CHAPTER 3

Topography and Related Information

Introduction and Overview

The preceding chapters of this manual provide *general* information on nautical charts, projections, orientation, measurement of position/distance/direction, etc. This is the first of several chapters that explain the symbols and chart conventions used to depict *specific* features of interest. As noted in earlier chapters, the use of a standardized and compact set of symbols and other chart conventions (e.g., stylized labels and notes, standardized colors, and typeface choices) to depict specific features contributes greatly to the efficiency with which a chart can communicate a mass of detailed information to the mariner. Moreover, except for a few supplementary national symbols, these same chart conventions are employed in numerous countries throughout the world. As noted in the introductory chapters of this manual, the publications that correspond to Chart No. 1 issued by other nations (e.g., Chart 5011, *Carte* No. 1) appear nearly identical.

Chart No. 1 organizes the symbols used to depict charted features into three broad categories: *topography* (Sections C through G), *hydrography* (Sections H through O), and *aids and services* (Sections P through U). In slightly modified form, this same classification system is used to organize the contents of this manual. Thus, Chapter 3 addresses topography and related information, Chapter 4 examines hydrography and related information, Chapter 5 presents information on ATONs, and Chapter 6 covers landmarks.

On nautical charts, the coastal configuration, prominent land features, landmarks, and cultural features are included to help the mariner determine the vessel's position, alert the mariner to potential land-based hazards to navigation (e.g., breakwaters, overhead cables), and inform the mariner of the availability and location of facilities and services (e.g., dry docks, piers, pilot stations, wharfs).

This chapter addresses topography and related information, including natural features (such as coastlines, terrain relief, and vegetation), cultural (manmade) features (such as settlements and buildings, roads, railways, airfields, bridges, and overhead cable crossings), landmarks (mentioned briefly in this chapter and explored in detail in chapter 6), and ports (such as hydraulic structures in general, harbor installations, canals, and transshipment facilities). In general terms, topographic and related information refers to charted features located on land, or at least those which are normally above water. (For logical consistency, land-based ATONs are covered in Chapter 5.)

As shown in figure 3–1, the chart features included in topography and related information are covered in Sections C through G (with

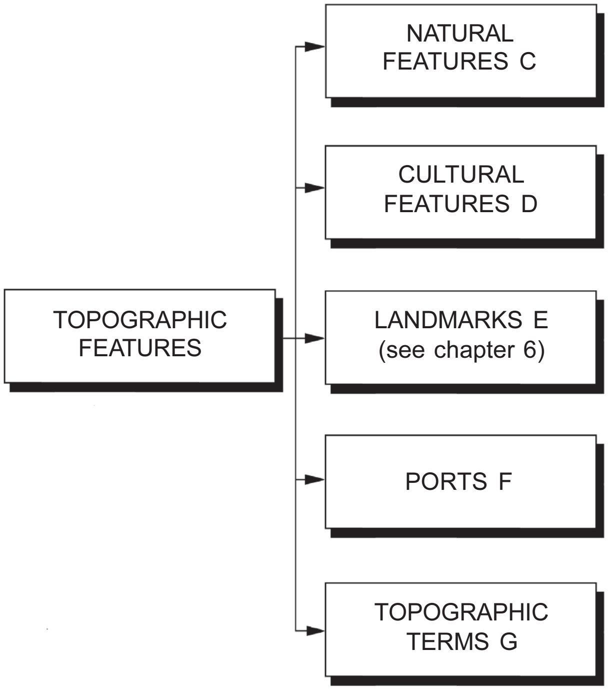

Fig. 3-1. Topographic and Related Information Depicted on the Nautical Chart

selected additions from Sections T and U and miscellaneous others) of Chart No. 1.

This chapter provides essential background, summarizes the utility of this information, describes the charting conventions (e.g., symbols, labels, and notes) used to depict this information, identifies other relevant sources (e.g., the *U.S. Coast Pilot),* and presents practical pointers on how this information can be used by the prudent mariner. By actual count there are more than 200 features or groups of features that fall into the category of topography and related information—well more than can be discussed in detail in this manual. For this reason, the focus of this chapter is limited to those features likely to be of greatest relevance to the recreational and commercial vessel operator.

Many specialized terms used in this chapter are defined in the Glossary in appendix A. Names enclosed in parentheses (e.g., Bowditch) refer to sources listed at the end of this chapter that contain additional relevant detail or useful general discussions. Letters and numbers (e.g., F 1) refer to specific sections and symbols presented in Chart No. 1. Although selected excerpts from Chart No. 1 are provided as illustrations in this chapter, space constraints prevent including this chart in its entirety. Therefore, it is recommended that Chart No. 1 be kept at hand when reading this chapter.

Utility of this Information and Implications for Chart Design

On first reflection it may seem odd to include *any* topographic and related information on a nautical chart. As noted in Chapter 1, nautical charts are distinguished from maps because the chart contains information of particular relevance to the mariner, whereas maps generally serve the terrestrial user. Nonetheless, depiction of topography and related information on the nautical chart is very important to mariners. Although many commercial vessels routinely voyage across the oceans, coastal navigation techniques (which exploit charted topographic features) are employed in the departure and arrival phases of every ocean voyage. Indeed, because of traffic density and the proximity of hazards to navigation, the arrival and departure segments of an ocean voyage are typically more challenging then the enroute segment (e.g., Graves)—requiring the most precise navigation. A 3-mile fix error typical of a celestial fix, for example, would be perfectly acceptable in the middle of the ocean, but entirely too large in a harbor or harbor entrance where appropriate tolerances on fix accuracy might be measured in yards or tens of yards.

Moreover, recreational vessels seldom venture out of sight of land. The majority of the USCG *search and rescue* (SAR) cases occur either on inland waters or within 3-nautical miles of the coastline. Vessels using coastal waters navigate by a variety of methods, including dead reckoning, electronic navigation, etc., but the use of visual observation of natural or artificial land features (pilotage) is essential for taking departure, position fixing, plotting danger bearings, determining turning bearings, compass spot checks and calibration, anchoring, and other assorted navigational chores (see Chapter 6). An abundance of accurately charted terrestrial features is essential for coastal piloting.

Although some coastal features clearly belong on a nautical chart, others would merely add clutter and require needless updating. The nautical cartographer must be selective in deciding which features should be charted. Generally features located along the shoreline are charted, but the density of charted features falls off rapidly with distance from the coast. The distance inland to which topographic features are depicted on the nautical chart varies with the chart scale, type of terrain, availability of source data, and the adequacy of ATONs. The significance of topographic features to the mariner is determined by the requirements of both visual and radar navigation. Because marine navigators see the coast in profile, their interest in land detail is greatest at the shoreline and diminishes rapidly inland. Nonetheless, some inland features, such as airports, are charted because navigators can infer the existence of the feature from other clues. For example, an airport may not be visible from seaward, but its existence could be inferred from aircraft seen to be departing and/or on approach to landing (see Markell). High mountains with defined peaks might also be charted even if located well inland, if these could be used for position fixing. On coasts poorly marked by ATONs, detailed coastal topography is particularly important to the navigator. Nonetheless, topographic detail depicted on the nautical chart is kept to a minimum consistent with the need to show the significant identifiable features and the general relief of the skyline. The amount of charted detail also varies with the distance inland. Inconspicuous features, such as marshes and minor lakes and streams are usually shown only when located within a short distance (e.g., 1 mile) of the shoreline. Conspicuous features, such as steep coasts with deep-water close inshore, are normally charted. Even inconspicuous or minor features (sand dunes, mangroves, low bluffs, etc.) might be charted in areas devoid of more prominent features.

This chapter includes many features other than coastline and topography. Features such as berthing structures (piers), erosion-control structures (breakwaters), ports and harbors, as well as bridges and roads, buildings and other structures (e.g., tanks and towers) are potentially relevant to the mariner for operational or safety reasons.

Coastline/Shoreline (C 1 – C 8)

For charting purposes the terms “coastline” and “shoreline” are considered to be synonymous. Standardized symbols (C 1 – C 8) are used to depict various coastline features. Figure 3–2 contains a diagram identifying several

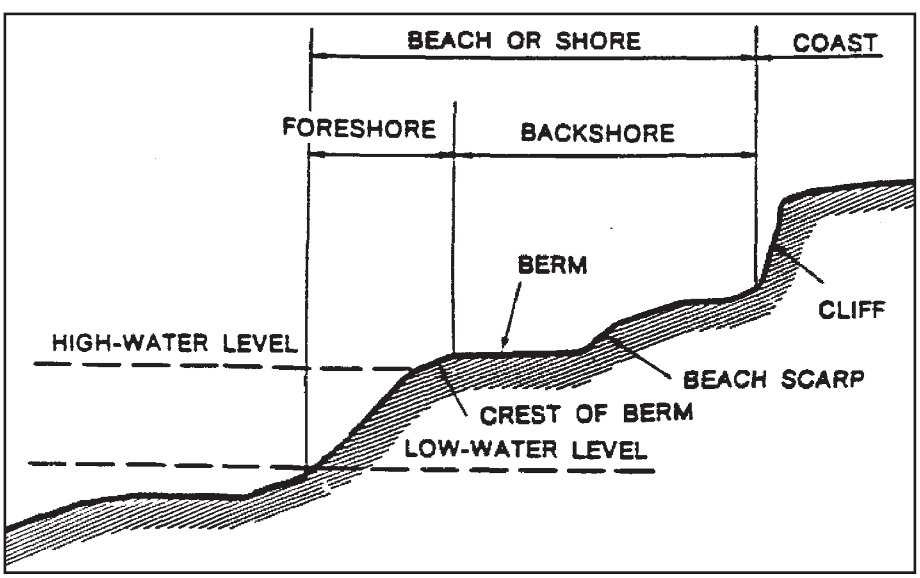

Fig. 3-2. Shoreline and Foreshore Features
Source: *Nautical Chart Manual*

of the more important shoreline and foreshore (defined below) features discussed in this section.

–Shoreline Plane of Reference

The shoreline is the line of contact between the land and a selected water elevation and is delineated whenever possible from survey data. This dividing line between land and water features is also termed the *shoreline plane of reference* (SPOR).

In areas affected by tidal fluctuation, the SPOR is usually the *mean high water* (MHW). In confined coastal waters of diminished tidal influence, a *mean water level line* (MWLL) may be used. The shoreline of interior waters (rivers, lakes) is usually a line representing a specific elevation above a selected datum which is noted on the chart.

Natural shoreline is generally depicted on nautical charts by a heavy solid black line. The exceptions to this lineweight convention are for apparent shoreline, minimum-size islets, and the various forms of manmade shoreline (wharfs, piers, jetties, breakwaters, etc.); these are delineated by a thinner solid black line. The land area delineated by the shoreline is tinted in a buff or gold color; the foreshore (if any) is green; and the water seaward of this line is shown in a blue tint or in white, depending upon the depth of the adjacent water (see Chapter 4 for details).

–Apparent Shoreline (C 32, C 33)

The apparent shoreline is defined in appendix A as the seaward limit of marine vegetation, such as mangrove, marsh grass, or trees in water that would reasonably appear (visually, not necessarily by radar) to the mariner from a distance to be the fast shoreline. Shorelines observed using radar (DMAHTC 1994 provides an excellent discussion of landmass recognition) may be quite different from those observed visually. Mangrove, for example, might give a strong radar return if sufficiently dense, but other vegetation may be relatively transparent to radar. The seaward limits of kelp, low grass in water, and other low-lying vegetation normally do not constitute an apparent shoreline. Apparent shoreline is depicted with a light solid black line. Labels (see below) may be added to describe the shoreline vegetation.

–Approximate or Unsurveyed Shoreline (C 2)

An approximate shoreline is one that has been inadequately surveyed. It is shown on larger scale charts by a dashed black line (C 2) delimiting the gold tint. Mariners voyaging near such shorelines should exercise caution—the hydrography may likewise be incomplete or approximate.

