.P.I.

For position fixing in hydrographic surveying we have developed two electronic systems. One is Shoran, or Short Range Navigation, which is an adaptation of a method used by the Air Forces during World War II for strategic bombing. Shoran constitutes no new principle in hydrographic surveying, but it does apply a new and effective method for measuring distances from control points. Shoran does the job quickly, accurately, and under adverse weather conditions. Shoran is based on the fact that radio waves travel through the atmosphere at a very nearly constant velocity of approximately 186,000 miles per second. Success of the method is due to the accomplishment of electronic engineers in devising means for accurate measurement of the remarkably small time intervals involved in the travel of electromagnetic waves to a target and back. In the familiar radar, dependence is placed upon the reflection of radio waves from natural objects encountered. Shoran strengthens and specializes this principle by use of responding radio stations set up at known points, which return intensified signals. Distances can be read to hundredths or even thousandths of a mile. Two such distances are measured simultaneously and thereby determine the position of the survey ship. Shoran will measure distances with a probable error of about 8 meters in a single measurement.



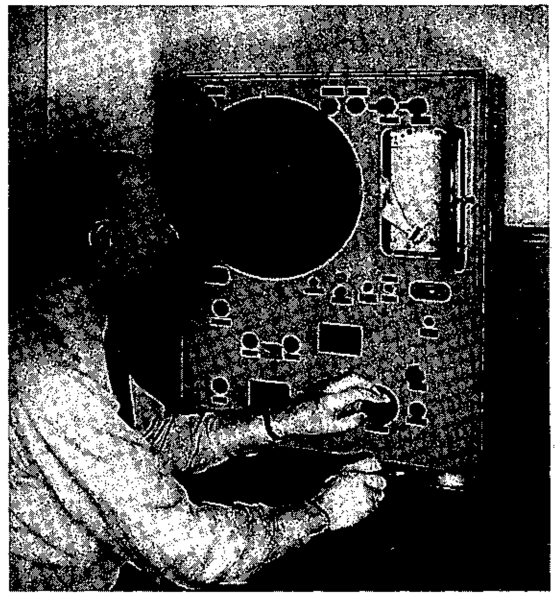
PORTION OF COAST AND GEODETIC SURVEY ELECTRONIC RESEARCH LABORATORY

The radio frequencies used in Shoran are in the ultra-high-frequency bands and are of the order of 250 megacycles per second. The range of the system is limited to line-of-sight distances. With a normal installation, control is possible over an area extending 50 to 75 miles from the ground stations. We have used Shoran successfully off the Atlantic coast and in Alaskan waters off the western Aleutians during the past 5 years.

Because of the line-of-sight limitation of Shoran, the Coast and Geodetic Survey developed an Electronic Position Indicator (E.P.I.) for use beyond the limits of Shoran. E.P.I. utilizes very low frequencies of the order of 2 megacycles per second which can be detected for great distances because they follow the curvature of the earth. The principles of position fixing with E.P.I. are essentially the same as with Shoran. The range of E.P.I. does not depend on elevation and therefore the system can be used with control stations of relatively low height. Distances close to 300 miles have been measured in the Gulf of Mexico. The over-all accuracy of the system is about 75 meters and is independent of distance from the control station.

Accuracy of Echo Soundings

Questions often arise as to the accuracy of the new methods of hydrographic surveying. With respect to depth measurement, it can be stated that, insofar as the equipment is concerned, the visual type of echo sounder, known as the "Dorsey No. 3," which was developed by the Coast and Geodetic Survey, has a probable reading accuracy of 1/10 foot for soundings of 100 fathoms and less. The graphic recorder type of echo sounder using supersonic frequencies (up to 25 kilocycles per second) gives good results for depths of from 3 feet under the keel to greater than 4,000 fathoms. The accuracy of these instruments is about 1:1,000 on the expanded shoal scales and about 1:100 on the compressed deep-water scales.



OPERATING A FATHOMETER

Echo-sounding instruments are usually calibrated for a velocity of 4,800 feet per second, whereas the velocity of sound in the different oceans varies from 4,500 to 5,100 feet per second. Depths read on the instrument must therefore be corrected for this difference, which constitutes perhaps the greatest single factor affecting the accuracy of an echo sounder. Inasmuch as velocity is dependent upon the temperature, salinity, and depth of the water and as these factors vary both seasonally and regionally, our specifications call for a determination of these physical characteristics with such frequency that the resulting depths will not be in error by more than 1 percent of the true depth. Thus, a sounding of 100 feet should be correct within 1 foot, and a 1,000-foot sounding within 10 feet.

NINE-LENS COMPOSITE AERIAL PHOTOGRAPH ☞
OF A HARBOR CONTAINING TYPICAL INSTALLATIONS

It is of interest to note that, in the early period of echo sounding, the standard of comparison was the leadline or wire, and echo soundings were frequently corrected from comparisons made with these standards. With improvements in the time-measuring device and in operational techniques, greater accuracy was gradually achieved. Today echo soundings are considered more accurate than the old standard of comparison, since they are not subject to the inherent and uncontrollable errors and difficulties associated with the leadline and wire.

Low-Water Line on Hydrographic Surveys

On hydrographic surveys the line of zero soundings, generally called the low-water line, represents the line where the plane or datum adopted for the soundings intersects the shore. On the Atlantic coast the reference plane is mean low water, while on the Pacific coast it is mean lower low water. Soundings obtained inshore of the zero line would be shown as minus depths on the survey, indicating that the area is exposed at low water.

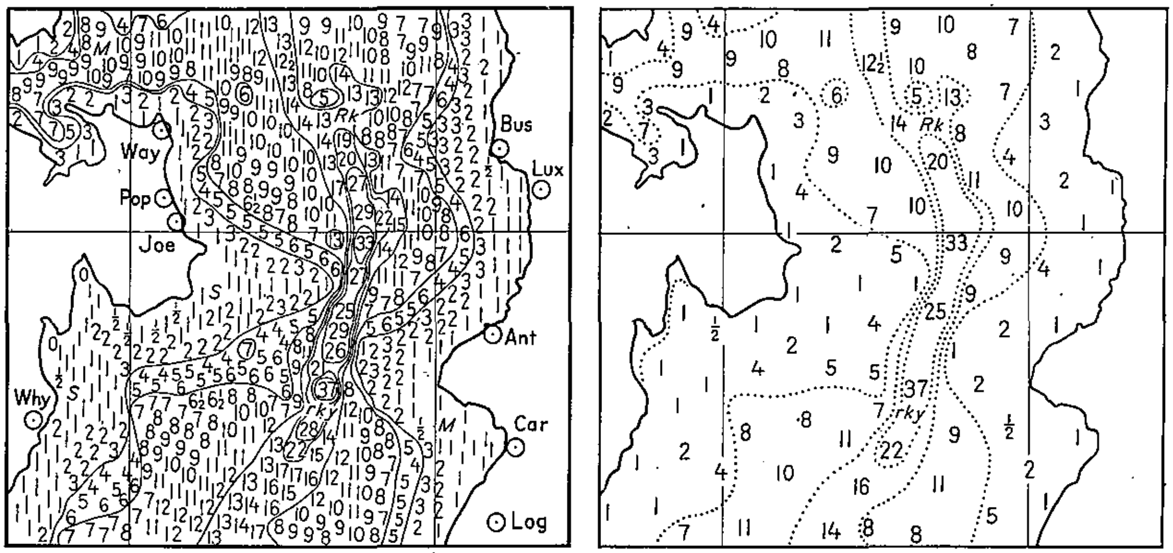
In general an attempt is made to fully develop the low-water line on our hydrographic surveys wherever tidal conditions permit. This is not always possible, particularly along an exposed coast, such as large portions of the California shoreline. Many of our surveys therefore do not show a continuous low-water line. For charting purposes low water in such cases is represented by an interpolated line based on the high-water line on the topographic survey and the inshore soundings on the hydrographic survey. In using such information for purposes other than charting, the engineer should keep in mind the accuracy limitations imposed by the survey methods used. The low-water line is located by methods adequate for purposes of navigation. To accurately delimit the line for fixing property boundaries would require, as in the case of the high-water line on topographic surveys, running lines of levels from established bench marks or using an aerial photographic method.

Character of Sea Bottom From Hydrographic Surveys

The determination of the character of the sea bottom--that is, its consistency, color, and classification--is an essential part of every hydrographic survey. Although only the immediate top layers of the bottom are sampled, the value of such information to the mariner for choosing an anchorage, to the fisherman for avoiding types of bottom likely to damage his equipment, to the engineer engaged in dredging operations or in underwater construction, and in a limited sense to the student of the earth sciences, is recognized and our field parties are given detailed instruction for gathering such data.

The frequency with which data on bottom characteristics are obtained depends upon the nature of the area and the method of survey. In harbors, anchorages, and channels and on shoals and banks the coverage is generally more complete. Along the open coasts and in large bays, where tests have indicated that a sameness of bottom material is to be expected, fewer samples are taken.

The character of the bottom is determined either by "feel" or by bringing up a sample for examination with the leadline or with a special snapper device. No samples are retained as a permanent record, except by pre-arrangement with a scientific institution or a commercial establishment. The basis for the classification of sediments is the size of the particles composing them. No mechanical analysis is used for typing a sediment. An estimation of its dimensions is made by eye, and classification is based on an available table covering



FROM DETAILED INFORMATION APPEARING ON THE HYDROGRAPHIC SURVEY (LEFT) THE CARTOGRAPHER SELECTS REPRESENTATIVE SOUNDINGS TO BEST PORTRAY THE SUBMARINE FEATURES ON THE CHART (RIGHT)

the range from "ooze" to "boulder." Standard abbreviations have been adopted on our survey sheets and charts for indicating the character of the sea bottom; for example "hrd SShP" denotes "hard sand, shells, pebbles." The adjective part of the characteristic is shown with lower-case letters and the noun part with capitals. An appropriate legend covering abbreviations is included on our nautical charts. Because of their larger scale, many more bottom characteristics appear on our survey sheets than are shown on the published charts.

C. HORIZONTAL CONTROL SURVEYS

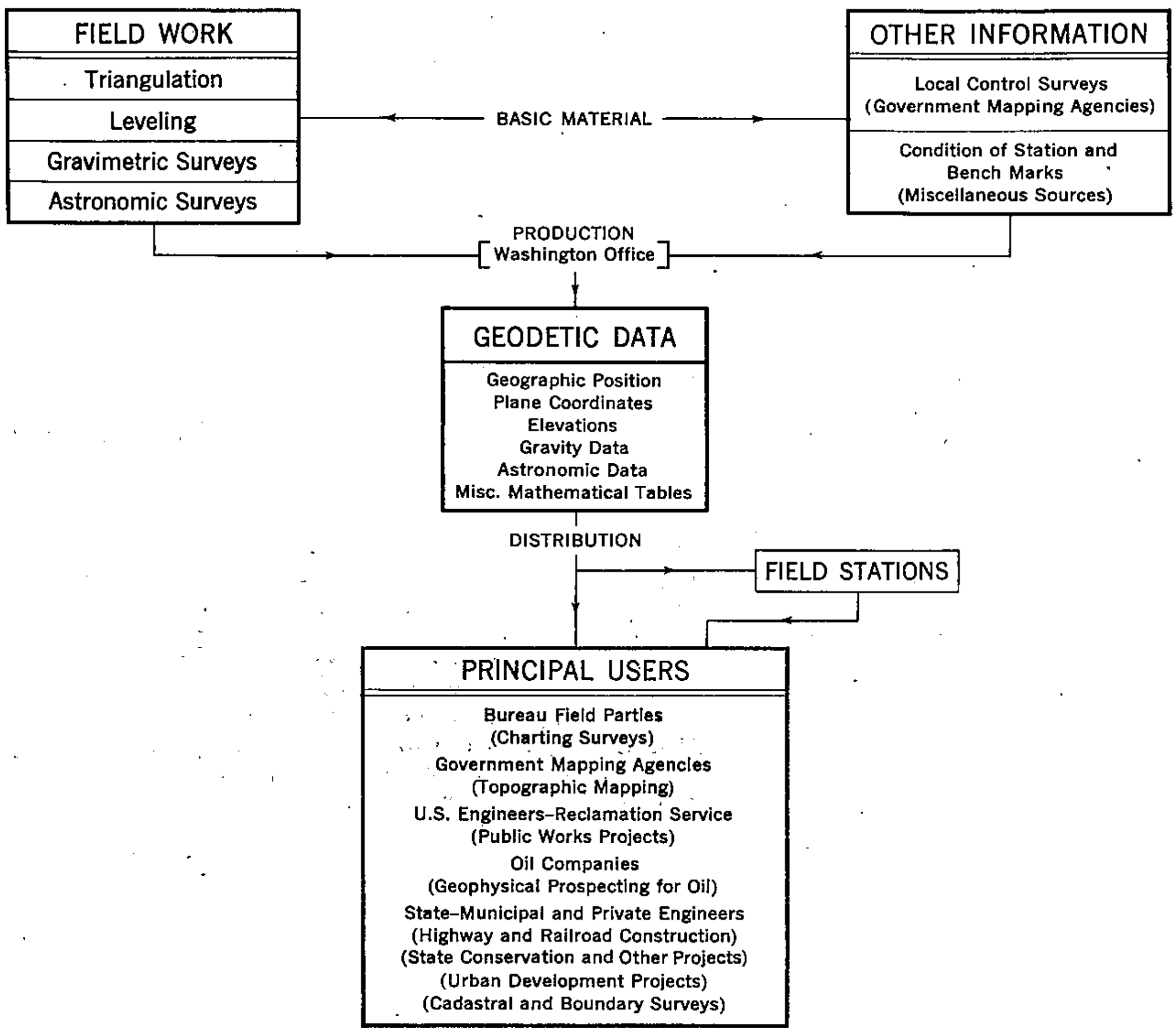
It was recognized at an early period in the history of the Coast Survey that an undertaking of such vast magnitude could not be attacked as a problem in ordinary surveying. To be of lasting value, the shape and size of the earth must be taken into account, and accurate latitudes, longitudes, and azimuths determined from astronomic observations and from triangulation. This was the method adopted at the beginning of our work. The great network of horizontal control which has since been established along our coasts and in the interior of the country forms a rigid geodetic framework for all our surveys and charts.

A NETWORK OF MONUMENTED POINTS

To span the continent from coast to coast and from north to south, widely spaced arcs of triangulation were first established. This gave a preliminary framework. Intermediate arcs, spaced 40 to 60 miles apart, provided control for boundary determinations and general purposes of the various States. The next logical step has been followed in the last decade and work has begun on filling in the areas between these arcs. There are now 115,000 miles of arcs of first- and second-order triangulation in the United States, and monumented stations have been established at an average of about 10 miles along the various arcs. Monumented stations are also placed at 4-mile intervals along the main highways in agricultural areas with closer spacing in met-

DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
GEODETIC SERVICE

GEOGRAPHIC POSITIONS (latitude and longitude of monumented stations), elevations of bench marks, and related data essential for charting, mapping, and other engineering projects, are provided by the Coast and Geodetic Survey throughout the United States and its possessions.



opolitan areas and along the coasts. n addition, a large number of prominent objects, such as water tanks, hurch spires, cupolas, and chimneys, ave been located in connection with ne triangulation, making a total of bout 150,000 stations for which geographic positions (that is, latitude and ongitude) have been determined. To acilitate the use of the triangulation tations by local surveyors and engineers, a nearby azimuth mark is established which gives directional ontrol and avoids the need of establishing a true meridian line.

Although great strides have been nade by the Bureau in establishing his basic network of control for the ountry, our job is far from completed.)ur concept of adequacy is continually hanging, as it necessarily must, with he ever-widening needs of commerce nd industry. Our present policy is to rovide for at least one triangulation tation in each 7½-minute quadrangle nap. To coordinate local urban surveys, at least one Federal base line is measured in metropolitan areas of 100,000 population or over.

DEVELOPMENT OF THE NORTH AMERICAN 1927 DATUM

All the horizontal control work of the Coast and Geodetic Survey, with few exceptions, is now referenced to a single geodetic datum, the North American 1927 Datum. This is a fact of great practical significance to the engineer who uses the horizontal control data of the Bureau or the surveys based on such control. But it is important to remember that this was not always the case.

The horizontal control surveys of the United States were begun during the early part of the nineteenth century and existed at first as separate surveys, each based on one or more astronomical determinations of latitude, longitude, and azimuth. Examples of such detached surveys were the early

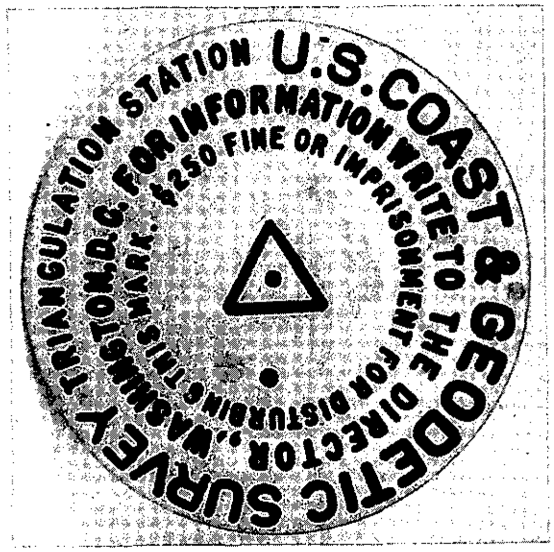
SOUTH DAKOTA JOURNAL, RAPID CITY, S. DAK.

GEODETIC FIELD PARTY HEADQUARTERS AT RAPID CITY, S. DAK.

triangulation in New England and along the Atlantic coast; a detached portion of the transcontinental arc centered on St. Louis, and another portion of the same arc in the Rocky Mountain region; and three separate surveys in California, in the vicinities of San Francisco, Santa Barbara Channel, and San Diego. With the lapse of time these separate pieces of triangulation were expanded, until they joined and difficulties immediately arose. The positions of common points computed from different triangulation schemes were found to differ by varying amounts, because each scheme was based on its own astronomic determinations, and such determinations are affected by the irregular distribution of masses in the earth's crust.

In any engineering or scientific undertaking involving a large area, such as the United States, it is essential that full coordination and correlation be obtained of the surveys, maps, and charts of the area. A depth along the coast or a point on shore can have but one latitude and longitude, which should be the same on every map or chart on which such feature appears. This can be accomplished only by establishing a single geodetic datum for the area, that is, by having the position of a single point in the country as the initial or datum to which all other stations are referred. This became possible about 1900, when the transcontinental arc was completed which joined all the detached portions into one continuous triangulation.

On March 13, 1901, a single datum was adopted by the Bureau and was named the United States Standard Datum. This datum corresponded to the one in use in the New England States, and hence did not change the latitudes and longitudes of triangulation stations in that area. In 1913, Canada and Mexico adopted this datum and its designation was changed to North American Datum to reflect its international character. The two datums are, however, identical.



