CHAPTER 4

Analysis and Interpretation of Topographic Surveys

The early topographic surveys of the Bureau have been the subject of inquiry from the legal profession perhaps more than any other of the Bureau products. These inquiries usually relate to the method of survey, the instructions under which the early field parties operated, the relative accuracy of the surveyed features, and the interpretation of certain conventional symbols used in the representation of the features. This chapter reflects many of these inquiries, and the analysis and interpretation are based on the author's field experience in the making of such surveys, on his office experience in the review of many hundreds of such surveys, and in the preparation of replies to inquiries which necessitated reference to original source material.

41. THE PLANETABLE

From the beginning of the Coast Survey, the principal instrument used for making topographic surveys was the planetable. Other methods have been employed occasionally to meet some special purpose or as an adjunct to the planetable, but the great bulk of the surveys along our coasts, prior to the advent of aerial photogrammetry, was executed with the planetable. While the instrument has undergone a number of refinements since its first use by the Bureau, the principle underlying its operation is the same.

The first published description of the planetable, insofar as it relates to Coast Survey work, is found in a paper by Hassler in the 1825 Transactions of the American Philosophical Society.[1] The discussion is limited, however, to the mechanical construction of the instrument and no instructions are given for its use in the field. Hassler emphasizes its usefulness and efficiency as a mapping

1. Hassler, *The Survey of the Coast of the United States*, II TRANSACTIONS, AMERICAN PHILOSOPHICAL SOCIETY (New Series) 348 (1825).

instrument in the following statement which is important to keep in mind in evaluating and interpreting the early surveys:

> The best method of surveying the minute details which are to fill up a triangulation, is undoubtedly by the plane table and its alhidade, with a telescope revolving in the vertical. This method will give to the detail surveyor the full result of the triangulation with respect to the relative position and distances of the points to be determined, in a mechanical form, appropriated to the nature of his work; and which will not only be a guide and reference, but also a means of enabling him to determine his distances, and to verify his work constantly as he proceeds, and by reviewing the fundamental points, to discover an error immediately, before it may mislead him. The detail surveyor can therefore proceed with confidence and celerity, and his work will be greatly diminished by this method, as well as by saving all the work commonly called plotting (necessary in all other methods), which besides introduces new errors, while those made in the field remain concealed until it is too late to correct them properly.

Here we have the key to all planetable surveying. No field notes are necessary for later office plotting. The planetable topographer maps as he surveys. Delineating the shoreline, sketching the contours, mapping the roads and other topographic features are accomplished in the field while the terrain is in full view of the topographer. All angles are measured graphically and all distances are determined optically, and both are immediately plotted on the survey sheet by the topographer and no record of the measurements is retained. This is an important fact. Information is repeatedly requested relative to the "field notes" of a particular planetable survey and it is often difficult to impress the inquirer with the fact that no such notes exist.[2] A brief description of the instrument and its use will be given in order to clarify this point.

411. Description of Instrument and Method of Use

As used in the Coast Survey, the planetable consisted of a drawing board, about 30 by 24 inches in size, mounted on a tripod in such manner that the board could be leveled and revolved about a central axis without disturbing the tripod. Clamped to the board was the field survey sheet containing a projection and the available triangulation stations in the area.

A part of the instrumental equipment of the planetable was the "alidade." This consisted of a ruler upon which a telescope was mounted, the telescope having motion in a vertical plane only, so that its line of collimation was always parallel to the edges of the ruler.

2. A description of the planetable is contained in an 1875 manuscript article by A. M. Harrison entitled, "A Historical Account of the Plane Table," and is on file in the Coast Survey library (Accession No. 2592).

4111. *How the Planetable Was Oriented*

Before any surveying was done with the planetable, it was first correctly oriented; that is, it was so placed in position that every line drawn on the survey sheet from the point which represented the position of the table on the ground to any other point on the sheet was parallel to the corresponding line in nature.

The simplest method of orienting the planetable was to occupy one of the triangulation stations shown on the survey sheet. The table was then placed over the station mark so that the plotted point was approximately over the point on the ground. The alidade was placed on the sheet so that its fiducial edge passed through the triangulation point occupied and through some other distant triangulation point shown on the sheet. The table was rotated until the distant signal was bisected by the vertical cross hair in the telescope. It was then properly oriented. If the telescope was then directed to any undetermined point and at the same time the edge of the alidade was kept on the point occupied, a line drawn along the edge of the ruler and through the occupied point gave a direction to the undetermined point. Similar directions from two other occupied stations fixed the position of the unknown point. A failure of the three lines to intersect in a common point indicated an error and the work had to be done over.[3]

Since the points located in this manner were graphic locations, no notes were available from which they could be later replotted. On the more modern topographic surveys, many such stations were permanently marked on the ground and descriptions to aid in their recovery were retained in the office files.

4112. *Introduction of the Telemeter Rod*

An important part of the instrumental equipment of a planetable party was the telemeter or stadia rod (*see* fig. 40). With its aid the topographer was able to locate topographic features without the necessity of direct measurement over the ground, such as by chaining. The telemeter was so graduated that the number of divisions on it that were intercepted between two horizontal wires in the eyepiece of the alidade was equal to the number of units in the distance

3. It was not always necessary to occupy a predetermined station in order to fix the position of the planetable or to determine the position of an unknown point. The instrument could be set up at any convenient point where three stations shown on the survey sheet were visible, and which conformed to certain geometric conditions, and the table oriented by a graphic solution of the *three-point problem*. This method is described in SWAINSON, TOPOGRAPHIC MANUAL 57–61, SPECIAL PUBLICATION NO. 144, U.S. COAST AND GEODETIC SURVEY (1928).

between the observer and the rod. (The units were usually in meters.) The distances thus determined were immediately plotted on the survey sheet and no other record was kept.

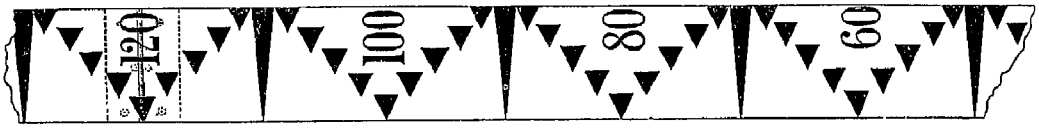

FIGURE 40.—Form of graduations on a telemeter rod used in 1865.

The telemeter rod was not always a standard part of the planetable equipment in Coast Survey work. In the earliest instructions for topographic work, it is noted that "The survey must always be conducted with the chain" (*see* 42, par. 35). The first published reference to the use of a telemeter for measuring distances is found in Appendix 22 of the Annual Report of 1865, where it is stated: "However frequent may be the number of bases furnished by the secondary triangulation, and however serviceable as a substitute in the measurement of distances the telemeter may have proved itself, we cannot entirely dispense with the chain."[4]

While the disadvantages resulting from the use of the chain were clearly recognized, especially on account of the necessity of dependence upon the chainmen for correct distances, the use of the telemeter was at first not generally regarded as valuable for most purposes as was the method of chaining. Even after its use by officers of the Survey had demonstrated the rapidity with which the details of a survey could be determined and the facility with which it could be used in places where the use of the chain was impracticable, together with the important fact that whatever errors occurred rested entirely with the observer, it was still considered merely as an "important acquisition" to the planetable equipment. However, in the Plane Table Manual published in Appendix 13 of the Annual Report of 1880, the chain is no longer mentioned as part of the planetable equipment.[5]

4. Annual Report, U.S. Coast Survey 226 (1865). For a description of the chain used during this period and the method of using it, *see id.* at 226, 227.

5. It is important to note that while the use of the chain in planetable work necessitated the keeping of a record by the chainman in which all crossings of high and low water, intersections of brooks, fences, roads, etc., were noted, such record, as far as it has been possible to ascertain, was never retained as a permanent part of the survey. The information was transferred to the planetable sheet before the topographer left the station so that any errors resulting from the chaining could be detected immediately. *Id.* at 227.

FIGURE 41.—Mapping an Alaska shoreline with the planetable. The planetabler constructs his map as he surveys. The rodman on the point of rocks is holding a telemeter rod and the observer is measuring its distance and direction from the planetable.

4113. *Mapping the Shoreline*

In mapping the shoreline, the topographer set up his instrument at some commanding point where he could see the beach for 400 or 500 yards. The rodman walked along the beach setting up his rod at short intervals and particularly wherever there was a change in direction. The topographer determined the direction and distance of the rod from his instrument, plotted the point on the sheet, and drew the shoreline through the series of points located, sketching in the shoreline between the rodded points. (*See* fig. 41.)

There is no way of ascertaining on early surveys which points along the shore were actually determined by a measured distance unless the prick points made by the dividers in plotting the distances, or some other identifying marks (*see* Register No. T–263 (1849)), can be recovered.[6]

6. On planetable surveys (aluminum mounted) used in conjunction with air photo compilations for delineating the shoreline (where indefinitely shown on the photographs), such shoreline was identified by a dot and dashed line, the dots indicating the precise locations of the rodded points, as distinguished from sketching. *Field Memorandum No. 1 (1935)*, 9 FIELD ENGINEERS BULLETIN 103, U.S. COAST AND GEODETIC SURVEY (1935). The latest practice, where the shoreline is not visible on the photographs, is to locate the shoreline on the photographs at intervals by measurements from the nearest identifiable points of detail (short dashes in red ink are used to delineate the shoreline at the measured points, the latter being close enough to ensure that the shoreline is correct within 0.5 mm.), or by planetable traverse or sextant fixes plotted in the water area on the photographs. SWANSON, TOPOGRAPHIC MANUAL (Part II) 339, SPECIAL PUBLICATION No. 249, U.S. COAST AND GEODETIC SURVEY (1949).

412. The First Planetable Manual

The first comprehensive treatise on the planetable and its use in topographic surveying was published as Appendix 22 of the Annual Report of 1865. This apparently was the first of its kind in the English language (*see* introductory note to Appendix 22). While this treatise was intended to set the practice for the future, it can be assumed that it represented to a large extent the existing practices of that period. It was prepared by A. M. Harrison and contains a description of the two-point and three-point problems.

4121. *Other Published Manuals*

Other topographic manuals were issued from time to time, each new manual comprising some significant change from the previous one.

(*a*) "A Treatise on the Plane-Table and Its Use in Topographical Surveying," by E. Hergesheimer, appeared in the Annual Report of 1880 (Appendix 13). In this treatise, the treatment of the three-point problem is considerably enlarged; references to the chain as a means of measuring distances in planetable work were removed and the telemeter method substituted (*see* 4112). The use of the word "stadia" was introduced and its theory discussed at length.

(*b*) "A Plane Table Manual," by D. B. Wainwright, was published in the Annual Report of 1898 (Appendix 8), and was reprinted as a separate in 1899. This was based on the material in the 1880 manual but with new arrangements, rewrites, and additions. The use of the word "stadia" was adopted in place of "telemeter" to accord with its common use by engineers and surveyors.

(*c*) "A Plane Table Manual," by D. B. Wainwright, was published in the Annual Report of 1905 (Appendix 7), and issued as a separate the same year. Although essentially a reprint of the previous manual, a new arrangement of the three-point problem was introduced with the idea of simplifying the description of the conditions found in practice and the several steps required for its graphic solution. A description of the hypsograph for computing elevations in planetable surveys was introduced for the first time in a planetable manual, having been designed in the Coast Survey in 1902. This manual was reprinted in 1915 (with corrections) and in 1916 as separates. The "corrections" in the reprint refer to the substitution of the symbols adopted by the U.S. Geographic Board in 1911 for the symbols included in the 1905 reprint (*see* note 72 *infra*). The Geographic Board symbols were also included in the 1916 reprint.

(*d*) A "Plane Table Manual," by D. B. Wainwright, was published in 1922 as Special Publication No. 85. The only significant changes from the previous manual are the addition of a historical note on the planetable, including some illustrations of early instruments and topographic maps, and a reduction in the page size to make it pocket size.

(*e*) The last planetable manual to be issued by the Bureau (as of March 1964) was the "Topographic Manual," by O. W. Swainson, published in 1928 as Special Publication No. 144. It is virtually a completely new treatment of the procedures for planetable surveying, in which all discussions of the theory of methods have been omitted. It is divided into four parts and covers the following topics in the order listed: General Requirements for Topographic Work, Instruments and Equipment, Field Work, and Office Work.

42. EARLIEST INSTRUCTIONS FOR TOPOGRAPHIC WORK

Prior to the publication of the 1865 manual, topographers were guided in their work by special instructions issued by the administrative officers of the Bureau.[7] The earliest instructions for topographic work now extant were issued about 1840 by Ferdinand Hassler, the first Superintendent of the Survey.[8] Because of their importance in indicating the practice intended to be followed by planetable parties at that time, and because of their value in interpreting early surveys, they are included here in their entirety.

INSTRUCTIONS FOR CHIEFS OF PLANE TABLE PARTIES

Sir:

In the execution of your Topl. duties you will be governed by the following instructions, to wit:

On Property

1. Make requisition upon the assistant having charge of the topography for all articles necessary to carry on your operations.

2. On taking the field transmit to said assistant an inventory of all property in your possession and another when your field work is ended, stating in this last what articles have been worn out, lost or destroyed and what is fit or unfit for further use, and where stowed.

3. You will give said assistant a receipt for all property committed to your charge, and be held responsible for said property until relieved from accountability by the Department in charge of the work.

On the Projections

4. You will make a projection upon paper according to the scale adopted for the section of your work, subdividing such projection to such distances of 1′, 2′, 5′ as best adapted to the scale of the intended map and the facility of introducing the points to be placed on it.

5. In the projections the points determined by the main and secondary triangulation are to be inserted by their situation in latitude and longitude with the help of the tables calculated for that purpose.

6. Every one of these individual projections must be made to start from about the centre of the sheet to be used in the field, and the elements for them to be taken in the tables must be those corresponding to the latitude of the middle of the sheet.

7. The introduction of the triangle points upon these projections is made by means of the shortest ordinates taken from the tables, for the quadrilateral which includes them,

7. This is evident from the following statement by Hassler in his report on "The Survey of the Coast of the United States," which was published prior to the execution of the first topographic survey: "The organisation of the detail surveys always depends upon the administrative views according to which the work is to be executed. Its details must therefore be omitted in the present papers. Regular and full instructions must be given to the detail surveyors in writing, both on the principles which they shall make use of in their works, and on the objects to be attended to." Hassler, *supra* note 1, at 404.

8. These instructions are handwritten and appear in the volume (17) of correspondence marked "Coast Survey, Scientific, 1844–1846." Although neither dated nor signed, other instructions for topographic work and for the general work of the Coast Survey (dated 1840 and 1841 and signed by Hassler) appear in the same volume and contain many paragraphs from the unsigned instructions. The assumption that the latter instructions were issued by Hassler around 1840 is therefore a reasonable one.

and from the nearest side of the square the points are marked by small dividers, the distances intersecting one another perpendicularly—by these means the distances to be taken will never exceed the half length of the divisions of the projection.

8. The points of the main triangulation are surrounded by a small triangle—those of the secondary by a small circle to distinguish the two kinds of points.

9. The sides of the triangles must be drawn upon the projections in Indian ink; and the numbers indicating their length must be written near them.

10. When a side of a triangle is only partially included in a projection its direction is to be had by calculating the latitude and longitude of a point taken on that side at such a distance from the point already fixed as will fall in the projection.

11. The meridians and parallels, as well as the names of the triangle points are to be all clearly written in ink.

On Surveying

12. You will first carefully reconnoitre the ground you are to survey in order to be able to form a regular plan of operation for the intended work.

13. In placing the plane table in its proper direction at the beginning of a station, upon which the future position of the work depends, only the actually determined lines of the triangles that have been marked, as stated above, must be used as *directrices*, but never a line between two points not so directly connected together, and not forming a side of the same triangle.

14. The magnetic needle is to be used for no important determination—the only use that is allowed of it will be to survey bye-roads, the extremities of which have been well determined, running through woods—also the outlines of woods and marshes that cannot be surveyed by any other means or that are of no great importance.

15. The names of the villages, rivers, brooks, hills, denomination given to a district or locality, and sometimes single houses, etc., are always to be written, and care is to be taken to get the exact orthography. The direction of the course of the rivers and creeks must be indicated by a small dart, the point of it down stream.

16. All mills, waterworks and factories on a large scale must be marked by peculiar and appropriate signs, together with their particular names if any they have.

17. On the sea shore and the rivers subject to the tides, the high and low water lines are to be surveyed accurately; and the kind of ground contained between them, whether sand, rock, shingle or mud marked accordingly. The low water line is taken by offsets whilst running the high water, and when not too far apart from each other, but when their distance is great they must be surveyed separately: a couple of hours before the end of the ebb, and the same time during the commencement of the flood tides will be the proper time for taking the low water line, and your operations must be so timed, as to be on the shore on those periods.[9]

18. You will establish points along the shores, and mark them securely by means of stakes, at suitable distances, for the use of the hydrographical parties in taking their soundings—and also furnish them with the high and low water lines, from your map, they may require.

19. The size of the scale upon which the survey is made will determine the degree of minuteness in the noticing and measuring of the details. The scale of 1/10,000, and still more that of 1/5,000, admit any details whatsoever.

