CHAPTER 4

*"Any ship can be a survey ship,... **once**."*
Richards

Hydrography and Related Information

Introduction and Overview

The scope of this chapter includes hydrography (e.g., depth curves, soundings, nature of the bottom) and various specific hazards to navigation. Hazards can be either *natural* (e.g., rocks, reefs, shoals, tide rips, breakers) or *artificial* (e.g., wrecks, marine structures, unexploded ordnance, cable, and pipeline areas). This chapter provides essential background (e.g., definitions, historical asides), summarizes the utility of this information, describes the charting conventions used to depict hydrographic information (e.g., symbols and notes), highlights possible limits to the accuracy of this information (some made explicit in chart information), identifies other relevant sources (e.g., the *U.S. Coast Pilot,* the *Tide Tables* and *Tidal Current Tables,* NM, and LNM), and contains practical pointers on how hydrography and related information can be used by the prudent mariner.

In broad terms, the chapter addresses *hydrographic features* (e.g., soundings, depth curves, channels, nature of the bottom) and the *cartographic depiction of several specific hazards* to navigation (e.g., rocks, shoals, obstructions, wrecks). Because the scope of this material is so broad and the information so important, this chapter is long and detailed.

Many specialized terms used in this chapter are defined in the Glossary in appendix A. Names enclosed in parentheses (e.g., Bowditch) denote references listed at the end of this chapter that contain additional relevant detail or useful general discussions.

–A Brief Aside: Dual Units

As of this writing, NOAA is in the process of converting charts from traditional or "English" units (e.g., feet, fathoms) to metric units (e.g., meters). The Metric System has been established by the Metric Conversion Act of 1975 and the Omnibus Trade Act of 1988 as the preferred system of weights and measures in the United States. For U.S. nautical charts, the conversion to metric units is a multiyear effort with full implementation expected after the year 2000. Admiralty charts will be fully converted to metric units by the year 2010 (Bunyon). In the interim, charts in both systems of units will be available, so this manual treats both systems. The changeover to metric units is complex for many reasons, but users should have no difficulty converting from one system of units to the other. Illustrations provided in conventional units (e.g., soundings) can be mentally converted to metric units (meters and tenths) so no particular emphasis has been placed on the use of metric illustrations in this manual.

Utility of Hydrographic and Related Information

Approximately 71percent of the surface of the earth is covered with water (Kember), and it is reasonable to believe that (on an overall basis) water would encompass at least this percentage of the area of the average nautical chart (excluding harbor charts). Regardless of the accuracy of this assertion, it is certainly true that the depiction of hydrographic and related information is one of the defining characteristics of the nautical chart as opposed to the landbound map.

In a sense, any question relating to the utility of hydrographic and related information on the nautical chart is almost rhetorical. Nonetheless, it is instructive to set forth some of the uses of hydrographic and related information. Table 4–1 outlines both general and specific uses of this information to the mariner. Simply put, this information is essential to effecting a safe and efficient voyage—determining a relatively direct course from origin to destination while avoiding hazards to navigation.

Depth information (particularly in areas of substantial gradient) can often be valuable as an aid in fixing the vessel's position. And following a depth contour (using the vessel's depth sounder) can be a useful technique in circumstances of restricted visibility. Charted islets (rocks which are above water) can also be used for position fixing—rather like a landmark (see Chapter 6) in the water.

Some of the features normally classified as hazards to navigation, such as fish havens, wrecks, and offshore drilling platforms, are of interest to particular chart users. The recreational or charter fisherman, for example, is vitally interested in the accurate location of fish havens and wrecks (where fish often

Table 4-1. Uses of Hydrographic and Related Information

Specific Illustrations:

- To voyage expeditiously without running aground (e.g., depth information, limits to channels, presence of shoals, reefs, submerged rocks, etc.).
- To ascertain whether anchoring is possible (e.g., depth, type of bottom, absence of restrictions, absence of unexploded depth charges, etc.) or desirable (e.g., designated anchorage areas[1]) and aid in the determination of the proper amount of anchor line to deploy (depth) or even type of anchor to deploy (type of bottom).
- To identify which slips/piers are suitable for berthing (depth, nearby hazards).
- To be used as an aid in fixing the vessel's position (e.g., depth curves, bare rocks, stranded wrecks, etc.).
- To facilitate tracking during times of reduced visibility and/or when operating in areas with few ATONs or distinguishing topography/landmarks (e.g., depth). For example, in waters with a relatively steep depth profile, a depth sounder can be used to track along a depth curve.
- To provide information relevant to fishing activities (e.g., locating wrecks or fish havens). Also, to avoid areas where fishing nets or other equipment might be damaged.
- To avoid possible hazards to operation (e.g., fish trap or stake areas, log booms, pilings, wrecks, deadheads, stumps, snags, tide rips, etc.).
- To identify areas of special interest to various user-community segments (e.g., drilling platforms, artificial islands, hunting and fishing structures, etc.).

[1] See chapter 7.

congregate). Vessels or aircraft that service offshore rigs need to know where these are located—not to avoid them but to travel to these structures.

Yet other features, such as foul areas, areas where unexploded depth charges lie, and cable or pipeline crossings do not necessarily present hazards to transiting vessels, but rather mark areas where certain activities may be restricted or ill-advised. For example, foul grounds may snag fishing nets or lines, anchoring is prohibited in the vicinity of submerged pipelines and cables, and anchoring is unwise in areas where unexploded ordnance is reported.

Finally, the bottom characteristics are relevant for several reasons. Bottom samples, drawn with tallow attached to a leadline, were used in bygone times as an aid in determining the vessel's position (Cohen). Nowadays, knowledge of the nature of the bottom is chiefly important in selecting a suitable place to anchor and the type of anchor to use (Hinz).

As noted above, hydrographic information is first discussed, followed by specific hazards to navigation.

Hydrographic Information

Hydrographic information, as portrayed on the nautical chart, consists of depth soundings, depth contours or curves, depth-dependent color designations (blue tints), notes showing the controlling depth of improved channels, and descriptions of the nature of the bottom. Taken together, this information enables the mariner to navigate safely and efficiently.

–Common Plane of Reference and Survey Scales

Hydrographic surveys are the basic source of soundings and related information. These surveys, conducted by NOAA and other vessels, utilize information derived from a wire drag apparatus (earlier technology), echo sounding, and side-scan sonar. Sounding data derived from these surveys are adjusted to reflect a common horizontal plane of reference, *mean lower low water* (MLLW), as shown in figure 4–1. By definition MLLW is an average (generally over a 19-year epoch) of all lowest

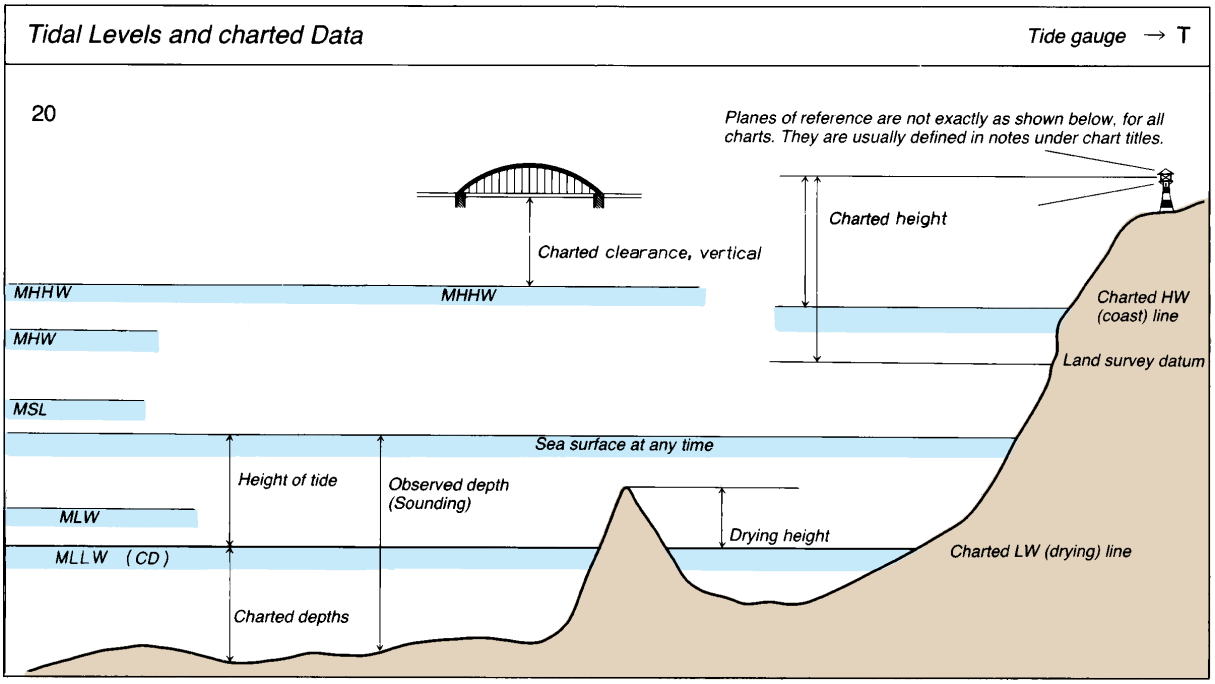

Fig. 4-1. Diagram taken from Chart No. 1 illustrating conventions used for charting soundings, drying heights, charted clearance of bridges, and the charted height of lights. Soundings determined from surveys are first reduced to depths relative to mean lower-low water before being charted. MLLW also serves as the reference plane for drying height.

water levels for tidal days.[1] Viewed from this perspective, charted soundings are *conservative,* in the sense that depths are typically greater than shown by soundings data. Even though the datum is based on averages of low water (lower low water in cases where there are two low-water periods in a day), *the actual water level at any time can be lower than this average—which means that the actual water depth can be less than the charted depth.* On days with spring tides (tides having a greater range than normal), prolonged winds from certain directions, or persistent extremes of barometric pressure, the actual depth of water can be less than the charted depth.

The basic scale for hydrographic surveys performed by NOAA is 1:20,000—other scales are multiples or fractions of this basic scale. As noted in the *NOS Hydrographic Manual,*

> "The criteria used for scale selection are based on the area to be covered and the amount of hydrographic detail necessary to depict adequately the bottom topography and portray the least depths over critical features. A cardinal rule of nautical chart construction is data from a hydrographic survey should always be plotted at a scale ratio larger than that of the chart to be compiled. The survey scale is generally

[1]In locations with two low tides each day, this is the average of the lower of the two.

The *Rainier* is one of the hydrographic survey ships in NOAA's fleet. Survey data are also provided by other government agencies and firms under contract to NOAA.

> at least twice as large as that of the largest scale chart published or proposed for the area... Inshore surveys, defined as those conducted adjacent to the shoreline and in general depths of 20 fathoms or less shall be plotted at scales of 1:20,000 or larger . . . In contrast, offshore surveys are those conducted in waters of general depths between 20 and 110 fathoms not adjacent to the shoreline.
>
> "Basic hydrographic and navigable area surveys of all important harbors, anchorages, restricted navigable waterways, and areas where dangers to navigation are numerous shall be plotted at scales of 1:10,000 or larger."

Cartographers, therefore, always have hydrographic information available at a larger scale than are plotted on the nautical chart (more below).

–Source Diagrams

A *source diagram* is included in all new editions (after November 20, 1992) of NOAA nautical charts at a scale of 1:500,000 or larger. (A source diagram is included on similar Admiralty charts.) It provides information on the source, date, and scale of the survey(s) used in the preparation of a given chart. The source diagram provides an indirect indication of the quality of the data (older surveys used less modern equipment, may not have been as complete, and the depth profile of the bottom may have altered over time as a result of suspension and deposition processes). This information allows users to make their own judgments of the data's fitness for a particular purpose. The date of the survey may prove useful in selecting a route—transiting areas more recently surveyed in preference to others.

Large-scale charts compiled exclusively from a single survey do not contain a source diagram. Instead, this information is provided in a parenthetical expression (e.g., from surveys of 1982 to 1984) to the AUTHORITIES note shown on each chart.

Figure 4–2 provides an illustrative source diagram, taken from NOS Chart No. 13218 (Martha's Vineyard to Block Island). The *Queen Elizabeth II* (*QE II)* ran aground (Brogden, Sabellico, Walsh, *Ocean Navigator*) in August 1992 on an uncharted rock in area "d" (plotted with soundings from a 1939 survey) on this source diagram. The *QE II,* drawing 32 feet, went aground in an area having a shoalest charted depth of 39 feet. A full discussion of the incident is beyond the scope of this manual, but it does serve as a cautionary tale and illustrates the wisdom of providing an ample margin of safety beyond the minimum depth required to accommodate the vessel's dynamic draft.

The master of the *QE II* might have selected a route which provided a greater margin of safety had a source diagram been available. Inspection of this source diagram and the chart itself indicates that, in general, the shallower areas have been the subject of more recent (and larger scale) surveys by NOAA.

Soundings

As noted, the inclusion of individual soundings is one of the ways in which hydrographic information is represented on the nautical chart. Individual soundings are expressed in meters and tenths (decimeters) on new charts, and in feet and fathoms on older charts, measured relative to MLLW. The source of the soundings data is the hydrographic survey(s) of the area to be charted.

As noted above, surveys are normally conducted at a scale larger than the largest scale chart of the area. Depicting all of the survey soundings on the chart—particularly at a smaller scale—would be difficult or impossible. Recall all the other features, such as ATONs, hazards, and areas and limits (Chapter 7) that compete for space on the nautical chart (Kember). Even if physically possible to prepare, a plot showing all hydrographic survey data would be very cluttered and difficult for the mariner to interpret—at least for the well-surveyed coastal areas. Figure 4–3 illustrates the differences between detailed hydrographic survey soundings (on the left side) and those generalized and plotted on a typical nautical chart (on the right side).