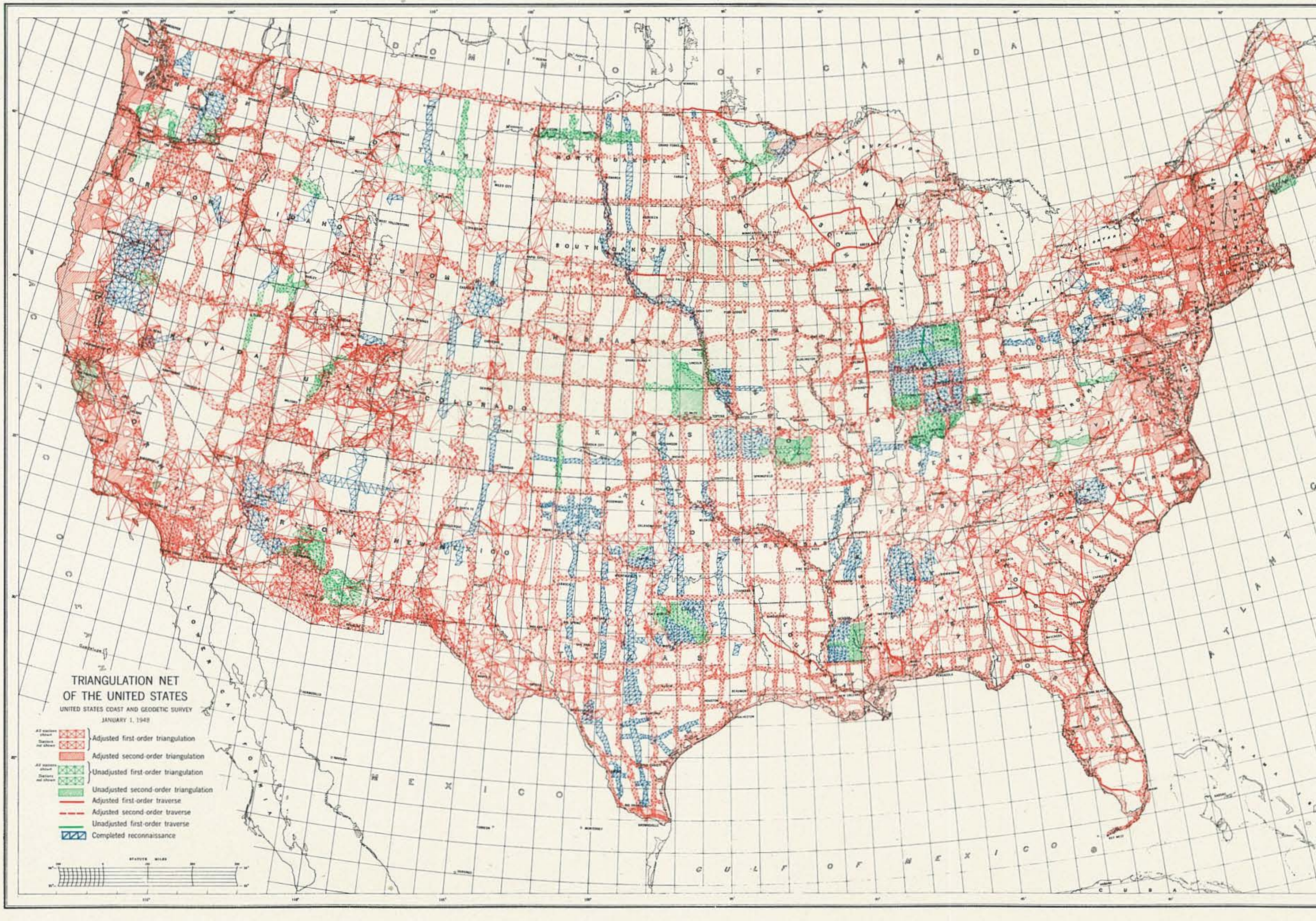
TRIANGULATION MARKER

As the triangulation of the country expanded and the principal arcs were completed it became necessary to make a unified adjustment of the whole network, first the western half--begun in 1927--and later the eastern half. This new adjustment assigned new values to all points except station Meades Ranch, which was held fixed. The new datum was called the North American 1927 Datum.

The engineer who uses surveys or charts made prior to the adoption of the North American 1927 Datum must keep in mind this development of a single geodetic datum. From the standpoint of datums the greatest differences in the geographic positions of triangulation stations occurred with the adoption of the United States Standard Datum.

ACCURACY OF HORIZONTAL CONTROL

Control surveys are classified as nearly as possible according to the accuracy of the resulting lengths and azimuths of the lines. Since the absolute errors of these quantities cannot be ascertained, indirect gages must

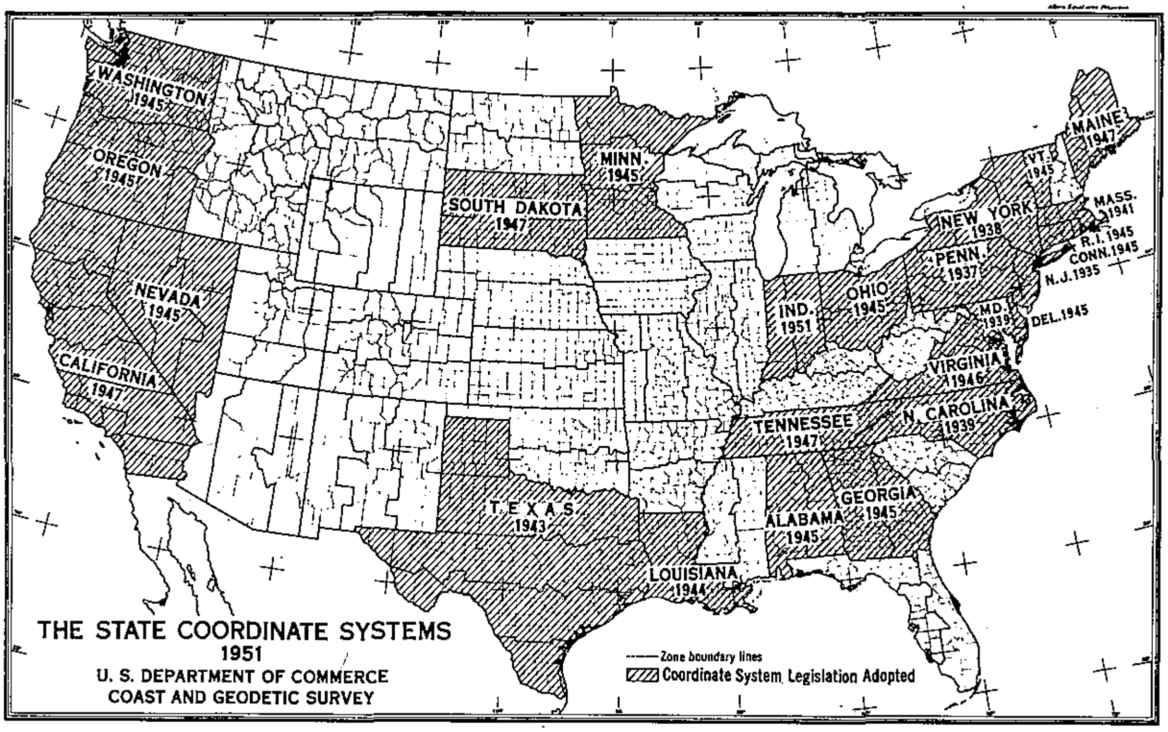

TRIANGULATION NET
OF THE UNITED STATES
UNITED STATES COAST AND GEODETIC SURVEY
JANUARY 1, 1948
All stations shown
Stations not shown
Adjusted first-order triangulation
Adjusted second-order triangulation
All stations shown
Stations not shown
Unadjusted first-order triangulation
Unadjusted second-order triangulation
Adjusted first-order traverse
Adjusted second-order traverse
Unadjusted first-order traverse
Completed reconnaissance
STATUTE MILES
DOMINION OF CANADA
MEXICO
GULF OF MEXICO
ATLANTIC OCEAN
CUBA

be used. For triangulation, the principal criterion is whether the discrepancy between a measured length of a base line and its computed length, as carried through the network from the next preceding base, is less than a certain fraction of the measured length. For first-order work, the computed length must agree on an average within 1 part in 75,000 or about 1 foot in 14 miles. Base lines are measured in both directions and are generally from 4 to 8 miles long with a probable error for the mean of the two measurements averaging about 1 in 2,000,000.

Another important indirect gage of the accuracy of the final results of triangulation is the average closure of the triangles. To insure adequate agreement among the component parts of the triangulation, basic criteria have been adopted for the observations. For first-order work, the requirements are an average triangle closure not in excess of 1 second.

STATE PLANE COORDINATES

The results of the triangulation of the Coast and Geodetic Survey are expressed in terms of geographic coordinates--that is, latitude and longitude. Such coordinates are most convenient where extensive areas are involved. They constitute a universal system, all points of which are directly related. We have recognized, however, that engineers and surveyors, unfamiliar with the computational methods involved, hesitate to use geographic coordinates for surveys of smaller areas, such as those performed within a state, county, or city. Considering the desirability of having all surveys tied into the Federal network of geodetic control, the Coast Survey in 1933 devised systems of plane coordinates for each state and developed the formulas for the transformation of geographic coordinates to their corresponding X and Y values. By these systems, points on the earth's surface are mathematically projected upon a surface which can be



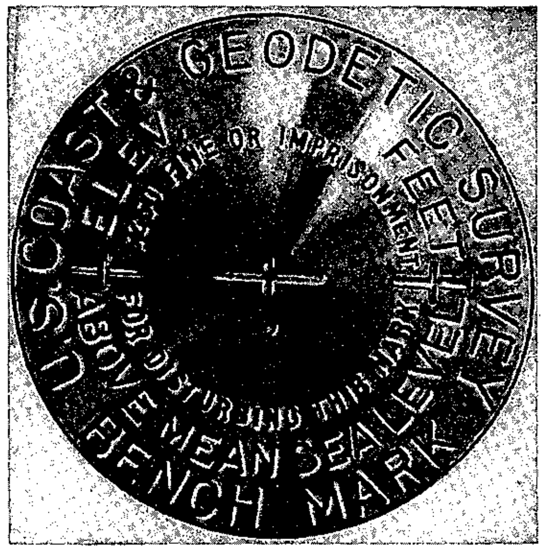
developed into a plane. Surveys between such points can then be treated as though the work were accomplished on a plane instead of a spheroidal surface.

In the practical field use of State Coordinates, the engineer needs only the plane coordinates of the triangulation stations and the plane azimuth to an azimuth mark within the area covered by his survey. These data are sufficient for him to run and adjust his traverse, using the ordinary methods of plane surveying, and obtain an accuracy of not less than 1 part in 10,000, without any corrections for scale error. The local engineer may bring his computations to geodetic accuracy, if such refinement should be desired, because the State Coordinate Systems are based on definite systems of projections with definite scale corrections.

D. VERTICAL CONTROL SURVEYS

In providing for the vertical control of the country, the Coast and Geodetic Survey followed a program starting with widely spaced lines 100 miles apart, later supplemented by lines spaced at 50-mile intervals. At the present time, we are providing area leveling with lines spaced 6 miles apart connected to the wider spaced lines in a consistent network of levels. Bench marks are set at 1-mile intervals along each line. For convenience in running and in the subsequent use of bench marks, the lines of leveling usually follow the routes of highways and railroads. There are now more than 370,000 miles of first- and second-order leveling in the United States and upward of 275,000 established bench marks.

First-order leveling represents the most exact method of determining elevations. Lines are run in both directions and the two runnings must be such that in a 100-mile circuit the error of closure will on an average be only slightly over an inch.



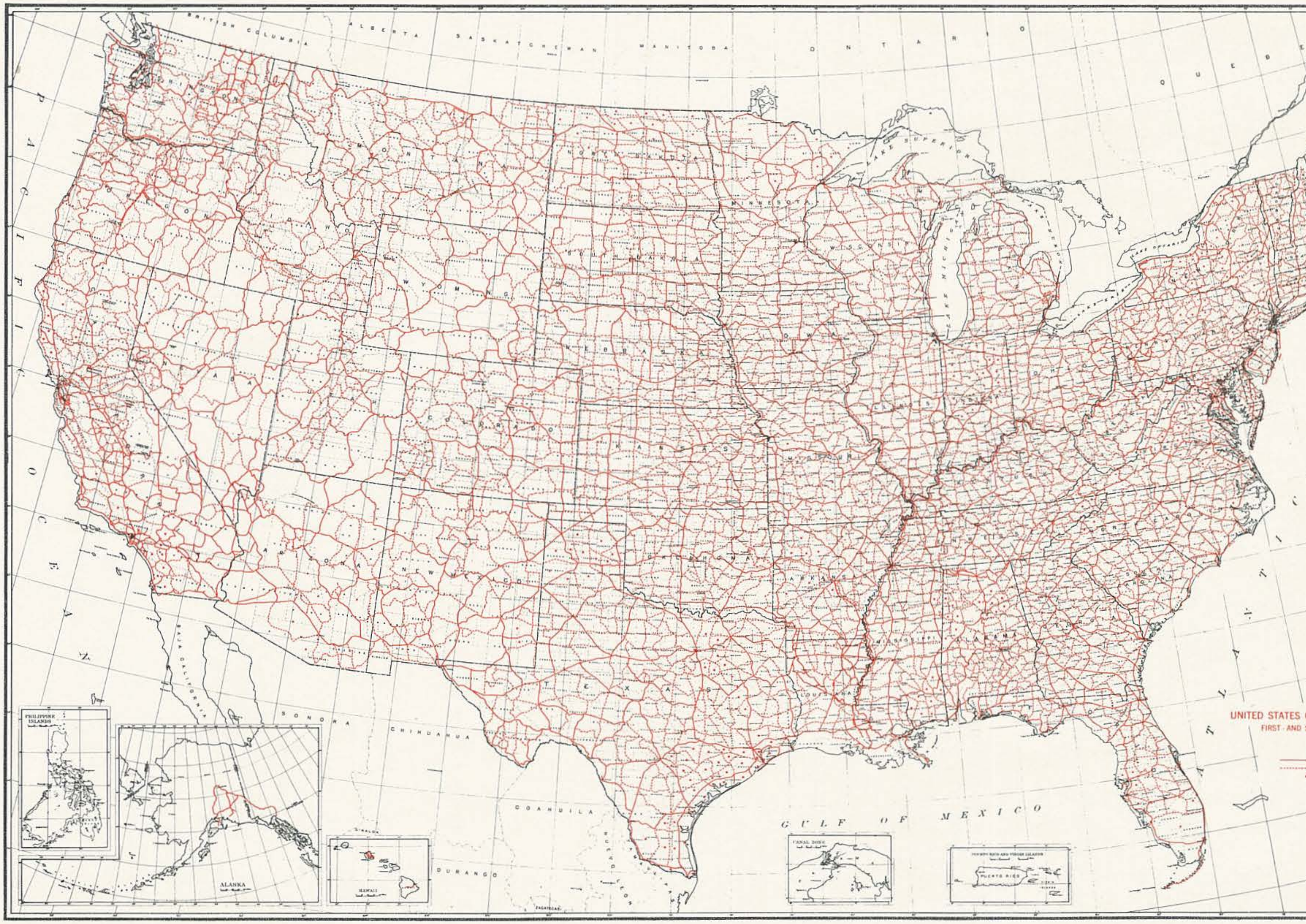
BENCH MARK

SEA LEVEL DATUM OF 1929

The reference datum for elevations in the vertical control network is MEAN SEA LEVEL. Originally, the leveling was extended from a tide station at Sandy Hook, N. J., to furnish accurate vertical control for the transcontinental arc of triangulation following approximately the 39th parallel. As the net expanded and new circuits developed with additional sea level connections, it was found desirable to make adjustments in the elevations. The first adjustment was made in 1899, with partial readjustments in 1903, 1907, and 1912. A complete readjustment of the network was made in 1929, in which sea level was held fixed as observed at 26 tide stations, 5 in Canada and 21 in the United States. Elevations in this adjustment are referred to as being based on the "Sea Level Datum of 1929."

E. TIDAL SURVEYS

The tidal work of the Coast and Geodetic Survey had its origin in the need for reducing to a common level,


UNITED STATES COAST & GEODETIC SURVEY
FIRST- AND SECOND-ORDER LEVELING
First-order Leveling
Second-order Leveling
Additional Second-order Leveling Within This Area
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEW BRUNSWICK
SONORA
CHIHUAHUA
COAHUILA
NUEVO LEON
DURANGO
BAJA CALIFORNIA
PHILIPPINE ISLANDS
ALASKA
HAWAII
CANAL ZONE
PUERTO RICO

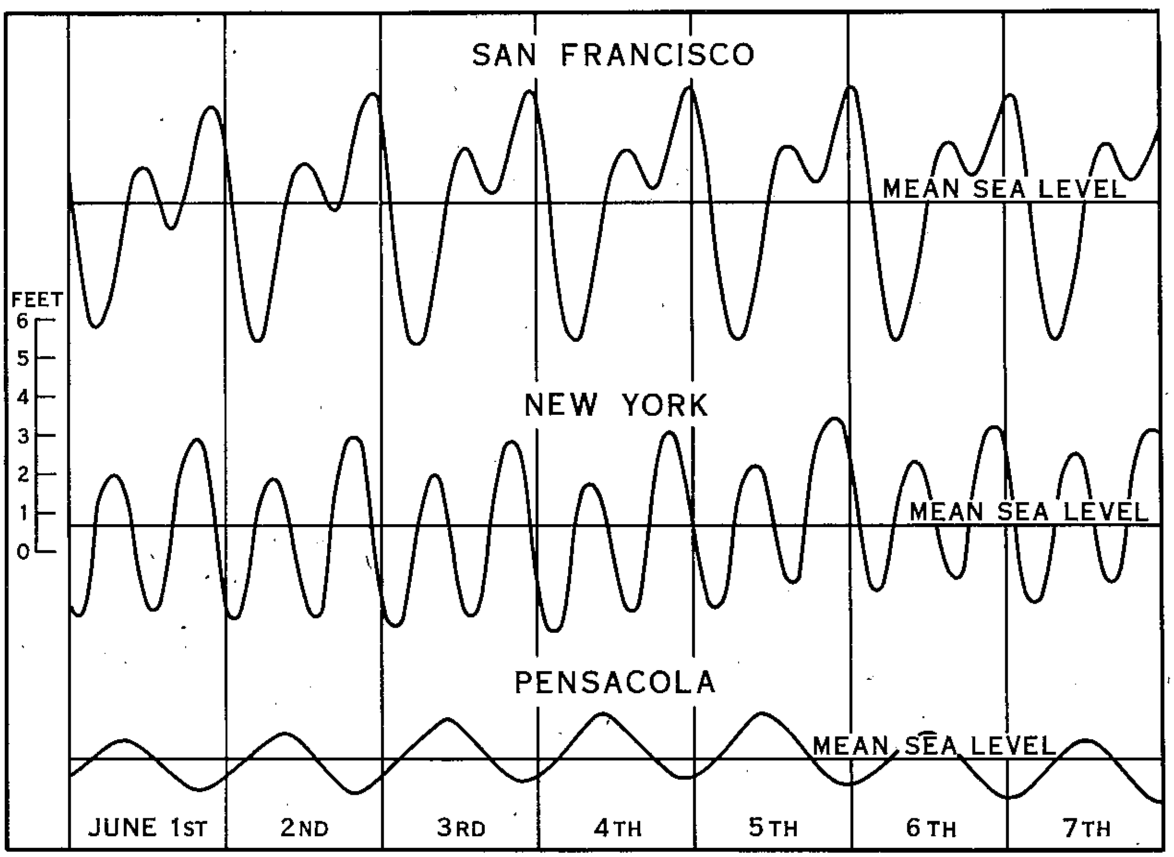
or datum plane, soundings taken at different stages of the tide during hydrographic surveys, so that nautical charts would show all depths referred to a uniform datum. The further needs of the mariner were met with the publication of tide tables giving the predicted times and heights of the tide annually in advance. Within recent years the needs of the engineer have been given consideration, and in 1922 systematic tide and current surveys were begun of all the important harbors.