9. In the supplemental instructions for planetable surveys issued by Hassler Sept. 7, 1840, the following is stated with respect to this item: "6. On the sea shore and the rivers subject to the tide, both lines of the high and the low water must be marked as near as possible, because this is not always possible to be done by the sounding parties; therefore in this part of the work, it is proper for the two parties to work together conjointly, and according to distinct agreement, or everyone to work according to his best knowledge, and compare afterwards."

20. The distinction and limitation between woods and cultivated lands are sufficiently permanent in that part of the country which falls within the Coast Survey at present to require the determination of the limits of the woods by more or less actual measurement: this must therefore be done.

21. You will distinctly mark and distinguish on your map the different kinds of culture of the open land: namely, the upland or grain land—the meadows, whether fresh or salt and the marshes of whatever kind.

22. The woods and bushy land can be well distinguished from one another; and the kind of wood or timber must be written on the spot that it may be attended to in the finished drawing of the maps.

23. The distinction between the culture of grain land and meadows, and the orchards, gardens, homesteads, etc. are to be indicated—the fruit trees and forest trees being marked by their different distinct forms.

24. The houses, gardens and outhouses, and all similar domestic establishments, are to be marked in their proper form by introducing into the drawing a sketch made at the place itself: the ability of estimating small distances, and of drawing by the eye will assist greatly in introducing them without much measurement whilst upon the spot. The dwelling houses are to be represented fully black, and the barns, outhouses and the like, thus ☒, for distinction sake.

25. All the details of known marks of pilot directions, principal churches and buildings are to be noticed with more or less accuracy or measurement according to their importance.

26. All improvements of dams, draining by ditches and similar works, the bye-roads through the woods, etc. are to be determined and followed up in their course with more or less accuracy according to their importance—the latter may lead to farms and other improvements of interest often of more extent than supposed.

27. The width of all roads must be measured and laid down—and where a road widens or contracts must always be shown.

28. Whenever regular maps of cities, towns or villages have been published they are to be procured, if possible, and inserted in the map under execution by means of such points as are determined by the secondary triangulation or plane table operations; should these points, which are usually churches or principal buildings, not be on the published map, they must be introduced on it with all possible accuracy by visiting their location and taking or procuring all necessary measurements. Whenever there is no such map, a survey of the main streets is necessary and the houses etc. will then be easily introduced in the same manner as given for farming establishments etc.

29. The delineations of the mountains, hills, declivities, rocks and all similar, so called, *accidents* of the ground, are to be introduced at the place itself by the eye whilst they are in presence of the surveyor, according to the regular principles adopted for the hachures.

30. The horizontal curves of equal elevation must always be described as near as possible by the eye, from the aspect of the hills; and the equidistant adopted, according to the scale, must be the same throughout the whole of the map: the tracing of the curves should always be done when the surveyor is on the ground.

31. In the representation of all topographical details you will follow strictly the conventional signs furnished you; and in writing the names of the different objects on your map you will conform as near as possible to the character and size of the letters given in the table accompanying the signs.

32. All these details when well executed will give to the resulting map that character of care and attention which it is absolutely necessary our works should have.

706-026 O-64—13

33. In order to secure all these topographical details, it is requisite that the pencil lines be drawn in Indian ink always near the spot—that is before any one encampment is left for the next one, in order that in any case of doubt it may be easy to verify the doubtful parts, and in general adapt the drawing closer to the reality by the objects being fresh in memory and still, either under the eye or easily accessible.

34. The days on which no field work can be done will be devoted to the drawing in ink, but if none should occur for some time it will be better to cease outdoor operations for a few days in order to secure in ink what is already done and avoid too great an accumulation of work in pencil and the effacing of the pencil lines.

35. The survey must always be conducted with the chain, and the "Method of intersections," and sketching by the eye the contours of shore lines, marshes, etc. must never be resorted to except where it is not possible to get along with the chain, or where a large extent of straight sandy or marshy sea coast exists, and then the points fixed by intersections should not exceed 400 metres when the scale of the survey is 1/10,000, and the like ratio inversely for all other scales.

36. When the parties break up at the end of the season, all the instruments, chains, etc. in whatever state they may be, belonging to the Coast Survey collection are to be brought or sent safely (always accompanied by some one of the party) to the office of the Coast Survey, as well as for accidental repairs and revision as for safe keeping, and these delivered to the assistant in charge of the topography.

37. The camp equipments, utensils and other implements will be lodged in the neighborhood of the station or camp last occupied under safe shelter and with responsible people.

38. At the end of each month you will communicate to the assistant having charge of the topography the place of your encampment and nearest post office.

39. You will make requisition upon the disbursing officer for whatever funds may be necessary to enable you to execute your operations, and send him, at the end of each month, an abstract of your disbursements accompanied by the vouchers. Economy is recommended in all your operations.

40. You will keep a diary, in which you will enter your daily occupation, the state of the weather and all occurrences that may happen of interest to the work.

421. Rules for Representing Topographic Features

Mention should also be made of a published pamphlet entitled "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey," which appeared in 1860.[10] While intended primarily to set the practice for the finished charts, the pamphlet contains discussions of certain features shown on topographic surveys and may be considered as representative of the practice of that period (*see* 4461). A large part of the pamphlet was reproduced as Appendix 20 to the Annual Report for 1860. Pages 216 to 222 of the report contain the pertinent data.

10. Reference to the correspondence of 1859 and 1860 shows that the material was prepared largely by Henry L. Whiting, an expert topographer.

43. THE FIRST TOPOGRAPHIC SURVEY

Although the organic act authorizing a survey of the coast was approved in 1807, actual work for triangulation was not begun until 1816. Congressional action caused a break until 1832 when work was again resumed.

The first topographic survey was made in 1834 (Register No. T–1) and covered the north shore of Great South Bay, Long Island, from Patchogue to Babylon. This is fairly typical of the topographic surveys of this period, although some departures in the treatment of certain features might be noticed on surveys made by different topographers. The details represented included the shoreline, roads, the limits of marshy and woodland areas, and individual buildings. The symbols representing the wooded areas were tinted green and the marsh areas blue.[11]

In considering these first surveys, it is important to keep in mind that this was the formative period of the Survey's existence, and standards of accuracy and definitive procedures had not yet been established. The amount of detail included by one topographer may have differed from what another topographer included. The importance which a surveyor attached to a given area was also a contributing factor to the amount of detail he included in his survey and was generally reflected in the extent to which minor convolutions in the shoreline were delineated. Of interest, in this connection, is the following commentary on Mr. Renard's topographic survey of 1837 (Register No. T–13):

> To be sure, the topography of those days differed very materially from that of later years. There was no contouring, the hills being indicated only by hachures and comparatively little close detail being given. As optical methods for distance measuring had not then been introduced and it was necessary to depend upon chaining when direct measurements were wanted, particular objects needed for the control of detail were usually fixed by intersections from two or more stations and there was far greater freedom in sketching details than is now usual. And Mr. Renard had the reputation, among some of his contemporaries, of stretching that freedom of delineation to an extent even then unusual.[12]

The above was true even in later years and ofttimes adjoining topographic surveys by different topographers exhibit differences in representation in the common area, particularly along a marshy shore. An example of this is found at the junction of Register No. T–1471*b* (1879) and Register No. T–1482*b* (1878).

11. In the same year, a survey was also made of Fire Island Beach on the south shore of Great South Bay (Register No. T–479).

12. HASSLER'S ADMINISTRATION (Part I) 86. This material is in typescript form and is unauthored and undated. It is filed in the Survey library and is identified as USCGS/.091/1921–2.

But apart from the personal interpretation of the individual topographer, many of the early surveys exhibit a generalization that is not evident on the later surveys. This may be attributed to the fact that during the first 10 years of the topographic work of the Bureau, several of the best features of the planetable were ignored in practice. Only the most salient points of the shoreline were delineated and located with any degree of accuracy, the bights and coves being sketched with the greatest freedom.[13]

Two factors contributed to this failure to take full advantage of the planetable as a mapping instrument. One was the use of the chain for measuring distances, which under the best of conditions was a slow process; the other was the fact that the graphic solution of the three-point problem for the determination of planetable stations had not yet become standard topographic practice.

431. Accuracy and Detail

It was stated in an earlier chapter that in the early days of the Coast Survey, when so much surveying was to be done and there was pressure to get out charts of the country's uncharted shores, it was only natural that some of the relatively unimportant areas would be surveyed with what today would be considered no more than reconnaissance accuracy (*see* 11). But excluding these, and surveys made during the very earliest period of the Bureau's work prior to the standardization of procedures, there were always certain prescribed standards of accuracy to which the work had to conform. If the work was done at all, it was done with that accuracy. But accuracy is not to be confused with detail. One topographic survey may show all the waterways tributary to the main waterway, whereas an earlier survey may have omitted them, thus lacking the detail of the later survey. But insofar as the main waterway was concerned both surveys could be of comparable accuracy. The difference between the two terms can better be illustrated by a hydrographic survey. A sparseness of soundings in an area of no navigational importance would simply mean that the survey in that area lacked detail, but the soundings that do appear in that area were obtained with the same degree of accuracy as they were in the fully sounded main channel.

13. Wainwright, Plane Table Manual 13, Special Publication No. 85, U.S. Coast and Geodetic Survey (1922).

44. FEATURES LOCATED ON TOPOGRAPHIC SURVEYS

441. The High-Water Line

The most important feature on a topographic survey is the high-water line. It is the line that is used on the nautical charts of the Coast Survey as the dividing line between land and water; the line that indicates whether the coast is building out or receding; and in most states it defines the seaward limit of riparian ownership.

Nautical charts are intended primarily for use in navigation. The limit of land and water is the most striking outline that exists in nature, and is shown as the strongest and most conspicuous line of boundary on the chart. From its delineation, the navigator is frequently able to identify his position along the coast. This line is therefore surveyed accurately, that is, as accurately as is consistent with economy and the purpose for which the survey is intended (*see* 4422).

4411. *Basis for Using the High-Water Line*

There are many reasons why the high-water line is preferred to any other tidal boundary for the dividing line between land and water on nautical charts, and hence on the topographic surveys of the Bureau. Among these are the following:

(*a*) The nautical chart depicts the land area and the water area. The most logical division is the high-water line because this includes all land not covered by the mean tidal range. It represents the line of permanent emersion of the land area. Seaward of this line is an area of alternate emersion and immersion. Seaward of the low-water line is the area of permanent immersion. Any line in between high water and low water could not be considered the dividing line between land and water since at some time during the tidal cycle the area inshore of that line would be covered by water.

(*b*) To the mariner, the high-water line gives the truest conception of the appearance of the shore, inasmuch as it generally represents the limits of vegetation.

(*c*) In taking bearings to distant points of land, the mariner can better identify the approximate high-water line than he can any other line between high and low water. Also, on a bold coast, the elevations of objects, such as lighthouses, if referred to a high-water datum, is a safety factor for the mariner when locating his distance from shore by angles of elevation to such objects. (The same measured angle would give a distance nearer to shore than if the elevation were reckoned from sea level.)

(*d*) From the standpoint of the surveyor, the high-water line is the only line of contact between land and water that is identifiable on the ground at all times and does not require the topographer being there at a specified time during the tidal cycle, or the running

of levels. The high-water line can generally be closely approximated by noting the vegetation, driftwood, discoloration of rocks, or other visible signs of high tides (*see* 4421).

(*e*) The treatment of isolated rocks along a coast is an important consideration on a nautical chart. If a tidal plane other than high water were used, for example mean sea level, some rocks would be shown as bare rocks which during half the tidal cycle would be covered with water. This would not only be a misrepresentation of their character under normal conditions, but would be a danger to navigation because misleading to the navigator. For example, a rock that projects 8 feet above low water in an area where the range of tide is 10 feet, would be shown as a rock baring 3 feet if the plane used were mean sea level—in other words, as visible at all times. Yet a mariner who was in the vicinity of the rock when the tide was 8 feet or more above low water would see no rock at all. For the same condition but using a high-water datum, a rock awash symbol would be shown and the navigator would not expect to see the rock at some stages of the tide.[14]

(*f*) The same reasoning that dictates the use of a low-water datum for soundings (*see* Part 1, 2321 B(*b*)) is applicable to rocks and a high-water datum but in reverse form; that is, the chart should never show a rock as always projecting above water that the mariner would find covered at some stage of the tide.

(*g*) Any other datum below high water would also contravene the generally accepted definition of an island as "A body of land extending above and completely surrounded by water at mean high water." [15] If mean sea level were used as the datum, there would be cases, as with rocks, where an island would be charted, although covered with 1 or 2 feet of water at mean high tide. It would be a contradiction to call such a piece of land an island.

(*h*) The above technical reasons for the use of the high-water line on charts also fit in with the legal concept of the boundary between public and private lands as developed through the common law of England and which has become a part of American jurisprudence. At common law, the line of ordinary high water was the limit of the rights of the Crown to the shore. The principle back of this was that it was land not capable of ordinary cultivation or occupation. Conversely, land inshore of that line was capable of cultivation and therefore was considered to be the subject of private ownership. It was also stated that the basis for rejecting the line of the high spring tides as the dividing line between Crown lands and private lands was "that such lands [lands covered by the high spring tides] are for the most part dry and maniorable." [16]

442. The Line of Mean High Water

Thus far, the term high-water line has been used in a very general sense, without regard to variations in this line due to the types of tide that prevail along

14. At the Seventh International Hydrographic Conference, held at Monaco in May 1957, it was proposed that a datum lower than mean high water be used on nautical charts as the dividing line between land and sea. The proposal failed of adoption. The United States delegation, representing the Coast and Geodetic Survey and the Hydrographic Office of the Navy Department, opposed the change. *Report of Proceedings* 64, 147, *Seventh International Hydrographic Conference (1957)*.

15. Mitchell, Definitions of Terms Used in Geodetic and Other Surveys 41, Special Publication No. 242, U.S. Coast and Geodetic Survey (1948).

16. *Attorney General* v. *Chambers*, 4 De G. M. & G. 206, 218 (1854). The common-law rule is applied in most of the states. In a few, it has been modified by statute to extend private ownership to the low-water line.

our coasts (*see* Part 1, 232). It is therefore important to define with greater exactness the nature of the line actually surveyed.

The topographic instructions for planetable work under which the Bureau now operates call for "The careful location of the mean high water line (not considering storm-high water)." [17] And generally, this has been the practice from a very early period. In the first planetable manual, it is stated: "It is always best to determine the high and low water lines, both at spring and neap tides." [18] This is interpreted to mean that from these determinations an approximate mean high-water line could be delineated.

The first specific instruction regarding the nature of the line to be surveyed is contained in the "Plane Table Manual," published as Appendix 8 to the Annual Report of 1898. It is there stated, at page 455, that "In tracing the shoreline on an exposed sandy coast care should be taken to discriminate between the average high-water line and the storm-water line." A similar instruction has been included in every subsequent edition of the planetable manual.

In the treatise on the planetable included as Appendix 13 to the Annual Report of 1880, no mention is made of the line to be considered the shoreline, but in discussing the plane to be used for elevations the following statement appears at page 189: "Probably the best reference for heights of points on the earth's surface is to the mean level of the sea, since the mean of any rise and fall of the tides is approximately this level. In practice, however, mean high water is usually taken, as this includes all land not covered by the tide range, and is the line dividing land from water."

It is therefore reasonable to assume that on all of our topographic surveys the intention was to delineate, as near as it was possible to determine without recourse to leveling, the line of mean high water. It remains, then, to inquire how the topographer identified such line on the ground.

4421. *The Surveyed Line*

As was explained in Volume One, Part 2, 1613, different types of tide prevail along the coasts of the United States. It was shown that along the Atlantic coast two high waters occur each day but with very little variation in the two heights, while along the Pacific coast there is a marked difference between successive high-water heights. Along either coast, the plane of mean high water at

17. SWAINSON (1928), *op. cit. supra* note 3, at 5.
18. Annual Report, U.S. Coast Survey 219 (1865).

any place has been defined technically as "the average height of all the high waters at that place over a considerable period of time." [19]

High water is the maximum height reached by a rising tide. The height may be due solely to periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. The rise and fall of the tide varies from day to day. For the most part, this variation is of a periodic nature related to the positions of the sun and moon relative to the earth. The variation in rise and fall results in varying heights for high water and low water. The term "high water" should not be confused with the term "mean high water" (*see* note 19 *supra*).

The mean high-water line along a coast is the intersection of the plane of mean high water with the shore. This line, particularly along gently sloping beaches, can only be determined with precision by running spirit levels along the coast. Obviously, for charting purposes, such precise methods would not be justified, hence, the line is determined more from the physical appearance of the beach. What the topographer actually delineates are the markings left on the beach by the last preceding high water, barring the drift cast up by storm tides. On the Atlantic coast, only one line of drift would be in evidence. On the Pacific coast, however, with two high waters of unequal height, each leaving its own line of drift, the tendency of the topographer would be to delineate a line somewhere in between the two lines of drift. If only one line of drift exists, as when a higher tide follows a lower one, the markings left by the lower tide would be obliterated by the higher tide and the tendency would be to delineate the line left by the latter, or possibly a line slightly seaward of such drift line.