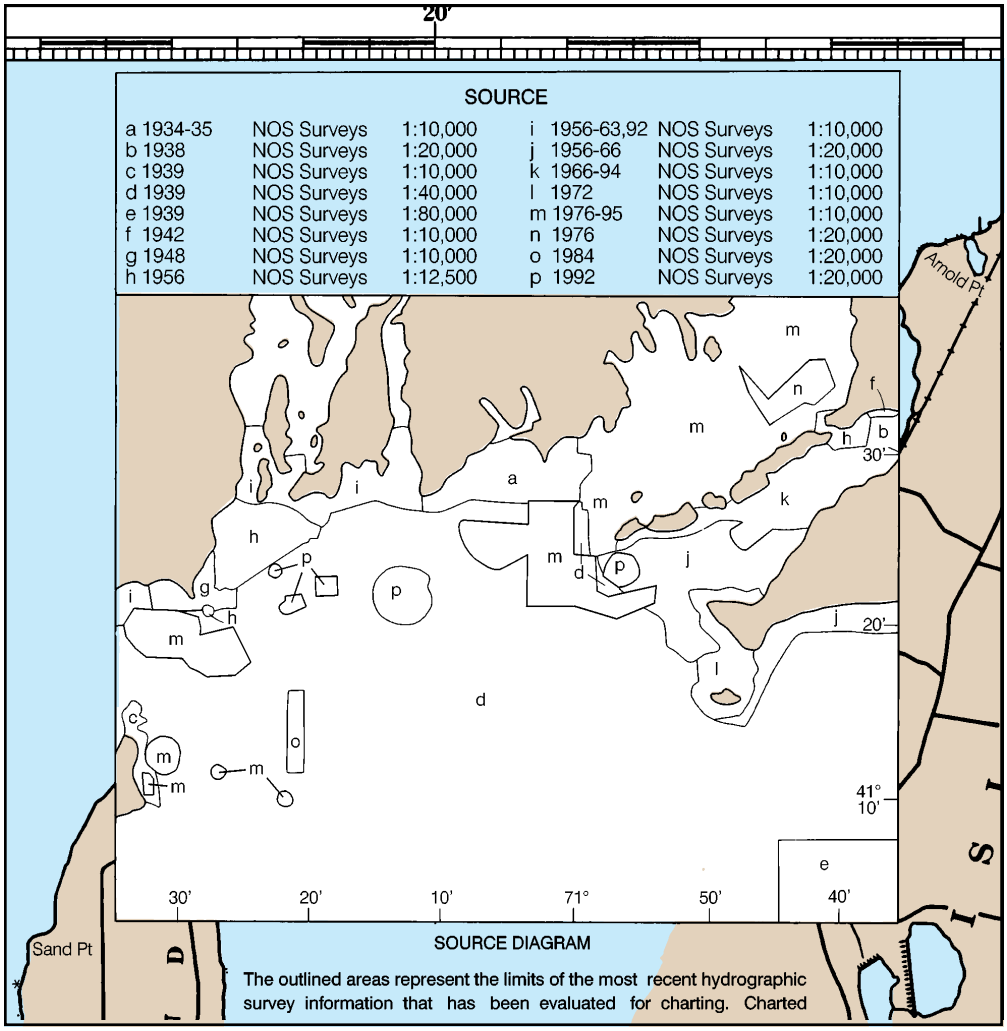

Fig. 4-2. Source diagram taken from NOS Chart No. 13218 (Martha's Vineyard to Block Island). The diagram provides an outline of the land areas and the areal limits of the various surveys used in the preparation of the chart. The date, source, and scale of the survey are shown at the top of the source diagram.

As a practical matter, therefore, the cartographer is faced with the important task of selecting a subset of the available soundings for depiction on the chart (e.g., Zoraster, Ekblom). The objectives of the selection process are to ensure that the overall presentation of depth data is accurate, as complete as feasible, and is easily understood by mariners.

–The Soundings Selection Challenge

To explain the particular selection rules and guidance followed by cartographers, it is well to remember that the primary function of soundings and depth curves on nautical charts is to present an accurate portrayal of the bottom configuration. Key bottom features that are charted include shallow areas, shoals, banks, and bars, irregular bottoms, smooth bottoms, deeps, and navigable natural channels and passages. These features are defined in table 4–2. (Additional material can be found in appendix A.) Briefly, these features serve to define preferred routes (e.g., navigable channels or passages), areas to be avoided (e.g., shoals, ledges), opportunities for position fixing (e.g., deeps, irregular bottoms), or other relevant detail (e.g., smooth bottoms).

The aim of the selection process, therefore, is to reduce the total number of soundings (so as to improve chart clarity) yet still provide a sufficient number of soundings to identify and locate the features described in table 4-2. The

selection process does not operate by merely deleting a certain number of survey soundings e.g., by deleting every second point. Rather, the process takes cognizance of the information content of each sounding, and preferentially retains "significant" soundings. A sufficient sounding density is retained to depict natural channels, shoals, or other hazardous areas to highlight these features for quick recognition by the mariner. Additional (but fewer) supportive soundings are selected to complete the bottom description. The spacing of soundings on the nautical chart is also relevant. Fill soundings (see below) over flat bottom areas are relatively widely spaced. Soundings in shoal areas are provided in greater density, which serves to draw the attention of the mariner to these potentially dangerous areas (Magee).

In general, cartographers first select soundings from shoal areas and natural channels and work toward deeper water so as to identify all shoal areas that might impede surface navigation, provide information about natural channels between or through shoal areas, and portray the configuration of the bottom (*Nautical Chart Manual,* Kember). As of this writing, the selection of soundings is still a manual process, although computer models (Zoraster) show promise.

–Selection Criteria for Soundings to be Charted

The above discussion summarizes the objectives and overall importance of the selection of appropriate soundings for depiction on nautical charts. This section summarizes the specific criteria and guidance used by cartographers for selection of soundings.

These criteria, and supporting guidance, are summarized in table 4–3. In brief, the emphasis is on selection of soundings which present information on least depths, critical soundings, deep soundings, supportive soundings, and fill soundings. Additional specific guidance is also given in table 4–3 for selection of channel range soundings, nonjunction soundings, changeable soundings, soundings in slips and around piers, depths over rocks, areas where the survey has not been able to detect the bottom, and river depths.

Broadly, the criteria offered in table 4–3 identify soundings to be emphasized (e.g., least depths, critical soundings, deeps), soundings of lesser importance (e.g., supportive soundings, fill soundings), and circumstances where the depiction of soundings is ill-advised (e.g., depiction of soundings in changeable areas).

Skippers of recreational craft often express

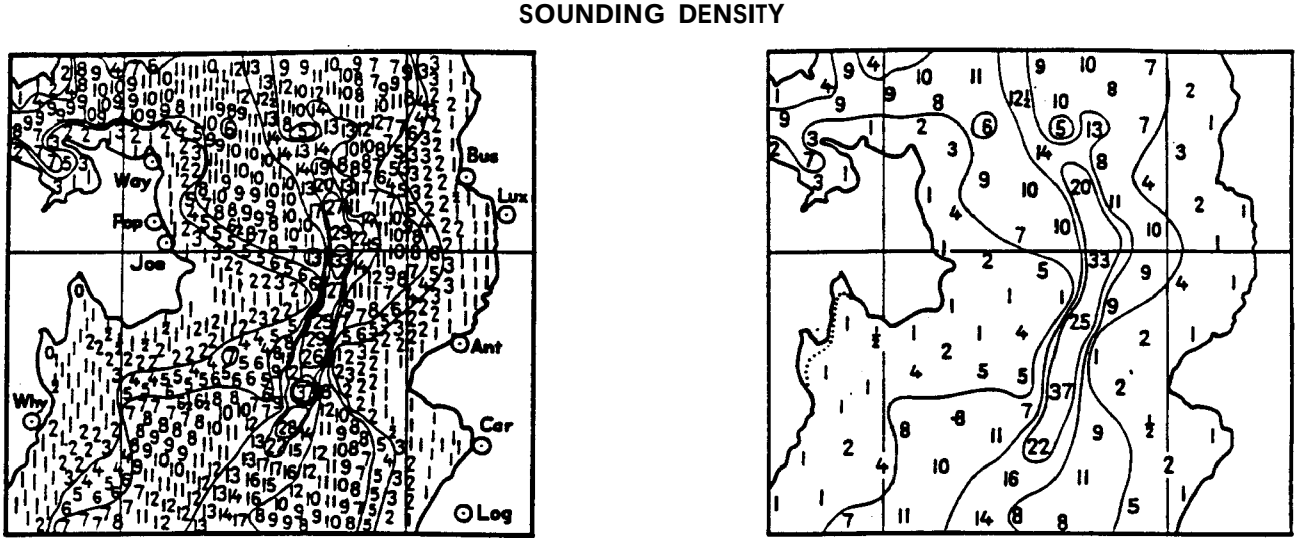

Fig. 4-3. Differences between hydrographic survey information and that provided on a typical chart. The chart on the right is much easier to read, yet does not sacrifice any information critical to navigation.

TABLE 4-2
Bottom Features Depicted on Nautical Charts

Shallow areas: Shallow areas are large expanses of shoals or of shallow water where the changes in depth are relatively slight. Some bays fed by river systems are shallow throughout.
Shoals, Banks, and Bars: Shoals are shallows that constitute offshore hazards to navigation. They are defined as having a depth of 10 fathoms or less and may be composed of any material except rock or coral. A shoal may be an isolated feature or part of a shoal area composed of two or more shoals. A bank is an area of relatively shallow water which is, however, of sufficient depth for safe navigation. Bars are ridges of sand or gravel, often at the mouth of a river, which may obstruct navigation. Note that shallow areas of rock and coral are charted as ledges and reefs and labeled, rather than being delineated solely by depth indicators.
Irregular Bottoms: Irregular bottom areas may consist of shoals, shallows, passages, deeps, etc., and are characterized by relatively large and abrupt depth differences throughout the region.
Smooth Bottoms: Smooth bottom areas are expanses where variations in depth are gradual and are relatively small compared to the size and depth of the area as a whole. Smooth areas in relatively deep water are the least important feature shown on charts. Generally, they pose no navigational hazard. These are depicted to provide "bottom detail" to navigators, rather than to enhance boater's "safety."
Navigable Channels and Passages: A channel or passage is a relatively deeper navigable route through an otherwise shallow area. Natural channels or passages are important features which contribute to the navigational value of a chart. Natural channels may constitute routes from deep water into shore or harbor areas, or routes between deep water areas through shoals or bordering shallow areas.
Deeps: Deeps are local deformations in the bottom configuration characterized by a significant increase in depth when compared to the surrounding areas. The boundary of a deep is the zone which separates the deep area from the surrounding shallower water. The size of the zone depends on how well the deep can be distinguished from the surrounding area.
SOURCE: *Nautical Chart Manual.*

puzzlement at some of the deeper soundings included on the nautical chart. After all, most recreational power boats draw 4 feet or less, and most recreational sailboats probably draw 6 feet or less. Why, they ask, include chart depths much greater than this? There are several reasons for inclusion of deeper soundings—but two are particularly relevant. First, as noted in Chapter 1, the nautical chart is prepared for several types of users. Although recreational vessels may draw 6 feet or less, large commercial vessels draw much more. Super tankers, for example, draw 40 feet or more (the ultra-large crude carrier, *Seawise Giant,* built in 1979 reportedly draws almost 100 feet!), and a submarine at periscope depth draws 100 feet (submarines operate at depths considerably greater). Second, operators of all types of vessels can use depth information as an aid in position fixing and for tracking along a depth curve (see below).

TABLE 4-3
Selection Criteria For Charted Soundings

Least Depths:
Least depth soundings over features (e.g., pinnacles, domes, ridges), which are delineated by depth curves should be identified because they are typically associated with hazardous shoal areas. When applying hydrography from larger to progressively smaller scales, a series of shoals may have to be generalized into a single-shoal feature. In this case, the most shallow sounding is selected to represent the least depth over the generalized shoal. The least depth of a natural channel (also termed the *controlling depth*) is also charted. Every natural channel has at least one controlling sounding, which identifies the minimum depth of the channel.

Critical Soundings:
Within each isolated feature bound by a depth curve, the shallowest seaward sounding must be selected. By definition this is a critical sounding and is given even if the same as the depth curve. Critical soundings represent least depths in proximity to known or potential navigational routes. Note that while a critical sounding is almost always a least depth, a least depth is not always a critical sounding; the location of the sounding is also an important factor.

Deep Soundings:
Deeps, like shoals, are local deformations of the bottom shape. Soundings which are approximately 10% to 20% deeper than their surroundings are considered important soundings and will usually be selected by cartographers. If chart space is constrained, however, a deep sounding does not normally take precedence over an adjacent critical shoal sounding.

Supportive Soundings:
Supportive soundings (also termed *developmental soundings*) supply additional information to the user about the shape of the bottom. These are also used to provide periodic identifiers for depth curves and to show changes in bottom slope away from shoals or deeps.

Fill Soundings:
Fill soundings are used to portray smooth bottoms or deep areas between shoals that are not adequately defined by supportive soundings. Normally, fill soundings provide information about large, gradually sloping depressions that are not deep enough to be enclosed by a depth curve. Ideally fill soundings radiate away from the deep sounding.

Channel Range Soundings:
When a range is charted to show the centerline of a channel, a line of soundings is selected on the range. This policy does not apply to improved (dredged) channels.

Nonjunction Soundings:
When the application of a recent survey to a chart reveals conditions so changed that a satisfactory junction cannot be made with the hydrography of former surveys, a blank band of approximately 5mm shall be left beyond the limits of the more recent survey and a note added, such as: "Hydrography to (eastward) from surveys of 1984."

Changeable Areas:
All hydrographic detail, including soundings and floating aids, may be omitted from all areas known to undergo continual and rapid change, such as ocean inlets and openings between barrier islands. (See figure 5-7 in chapter 5.)

Continued on next page

Table 4-3—*Continued*
Selection Criteria For Charted Soundings

Soundings in Slips and Around Piers: Soundings in docks, slips, and around piers should be shown where space allows. The cartographer should select soundings far enough off piers to provide depths at the keel lines of vessels which use these piers.
Depths over Rocks: A sounding over an isolated rock shall have the label *"Rk"* placed next to it.
No Bottom Soundings: When no bottom is reported in the survey, the measured depth shall be shown under a bar with a small dot over it. (This type of fill sounding shall be avoided whenever possible.)
River Depths: The shoreline shall be broken to accommodate soundings for narrow rivers where the sounding units would touch the shoreline because of the size of the feature at chart size. When portraying hydrography in navigable tributaries, the cartographer must select soundings that indicate controlling depths in conjunction with those that portray the best navigational channel. Where feature size or chart scale do not allow for the representation of both controlling depths and channel depths, the controlling depths take precedence.
SOURCE: Adapted (with minor word changes) from *Nautical Chart Manual.*

–Charting Practices

Soundings information is shown on the chart by many small printed figures, each denoting a particular sounding. Soundings in traditional units (fathoms, feet) are shown in conventional (vertical) type, soundings in metric units (meters and tenths) are charted in italic type.[2] Soundings are charted in their exact geographic location, and oriented parallel to the base of the chart, even if the chart projection is skewed.