ENGINEERING ASPECTS OF TIDES

Tidal observations are of particular interest to the coastal engineer. The rise and fall of the tide is a continuing phenomenon and varies from day to day and from place to place. Thus, at New York the mean range is about 4.5 feet while the maximum range may be 7 feet. At the Atlantic entrance to the Panama Canal the range is less than a foot while at the Pacific entrance it averages 12.5 feet. On the other hand, at Anchorage, Alaska, a rise and fall of approximately 35 feet may be encountered on certain days.

Tides also differ in the character of the rise and fall. At New York, for example, there are two tides a day of approximately equal range; at San Francisco there are two tides a day of unequal range; and at Pensacola, there is but one tide a day.

These and other aspects of the



TYPES OF TIDE ALONG COASTS OF THE UNITED STATES tidal phenomenon are matters which the coastal engineer must take into account in planning or designing waterfront structures.

The accumulated tide records of the Coast and Geodetic Survey furnish the fundamental data required in the establishment of datum planes based on tidal definition; in the prediction of tides; in the determination of mean and extreme ranges of tide; and in the study of changes in the plane of mean sea level and its correlative coastal stability.

PRIMARY TIDE STATIONS

Although tidal constants and tidal datum planes may be established (within certain limits of accuracy) from observations extending over a month or a year, for geodetic and scientific purposes continuous observations for a period of 19 years are required. This takes into account all changes due to astronomic causes and tends to balance out the disturbing effects of wind and weather.

For the collection of tidal data, the Bureau has in operation some 80 primary stations at coastal ports where automatic tide-gage installations provide continuous graphic records of the rise and fall of the tide over a long period of years. Most of the basic data are obtained from this source. In addition, short-period observations are obtained in connection with our hydrographic operations or for some other purpose. By means of simultaneous observations with primary stations, short-period observations may be converted to long-period means with an accuracy closely approximating the 19-year cycle.

The 1924-1942 Epoch

Long-period observations indicate a slow secular change in sea level. Therefore, in defining tidal datums, it is necessary to identify them with a particular 19-year group. To make datums comparable at all localities the same group of years must be used. In the Coast and Geodetic Survey the 1924-1942 epoch has been adopted for datum plane reference.

Changes in Sea Level

Long series of tidal measurements furnish the only quantitative data for the study of changes in sea level and the important geophysical problem of coastal stability, that is, whether any given coastal region is rising or sinking relative to the sea. For example, along the Atlantic coast of the United States, investigations indicate that in the last 20 years mean sea level has risen, or the land has subsided, about 0.3 foot; while on the Pacific coast sea level has risen about 0.1 foot. On the other hand, at Skagway, Alaska, observations over the last 40 years show a fall in sea level of over 2 feet.

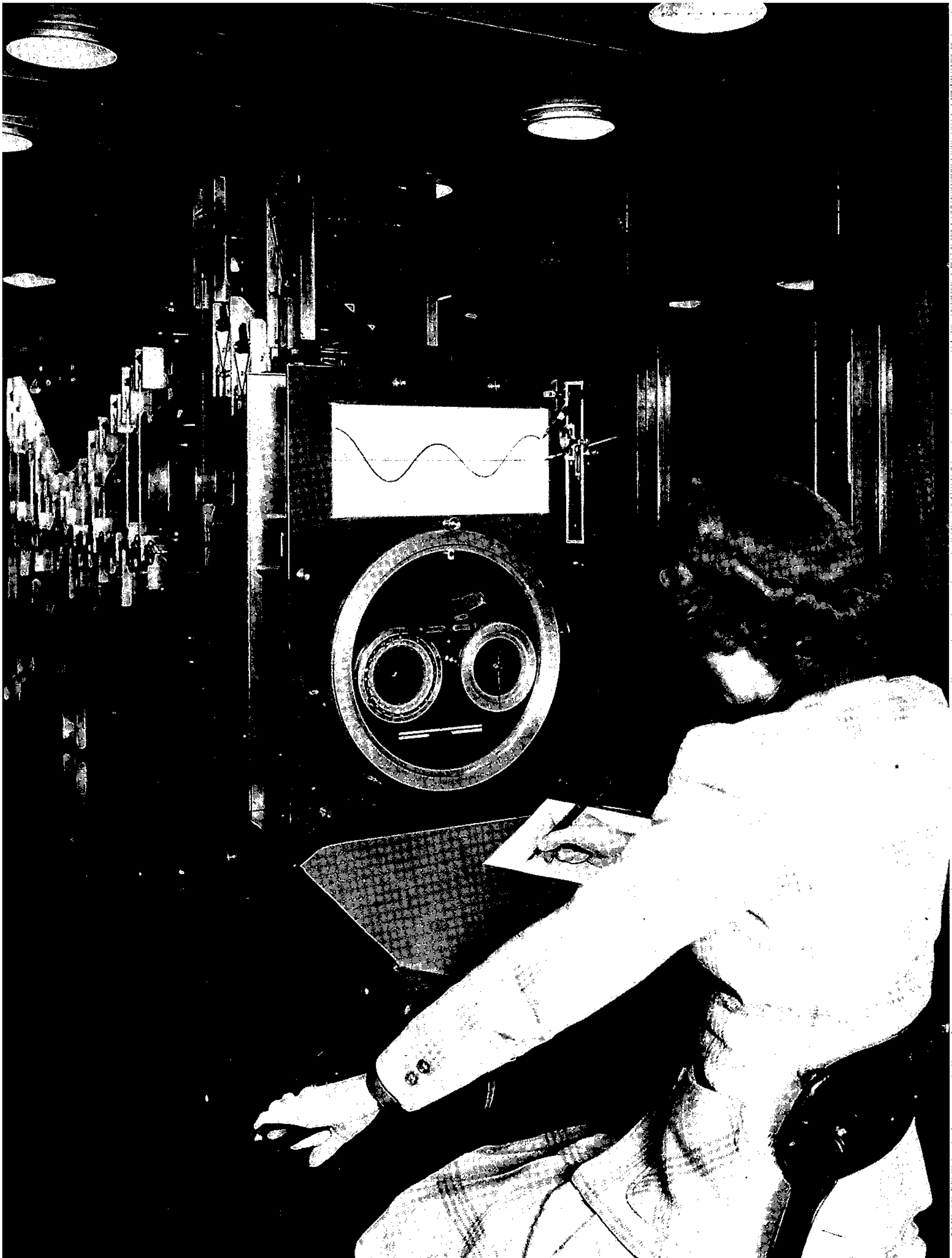
DETERMINATION OF DATUM PLANES

Besides the datum of mean sea level, which is used for the vertical control surveys of the country, other datums are established from tide observations for use on our hydrographic surveys and nautical charts, and for other purposes.

Chart Datums

Chart datums are selected primarily for their practical utility to the navigator and depend upon the characteristics of the tide in a given area. The aim is to provide the mariner with as wide a margin of safety in navigating his vessel as will be consistent with prevailing conditions.

TIDE-PREDICTING MACHINE, DESIGNED FOR ☞ PREDICTING THE TIMES AND HEIGHTS OF THE TIDE FOR ANY PORT IN THE WORLD, AND FOR ANY YEAR



From the standpoint of navigation, the critical part of the tidal cycle is at the time of low water. At this time depths in a channel or over a shoal area are at a minimum. If a datum higher than low water were to be used as a reference plane, depths shown on the nautical charts would be greater than actually exist at the time of low water. This might result in giving the mariner a false sense of security, particularly in areas where the controlling depth approaches the draft of his vessel. Another practical advantage of a low-water datum is that tidal corrections given in the Tide Tables, which the mariner uses in conjunction with the chart to find the depth at a specified time and place, will be mostly additive values. It is for these reasons that low-water datums have been adopted for the nautical charts of the Coast and Geodetic Survey.

But even low-water datums differ on the different coasts of the United States, depending upon the prevailing type of tide. On the Atlantic coast, for example, the tide is of the semidaily type, with two tides a day of approximately equal range. Successive low waters differ but slightly and the adopted chart datum is MEAN LOW WATER, which is the mean of all the low waters in a given area. On the Pacific coast, the tide is of the mixed type, with two tides each day of unequal range. Successive low waters exhibit a marked inequality and the datum of MEAN LOWER LOW WATER is used, which is the mean of all the lower of the two low waters each day.

The advantages of using a mean lower-low-water datum over a mean low-water datum for Pacific coast charts are similar to those described above for low-water datums. The important thing to keep in mind is that the selection is dictated by the practical needs of navigation. Its use should be so appraised.

In order that datum planes once derived may be preserved for future use, they are referenced as so many feet below bench marks established in the vicinities of tide stations. This makes the recovery of datum planes a simple matter, so long as the bench marks are maintained.

TIDAL SURVEYS OF IMPORTANT HARBORS

In some areas a need has developed for more detailed tidal information than is provided by the nearest primary stations and those stations established in connection with hydrographic surveying. To supplement these sources special tide surveys have been made in selected areas. Numerous tide-gage installations, at carefully selected sites, are required in most coastal harbors, or in any system of tidal waterways, to determine the varying times and heights of high and low waters at critical points. The first of such systematic surveys was begun in New York Harbor in 1922.

PREDICTION OF TIDES

Mention has been made of the use of the Coast and Geodetic Survey Tide Tables for navigational purposes. These tables, which give the daily predictions of the times and heights of the tide at the important ports of the world, can also serve the coastal engineer who may wish to know in advance the height of the tide that may be expected at a given time and place.

To predict the tides for any given port, tidal observations must first be obtained to determine the characteristics of the tide at that port. From these data, predictions can then be made for any date in the future. Tide prediction is a complicated mathematical process; however, the work has been greatly simplified through the design and use in the Bureau of a tide predicting machine which can reproduce the tide in nature by solving equations involving as many as 37 variables. Tide Tables are published by the Bureau approximately 6 months in advance.

Accuracy of Tide Tables

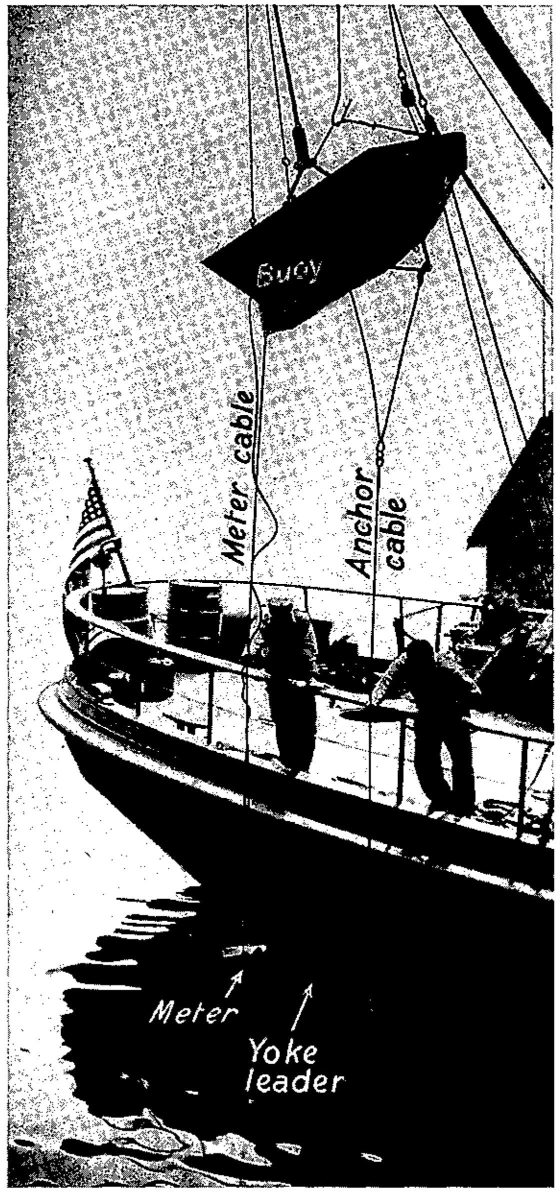
To test the accuracy of the Tide Tables, comparisons have been made for different ports between predicted tides and observed tides. These tests indicate that, under normal weather conditions, the predicted tides closely approximate the actual tides. At Los Angeles, for example, where the tide is of the mixed type with a mean range of 3.8 feet, a full year of comparisons showed that 90 percent of the predicted times of high and low waters agreed within 5 minutes of the observed times; 98 percent of the predicted heights agreed within half a foot of the observed heights; and 59 percent agreed within one-tenth foot.

F. TIDAL CURRENT SURVEYS

Observations of the strength and direction of tidal currents along our coasts and in tidal waterways have been made by the Coast and Geodetic Survey in connection with hydrographic operations and as special surveys, as an aid to navigation. Currents must also be considered by the engineer engaged in the maintenance and improvement of channels and harbors, in marine construction and improvement of beaches, and in the problem of sewage disposal.

Comprehensive tidal current surveys have been made of our more important harbors and waterways. In recent years current observations have been greatly expedited by the Bureau's development of the Roberts Radio Current Meter, which not only measures the velocity and direction of the current but transmits the data by radio to a central receiving station. As many as eight meters can be operated simultaneously in an area.

Tidal current data are used in the Current Tables published by the Bureau annually in advance. The tables give daily predictions of the times of slack water and the times and velocities of strength of flood and ebb currents for numerous places along our coasts and in our waterways.



INSTALLATION FOR AN UNATTENDED RADIO CURRENT METER

II. Availability of Coast and Geodetic Survey Data

An important part of the work of the Coast and Geodetic Survey is the dissemination of its technical information, which is meticulously collected, analyzed, and compiled, and made available to the public in the form of charts, maps, and printed publications. Although our nautical and aeronautical charts and related publications are well known to mariners and aviators, we frequently find that much of the fundamental data on which these products are based is unknown to those dealing with engineering and scientific problems.

Some of these data, of special interest to the coastal engineer, and the forms in which they are available are described in the balance of this paper. Illustrative samples of indexes and other forms of available data are also included.

A. TOPOGRAPHY AND HYDROGRAPHY

COPIES OF FIELD SURVEYS

Photographic copies of field topographic and hydrographic surveys are available at the nominal cost of reproduction. Detailed topographic and hydrographic surveys have been made since 1834 of most of the coastline of the United States and Alaska and of our island possessions. Along some portions of our coast, surveys have been repeated at periodic intervals.

Most of the topographic surveys compiled from aerial photographs are published as lithographic prints. Planimetric maps show nearly all interior topographic features except contours and elevations. More than 1,000 planimetric maps are now available which cover the greater part of the Atlantic coast and extensive areas of the Gulf and Pacific coasts.

Notwithstanding their accuracy limitations, as already explained, these surveys nevertheless represent an authentic historical record of the evolution of our coastline and the underwater features, useful in the study of beach erosion and protection and for other engineering purposes. The scales are large enough (usually 1:10,000 and 1:20,000) to provide the engineer with a background of information from which a quantitative appraisal can be made of changes.

An important by-product value of our topographic and hydrographic surveys is their use in waterfront boundary disputes where the seaward limit of property is defined by the high- or low-water line. Our early surveys may be very informative in cases where it is important to determine, as of a specific date, whether a coastal strip was exposed, or covered with water, at high tide.

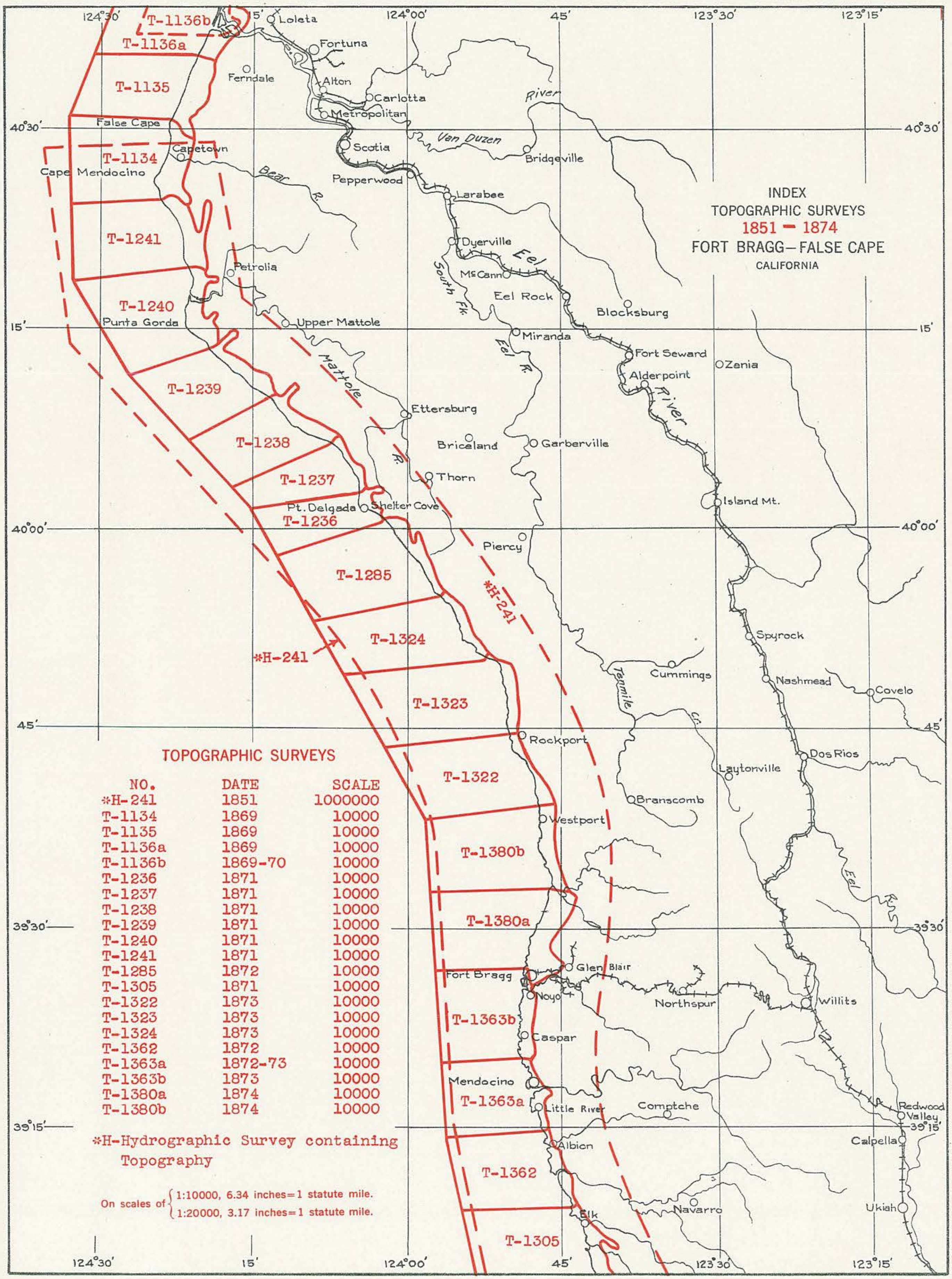
A cautionary note must be sounded, however, regarding the use of original field surveys made at different periods. Because different geodetic datums were used at various periods in the history of the Bureau, surveys must be brought to the same datum before an accurate comparison can be made of shorelines or other data. Copies of old surveys furnished from the Washington Office usually show at least one projection intersection based on the North American 1927 Datum.