–Flat Coast (C 5)

A flat coast is characterized by a shallow slope without any distinguishing features. The position of a flat coast may be difficult to determine by either visual means or with the use of radar. It is depicted with a unique symbol (C 5), and may also include a descriptive label, e.g., "Sandy," "Stony," "Marsh," or "Dunes," which is written in black vertical type, initial capitals only. (Label conventions are discussed in more detail in other chapters. Briefly, vertical type is used for names of topographic features and fixed objects which extend above high water. *Italic* type is used for names of hydrographic features, including names of water areas, underwater features, and floating ATONs. Soundings may be shown in either type according to whether conventional (vertical type) or metric (italic type) units are given.)

–Steep Coast–Bluff; Cliff (C 3)

A coast backed by a conspicuous cliff or very sharp rise is considered to be a bluff (if it is not rocky) or a cliff (if it is rocky). Such a coast is potentially useful for both visual and radar identification.[1] (See Mellor or Graves for a contrary opinion.) Cliffs/bluffs are a particularly useful shoreline reference if these alternate with low-lying coast along the shore-

[1]Visually, rocky cliffs can sometimes be distinguished from soil-covered bluffs by the relative absence of observed vegetation.

line. Prominent cliffs/bluffs are shown on all scales of charts provided there is charted hydrography within their range of visibility. The maximum elevation of a cliff may be used by mariners for determining a vessel's distance offshore (see Bowditch or Dutton) and is often shown as an elevation if it is prominent and conspicuous (C 11). The series of marks depicting the face of the cliff/bluff symbol (C 3) are referred to as *hachures* (derived from the French noun *"hache"*—meaning axe—because these resemble axe marks). Hachures are used to depict relief in cases where contour lines are omitted.

–Surveyed Coastline (C 1)

Surveyed coastline is shown by a solid black line delimiting the gold land tint. On small-scale charts the details of the shoreline must be generalized. Such generalization, although necessary, makes visual identification of charted features more difficult. This is just one of many reasons why the largest scale chart of the area should be used for near-shore navigation

–Other Shoreline Types

Symbols (C 4, C 6, C 7, and C 8) are used to depict coastal hillocks (undetermined elevation), sandy, stony, or shingly shore, and sandhills/dunes respectively.

–Foreshore

The part of the shore lying between the crest of the seaward berm (or upper-limit of wave wash at high tide, see figure 3–2) and the ordinary low-water mark is called the *foreshore*, which is ordinarily covered and uncovered by the waves as the tide rises and falls. Foreshore areas are tinted green (C c) on nautical charts, and the character of the area labeled (e.g., *"Mud," "Gravel,"* etc.) in italic type as appropriate.[2] These labels may assist the mariner in deciding where a safe landing may be made in an emergency (the hydrography must be examined as well) and in determining the vessel's location.

–Chart Sounding Datum Line (C a)

The chart sounding datum line in tidal areas is represented by a single row of dots called the low-water curve. The area between the SPOR and the sounding datum is tinted green, and (if known) the character of this area is labeled appropriately.

–Approximate Sounding Datum Line (C b)

A special symbol (C b) is used in cases where the sounding datum line is only approximately known.

–Breakers (C d)

Breakers along a coast are charted if these appear consistently in a location where no shoals or reefs (see Chapter 4) are charted. If charted, a unique symbol (C d) is used and a label *"Breakers"* in black italic type is added. Limits of large areas of breakers may be shown using another special symbol (K 17). *Vessel operations in surf zones are potentially hazardous and should be avoided.*

–Grass

Grassy areas seaward of the high-water line are charted using a dashed line to show the limit of the grassy area, and labeled *"Grass"* in black italic type. Grass can foul propellers and clog water intakes.

–Mud/Sand/Stone or Gravel/Sand and Mud/Sand and Gravel/Rock/Coral/Rubble

Appropriate labels (e.g., *"Mud," "Sand,"* etc., in black italic type) describing the foreshore may be added along the inshore side of the low-water limit line, and the enclosed area depicted with a green tint. The offshore limit of the uncovering area is symbolized by a dotted line (C c, J 20.1).

Rock or coral that uncovers at sounding datum is charted using the appropriate label and symbols (J 21, J 22). Rubbled (i.e., a foreshore characterized by loose angular rock fragments) foreshore is depicted by a unique symbol (C e) and labeled *"Rock"* in black italic type.

[2]The green tint is produced by overprinting the gold land tint and the blue water tint.

–Illustration

Figure 3–3 contains an excerpt from NOS Chart No. 12284 (Patuxent River, Solomon Island, and Vicinity),[3] which illustrates many of the above features. Note the hachures (C 3) along the coast south of ***Cuckold Creek*** indicative of an elevated coastline. The coastline (C 1) in this vicinity is surveyed. Further to the southeast is a marsh (C 33). Just north of **Half Pone Pt.** the foreshore (C c) is shown.

Elevation and Relief Data

Elevation and relief are important features depicted on the nautical chart. These features can be used by the mariner for both general orientation and more precise position fixing (see Eyges). Another use of terrain data is to identify areas where protection from the elements would be expected. For example, a lagoon with elevated terrain to the northeast would probably be reasonably well-protected from “Nor’easters.” An ideal anchorage (see Chapman) is a harbor protected on all sides with water of suitable depth and good holding ground. Water depths and bottom characteristics are discussed in Chapter 4. But shelter from the winds can be determined approximately from the characteristics of the terrain surrounding the harbor, inlet, cove, or lagoon. Finally, it should be mentioned that the “underwater topography” or hydrography of an area is likely to be generally similar to that observed and charted on the nearby land. Thus, an area characterized by numerous rocky peaks would probably have a similar underwater profile. The charted hydrography should bear this out. If not, it is a possible indication of the unreliability of the charted hydrography (see Chapter 4).

This section provides information on the charting conventions used for elevation and relief data.

Hachures, spot elevations, and *contour lines* present elevation and relief data on nautical charts. Hachures provide a *qualitative* indication of relief; contour lines and spot elevations provide *quantitative* data able to be used for “distance-off” computations using a sextant or stadimeter (Bowditch, Dutton, Maxim).

–Land Contours (C 10)

Contour lines depict a vertical distance (in feet on conventional charts, in meters on metric charts) above a datum plane, usually *mean sea level* (MSL).[4] (Note that the vertical datum plane for contours generally differs from that used to depict bridge heights and other charted height information.) When contours and spot elevations (C 11) are charted, a note labeled “HEIGHTS” is included specifying the plane of reference used. The text of the heights note is:

> “HEIGHTS
> Elevations of rocks, bridges, landmarks and lights are in feet and refer to Mean High Water. Contour and summit elevation values are in feet [meters] and refer to Mean Sea Level.”

(The contour height datum is potentially relevant because it is necessary to correct for the

[3]Note also the two tanks on the land south of ***Cuckold Creek.*** Both are landmarks (see chapter 6). The southernmost of these tanks is shown with the *approximate* position symbol explained in chapter 6—a small black circle 0.5 mm in radius without any center dot. This tank is plotted within 100 feet of its correct geographic position. Slightly northwest of this tank is another denoted with an *inexact* position symbol: the small circle with the letters PA. This is plotted with a position accuracy of 101 feet to 300 feet of its correct position. Neither landmark would be shown if more accurately located and conspicuous landmarks were available in this area. The absence of charted land detail tells the mariner that this area has few distinguishing features.

[4]Heights given are for *land* elevations—not from MSL to the tops of any trees. In low-lying areas where tree heights are relatively large, this difference can be substantial. See text on tree-top elevations.

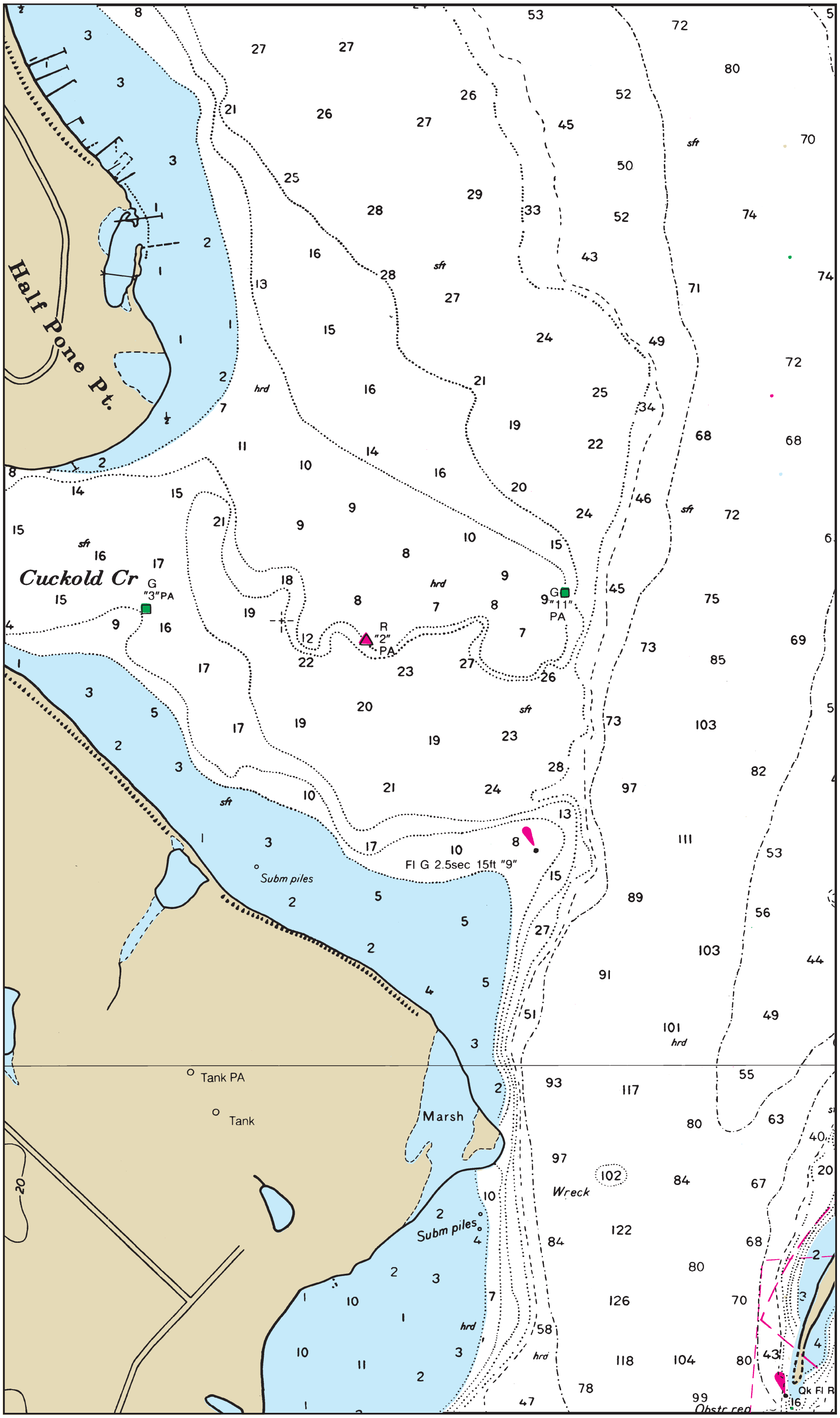

Fig. 3-3. Excerpt from NOS Chart No. 12284 (Patuxent River, Solomons Island and Vicinity) Showing Several Features of Interest

state of the tide in making precise distance-off calculations.)