All hydrographic detail and floating ATONs are removed from certain areas undergoing continual and rapid change, such as ocean inlets and openings between barrier islands if inclusion of this information might present an unreasonable risk to mariners. The area of omitted soundings is tinted in blue, and an explanatory note charted, as shown in figure 5–7 in the following chapter. Normally, only small-draft vessels would consider using such areas, but some of these areas are frequented by larger draft commercial vessels—sometimes with unpleasant consequences (see Walsh, *Professional Mariner,* Issue No. 5). The safest course of action is to imagine these areas have "Keep Out" signs posted. On small-scale nautical charts, soundings within a group of rocks or coral heads through which there is no well-defined channel are also omitted.

Depth Curves (Section I of Chart No. 1)

In addition to sounding data, depth information on nautical charts is summarized by charted *depth curves* and *labels*. According to the *Desk Reference Manual,* a *depth curve...*

> "...is a line connecting points of equal water depth which is sometimes significantly displaced outside of soundings, symbols, and other chart detail for clarity as well as safety. Depth curves, therefore, often represent an approximate location of the line of equal depth [a depth contour] as related to the

[2]The difference in type face serves to alert mariners to the difference in depth units.

surveyed line delineated on the source. The term curve is often used collectively for both depth curves and depth contours." [Material in brackets added for clarity]

Depth curves complement the sounding data and enable the mariner to form a better mental image of the shape of the ocean bottom. Griffin and Lock, writing in the *Cartographic Journal,* offer the following comments on contours,

"The origins of the contour may remain indistinct, but in its earliest known (submarine) form it manifested two major advances from the earlier sporadic use of spot heights (soundings). Firstly, it provided spatial continuity of information, developing a statistical surface from a set of discrete control point data, thereby introducing additional information by the process of interpolation. Secondly, it simplified the symbol array and stressed the need for visual integration of the contours to form a mental image of the configuration of the surface of the lithosphere."

Depth curves (or contours) resemble elevation curves used to depict topographic relief (see Chapter 3), but there are subtle conceptual differences between these terms. Kember, also writing in *The Cartographic Journal,* offers these colorful insights on the use and interpretation of depth contours on Admiralty nautical charts; comments equally applicable to NOAA charts,

"Depth contours also receive treatment that may surprise topographic cartographers. For years, in hydrographic departments all over the world, these were hardly regarded as contours at all but as danger lines meaning precisely 'keep out.' Each depth contour said 'keep out' to a particular type of vessel. The 1-fathom line warned small river and fishing vessels; 2 fathoms—many coasters, colliers, small ocean-going ships; 3 fathoms—the majority of ocean-going ships. For the mighty few, the largest battleships and the proudest ocean liners, the 5-fathom line was specially provided. As 'keep out' lines they were drawn to embrace all depths that might possibly offer danger to a vessel of the appropriate type. Caught in the contour's net were often a large number of depths greater in value than the contour itself, but nobody minded the ninety and nine greater depths caught inside so long as there was not one lesser depth left in outer darkness.

"Today marine cartographers are more inclined to treat contours in the manner of our topographic colleagues and to allow contours to play their part in revealing underwater topography. But when it comes to the crunch—and we must simplify or generalize—we do, deliberately and knowingly, and on behalf of the navigator, include all lesser depths within a contour even if it means that our catch includes many deep ones as well.

"So on the Admiralty Chart the depiction of depth is a curious mixture of the exact (high accuracy of spot soundings for example) coupled with this danger fixation which gives great prominence to lesser depths. The result is a navigator's bathymetry—a very different thing from a bathymetrist's bathymetry. In spite of appearances the chart is not a navigational document of the superimposition type. It has something of the underground map's ruthless selectivity and single minded user orientation."

Depth curves are used on charts to illustrate shallow areas, shoals and banks, irregular bottoms, navigable channels and passages, and deeps—much the same information as that identified in table 4–2 for soundings.

Depth curves are particularly relevant to navigators using electronic depth sounders. Of

course, the mariner must make adjustments for the placement of the echo sounder with respect to the surface of the water and for the state of the tide in order to compare the observed depth with the charted depth. For example, assume that the observed reading on the echo sounder is 15 feet of water under the keel, the position of the transducer is 3 feet beneath the vessel's water line, and that the calculated height of tide is 7 feet (relative to chart datum). To reduce these data to a figure comparable to the charted depth, it is first necessary to add the difference between the location of the transducer and sea level, and then subtract the calculated height of tide, so the comparable figure would be 15 + 3 - 7 = 11 ft.

Guidelines for charting depth curves abstracted from the *Nautical Chart Manual* include:

> The development of curves varies according to the particular bottom feature being charted. Large shallow areas are generally represented by a sparsity of depth curves, while banks and bars and isolated shoals are represented by a series of closely spaced contour closures.
>
> In areas with irregular bottoms, contours are selected for each isolated shoal's least depth. Supportive soundings and curves are then selected to reinforce this least depth as well as to define the zones between the shoals. This helps to convey to the user the large depth variations in the area.
>
> Smooth bottom areas are characterized by smoothly flowing and relatively widely spaced contours with only occasional closures identifying shoals.
>
> Depth contours are particularly useful in showing natural channels from deep water into shore or harbor areas and routes between deep-water areas through shoals. If the chart scale is too small to illustrate all the channels shown on the survey, the most important routes are retained in preference to less important routes.
>
> Depth curves are not typically shown around charted isolated deeps in shallow areas, unless the deep is part of a natural channel. Depth curves will usually be shown with charted deeps in deeper water. Isolated deep curves are always supported with a sounding inside.
>
> Depth curves around depressions are of little value, and are not typically charted. However, these are shown if they reveal features which may have some navigational value, or if they indicate the deepest side of a river.
>
> Very steep slopes would entail numerous closely spaced depth curves and create a problem in terms of chart clutter. In this case the shallowest and the deepest curves are retained in lieu of less important intermediate curves.
>
> A series of standardized values for depth curves is employed. For example, the standardized curve intervals when depth is given in feet includes (in feet), 6,[3] 12, 18, 24, 36, 60, 120, 180, 240, 300, etc. For metric charts the standard intervals (in meters) are, 2, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, etc.

–Charting Practices

On earlier charts, depth curves were depicted using a variety of symbols (see Section I 30 in Chart No. 1), line weights, and colors. This section details *present* charting practices. Charting conventions for the depiction of depth curves include *lines or curves, labels,* and a *blue tint.*

[3]In addition to the "standard" curves, a 3-foot curve is also used in some shallow water areas, such as the Florida keys.

–Symbol

Depth curves are charted with a solid black (blue on some charts) line of 0.10 mm thickness. Approximate depth curves are charted with a dashed line. These curves may be broken for curve labels (the depth) and chart notes. However, curves do not overprint any other charted feature. Depth curves are charted to scale as depicted on source documents, but may be generalized. (Where generalization is necessary, a curve is always displaced toward deeper water, unless this closes or seriously reduces the width of a navigable channel. The minimum width between depth curves identifying a natural channel is 0.3 mm.)

–Labels

Depth contour/curve labels are shown in italic type for charts where depths are given in feet/fathoms. Labels for depth contours and curves on metric charts with italic soundings are printed in conventional type. The convention of printing soundings and curve labels in different type (e.g., vertical if soundings printed in italic) prevents any confusion between the estimated contour level and actual soundings. The contour or curve line is broken for the labels with the label centered on the line. As a general rule, labels are placed along the lines at 10 cm to 15 cm intervals so as not to interfere with soundings and other charted data. In congested areas, labels may be staggered along the lines if this improves the legibility of the chart. All depth contours and curves are labeled in the same unit as the soundings shown on the chart (e.g., in meters for metric charts, in feet if soundings are given in feet, etc.).

–Shallow Water Tint(s)

A blue tint (Blue Tint No. 1) is shown on the chart to emphasize shallow water areas considered dangerous to navigation. *The depth contour selected as the boundary for the tinted area is not a constant for all charts, but rather determined by the chart scale, prevailing depths available, and the draft of the vessels expected to navigate within the charted area.* The limit value for the tint for any chart can be determined by noting the soundings on either side of the tinted area (see Kals). Having said this, the limit of the blue-tinted area is typically the 6-foot curve on harbor charts, and the 12-, 18-, or 30-foot curves on coastal charts (Dutton, Chapman).

For some charts two separate tints are used, Blue Tint No. 1 and a lighter Blue Tint No. 2. The use of two tints enables two depth zones to be delineated; the second depth zone (deeper and tinted in a lighter blue) expands the usefulness of the blue-tinted danger area to another group of chart users.

Figure 4–4 provides an excerpt from NOS Chart No. 13218 (Martha's Vineyard to Block Island) which illustrates many of the chart conventions discussed above. In this case, the limit of the blue tinted area is the 30-foot curve. Depth curves are shown at 30, 60, 90, 120, and 150 feet. Note that the soundings density is greatest in shoal areas and where necessary to characterize the shape of the depth curves.

–Improved (Artificial) Channels

Unlike natural channels, improved (artificial) channels are those which are dredged to establish and maintain project depths. The side limits of improved channels are shown on charts by dashed lines (I 22 of Chart No. 1). Depth curves are not shown for improved channels. Channel depth information is either tabulated or shown within or adjacent to the channel.

Controlling depths are charted in feet on nonmetric charts (including those with soundings in fathoms) and meters and decimeters on metric charts.

Channels for which graphic surveys are received by NOAA and which are 400 feet or more in width (Type 1) for their major portion provide depth information tabulated by quarters; channels 100 feet to 400 feet (Type 2) are tabulated by outside quarters and middle half; and channels less than 100 feet (Type 3) are tabulated by full width. On charts where dredged channel legends and tabulations are adequately covered by larger scale charts, the legend and tabulation are omitted, a "(see note)" placed in the channel, and a note (preferably on a land area of the chart) is added, as illustrated by the following example:

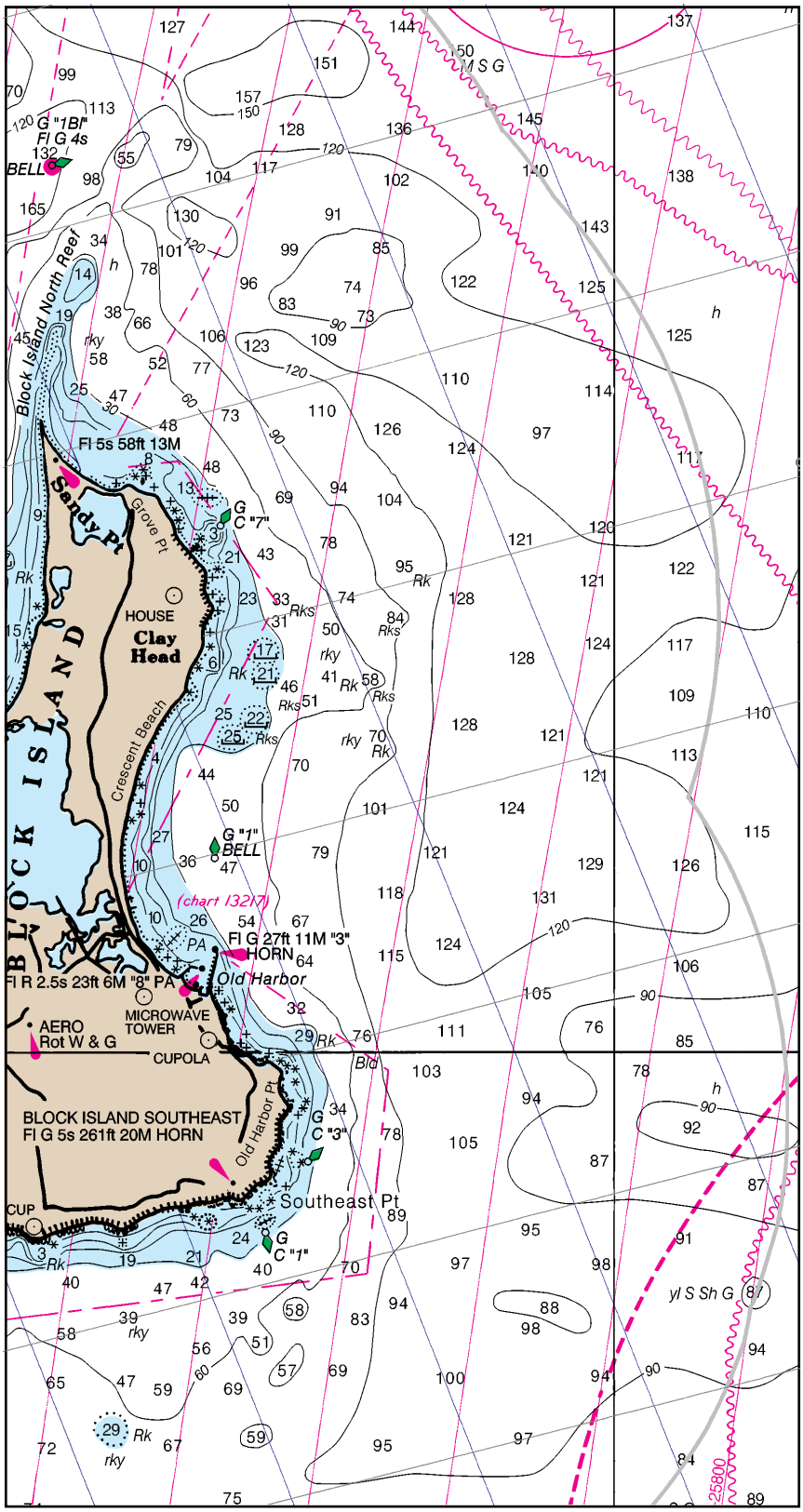

Fig. 4-4. Excerpt from NOS Chart No. 13218 (Martha's Vineyard to Block Island). The 30-foot curve is the limit of the blue tint. Depth curves are shown at 30, 60, 90, 120, and 150 feet. Note that the soundings density is greatest in shoal areas or where necessary to characterize the shape of the bottom. The characteristic of the bottom is principally rocky, and there are numerous sunken rocks in the area. Two dangerous sunken wrecks can be seen, with unknown depths.