SURVEY INDEXES

Index maps--showing the date, area covered, and scale of each survey--are available for the planetable and planimetric surveys along the Atlantic, Gulf, and Pacific coasts, and for the hydrographic surveys along the Atlantic and Gulf coasts. They are furnished on request without cost.

DEPARTMENT OF COMMERCE
U.S. Coast and Geodetic Survey
Washington, D.C.

Topographic Index No. 40 A



TOPOGRAPHIC SURVEYS

NO.	DATE	SCALE
*H-241	1851	1000000
T-1134	1869	10000
T-1135	1869	10000
T-1136a	1869	10000
T-1136b	1869-70	10000
T-1236	1871	10000
T-1237	1871	10000
T-1238	1871	10000
T-1239	1871	10000
T-1240	1871	10000
T-1241	1871	10000
T-1285	1872	10000
T-1305	1871	10000
T-1322	1873	10000
T-1323	1873	10000
T-1324	1873	10000
T-1362	1872	10000
T-1363a	1872-73	10000
T-1363b	1873	10000
T-1380a	1874	10000
T-1380b	1874	10000

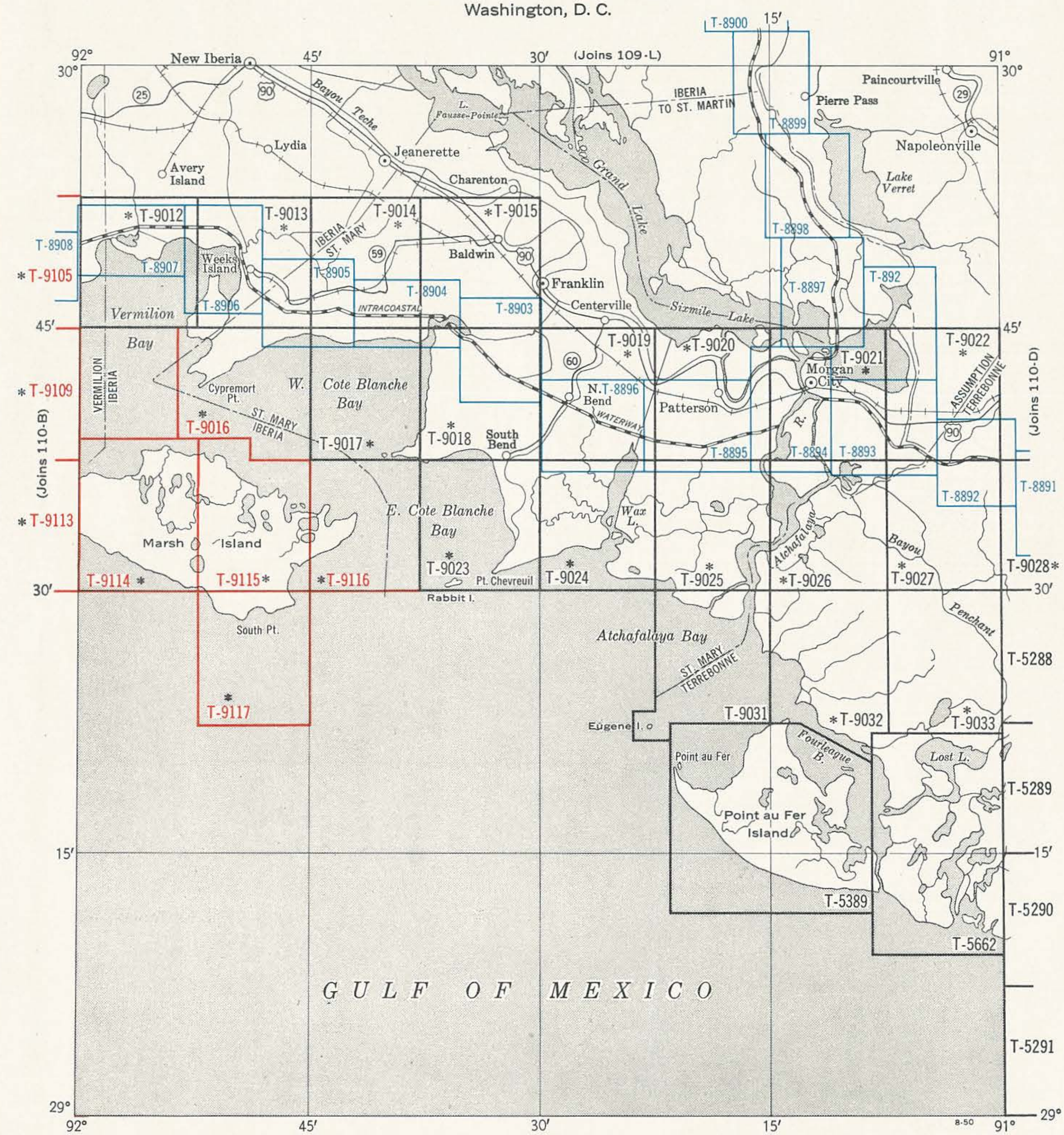
*H-Hydrographic Survey containing Topography

On scales of { 1:10000, 6.34 inches = 1 statute mile.
1:20000, 3.17 inches = 1 statute mile.

LOUISIANA

UNITED STATES
DEPARTMENT OF COMMERCE
Coast and Geodetic Survey
Washington, D. C.

MAP INDEX 110-C



PLANIMETRIC MAPS: Show natural and cultural features within the map limits except contours and elevations. Maps T-5389 and T-5662, scale 1:20,000, prepared from aerial photographs taken February and March 1931; maps T-9012 to T-9033, scale 1:10,000, prepared from aerial photographs taken December 1947 to March 1948. Printed and distributed by the U. S. Coast and Geodetic Survey. Price 75c each.

SHORELINE SURVEYS: Similar to planimetric maps, but cover only the shoreline and the land area immediately adjacent thereto. Surveys T-8892 to T-8898, T-8903 to T-8907 and T-8921, scale 1:10,000, prepared from aerial photographs taken November 1946. Not to be published, but photographic copies of the original manuscripts can be furnished by the U. S. Coast and Geodetic Survey at 75c each.

TOPOGRAPHIC MAPS: Part of the 7½-minute series of standard topographic quadrangle maps of the United States. Maps T-9016 and T-9114 to T-9117 were compiled by the U. S. Coast and Geodetic Survey at scale 1:20,000 from aerial photographs taken December 1947 to March 1948. Printed and distributed by the U. S. Geological Survey at the scale of 1:24,000. Pending final publication by the U. S. Geological Survey, and for special purposes after publication, photographic copies of the original map manuscripts can be furnished by the U. S. Coast and Geodetic Survey at 75c each.

*Denotes sheet not published to date

DEPARTMENT OF COMMERCE

U. S. Coast and Geodetic Survey

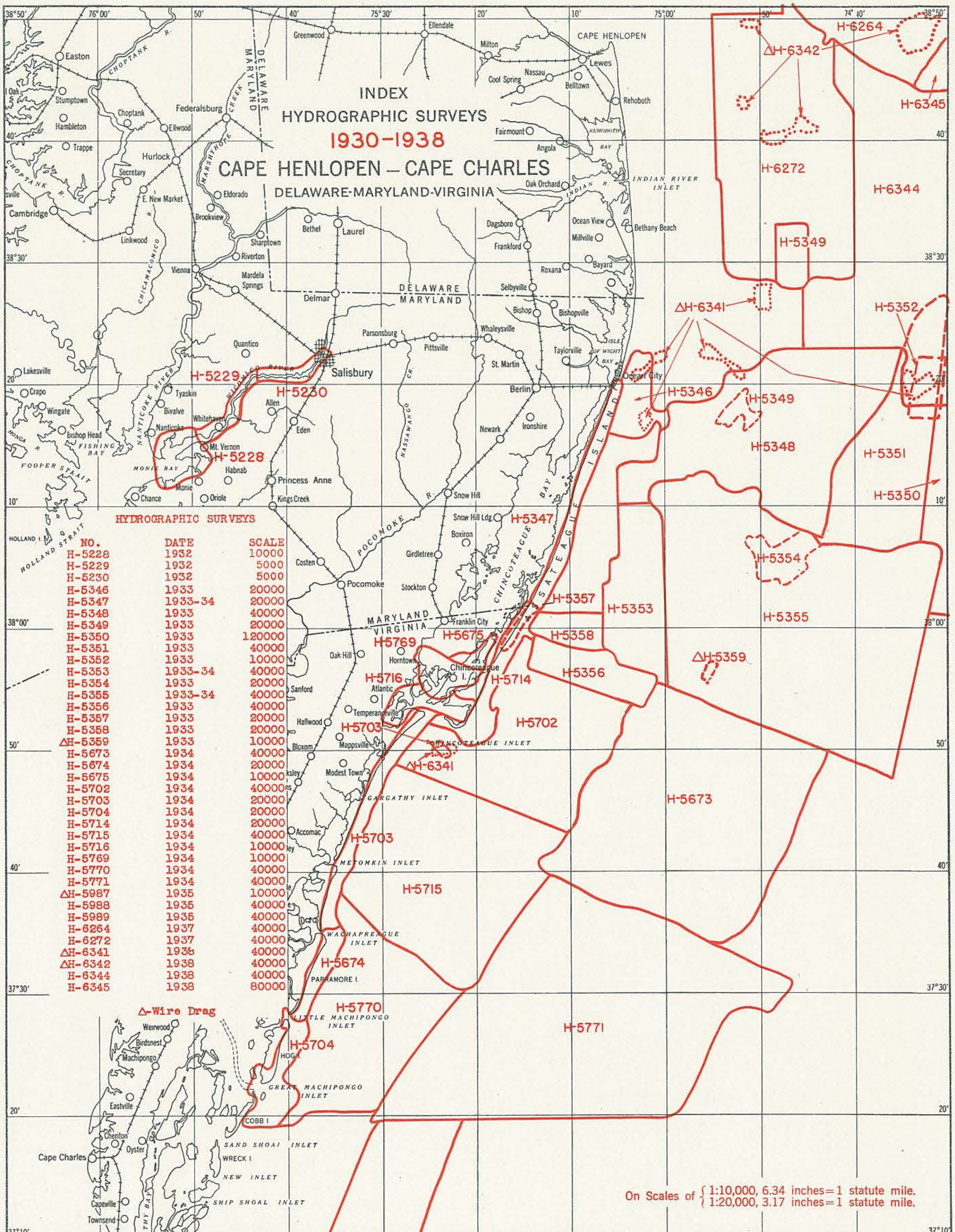
Washington, D. C.

Hydrographic Index No. 69 H

INDEX HYDROGRAPHIC SURVEYS 1930–1938

CAPE HENLOPEN – CAPE CHARLES

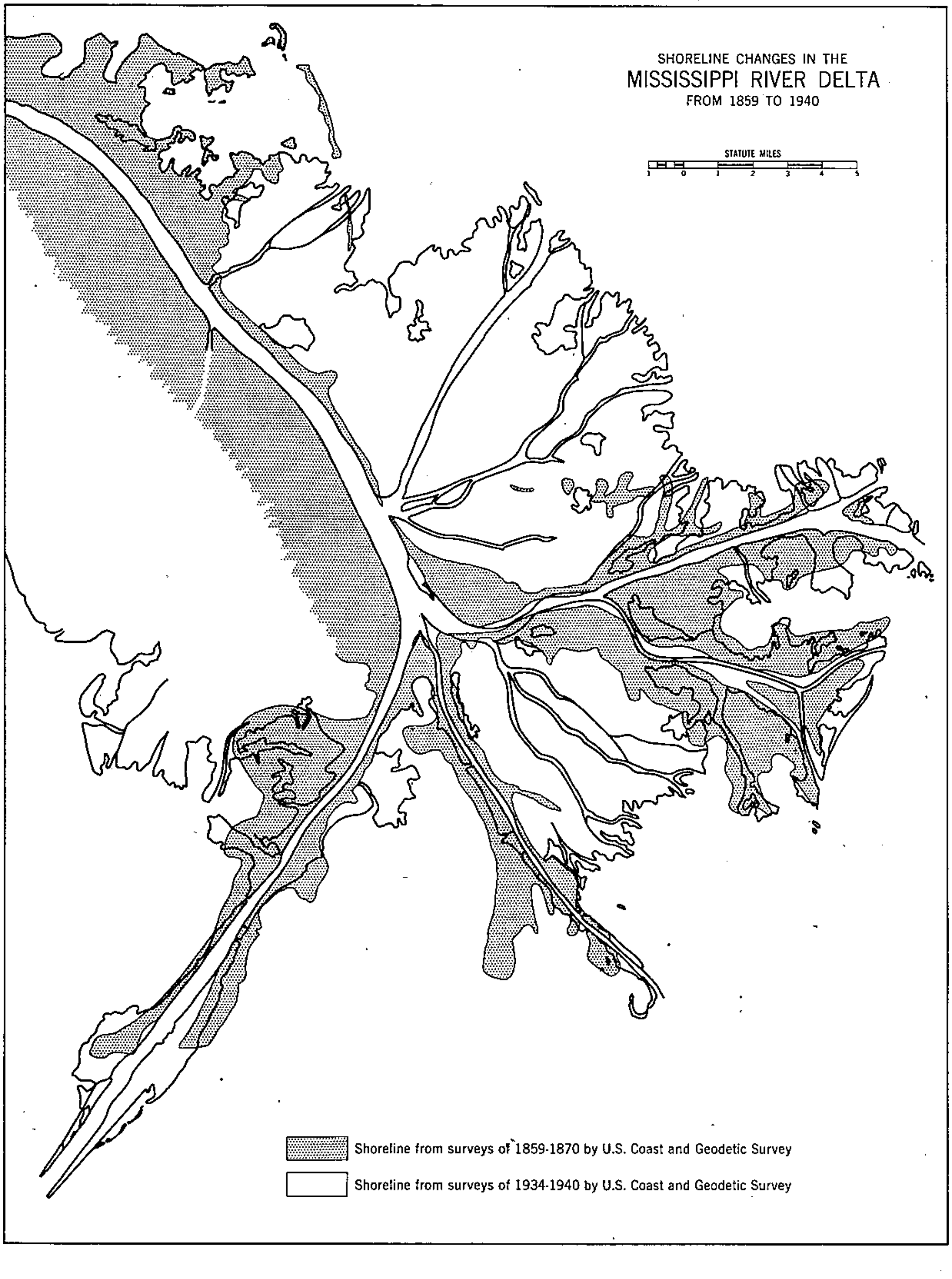
DELAWARE-MARYLAND-VIRGINIA



HYDROGRAPHIC SURVEYS

NO.	DATE	SCALE
H-5228	1932	10000
H-5229	1932	5000
H-5230	1932	5000
H-5346	1933	20000
H-5347	1933-34	20000
H-5348	1933	40000
H-5349	1933	20000
H-5350	1933	120000
H-5351	1933	40000
H-5352	1933	10000
H-5353	1933-34	40000
H-5354	1933	20000
H-5355	1933-34	40000
H-5356	1933	40000
H-5357	1933	20000
H-5358	1933	20000
ΔH-5359	1933	10000
H-5673	1934	40000
H-5674	1934	20000
H-5675	1934	10000
H-5702	1934	40000
H-5703	1934	20000
H-5704	1934	20000
H-5714	1934	20000
H-5715	1934	40000
H-5716	1934	10000
H-5769	1934	10000
H-5770	1934	40000
H-5771	1934	40000
ΔH-5987	1935	10000
H-5988	1935	40000
H-5989	1935	40000
H-6264	1937	40000
H-6272	1937	40000
ΔH-6341	1936	40000
ΔH-6342	1938	40000
H-6344	1938	40000
H-6345	1938	80000

Δ-Wire Drag


SHORELINE CHANGES IN THE
MISSISSIPPI RIVER DELTA
FROM 1859 TO 1940
STATUTE MILES
Shoreline from surveys of 1859-1870 by U.S. Coast and Geodetic Survey
Shoreline from surveys of 1934-1940 by U.S. Coast and Geodetic Survey

B. CONTROL SURVEY DATA

STATE INDEX MAPS

Index maps are available showing the triangulation and leveling accomplished in each state. The scales of the maps are large enough (1:650,000) to show graphically the locations of the individual stations and bench marks. On the leveling map the lines are numbered and the engineer desiring information on any particular level line can refer to the line by its number.

TRIANGULATION AND LEVELING DATA

Triangulation and leveling data are issued in several series in looseleaf form. One series gives the latitudes and longitudes of the established triangulation stations and the lengths and azimuths of the lines to contiguous stations; another the descriptions of the stations; and a third the plane coordinates of the stations, together with the grid azimuths to adjacent stations. Descriptions and elevations of bench marks are given in a fourth series.

C. TIDES AND CURRENTS

TIDAL BENCH MARK DATA

Tidal bench mark data are available for each tide station. These include the elevations of the bench marks above the basic hydrographic datum; the date and length of the tidal series; and a table showing the relations between the basic datum and other tidal planes in general use, for conversion of elevations to any of these planes. Heights of observed or estimated highest and lowest tides are also given. In addition, special index maps are prepared for each coastal state showing, by place name and number, the localities for which tidal bench mark data are available. Where spirit level connections have been made between the tidal bench marks and the geodetic bench marks of the vertical control survey net, information can be furnished on the relationship between the hydrographic datum and sea level datum.

TIDAL CURRENT CHARTS

For many areas, where comprehensive current surveys have been made, TIDAL CURRENT CHARTS are published showing graphically, by a set of 12 charts, the direction and velocity of the tidal current for each hour of the tidal cycle.

D. COMPILED CHARTS

The nautical charts of the Coast and Geodetic Survey are compiled from the basic topographic and hydrographic surveys of the Bureau, supplemented by data from the Corps of Engineers, Coast Guard, Harbor Boards, and other agencies.