The vertical distance between adjacent contour lines is termed the *contour interval*. The contour interval is not given explicitly on the chart, but can often be deduced from contour labels. Figure 3–4 contains an excerpt from NOS Chart No. 18650 (San Francisco Bay) showing a prominent hill west of Candlestick Park Stadium, home of the San Francisco Giants baseball team. Index contours (see below), drawn with a thicker line, are shown at 200-foot and 400-foot elevations. There are three contour lines between these index contour lines. Therefore, the contour interval is 50 feet, and the intermediate contour lines are at elevations of 250 feet, 300 feet, and 350 feet.

Contour lines are shown on a nautical chart only when considered useful for radar navigation or for identifying the land features and profiles from seaward. Landforms on the "back side" of mountains (i.e., those hidden when looking from seaward) add little to the utility of the nautical chart, and are often omitted.

Contour intervals are selected to maximize clarity in depiction—considering the chart scale, general slope, and the need to show the topographic relief of the land area. The contour interval varies from chart to chart, but is uniform on any given chart. Because the contour interval is constant for any given chart, the spacing of the contour intervals can be used to infer the shape of the land. Closely spaced contours imply relatively steep slopes; those further apart more moderate shapes. The mariner can use the distance between contour lines and the overall pattern of hummocks, hills, peaks, ridges, and saddles to form a mental picture of the profile view of the land (Eyges offers a particularly detailed discussion of this point).

Contours are depicted as solid black (intermediate contours may be dashed) lines. *Index contours*, usually every fifth contour, are

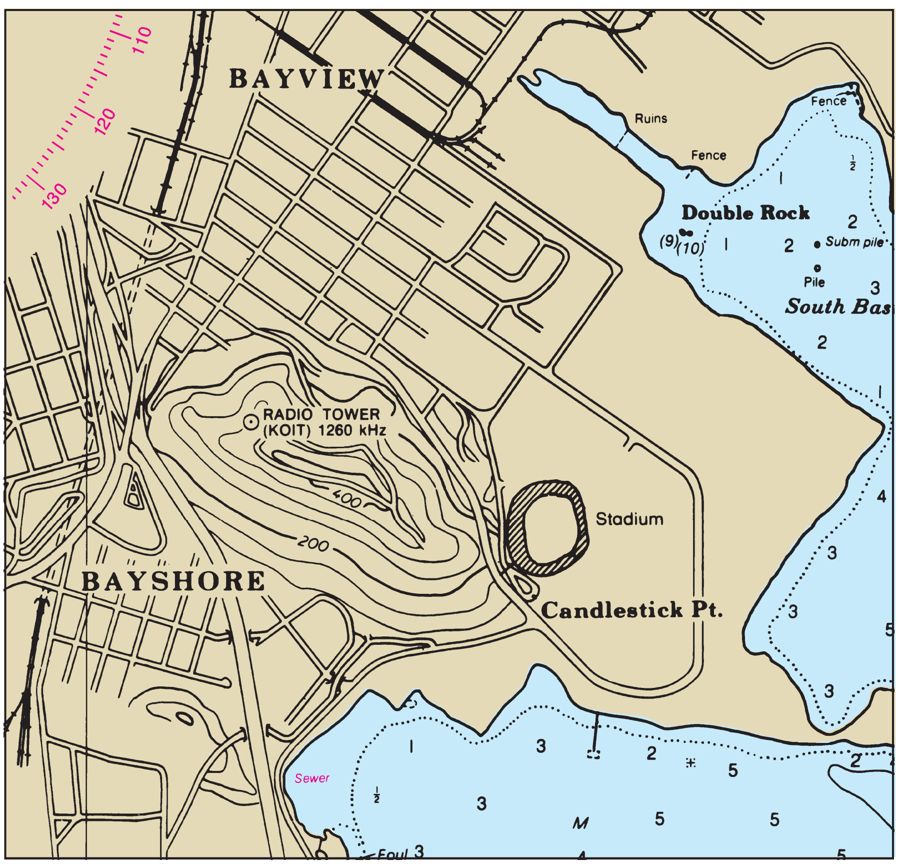

Fig. 3-4. Excerpt from NOS Chart No. 18650 (San Francisco Bay), showing contour lines on hill near Candlestick Park

emphasized by the use of a bolder line. In cases where slopes are steep—which would crowd contours—contour lines are not merged. Rather intermediate contours are omitted to leave a space of approximately 0.3 mm between those shown.

Labels are used to identify the elevation depicted by the contour line. Contour labels are printed in black vertical type. Labels are placed at suitable intervals parallel to, and centered on, the index lines (see figure 3–4). In flat areas where the index lines are relatively far apart, labels may be shown on each contour line, rather than on the index lines only.

Form lines (C 13), or sketch contours, are shown by broken lines and are contour approximations depicting the general form of terrain formations without providing exact contour information. (See approximate contour lines.)

–Approximate Contour Lines (C 12)

Approximate contours are shown using dashed (C 12) lines, rather than the solid lines used to depict accurately known contour lines.

–Peaks (C 10, C 11) and Treetop Elevations (C 14)

Prominent peaks are represented by the spot elevation dot and accompanying elevation label (C 11). An intermediate interval may be approximated by a dashed line and labeled to show a summit (C 10). Spot elevations of land on slopes are omitted because these would be of little value to the mariner.

The charted position of mountain peaks or other prominent topographic features can be used to take bearings (and, therefore, determine a LOP) using either radar or visual means (e.g., Pelorus or hand-bearing compass). Two bearings (if widely separated in azimuth, see Chapter 6) can be used to determine a fix. A bearing and a range (determined by radar, sextant, or stadimeter) also fix the vessel's position, as can two ranges from different objects. Elevation data enable calculation of the vessel's distance-off by visual means, but also can be used to aid in the identification of a particular peak.

Some peaks, such as Mt. Fujiyama on the Japanese island of Honshu, are visually prominent, and admit to little-or-no possibility of mistaken identity. However, other peaks are less distinct or unique, and it may be difficult to distinguish one from another. Errors in feature identification result in fix errors. Elevation data, even if not used for distance-off computations, can be valuable in identifying the particular peak used to determine a LOP. *Mariners should study the chart carefully if using natural features for determining LOPs, particularly in areas where similar features abound.* Positions determined from these features should be checked using all available means, such as by cross-checking with soundings or electronic fixes.

Treetop elevations may be charted on peaks in southeast Alaska only and are labeled "TT." A treetop height may also be useful to show the profile height of an island and may be charted if based upon a site inspection (C 14). However, just as trees are not typically selected as landmarks, because these may be only temporary, treetop elevation data are provided selectively.

–Hachures

Hachures (C f) are used to provide a qualitative indication of the steepness of a coast. As noted, these appear as wedge-shaped marks which are oriented perpendicular to contour lines. The length of the hachure is greatest where the slope is steepest. Hachures are not used to represent large areas of relief. Hachures are used to accentuate a spot elevation on very small-scale charts without contours.

–Height of Object

The distance at which an object can be seen depends upon several factors (see Chapter 6). In particular, this distance is limited by the curvature of the earth. Equations have been developed (see Chapter 6) to calculate the maximum distance at which an object can be seen including the effects of refraction and horizon geometry. Figure 3–5 shows the maximum distance at which an object can be seen as a function of the height of the object and the height of eye of the observer as calculated from the equation given in Chapter 6. Table 3–1 provides a table of these distances, which is more useful for voyage planning. As can be seen from either figure 3–5 or table 3–1, this distance increases with the height of the object and the height of eye of the observer. It follows that, other things being equal, taller objects can be seen at greater ranges, so high prominent peaks are likely to be sighted at a greater range and are more useful for position-fixing.

The distances shown in figure 3–5 and table 3–1 are *maximum* distances at which an object may be seen. The prevailing visibility limits this distance. On any given day, fog or low-lying clouds may obscure some of the tallest peaks in the area, so it is well to select both high- and low-objects for range or bearing determination.

–An Aside: Indirect Use of Terrain Information

In thinking how terrain information may be used, what may be termed *direct uses* come immediately to mind. A direct use of a charted mountain peak, for example, would be to determine a bearing and distance-off to fix the vessel's position. Many authors of texts on navigation (e.g., Graves, Kals, Mellor) note correctly that it may be difficult to identify charted terrain features. By implication, the utility of charting this information is questioned.

It is important to state that terrain features and related information can be used in less direct ways as well. The following three vignettes illustrate the concept of *"indirect uses":*

A tower is visible, but the mariner is uncertain of its identity; the vessel's position is not known with sufficient precision to decide which of two charted towers (landmarks) is being seen. Reference to the terrain features depicted on the chart in the vicinity of each of the candidate towers may enable one of these possibilities to be eliminated. In other words, the charted terrain features provide a context or setting for each of the landmarks which could be useful in identification, even if the terrain features are not sufficiently unique to be used alone. Put another way, what is seen is more than just a tower, it is a tower on a high bluff or a tower on low-lying land near a rise, etc.

A vessel is lying off a coastline marked by high but otherwise featureless cliffs. These cliffs are not sufficiently identifiable to fix the vessel's position, but do provide a useful radar return so that a distance-off can be determined. The navigator might consult the charted hydrography in the overall vicinity and compare this with the observed depth to narrow down the possible position(s) of the vessel. Alternatively, the vessel might proceed along the coastline—using radar to maintain a safe distance offshore—until a recognizable feature is encountered. As in

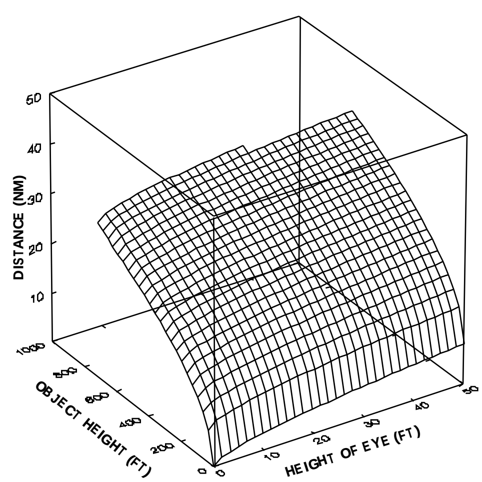

Fig. 3-5. Distance to the Visual Horizon

Table 3-1. Distance to the Visual Horizon (NM) as a Function of the Height of Eye (ft) and Object Height (ft)

Object Height (ft)	Height of Eye (ft) 8	10	12	14	16	18	20	25	30	35	40	50
5	5.9	6.3	6.7	7.0	7.3	7.6	7.8	8.5	9.0	9.5	10.0	10.9
10	7.0	7.4	7.8	8.1	8.4	8.7	8.9	9.5	10.1	10.6	11.1	12.0
15	7.8	8.2	8.6	8.9	9.2	9.5	9.8	10.4	10.9	11.5	11.9	12.8
20	8.5	8.9	9.3	9.6	9.9	10.2	10.5	11.1	11.6	12.2	12.6	13.5
30	9.7	10.1	10.5	10.8	11.1	11.4	11.6	12.3	12.8	13.3	13.8	14.7
40	10.7	11.1	11.5	11.8	12.1	12.4	12.6	13.2	13.8	14.3	14.8	15.7
50	11.6	12.0	12.3	12.7	13.0	13.2	13.5	14.1	14.7	15.2	15.7	16.5
60	12.4	12.8	13.1	13.4	13.7	14.0	14.3	14.9	15.5	16.0	16.5	17.3
70	13.1	13.5	13.8	14.2	14.5	14.8	15.0	15.6	16.2	16.7	17.2	18.1
80	13.8	14.2	14.5	14.8	15.1	15.4	15.7	16.3	16.9	17.4	17.9	18.7
90	14.4	14.8	15.2	15.5	15.8	16.1	16.3	16.9	17.5	18.0	18.5	19.4
100	15.0	15.4	15.8	16.1	16.4	16.7	16.9	17.6	18.1	18.6	19.1	20.0
120	16.1	16.5	16.9	17.2	17.5	17.8	18.0	18.7	19.2	19.7	20.2	21.1
140	17.2	17.5	17.9	18.2	18.5	18.8	19.1	19.7	20.3	20.8	21.2	22.1
160	18.1	18.5	18.9	19.2	19.5	19.8	20.0	20.6	21.2	21.7	22.2	23.1
180	19.0	19.4	19.8	20.1	20.4	20.7	20.9	21.5	22.1	22.6	23.1	24.0
200	19.9	20.2	20.6	20.9	21.2	21.5	21.8	22.4	23.0	23.5	23.9	24.8
250	21.8	22.2	22.6	22.9	23.2	23.5	23.7	24.3	24.9	25.4	25.9	26.8
300	23.6	24.0	24.3	24.6	24.9	25.2	25.5	26.1	26.7	27.2	27.7	28.5
350	25.2	25.6	25.9	26.3	26.6	26.9	27.1	27.7	28.3	28.8	29.3	30.2
400	26.7	27.1	27.5	27.8	28.1	28.4	28.6	29.3	29.8	30.3	30.8	31.7
450	28.1	28.5	28.9	29.2	29.5	29.8	30.1	30.7	31.2	31.7	32.2	33.1
500	29.5	29.9	30.2	30.5	30.8	31.1	31.4	32.0	32.6	33.1	33.6	34.4

the first example, the charted feature is not used directly to fix the vessel's position, but rather in an indirect manner.