BEAUFORT INLET

The project depth is 30 feet to Morehead City. For controlling depths, use chart 11547.

If the reported depth is less than the charted depth, an additional notation such as *"Reported shoaling in channel 1986"* is added.

–Symbols

Dashed lines are used to show channel limits for improved channels. The line thickness, length of dash, and space vary with the type of channel. Blue tint is charted inside the limits of improved channels when the project depth or controlling depth is equal to or less than the value of the charted blue tint curve or when the seaward end of an improved channel terminates in a blue tint area, regardless of channel depth.

Figure 4–5 presents an excerpt from NOS Chart No. 12314 (Delaware River, Philadelphia to Trenton), which shows how improved channels are depicted on the nautical chart. A table of channel depths is included elsewhere on this chart. Controlling depths in this area are between 16 and 18 feet according to surveys of 1-91. There is actually a powerplant located near the two stacks to the right of the Duck Island Range. Barges laden with coal are unloaded at the overhead conveyor. Note that barges coming from seaward (the south) cannot travel directly to the conveyor from the main channel. Rather, they must be pushed north to the Perriwig Channel to avoid shoals and rocks. Here is indisputable evidence of the benefits of a chart!

Bottom Characteristics

The character of the bottom is identified on all nautical charts, particularly in harbors, designated anchorages, and all other areas where vessels may anchor. Bottom characteristics determine the suitability of the area for anchoring, and the type of anchor best suited to the area (see Hinz, or the introduction to appendix A).

Bottom characteristics are of interest for other reasons. According to the *Nautical Chart Manual,* bottom characteristics are charted to provide the following information;

"1. They assist fishermen in selecting areas where fish may be found and in avoiding places where nets and equipment may be damaged.

"2. In tidal areas, they show where vessels may safely take the ground at low water.

"3. In shoal areas, they help navigators to assess the stability of shoals and to distinguish rocky areas from areas of unconsolidated materials."

Descriptors used for bottom characteristics are shown in Section J of Chart No. 1. The most commonly used bottom characteristics on nautical charts are provided in table 4–4. Definitions of these terms are given in appendix A. Nouns and their abbreviations begin with a capital letter; adjectives or qualifying words and their abbreviations are composed of lowercase letters only. Bottom characteristics are charted in black italic type.

Figure 4–4 also shows the use of bottom descriptors. In the area around Block Island, the bottom is described in various places as *"hrd"* (hard), *"rky"* (rocky), *"Blds"* (boulders), *"yl S Sh G"* (yellow sand, shells, and gravel), and *"M S G"* (mud, sand, and gravel).

Specific Hazards to Navigation

The balance of this chapter addresses specific hazards to navigation, including danger curves, rocks, shoals, ledges and reefs, foul areas, wrecks, obstructions, marine structures, unexploded ordnance, and dangerous water conditions. Many of these objects/areas have special symbols described in Chart No. 1. Specific references to section of Chart No. 1 are shown in parentheses. Thus, for example, the symbol used to represent the danger curve or danger line is shown in Section K, item 1, of Chart No. 1. It is noted in what follows as "danger curve (K 1)." Although pertinent excerpts of Chart No. 1 are included in this and other chapters, space constraints do not permit inclusion of the entire chart in this manual. Users should read this

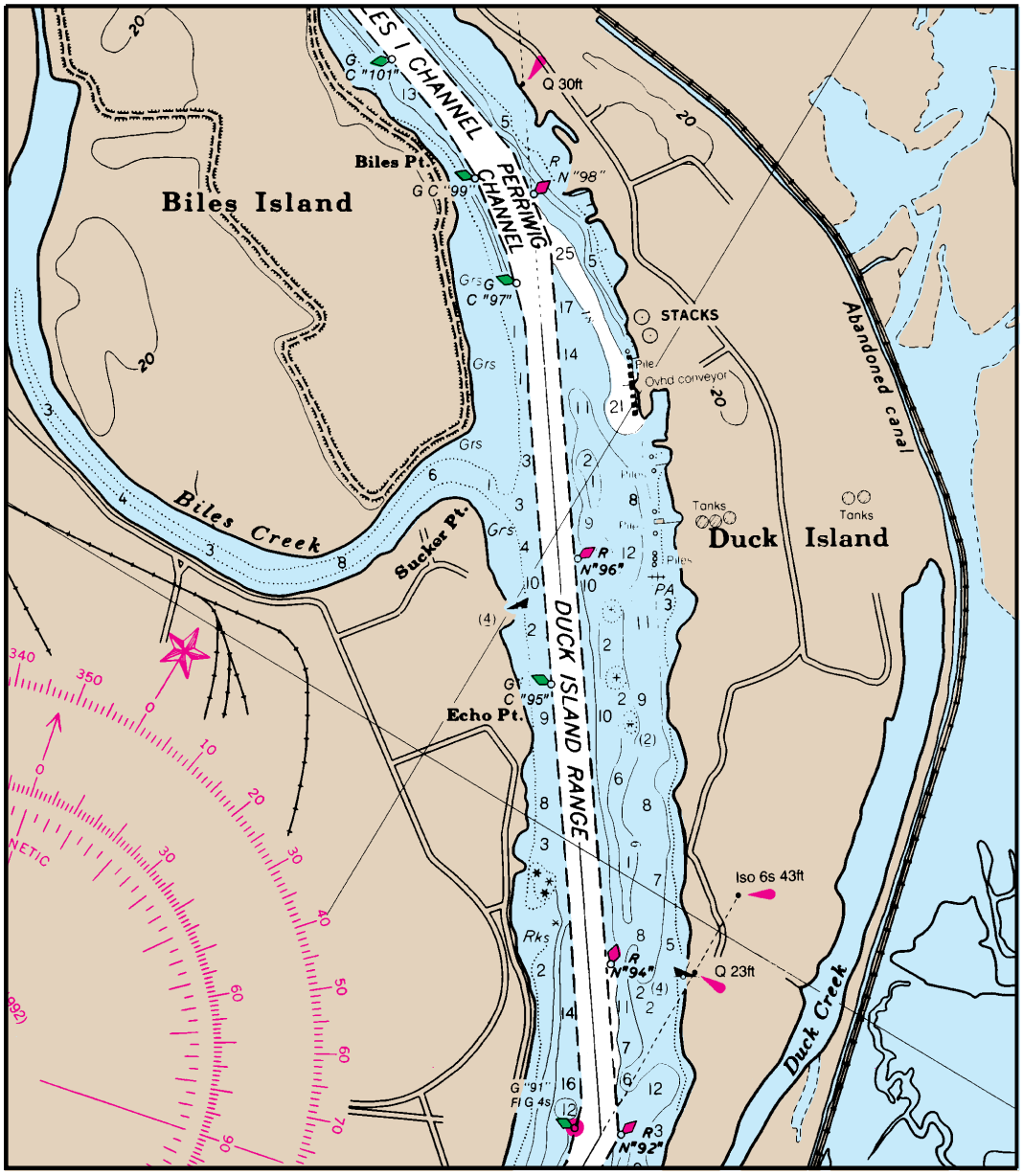

Fig. 4-5. Excerpt from NOS Chart No. 12314 (Delaware River, Philadelphia to Trenton). This excerpt illustrates the chart conventions for depicting improved channels. A table of controlling depths for each channel segment is shown elsewhere on the chart.

manual with a copy of Chart No. 1 at hand for ready reference.

As a point of general interest, it is useful to note the type convention used to depict these objects/features. Vertical type is used for names of topographic features and fixed objects, which extend above high water—i.e., "bare" features are shown in conventional type. *Slant (italic) type is used for names of hydrographic features, including names of water areas, underwater features, and floating ATONs (see Chapter 5).* Because this convention is common to all charted items discussed below, a discussion on type styles is not repeated in each of the subsections, except where necessary for clarity.

The various specific dangers to navigation are charted principally to alert the mariner to submerged artificial and natural hazards. However, it should be noted that certain types of vessels may congregate in these areas, and present an additional collision hazard. Thus, for example, private and charter fishing vessels

TABLE 4-4
Bottom Characteristics and Abbreviations

Nouns		
Noun	**Source Abbreviation**	**Chart Abbreviation**
Boulders	Blds	Blds
Clay	Cl	Cy
Coral	Co	Co
Coralhead	ClHd	ClHd
Gravel	G	G
Grass	Grs	Grs
Mud	M	M
Ooze	Oz	Oz
Pebbles	P	P
Sand	S	S
Shells	Sh	Sh
Shingle	Sn	Sn
Silt	Silt	Si
Stones	St	St
Seaweed	Wd	Wd

Adjectives		
Adjective	**Source Abbreviation**	**Chart Abbreviation**
Broken	brk	bk
Coarse	crs	c
Dark	dk	dk
Fine	fne	f
Gritty	gty	gty
Hard	hrd	h
Large	lrg	lrg
Light	lt	lt
Rocky	rky	rky
Small	sml	sml
Soft	sft	so
Speckled	spk	spk
Sticky	stk	sy

Colors	
Color	**Abbreviation**
Black	bl
Blue	bu
Brown	br
Gray	gy
Green	gn
Orange	or
Red	rd
White	wh
Violet	vi
Yellow	yl

SOURCE: *Nautical Chart Manual*

may be found in the vicinity of fish havens and wrecks, dive boats may be found in the area of charted wrecks, and service vessels of various types may be found in the area of artificial platforms. Rule 5 of the Navigation Rules specifies:

> "Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision."

Particular vigilance is appropriate in areas of greatest vessel density.

Figure 4–6 provides an excerpt of Section K from Chart No. 1, which illustrates many of the symbols referenced in what follows.

Danger Curve (K 1)

According to the *Desk Reference Guide,* a *danger curve...*

> "...is a dotted curve used to draw the navigator's attention to a danger which would not stand out clearly enough if it were represented on the chart solely by other specific symbols. This dotted curve is also used to delimit areas containing numerous dangers, through which it is useful to navigate."

Danger curves are used to outline areas or emphasize discrete features (e.g., rocks, shoals, submerged structures) that are known or potential hazards to navigation. As with depth curves generally, the limiting line is always charted on the side of safety—that is, the danger curve is either drawn to scale or slightly larger, to help ensure that any errors are conservative.

Submerged structures covered by 66 feet, or 11 fathoms (20 meters) or less are indicated by a dotted danger curve enclosing the symbol for the particular danger. If the structure is covered by depths greater than 11 fathoms (20 meters), the danger curve is charted only if the structure is considered hazardous to navigation.

–Charting Practices

The danger curve is charted with a black dotted line. Insofar as possible, the danger curve is charted in its exact geographic position. This curve is an integral part of other symbols used to depict hazards. If chart space presents a problem for inclusion of a specific symbol within a danger curve, the symbol may be omitted and only the depth included. Areas enclosed by a danger curve that are less than 2.5 mm in diameter at chart scale are charted with the minimum size circle 2.5 mm in diameter. Adjacent features individually enclosed with a danger curve may be enclosed with a common generalized curve on small-scale charts. *A blue tint is used within a danger curve to mark depths of 66 feet or 11 fathoms or less. The blue tint can be used in areas of greater depths if the object is considered a hazard to navigation.*

–Labels and Notes

Appropriate labels are included to describe the danger being enclosed with the danger curve.

Rocks (K 10-17, a, b, f)

According to the *Desk Reference Guide,* a *rock...*

> "...is an isolated large mass of stone, usually one constituting a danger to navigation. Rock is a collective term for masses of hard material generally not smaller than 256 mm.
>
> Rocks are classified as bare, awash, rocks awash at the sounding datum only, or sunken. Bare rocks are those extending above the plane of *mean high water* [MHW see figure 4–1]; rocks awash are those exposed at some stage of the tide; ...sunken rocks are those covered at the chart datum. A sunken rock is potentially the most dangerous natural hazard to navigation. When selecting rocks for [charting], the character of the area, whether exposed or protected; the proximity to shore; the range of tide; and the probable visibility of the rock at some stage of the tide are factors to be considered. Special care shall be used in

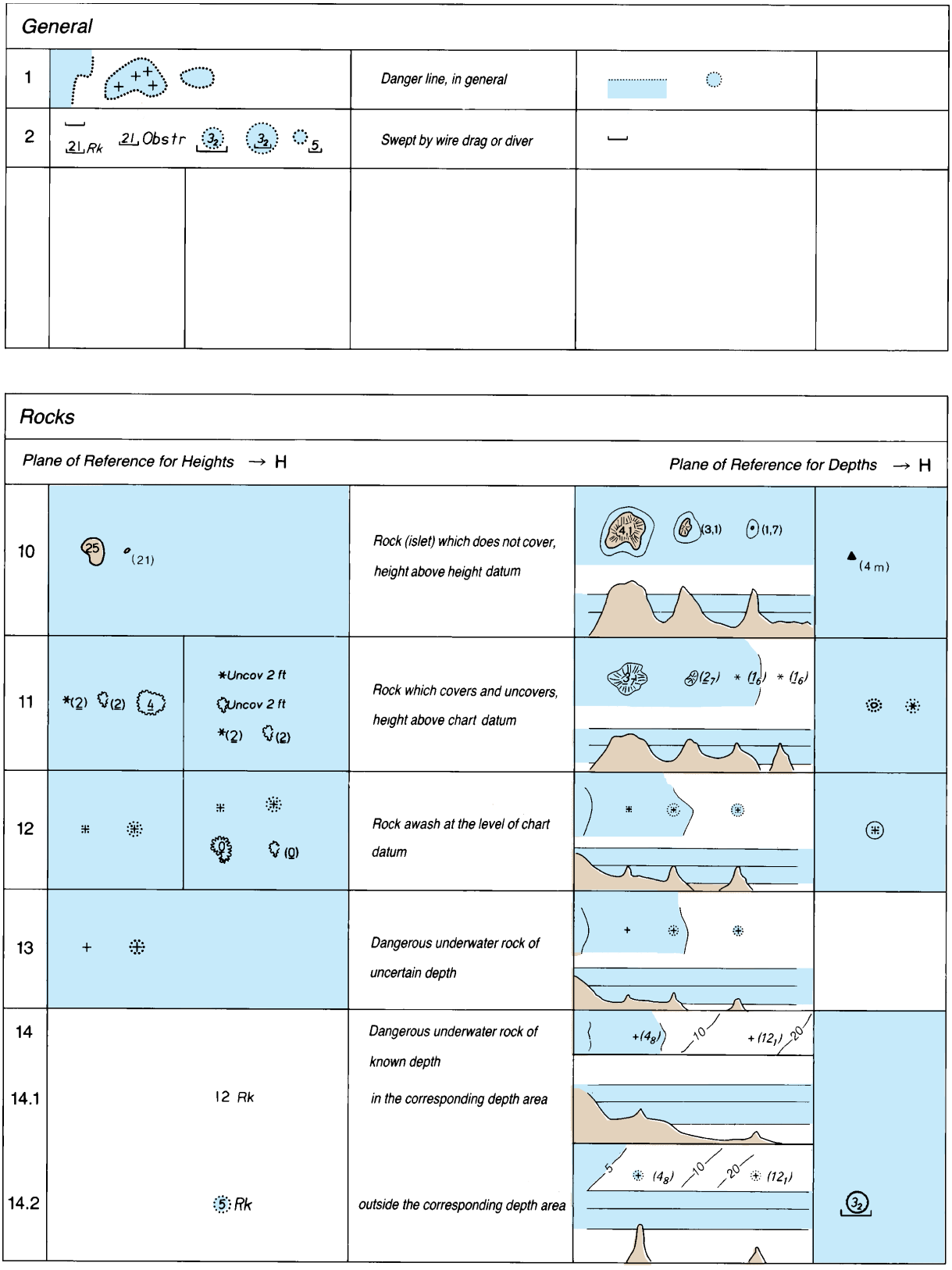

Fig. 4-6. Excerpt from Section K of Chart No. 1

Continued on next page

15	+ 35 Rk	35 Rk	Non-dangerous rock, depth known	21 R	35 R. 35 R +(35)
16	Co, Reef Line		Coral reef which covers	Co, Co	
17	Breakers	Br	Breakers	19, 5 Br, 18	