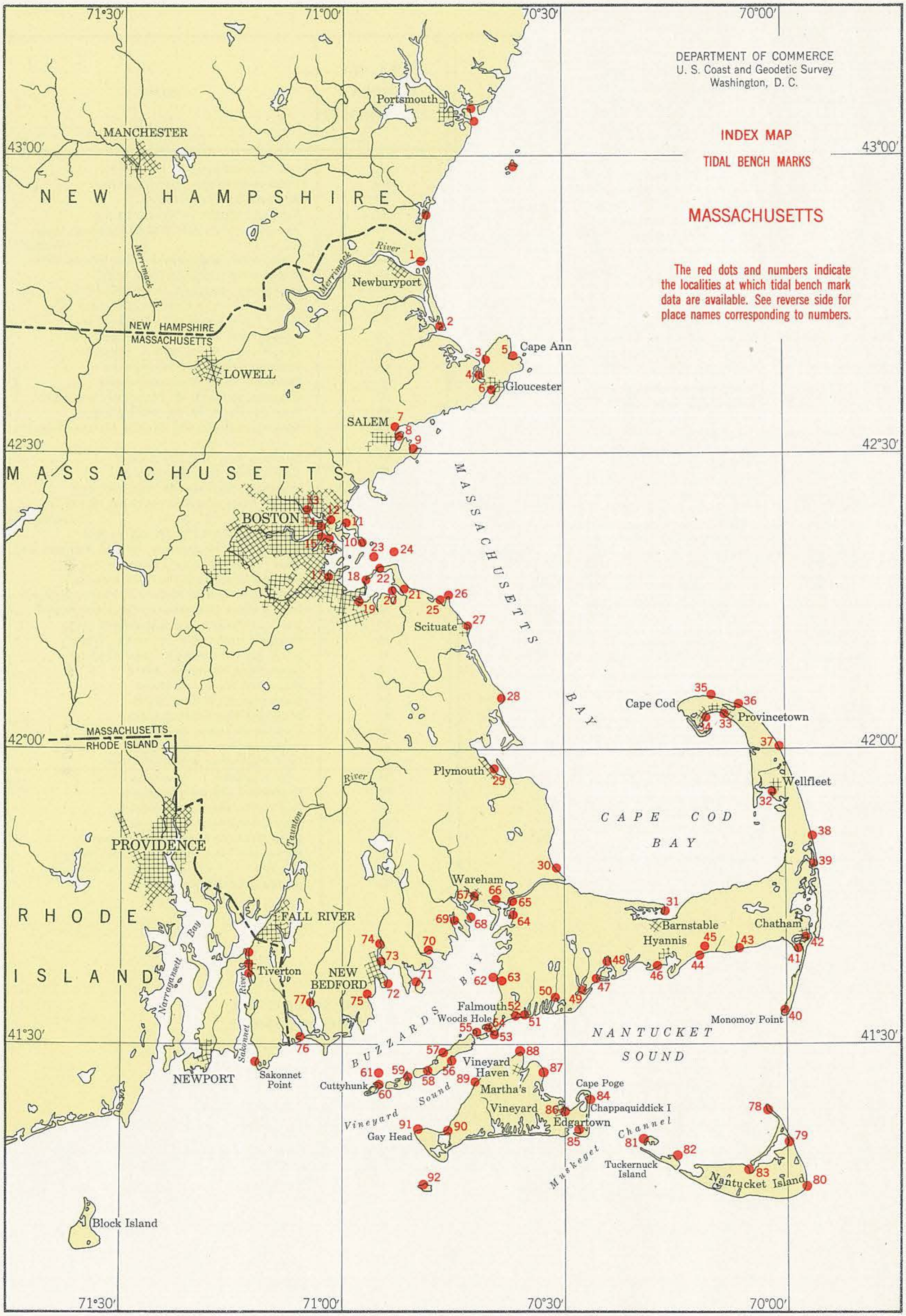
Charts are published on different scales to meet the various needs of navigation. They are revised frequently to reflect the many natural and manmade changes that are constantly taking place along our coasts.

SURVEYS AND CHARTS

In using charts for purposes other than navigation, the distinction between a survey and a chart must be kept in mind. Perhaps the principal distinction is that the former, whether hydrographic or topographic, shows the condition as of a specific date and is the result of a field examination. A chart, on the other hand, is the result of an office study and compilation, is usually on a much smaller scale than the field survey, and may show information obtained over a long period of time.

Dates on Charts

Many misconceptions have grown up regarding the import of our published charts, particularly with ref-


DEPARTMENT OF COMMERCE
U. S. Coast and Geodetic Survey
Washington, D. C.
INDEX MAP
TIDAL BENCH MARKS
MASSACHUSETTS
The red dots and numbers indicate the localities at which tidal bench mark data are available. See reverse side for place names corresponding to numbers.
71°30′
71°00′
70°30′
70°00′
43°00′
42°30′
42°00′
41°30′
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
NEW HAMPSHIRE
MASSACHUSETTS
MASSACHUSETTS
RHODE ISLAND
Portsmouth
MANCHESTER
Merrimack River
Merrimack R.
Newburyport
LOWELL
Cape Ann
Gloucester
SALEM
BOSTON
Scituate
MASSACHUSETTS BAY
Plymouth
Cape Cod
Provincetown
Wellfleet
CAPE COD BAY
PROVIDENCE
Taunton River
Wareham
FALL RIVER
Tiverton
NEW BEDFORD
Barnstable
Hyannis
Chatham
Monomoy Point
Narragansett Bay
Sakonnet River
Falmouth
Woods Hole
BUZZARDS BAY
NANTUCKET SOUND
NEWPORT
Sakonnet Point
Cuttyhunk
Vineyard Sound
Vineyard Haven
Martha's Vineyard
Cape Poge
Chappaquiddick I
Edgartown
Gay Head
Muskeget Channel
Tuckernuck Island
Nantucket Island
Block Island

MAY 1949

INDEX MAP NUMBER (see reverse side)	NAME
1	Salisbury Beach, Merrimack River Entr.
2	Plum Island (Bluff Wharf) Plum I. Sound
3	Annisquam, Annisquam River
4	Wolf Hill, Annisquam River
5	Rockport Harbor
6	Ten Pound Island, Gloucester Harbor
7	Beverly
8	Salem
9	Marblehead
10	Fort Dawes, Deer I., Boston Harbor
11	Belle Isle Inlet, Winthrop
12	Chelsea St. Bridge, Chelsea R., E. Boston
13	Wellington Memorial Bridge, Mystic River
14	Boston Naval Shipyard, Charlestown
15	Boston (Appraisers Stores)
16	South Boston and Vicinity
17	Neponset R. Highway Bridge, Boston Harbor
18	Nut Island, Quincy
19	Weymouth Fore River Bridge
20	Crow Point, Hingham Harbor Entrance
21	Nantasket, Weir R., Hingham Bay
22	Hull (Windmill Pt.) Hingham Bay
23	Georges Island, Boston Harbor
24	Boston Lt., Lighthouse I., Boston Harbor
25	White Head, Cohasset Harbor
26	Cohasset Hbr. Entr., Sheppard Ledge
27	Scituate
28	Green Harbor, Cape Cod Bay
29	Plymouth, Plymouth Harbor
30	Sagamore Beach, Cape Cod Bay
31	Barnstable Harbor, Cape Cod
32	Wellfleet Harbor, Cape Cod
33	North Truro, Cape Cod
34	Provincetown and Vicinity, Cape Cod
35	Peaked Hill Bar, Outer Coast, Cape Cod
36	Old High Head Coast Guard Station-Cape Cod Lighthouse
37	Pamet R. Coast Guard Station, Cape Cod
38	Nauset Beach Light, Cape Cod
39	Nauset Harbor Entrance, Cape Cod
40	Powder Hole, Monomoy Point
41	Harding Beach, Stage Harbor
42	Chatham, Stage Harbor
43	Herring River Entrance
44	Bass River Entrance (Parkers Neck)
45	South Yarmouth, Bass River
46	Hyannisport
47	Cotuit Highlands

INDEX MAP NUMBER (see reverse side)	NAME
48	Cotuit, Great Bay
49	Poponesset Island, Poponesset Bay
50	Waquoit Bay (Yacht Club)
51	Falmouth Heights, Vineyard Sound
52	Falmouth (Municipal Wharf) Falmouth Inner Harbor
53	Little Harbor and Nobska Point, Woods Hole
54	Woods Hole (Oceanographic Inst.)
55	Uncatena I., Elizabeth Is., Woods Hole
56	Tarpaulin Cove, Naushon I., Elizabeth Is.
57	Kettle Cove, Naushon I., Elizabeth Is.
58	Robinsons Hole, Pasque I., Elizabeth Is.
59	Quicks Hole, Nashawena I., Elizabeth Is.
60	Cuttyhunk Pond Entr., Cuttyhunk I.
61	Penikese Island, Elizabeth Islands
62	Chappaquoit Point, W. Falmouth Harbor Entr.
63	West Falmouth, W. Falmouth Harbor
64	Monument Beach and Back R. Harbor, Buzzards Bay
65	Buzzards Bay, Monument River
66	Onset, Onset Bay, Buzzards Bay
67	Wareham, Wareham R. ,Buzzards Bay
68	Great Hill (½ mile north of Great Hill Pt.,) Buzzards Bay
69	Marion, Sippican Hbr., Buzzards Bay
70	Mattapoisett, Mattapoisett Harbor, Buzzards Bay
71	West Island (W. Side,) Buzzards Bay
72	New Bedford (Clark Pt.,) Buzzards Bay
73	New Bedford (New Bedford-Fairhaven Bridge)
74	New Bedford (Nashawena Mills) Acushnet R.
75	South Dartmouth, Apponaganset R. Entr.
76	Westport Harbor Entr. (Charlton Wharf)
77	Hix Bridge, Westport R. (East Branch)
78	Great Point, Nantucket Island
79	Wauwinet, Nantucket Island
80	Siasconset, Nantucket Island
81	Muskeget Island (West Side)
82	Tuckernuck Island (North Side)
83	Nantucket, Nantucket Island
84	Cape Poge, Chappaquiddick Island
85	Chappaquiddick I. (Southwest Side)
86	Edgartown, Martha's Vineyard
87	Oak Bluffs, Martha's Vineyard
88	West Chop, Martha's Vineyard
89	Cedar Tree Neck, Martha's Vineyard
90	Menemsha Pond Entr., Martha's Vineyard
91	Gay Head and Vicinity, Martha's Vineyard
92	No Mans Land Island

NOTE: Unnumbered red dots on the index map on the reverse side indicate nearest tidal bench mark locations in the States of New Hampshire and Rhode Island

Tidal bench mark data are available for the above locations and may be obtained by writing to the Director, U. S. Coast and Geodetic Survey, Washington 25, D. C. **In requesting these data, please refer to both the index map numbers and the names of the particular localities in which you are interested.**

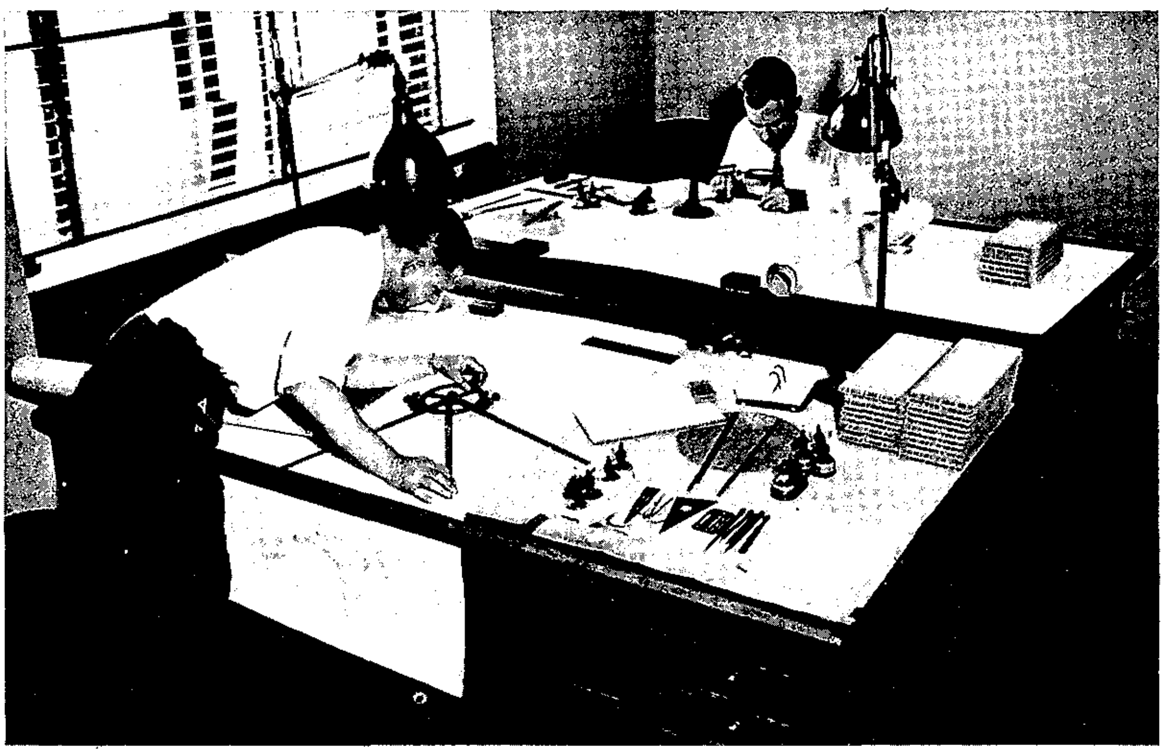
erence to the publication dates shown. The significance of the several dates on Coast and Geodetic Survey nautical charts should be understood by all who have occasion to use them.

When a new nautical chart is printed, the date (month and year) and edition number are given in the publication note, which is placed in a central position in the lower margin of the chart. This date is known as the PUBLICATION DATE, and remains unchanged until a new edition is printed, when the date and edition number are changed. A new edition is printed when it becomes necessary to chart important corrections too numerous to be applied by hand.

An additional printing of a chart which includes any change in any portion of the chart is designated as a new print and the year, month, and day are noted in the lower left margin of the chart. This date is known as the NEW PRINT DATE. For each new print an additional date is added. New prints include corrections which generally are not of sufficient importance to require a new edition.

One other date appears on nautical charts which it is well to keep in mind. This is the CORRECTION DATE. It is a stamped date placed in the lower right margin of the chart and represents the date to which all essential changes for lights, buoys, beacons, recently reported dangers, and other critical information have been corrected.

The user of a chart should therefore not be misled by the edition or printing dates on a chart. These dates bear no relationship necessarily to the date when the survey was made or when certain material was obtained. If the precise date pertaining to any



VERIFYING HYDROGRAPHIC SURVEYS PRIOR TO USE IN CHART COMPILATION

PRESSROOM OF THE COAST AND GEODETIC SURVEY

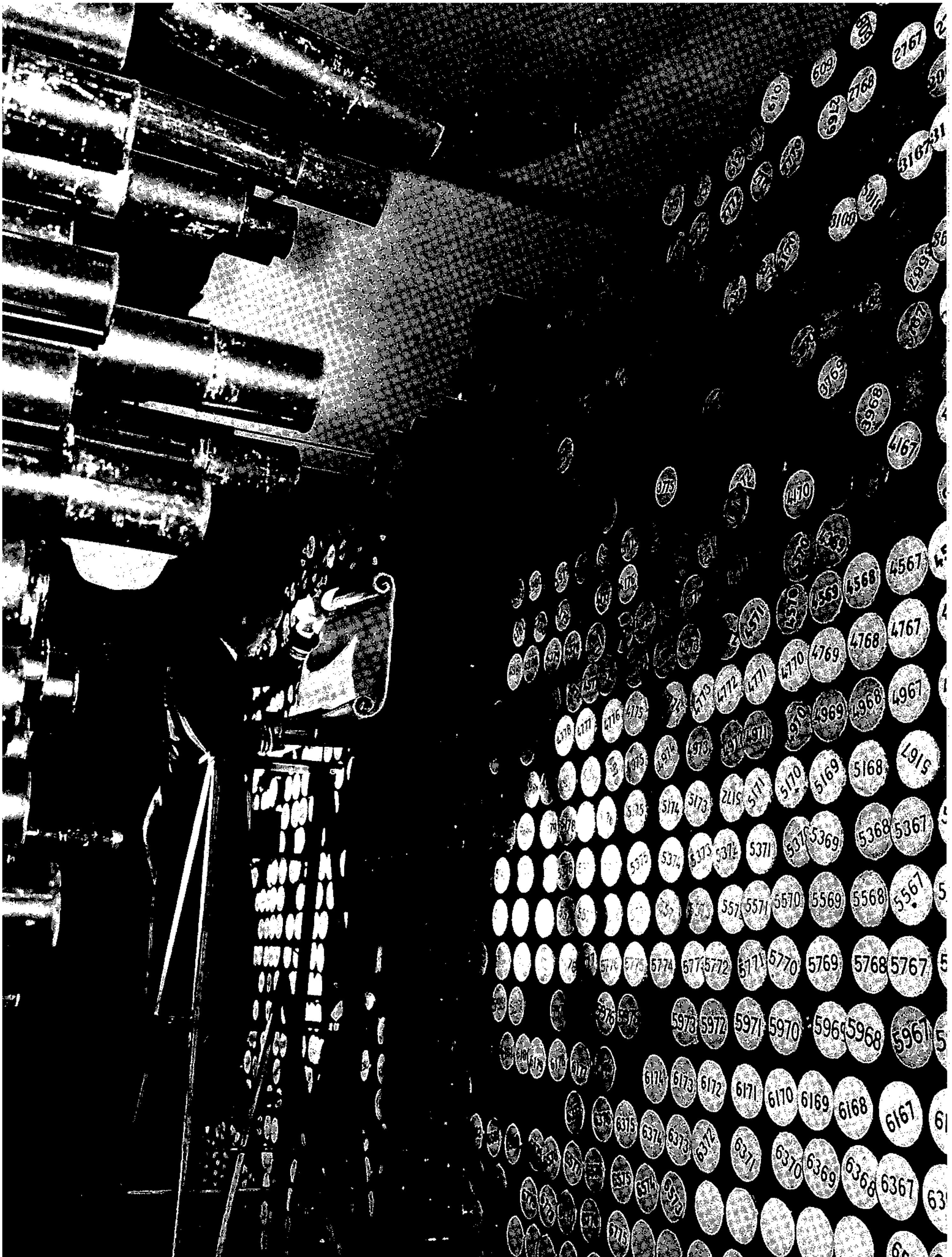
section of the chart is required, recourse must be had to the original material from which the chart was compiled.

E. HOW TO OBTAIN DATA

Nautical charts and related publications (Coast Pilots, Tide Tables, Current Tables, Tidal Current Charts) of the Coast and Geodetic Survey can be purchased at its Washington Office and field offices and from authorized sales agencies at the principal seaports of the United States and possessions. These offices and agencies are listed in the Catalog of Nautical Charts published by the Bureau. Copies of field surveys, planimetric maps, triangulation and leveling data, bench mark data, and information on temperature and density of sea water are also obtainable from the Washington Office. Other printed publications, such as manuals, are obtainable on a sales basis from the Superintendent of Documents, Government Printing Office at Washington, D. C.