A navigator reads the vessel's latitude and longitude from an electronic aid, such as a LORAN-C or GPS receiver. On plotting this position on the nautical chart, it is seen to lie close to low-lying featureless terrain with marshes and lagoons. However, a prominent headland is clearly visible where the marshes and lagoons are supposed to be. The observed terrain may not be sufficiently distinctive to enable the mariner to fix the vessels position directly; however, the discrepancy between the observed coastline and that charted indicates that the electronic fix is in error. Perhaps a digit was transposed in copying the coordinates from the display, perhaps the display should be checked for warning flags or error messages, etc. Even though the terrain evidence is inadequate to locate the vessel, it provides an important "reality check" on positions determined using other means.

Navigation is conventionally thought of as an exercise in geometry or mathematics. But in some cases it may be appropriately likened to fitting together the pieces of a jigsaw puzzle. Each piece contributes to the finished image, but no piece is sufficient in itself. It is well to remember that navigation is an art as well as a science.

Inland Waters

Shoreline bounding navigable inland waters is charted as fully as practicable, considering the scale of the chart. Shoreline bounding nonnavigable inland waters is charted only to provide a general picture of land and water areas. Features related to inland waters are discussed below.

–Glaciers (C 25)

For nautical charting purposes, a glacier is considered to be a landform and is outlined by a dashed line within which there is no tint (C 25). The label “Glacier” or the geographic name of the glacier is shown in black vertical type (initial capitals only) inside the feature in lieu of interior fill.

–Intermittent Rivers and Streams (C 21)

Intermittent rivers and streams, which are frequently dry, are represented by a symbol consisting of a series of three dots and a dash (C 21).

–Lakes and Ponds (C 23); Lagoons (C h)

Lakes, ponds, and lagoons are shown in blue tint on nautical charts if these are part of the course of major rivers or are close to the coastline. The shoreline is charted with a black line, and the lake, pond, or lagoon is normally tinted blue. (Hydrographic detail is not presented.) Names, if given, are shown in italic type placed inside the feature. Lakes and a lagoon are shown in figure 3–3.

–Rapids and Waterfalls (C 22)

Rapids and waterfalls that limit navigation are represented by one or more lines of dashes drawn parallel to the shoreline (C 22). Rapids and waterfalls can present a major hazard for vessels, and should be given a wide berth.

–Rivers and Streams (C 20)

Rivers and streams are shown with a solid black line. If no hydrographic detail is presented, the enclosed area is shown in a blue (shallow water) tint. Names of rivers, if given, are shown in black italic type along the course of the river. Figure 3–3 shows two small streams which feed lakes on the land area south of ***Cuckold Creek.***

–Salt Pan (C 24)

A salt pan is an area bounded by dikes in which sea water is evaporated. It is depicted by a unique symbol (C 24) or with a label “Salt pan” in lieu of the cross-hatched interior of the symbol.

Trees

Isolated trees are not generally charted as landmarks (see Chapter 6) because these are considered to be temporary features. Lightning, the logger’s axe, or the developer’s bulldozer could easily remove a charted feature. However, in areas without other conspicuous features these may be charted. If a conspicuous tree is charted, the landmark symbol and label (“TREE”) is used. Pictorial tree symbols (C 31) are not used on NOAA charts.

Lava Flow (C 26)

A lava flow is often conspicuous, and if so is outlined by a dashed line with the land tint shown within the enclosed area. The label “Lava” is charted in lieu of the symbol (C 26) shown in Chart No. 1.

Vegetation (C o, C j, C l, C i, C m, C n, C k, C 30)

Vegetative cover is generally of little importance to the mariner, except along an otherwise featureless shoreline, where the type and extent of vegetation may aid in shoreline identification. Mangrove vegetation is generally impenetrable, and is often charted to identify areas where access to the shore is difficult or impossible.

Although a variety of special symbols have been developed to depict various types of vegetation, current NOAA usage omits these symbols in favor of descriptive labels (e.g., “Bushes,” “Coniferous Woodland,” Deciduous Woodland,” “Paddy (Rice) Fields,” “Park,” and “Tree Plantation”).

Marshes and Swamps (C 32, C 33)

Marsh and swamp areas are depicted on NOAA charts as follows. The seaward limits of mangrove (C 32) are shown with the apparent shoreline symbol. A dashed line is used for the landward limits of the area. Gold tint and the label “Mangrove” in black vertical type (initial capital letters only) is shown within the charted limits. The pictorial mangrove symbol (C 32) is used only when space is at a premium.

Marsh areas inside the shoreline are represented by green tint and labeled “Marsh” or “Ma.” Other symbols (e.g., for roads, railroads, levees, and bluffs) may be used for the inshore limits of the marsh area.

A swamp area inside the shoreline is shown with gold tint, to denote the inshore limit and labeled “Swamp.”

Ports and Harbors

Ports and harbors are important features shown on the nautical chart. This section explains the chart conventions used for depicting these features. Many of the terms used in this section have very specific and technical meanings—often different from general usage. Some of these specialized terms are defined below. The reader is referred to appendix A for definitions of other terms. Figures 3–6 and 3–7 contain excerpts from Chart No. 1 illustrating hydraulic control and port/harbor features.

In general, manmade shoreline and structures (e.g., piers and breakwaters) are shown with a solid black line. Any feature, or portion thereof at or above the SPOR is depicted with a solid line and gold tint; the portion of the feature below the SPOR (such as the submerged end of a jetty) is shown with a dashed line and blue tint. The single-line/double-line criterion noted below for charting piers is also followed for depicting other structures of this type. New construction projects extending into the water area are charted (upon notification that construction has begun) using special symbols (F 31, F 32). The limits of the new construction are outlined with a black dashed line and labeled “Under construction.” Charted detail, including the shoreline, is deleted from within the new area, and gold tint added when construction is complete. The dashed line is also changed to a solid line upon project completion.

–Berthing Structures

Berthing structures (including fixed and floating piers, wharfs, and gridirons) provide facilities for mooring a vessel. These adjoin berthing areas and are connected to the shoreline at one end.

A *grid* or *gridiron* is a flat frame structure erected on the foreshore so that a vessel may be placed on it at highwater for servicing at low water. The outline is charted and labeled *“Grid”* in black italic type.

A *pier* is a structure extending into the water to provide a mooring or landing. Piers are shown in their exact geographic location with a black double line (F 14) where space and scale permit, and filled with a gold tint. Figure 3–8 provides another excerpt from NOS Chart No. 18650 (San Francisco Bay) showing numerous large and small piers along the downtown San Francisco waterfront. Unlike many waterfront areas, these are all working piers—none are depicted in ruins.

If the centerline separation of the sides of a parallel double-line pier is less than 0.3 mm at chart scale, the pier is charted as a single line centered on the space between the two sides. Figure 3–3 shows numerous small piers north of **Half Pone Pt.,** which are charted with single rather than double lines, because of their size. Figure 3–8 shows many small piers in a marina just north of ***China Basin.***

Piers are not charted if less than 0.8 mm in their greatest dimension (typically length) at chart scale except if identified as essential to navigation in the source material used for chart compilation. “Essential” piers less than the minimum specified length at chart scale are extended to this minimum length in order to be recognizable. Essential piers include

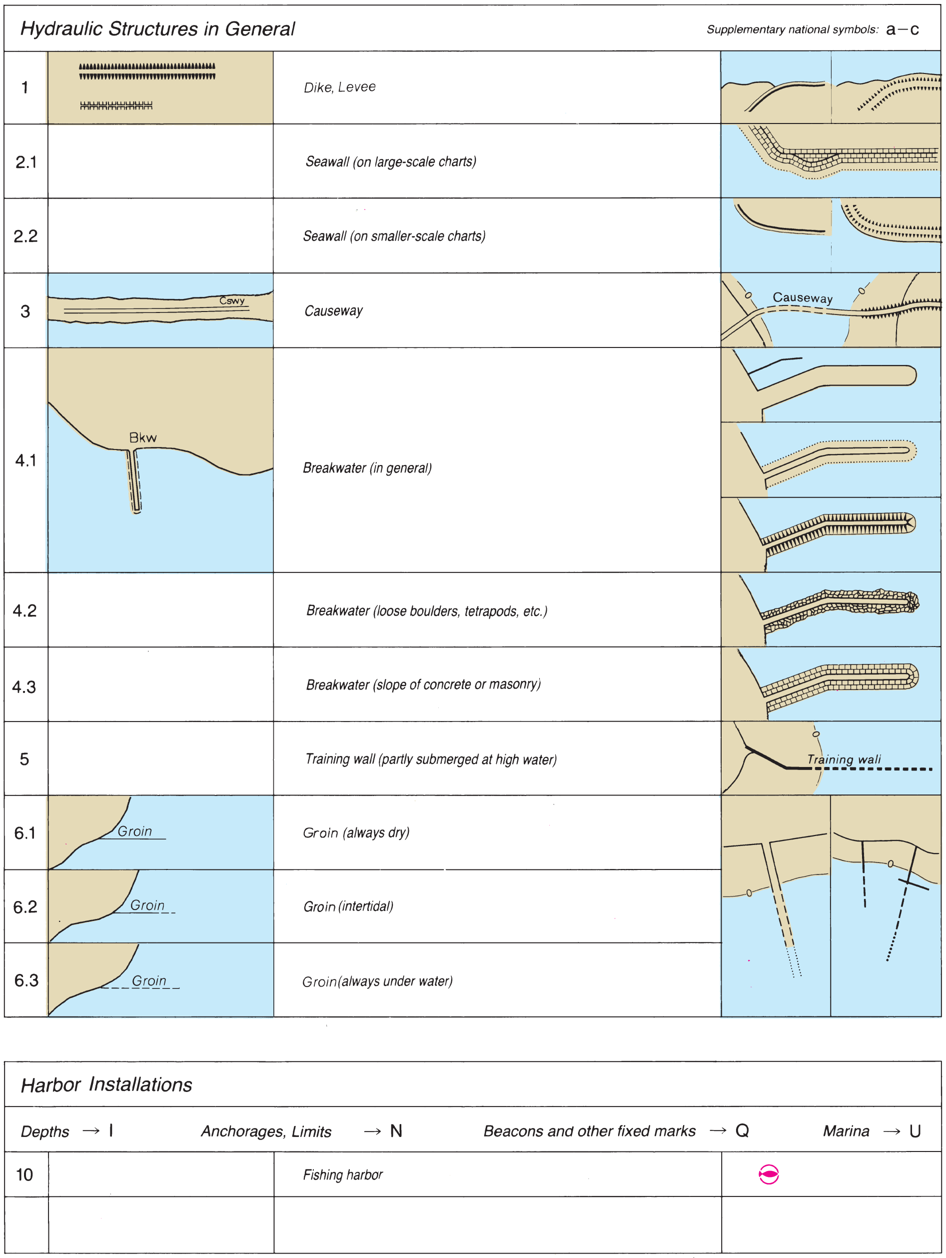

Fig. 3-6. Excerpt from Chart No. 1

piers of unusual commercial importance (e.g., a ferry terminal, oil terminal), piers at possible emergency facilities (e.g., USCG station, harbor police, hospital), piers which indicate the extension or termination of a primary (charted) road, piers limiting a harbor entrance or inlet, and conspicuous piers that could be used for navigational reference. (Incidentally, one of the questions often asked of NOAA personnel by mariners owning waterfront property with piers is “Why isn't my pier shown?” The answer is that it is probably too small at chart scale and not otherwise considered an essential pier.)