Wrecks					
Plane of Reference for Depths → H					
20	Hk	Hk	Wreck, hull always dry, on large-scale charts	Wk	
21		Hk	Wreck, covers and uncovers, on large-scale charts	Wk	Wk, Wk, Wk, Wk
22			Submerged wreck, depth known, on large-scale charts	5 2 Wk	9 Wk
23		Hk	Submerged wreck, depth unknown, on large-scale charts	Wk	Wk, Wk
24	PA		Wreck showing any portion of hull or superstructure at level of chart datum		Wk, Wk, Wk
25	Masts, Mast (10 ft) Funnel		Wreck showing mast or masts above chart datum only	Mast	
26	5 2 Wk		Wreck, least depth known by sounding only	4 6 Wk, 25 Wk	(9)
27	21 Wk, 5 Wk	21 Wk, 5 2 Wk, 5 Wk	Wreck, least depth known, swept by wire drag or diver	4 6 Wk, 25 Wk	21 Rk
28			Dangerous wreck, depth unknown		
29			Sunken wreck, not dangerous to surface navigation		
30	8 Wk		Wreck, least depth unknown, but considered to have a safe clearance to the depth shown	25 Wk	5

Fig. 4-6. Excerpt from Section K of Chart No. 1

Continued on next page

31	Foul Wks # Wreckage	Foul Wks Wreckage	Remains of a wreck or other foul area, dangerous to navigation should be avoided by vessels anchoring, trawling etc.	# Foul	# / FB

Obstructions					
Plane of Reference for Depths → H				Kelp, Sea-Weed → J	
40	Obstn	Obstn	Obstruction, depth unknown	Obstn Obstn	#
41	5½ Obstn	5½ Obstn	Obstruction, least depth known	4 6 Obstn 16 8 Obstn	
42	21 Obstn 5 Obstn	21 Obstn 5 Obstn	Obstruction, least depth known, swept by wire drag or diver	4 6 Obstn 16 8 Obstn	
43.1	Subm piles Stakes, Perches	Subm piles Subm piling	Stumps of posts or piles, all or part of the time submerged	Obstn	Subm piles
43.2	Snags Stumps		Submerged pile, stake, snag, well or stump (with exact position)		
44.1	Fsh stks		Fishing stakes		
44.2			Fish trap, fish weirs, tunny nets		
45			Fish trap area, tunny nets area	Fish traps Tunny nets	
46.1	Obstruction (fish haven) (actual shape)	Obstruction (fish haven)	Fish haven (artificial fishing reef)		
46.2	Obstn Fish haven (Auth min 42 ft)		Fish haven with minimum depth	(24) 24	
47	Oys		Shellfish cultivation (stakes visible)	Shellfish	

Fig. 4-6. Excerpt from Section K of Chart No. 1

Continued on next page

Supplementary National Symbols					
a	*		Rock awash (height unknown)		
b	5 Rk	5 Rks	Shoal sounding on isolated rock or rocks		9 R 2 P 2 r (8)
c			Sunken wreck covered 20 to 30 meters		
d	Sub vol		Submarine volcano		
e	Discol water		Discolored water		
f	21 Rk	3_2 3_2	Sunken danger with depth cleared (swept) by wire drag		Obstn 21 5
g	Reef		Reef of unknown extent		
h	Co	Coral Co Co Co	Coral reef, detached (uncovers at sounding datum)		
i	Subm Crib		Submerged Crib		
j	Crib (above water)		Crib (above water)		
k			Submerged Crib with depth		(2)
l			Crib with drying height		(2)

Continued

Fig. 4-6. Excerpt from Section K of Chart No. 1

charting dangerous rocks. Isolated and dangerous rocks, whether bare, awash, or sunken, shall be emphasized by a danger curve encircling the symbol." [Material in brackets has been inserted for clarity.]

Rocks are particular hazards to navigation. Running into a rock not only grounds the vessel—problem enough—but also may severely damage the hull of the vessel. Attempts to free the vessel may only make matters worse if the hull was damaged by the grounding (Cahill, Minnoch).

Bare rocks, however, can serve as useful landmarks for fixing a vessel's position. A sufficiently prominent bare rock at or near a sunken rock or other danger may be an excellent natural marker for the sunken hazard—a natural wreck marker. In cases where the bare rock is in the general vicinity of invisible hazards to navigation, this rock can be used by the mariner to establish a danger bearing or danger circle (see Bowditch, Dutton).

–Charting Practices

Charting conventions consist of a *symbol,* and various *labels or notes,* which could include the height of the rock, depth of water over the rock, and the name of the rock. Names and labels or rocks covered or periodically covered at certain tide levels or that refer to the sounding datum are charted in black italic type. Corresponding labels for bare rocks are shown in vertical type. Symbols and labels are discussed below.

–Rocks Symbols and Labels

The classification of rocks shown on NOAA charts varies according to the geographic location of the charted area—Atlantic and gulf coasts, Pacific coast, and Great Lakes. For this reason, separate remarks are included for each region.

–Bare Rock (K 10)

A bare rock (islet) is defined as one with an elevation at least 2 feet above MHW for the Atlantic and gulf coasts, at least 3 feet above MHW for the Pacific coast, and at least 5 feet or more above low-water datum for charts of the Great Lakes. An islet is charted in its exact geographic location. Islets are drawn to scale (if possible at the chart scale). If not, the bare rock symbol (K 10) is used. On small-scale charts, the minimum size (0.5 mm by 0.65 mm) symbol may exaggerate the size of the rock. If known, the elevation (in feet or meters above the chart datum) is shown in vertical type enclosed in parentheses.

In some cases, fixed ATONs are located on a rock. The light or daybeacon symbol (see Chapter 5) takes precedence over the rock symbol. (Cartographers take particular care to restore the rock symbol if the light or daybeacon is moved.)

–Rocks Which Cover and Uncover (K 11)

A rock which covers and uncovers (rock awash) is defined as a rock with an elevation 1 foot above MLLW to less than 1 foot above MHW for the Atlantic and gulf coasts, 2 feet above MLLW to less than 2 feet above MHW for the Pacific coast, and 2 feet above low-water datum to 4 feet above low-water datum for the Great Lakes. A rock awash is charted in its exact geographic location and shown to scale if possible. If not, the symbol (K 11) for this type of rock is used. If known, the elevation (in feet or meters above the chart datum) is given in vertical type. For these rocks, the elevation is charted in vertical type enclosed in parentheses and underlined.

–Rocks Awash at the Level of Chart Datum (K 12)

A rock awash at the level of chart datum is defined as a rock with an elevation 1 foot below MLLW to less than 1 foot above MLLW for the Atlantic and gulf coasts, 2 feet above MLLW to less than 2 feet above MLLW for the Pacific coast, and 2 feet below low-water datum to less than 2 feet above low-water datum for the Great Lakes. This rock is charted in its exact geographic location and shown to scale if possible. If not, the symbol (K 12) for this type of rock is used.

–Sunken Rocks (K 2, 13)

A sunken or submerged rock is defined as a rock covered more than 1 foot at MLLW for the Atlantic and gulf coasts, more than 2 feet at MLLW for the Pacific coast, and covered more

than 2 feet at low-water datum for the Great Lakes. If the depth is unknown, a special symbol (K 13) is charted. If the depth is known, it is given (in feet or meters relative to chart datum).

A depth determined by a wire-drag survey is denoted by a special symbol (K 2). The maximum wire-drag cleared depth over a rock is charted.

Critical dangers to navigation, including rocks, located under bridges are charted in their position on the largest scale chart coverage. The bridge symbol is broken when such dangers are charted beneath the bridge structure—a policy that reflects the potential importance of the hazard.

Figure 4–7 provides illustrations of chart conventions for numerous hazards to navigation.

–Doubtful Danger Labels

In some cases information regarding rocks or other specific hazards is uncertain or incomplete. A series of labels (and associated definitions) has been developed and may be appended to the symbol. According to the *Desk Reference Guide,* these *labels* include:

> "SD" (Sounding Doubtful). Of uncertain depth. This shall be used when a depth shown on a chart over a rock is strongly suspected of being less than that stated. The position is not in doubt.
>
> "Rep" (Reported). The "Rep" label shall be attached to a charted rock because it is considered dangerous to navigation, but which has not been confirmed by an authoritative field observation party. The year the feature is reported shall be included as part of the label (e.g., Rep (1985)) and shall be enclosed with parentheses. "Rep" may be combined with the other labels in these groups.
>
> "ED" (Existence Doubtful). Of uncertain existence. The expression shall be charted to indicate the possible existence of a rock, the actual existence of which has not been established.
>
> "PA" (Position Approximate). Of inexact position. The expression shall be charted to state that the position of a rock has not been accurately determined. The plotting of an object from preliminary data is not of the desired accuracy [10 feet, see Chapter 6] . . ., but it is acceptable for interim charting until an accurate position is available.
>
> "PD" (Position Doubtful). Of uncertain position. This expression shall be charted to indicate that a submerged rock has been reported in various positions but no one position has been definitely verified. The existence of the feature is not in question, only its correct position.

Similar labels are used to depict other hazards, so these labels are not repeated in each of the following sections. As a practical matter, mariners would do well to resolve the cartographers' uncertainty by assuming that the feature exists. Where adequate safe water exists adjacent to the feature, mariners should simply avoid the potentially hazardous area.

Shoals (K b, O 25)

According to the *Desk Reference Guide,* a *shoal...*

> "is an offshore hazard to navigation on which there is a depth of 16 fathoms (30 meters) or less, and is composed of any material except rock or coral."

Although not all shoals are hazards to navigation for all vessels—note that shoals can have charted depths as great as 30 meters—shoals certainly represent a hazard for deep-draft vessels. Moreover, water over a shoal may be disturbed and present other hazards to recreational vessels even if there is sufficient depth over the shoal. Finally, the prudent mariner should remember that shoals can shift location—particularly after storms or in areas of strong currents. Where these conditions are known, these are noted as "changeable areas" and hydrography is not reported. However, care is always required when navigating shoal areas (e.g., *Professional Mariner,* Issue No. 1).

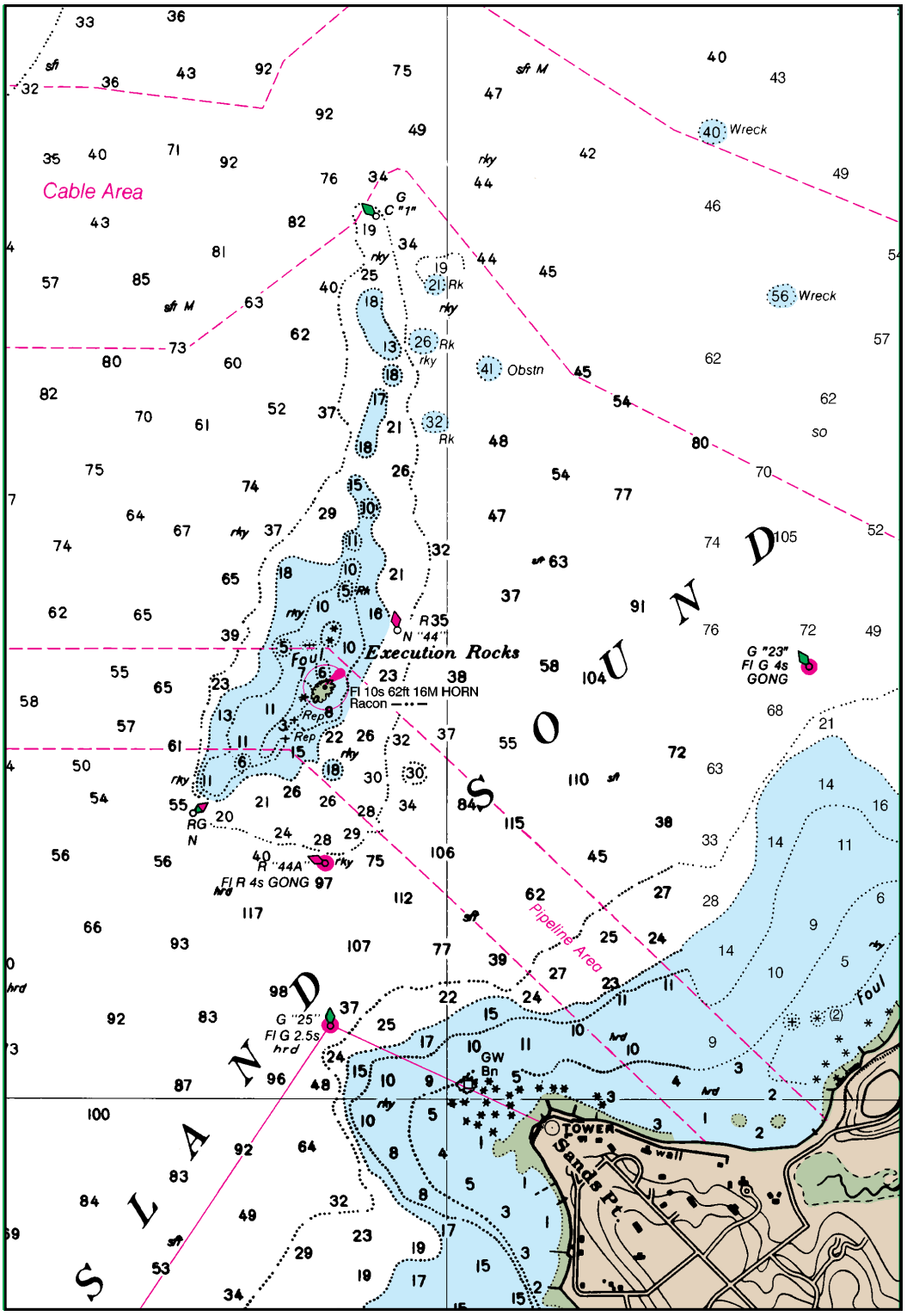

Fig. 4-7. Excerpt from NOS Chart No. 12366 (Long Island Sound and East River). This excerpt shows a number of hazards, including danger curves, foul areas, sunken rocks, wrecks, obstructions, and pipeline and cable areas.