In conclusion, I would like to say that it is my hope that out of this brief presentation will come a better understanding and a wider use on the part of engineers of the results of our activities. The Coast and Geodetic Survey has an important interest in the problems of the coastal engineer. Our surveys are uncovering new and interesting facts about the coastal regions. We are pleased to make these available to all who have occasion to use them.

SECTION OF FIREPROOF VAULT IN THE COAST ☞ AND GEODETIC SURVEY. THESE METAL TUBES HOUSE MORE THAN 15,000 HYDROGRAPHIC AND TOPOGRAPHIC SURVEYS OF OUR COASTS DATING BACK TO THE YEAR 1834. *(National Geographic Society.)*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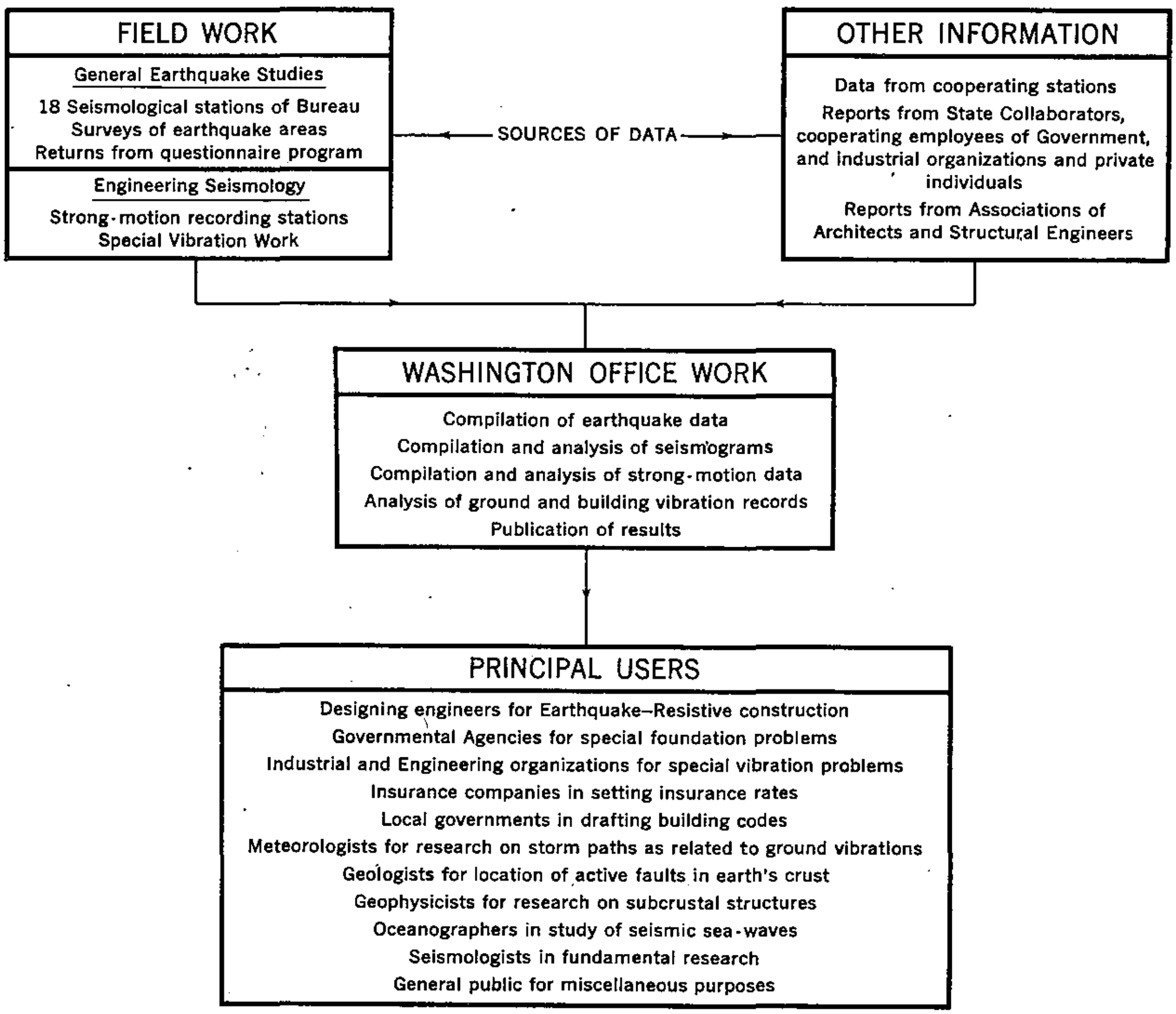
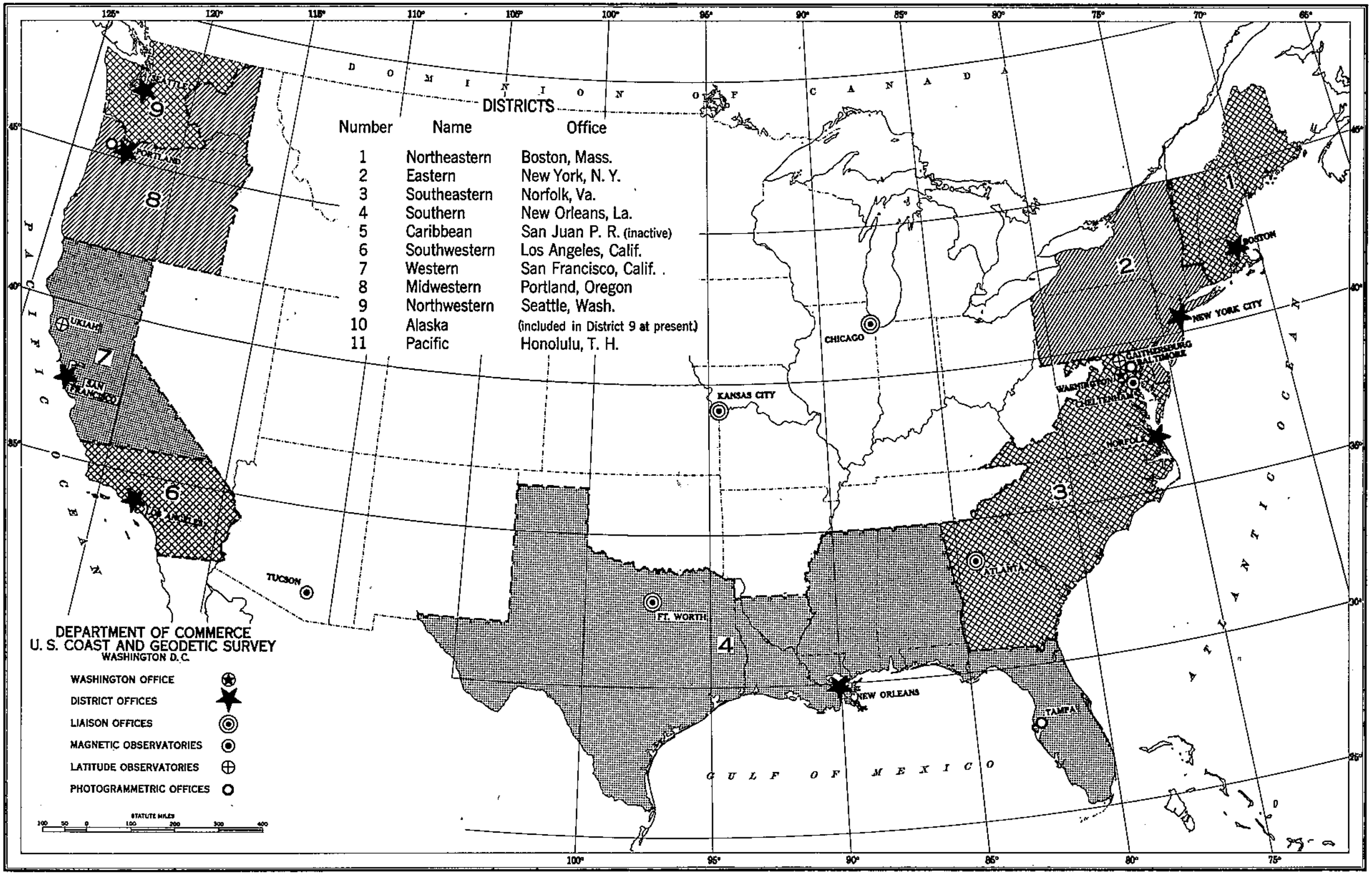
DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
SEISMOLOGICAL SERVICE

EARTHQUAKE HISTORY, seismograph operation and earthquake location, mapping of earthquake areas, recording and analyzing destructive earthquake motions for use in design of earthquake-resistant structures. Special studies of general vibrations affecting foundations and structures.



APPENDIXES
I and II



DISTRICT AND OTHER OFFICES OF THE COAST AND GEODETIC SURVEY

APPENDIX I

District and Field Offices of the Coast and Geodetic Survey

District Offices are maintained at the following principal ports for disseminating nautical and engineering data in response to requests from official sources and from the public.

Northeastern District
Tenth Floor, Customhouse
State Street
Boston 9, Mass.

Eastern District
602 Federal Office Building
90 Church Street
New York 7, N. Y.

Southeastern District
418 Post Office Building
Norfolk 10, Va.

Southern District
314 Customhouse
423 Canal Street
New Orleans 16, La.

Southwestern District
1434 Federal Building
Los Angeles 12, Calif.

Western District
114 Customhouse
San Francisco 26, Calif.

Mid-Western District
502 Panama Building
534 S. W. Third Avenue
Portland 4, Oreg.

Northwestern District
(Including Alaska)
705 Federal Office Building
Seattle 4, Wash.

Pacific District
244 Federal Office Building
P. O. Box 3887
Honolulu, T. H.

The following field offices are maintained for liaison with the Civil Aeronautics Administration, for general dissemination of Coast and Geodetic Survey data, and for distribution of aeronautical charts:

Atlanta, Georgia
80 Marietta St., N. W.

Park Ridge, Illinois
O'Hare Field
Chicago International Airport

Fort Worth 2, Texas
311 U. S. Court House

Kansas City 6, Missouri
2202 City Hall Building

Geophysical offices and observatories are at the following locations:

San Francisco 3, California
214 Old Mint Bldg., 5th and Mission Streets
(Seismological Field Survey)

Boulder City, Nevada
(Lake Mead Seismological Survey)

Cheltenham, Maryland
(Magnetic Observatory)

College, Alaska
P. O. Box 1028
(Magnetic Observatory)

Ewa, Oahu, Territory of Hawaii
P. O. Box 117
(Magnetic Observatory)

Santurce 29, Puerto Rico
Box 3067
(Magnetic Observatory)

Sitka, Alaska
(Magnetic Observatory)

Tucson, Arizona
Route 2, Box 682
(Magnetic Observatory)

Gaithersburg, Maryland
P. O. Box 27
(Latitude Observatory)

Ukiah, California
(Latitude Observatory)

Processing, computing and photogrammetric offices are located at the following places:

Seattle, Washington
1500 Westlake Avenue North
(Processing Office)

New York 14, New York
641 Washington St.
(Computing Office)

Baltimore 18, Maryland
518 East 32nd Street
(Photogrammetric Office)

Tampa, Florida
P. O. Box 1689
(Photogrammetric Office)

Portland 18, Oregon
Swan Island Postal Station
(Photogrammetric Office)

APPENDIX II

Selected List of Publications of the Coast and Geodetic Survey

The following publications of the U. S. Coast and Geodetic Survey, listed in several categories, will be found of special interest to coastal engineers. Most of the publications are obtainable from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at the prices indicated. Those marked with an asterisk may be obtained by writing to the Director, U. S. Coast and Geodetic Survey, Washington 25, D. C. Where no price is listed they are obtainable without charge. A complete List of Publications will be furnished free on request.

GEODETIC SURVEYING AND RELATED SUBJECTS

*CONTROL LEVELING (Special Publication No. 226). Revised (1948) edition. 22 pages.

This publication defines the purposes and describes the methods and equipment employed by the Coast and Geodetic Survey in its program of first- and second-order leveling. It contains a history of the United States level net; information concerning bench marks and their establishment and how to obtain leveling data; and specifications for vertical control.

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*HORIZONTAL CONTROL DATA (Special Publication No. 227). 1941. 26 pages. $0.15.

This pamphlet contains a comprehensive description of the horizontal control network of the United States established by the Coast and Geodetic Survey. It tells how it was begun, how it was adjusted to the North American datum of 1927, and how it is being expanded. It explains horizontal control data, their uses, and how they may be obtained.

THE STATE COORDINATE SYSTEMS (A MANUAL FOR SURVEYORS) (Special Publication No. 235). 1945. 62 pages. $0.45.

This publication explains to the practical surveyor the way in which he can make use of the State Plane Coordinate Systems. It treats of controlled systems in their simpler terms, outlining the advantages of a co-ordinated control system by use of problems, examples, and diagrams. It develops formulas for conversion of geodetic control to the use of the land surveyor, continuing through a hypothetical problem to the use of a State Coordinate System by a practicing surveyor in the pursuit of his profession. Several tables of value in the reduction of field observations for temperature, slope, sea level factor, etc., are furnished.

MANUAL OF GEODETIC ASTRONOMY (Special Publication No. 237). 1947. 200 pages. $1.00.

This is an instruction manual for making longitude, latitude, and azimuth observations and computations by the most modern methods of the Coast and Geodetic Survey. The publication is a revision of Special Publication No. 14, Determination of Time, Longitude, Latitude, and Azimuth, only to the extent that much of the information and many of the tables of that manual were used in the new publication. Otherwise, the treatment is new. It does not, however, supplant Special Publication No. 14 for astronomic observations for longitude and latitude using the older instruments, such as the meridian telescope and the zenith telescope.

AIR-LINE DISTANCES BETWEEN CITIES IN THE UNITED STATES (Special Publication No. 238). 1947. 246 pages. $2.00.

This publication contains a table of distances between 492 cities in the United States. The table consists of more than 120,000 distances listed in statute miles. The distances were computed with an accuracy of 1 part in 10,000 by formulas using the dimensions of the Clarke Spheroid of 1866.

MANUAL OF GEODETIC LEVELING (Special Publication No. 239). 1947. 90 pages. $0.55.

This manual covers the field work involved in first- and second-order leveling as carried on by the Coast and Geodetic Survey. The publication is a revision of Special Publication No. 140, Manual of First-Order Leveling, and supersedes the older publication.

MANUAL OF LEVELING COMPUTATION AND ADJUSTMENT (Special Publication No. 240). 1948. 178 pages. $0.75.

This Manual covers the office computation and adjustment of the geodetic leveling executed by the Coast and Geodetic Survey. The publication is a revision and expansion of Part II of Special Publication No. 140, Manual of First-Order Leveling, and supersedes the older publication.

The Manual was designed to serve the dual purpose of providing for uniform practice in the work of the Section of Leveling and to aid in the training of new computers. It should also be of considerable value as a guide to anyone who may from time to time be concerned with the processing and adjustment of networks of lines of levels of any order of accuracy.

NATURAL TABLES FOR THE COMPUTATION OF GEODETIC POSITIONS: Clarke Spheroid of 1866 (Special Publication No. 241). 1949. 86 pages. $0.35.

The contents of this publication are essentially the same as those in Publication G-43, a lithoprint edition which has been available at the Coast and Geodetic Survey for several years. The tables contain natural functions with which geographic positions of a triangulation scheme may be computed by means of a desk calculating machine. In the inverse problem, a direct means is presented for computing the arc-sine correction in the longitude difference. This greatly facilitates the computation of geodetic lengths and azimuths when the positions of the ends of the lines are given.

DEFINITIONS OF TERMS USED IN GEODETIC AND OTHER SURVEYS (Special Publication No. 242). 1948. 87 pages. $0.45.

This publication is an outgrowth of the work started by the Federal Board of Surveys and Maps in 1938. The Board was abolished by Executive Order in 1942 and its Committee on Definitions of Surveying and Mapping Terms thereby discharged. At that time, comparatively few definitions in geodesy and geodetic surveying had been completed, and it was to provide such definitions that the work which the Committee had previously been performing was continued by the Coast and Geodetic Survey.

SINES, COSINES, AND TANGENTS —TEN DECIMAL PLACES WITH TEN-SECOND INTERVAL 0°-6° (Special Publication No. 246). 1949. 36 pages. $0.20.

The natural trigonometric functions in this table were compiled primarily for use in computing State Plane Coordinates on the Lambert projection system by means of a desk calculating machine.

MANUAL OF GEODETIC TRIANGULATION (Special Publication No. 247). 1950. 344 pages. $1.50.

This manual contains detailed instructions for the execution of geodetic triangulation, base measurement, and azimuth observations based on the experience accumulated over many years in the extensive field and office work of the Coast and Geodetic Survey. Essentially a field manual, it is written from the field engineer's viewpoint. It is devoted principally to general instructions and specifications for first-, second-, and third-order triangulation, and information on the preparation, organization, and equipment of triangulation parties; the instruments used and their adjustment; and signal building, observing, and field computations. There are also chapters on reconnaissance, base line measurements, and first-, second-, and third-order azimuth determinations. One chapter is devoted to special surveys and deals briefly with metropolitan surveys and some other methods of triangulation such as Shoran, flare, and ship-to-shore triangulation.

PLANE COORDINATE PROJECTION TABLES FOR TEXAS (Special Publication No. 252). 1950. 64 pages. $0.30.

PLANE COORDINATE PROJECTION TABLES FOR CALIFORNIA (Special Publication No. 253). 1951. 70 pages. $0.35.

These are two of a new series of special publications on plane coordinate projection tables for the various states to replace the former G-publications on the same subject which were available in a lithoprint edition. The new series contains the fundamental tables for converting geographic positions to plane coordinates (and vice versa) on the State Plane Coordinate System. Examples are given for the computation of plane coordinates from geographic positions and the inverse problem—obtaining the geographic positions from the plane coordinates.

For States using the Lambert conformal projection, the required natural functions are given in Special Publication No. 246 (described above). For those using the transverse Mercator projection, the tables will contain the necessary natural functions to permit the computation with the calculating machine.

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*CONTROL SURVEYS AND THEIR USES (Serial 583). 1935. 15 pages.

This contains a general discussion of the geodetic work of the Coast and Geodetic Survey and its relation to the determination of political and property boundaries.

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TIDES AND CURRENTS

*TIDE TABLES, East Coast, North and South America, including Greenland. $0.25.

*TIDE TABLES, West Coast, North and South America, including Hawaiian Islands. $0.25.

*TIDE TABLES, Europe and West Coast of Africa, including Mediterranean Sea. $0.50.

*TIDE TABLES, Central and Western Pacific Ocean and Indian Ocean. $0.50.

The tide tables are issued in advance annually and include the predicted times and heights of high and low waters for every day in the year for many of the more important harbors, and data by means of which predictions may be readily obtained for thousands of other places.

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*CURRENT TABLES, Atlantic Coast, North America. $0.25.

*CURRENT TABLES, Pacific Coast, North America. $0.25.

*TIDE AND CURRENT TABLES, Philippine Islands. $0.25.

*TIDE AND CURRENT TABLES, Japan and China. $0.25.

The annual current tables include the predicted times of slack water and the times and velocities of strength of current for each day in the year in a number of the more important waterways together with data by means of which similar predictions may be readily obtained for many other places. They contain other useful information pertaining to currents.