In addition to the above, the topographer, who is an expert in his field, familiarizes himself with the tide in the area, and notes the characteristics of the beach as to the relative compactness of the sand (the sand back of the high-water line is usually less compact and coarser), the difference in character and

19. MARMER, TIDAL DATUM PLANES 76, SPECIAL PUBLICATION NO. 135, U.S. COAST AND GEODETIC SURVEY (1927). This edition was cited by the Supreme Court in *Borax Consolidated, Ltd.* v. *Los Angeles*, 296 U.S. 10, 26 (1935), in defining ordinary or mean high-water mark along the California coast. In the 1951 edition of Tidal Datum Planes, at page 86, the definition of mean high water has been changed slightly so as to make it of more general application. The definition now reads: "Mean high water at any place may be defined simply as the average height of the high waters at that place over a period of 19 years." For a discussion of the *Borax* case in relation to the term "ordinary high-water mark," *see* Volume One, Part 1, 6413.

color of the sun cracks on mud flats, the discoloration of the grass on marshy areas, and the tufts of grass or other vegetation likely along the high-water line.

4422. *Accuracy of Determination*

The accuracy of the surveyed line here considered is that resulting from the methods used in locating the line at the time of survey. It is difficult to make any absolute estimate as to the accuracy of the early topographic surveys of the Bureau. In general, the officers who executed these surveys used extreme care in their work. The accuracy was of course limited by the amount of control that was available in the area.[20]

With the methods used, and assuming the normal control, it was possible to measure distances with an accuracy of 1 meter,[21] while the position of the planetable could be determined within 2 or 3 meters of its true position. To this must be added the error due to the identification of the actual mean high-water line on the ground (*see* 4421), which may approximate 3 to 4 meters. It may therefore be assumed that the accuracy of location of the high-water line on the early surveys is within a maximum error of 10 meters and may possibly be much more accurate than this. This is the accuracy of the actual rodded points along the shore and does not include errors resulting from sketching between points. The latter may, in some cases, amount to as much as 10 meters, particularly where small indentations are not visible to the topographer at the planetable.

The accuracy of the high-water line on early topographic surveys of the Bureau was thus dependent upon a combination of factors, in addition to the personal equation of the individual topographer. But no large errors were allowed to accumulate. By means of the triangulation control, a constant check was kept on the overall accuracy of the work.

20. In the 1865 Annual Report of the Survey, at page 229, the following statement is made with regard to the accuracy that was attained in military reconnaissance work during the Civil War: "At Chattanooga, from two different bases of about half a mile each, plotted on separate sheets, and measured once carefully with the common 20-metres chain, the same chain being used for both measurements, after considerable intermediate plane-table triangulation carried on by two officers, two objects were determined two and a half miles apart, common to both sheets, which were on a scale of 1–10,000, and the discrepancy was but about 15 metres. Many other points of junction indicated this to be the maximum error. In this case the leaves were mostly off the trees, and the hills afforded good points. The sheets covered about 20 square miles each. At Nashville there was a discrepancy of about 10 metres in two miles. This would not do, of course, in finished work, but it is very close under the circumstances."

21. Annual Report, U.S. Coast and Geodetic Survey 192 (1880).

443. High-Water Line in Tidal Marshes

4431. *Formation of Marsh*

In areas of tidal marshes, a different procedure was followed. Marsh is a product of the shallow water of lagoons and other sheltered localities. It usually results from the deposit of sediment on the bottom, which is thus built up to a point where certain kinds of vegetation can take root. The presence of this vegetation accelerates the upward building by its own decay and deposit upon the bottom and by intercepting fine sediment in the waters causing its deposit. During the early stages of the marsh, grass may even grow so rankly that it will rise above the water surface when the ground in which it grows is still below the plane of low water. When marsh building has progressed to a stage where the level is somewhere between high and low water, waves and currents attack its seaward edge, forming a small vertical cliff here. This is a characteristic feature of marsh in this stage of development. The marsh continues building, somewhat more slowly, until ultimately it is dry all the time or substantially all the time. It is then known as meadow. Unless there is some evidence on the survey, it must be assumed in the case of marsh that the high-water line has not been determined.[22]

4432. *The Surveyed Line—Outer Edge of Marsh*

Obviously, it would be an extremely difficult task to identify the actual high-water line in marsh areas. The marsh may be in various stages of growth, from its early beginnings, when it is mostly in a submerged stage, to its latest development, when it is close to or slightly above the plane of high water. Between these two extreme conditions, marsh areas may be entirely submerged at low water, may be exposed at low water and submerged at high water, or may be partially exposed at high water. From the standpoint of the Bureau's topographic surveys, this means that where there are marsh areas, the actual high-water line might start at the water's edge in one portion of the marsh and meander through the area in irregular fashion, terminating at another portion at the water's edge or at the edge of firm ground in the interior.

22. This statement on marsh formation is paraphrased from testimony given by R. S. Patton, while Chief of the Chart Division (later Director) of the Bureau, in the case of *Best Renting Co.* v. *City of New York*, 162 N.E. 497 (1928). Involved was the question whether under a deed from the Crown conveying land, including all marshes and creeks, the land of the plaintiff was included in a grant as meadows or marshes. Material on tidal marshes can be found in Annual Report of the U.S. Coast Survey 82–86 (1869); in Nesbit, Tide Marshes of the United States, Misc. Special Report No. 7, U.S. Department of Agriculture (1885); and in Johnson, The New England-Acadian Shoreline 517–561 (1925).

In surveying such areas, the Bureau has not deemed it necessary to determine the actual high-water line but rather the outer or seaward edge of the marsh, which to the navigator would be the dividing line between land and water.[23] Therefore, from the topographic survey alone, and in the absence of any corroborating collateral information, no conclusion could be drawn as to the exact location of the high-water line, nor as to the condition of the marsh area with reference to the tidal plane of high water; that is, whether the ground itself was above water, or whether only the marsh grass was above water, and the ground below water at the time of high tide.

Where the topographic or hydrographic survey shows a low-water line outside the marsh line it would be a safe indication that the marsh at its outer edge was above low water, but it would still be no indication as to the condition of the marsh with respect to high water unless determined by other evidence (*see* 4433).[24]

(*a*) *Modern Practice.*—On modern planimetric, shoreline, and topographic manuscripts, where the actual shoreline is obscured by marsh grass, mangrove, cypress, or other similar marine vegetation, the outer edge of the vegetation is mapped as an *apparent shoreline* and is shown by a thin, solid line, the change from the line marking the actual shoreline being abrupt and not gradual.[25]

4433. *Condition of Marsh—Evidence From Collateral Sources*

An important source of information that sometimes throws light on the condition of the marsh area, with respect to the tide, is the contemporary hydrographic survey. This is illustrated in figures 42 and 43. Figure 42 is a section of Register No. T–1482*b* (1878), a topographic survey of Jamaica Bay, Long Island. It will be observed that in the vicinity of "Craft's Dock," both to the north and to the southeast, the outer edge of the marsh is indicated by the usual solid line, with the conventional marsh symbol inshore. Standing alone, no definite conclusion is possible regarding the stage of development of

23. On most of the early surveys, no distinction was made between this line and the line of high water on fast ground. Beginning with 1938, the shoreline marking the outer edge of marsh, mangrove, or cypress swamps was shown by a fine solid black line to distinguish it from the high-water line on fast land which is shown by the standard weight solid black line, the change from one to the other being made abruptly. *Field Memorandum No. 1 (1938)*, 12 FIELD ENGINEERS BULLETIN 241, U.S. COAST AND GEODETIC SURVEY (1938).

24. Register No. T–1392 (1875) (Newport Bay, Calif.) is a good example of such condition. Where the topographer has delineated a low-water line in some areas but showed a merger with the edge of the marsh in other areas, the presumption would strongly favor the existence of a vertical cliff (*see* 4431). This is exemplified by Register No. T–892 (1859) (San Gabriel River, Calif.) (*see* fig. 44).

25. SWANSON, TOPOGRAPHIC MANUAL (Part II) 338–341, SPECIAL PUBLICATION No. 249, U.S. COAST AND GEODETIC SURVEY (1949).

the marsh, whether late or early. All that can be said is that the high tide covered the area of the marsh to a line somewhere between the outer and inner limits. An examination, however, of Register No. H–1392 (1878), the contemporary hydrographic survey of the area (*see* fig. 43), discloses two lines of soundings crossing the area indicated as marsh on the topographic survey. The soundings, reduced to the plane of mean low water, range from zero to minus ½ foot, which means that the bottom of the marsh varied in elevation from zero to ½ foot above the plane of mean low water. With an average range of tide of about 5 feet, the relation of the marsh to the plane of high water becomes readily apparent.[26]

On the more recent surveys, clarifying information may frequently be obtained from the "Descriptive Reports" that accompany the surveys (*see* 1242). This is illustrated by an examination of Register No. T–4456 (1929), a topographic survey of the south shore of Chesapeake Bay. Along the north shore of one of the waterways on the survey, a marsh area is indicated which is bounded on its outer edge by a solid black line, the symbol for the high-water line, and at its inner edge by a growth of grass, brush, and trees. Here again it would be impossible to determine the character of the marsh, in relation to the stage of the tide, from a mere physical examination of the survey sheet. But in the accompanying Descriptive Report, this pertinent information is found: "The northerly shore line of Long Arm from the highway bridge to the log bridge is a continuous grassy marsh of varying width as shown and *covered at high tide by water from one-quarter to one foot in depth.*" (Emphasis added.) This is further clarified by the following general note in the report which is applicable to all references to marsh areas on the survey: "Note 1: In the preceding discussions of details the statement that a marsh is submerged or covered by a certain depth of water at high tide, is intended to convey the idea that the ground and not the grass is covered. In no place where grassy marsh is shown is the grass or seed growth covered by water."

In one of the great marsh expanses along the Massachusetts coast, much light was thrown on the interpretation of the outer marsh line by the statement that "while the outer edge of the marsh as shown on this sheet is a definite line at about half tide the line of demarcation between marsh and water at high tide is in most cases considerably further inshore and not well defined."

26. An excellent illustration of the value of the contemporary hydrographic survey in determining the elevation of marsh areas is Register No. T–967 (1860). An examination of Register No. H–790 (1861) shows the corresponding areas with minus soundings ranging in elevation from 0 to 5 feet (with a 6-foot range of tide) indicating the marsh area to be above low water but below high water (*see* 5621).

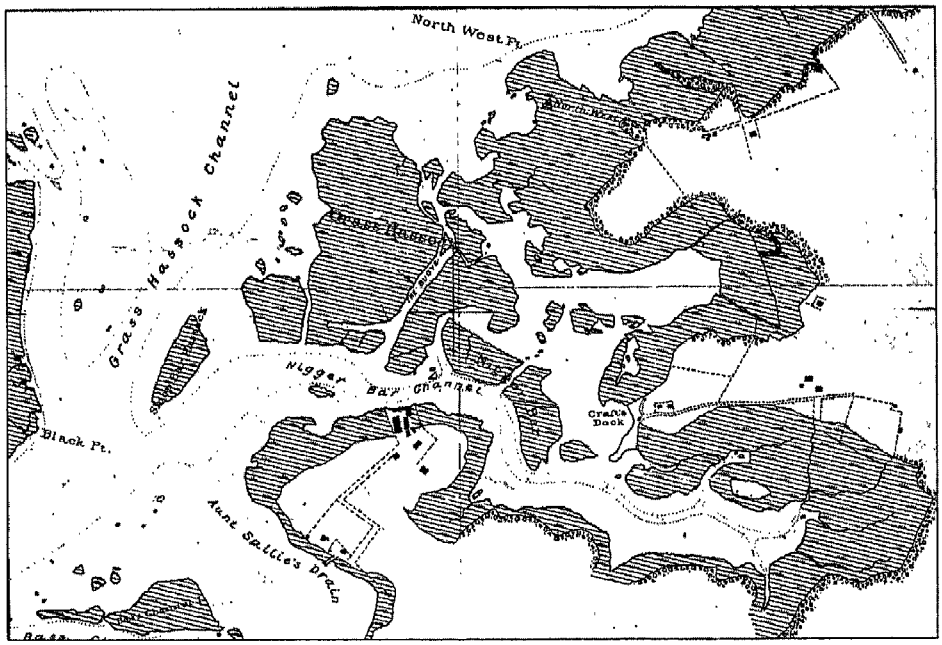

FIGURE 42.—Portion of topographic survey of 1878.

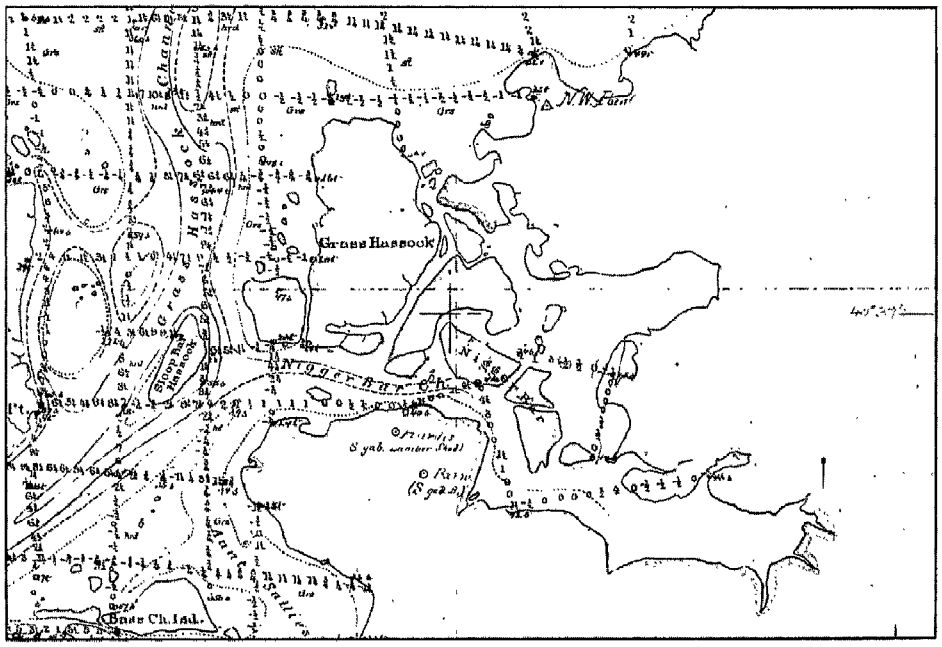

FIGURE 43.—Contemporary hydrographic survey of area shown in figure 42.

While in the cases cited, the collateral information tended to prove that the outer edge of the marsh line was below high water, the same sources may often disclose evidence which shows that the marsh was in a later or meadow stage of development. If the records for the contemporary hydrographic survey showed that the sounding lines were run at high water or nearly high water and the lines stopped short of the outer edge of the marsh, it would be strong indication that the survey boat could not penetrate beyond the outer edge because there was not enough water to float it. It is not uncommon to find such notes in the sounding records as "boat aground" or "end of line on beach" which would throw additional light on the status of the marsh area.

Other collateral sources may be the descriptions of the old triangulation stations in the area,[27] if such exists, which sometimes were quite elaborate as to description and sketch, or the annual reports of the Bureau, which in the early days included considerable information regarding certain individual surveys.[28]

While not necessarily related to the condition of marsh growth with respect to the plane of reference, aerial photographs, particularly infrared and color photographs, if available, should always be examined for possible clarifying information as to some detail on the planetable survey (*see* Part 1, 2232). Aerial photographs furnish a fruitful source of information for ground details because the camera with its view from above registers a complete picture of the terrain below, whereas the planetable topographer is limited in any instance to what he can see from the point where he stands. Differences in detail between a planetable survey and a later photogrammetric survey from aerial photographs must be carefully evaluated to determine whether such differences are the result of changes or are due to omissions.

27. On the early surveys, the symbol for a main triangulation station was a triangle, but for a secondary station it was a small circle (*see* 42, par. 8).

28. The survey itself may contain information from which a deduction can be made as to the character of the marsh at a given date. In a case involving an area in Jamaica Bay, the following testimony was adduced from an official of the Coast Survey (*see* note 22 *supra*) in answer to the question: "Now, drawing your attention to this ink line on Plaintiff's Exhibit 4, and particularly with reference to the word 'Marsh,' would you say that as far as that map shows that piece of land marked 'Marsh' might be below low water?" A. "There is one indication there which leads me to believe that that particular marsh was in the meadow stage, bare at—certainly—there is no question of it being bare at low water, but very probably bare at high water. That indication is this, on the righthand side of that area, you find a straight line which indicates the limit of the artificial dredging. That is not a natural shore line. That would be my inference, that it is the result of dredging. The fact that the area designated as 'Marsh' extends to that line and is not separated by a boundary similar to this, leads me to infer, and it is only an inference, that it has not been necessary to fill in the section just to the left of that line in order to have a boundary or a formation which would retain the waters in the channel at all stages of the tide and prevent it spreading over here. In other words, if it had been necessary to deposit material here in order to limit the channel, there would probably have been an indication similar to this (indicating)." From Transcript of Record on Appeal, *Best Renting Co.* v. *City of New York*, *supra* note 22, at 266.

444. Inner Edge of Marsh

On many of the early topographic surveys, the inner or landward limits of the marsh (the line separating the marsh from the fast land) are shown variously by "a continuous line, a dotted line, or by a continuous line with short hachures at right angles to it, by lone hachures or ends of the parallel lines significant of marsh areas." [29] The Bureau has always interpreted such line as indicating merely the dividing line between the marsh land and the fast or upland, and not as representing any particular tidal elevation other than that inshore of this line the land is bare at all stages of the tide. Generally, it may be considered as the limit of penetration of the highest tides, but, as has been noted previously, in certain stages of marsh development it may coincide with the high-water line (*see* 4432).