In some areas, piers are located so close together that unacceptable congestion would result if all piers were charted. In such cases the cartographer selectively “thins out” piers for inclusion in the chart.

Floating piers are charted in the same manner as other piers, except that the line symbol for a floating pier is detached from any fixed portion of pier or the shoreline by a gap of at least 0.3 mm. Where space permits, the

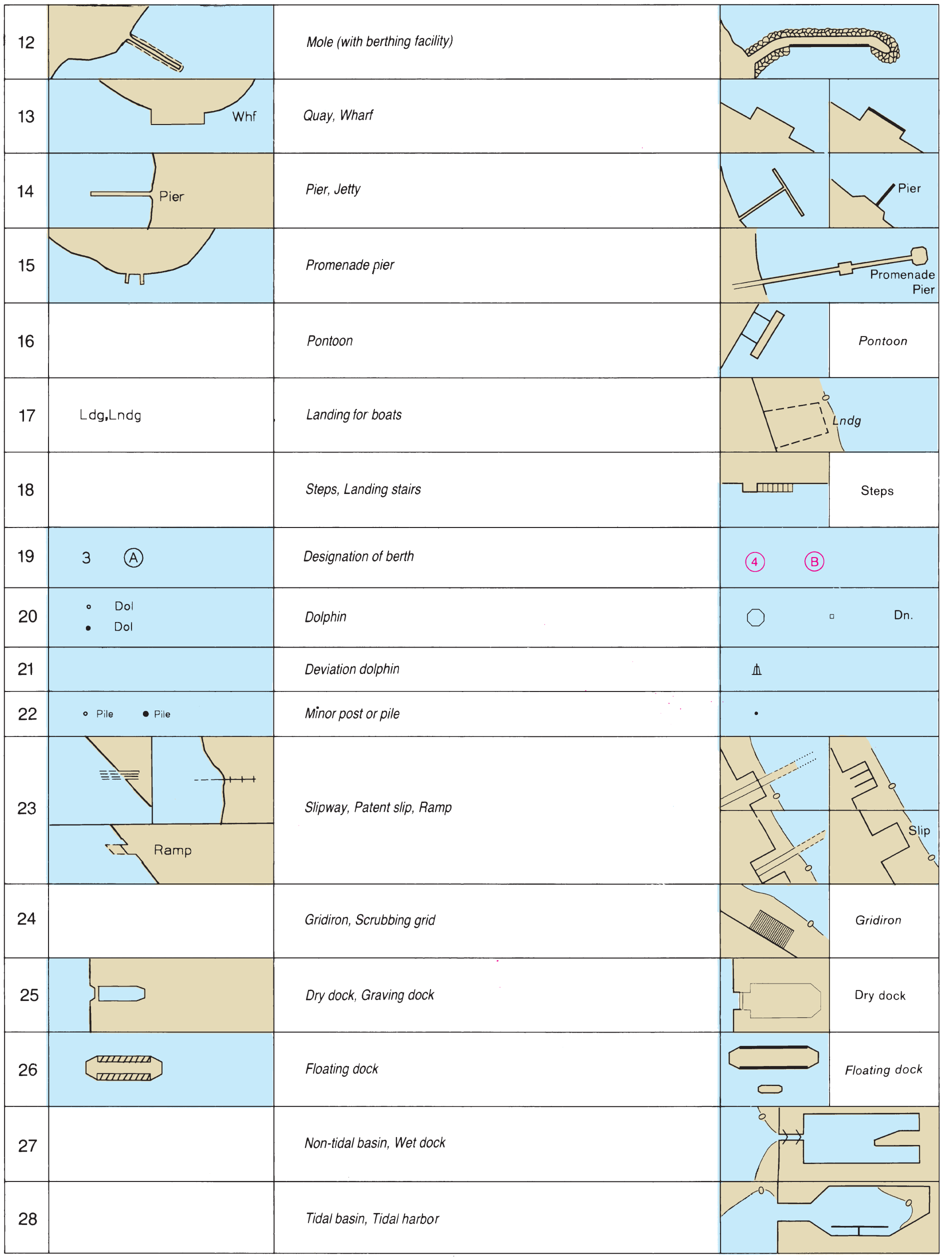

Fig. 3-7. Excerpt from Chart No. 1

label *"Floating pier"* is shown in black italic type.

Piers in ruins (F 33.1, F 33.2) are of particular concern to the mariner, because these may present a navigational hazard. A dashed line is used to depict these piers, or portions of these piers, that are submerged at the SPOR. The same symbol may also be used[5] for piers above the SPOR to alert the mariner that submerged debris may be nearby. A label "Ruins" may be added if space permits to alert the mariner that piers formerly deemed "essential" cannot now be used. If double-line, gold-tinted piers later become ruins, blue tint is substituted for the former gold tint. Piers in ruins which are 0.8 mm or longer at chart scale are considered potentially hazardous and are charted.

[5] Features in ruins are important to identify for several reasons. In some cases ruins can be readily distinguished, permitting positive identification. And, as noted, piers and harbor features in ruins also present navigational hazards to be avoided.

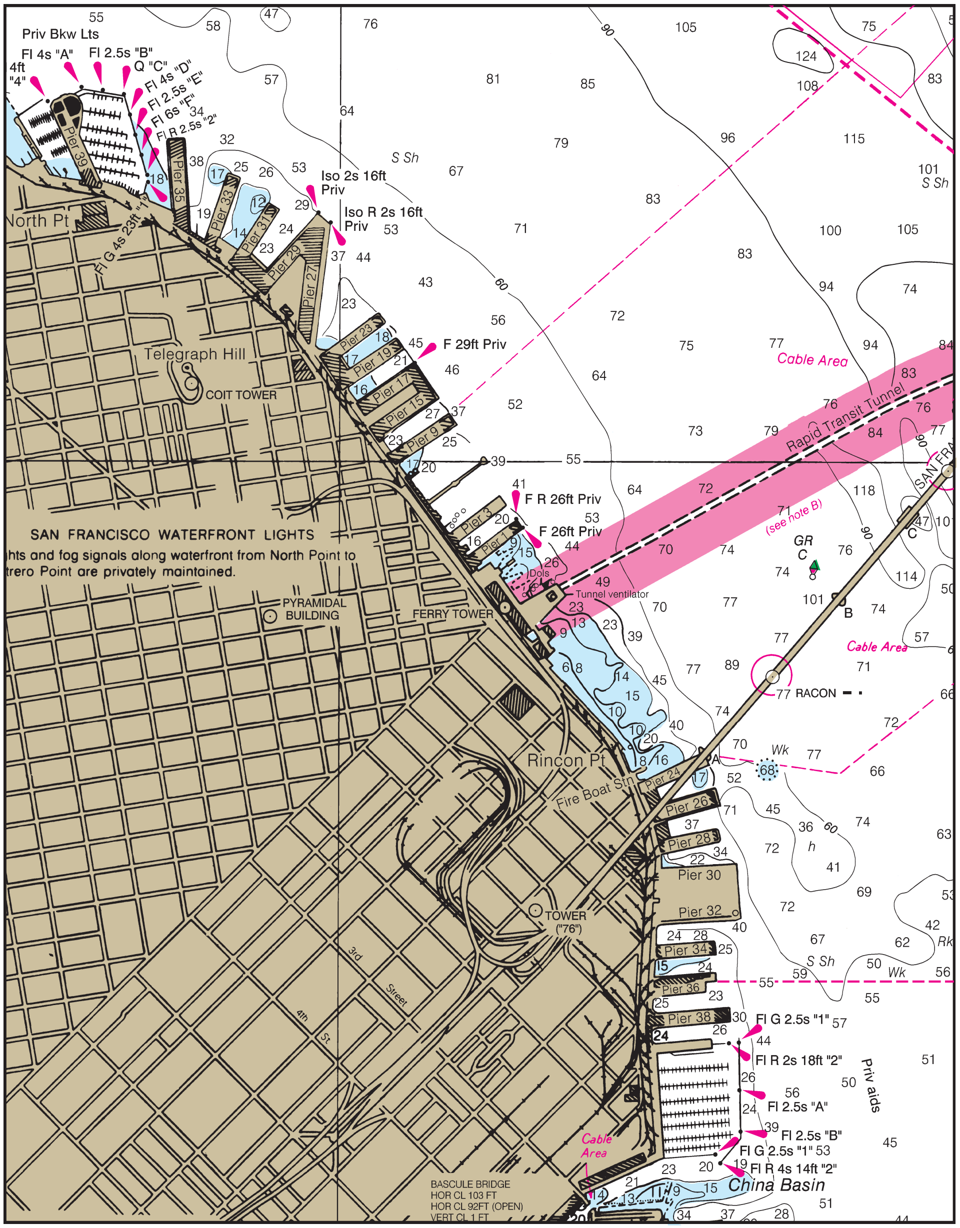

Fig. 3-8. Another excerpt from NOS Chart No. 18650 (San Francisco Bay), showing numerous small and large piers along the waterfront

A *wharf* usually runs parallel with the shoreline and is used for loading and discharging cargo. Its seaward face is charted using a special symbol (F 13), as well as the depth alongside.

–Additional Sources

The *U.S. Coast Pilot* provides valuable information regarding ports and harbors which supplements that presented in the nautical chart. According to the *Coast Pilot Manual*, port information presented includes such topics (in order to presentation) as charts, major features, major ATONS, shipping safety fairways, COLREGS, traffic separation schemes, vessel traffic services, routes, channels, anchorages, dangers, regulated navigation areas as defined in the CFR, cautions, local magnetic disturbances, bridges, tides/water levels, currents, weather/ice, coastal warning displays, pilotage, towage, quarantine, customs, immigration, and agricultural quarantine information, harbormaster/harbor regulations, wharves, supplies (deep-draft) repairs (deep-draft), small-craft facilities, ferries, and communications. The information presented in the *U.S. Coast Pilot* is applicable to commercial and recreational vessels alike. Depending on the size and commercial significance of the port, the discussion can run to several pages.

Erosion–Control Structures

Erosion-control structures are structures that extend into the water, or are solely within the water, constructed to protect a harbor or shoreline and not intended for berthing. Included in this general category are *breakwaters, jetties, groins, seawalls, dikes,* and *levees.* Some of these features are conspicuous and may be charted for their value in position fixing, but not all such features are conspicuous. Breakwaters, in particular, would appear to be a good reference point because of their large size in plan (top) view. However, experience soon shows that the relatively low height of the breakwater makes it difficult to see from any substantial distance (see Eyges, Mellor). As a practical matter, these structures are charted principally because they pose a hazard to navigation and create a potential harbor/ anchorage.