–Charting Practices

Shoals are depicted by *soundings, danger curves*, and *blue tint* as appropriate (see above). Shoals are charted in their exact geographic positions. Shoals carry the primary label *"Shoal"* (or abbreviation *"Shl"* where space is limited) in black italic type. The label may include the name of the shoal (e.g., *"Nebraska Shoal"*). If the danger is doubtful or its position approximate, the appropriate qualifiers (i.e., "SD," "PD," "ED," or "PA") are included.

Ledges and Reefs (Various)

According to the *Desk Reference Guide, ledges and reefs* are defined as follows:

> "A ledge is a rock formation connecting and fringing the shore of an island or large land mass; it is generally characterized by a steep sheer in the submarine topography.
>
> "A reef is a rocky or coral formation dangerous to surface navigation which may or may not uncover at the sounding datum. A rocky reef is always detached from shore; a coral reef may or may not be connected with the shore."

Reefs and ledges are further subdivided into *uncovering ledges and reefs* (J 21, J 22, K h), *submerged ledges and reefs* (K 16, K g), and *oyster reefs* (K 1, K 47). Obviously, reefs and ledges represent a major hazard to navigation. Running aground on ledges and reefs, as with rocks, entails the ever present danger of structural damage. Moreover, these are (at least at some part of the tidal cycle) invisible dangers to navigation. Their depiction on the nautical chart is, therefore, particularly important.

–Charting Practices

Charting conventions consist of a *symbol* and various explanatory *labels and notes.*

For uncovering ledges and reefs standard symbols (J 21, J 22, and K h) are charted. A label is added when scale permits to identify the feature, e.g., *"Rock"* or *"Coral."* Names may be incorporated into the label.

Submerged ledges and reefs are shown by a danger curve (black dotted line), and blue tint to delineate the limits of the feature. A label is added to further identify submerged ledges and reefs, e.g., *"Subm ledge" or Subm reef."* Depths over rocks and coral heads within submerged ledge or reef limits are charted using soundings and labels, e.g., *"5 Rk"* or *"5 Co Hd."* If the depth over these features is unknown, the submerged rock symbol (K 13) is used with the appropriate label.

On small-scale charts where space constraints limit the amount of detail that can be included, the most shallow depth over the submerged ledge or reef is included in the label. As with other underwater features, labels are shown in italic type, e.g., *"Subm ledge (cov 5 feet at MLLW)."*

Oyster reefs are charted using the same charting conventions. If oyster reefs bare at the chart sounding datum, green tint is added to the dotted danger curve. A label is added to identify oyster reefs, e.g., *"Oyster Bar,"* or *"Oyster Reef"* in italic type. Oyster reefs and bars are charted if these present a hazard to navigation or upon request or recommendation of state or local agencies for informational purposes.

Foul Area (K 31)

According to the *Desk Reference Guide,* a *foul area...*

> "is an area of numerous uncharted dangers to navigation. The area charted serves as a warning to the mariner that all dangers are not charted individually and that navigation through the area may be hazardous."

A foul area is an area where the bottom is known to be strewn with rocks, reefs, boulders, coral, obstructions, heavy concentrations of kelp, or other debris that could impede navigation. Foul grounds should be avoided by vessels intending to anchor or engage in activities, such as trawling, which could be adversely affected by the presence of hazards in the foul area (e.g., nets could snag). The term foul does not apply to areas where the bottom is soft (e.g., mud or sand) or composed of other bottom

materials not likely to cause damage to a vessel or otherwise restrict activities.

–Charting Practices

A foul area is charted with a *limiting danger curve* (see above) and *label(s).* A *blue tint* and *soundings data* may also be included.

–Symbol (K 31)

The symbol for a foul area (K 31) may be shown in isolation, but may also be combined with other symbols, e.g., those for rocks, to provide a more complete description to the mariner.

Important visible objects located in foul areas, which are useful as landmarks (see Chapter 6 for chart conventions for landmarks), are also charted. These landmarks can alert the mariner to the presence of the foul area and be used for danger bearings, etc. (see Bowditch, Dutton).

Foul areas are charted in their exact geographic positions as provided in the source material available to cartographers. Where possible, foul areas are charted to scale to show the actual size and shape of the actual foul area. Foul areas less than 2.5 mm in diameter at chart scale are charted with the minimum size (2.5 mm) symbol. A blue tint is added to foul areas dangerous to navigation, generally those having depths of 66 feet or 11 fathoms (20 meters) or less, when enclosed with a danger curve and not supported by depth contours and soundings.

–Label(s) and Notes

Descriptive labels, including *"Foul," "Foul Area," "Boulders," "Blds," "Kelp," "Danger line," "Reef line,"* are included to indicate the type of danger present. Labels are printed in black italic type.

Wrecks and Hulks (K 20-31)

According to the *Desk Reference Guide,*

> "A WRECK is the ruined remains of a vessel which has been rendered useless, usually by violent action, such as the action of the sea and weather. In hydrography the term is limited to a wrecked vessel, either submerged or visible, which is attached to or foul of the bottom or cast upon the shore.
>
> "A HULK is generally defined as the remnants of an abandoned wrecked/stranded vessel, the actual shape of which is shown on large-scale charts. May also be used to define stored or permanently berthed vessels where actual shape is shown on large-scale charts."

Wrecks depicted on nautical charts are classified as either *stranded* or *sunken (Nautical Chart Manual).* A stranded (visible) wreck is defined as one which has any portion of the *hull* or *superstructure* above the sounding datum. Submerged wrecks are located below the sounding datum or have only the masts visible.

Wrecks are continually subject to the effects of current and weather. As a result, wrecks can change in physical form and in location. Particularly if not visible and at depths at or near the draft of the vessel, wrecks present a hazard to navigation. Important information received on "new" wrecks or changes in the status of existing wrecks are published in the NM and LNM.

Wreck locations are not only of interest to mariners seeking to avoid potential dangers, but also to divers and charter captains. Fishing vessels using nets generally avoid areas with wrecks because of the potential for wrecks to snag or damage nets.

–Charting Practices

All stranded and sunken wrecks are charted on the largest scale chart nautical chart of the area. Wrecks not classified as dangerous (see below) are omitted on charts smaller than 1:150,000 scale in areas covered by larger scale charts. Charting conventions for wrecks/hulks consist of a *symbol, labels and notes,* and *blue or yellow tint.* Additionally, doubtful or questionable wrecks are so noted by appropriate label (e.g., "PA," "PD," "ED," etc).

–Symbols, Labels, and Tints

Stranded wrecks are charted with a standard black symbol (K 24) which may face either

left or right. The baseline of the symbol is shown parallel to the bottom of the chart, and the small "circle" at the base of the symbol (look closely at the symbol) marks the published position of the wreck. If the scale of the chart is sufficiently large, the true outline of a stranded wreck is shown with a solid line, land (gold) tint, and labeled. If a significant portion of the wreck is determined to be bare at the SPOR, it is considered a topographic feature and labeled with vertical, rather than italic, type.

Sunken wrecks are considered dangerous to navigation if any part of the wreck lies at 66 feet or 11 fathoms (20 meters) or less below the sounding datum. Wrecks deeper than 66 feet or 11 fathoms may also be considered dangerous in areas expected to be traveled by deeper draft vessels. Wrecks in areas where water depths and submerged features have been removed (changeable areas) are not charted as this information could be misleading. Dangerous sunken wrecks are denoted by one of several symbols (K 25-28) as noted below:

> Dangerous wrecks lacking precise depth information and those where the depth over the wreck is unknown are charted with the center cross lines of the dangerous wreck symbol (K 28) marking the published position of the wreck. The symbol is rotated so that it is coincident with the known alignment of the wreck. If the alignment of the wreck is unknown, the symbol is aligned with the baseline of the chart. A blue tint is added for emphasis within the enclosing danger curve.
>
> Sunken wrecks with only their masts visible at the sounding datum are charted using symbol (K 25) with the added label *"Masts."*
>
> A dangerous wreck over which a precise least depth has been determined is charted with a sounding surrounded by a dotted danger curve, blue tint, and a label (K 26).
>
> A cleared depth obtained by a wire-drag survey over a dangerous wreck is shown with a sounding surrounded by a dotted danger curve, blue tint, a wire-drag symbol outside the danger curve below the sounding, and the label *"Wk"* (K 27).
>
> The label *"Wreckage"* and a dotted danger curve (K 31) is used to identify areas where numerous dangerous wrecks are located or where the wreckage is scattered. Blue tint is added within the danger curve.
>
> Sunken wrecks that are not deemed to be dangerous to surface vessels expected to frequent the area are charted with a sunken wreck symbol only (K 29).

–Wrecks Marked by Buoys

Buoys used to mark dangerous wrecks are charted in their exact position if possible (see Chapter 5). However, if the chart scale does not permit showing both symbols in their exact locations, the wreck is charted in its exact location, and the buoy is moved slightly.

Obstructions (K 40-42)

According to the *Desk Reference Guide,* an *obstruction...*

> "is anything that might hinder marine navigation. An obstruction on a nautical chart is usually considered to be a hard, unyielding isolated object, such as a sunken rock or manmade article commonly located in deeper depths, that would endanger or prevent the safe passage of vessels. The term 'obstruction' is often used as a preliminary label for reported dangers until they can be identified and properly labeled, and includes such objects as submerged piles, sunken wrecks, uncharted rocks, etc."

From the mariner's perspective, obstructions have the same significance as rocks or wrecks—obstructions are objects that may present a

hazard to navigation. The majority of items charted as obstructions are reported to NOAA through the NM and LNM and from USCGAUX and USPS reports.

–Charting Practices

The guidelines for classifying an obstruction as dangerous to surface navigation are the same as those used for sunken wrecks and rocks—e.g., those covered by 66 feet or 11 fathoms (20 meters) or less of water, unless in an area frequented by deeper draft vessels. An unidentified submerged object that is not considered to be the remains of a submerged wreck and is not considered a danger to surface navigation is termed a *"Snag"* rather than an obstruction.

Obstructions are charted with *symbols, labels,* and a *blue tint.* Appropriate qualifiers (e.g., *"*ED, *"*), discussed above, are included if the obstruction is questionable or uncertain.

–Symbols and Labels

Three symbols are used to depict obstructions (K 40-42), depending upon the available depth information. These objects are charted to scale in the exact position of the obstruction and enclosed with a danger curve filled with blue tint. If the chart scale does not permit a rendition to scale, the minimum size (2.5 mm) circle is used. All obstructions carry the label abbreviation *"Obstn"* in black italic type.

Snags are charted with a 1 mm circle and labeled *"Snag."*

The depth over the obstruction is charted if known. In cases where a cleared depth over the charted position has been obtained from a wire-drag survey, the label *"cleared __ ft 19__"* is added.

Natural Dangers (K 43.2)

Natural dangers include deadheads, logs, snags, and stumps. Running into any of these dangers can cause structural problems and/or damage propellers. (It is generally agreed by most mariners that propellers are not the depth sounding apparatus of choice!) Definitions and charting practices for these natural dangers are described briefly below.

A deadhead is a grounded log or tree trunk often floating free at one end or below the surface of the water. A deadhead is usually charted with a 1 mm circle and labeled *"Snag."*

Logs that are grounded with some parts visible above the surface of the water are charted in some cases. These logs are charted with a 1 mm circle and labeled *"Snag."*

A tree or branch embedded in a river or lake bottom and not visible on the surface is charted as a snag.

Stumps are the stationary remains of trees, often submerged. These are labeled *"Stumps."*

Fish Havens Regulated by State and Federal Permits (K 46.1, K 46.2)

Fish havens are artificial shelters constructed of rocks, concrete, car bodies, and other debris and put on the seafloor to attract fish. Fish havens are often found in the vicinity of fishing ports or major coastal inlets and are usually considered hazards to navigation (and certainly to anchoring). Some fish havens are periodically altered, which increases the potential hazard.

–Charting Practices

Fish havens are denoted with a *symbol* (K 46.1, K 46.2), *labels/notes, soundings,* and *blue tint* (if considered a danger to navigation). Fish havens are charted in their exact position and to scale—subject to a minimum dimension of 2 mm to ensure that the chart feature is readily recognizable. Fish havens with authorized minimum depths of 66 feet or 11 fathoms (20 meters) or less are charted with a dotted limiting danger curve and blue tint. Those greater than 66 feet or 11 fathoms are charted with a dashed limiting danger curve and no tint, unless the fish haven is considered to be a danger to navigation, in which case the blue tint is used. The label *"Fish Haven"* is appended.

Fish havens are often marked with privately

maintained buoys. These are charted if published in the LNM but omitted otherwise.