The detail with which the line was surveyed depended largely upon its accessibility. Not being a feature readily seen by the mariner the tendency was towards generalization.[30] Where the dividing line between the two characters of land was inaccessible, as where the upland was heavily wooded or overgrown, or where marsh faded imperceptibly into meadow, the dividing line was altogether omitted and the transition shown by the appropriate conventional symbol.

Notwithstanding its use on some of the early surveys, the representation of the inner edge of the marsh by a definite line was never a requirement until the publication of the Topographic Manual of 1928 when it was made permissive by the instruction that "The inner edge of the marsh (the limit of submergence at high water) when clearly defined may be drawn by a line distinctly lighter than the high-water line." [31] The parenthetical phrase used here should be considered as a very general definition of the "inner edge of the marsh" and not as referring to an exact tidal plane (*see* 4432).

29. From letter of F. C. Donn, a field and office man, to the chairman of the topographical conference convened in 1892 by the Superintendent of the Coast Survey (*see* 465). Annual Report, U.S. Coast and Geodetic Survey (Part II) 610 (1891).

30. In all references to the inner edge of marsh or fast land in the early manuals, the discussion deals with the inking of the topographic sheet (by appropriate conventional symbols) and not with the surveying aspect. But it may be concluded that there was no intention that the dividing line be located with great accuracy and detail the value of which would be vitiated by a generalization in the final inking. Annual Report, U.S. Coast Survey 218 (1860), and Wainwright (1922), *op. cit. supra* note 13, at 66. Occasionally, however, as a result of the judgment of the individual topographer, the inner edge of the marsh was very carefully delineated. For example, on Register No. T–1369 (1874), the dividing line between the inner edge of the salt marsh and the outer edge of the fresh marsh is shown by a continuous fine black line. A note in the early correspondence (Jan. 2, 1875) states that "Care was taken to delineate exactly the division line between salt and fresh water marsh, a point that may be of future value in land dispute."

31. Swainson (1928), *op. cit. supra* note 3, at 9. But at page 93 it is stated that "Neither the inner border of a marsh nor a shoal covered at high tide has a distinct continuous line to mark its limits, each being represented in its proper form and within its area by its conventional symbol only."

This practice of using a definite line for the inner edge of the marsh was reversed in 1938 by *Field Memorandum No. 1, supra* note 23, at 242, which provides in part that "The edge of high ground at the back of the marsh, mangrove and cypress areas shall be indicated by symbols only . . . and *not* by a fine line."

The practice in 1949 was to show the inshore limits of marsh by a broken blue line on planimetric and topographic manuscripts, but by conventional symbols on shoreline manuscripts.[32]

445. Marsh Areas Mostly Flooded at High Water

A feature frequently encountered on topographic surveys is a marsh representation (with solid or broken horizontal rulings), without a solid bounding line. This is interpreted to indicate that there existed no well-defined edge at high water which the topographer could consider the dividing line between land and water. What he saw was a marshy area mostly flooded at high water. Such formations are characteristic of marsh in the early stages of development and may be found contiguous to a well-defined marsh or outside the high-water line. The elevation of the ground in such cases is below high water and usually below low water, although scattered tufts of grass may in places protrude above high water.

The earliest reference to such formations was contained in the treatise on the planetable published in the Annual Report of 1865. They were referred to as "grassy shoals" and "grass upon flats, or shoals covered at high tide," and were described as "always found in water scarcely agitated by waves or currents." They were to be shown on the finished topographic sheet without a "distinct continuous line to mark their limits, each being represented in its proper form and within its area by its conventional sign only, but the shape should be well and correctly defined." [33] This practice is still continued on planetable surveys [34] and on photogrammetric surveys.[35]

The same collateral sources mentioned in 4433 should be examined for additional information regarding the condition of such marsh areas with respect to the tidal plane.[36]

32. Swanson (1949), *op. cit. supra* note 25, at 340, 343.

33. Annual Report, U.S. Coast Survey 220, 230 (1865). Appended to this report, as Sketch No. 32, is a composite drawing of the eastern end of Deer Island and shows the method of representing such marsh areas. (*See* fig. 49.)

34. *Field Memorandum No. 1 (1938), supra* note 23, at 241.

35. Swanson (1949), *op. cit. supra* note 25, at 343.

36. *See*, for example, Descriptive Report for Register No. T-5976 (1949). There have been instances where such marsh formations have been enclosed by a dotted or pecked line (*see* Register No. T-1115 (1869)). This is interpreted to be a cartographic expedient rather than a distinction from those areas shown without such enclosing line (*see* contemporary hydrographic survey Register No. H-1064 (1869), and representation on recent topographic survey of same area, Register No. T-5976 (1949)).

From a study of successive topographic and hydrographic surveys, the progressive development of a marsh area with relation to the tide can be traced. This is important in determining ownerships of a past date, especially where the land has become bare at high water either through natural processes or through artificial development.

446. The Low-Water Line

A feature on topographic surveys which frequently assumes significance for purposes other than charting is the low-water line. One reason for this is that in some of the states the tidelands (lands between high and low tide) are subject to alienation by the state.[37] Many of the grants to such lands were made years ago prior to waterfront improvements, and it frequently becomes important to know where the low-water line was located at the time of the grant or as close thereto as possible. The hydrographic and topographic surveys of the Bureau often provide the only authentic evidence available.[38] In using these surveys, it is essential that a proper understanding be had of the method of surveying such line, the accuracy with which it is determined, and any other information that would tend to throw light on its delineation on the survey sheet.

4461. *How Determined*

Both to the hydrographer and the topographer, the low-water line is one of the most uncertain and difficult features to delineate. Unlike the high-water line, it is actually visible but momentarily to the topographer. If located by the hydrographer it must generally be accomplished when the height of the tide is well above low water, making it difficult to develop readily its many irregularities. It was, therefore, recognized at a very early period in the work of the Coast Survey that the determination of the low-water line must be left for its final delineation to both parties, "everyone to work according to his best knowledge, and compare afterwards."[39] This provision was, of course, never interpreted to mean that the low-water line on both surveys must be made to agree (an examination of a number of the early surveys supports this conclusion), but

37. In *Oakland* v. *Buteau,* 29 P. 2d 177 (1934), the Supreme Court of California defined the "line of ship channel" as the line of "ordinary low tide."

38. Although riparian ownership in this country extends generally to high-water mark, in a few states it extends to low-water mark. In Massachusetts, for example, by virtue of a 1641–1647 ordinance, the title of the owner of land bounded by tidewater extends to low-water mark where the sea does not ebb beyond 100 rods (1,650 feet). *Commonwealth* v. *Alger,* 61 Mass. 53, 67–81 (1853).

39. "Addition to the Instructions lately given for the planetable surveys of the Coast Survey," dated Sept. 7, 1840, and filed in volume (17) of correspondence marked "Coast Survey, Scientific, 1844–1846."

rather that the chart compiler, cognizant of the limitations of both methods of surveying, should use his best judgment in selecting the portion to be taken from each survey for the delineation and location of the low-water line on his chart.

In the pamphlet on "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey," published in 1860 (*see* 421),[40] the following pertinent observations are made on the difficulties surrounding the determination of the low-water line in the field:

> There are circumstances and cases where the topographical survey could not embrace all features of low water unless at great disadvantage and expense, and even then imperfectly and inconsistently with hydrographic results. On the other hand, the hydrography could not develop all the irregularities of low water by the ordinary process of field-work. In bays, coves, rivers, etc., where the character of the shore is irregular, the condition of the shore at low water generally corresponds to that of high water, and the points, islands, banks, etc., of such shores, afford facilities for the topography to determine the low-water line with rapidity and accuracy, with all minor details commanded and determined. The same degree of detail, however, could not be obtained by the usual hydrographic process of work.
>
> Shoals off-shore, in the middle of large sounds and bays and extensive flats, either connected or unconnected with the main shore, can be determined more favorably and economically by the hydrography. They come within the full scope of that work, and can generally be commanded by sounding lines and angles in a satisfactory manner. The position being remote from shore, often of soft and undefined substance, impracticable for occupied stations, makes the determination by the topographical parties difficult and objectionable.[41]

This idea has been reflected in every planetable manual, since the earliest in 1865, except the one included in the Annual Report for 1880.[42] In the Topographic Manual of 1928, provision for surveying the low-water line is included in the instruction that "The mean low water line should be delineated, but when it is beyond the reach of the plane table and presents no marked points for determination, or is of a character that will not permit the use of the instrument (as along the swampy shores in the South, where the muddy shoals are of great extent, and among the shifting quicksands of our great estuaries and bays), it may be left to be traced by the work of the hydrographic parties."[43] In addition, there is an instruction for "the careful location of . . . the low water line so far as the latter can be determined or estimated without waiting for low tide."[44]

40. There is only one complete copy of this pamphlet in the Bureau (*see* 462).

41. Annual Report, U.S. Coast Survey 220 (1860).

42. The reason for this omission, as well as for an absence of reference to other features of the survey, is that the 1880 manual was essentially a treatise on the planetable and its use, rather than a manual of topographic surveying.

43. SWAINSON (1928), *op. cit. supra* note 3, at 70.

44. *Id.* at 5.

It may therefore be inferred that whether expressed in the instructions or not, the intention was for the topographer to locate the low-water line as far as it was feasible for him to do so.[45] This conclusion is important in a consideration of the plane of reference used for the low-water line on the Pacific coast (*see* 4462).

4462. *Planes of Reference*

Along the Atlantic and Gulf coasts, where the diurnal inequality in the low waters is small and the plane of reference for soundings is mean low water, it must be assumed that the low-water line delineated on the topographic survey approximates mean low water. But on the Pacific coast, where the diurnal inequality in the low waters is quite pronounced, questions have arisen regarding the plane of reference for the low-water line on topographic surveys, that is, whether it approximates mean low water or mean lower low water.

Based on a detailed study of many topographic surveys, together with the contemporary hydrographic surveys, along the coasts of California, Oregon, Washington, and Alaska, and covering the period from 1850 to 1920, the conclusion was reached that the low-water line delineated on topographic surveys represents the topographer's estimate of the mean lower-low-water line rather than the mean low-water line. This necessarily results from the fact that in the determination of the low-water line on the nautical chart the compiler selected portions of the low-water line from both the hydrographic and topographic surveys whenever necessary (*see* 4461).[46] It would have been a contradiction for the topographer to delineate the *mean low-water line* when it was to be used on a chart where the plane of reference was *mean lower low water.* A comparison of topographic surveys with hydrographic surveys in lower San Francisco Bay bears this out.[47] The low-water line on the hydrographic surveys is well controlled by sounding lines that terminate at the shore so that minus soundings are available from which a mean low-water line can be plotted.[48] While the topographic low-water line is sometimes inshore and sometimes off-

45. An examination of many of the early topographic surveys shows a failure to locate the low-water line on many portions of the survey. The 1949 instructions for photogrammetric surveys state that "Features seaward from the high-water line, including the low-water line . . . are the mutual responsibility of both the photogrammetric survey and the hydrographic survey." SWANSON (1949), *op. cit. supra* note 25, at 507, 524.

46. On some hydrographic surveys, such as Register No. H–564 (1856) in San Diego Bay, where portions of the low-water line were not well controlled by soundings, the line was transferred from the topographic survey. This is also true of Register No. H–1256 (1875) in Newport Bay.

47. *See* Register No. T–664 (1857), Register No. H–628 (1857–58), Register No. H–629 (1857–58).

48. The hydrographic surveys show only zero soundings above the plane of reference, but by replotting some of the lines from the original records, soundings ranging from zero to minus 5 feet were available from which the mean low-water line could be ascertained.

shore of the hydrographic line, it does not approximate the mean low-water line and shows conclusively that the topographer was attempting to delineate a mean lower-low-water line. This is also borne out by surveys in Puget Sound. A comparison of the topographic survey with the contemporary hydrographic survey shows the topographic low-water line to correspond generally to the mean lower-low-water line on the hydrographic survey. It definitely does not correspond to the mean low-water line.[49] And on the 1913 topographic survey of Olympia Harbor (Register No. T–3379), there is a note "L.L.W. (Sketched)" which negatives any inference of a mean low-water line.

Further evidence that the topographer attempted to delineate a line based on the plane of reference for the soundings is had from a study of some "awash rocks" in Alaska. On one survey in Frederick Sound, where the plane of reference is mean lower low water, a rock was located by the topographer and marked as baring 8 feet at mean lower low water. This indicates that he was conscious of the plane of reference for the soundings. Had he been thinking of mean low water, his description of the rock would have also referred to this plane.[50] On a 1910 survey in Wrangell Narrows (Register No. T–3111), where the plane of reference at that time was 3 feet below mean lower low water (*see* 5644), "Spike Rock" is indicated as uncovering 1 foot at lowest low water (the approximate plane of reference). It was so interpreted in subsequent *Coast Pilots* which refer to the rock as "awash at extreme low water."[51] Had the topographer meant lower low water, then the rock would have uncovered 4 feet at the plane of reference and would have been in substantial variance with other sources of information for this feature.

Requirements for present-day photogrammetric surveys leave no doubt as to the low-water plane intended to be delineated. In the topographic manual it is stated: "The low-water line (designated as mean low-water line on the East Coast and as mean lower low water on the West Coast) shall be determined by office interpretation only when the aerial photographs have been taken at or near the time of low water."[52]

49. *See* Register No. T–1682 (1885) and Register No. H–1728 (1886). The plane of reference for the hydrographic survey was based on the mean of the lower low waters of a few days. This was later found to correspond to a plane 2 feet below mean lower low water. Allowance for this was made in the comparison.

50. *See* Register No. T–3687 (1917). This is also borne out by a comparison with the low-water line on the hydrographic survey of 1887 (Register No. H–1806).

51. This is also corroborated by a note on the hydrographic survey of 1881 (Register No. H–1525*b*) which reads "Rock with 1 ft. Uncovers at extreme low tides," and a minus 1 foot sounding on the hydrographic survey of 1884 (Register No. H–1616), although there is some uncertainty as to the exact plane of reference on these surveys.

52. SWANSON (1949), *op. cit. supra* note 25, at 341.

Where the mean lower-low-water line is delineated on the hydrographic survey by actual soundings, it would generally be expected to find the topographic delineation inshore of this line rather than offshore, unless it was an estimated location and not the line of contact between land and water that was visible to the topographer. This would follow from the fact that the times when the water level would fall below the plane of reference would be inconsequential when compared with the times when the water level was above the reference plane. However, in comparing surveys, the existence of a minus tide at the time the topographer surveyed the low-water line should not be ruled out.

4463. *Accuracy of Determination*

The low-water line on topographic surveys must necessarily be an approximation for the most part, coinciding but rarely with the actual low-water line. This is evident from the nature of the circumstances. Along most of our coastline there are two low waters in every tidal day, so that a low water occurs but once every 12½ hours. During a large percentage of the tidal cycle, the actual low-water line is not visible, the interval of visibility depending upon the slope of the shore and the range of the tide. The topographer is therefore unable to locate a continuous low-water line by measurement. To do so accurately would require projecting the low-water line along the beach by means of levels from known elevations. This method was never followed in the Bureau, unless for some special-purpose survey. The topographer usually informed himself of the time of low water and whenever possible worked along the beach at such times as to enable him to rod in both the high- and low-water lines. In exceptional cases, as where low water revealed an extensive spit penetrating the fairway, or where the low-water line made out a considerable distance from shore and the shallowness of the water or the small range of tide would have made it difficult for the hydrographic party to locate, the topographer sometimes returned to the area for the express purpose of locating the line. But generally no attempt was made to survey the line completely. The topographic survey was primarily for the purpose of delineating the high-water line and for locating signals for control of the hydrographic survey. If the topographer delineated the low-water line at all it was more or less incidental to his survey and was quite often sketched, such an estimated low-water line being merely a guide for the hydrographer who followed. No distinction was made between a sketched low-water line and a rodded one. But even where the line was actually surveyed, it was only a contact line between the water and the land, rather than the intersection of the adopted tidal plane with the shore,

because the topographer might rod such line at stages of the tide from the lowest of the day to well above low water.

The provision in the earliest instructions for topographic work that "the low water line is taken by offsets whilst running the high water, and when not too far apart from each other, but when their distance is great they must be surveyed separately: a couple of hours before the end of the ebb, and the same time during the commencement of the flood tides will be the proper time for taking the low water line" (*see* 42, par. 17), bears out the approximate nature of the line as surveyed by the topographer. Two hours of the tidal cycle might shift the contact line a considerable distance horizontally on a gently sloping beach.[58]

447. Rocks—Bare, Awash, and Sunken

All rocks—bare, awash, or sunken—are located by the topographer wherever possible. The topographic survey being essentially a survey of the land area, is authority, both as to location and elevation, for all features in the water area that are above the plane of mean high water. In the case of a bare rock some distance from shore which was located by the topographer by "cuts" without actually visiting the rock, the determination of the elevation above high water by the hydrographic party might be given preference. The elevations of rocks awash (*see* 565) above the sounding datum would generally be taken from the hydrographic survey because the estimated height would be tied in with an exact tide stage, but the topographic location of such feature would be acceptable. Sunken rocks (*see* 565) when located by the topographer would usually show as a breaker, and the hydrographic survey would be the better authority for such features both as to location and depth below the sounding datum.