–Breakwater (F 4.1)

A *breakwater* is an artificial embankment protecting a shore area, harbor, anchorage, or basin from waves. A breakwater is typically a large and extensive structure (with only a low vertical profile, however) built of masonry and stone. The breakwater may extend out from shore in various configurations, or it may be placed roughly parallel to and separated some distance from the shore, providing access for safe anchoring in the protected area behind. Breakwaters are often associated with Harbors of Refuge (see Chapter 7).

Breakwaters detached from the shoreline usually represent a significant obstruction to navigation and are always charted. A *floating breakwater* is a structure consisting of floating materials connected by mooring chains or cables attached to anchors or stone blocks in such a manner as to form a basin within which vessels may be protected from the violence of the waves.

The breakwater is charted with a unique symbol (F 4.1). The line width used to symbolize a breakwater is increased on small-scale charts if a single line rather than a double line is used. The minimum charted length of the breakwater is 0.8 mm. Floating breakwaters are charted the same as fixed breakwaters, but with the addition of necessary symbols to depict retaining structures, and labeled *"Breakwater,"* in black italic type.

–Groins (F 6.1, F 6.2, F 6.3)

A *groin* is a low wall-like structure built from shore and designed to break the current and reduce erosion and fill out the shore by deposition of new materials. Different charting symbols are used to depict groins, according to whether they are always dry (F 6.1), intertidal (F 6.2), or always under water (F 6.3). Groins that are intertidal or always under water present the greatest hazard to navigation.

–Jetties (F a, F b, F c)

A *jetty* is a structure, ordinarily constructed of riprap, stone, and concrete, extending into the water perpendicular to the shoreline, typically used to protect a channel entrance (see also appendix A). Jetties at channel entrances often have ATONS located at the seaward end (e.g., lights or daybeacons, see Chapter 5 for details on how these are charted).

A jetty is charted using the same charting conventions as a pier.

–Seawall (F 2.1, F 2.2)

A *seawall* is a solid erosion-control device primarily designed to prevent erosion and other damage due to wave action. It is usually constructed of masonry, sometimes with a sloping face, and typically aligned with the shoreline.

On very large-scale charts, the feature may be outlined as shown on the source. On smaller scale charts, it is outlined with a solid black line.

–Dikes and Levees (F 1)

Dikes and *levees* are considered to be synonymous for charting purposes. Both are artificial embankments composed of earth rubble and constructed for shoreline protection, containment of landside material (e.g., dredged spoil), and protection from flooding.

Dikes and levees are depicted with a unique symbol (F 1) which may be slightly displaced so as not to overprint the shoreline. A half symbol may be shown in areas of chart congestion. A label "Road on levee" may be added if important.

–Additional Sources

The *U.S. Coast Pilot* provides additional information on breakwaters, groins, jetties, seawalls, and dikes and levees. This information includes materials of construction (if unusual), whether or not the structure is in ruins, a description of ATONs, whether or not the structure covers at any stage of the tide, tides and currents, and the protection afforded by the structure. Particularly valuable are qualitative comments on the efficiency of such structures as breakwaters. For example, the entry describing the breakwater at the southern entrance to the Delaware Bay notes that the Harbor of Refuge behind this breakwater "affords good protection during easterly gales," and that ***Breakwater Harbor,*** between the inner breakwater and the shore, "is excellent for light-draft vessels in all weather except heavy northwestern gales and even then affords considerable protection." No such information is provided on the nautical chart.

Docks and Tidal Basins

A *dock* is defined as the berthing slip between two piers or an area cut into land for the berthing of vessels. A *pier* is sometimes erroneously called a dock, but the two terms are not synonymous. A dock is also a basin or enclosure for the reception of vessels which has a means for controlling the water level. A dock (not otherwise classified), sometimes called a *slip,* is usually shown as the area between two piers.

–Dry Dock, Graving Dock (F 25)

A *dry dock* is a structure providing support for a vessel, and means for removing the water so that the bottom of the vessel can be exposed for servicing. A dry dock consisting of an artificial basin is called a *graving dock;* one consisting of a floating structure is called a *floating dock.*

A dry dock is charted (F 25) by its actual shape, with the gate closed. Floating dry docks are charted (F 26) by actual outline and gold tint only when known to be permanently moored in a fixed position.

–Tidal Basin (F 28)

A *tidal basin* serves as a dock, but has no gate to control the water level, which rises and falls with the tide. It is charted by its actual shape and labeled *"Tidal basin"* in black italic type.

–Wet Dock (F 27)

A *wet dock* (also called *nontidal basin)* is an enclosed basin separated from tidal waters by a caisson or flood gates. Ships are moved into the dock near high tide. The dock is closed when the tide begins to fall. If necessary, ships are kept afloat by pumping water into the dock to maintain the desired level. It is charted by its actual shape and labeled "Wet dock" in vertical black type.

–Additional Sources

The *U.S. Coast Pilot* provides additional information on piers, dry docks, tidal basins, and wet docks. For example, capacities of marine railways (see below), dry docks, floating docks, berth space, capacities of petroleum unloading facilities, deck heights, cranes, conveyer unloading systems, rail connections, open and covered storage areas, depths alongside piers, cargo limitations, bunkering facilities, and related information of relevance to freighters, tankers, and bulk carriers are provided in the *U.S. Coast Pilot.* Local, as well as federal, harbor regulations are also presented.

Bridges (D 22 – D 24, D d, D e)

Bridges over navigable waters present an obstruction to navigation and are charted principally for this reason. Bridges can also be used to determine a vessel's position. Passing under a bridge which spans a relatively narrow waterway is equivalent to a fix. Even if the waterway is quite wide, bearings can be taken on the bridge supports to determine a fix. Despite being carefully charted, bridges seem to be a tempting target for passing vessels.

Bridge symbols are shown as appropriate for roadways, railroads, and other crossings where they intersect navigable waterways on nautical charts. Bridges are not charted in cases where navigation is obviously not intended, e.g., drainage canals, cooling outlets, oil exploratory canals, and where the bridge is not listed in authoritative publications. (In these instances, the water crossing symbol is shown without the bridge symbol detail.) Charting conventions for bridges consist of a bridge *symbol*, *labels*, and *notes*. The symbol identifies the bridge type and generally provides a scale drawing of the bridge. The label identifies the type of bridge, and provides clearance data (see below), and the note(s) identify the basis for measurement of vertical clearances ("HEIGHTS" note) and a note of caution regarding bascule bridge clearances.

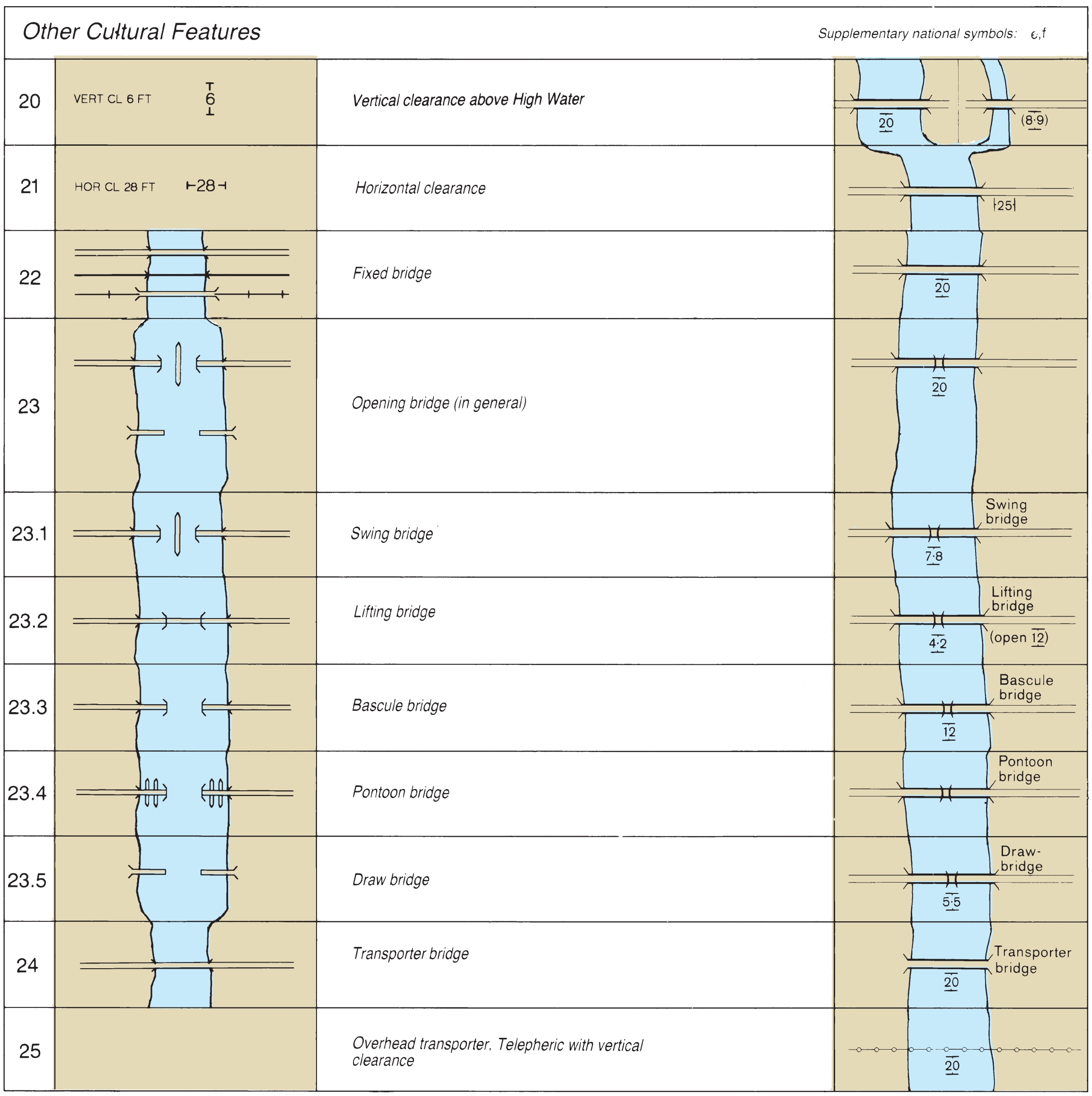

Fig. 3-9. Excerpt from Section D of Chart No. 1 Illustrating Various Bridge Symbols

–Bridge Symbols (D 22 - D 24, D d, D e) and Related Symbols

Figure 3-9 contains an excerpt from Chart No. 1 illustrating a variety of symbols used to depict several types of bridges. (These symbols are a great help in identifying bridges in some areas. For example, of the many bridges that span the navigable portion of the Delaware River, there is only one railroad bridge, one bascule bridge, and one vertical lift bridge designed for road traffic. Identification of any of these bridge types uniquely determines the vessel's location.)

Selected definitions, labels, and symbols of charted bridges include:

Fixed Bridge : A fixed bridge ("FIXED BRIDGE") is one that has no provision for opening, closing, raising, or lowering. The vertical clearance under this bridge is constant, except for the fluctuation of the water level.[6] Fixed bridges over waterways used by large commercial vessels typically have large vertical clearances. Fixed bridges are depicted with one of three symbols (D 22).

Swing Bridge: A swing bridge ("SWING BRIDGE") can be rotated (swung) in the horizontal plane to allow tall ships to pass. Swing bridges are depicted with a unique symbol (D 23.1).

Lifting Bridge: A lifting bridge, also called a vertical lift bridge ("LIFT BRIDGE"), is equipped with a movable span between two lift towers such that the entire span can be raised uniformly in the vertical direction. A lifting bridge is depicted with a unique symbol (D 23.2).

Bascule Bridge: A bascule bridge ("BASCULE BRIDGE") is a single- or double-leaf span, with the shoreward ends hinged, allowing the span to be elevated vertically. It is depicted with a unique symbol (D 23.3).