Miscellaneous Hazards

Other hazards that are charted when considered dangerous to navigation include marine structures (e.g., platforms and cribs, fishing and hunting structures, drilling platforms), fishing structures (e.g., fish/crab pens, fish stakes, and fish traps, weirs, tunny nets), floating structures (e.g., floats, floating breakwaters, and floating piers), logging structures (log booms), mineral development structures (e.g., wells, wellheads, platforms, and artificial islands). Charting practices are similar to those identified above. Space constraints do not permit an exhaustive discussion of each of these hazards in this manual. A brief sampling of the chart symbols used to depict these hazards includes:

Platforms and Cribs; charted as topographic features if at or above the shoreline plane of reference, charted as hydrographic features if below the shoreline plane of reference.

Fish Stakes (K 44.1)

Fish Traps, Weirs, Tunny Nets (K 44.2, K 45)

Floating Breakwaters (F 4.1)

Log Booms (N 61)

Wells (L 20)

Wellheads (L 21.1-21.3, L 13)

Artificial Islands (L 15)

Dolphins (F 20), Piles (F 22, K 43.1, K 43.2)

Unexploded Ordnance

According to the *Desk Reference Guide,* the term *unexploded ordnance...*

"...refers to any undetonated explosive material which is reported to be outside the charted limits of established regulated explosives dumping areas. (Unexploded bombs, depth charges, torpedoes, ammunition, pyrotechnics, etc.)"

Unexploded ordnance generally does not pose a hazard for transiting vessels, but anchoring in these areas could be risky. Other activities, such as diving, or use of fishing nets would also be imprudent. (Disentangling a torpedo or depth charge from a fouled net would present an unwelcome challenge!) Unexploded ordnance is charted when reported in LNM or by reliable sources. Sunken wrecks containing unexploded ordnance are considered dangerous wrecks and so charted.

–Charting Practices

Charting conventions for unexploded ordnance consist of a *symbol* and *explanatory labels.*

–Symbols

Unexploded ordnance areas are outlined with a dashed line. The ordnance is charted in its exact geographic positions. The dashed limit lines are charted to scale. If the area is less than 2.5 mm in diameter at chart scale, the minimum size 2.5 mm symbol is used. The size of the unexploded ordnance area includes an allowance for the uncertainty of the reported position.

Sunken wrecks containing unexploded ordnance are charted with the dangerous sunken wreck symbol (see above).

–Labels and Notes

Unexploded ordnance areas are labeled (in black italic type) *"Unexploded Ordnance,"* followed by the year the hazard was reported, *"(Reported 19__),"* in parentheses beneath the area label. Sunken wrecks carrying unexploded ordnance are labeled *"Wk (Unexploded Ordnance)."* The type of ordnance (e.g., bombs, depth charges, etc.) may be charted if known.

Unsurveyed Area (I 25)

According to the *Desk Reference Guide,* an *unsurveyed area...*

"...is an area on a nautical chart where hydrographic surveys are unavailable or limited. These areas are usually labeled 'Unsurveyed.' "

Unsurveyed areas are charted to alert the mariner to areas where depth information is unknown. In general, hydrographic detail is not charted in areas of continual and rapid change. If a recent survey reveals conditions so different that a satisfactory match (junction) cannot be made with the hydrography of former surveys, a blank band is charted beyond the limits of the more recent survey.

–Charting Practices

Unsurveyed area limit lines are charted with a dashed line (I 25). A blank space approximately 5.0 mm wide is charted between the limits of hydrographic surveys that fail to match satisfactorily.

The label *"Unsurveyed Area"* is charted in black italic type. In constantly changing areas, an appropriate note explaining the lack of hydrography is charted in black. Where surveys do not junction satisfactorily, a note (e.g., *"Hydrography to (eastward) from surveys of 1934"*) is charted in black italic type.

Dangerous Water Conditions (Various)

According to the *Desk Reference Guide, dangerous water conditions...*

"...are physical characteristics of water including visible movement, coloring, and the presence of marine vegetation that constitute a hazard to navigation or indicate the presence of submerged obstructions or shoal areas."

Illustrative dangerous water conditions include rapids/waterfalls (C 22), breakers (C d, K 17), overfalls/tide rips/races (H 44), eddies (H 45), kelp (J 13.2), discolored water (K e), and currents (H 40, 41, H m, t). Their relevance to safe navigation is so obvious as not to require further explanation.

–Charting Practices

Extensive dangerous water conditions are *outlined* and *labeled* to identify the condition. Small areas are charted with symbols or labels only. On conventional and small-craft nautical charts or areas where significant tidal currents exist, tidal current arrows (H 40, 41, H m, t) are charted at locations selected from the "Current Differences" listed in the latest edition of the *Tidal Current Tables.*

–Symbols

As noted, limits to dangerous water areas are charted in their exact geographic positions with a dashed line or (for small areas) with various symbols.

–Labels and Notes

A label describing the nature of the conditions is charted to provide further information. Labels are charted with capital and lower case letters in black italic type; e.g., *"Tide Rips."* Discolored water—often an indication of shoals—is abbreviated *"Discol Water,"* or *"Discol"* if space is at a premium.

Where particularly strong currents exist, a label and a note may be charted in addition to a current arrow and velocity label. The following note provides an illustrative example;

"CURRENTS AT SERGIUS NARROWS

At times the velocity reaches 8 knots. On an average, the current turns from North to South about 2 hours before the time of high water at Sitka and from South to North about 1-3/4 hours before the time of low water at Sitka.

For more precise information consult the Pacific Coast Current Tables of the National Ocean Service which includes predictions of the times of slack and times and velocities of strength for every day of the year."

Additional information on currents may be provided in the form of a current diagram (H t) or limits to major currents, such as the Gulf Stream.

Although not necessarily considered a dangerous water condition, tidal information is relevant to the mariner, and presented in summary form on the nautical chart. Information on the height of the water is presented in two forms, tide notes for areas with appreciable tidal range, and hydrographs (diagrams showing seasonal variability in water levels) for charts of the Great Lakes. In either case, these data are averages of water levels only, and not specific predictions. The notes alert the mariner to the presence of large variations in water level, and the need to consult other references for tidal predictions.

Submarine Pipelines and Cables (L 30.1—44)

Submarine pipelines and cables can be damaged as a result of vessel groundings. Anchors can also damage these objects, and anchoring restrictions are in effect in these areas. Moreover, submarine pipelines may present significant hazards to navigation, similar to a submerged wreck, rock, or other hazards discussed above.

Submarine cables include those used for power transmission and those used for communications. Damage to either can have significant adverse consequences (e.g., loss of power, disruption of communications) as well as causing damage to the vessel and/or its propellers.

–Submarine Pipelines (L 40.1, 40.2, 41.1, 41.2, 43, 44)

Submarine pipelines are partitioned into four classes; those used for *nonvolatile material transport, potable water intakes, volatile material transport,* and *abandoned* (or unused) pipelines.

Nonvolatile material transport pipelines are conduits for the intake of nonpotable water (e.g., for cooling or irrigation purposes) and for discharge of wastes (e.g., cooling water).

Potable water intakes are structures designed for the intake of drinking water. These are usually elevated above the bottom and supported and protected by a debris-screening structure (a crib), which is separately charted. These are charted in the Great Lakes and other freshwater inland lakes.

Volatile material transport pipelines are used to convey liquids and gases, usually petroleum or other mineral products of a hazardous nature. Collisions with, or dragging an anchor on, these pipelines also entail the risk of pollution incidents, explosions, and fires.

Abandoned (unused) pipelines are no longer in service, but still present a hazard to navigation.

Chart symbols and conventions differ among these pipeline classes. All pipelines may be charted either as an *individual pipeline,* or included in a *pipeline area.*

–Individual Pipelines

Individual pipelines are charted using several *symbols, labels,* and *notes.*

Intake and discharge pipes (nonvolatile material transport) are charted in black using a unique symbol (L 41.1). This symbol is directional—the ball part of the symbol being placed at the end furthest from the assumed source of flow. No label is added. Conduits for discharging effluents; e.g., industrial, chemical, sanitary, and storm water discharge, are charted with the same black symbol (L 41.1) and labeled *"Sewer"* in italic type on the largest scale chart and on smaller scales as space permits.

Potable water intakes are charted using one of two black symbols (L 41.1, L 43), and labeled *"PWI"* in italic type.

Abandoned pipelines are charted in black using a unique symbol (L 44) without any label.

Pipelines used for liquids and gasses are depicted by a unique magenta symbol (L 40.1) without any label.

In addition, the following caution note (in magenta vertical type) is added to all charts containing submarine oil and gas pipelines and submarine cable areas:

"CAUTION
SUBMARINE PIPELINES AND CABLES

Charted submarine pipelines and submarine cables and submarine pipeline and cable areas are shown as:

Symbols (L 40.2, L 30.2)

Additional uncharted submarine pipelines and submarine cables may exist within the area of this chart. Not all submarine pipelines and submarine cables are required to be buried, and those that were originally buried may have become exposed. Mariners should use extreme caution when operating vessels in depths of water comparable to their draft in areas where pipelines and cables may exist, and when anchoring, dragging, or trawling.

Covered wells may be marked by lighted or unlighted buoys."

–Pipeline Areas

As noted above, pipelines can be charted individually or in areas. Pipeline areas are shown in magenta by dashed area limits (L 41.2) and labeled *"Pipeline Area."* According to the *Nautical Chart Manual:*

"The extent of the limits of the area will be governed by local conditions (e.g., the number of pipelines or cables) but shall in all cases include the immediate area which overlies the pipeline or cables. The limiting lines shall be spaced 1,000 feet apart or 500 feet on each side of the pipeline or cable position or from the outer ones of a group, or a minimum of 5.0 mm at charting scale for small-scale charts. Cable and pipeline areas shall be labeled in Newton Light Italic type, capital and lowercase letters, with type size appropriate to the size of the feature or scale of the chart."

–Submarine Cables (L 30.1, 30.2, L 31.1, L 32)

According to the *Nautical Chart Manual:*

"Cables are classified as power cables and communication cables. Power cables are used to transmit electricity across a large expanse of water where overhead transmission is not feasible, or in areas of heavy commercial shipping where greater danger would exist by use of overhead transmission. Communication cables are used to transmit messages. Submarine cables shall be charted within protected waters such as harbors, rivers, bays, estuaries, or other inland navigable waterways to warn the mariner of possible interference with navigation and to help prevent damage to cables from anchors. Cable and pipeline areas should not be charted in large areas void of hydrography, except to show the terminus of a line."

As with pipelines, cables can be charted individually or in areas.

–Individual Cables

Power cables are depicted by one of two magenta symbols (L 30.1 "generic cable," or L 31.1). Abandoned or unused cables are depicted by a unique magenta symbol (L 32). Communications cables are depicted by a magenta symbol (L 30.1). The continuity of the wavy-line symbol (L 30.1) is not broken for soundings or other chart details except where legibility of the overprinted feature would be impaired. No labels are included.

–Cable Areas

Cable areas are charted in the same manner as pipeline areas, except that a unique symbol is used (L 30.2).

Other Relevant Sources of Information

In addition to the nautical chart and Chart No. 1, several other sources provide information on hydrography and specific hazards to navigation. These include the *U.S. Coast Pilot, Local Notices to Mariners,* and the *Tide Tables and Tidal Current Tables.*

U.S. Coast Pilot

The *U.S. Coast Pilot* contains valuable material on hydrography and hazards to navigation that supplements the nautical chart. In particular (see the *Coast Pilot Manual)*, this publication provides textual information on aquacultural sites, bars, basins, channels, currents, dangers depths, fish havens, fishtraps, heights, submarine features, tides, and wrecks. In general, the *U. S. Coast Pilot* provides narrative material that goes beyond that provided by the symbols, notes, and legends used on the nautical chart. For example, the guidance offered in the *Coast Pilot Manual* for a description of bars, dangers, submarine features, and wrecks is:

> "Bars. Where a bar is dangerous, state under what conditions it is dangerous and describe the most favorable conditions for crossing. State whether the bar breaks in ordinary weather or only in heavy weather and how far out the breakers extend. Give the least depth at the best place for crossing the bar (where there is no dredged channel)....
>
> "Dangers. Give kind and extent of natural dangers; least depths over them; if they break, at what stage of the tide; and how much, if any, is bare at the chart datum. Do not list each individual danger in a group; a description of the most prominent, or the one nearest the channel, or the one farthest from shore is usually sufficient.
>
> "Submarine features. Describe the character of the bottom slope, especially when approaching the shore. State whether soundings can be depended upon to warn of the approach to danger. Note any special submarine features, such as valleys and escarpments, that may be useful in depth curve navigation.
>
> "Wrecks. Describe dangerous wrecks in or near channels not maintained (dredged) by the Corps of Engineers and along established routes or likely passage. . . . Do not discuss wrecks lying well offshore unless they present a hazard in a normal coastal route or in the approach to port (e.g., within a safety fairway). A wreck lying amid other described dangers should not be mentioned, nor should those lying in shallows or other areas out of the way of normal navigation."

The *U.S. Coast Pilot* reads as though an experienced mariner, with local knowledge, were briefing the navigator. For example, here are three brief excerpts from the *U.S. Coast Pilot, Volume 3, Atlantic Coast: Sandy Hook to Cape Henry* (1993) applicable to waters off Cape May, NJ.

> "The approaches to Delaware Bay have few off-lying dangers. The 100-fathom curve is 50 to 75 miles off Delaware Bay, and the 20-fathom curve is about 25 miles off. Depths inside the 20-fathom curve are irregular, and in thick weather a deep-draft vessel should not approach the coast closer than depths of 12 fathoms until sure of its position; the safest approach or passing courses would be outside Five Fathom Lighted Buoy F and Delaware Lighted Horn Buoy D.
>
> "The shoals off Cape May are mixed clay and sand and have the consistency of

hardpan; the ridges run in approximately the same directions as the currents. Cape May Channel, 1-mile southwest of the cape, is an unmarked passage between shoals, with depths from 2 to 6 feet on either side. The channel is seldom used, and then only by fishing vessels and pleasure craft; local knowledge is required for safe passage.

"The channels have strong currents, and many tide rips form near Prissy Wicks Shoal, which has depths as little as 2 feet about 2 miles south of Cape May Light. In Cape May Channel, the current velocity is 1.5 knots on the flood and 2.3 knots on the ebb."

Tide Tables and Tidal Current Tables

These publications, described in Chapter 1, provide information necessary to estimate the set and drift of the current, and the height of the tide at any time for numerous locations. Tide and current information provided on the nautical chart is very general, and use of the *Tide Tables and Tidal Current Tables* is recommended.