45. SYMBOLIZATION ON TOPOGRAPHIC SURVEYS

In the early, formative period of the Bureau (*see* 43), complete consistency in the use of conventional symbols on topographic surveys was never attained. This was due to the lack of standard symbols, the personal views of the different topographers, and the lack of complete central control. The various symbols

53. The quoted provision regarding the separate surveying of the low-water line when its distance from the high-water line was great may have been applicable during a very brief period only, because in the supplemental instructions dated Sept. 7, 1840, it is clearly stated that in the delineation of the low-water line the topographic and hydrographic parties are "to work together conjointly, and according to distinct agreement" (*see* notes 9 and 39 *supra*). No subsequent planetable manual has ever required otherwise.

used at different periods will be covered in a later section (*see* 46). In the present section will be included a discussion of a topographic survey made in mid-19th century covering a variety of features about which requests for interpretation have been received (*see* 451), and a recent example of specialized symbolization (*see* 452).

451. Interpretation of Symbolization on an Early Survey

Figure 44 is a photographic copy on a reduced scale of a section of Register No. T–892 (1859), a topographic survey along the southern California coast. The features that have been identified by letters of the alphabet are those about which interpretive guides were requested. The following enumeration reflects the answers furnished:

(*a*) The solid line at points such as (*A*), where not adjoining salt marsh, delineates the mean high-water line as near as it could be interpreted by the surveyor in the field from the appearance of the beach, or by reference to predicted tides, but without recourse to leveling (*see* 4421).[54]

(*b*) The solid line at points such as (*B*) delineates the edge of vegetation and may or may not be the mean high-water line. This line may be defined as the line which to the navigator would appear to be the dividing line between land and sea.[55]

(*c*) The dotted line at points (*C*) is the low-water line as estimated by the surveyor and not determined by levels (*see* 4461).[56] It is probable that the junction of the dotted line and the solid line at points such as (*C'*) means that the bank is so steep that the low-water line and the edge of vegetation practically coincide. Points (*C''*) represent the limits of the low-water line insofar as delineated by the topographer.

(*d*) The solid line at points (*D*) represents the dividing line between marsh and the somewhat higher land covered by grass. At points such as (*D'*) the solid line represents the junction between the marsh and an alkali flat (*see* (*i*), below). The solid line at (*D''*) is the dividing line between salt marsh on the north and the higher sand area on the south.

(*e*) At points (*E*) it is probable that the solid line was omitted because the dividing line between the marsh and the sand or alkali flat was not as definite as at other points.

(*f*) The area marked (*F*) is ground above high tide covered with grass.

(*g*) Areas marked (*G*) are sand areas. The areas marked (*G'*) are shown on the original survey by small irregular circles drawn in red. No definite reason is known for the use of this symbol by the topographer, but it is believed to have been intended to represent small sand dunes probably covered with brush or scrub growth.

(*h*) The series of close parallel lines in the area marked (*H*), as well as in other similar areas, represent salt marsh. Although the symbol is incomplete (it should include tufts of

54. Predicted tides in their present form were not published in 1859, but could have been computed from data contained in the annual reports of the Survey (*see* Part 1, 2322 note 56).

55. Actually the land at point (*B*) may have been covered by a few inches of water at mean high tide and the high-water line would be somewhere in the interior marsh area (*see* 4432).

56. Within the estuary, the dotted lines probably represent low-water channels through the mud flats at some stage of low tide but not necessarily at mean lower low water. The defining limits of low-water channels may therefore have been higher than the low-water line shown on the outer coast.

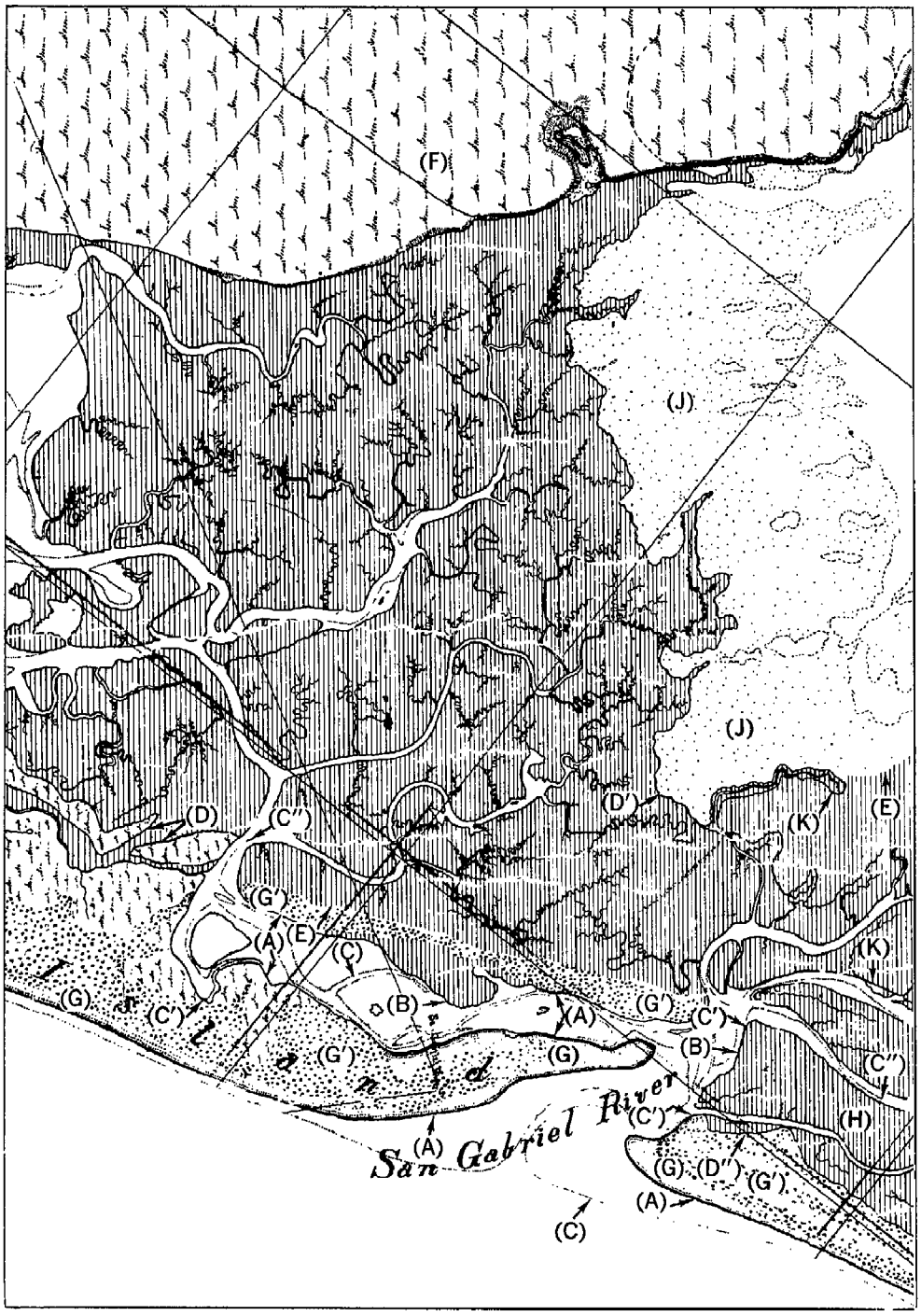

FIGURE 44.—Symbolization on a topographic survey of 1859.

grass at intervals) it was also used on several other early surveys in the locality and in the vicinity of San Francisco Bay.

(*i*) The area marked (*J*) is an alkali flat. The symbol used is an uncommon one and so far as known is unique in this area. On a later topographic survey in the same locality (*see* Register No. T–1283 (1872)), the same symbol was used in the same area but with the addition of the words "Alkali Flat," thus making the character of the area unmistakable.[57]

(*j*) The line at points (*K*), it is believed, represents a rather definite break between the higher marsh area and a lower marshy area. This is borne out by a comparison with Register No. T–1283 (1872) on which the area to the eastward of the small stream is shown as alkali flat and the line marked (*K*) appears in about the same position as the dividing line between marsh and alkali flat. Probably the marsh in that area was quite high and changed in the interval between the two surveys from a slightly marshy area to an alkali flat.

4511. *Representation of Marsh Areas*

Many inquiries are received in the Bureau regarding marsh areas on topographic surveys. These usually relate to the elevation of the marsh with respect to the planes of mean high water and mean low water, and to the symbolization used.

The importance of knowing the elevation of the marsh arises from the fact that prima facie the state is the owner of submerged lands under inland navigable waters, and of the tidelands (lands between high- and low-water marks). Marsh land covered at high water falls into the category of tidelands and hence belongs to the state, while such land that has built up to the meadow stage and is above the plane of mean high water is part of the upland and belongs to the riparian owner. What the condition of the marsh was as of a given date thus assumes special significance. This has been dealt with in 4433.

As to symbolization of marsh areas, the practice was not always uniform. On the first topographic survey (Register No. T–1 (1834)), the marsh area was shown tinted. On some of the early surveys, salt marsh was shown without the tufts of grass (*see* 451(*h*)). This was a draftsman's omission rather than a change in the symbol, or another form of vegetation. This has been verified by examining adjoining surveys executed by the same topographer during the same period, and therefore must have represented the same practice. On one survey grass tufts are omitted while on the other they are included.[58]

In 1938, the representation of marsh and other swamp areas on planetable and photogrammetric surveys was standardized with the issuance of a field memorandum. Covered in this memorandum are instructions for showing the outer edge of the marsh where it is continuous, and where it is broken and

57. An alkali flat is an alkaline, marshy area in an arid region. In the dry season, when all the water has evaporated it is a barren area of hard mud covered with alkali (a soluble salt or mixture of soluble salts). MOORE, A DICTIONARY OF GEOGRAPHY 9 (1949). *See also* STAMP, A GLOSSARY OF GEOGRAPHICAL TERMS 16 (1961).

58. *See* Register No. T–1471*a* (1879) and Register No. T–1538*a* (1880).

mostly flooded at high water, and for showing the junction between the marsh and the fast land in the interior.[59]

452. Specialized Symbolization

In the photogrammetric mapping and nautical charting of the Laguna Madre area of Texas, and similar areas elsewhere, where very little of an astronomic tide exists and the variation in water level is primarily due to meteorological conditions, the following special symbolizations and notation were used to represent existing conditions as nearly correct as possible:

(1) On the manuscript topographic maps (black and white copies), a solid, heavy, black line was used for the high-water line where the feature was definite and marked by visible evidence on the ground; where indefinite, without visible evidence on the ground, a broken line was used to indicate the approximate inshore limits of areas subject to inundation. The approximate low-water line was represented by a dotted line.

(2) On the nautical charts, the solid, black line was used where it was so shown on the topographic map, and a light, broken line was used to indicate the approximate inshore limits of areas subject to inundation. Inshore of these two lines, a buff tint was used to show land above high water. Between either of these lines and the low-water line (this was shown as a dotted line) a green tint was used. Offshore of the low-water line, the area was left blank or a blue tint used.

(3) On the manuscript topographic maps, the following notation was added where the high-water line was omitted: "Water stages in this area vary widely with meteorological conditions. The high-water line has been omitted where it is indefinite and is not marked by visible evidence on the ground. The broken line indicates the approximate inshore limits of areas subject to inundation. The dotted line represents the approximate low-water line." (*See* Register No. T-9201 (1948–1950) and Coast Survey chart 894.)[60]

46. CHRONOLOGY OF CONVENTIONAL SYMBOLS USED IN THE COAST SURVEY

It has been noted previously that a topographic survey is a small-scale representation of the natural and artificial features of a portion of the earth's surface (*see* 124). The aim of the topographer, and in a more refined sense the map maker, is to give graphic expression to the dominant features of the landscape. While the survey or map is drawn to scale as far as general dimensions are concerned, the indication of details, except on the larger scales, is almost always pictorial. If the real proportion of such features were used on the small-scale maps, many of them would appear microscopic. It has therefore been necessary to adopt a carefully considered scheme of conventions in which the character

59. *Field Memorandum No. 1 (1938)*, *supra* note 23, at 241–245. This was still the practice generally in 1949. Swanson (1949), *op. cit. supra* note 25, at 340.

60. Letter of June 7, 1951, from Director, Coast and Geodetic Survey, to Humble Oil and Refining Co.

of every line and every symbol conveys a definite meaning. The system so adopted is called *conventional symbols.*

Conventional symbols permit the greatest amount of information to be compressed into the minimum amount of space, yet without loss of clearness or legibility. The survey or map becomes, in a sense, a shorthand script, the full meaning of which can be understood only through a thorough knowledge of the system employed. Although there was in general a tendency to use the same type of symbols for the field surveys as for the engraved maps or charts, the smaller scales of the latter sometimes necessitated a departure in certain representations. There was always greater freedom in delineation on the surveys than on the charts, the main purpose being to convey information emphatically and unmistakably, beauty of delineation being of secondary consideration.

The symbol idea used today probably owes its origin to the drawing of pictures on the map to represent a variety of purposes. Many of these represented ideas and beliefs rather than topographic features. In many of the Portolan maps of the 14th and 15th centuries, the atmosphere figured rather prominently and the bellying sails of galleons were used to represent wind and its direction.[61] The superstitions of the old Saracen geographers regarding the coast of Africa resulted in fringing it with sea monsters and deformed humans. By 1775 there was in use in France a rather complete set of conventional symbols to represent the various features of the terrain (*see* fig. 45). Many of these resemble our modern symbols and it is quite likely that in the early surveys of the Bureau, before the adoption of standards, the representation of topographic features was modeled after these.

Since a survey or map is in reality a bird's-eye-view of the landscape, conventional symbols have for the most part been devised to suggest a shape which the object would assume if viewed from above. There are some exceptions to this rule, as where the object to be represented is better emphasized in elevation than in plan. (The early symbols for lighthouses and windmills followed this pattern, as does the present symbol for palm trees.)

Conventional symbols cover a wide range of features and it would be outside the scope of this publication to compare the practices relating to all of these during different periods of the Survey's existence. Therefore, only those symbols will be considered that are fundamental to the interpretation of our surveys and charts, particularly as they pertain to alongshore features. Fortunately, the character of these symbols have undergone few changes, once a standard was adopted. Isolated departures will be encountered in the field

61. JERVIS, THE WORLD IN MAPS 41 (1936).

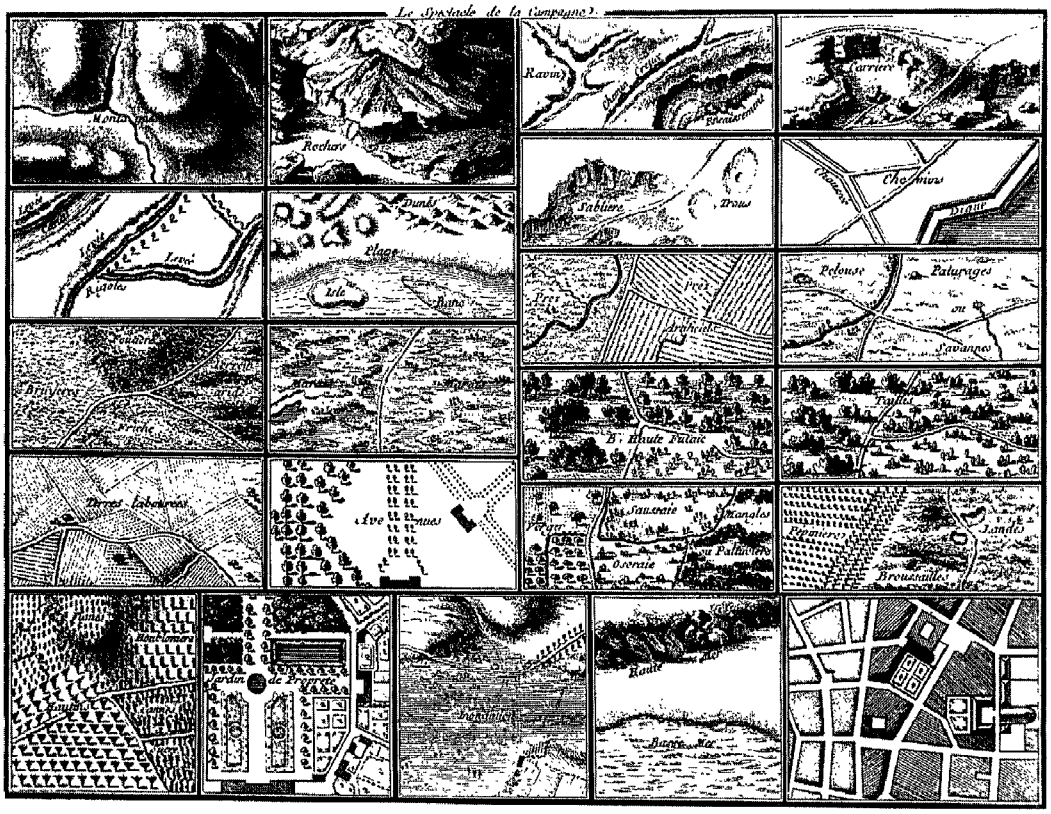

FIGURE 45.—Topographic symbols used in France in 1775.

surveys due to difficulty of securing complete uniformity where field parties are scattered over a wide area. Such was not the case with the published charts, since they were prepared in one central office where close supervision could be exercised.