TIDAL CURRENT CHARTS are published for the following localities at $0.25 per set:

Boston Harbor
Narragansett Bay to Nantucket Sound
Long Island Sound and Block Island Sound
New York Harbor
Delaware Bay and River
San Francisco Bay
Puget Sound, Northern Part
Puget Sound, Southern Part
Tampa Bay

These charts consist of bound sets of twelve and depict, by means of arrows and figures, the direction and velocity of the current for each hour of the tidal cycle. In addition they present a comprehensive view of the tidal current movement for the harbor as a whole.

TIDES AND CURRENTS IN NEW YORK HARBOR (Special Publication No. 111). Revised (1935) edition. 205 pages. $0.25.

TIDES AND CURRENTS IN SOUTHEAST ALASKA (Special Publication No. 127, Serial 364). 1927. 153 pages. $0.25.

TIDES AND CURRENTS IN BOSTON HARBOR (Special Publication No. 142). 1928. 120 pages. $0.30.

TIDES AND CURRENTS IN PORTSMOUTH HARBOR (Special Publication No. 150). 1929. 104 pages. $0.20.

TIDES AND CURRENTS IN CHESAPEAKE BAY AND TRIBUTARIES (Special Publication No. 162). 1930. 151 pages. $0.65.

TIDES AND CURRENTS IN LONG ISLAND AND BLOCK ISLAND SOUNDS (Special Publication No. 174). 1932. 195 pages. $0.75.

TIDES AND CURRENTS IN HUDSON RIVER (Special Publication No. 180). 1934. 112 pages. $0.25.

CURRENTS IN NARRAGANSETT BAY, BUZZARDS BAY, AND NANTUCKET AND VINEYARD SOUNDS (Special Publication No. 208). 1938. 109 pages. $1.25.

CURRENTS IN ST. JOHNS RIVER, SAVANNAH RIVER, AND INTERVENING WATERWAYS (Special Publication No. 211). 1938. 63 pages. $0.60.

COASTAL CURRENTS ALONG THE ATLANTIC COAST OF THE UNITED STATES (Special Publication No. 230). 1942. 73 pages. $0.75.

These publications make available in considerable detail the data derived from comprehensive tide and current surveys in the areas described.

MANUAL OF HARMONIC ANALYSIS AND PREDICTION OF TIDES (Special Publication No. 98). Revised (1940) edition. 321 pages. $1.00.

This volume was designed primarily as a working manual for use in the Coast and Geodetic Survey and describes the procedure for the harmonic analysis and prediction of tides and tidal currents.

MANUAL OF TIDE OBSERVATIONS (Special Publication No. 196). Revised (1941) edition. 96 pages. $0.30.

MANUAL OF CURRENT OBSERVATIONS (Special Publication No. 215). Revised (1950) edition. 87 pages. $0.55.

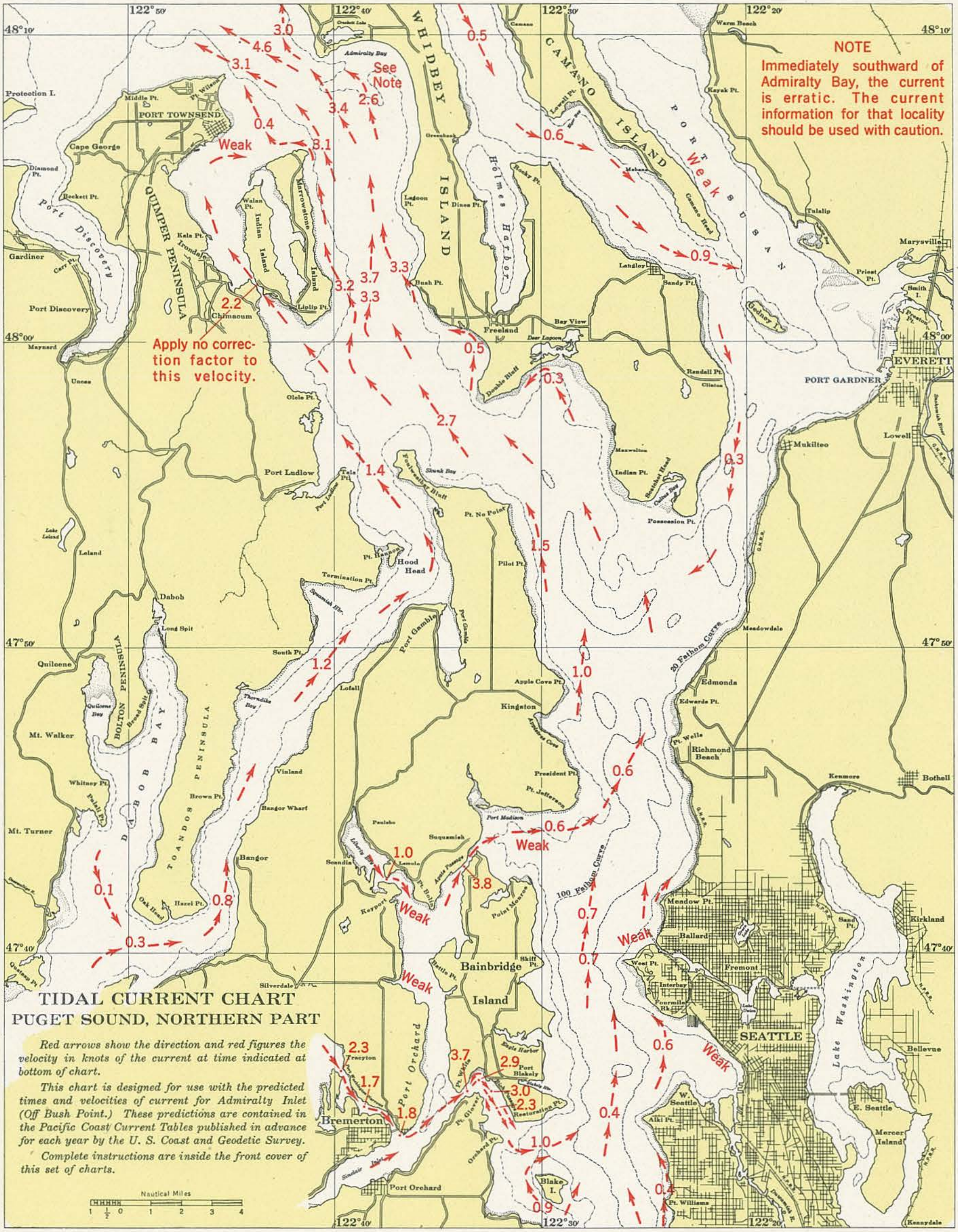
These manuals give the general requirements of the Coast and Geodetic Survey in carrying on its tide and current work and serve as guides to those engaged in taking tide and current observations. Instructions are given for the maintenance of primary tide stations, for securing tidal data necessary in hydrographic surveys, and for the observation and reduction of currents.

TIDE AND CURRENT GLOSSARY (Special Publication No. 228). Revised (1949) edition. $0.15.

This is a list of terms used in tide and current work augmented by definitions of related scientific and meteorological terms, identification of scientists who pioneered or were prominent in tide and current work, and names of notable currents.

TIDAL DATUM PLANES (Special Publication No. 135). Revised (1951) edition. (In press).

This is a complete revision of the



MAXIMUM EBB OFF BUSH POINT.

1927 edition and contains a comprehensive discussion of tides and tidal datum planes which are the basic planes of reference used in the hydrographic and geodetic work of the Coast and Geodetic Survey. It is profusely illustrated with diagrams and photographs and contains a number of valuable tables of interest to coastal engineers.

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GEOMAGNETISM

MAGNETISM OF THE EARTH (Serial No. 663). 1945. 79 pages. $0.35.

This is a revision of an earlier publication of the Bureau entitled, "The Earth's Magnetism," and reflects the many new developments in the field of geomagnetism. There are six chapters covering such subjects as magnets and magnetic fields, the earth's general magnetic field and secular change, transient variations (daily variation and magnetic storms), magnetic measuring instruments, magnetic surveys, and a history of geomagnetism since earliest times. The language employed is largely nontechnical. A bibliography of important general references is included to serve as a reader's guide to more detailed information.

MAGNETIC DECLINATION IN THE UNITED STATES, 1945 (Serial 664). 1946. 69 pages. $1.00.

For nearly a hundred years, the Coast and Geodetic Survey has maintained a search for information on the secular or long-term change of the magnetic declination in the United States. The publication embodies the current findings on this subject in a concise set of tables from which the surveyor and engineer can deduce the specific data needed in their work. The tabular entries are spaced at 10- or 5-year intervals, commencing with 1750 or the subsequent settlement of the region. Detailed directions are given for using the tables under various conditions. The publication includes a folded copy of the current isogonic chart of the United States.

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*MAGNETIC SURVEYS (Serial 718). 1949. 21 pages.

This pamphlet presents briefly a variety of subjects dealing with the earth's magnetism, and includes the following topics: Why we must study the earth's magnetism; distribution of the earth's magnetic field; some misconceptions about magnetic poles; changes of the earth's magnetism; local magnetic anomalies; how magnetic observations are made; use and preservation of magnetic stations; interpreting magnetic charts; retracing old compass surveys; and making new compass surveys.

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*MAGNETIC POLES AND THE COMPASS (Serial 726). 1949. 9 pages.

This pamphlet discusses the relationship between the magnetic poles and the compass. It points out that the compass does not point toward the magnetic pole; that the secular change of the earth's magnetism is not caused by motion of the magnetic pole; that the magnetic pole is not a precise point that can be accurately located; and that the secular change of the magnetic field cannot be predicted.

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COAST PILOTS

*ATLANTIC COAST, SECTION A, ST. CROIX RIVER TO CAPE COD (Serial 737). Fifth (1950) edition. 410 pages. $1.50.

*ATLANTIC COAST, SECTION B, CAPE COD TO SANDY HOOK (Serial 736). Fifth (1950) edition. 503 pages. $1.50.

*ATLANTIC COAST, SECTION C, SANDY HOOK TO CAPE HENRY INCLUDING DELAWARE AND CHESAPEAKE BAYS (Serial 694). Fifth (1947) edition. $1.50.

*ATLANTIC COAST, SECTION D, CAPE HENRY TO KEY WEST, INCLUDING CHESAPEAKE BAY ENTRANCE AND INTRACOASTAL WATERWAY BETWEEN NORFOLK AND KEY WEST (Serial 715). Fifth (1948) edition. 414 pages. $1.50.

*GULF COAST, KEY WEST TO THE RIO GRANDE (Serial 725). Third (1949) edition. 505 pages. $1.50.

*PACIFIC COAST, CALIFORNIA, OREGON AND WASHINGTON (Serial 750). Seventh (1951) edition. $1.50. (In press).

*ALASKA, PART I, DIXON ENTRANCE TO YAKUTAT BAY (Serial 654). Ninth (1943) edition. 466 pages. $1.00.

*ALASKA, PART II, YAKUTAT BAY TO ARCTIC OCEAN (Serial 680). Fifth (1947) edition, 659 pages. $1.50.

*HAWAIIAN ISLANDS (Serial 735). Third (1950) edition. 243 pages. $1.50.

*WEST INDIES, PUERTO RICO AND VIRGIN ISLANDS (Serial 721). Fifth (1949) edition. 296 pages. $1.50.

The Coast Pilots are primarily for navigational use and contain information which cannot be shown conveniently on the nautical charts. However, they contain information relative to the coast and harbors, port information, climatic data, and Federal Regulations concerning anchorages, bridges, etc.

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MISCELLANEOUS

TABLES FOR A POLYCONIC PROJECTION OF MAPS AND LENGTHS OF TERRESTRIAL ARCS OF MERIDIAN AND PARALLELS BASED UPON CLARKE'S REFERENCE SPHEROID OF 1866 (Special Publication No. 5). Sixth edition, 1935. 189 pages. $0.75.

ELEMENTS OF MAP PROJECTION WITH APPLICATIONS TO MAP AND CHART CONSTRUCTION (Special Publication No. 68). Fifth edition (1944), revised. 226 pages. $1.50.

This publication contains a comprehensive treatise on the history, properties, and construction of numerous map projections. It is profusely illustrated with diagrams and maps and includes tables for use in the construction of a number of the projections.

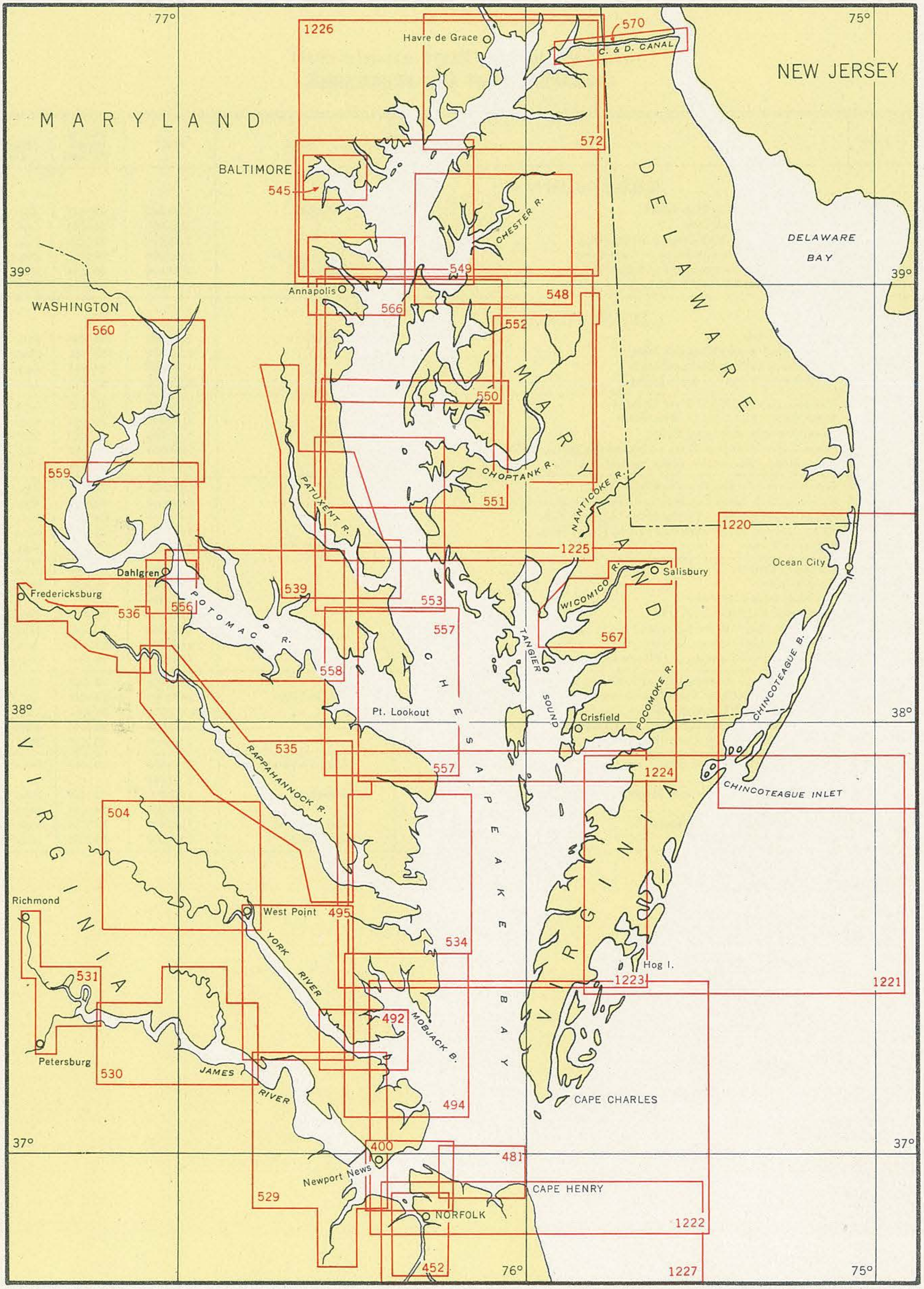
HYDROGRAPHIC MANUAL (Special Publication No. 143). Revised (1942) edition. 940 pages. $4.75.

As a guide to the methods used by the Coast and Geodetic Survey in its hydrographic work, this manual provides a comprehensive coverage of all phases of that work. It contains a large body of information of interest to coastal engineers.

TOPOGRAPHIC MANUAL, PART II, PHOTOGRAMMETRY (Special Publication No. 249). 1949. 570 pages. $3.25.

Another in the series of manuals covering the various operations of the Bureau, this volume contains the requirements and detailed procedures for all photogrammetric work except photogrammetric field surveys. Volume I of the manual, covering topographic field work, will be published at a later date.