Pontoon Bridge: A pontoon bridge ("PONTOON BRIDGE") is a bridge supported by a flat-bottomed boat or a number of flat-bottomed boats or other floating objects, such as hollow cylinders. It is depicted by a unique symbol (D 23.4).

Draw Bridge: A draw bridge ("DRAW BRIDGE") is a generic term for a bridge that can be raised or lowered or drawn aside. It is depicted by a unique symbol (D 23.5).

Viaduct: A viaduct ("Viaduct")[7] is a structure consisting of a series of arches or towers supporting a roadway, waterway, or pathway across a depression, or other obstacle. It is depicted using a unique symbol (D f).

For additional definitions regarding bridges, see the *Coast Pilot Manual*, or appropriate sections of the *Desk Reference Guide.*

–Hazards Under Bridges

Critical dangers to navigation located under bridges (such as rocks and shoal soundings, see Chapter 4) are charted in their exact geographic position on the largest scale chart coverage. The bridge symbol is "broken" (interrupted) if these dangers are charted beneath the bridge structure. Deletion of a portion of the bridge symbol not only exposes these features, but also serves to emphasize the potential dangers. Dolphins, piles, snags,

[6]Actually, the clearance of a fixed bridge may vary with temperature and road traffic. If material, this is mentioned in a separate note, as discussed later in the text.

[7]The reader may wonder that the word "Viaduct" is shown in initial capital letters only, whereas labels such as "FIXED BRIDGE" are in all capitals. "Viaduct" is used merely to identify a feature. "FIXED BRIDGE" is in capital letters to draw attention to the label giving important clearance data.

etc., charted prior to bridge construction are deleted from the chart when bridge construction is complete only upon receipt of authoritative information that these obstructions have been removed.

–Bridge Clearances (D 20, D 21)

Clearance data, both vertical and horizontal, are critical for mariners using the waterways spanned by bridges. Although operators of sailboats are particularly concerned with clearances, other mariners also use this information. Horizontal and vertical clearances are provided on nautical charts for all bridges where there is information showing that navigation can take place on both sides of the structure. On charts using conventional units (e.g., feet) charted clearances are rounded down to the nearest foot—on metric charts to the nearest tenth of a meter (rounded down).

Vertical clearances are charted relative to MHW, and thus tend to *understate* the actual vertical clearance—that is, the charted clearance is somewhat conservative.[8] The actual vertical clearance at any time in any location (see Hobbs) is given by adding the mean range of the tide (available from the *Tide Tables*) to the charted vertical clearance, and subtracting the calculated height of the tide at that time (also determined from data given in the *Tide Tables*) at that location. Thus, for example, if the charted clearance were 25 feet, the mean range of tide 5 feet, and the estimated height of the tide 1 foot, the actual clearance would be 25 + 5 - 1 = 29 feet. Mariners should use an ample safety factor to allow for the possibility that the calculated height of tide may be in error. Many bridges, particularly draw bridges, are equipped with "board gauges" (painted white with black figures) to indicate the vertical clearance at all stages of tide.

The general format for the bridge label is the bridge name (see below), the bridge type, the horizontal clearance (including horizon clearance in the up position if not a fixed bridge), the vertical clearance (or vertical clearance in the down position if not a fixed bridge), VHF radio information (see below), and clearance data for overhead power cables (see below) if any. For example, the label describing the ConRail lift bridge that crosses the Delaware River near Delair, NJ, reads as follows:

CONRAIL LIFT BRIDGE
HOR CL 500 FT
VERT CL 49 FT DOWN
VERT CL 135 FT UP
OVHD POWER CABLE
AUTHORIZED CL 140 FT.

If there is more than one draw, information is provided for each. For example, this is the label describing the swing bridge across the Rancocas Creek bridge near Delanco, NJ:

SWING BRIDGE
HOR CL N DRAW 50 FT
HOR CL S DRAW 50 FT
VERT CL 4 FT.

(Vertical clearances for swing bridges are in the closed position.)

With certain long-span fixed bridges, the vertical clearance depends upon temperature and vehicular traffic as well as the water level. In these cases a cautionary note may be added to this effect. For example, the note corresponding to the Bay Bridge linking San Francisco with Oakland, CA, reads as follows:

> "CAUTION—Mid-span clearance under the long spans of the San Francisco–Oakland Bay Bridge are approximate and at a temperature of 55°F. These clearances may be reduced several feet due to extreme traffic conditions and a prolonged period of abnormally high temperature."

[8]This convention is in keeping with the convention of showing soundings with respect to MLLW discussed in chapter 4. However, the actual water level is sometimes higher than MHW, so the prudent mariner makes the more exact calculations shown in the main text if the clearance is at all marginal.

Many bascule bridges do not open to a fully vertical position as a result of operator action, physical limitations of the design, and/or capability of the operating machinery. However, if the source data do not indicate any restricted horizontal clearance information for the bascule bridge in the open position, the bridge label text provides clearances for the bridge in the closed position only. These clearances are charted as shown in the following example:

BASCULE BRIDGE
HOR CL 46 FT
VERT CL 10 FT.

Many bridges do not provide the same horizontal clearance between the open ends of the drawspan(s) as is provided between the bridge fenders at the water surface. The drawspan(s) may overhang the bridge fenders when the bridge is open. If such clearance data are available for the bascule bridge in the open position, the restricted horizontal clearance is incorporated into the bridge clearance text following the closed horizontal clearance as shown in the following example:

BASCULE BRIDGE
HOR CL 173 FT
HOR CL 102 FT (OPEN)
VERT CL 44 FT.

In addition to adding restricted horizontal clearance information to the bascule bridge label text, the following cautionary note is added to all nautical charts depicting bascule bridges:

"CAUTION
BASCULE BRIDGE CLEARANCES

For bascule bridges, whose spans do not open to a full upright or vertical position, unlimited vertical clearance is not available for the entire charted horizontal clearance."

This cautionary note is typically placed somewhere in the land area of the chart.

–Names

Bridge names known to NOAA are also charted. These names are sometimes used to separate channel reaches and, in any event, are often used as a position reference by mariners (e.g., in bridge-to-bridge communications). Bridge names are printed in black vertical type as shown above.

Names for railroads, major streets and highways, and routes at bridges are labeled with the name and route number.

–VHF Radio Capability

For bascule bridges, vertical lift suspension bridges, swing bridges, and others capable of opening, bridge tenders are equipped with VHF radios for communication with mariners. Radio communications are both safer and more convenient than whistle signals. Using radio, opening arrangements can be made from a greater distance and with greater clarity. Sound signals may be inadequate, especially if there is to be a delay in opening the bridge. For this reason, bridge call letters are given as the last line of the charted bridge clearance note in black vertical type. The last line reads "VHF," and gives the bridge call sign.

–Additional Sources

The *U.S. Coast Pilot* also provides relevant bridge information. This publication provides a description of the bridge, the location, radio call sign, VHF channel for communications. Chapter 2 of the *U.S. Coast Pilot* provides the *Drawbridge Operation Regulations,* both general and specific to each bridge, as taken from the CFR.

–Illustration

Figure 3–10 provides an excerpt from NOS Chart No. 13225 (Providence Harbor). This excerpt illustrates three different types of bridges: two fixed-road bridges, a bascule railroad bridge, and a railroad swing bridge. Shown also is an overhead power cable stretching between **Fort Hill** and **India Pt.** The towers from which the cable is suspended are charted as accurate landmarks. Principal

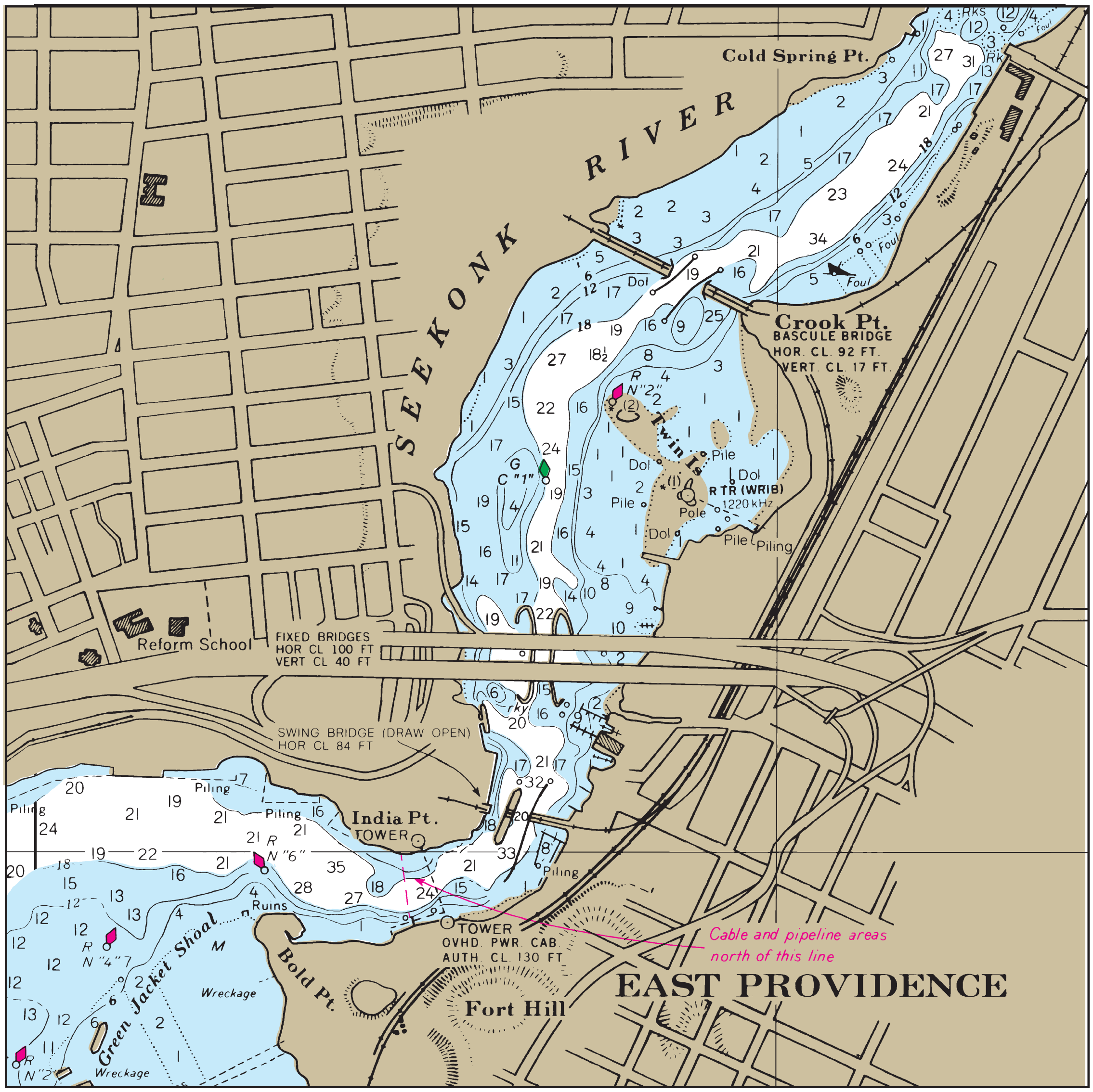

Fig. 3-10. Excerpt from NOS Chart No. 13225 (PROVIDENCE HARBOR) Showing Various Bridges

roads and streets are charted, together with selected buildings, including a reform school—one of the few found on a nautical chart.

Locks and Other Barriers

Locks, gates, barriers, and other manmade structures are used to control the height and flow of water. Structures that can prevent navigation under certain conditions and/or close an otherwise navigable waterway are charted. (For a useful discussion of locks and how these are used, see Chapman.)