In this chronology, no attempt is made to reproduce all the symbols or plates that were in use during any given period, but rather to provide continuity without duplicating identical symbols. This has been accomplished through the use of explanatory notes and cross-references. All the references to annual reports and other publications of the Bureau are those for which at least file copies are available, and it would be possible to reproduce these symbols should this become of importance in a particular situation.

461. EARLIEST PUBLISHED SYMBOLS (*Circa* 1840)

The earliest reference to conventional symbols in the topographic literature of the Coast Survey is found in the instructions for topographic work, issued

about 1840 by Superintendent Hassler, where it is stated: "In the representation of all topographical details you will follow strictly the conventional signs furnished you" (*see* 42, par. 31). This reference was evidently intended to apply to features associated with the works of man (except for rock symbolization), because features such as upland, meadow, marsh, woods, etc., were dealt with in other paragraphs of the instructions. As far as is known, figure 46 shows the earliest topographic symbols published by the Bureau. While undated, the record of the plate shows that it was engraved around 1840 and is probably the "conventional signs" referred to by Hassler. The symbols for the most part deal with bridges, roads, fences, and navigational aids. Of special interest are the symbols relating to rocks and ledges. These are discussed in the chapter on hydrographic surveys (*see* 565).

462. Rules for Representing Certain Topographical and Hydrographical Features, etc. (1860)

In 1860, a publication was issued entitled "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey." This was in pamphlet form and consisted of a series of instructions—from the Superintendent to the Assistant in Charge of the Office—pertaining to the drawing and engraving of Coast Survey maps and charts on the scale of 1:80,000. Every detail of the finished chart was covered by these rules, from the symbols and dimensions for the topographic and hydrographic features to the style and gage of lettering. These rules were based on a report by Henry L. Whiting, a field engineer in the Survey, and were the result of an effort to revise and standardize the existing practice, in the light of the experience gained both in the field and in the Office, and to meet new developments in the methods of reproduction, particularly the introduction of photography.

Prior to this, and more particularly in 1845 and the years immediately following, the subject of drawing and engraving the maps and charts of the Survey was studied in detail. While great pains were taken to introduce uniformity and system, many departures had occurred in the intervening years. The reactions of the maritime public to the first published charts of the Bureau also needed reflection. It was in this atmosphere that the rules of 1860 were formulated. The rules comprised 37 printed pages, of which pages 7 to 19—covering generalization of topographic and hydrographic details and cartographic routine for reproduction by photography—were for the most part reprinted as Appendix 20 to the Annual Report of 1860.[62]

62. The only complete copy of these rules now extant is filed in the Coast Survey library and is identified as Accession No. 61834.

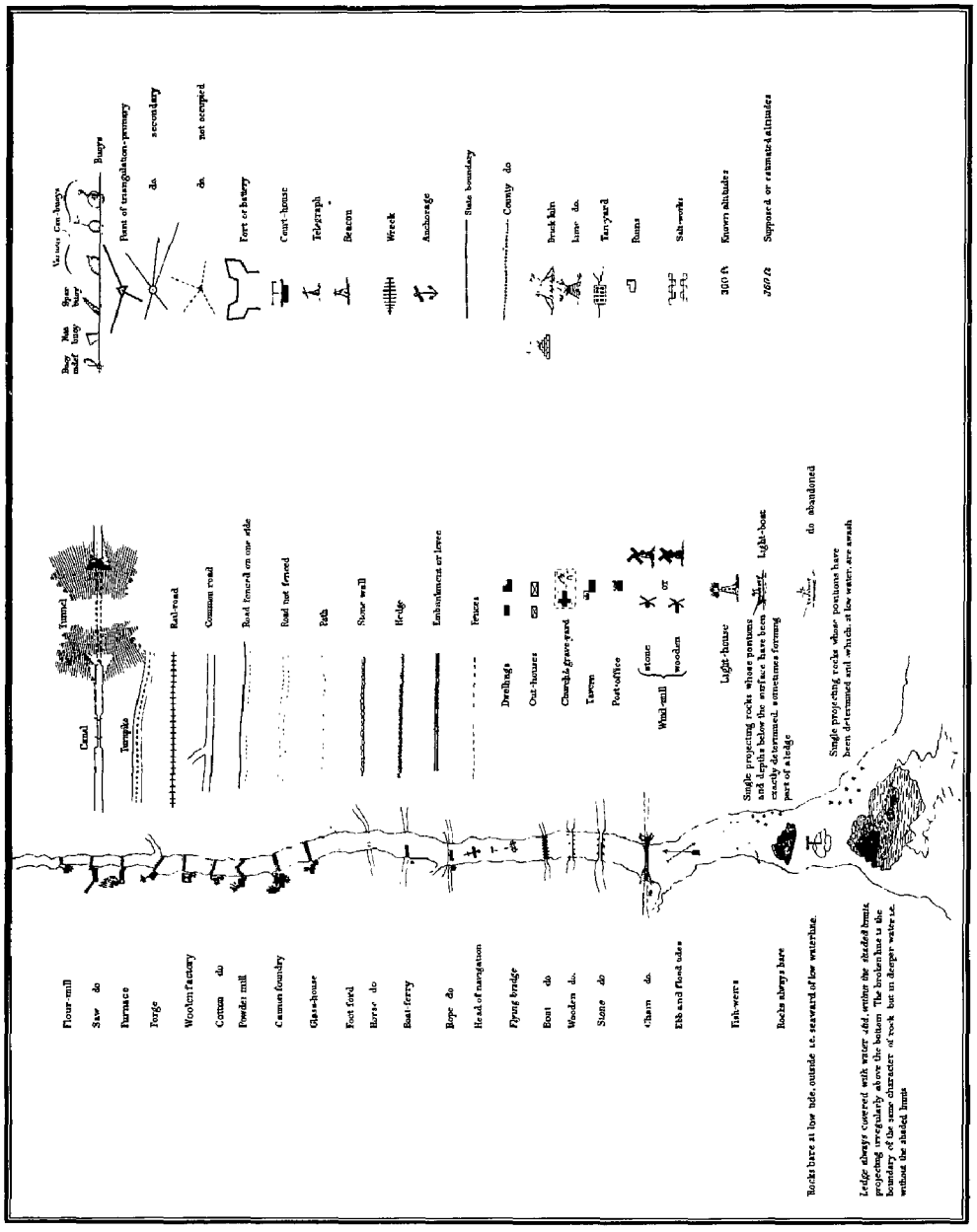

FIGURE 46.—Earliest conventional symbols published by the Coast Survey—*circa* 1840.

Attached to these rules were two paste-up sheets of printed conventional symbols, some of which were cut-outs from printed charts and others were apparently prepared to illustrate the symbols adopted (*see* figs. 47 and 48). These are no doubt the "Samples" referred to on page 4 of the rules.[63] In addition to the samples referred to, there are several symbols included within the text as paste-ups or as original drawings. Of particular interest are the symbols for salt marsh and the dividing line (a pecked line) between such marsh and the fast land (*see* p. 9 of the rules).

While the rules of 1860 were primarily for the guidance of the office, the fact that they were prepared by Whiting, whose experience in field topography was, in the words of Superintendent Bache, "greater than that of any other assistant in the Survey," [64] would indicate that in all probability they represented the current thought of the field engineers of that period in the interpretation of topographic features and in the method of representing them on the survey sheets.

463. Specimen Topographic Symbols (1865)

The Annual Report for 1865 contained the first comprehensive treatise on the planetable (*see* 412). Accompanying this treatise was a specimen sheet (Sketch No. 32 in the report) at a scale of 1:10,000, showing all the leading characteristics of country, together with the conventional symbols adopted and used by the Survey at that time. While the drawing is of necessity a composite, nevertheless all its separate features are from actual surveys. This is the earliest illustration of conventional symbols, of which we now have knowledge, which were prepared specifically for the guidance of the field engineer. Figure 49 is a photographic reduction of the topographic work, and figure 50 is a reproduction of the symbols only.[65]

464. Specimens of Topographical Drawing (1879 and 1883)

In 1879, an important change in topographic procedure was inaugurated. It had heretofore been the practice for topographers to ink their own topographic surveys. There was an obvious advantage in this practice since the

63. These symbols have been identified as similar to the rougher samples submitted by Whiting in his manuscript report to the Superintendent of the Survey (filed in the volume (289) of correspondence marked "Civil Assistants H–Z, 1860"), of which the printed pamphlet is practically a verbatim copy.

64. Annual Report, U.S. Coast Survey 20 (1860).

65. Of special interest is the checkerboard symbol for "salt works." This has been encountered on various surveys along the southern coast of Massachusetts made between 1845 and 1851 (*see*, for example, Registers Nos. T–191 (1845) and T–402 (1851)).

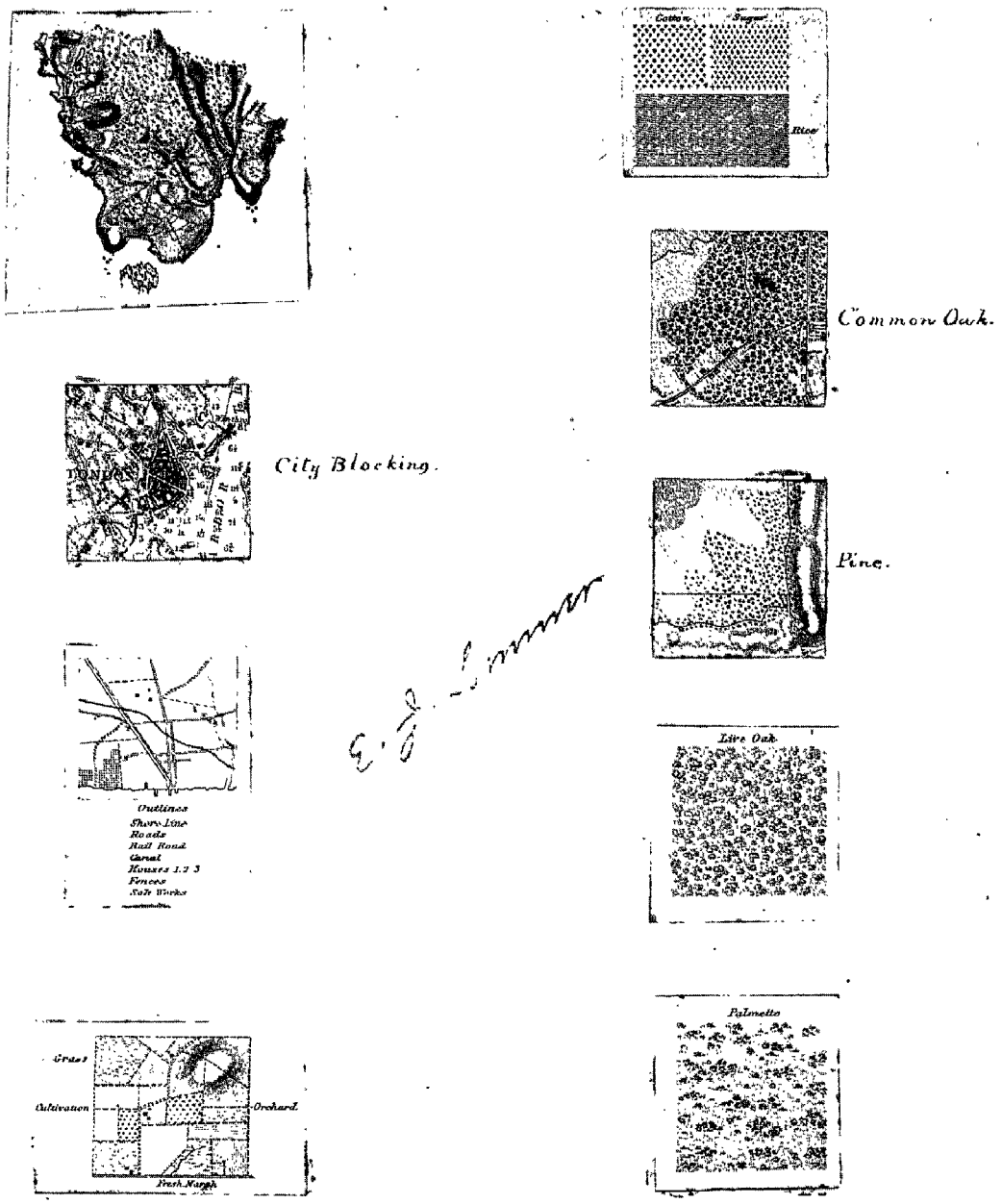

FIGURE 47.—Conventional symbols used in 1860.

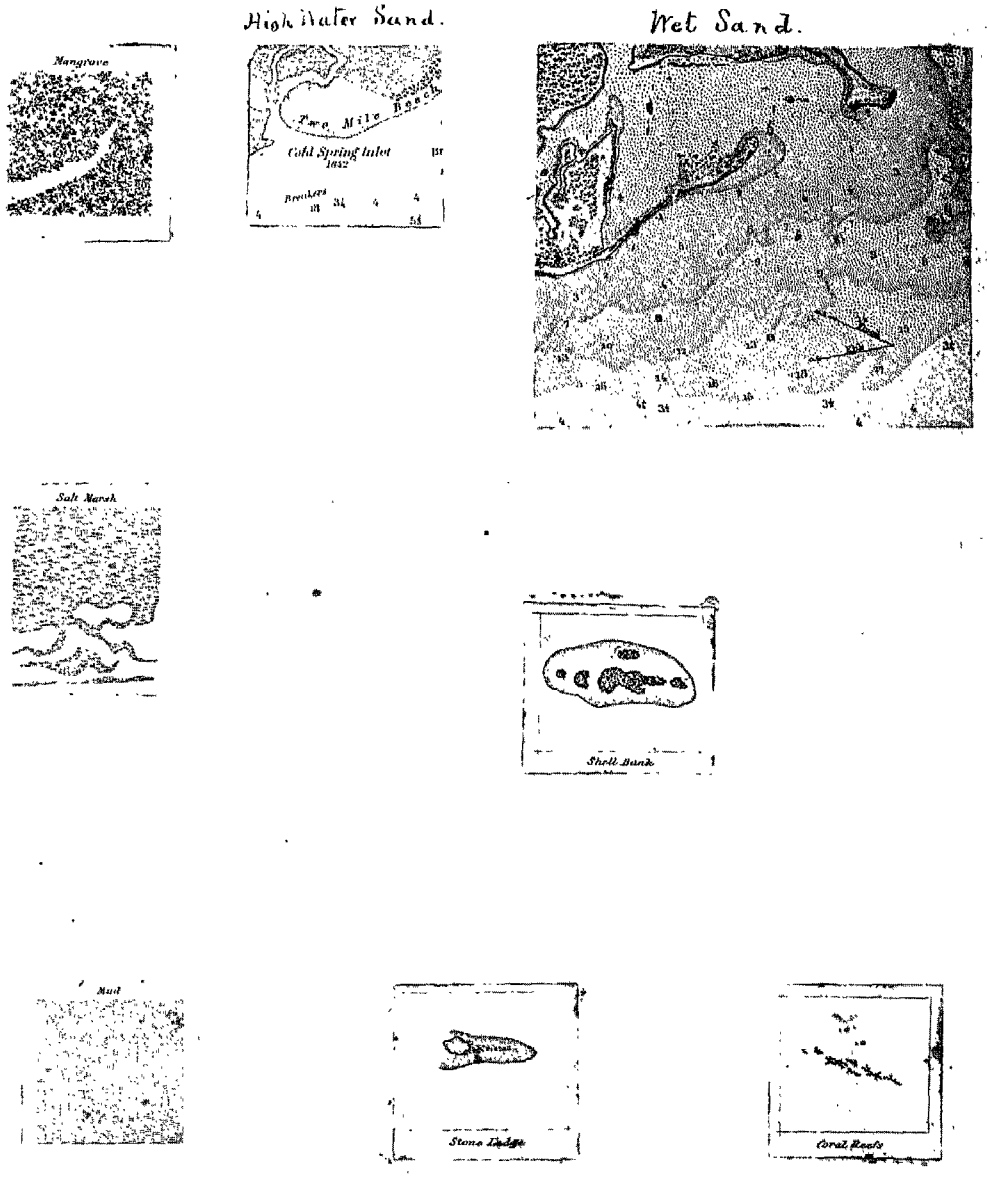

FIGURE 48.—Conventional symbols used in 1860.