CHESAPEAKE BAY AND TRIBUTARIES



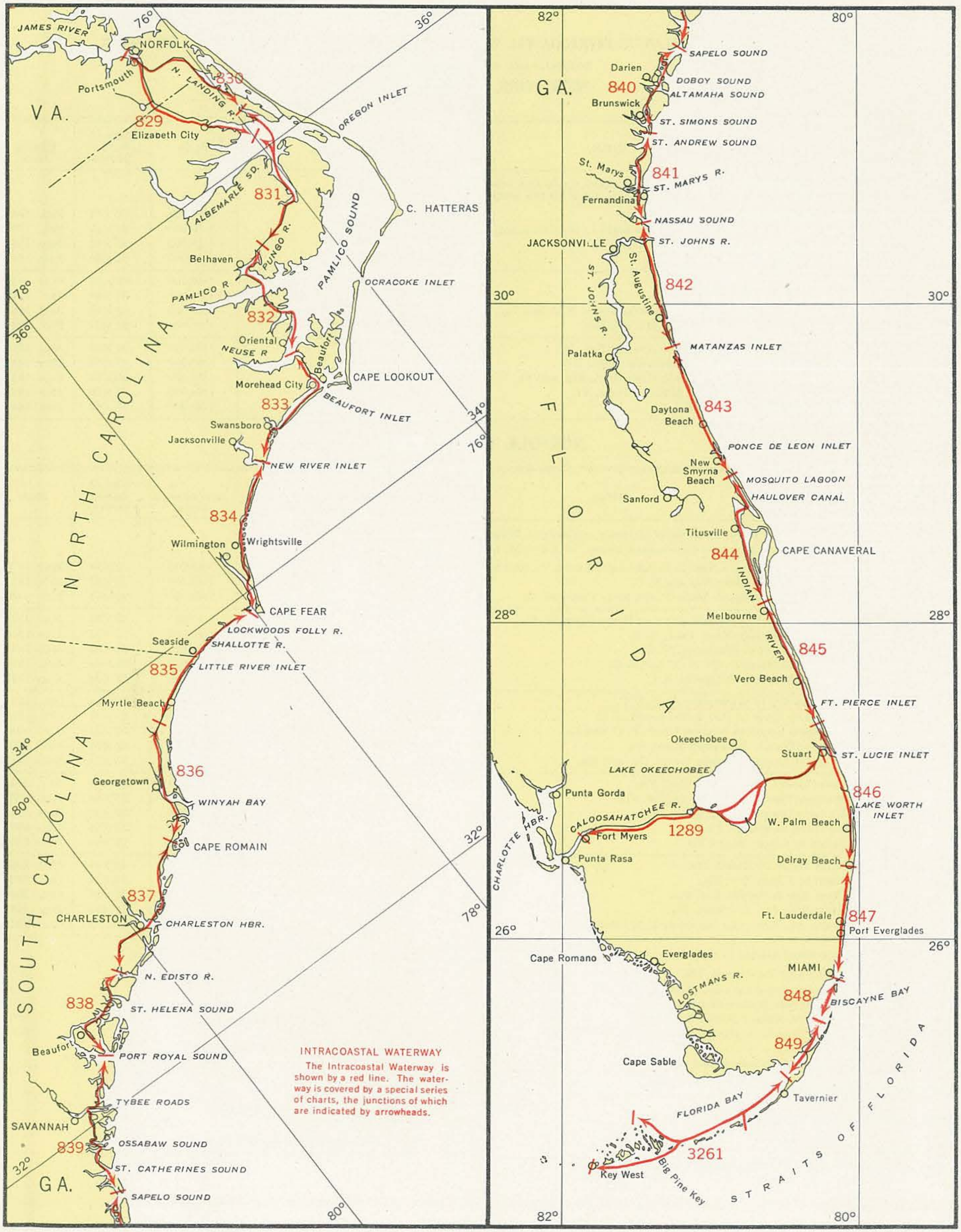
COAST AND HARBOR CHARTS—ATLANTIC COAST

CHESAPEAKE BAY AND TRIBUTARIES

No.	Price	Title	State	Scale	Size of border (inches)	Edition Date
		COAST CHARTS				
1221	$0.75	Chincoteague Inlet to Hog Island	Virginia	1:80,000	31×41	Apr. 1943
1222	.75	Chesapeake Bay Entrance	"	1:80,000	33×43	Dec. 1946
1223	.75	Chesapeake Bay—Wolf Trap to Smith Point	"	1:80,000	31×39	July 1943
1224	.75	Chesapeake Bay—Smith Point to Cove Point	Md. and Va.	1:80,000	30×41	Feb. 1947
1225	.75	Chesapeake Bay—Cove Point to Sandy Point	Maryland	1:80,000	35×38	May 1943
1226	.75	Chesapeake Bay—Sandy Point to Head of Bay	"	1:80,000	34×38	Aug. 1942
		HARBOR CHARTS				
400	.75	Hampton Roads	Virginia	1:20,000	34×43	Jan. 1944
452	.75	Norfolk Harbor and Elizabeth River	"	1:20,000	33×41	Mar. 1948
481	.75	Cape Henry to Thimble Shoal Light	"	1:20,000	29×43	Aug. 1948
492	.75	York River—Yorktown and vicinity	"	1:20,000	32×46	Apr. 1947
494	.75	Mobjack Bay and York River Entrance	"	1:40,000	32×42	Sept. 1943
495	.75	York River—Yorktown to West Point	"	1:40,000	30×40	Aug. 1931
504	.75	Pamunkey and Mattaponi Rivers	"	1:40,000	34×40	Mar. 1936
529	.75	James River—Newport News to Jamestown Island	"	1:40,000	34×40	Aug. 1944
530	.50	James River—Jamestown Island to Jordon Point	"	1:40,000	21×41	Sept. 1940
531	.75	James River—Jordon Point to Richmond	"	1:20,000	31×42	Oct. 1947
534	.75	Rappahannock River Entrance and Great Wicomico River	"	1:40,000	33×42	Apr. 1933
535	.75	Rappahannock River—Towles Point to Marsh Point	"	1:40,000	34×41	Oct. 1946
536	.75	Rappahannock River—Marsh Point to Fredericksburg	"	1:20,000	32×41	Nov. 1946
539	.75	Patuxent River	Maryland	1:40,000	32×37	Sept. 1934
545	.75	Baltimore Harbor	"	1:15,000	30×40	June 1942
548	.75	Chester River	"	1:40,000	33×39	Sept. 1944
		Kent Island Narrows		1:10,000		
549	.75	Approaches to Baltimore Harbor	"	1:40,000	34×43	Dec. 1944
550	.75	Chesapeake Bay—Eastern Bay and South River	"	1:40,000	33×47	Mar. 1948
551	.75	Chesapeake Bay—Choptank River & Herring Bay	"	1:40,000	33×45	Feb. 1950
552	.75	Choptank River—Cambridge to Greensboro	"	1:40,000	26×42	Aug. 1949
553	.75	Chesapeake Bay—Patuxent River to Sharps Island	"	1:40,000	33×44	Oct. 1942
556	.25	Potomac River—Upper Machodoc Creek—Dahlgren and vicinity	Md. and Va.	1:20,000	23×28	Apr. 1948
557	.75	Potomac River—Chesapeake Bay to Piney Point	"	1:40,000	35×44	Aug. 1946
558	.75	Potomac River—Piney Point to Lower Cedar Point	"	1:40,000	34×45	Aug. 1935
559	.75	Potomac River—Lower Cedar Point to Mattawoman Creek	"	1:40,000	30×39	July 1935
560	.75	Potomac River—Mattawoman Creek to Georgetown	Md., Va., and D.C.	1:40,000	29×40	Oct. 1948
		Washington Harbor		1:20,000		
566	.75	Chesapeake Bay—Severn and Magothy Rivers	Maryland	1:25,000	31×39	Aug. 1948
567	.75	Wicomico River	"	1:20,000	34×44	Sept. 1945
570	.50	Chesapeake and Delaware Canal	Md. and Del.	1:20,000	22×34	Feb. 1947
572	.75	Head of Chesapeake Bay	Maryland	1:40,000	34×43	May 1941

CHARTS OF THE ATLANTIC INTRACOASTAL WATERWAY

NORFOLK TO KEY WEST



CHARTS COVERING THE ATLANTIC INTRACOASTAL WATERWAY (INSIDE ROUTE)—NEW YORK TO KEY WEST

Arranged in order of progression southward

NEW YORK TO NORFOLK

No.	Price	Title	Scale	Size of border (inches)	Edition Date
		The following coast and harbor charts, listed with others on pp. 4 to 7 inclusive are relisted here as those best suited for this section of the route.			
369	$0.75	New York Harbor, N. Y. and N. J.	1:40,000	34×43	Feb. 1947
1215	.75	Approaches to New York—Fire Island Light to Sea Girt Light, N. Y. and N. J.	1:80,000	33×41	Feb. 1947
825	.25	Manasquan Inlet to Little Egg Harbor, N. J.	1:40,000	22×34	July 1946
826	.25	Little Egg Harbor to Longport, N. J.	1:40,000	22×34	June 1949
827	.25	Longport to Cape May, N. J.	1:40,000	22×34	Oct. 1943
1218	.75	Delaware Bay, N. J. and Del.	1:80,000	31×37	Jan. 1942
294	.75	Delaware River—Smyrna River to Wilmington, N. J. and Del.	1:40,000	29×45	Sept. 1943
570	.50	Chesapeake and Delaware Canal, Md. and Del.	1:20,000	22×34	Feb. 1947
1226	.75	Chesapeake Bay—Sandy Point to Head of Bay, Md.	1:80,000	34×38	Aug. 1942
1225	.75	Chesapeake Bay—Cove Point to Sandy Point, Md.	1:80,000	35×38	May 1943
1224	.75	Chesapeake Bay—Smith Point to Cove Point, Md. and Va.	1:80,000	30×41	Feb. 1947
1223	.75	Chesapeake Bay—Wolf Trap to Smith Point, Va.	1:80,000	31×39	July 1943
1222	.75	Chesapeake Bay Entrance, Va.	1:80,000	33×43	Dec. 1946

NORFOLK TO KEY WEST

No.	Price	Title	Approximate Scale	Size of border (inches)	Date
		The following series of Atlantic Intracoastal Waterway (Inside Route) charts shows the route in strips of convenient widths, with 3 strips to each sheet.			
829	$0.25	Dismal Swamp Canal—Norfolk to Albemarle Sound, Va. and N. C.	1:40,000	22×34	May 1938
830	.25	Norfolk to North River, Va. and N. C.	1:40,000	22×34	Feb. 1943
831	.25	North River to Alligator River-Pungo River Canal, N. C.	1:40,000	22×34	Feb. 1943
832	.25	Alligator River-Pungo River Canal to Neuse River, N. C.	1:40,000	22×34	Jan. 1938
833	.25	Neuse River to New River Inlet, N. C.	1:40,000	22×34	June 1946
834	.25	New River Inlet to Southport, N. C.	1:40,000	22×34	Sept. 1942
835	.25	Southport to Socastee Cr., N. C. and S. C.	1:40,000	22×34	Jan. 1943
836	.25	Socastee Cr. to McClellanville, S. C.	1:40,000	22×34	Aug. 1942
837	.25	McClellanville to Wadmalaw River, S. C.	1:40,000	22×34	Oct. 1942
838	.25	Wadmalaw River to Port Royal Sound, S. C.	1:40,000	22×34	Oct. 1942
839	.25	Port Royal Sound to Johnson Creek, S. C. and Ga.	1:40,000	22×34	Apr. 1943
840	.25	Johnson Creek to Brunswick River, Ga.	1:40,000	22×34	July 1942
841	.25	Brunswick River to Nassau Sound, Ga. and Fla.	1:40,000	22×34	Mar. 1943
842	.25	Nassau Sound to Matanzas Inlet, Fla.	1:40,000	22×34	July 1944
843	.25	Matanzas Inlet to Mosquito Lagoon, Fla.	1:40,000	22×34	Nov. 1938
844	.25	Mosquito Lagoon to Eau Gallie, Fla.	1:40,000	22×34	May 1942
845	.25	Eau Gallie to Walton, Fla.	1:40,000	22×34	June 1938
846	.25	Walton to Delray Beach, Fla.	1:40,000	22×34	Jan. 1943
847	.25	Delray Beach to Miami, Fla.	1:40,000	22×34	Mar. 1943
848	.25	Miami to Elliott Key, Fla.	1:40,000	23×34	Oct. 1939
849	.25	Elliott Key to Florida Bay, Fla.	1:40,000	22×34	Oct. 1939
3261	.25	Barnes Sound to Key West, Fla.	1:80,000	22×34	July 1944
1289	.75	Okeechobee Waterway including Lake Okeechobee	1:80,000	33×46	Mar. 1949

The following charts are recommended to supplement the special Atlantic Intracoastal Waterway series. For diagrams see pages 6 to 10 inclusive.

291 Lake Worth Inlet and Palm Beach, Fla.
419 Ocracoke Inlet and part of Core Sound, N. C.
420 Beaufort Inlet and part of Core Sound, N. C.
440 Savannah River and Wassaw Sound, S. C. and Ga.
447 St. Simon Sound, Brunswick Harbor and Turtle River, Ga.
448 St. Andrew Sound, Ga.
452 Norfolk Harbor and Elizabeth River, Va.
453 Fernandina Harbor, Ga. and Fla.
491 Charleston Harbor Entrance, S. C.
538 Neuse River and Upper Part of Bay River, N. C.
546 Port Everglades, Fla.
547 Miami Harbor, Fla.
571 Port Royal Sound and inland passages, S. C.
573 Ossabaw Sound and St. Catherines Sound, Ga.
574 Sapelo and Doboy Sounds, Ga.
575 Altamaha Sound, Ga.
577 Fernandina to Jacksonville, Fla.
582 Fort Pierce Harbor, Fla.
584 Key West Harbor and approaches, Fla.
777 New River, N. C.
787 Winyah Bay, S. C.
792 Stono and North Edisto Rivers, S. C.
793 St. Helena Sound, S. C.
794 Parts of Coosaw and Broad Rivers, S. C.
795 Shark River, Manasquan River and Bay Head Harbor, N. J.

DISTANCES BETWEEN UNITED STATES PORTS (Serial 444). Revised (1938) edition. 55 pages. $0.10.

Tables and instructions for determining the distance between any two ports in the United States, its Territories, and possessions are provided in this booklet. It includes this information for ports on inland waterways and the Great Lakes.

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*DENSITY OF SEA WATER, Atlantic and Gulf Coasts (DW-1).

*DENSITY OF SEA WATER, Pacific Ocean (DW-2).

*SURFACE WATER TEMPERATURES, Atlantic and Gulf Coasts (TW-1).

*SURFACE WATER TEMPERATURES, Pacific Coast (TW-2).

These publications contain monthly and yearly means, together with the yearly maximum and minimum, based on the daily readings of the density and temperature of sea water at tide stations.

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*CATALOG OF NAUTICAL CHARTS AND RELATED PUBLICATIONS (Serial No. 665). 1949.

This lists all nautical charts published by the Coast and Geodetic Survey giving numbers, scales, sheet sizes, and diagrams showing chart limits. Also listed are special maps and charts, tidal current charts, tide and current tables, and coast pilots. Complete information is given on how to obtain charts and publications together with a list of authorized sales agents for the Bureau.

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*THE UNITED STATES COAST AND GEODETIC SURVEY (A reprint). 1951. 15 pages.

This pamphlet contains a brief history and a description of the organization and activities of the Bureau. It appeared originally as an article in the journal "Surveying and Mapping" and was one of a series on Federal mapping agencies.

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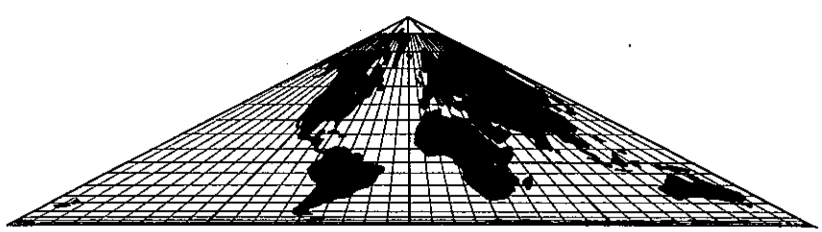
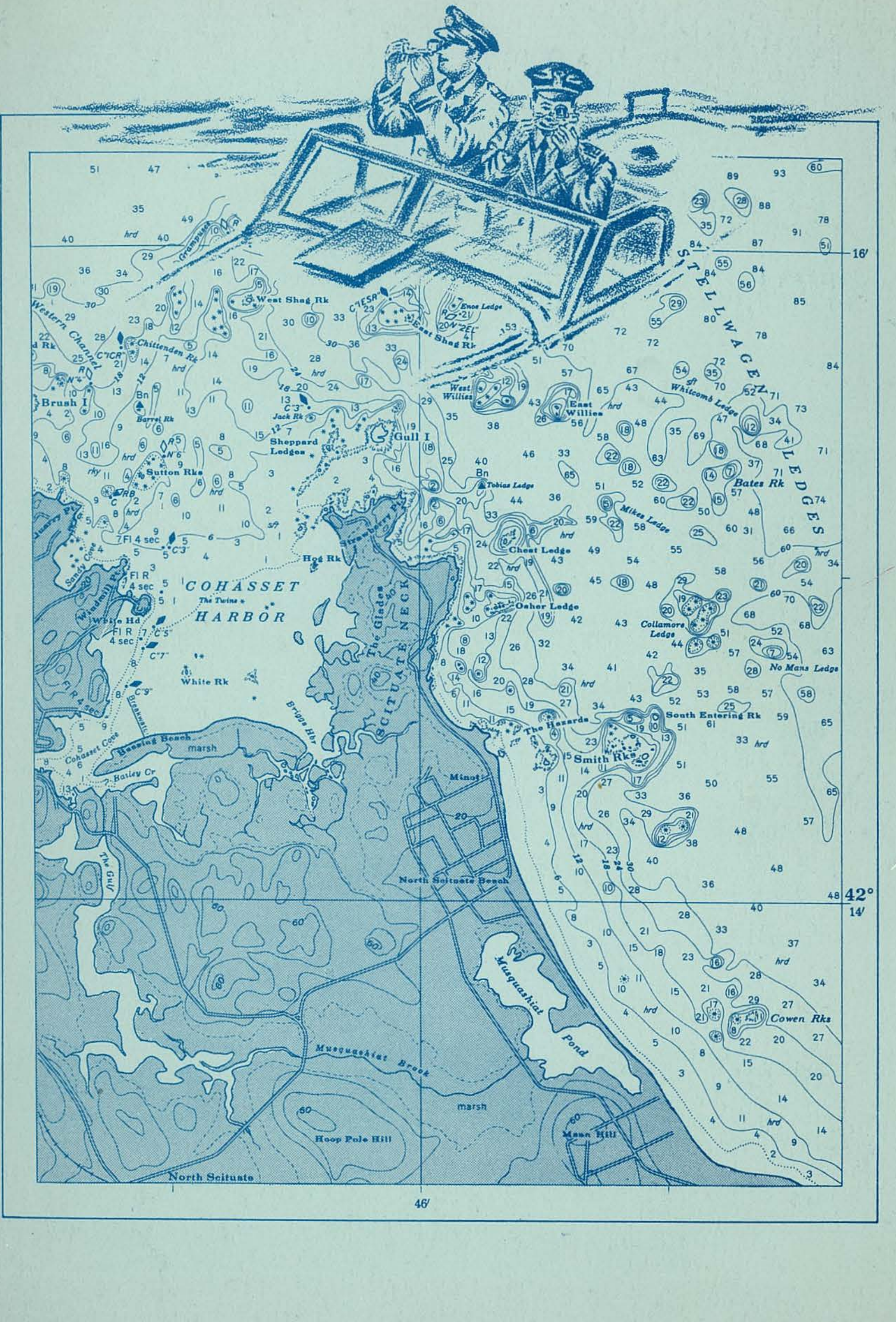
*TECHNICAL SERVICES: COAST AND GEODETIC SURVEY. (Special Handbook). 1948. 27 pages.

An illustrated handbook of the varied technical services of the Coast and Geodetic Survey, resulting from the data gathered by the Bureau in the production of its nautical and aeronautical charts, its geodetic control surveys, and other activities. The products of the Bureau, as well as their by-product uses, are described, and a number of indexes are included showing the areas of original hydrographic and topographic surveys, the locations of primary tide stations, and triangulation and leveling nets of the United States.





STELLWAGEN LEDGES
COHASSET HARBOR
SCITUATE NECK
Western Channel
Brush I
Chittenden Rk
West Shag Rk
East Shag Rk
Enos Ledge
Grampuses
Barrel Rk
Sutton Rks
Jack Rk
Sheppard Ledges
Gull I
West Willies
East Willies
Whitcomb Ledge
Bates Rk
Tobias Ledge
Mikes Ledge
Chest Ledge
Osher Ledge
Collamore Ledge
No Mans Ledge
Hog Rk
Strawberry Pt
The Glades
The Twins
White Hd
White Rk
Windmill Pt
Sandy Cove
Cohasset Cove
Bassing Beach
Bailey Cr
Briggs Hbr
The Hazards
Smith Rks
South Entering Rk
Minot
North Scituate Beach
Musquashicut Pond
Musquashicut Brook
Cowen Rks
Hoop Pole Hill
Mann Hill
North Scituate
The Gulf
marsh
Breakwater
42°
14′
16′
46′