Notice to Mariners (NM)

The NM is a bulletin in pamphlet form issued weekly by the *National Imagery and Mapping Agency (NIMA)*. NM contains all corrections, additions, and deletions to all NIMA and NOAA charts.

Local Notice to Mariners (LNM)

The USCG *Local Notice to Mariners* (LNM) contains important information on changes to hydrographic features and dangers to navigation. Charts should be corrected with the LNM before being used.

With respect to hydrographic features, the LNM provides information on changes to charts for individual features; e.g., a revised depth over a charted hazard, and more general information. In some cases, the revised information can be described fully by a simple narrative statement; e.g., "Add, dangerous wreck at location." In other cases, a chartlet is provided in the LNM showing the updated information. The chartlet is published in the exact scale of the chart being updated, so that all that is necessary is to cut out the chartlet and paste it over the corresponding area of the nautical chart. Figures 4–8 and 4–9, for example, provide an illustration from NOS Chart No. 12366 and the revised chartlet published on December 6, 1993. This chartlet was included to amend the published soundings and depth curve data in the East River, near the Throgs Neck Bridge, NY. As can be seen in this example, the changes are substantial, and chart correction is particularly easy.

Concluding Remarks

No attempt is made to summarize this extensive chapter. Rather, it is fitting to conclude with some general remarks on chart accuracy and tips for using the hydrographic information provided on charts. Some of the suggestions are identical to those furnished in other chapters. These points are also made here for emphasis.

The *Admiralty Manual of Navigation* offers the following comments on the reliability of nautical charts:

"... no chart is infallible; every chart is liable to be incomplete in some way or another. Charts based on lead-line surveys are particularly fallible; a single lead-line sounding, which surveyed at best a few centimeters on the sea bed, may be reflected by a figure occupying several hectares of ground depending on the scale of the chart. Any such chart being used for pilotage would have to be treated with the greatest suspicion.

" The degree of reliance to be placed on a chart must depend upon the character and completeness of the original survey material and on the completeness of reports and subsequent changes. Apart from any suspicious inconsistencies ...matters which must be taken into account are the scale of the chart, its soundings in relation to the dates of the surveys or authorities from which it has

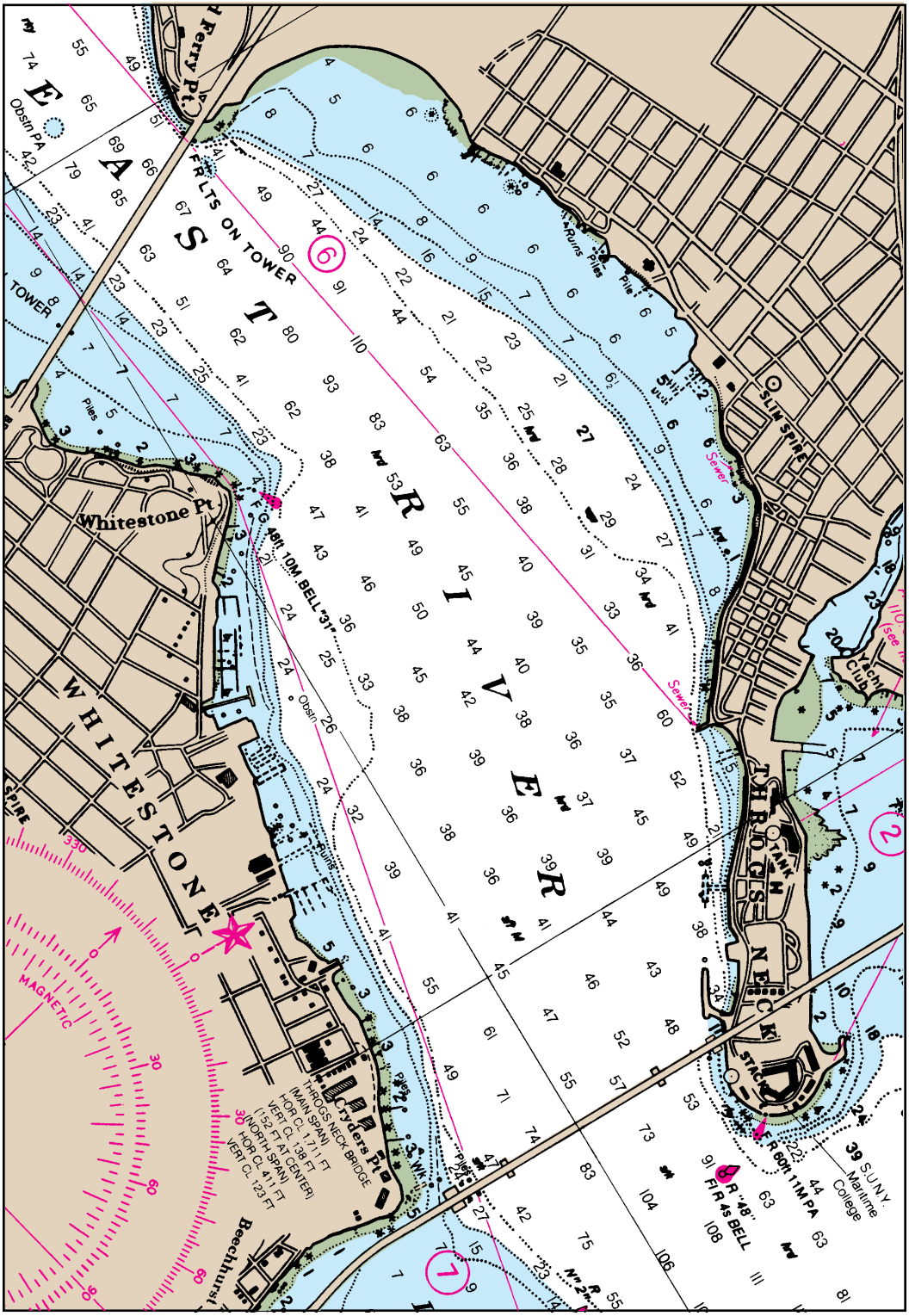

Fig. 4-8. Excerpt from NOS Chart No. 12366 (Long Island Sound and East River). The area shown was subject to a correction in the LNM.

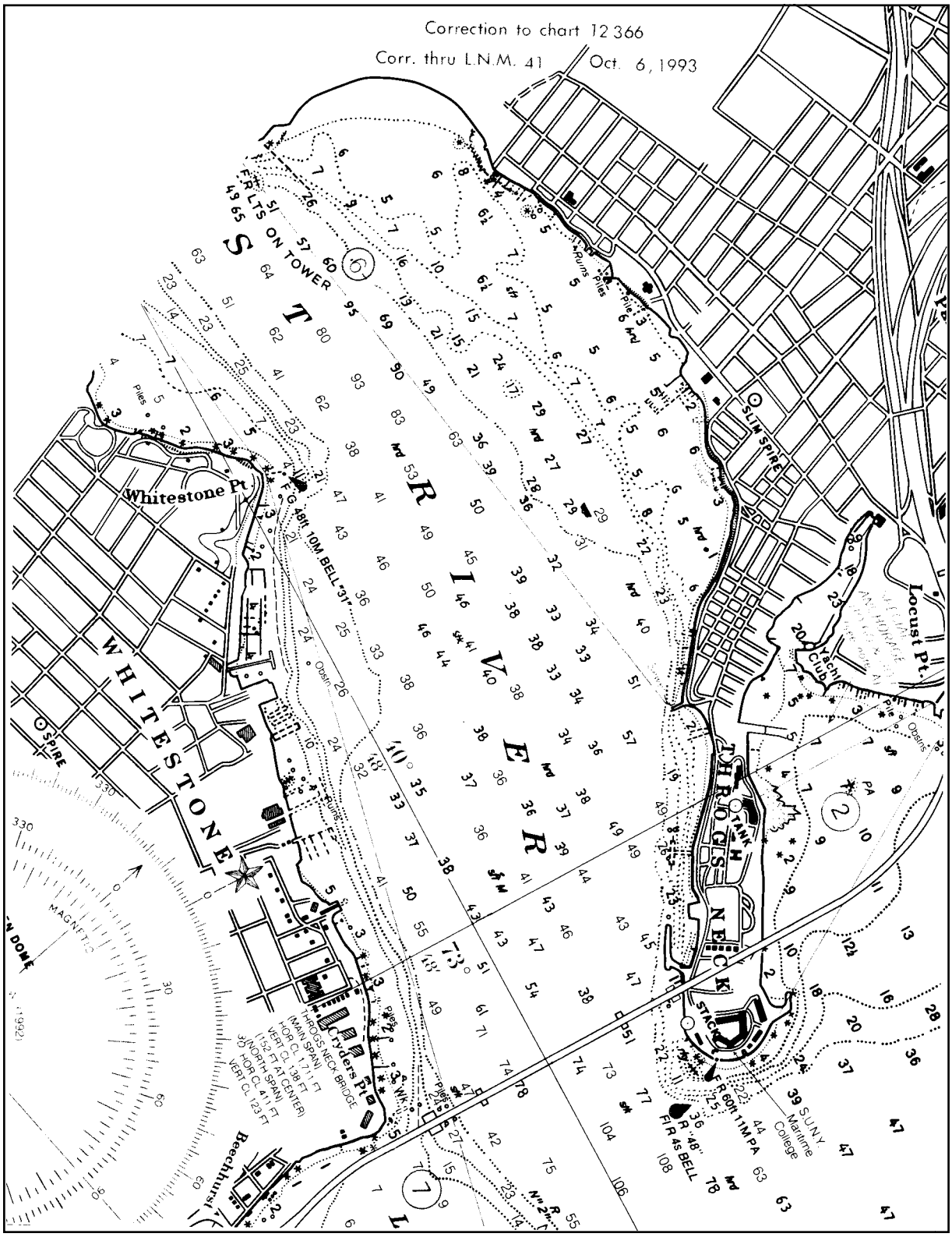

Fig. 4-9. Chartlet LNM issued to correct exhibit shown in Figure 4-8.

been compiled and examination of the chart itself. Even these considerations can only suggest the degree of reliance to be placed on the chart. The chart must never be taken for granted."

Although NOAA produces some of the finest nautical charts in the world, even these charts have some limitations. Depth information on nautical charts is based on soundings from the latest available hydrographic survey which, in many cases, may be quite old. The age of hydrographic surveys supporting nautical charts varies. Approximately 60 percent of inshore hydrography was acquired by **leadline** (pre-1940) sounding technology. The mariner should consult the source diagram to identify areas recently surveyed. Where possible, courses should be selected that pass through recently surveyed areas.

Always use the largest scale chart of the area to be navigated.[4] Large-scale charts provide the greatest amount of hydrographic detail for a small area as well as showing more ATONs and landmarks. Ensure also that the chart has been corrected with information provided in the NM and LNM. These points are especially important if using electronic charts. It is very tempting to "zoom out" on the chart scale in an attempt to "fit in" the entire track in setting waypoints. However, this may obscure important information on hazards to navigation. Remember also that most electronic charts are obsolete shortly after production. There is no presently available substitute for a corrected large-scale paper chart, although this may change in the future.

Remember that the general appearance of the sea bottom is likely to resemble the adjacent land features, even if the chart soundings do not show this pattern. For example, if the adjacent land mass has steep hills, is strewn with boulders and rocks, and rocky islands are found offshore, the sea bottom is likely to have a similar appearance. Look carefully at the charted depths and bottom contours. Adjacent depths that differ greatly from one another (shown on the chart or observed on the depth finder) indicate boulders, pinnacles, or other natural hazards that project upwards from the sea bottom. These areas are most likely to have uncharted natural hazards. Leave an extra margin—an ample safety margin—of depth under the keel in such areas. Also, where possible, travel in well-established channels in preference to other areas.

Safety margins are important in the *horizontal,* as well as the *vertical* plane. Unless the vessel's mission is to voyage to a charted hazard, any hazard should be given a wide berth. (In figuring a horizontal safety margin, it is important to consider the probable error in the vessel's position—i.e., different margins are appropriate depending upon the navigation systems in use.)

Be particularly careful when voyaging in areas, such as changeable areas, for which hydrographic information is not charted. Natural channels in certain inlets or other areas where there are strong currents change fre-

[4]Amazingly, operators of even commercial craft—such as the skipper of the tug *Mauvilla* (which ran into a railroad bridge precipitating an AMTRAK rail wreck in September 1993)—sometimes venture forth without *charts,* let alone corrected large-scale charts (see Anon, *Professional Mariner,* 1994).

In another incident (Anon, *Professional Mariner,* Issue No. 1) the *Little Gull,* an offshore clamboat skippered by a hired delivery captain, ran aground off Brigantine, NJ. The vessel was found to have no fixed compass and no charts of the area of the grounding. The captain was quoted as saying that he never plots anything on a chart and rarely refers to them. "I don't have to plot; I just know it all by heart. My brain is so impregnated with loran bearings (sic) that I can figure out where to go without charts."

quently, and should be used only by mariners with local knowledge.

Fix the vessel's position at frequent intervals. This reduces the likelihood of straying from the intended track into more hazardous areas. If the vessel's position is appreciably off course, plot a revised track to ensure that it is safe to return to the original course.

The *U.S. Coast Pilot* and other sources, such as commercial cruising guides, should be consulted for additional information. Other mariners with local knowledge are also useful sources. (However, do not blindly follow other vessels in the belief that they know where they are going, unless their draft is considerably greater than yours!)

Finally, mariners should make it a point to report chart discrepancies/update. In order-of-magnitude terms, there are approximately 2,000 employees involved in one aspect or another of chart production—including hydrographic survey crews—but nearly 16 million recreational boats owned. Even if only a small fraction of these boaters were to send chart updates to NOAA, the quality of nautical charts would improve significantly.

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"The sound navigator never trusts entirely to the obvious. The price of good navigation is constant vigilance. The unusual is always to be guarded against and when the expected has not eventualized, a doubtful situation always arises which must be guarded against by every precaution known to navigators... It is always the captain who is sure in his own mind, without the tangible evidence of safety in his possession, who loses his ship."

Excerpt from Report of Court Inquiry investigating the Point Honda disaster in 1923.

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———: *Low Water Line.*
———: *Natural Resources.*
———: *Obstruction.*
———: *Platform.*
———: *Rock.*
———: *Ruins.*
———: *Shallow.*
———: *Shoal.*
———: *Tides.*
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