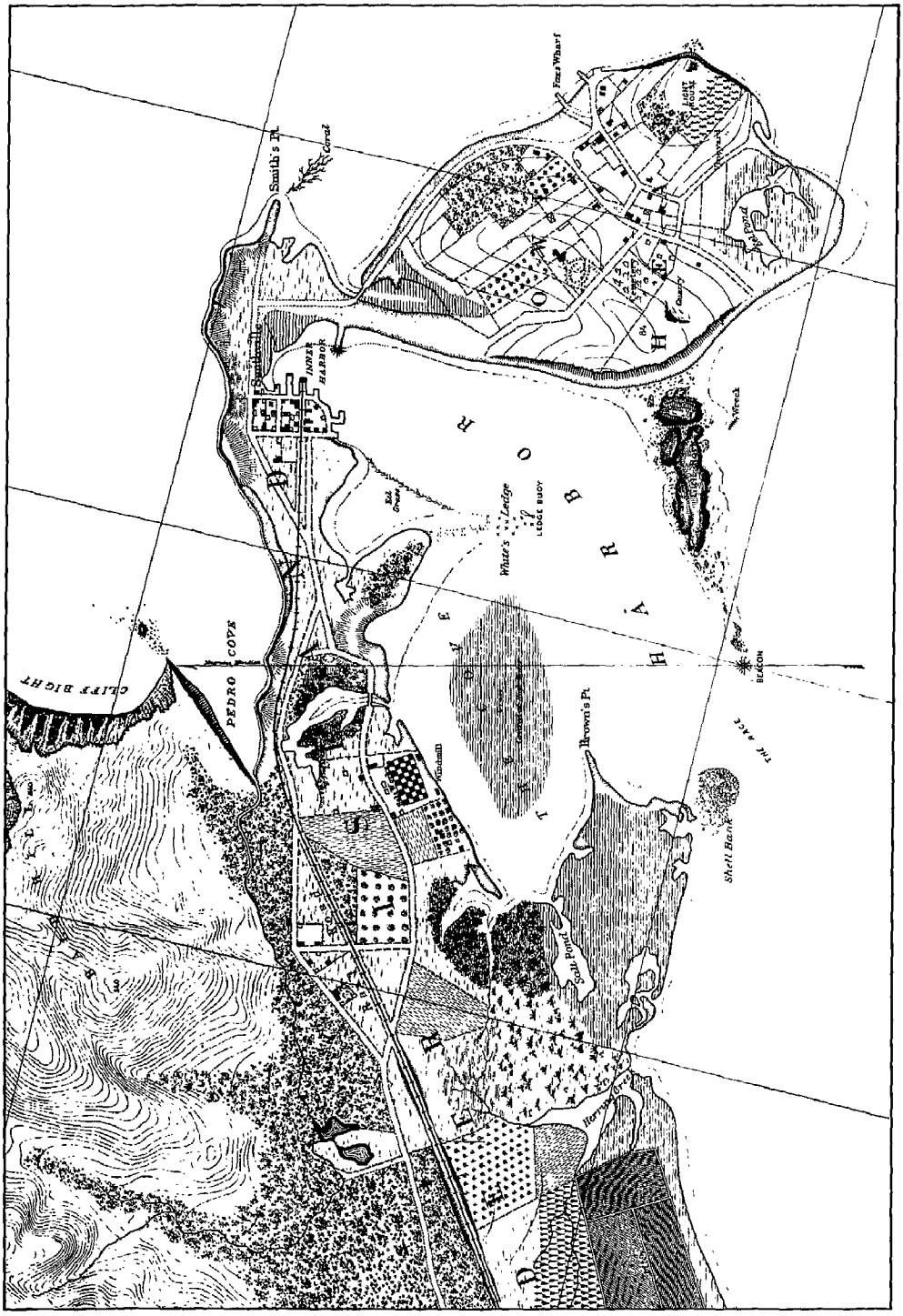

FIGURE 49.—Composite topographic survey of 1865 showing the leading characteristics of country. The separate features are from actual surveys.

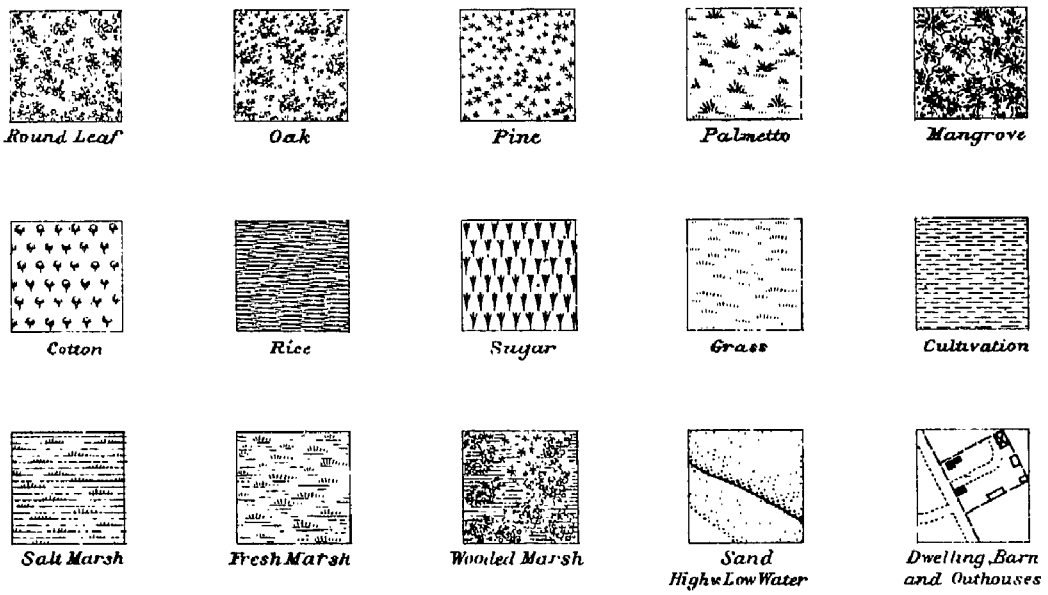

FIGURE 50.—Conventional symbols used in 1865.

final drawing was done by one familiar with the character of the ground. On the other hand, there was an accompanying disadvantage in that the various topographic surveys lacked uniformity of style, since good surveyors were not always good draftsmen. As long as the maps were not drawn for the purpose of direct reproduction this was not a matter of great moment, but with the advent of photolithography which made practicable the publication of maps directly from the original drawing, either on the same or on a reduced scale, it became desirable to have the original drawing made in a suitable and uniform style. Specimen drawings were therefore prepared, on the scale of the original sheets, of the various topographic features to be represented, to serve as guides for the office draftsmen who were thereafter to ink the planetable surveys.[66]

66. Annual Report, U.S. Coast and Geodetic Survey 71–72 (1879). In the preparation of these drawings, a selection was first made of those features, natural and artificial, that were most prevalent along the coasts of the United States. In some instances, departures from the existing form of representation were introduced and this became the practice for the future. Fresh marsh representation is one such case. Regarding this the report states: "Fresh marsh is also represented in a style different from that heretofore in use. Its representation had previously been by irregularly distributed tufts of grass, underlined by free hand with water lines, which, drawn with taste, is perhaps the most artistic representation of the feature; but which is seldom represented the same by any two persons. It was therefore thought best to introduce a style that could be definitely described and required. For this purpose, lines of the same strength and the same distance apart as those of the salt marsh are ruled and irregularly broken, then interlined and tufted by free hand with light short lines grouped irregularly, as shown in the first of the series of sketches accompanying this paper." *Id.* at 191.

These drawings were published in two series, the first appearing in the Annual Report for 1879 (p. 191). This comprised 8 lithographed plates with contours shown in color. The second series appeared in the Annual Report for 1883 (p. 368), and comprised 8 additional plates in color, but the plates of the first series were also included, making a total of 16 plates.[67]

The practice of office inking of planetable surveys was diligently followed during the first few years after its inauguration. Later, there was a return to the old practice of the topographer inking his own survey. In the planetable manual included in the Annual Report for 1898 (p. 460), this observation appears: "It is expected that every topographer shall have learned to draw sufficiently well to ink his sheet in a clear and distinct manner." [68]

It is not always an easy matter to determine from an inspection of the survey sheet whether it was inked by an office draftsman or by the topographer, because on many of them only the name of the latter appears. However, in the early years of this practice, itemized statements were included in the annual reports giving the locality of the survey and the name of the draftsman who inked it.[69] Later, and in particular the years subsequent to 1912, information regarding the inking was included either on the sheet proper or on a title sheet attached to the Descriptive Report (*see* 1242).

465. Conventional Signs for Field Sheets (1892)—The Topographical Conference

In the early part of 1892, a topographical conference was convened in the Bureau for the purpose of studying the state of the science and art of topography and looking toward improvement and standardization of the methods of survey and representation of the results. The conference was composed of the most eminent topographers of the Survey, and one of the subjects which came before it was "The establishment of uniformity in the use of conventional signs."

The procedure adopted by the committee delegated to study this matter was "to take as a basis the whole range of conventional signs heretofore used on the Survey, cancelling some of them, adding some, and modifying others." The symbols adopted were made a part of the conference report, the entire report being embodied in the Annual Report for 1891. Four plates of symbols

67. Selections from these plates have appeared in the various planetable manuals issued between 1897 and 1928.

68. This date did not exactly represent a sharp cleavage in the two practices, and in the annual reports to and including 1908 mention is still made of the inking of topographic sheets as one of the functions of the Drawing Division.

69. *See,* for example, Annual Report, U.S. Coast and Geodetic Survey 101–102 (1883).

were included in the report, two of which are reproduced here (*see* figs. 51 and 52). Of special interest is the symbol for submerged marsh which appears for the first time. This is probably intended to represent marsh areas mostly flooded at high water (*see* 445 and fig. 49).[70]

466. Topographical Symbols (1898)

The Annual Report for 1898 (Appendix 8) contained "A Plane Table Manual," by D. B. Wainwright. This was published as a separate in 1899 and was the first manual to include a set of standard topographic symbols. These symbols are the same as those adopted by the topographical conference in 1892 (*see* figs. 51 and 52), except for the salt-pond symbol, which was shown stippled (the same as is used today), and the cypress-swamp symbol which was changed to resemble a wooded marsh but with more pine stars and the grass tufts removed.[71]

467. Conventional Signs (1905)

The Annual Report for 1905 (Appendix 7) contained a revision of the 1899 planetable manual (*see* 466). (This was also issued as a separate.) The conventional signs included in this revision did not differ materially from those

70. Annual Report (Part II), U.S. Coast and Geodetic Survey 576, 706 (1891). The symbols not reproduced here covered rapids, falls, dams, ferries, houses, barns, sheds, roads (various kinds), fences, aids to navigation, sunken rocks (a simple cross), and rocks awash (four lines crossing). Also included, but not reproduced here, were the symbols for a topographic station (a small circle with dot in center) and a triangulation point (a small triangle with dot in center). In the "General Instructions for Hydrographic Work," published in 1883, a plate of conventional signs and symbols was included covering some topographic features. These are for the most part the same as shown in figs. 51 and 52, except for the symbols for live oak, cultivated land, and mud, which were omitted from the symbols recommended by the conference. The symbol for a rock awash in the 1883 instructions was three lines crossing, which is the same as the symbol used today (*see* fig. 64). In the "General Instructions for Hydrographic Work," published in 1894, four plates of topographic symbols were included. Two of the plates are identical with figs. 51 and 52, and need no further comment. The other two plates correspond to those included in the Annual Report for 1891 (*see* above), except for the following changes: The symbol for a topographic station was extended to hydrographic stations as well, and the symbol for a triangulation point was changed from a triangle to a triangle with an inscribed circle. Also, the rock-awash symbol was represented by three lines crossing instead of four lines, thus following the symbol contained in the 1883 instructions. Other departures are in the aids to navigation.

71. Of the 1892 symbols not reproduced here (*see* note 70 *supra* and accompanying text), some slight modifications were also made in the windmill symbol (changed to a formé cross), the fence symbol, and the symbol for a road fenced on one side. Also included in the report were nine of the specimen topographical drawings (without color) that were made part of the Annual Report for 1883 (*see* text at note 67 *supra*). In 1900, Special Publication No. 6, entitled, "Notes Relative to the Use of Charts," was published. In it were included five plates of topographic and hydrographic signs. Four of these are identical with the symbols adopted by the topographical conference in 1892 (*see* 465 and figs. 51 and 52), except as modified by the 1898 symbols and the addition of a symbol for "tundra"—similar to a grass symbol (*see* fig. 52), but with the addition of one or two horizontal lines under some of the tufts. (The tundra symbol was not carried in subsequent planetable manuals.) The fifth plate was of hydrographic signs.

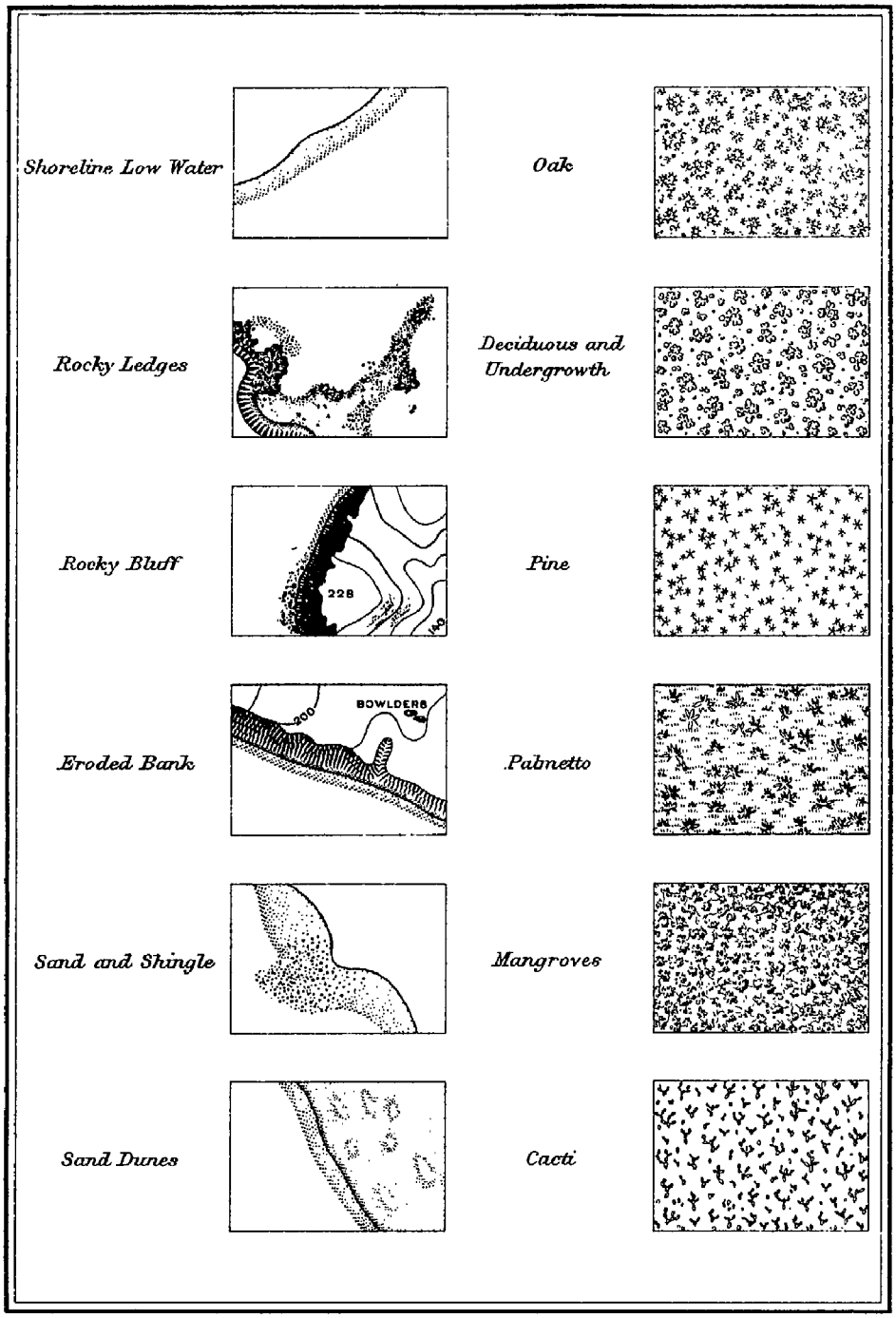

FIGURE 51.—Conventional symbols used in 1892.

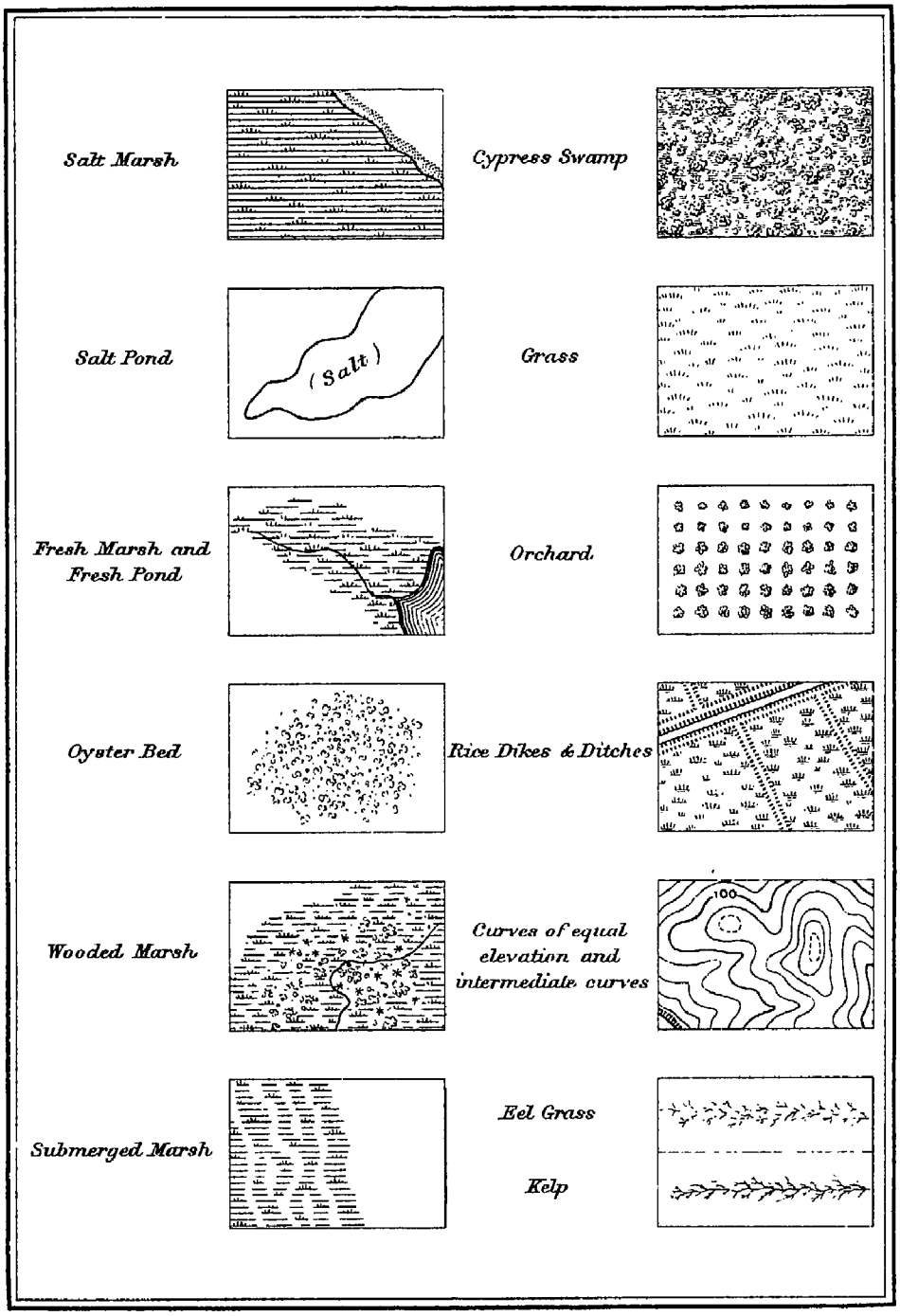

FIGURE 52.—Conventional symbols used in 1892.

published in 1900 (*see* note 71 *supra*), but symbols for "palms," "mud," and a "covering and uncovering rock" (three lines crossing) were added. Also included were nine plates of specimen drawings of topographic features from the 1883 Annual Report (*see* text at note 67 *supra*).[72]

468. Conventional Signs (1911)—The United States Geographic Board

The United States Board on Geographic Names was created by President Harrison on September 4, 1890, for the purpose of standardizing usage in regard to geographic nomenclature in the executive departments of the Government, particularly on the maps and charts issued by the various agencies. On August 10, 1906, President Roosevelt enlarged the duties of the board to include advisory powers concerning, among other things, the unification of the symbols and conventions used on maps. Because of the board's broader scope, its name was changed to United States Geographic Board.[73]

In 1911, the board adopted and promulgated a set of conventional signs covering all topographic and hydrographic features shown on maps and charts. This was the first complete set of symbols ever to be published by a government agency.[74] Many new symbols were added and modifications made of existing ones. The symbols for "sand and shingle," "oak," "oyster bed," "rice dikes and ditches," and "tundra" were omitted. The 1915 and 1916 reprints of the 1905 planetable manual (*see* note 72 *supra*) and the 1922 manual (*see* 4121(*d*)) all contained reproductions of these symbols except the special military ones. They are not being reproduced here because they differ but little from those published in the 1928 planetable manual, the last to be issued by the Bureau (*see* 469).

469. Standard Symbols (1925)—The Board of Surveys and Maps

President Wilson created the Board of Surveys and Maps on December 30, 1919, for the purpose of coordinating the activities of the various map-making agencies of the Government and to standardize results. The advisory powers

72. The planetable manual of 1905 was reprinted in 1915 (with corrections) and 1916 as separates. The reprints were issued subsequent to the adoption by the U.S. Geographic Board of a set of conventional signs (*see* 468). These symbols were substituted for those in the 1905 revision of the 1899 manual, and are the "corrections" noted on the 1915 reprint.

73. Sixth Report of the United States Geographic Board (1890–1932) V, VI (1933).

74. The symbols were grouped under the following classifications: Works and Structures; Boundaries, Marks, and Monuments; Drainage; Lettering; Relief; Land Classification; Hydrography, Dangers, Obstructions; Aids to Navigation, etc.; and Special Military Symbols.

which had been granted in 1906 to the U.S. Geographic Board (*see* 468) were rescinded and transferred to the newly created board.[75]

In 1925, the board published a set of "Standard Symbols" following the classification system of the Geographic Board. The greatest changes made by the Board of Surveys and Maps were in the addition of symbols for aerial navigation and in the extension of the military symbols. With the exception of the latter and a few others not applicable to topographic surveys nor to nautical charts, these symbols were all included in the Topographic Manual of 1928, the last planetable manual to be published by the Bureau.[76] In the symbols pertinent to the subject matter of this publication few changes were made from those in use in 1915 and 1922, the modifications being principally in the addition or abandonment of a symbol for a particular feature (*see* 468). Inasmuch as the 1915 and 1922 symbols are not reproduced in this publication, the following footnote comparisons in the different classifications will provide continuity to the chronology of symbols used in the Coast Survey.[77] The pertinent symbols from the 1928 manual are reproduced here in a slightly rearranged form (*see* figs. 53, 54, and 55).

Another edition of the Board of Surveys and Maps symbols was published in 1932. The only change from the 1925 edition, insofar as the symbols heretofore discussed are concerned, was in the addition of a symbol for "overflowed land" (regularly spaced, horizontal, open lines broken at intervals).

75. Executive Order 3206. Its name was changed to Federal Board of Surveys and Maps by Executive Order 7262 of Jan. 4, 1936. President Roosevelt abolished the board on Mar. 10, 1942, by Executive Order 9094, and transferred its functions to the Bureau of the Budget.

76. SWAINSON, TOPOGRAPHIC MANUAL, SPECIAL PUBLICATION NO. 144, U.S. COAST AND GEODETIC SURVEY (1928).

77. WORKS AND STRUCTURES—*Symbols added:* good pack trail, narrow gage railroad, railroad crossing, ford trail, telephone line, cliff dwellings, abandoned canal, canal lock (large scale), and intermediate bench mark. *Symbols discontinued:* metaled wagon road, railroad station, telegraph line along road or trail, infantry and cavalry ford, hospital, post office, telegraph office, waterworks, and city, town, or village. DRAINAGE—*Symbols added:* probable drainage (unsurveyed) and wells or water tanks. RELIEF—*Symbols added:* contours (approximate only), form-lines (no definite interval), hachures, cuts, fills, mine dump, tailings, and washes. LAND CLASSIFICATION—*Symbol added:* woodland (impenetrable). *Symbol discontinued:* wooded marsh. HYDROGRAPHY, DANGERS, OBSTRUCTIONS—*Symbols added:* breakers along shore, fishing stakes, and coral reef (symbol modified). *Symbol discontinued:* eel grass (symbol for kelp was made applicable also to eel grass). Other symbols under this classification included in the earlier manuals but omitted from the 1928 manual because they do not refer strictly to topographic surveys are limiting danger line, whirlpools and eddies, submerged derelict, cable, currents, no-bottom soundings, and depth curves.

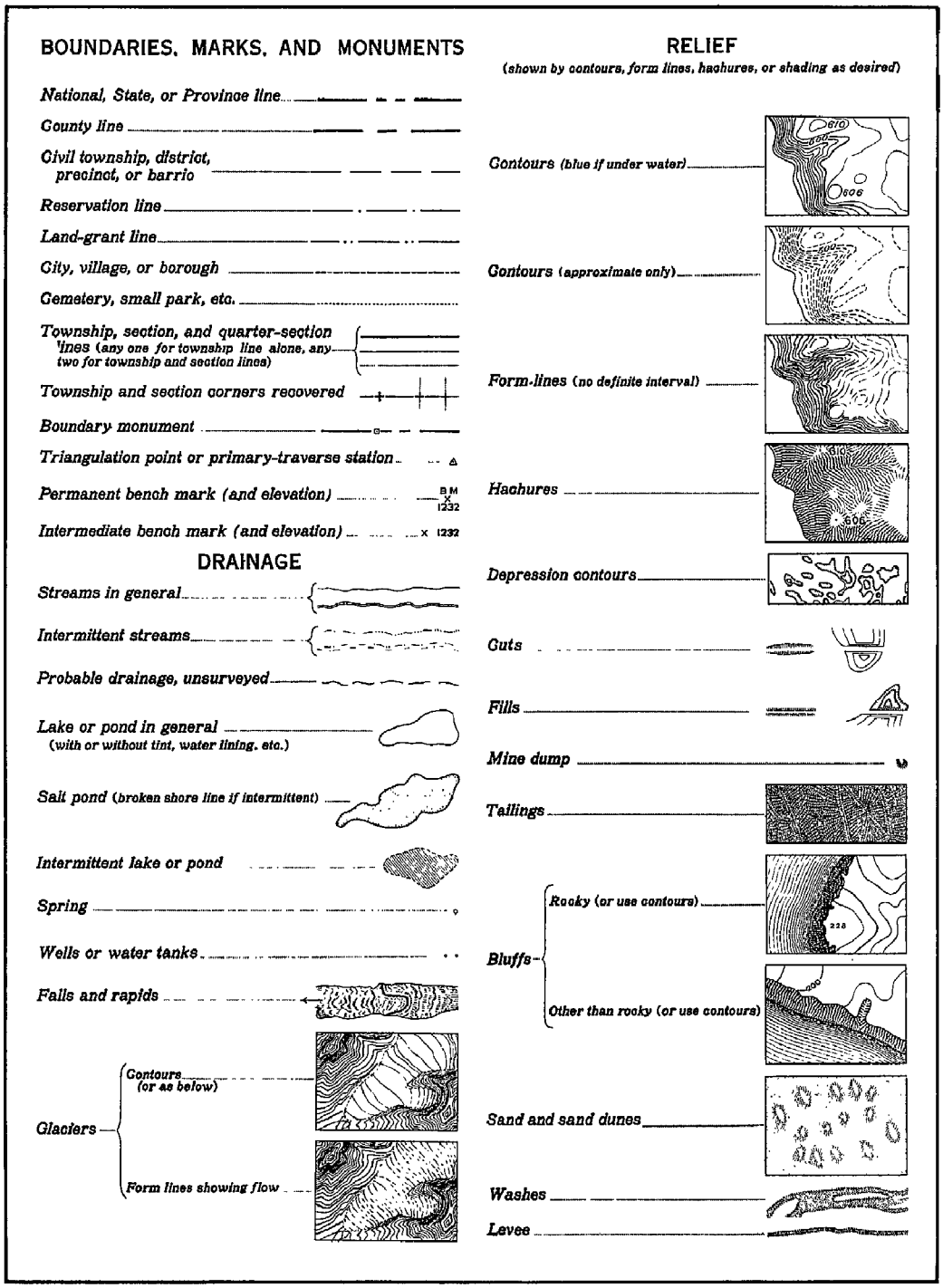

FIGURE 53.—Conventional symbols used in 1925.

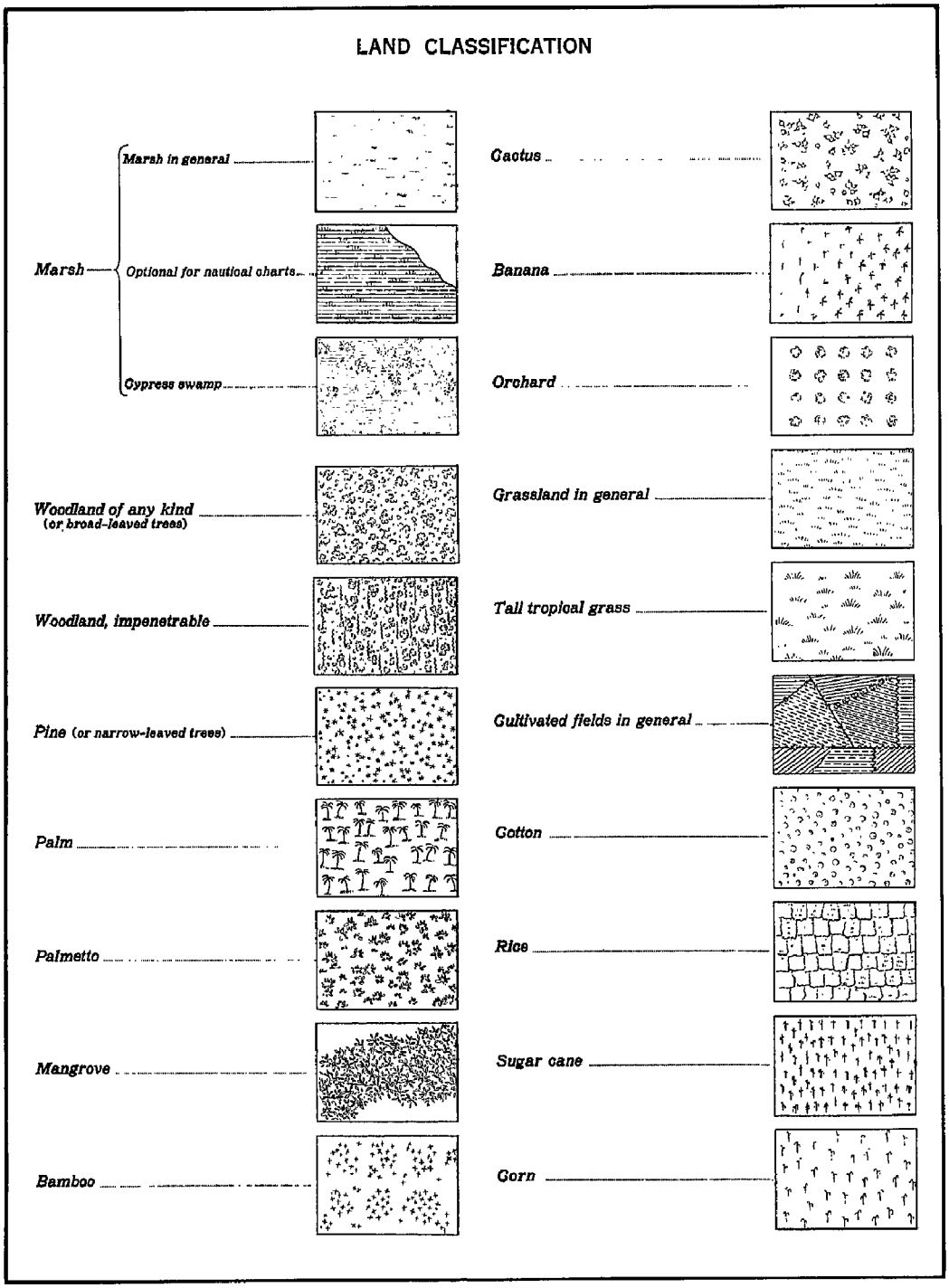

FIGURE 54.—Conventional symbols used in 1925.

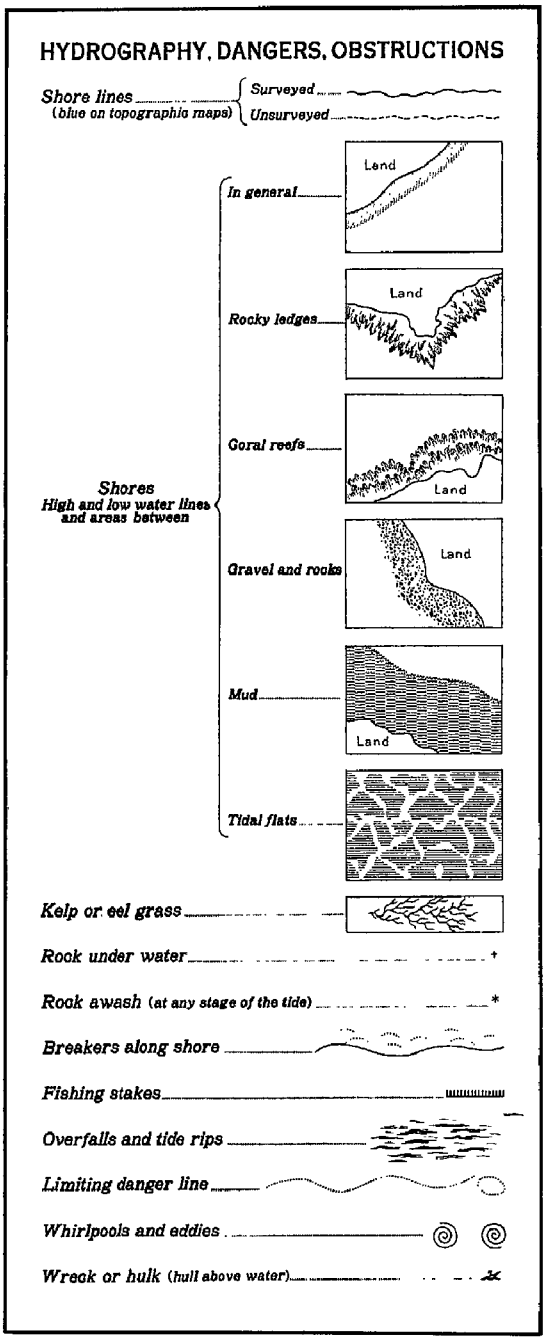

FIGURE 55.—Conventional symbols used in 1925.