Clearances are shown using the same conventions as those for bridges (see above), giving the lock dimensions, sill clearances, traffic control lights and information, appropriate references to the CFR, and other pertinent information. Radio information is given for these facilities in the same format as that given for bridges.

–Locks (F 41.1, F 41.2)

Navigation locks are charted in the closed position by a solid black line. Where possible, locks are charted to scale. Otherwise a symbol is used. Caissons and gates for controlling the water level in a wet dock or nontidal basin are also shown in the closed position by a solid line.

The *U.S. Coast Pilot* provides valuable additional information regarding locks. This information (see *Coast Pilot Manual)* includes the length and width of each lock, depth, vertical lift, and details on communication with lockmasters, traffic signals, and applicable excerpts of the CFR where navigation is governed by federal regulations.

–Floodgates, Sills, and Miscellaneous Other

Floodgates and saltwater intrusion barriers are shown in the open position, with the closed position shown by a black dashed line. *Sills,*[9] when charted as part of these structures or as a separate structure for controlling a water level, are also depicted by a dashed line as these are submerged at some tide stage. Power plant cooling water intakes and discharges, barriers for dam spillways, intakes, and overflows are charted with a solid black line (0.15 mm).

Landing and Launching Sites

Nautical charts also present information on landing and launching sites.

–Marine Railway (F 23)

A *marine railway* is used to haul vessels from the water, usually to expose the hull as in a dry dock. It is charted with the hatched railroad symbol (F 23) for the visible portion and a dashed line for the submerged portion, and is labeled "Marine railway." The term "Patent slip" is used on foreign charts.

–Ramps (F 23)

Ramps are sloping runways, often hard surfaced, used for launching boats from a trailer. An outline is shown, appropriate to the chart scale, and labeled "Ramp." If included on a small-scale chart, the name may also be charted.

Artificial Features

On large-scale charts, artificial features along the coastline, such as roads, railroads, embankments, levees, power lines, etc., are charted if scale permits. Major features may be charted inland to give an indication of the extent of development. Symbols for these features are shown in Section D of Chart No. 1. A representative sample of these features are discussed below.

–Roads and Related

Major railroads, streets, and highways are shown in port areas, adjacent to the coast, and approaching bridges over navigable waterways. These are charted, named, and numbered as appropriate. In major cities, such as San Francisco, CA (see figure 3–8), road and street names are seldom charted.

–Cable Ferry (M 51)

A *cable ferry* is a ferry guided across navigable waters by a cable attached to each shoreline. It is charted with a black dashed line and black label "Cable ferry." To emphasize the possibility of fouling the cable, which is raised when the ferry is in operation, a magenta screened band is centered on the cable alignment. Details on the operating procedures for cable ferries can be found in the *U.S. Coast Pilot.*

–Canal (F 40)

A *canal* is generally shown by a double line with a blue tint between the lines. If the scale is too small to use the double line, a single line is used with the label *"Canal"* in italic type. As a point of interest, canals often have bridges over them, but in the Netherlands, there are some canal bridges that pass over roadways. It is disconcerting to drive on the motorway and see a sailboat floating on an overhead canal! No such canals are depicted on NOS charts, however, which spares the U.S.

[9] A sill is the foundation at the bottom of the entrance to a dry dock or lock against which the caisson or gates close. The depth of water controlling the dock or lock is measured from the sill to the surface.

mariner the task of having to learn yet another symbol.

–Dam (F 44)

Dams across navigable waters are a significant obstruction/hazard to navigation and are always shown on nautical charts. A dam is charted to scale whenever possible. At small scale, a comb-shaped symbol is substituted for the scale depiction. This symbol is drawn across and slightly overlapping the banks of the river, with the "teeth" pointing in the direction of the river flow.

–Ditch (F 40)

A ditch is drawn as a single line with the label *"Ditch"* in italic type.

–Pipelines on Land (D 29)

Pipelines on land are generally not charted, but are shown in black if they cross above navigable waters. Buried pipelines are not charted. For information on charting conventions for underwater pipeline areas, see Chapter 4.

–Railroads (D b)

Trains may be visible from seaward. Even if not visible, train whistles or horns can sometimes be heard, which may be helpful in identifying this feature (Markell). A single 0.20 mm hatched line is used to symbolize both single- and double-track railroads. The initials of the railroad name (if known) is charted along the track in black vertical type. In the case of railroad yards, enough of the tracks are represented to indicate the area covered (e.g., the limiting tracks) and an appropriate legend may be given. Electric railways in cities are generally not charted.

–Roads and Road Patterns (D 1, D 2, D 10, D 11, D a)

Roads are generally not shown on charts smaller in scale than 1:250,000. At larger scales, only through or connecting public highways and roads leading from highways and terminating at the shore are generally shown. Private roads leading from public highways to buildings are omitted. In urban and suburban areas, streets are often shown, but may be omitted where necessary for clarity. Numbers and names of important U.S. highways are charted when the information is available. Lesser routes may also be labeled, depending upon chart congestion.

Primary transportation routes in cities, towns, and rural areas are symbolized by single or double lines depending upon the chart scale. Generally the double-line road symbol is used only on charts of scale 1:20,000 and larger. Roads may be shown to scale at charts of scale 1:10,000 where this will be useful to the chart user. Figures 3–8 and 3–10, for example, shows roads and highways charted to scale.

Streets and roads providing access to marine facilities and potential waterfront landing sites are shown if practical. Roads in rural areas that serve as connectors to major highways are also shown, even if these are not major arteries. However, extensive street patterns serve little purpose on charts and are difficult to update—raising problems of chart credibility. The urban screen (see below) is used in lieu of street patterns to denote built-up areas.

–Trails (D 12)

Trails are not generally shown on nautical charts. However, portage trails are shown on canoe charts.

–Tunnel Entrances (D 16)

Tunnel entrances are indicated by a symbol similar to a bracket (D 16); the path of the railway or road underground is represented by dashed lines.

Buildings and Structures

The purpose of charting buildings in urban and suburban areas, villages, and other built-up areas, is to leave a correct impression of the extent of the built-up area and the density of the buildings. Within built-up areas, only waterfront, landmark (see Chapter 6), and certain public buildings of interest are shown individually. The extent of the built-up area is shown by an urban screen (see below).

Referring to figure 3–8, for example, note how few buildings are shown in San Francisco, CA. Only the TransAmerica Tower (referred to as a "PYRAMIDAL BUILDING") and a few buildings located on piers are shown.

Away from ports and other built-up areas, even minor buildings (such as boathouses) may be charted individually if they lie close to the coastline and could be used by the mariner for orientation. In ports, buildings along the waterfront considered of significance to commercial shipping or recreational boating are individually represented if scale permits. Conspicuous buildings may be charted as landmarks to aid in navigating the adjacent waters. Landmarks are prominent as viewed from seaward and are useful for position fixing.

The prudent mariner realizes that it may not always be possible to detect and identify all charted buildings. New construction may mask buildings formerly visible from seaward. Waterfront areas are often the site of urban renewal projects, which may result in older buildings being torn down and new buildings erected. Of course, charts are continually being revised, and any such changes will ultimately be reflected as new charts are issued. Nonetheless, the time required to incorporate these corrections may be substantial. This is particularly a problem in cities undergoing rapid change.

–Airports (D 17, N e)

On large-scale charts, the limits of runways of commercial airports may be shown. Pictorial symbols are not used for airports.

–Buildings (D 5, D 6, E d, F 61, F 62.2, F 63) and Tanks (E 32)

Prominent buildings along the waterfront and large individual buildings away from the waterfront are shown by actual shape on charts of scale 1:40,000 and larger if these can be used for navigation. Not all such buildings are shown, however. Rather, the cartographer charts enough buildings for position-fixing purposes. *Therefore, the mariner should not expect the chart to provide a literal representation of the city skyline.*

A landmark symbol (see Chapter 6) and label is charted for selected buildings on small-scale charts. Note how few buildings and other structures are charted on figure 3–8.

Charting conventions for buildings are as follows:

> the line thickness is 0.15 mm,
>
> structures are shown to scale, subject to minimum size criteria (see below),
>
> ruins are labeled for identification,
>
> land or urban tints are shown as required, and,
>
> crosshatching is used to fill in buildings and tanks. This cross–hatching is normally oriented at an angle of 45°.

The minimum size criteria referred to above include:

> noncylindrical structures not in ruins are charted to scale by solid outline and crosshatching if the size at chart scale is at least 1.3 mm in any dimension. The smallest dimension for an outlined symbol is 0.3 mm. Buildings that do not satisfy the above criteria are charted with a minimum-size black square 1.3 mm on a side,
>
> ruins are labeled and shown with a dashed outline without crosshatching—minimum size constraints also apply for ruins, and
>
> cylindrical structures or tanks (not in ruins) are charted to scale by solid outline and crosshatching if the diameter is at least 1.6 mm at

chart scale. If smaller than this diameter at chart scale, a solid black circle with 1.6 mm diameter is shown instead. Ruins are labeled and shown by a dashed outline without crosshatching. Tanks in ruins with a diameter of less than 1.6 mm at chart scale are charted using an open black dashed circular symbol 1.6 mm in diameter.

At smaller chart scales, the minimum-size symbols for tanks or buildings in a dense group may become too closely spaced. Rather than deleting some of the symbols where the individual structures cannot be symbolized distinctly, a dashed area outline replaces the group of symbols and is appropriately labeled (e.g., “Tanks (oil)”) so that active buildings are not mistaken for ruins. The dashed area outline for such groups of tanks or buildings is never smaller than 1.3 mm on any side.

–Illustration

Figure 3–11 shows another excerpt from the 1:10,000 scale NOS Chart No. 13225 (Providence Harbor). Note that certain buildings and tanks are drawn to scale and crosshatched. Selected other buildings are shown using the minimum-size symbol. Active piers and piers in ruins are shown along the waterfront. Dolphins, pilings, and foul grounds are also in evidence. The ConRail railroad runs along the waterfront, depicted by the railroad track symbol. Numerous streets and an elevated highway are found. Rhode Island Hospital, charted as an emergency facility, is drawn to scale on this chart.

–Cemeteries (E 19)

Cemeteries are not normally conspicuous features. Headstones and other markers are not often prominent when viewed from seaward. However, cemeteries on sloping ground near the shoreline may be readily identifiable and, thus, would be charted.

On large-scale charts, the limit of charted cemeteries is shown and labeled “Cemetery” or “Cem” in black vertical letters.

–Church Buildings (E 10.1 - E 18)

Church buildings considered to be prominent, but not selected as landmarks, may be charted using one of several symbols. Minimum size criteria (see above) apply.

–Hospitals (F 62.2)

Hospitals and related emergency facilities are shown on nautical charts. The label “Hospital” is added in black vertical type. Note the hospital in figure 3–11.

–Urban Screen

The urban screen (a dark gold tint, rather than the buff or lighter gold land tint) is charted primarily to enable the mariner to identify developed areas at night by the projection and reflection of lights in the low atmosphere—a phenomenon termed “nightglow.” These lighted areas of sky can be seen from great distances offshore under many atmospheric conditions and may provide assistance to mariners making a landfall.

Figure 3–12 contains an excerpt from NOS Chart No. 12278 (Approaches to Baltimore Harbor) showing the dark gold urban screen to the east and northwest of SPARROWS POINT. Note also the bridge being removed south of **Long Pt.**—dashed lines with gold tint are used to depict this bridge. Subsequent editions of this chart will, no doubt, eliminate this feature. The dark gold urban screen indicates a built-up area with many buildings, none of which are specifically charted because SPARROWS POINT contains so many prominent features. Silos, stacks, a tower, and tanks are charted as landmarks in this excerpt—more than enough for position fixing.

Miscellaneous Stations

There are a number of other structures shown on the nautical chart of particular interest to the mariner. Several of these are explained below.

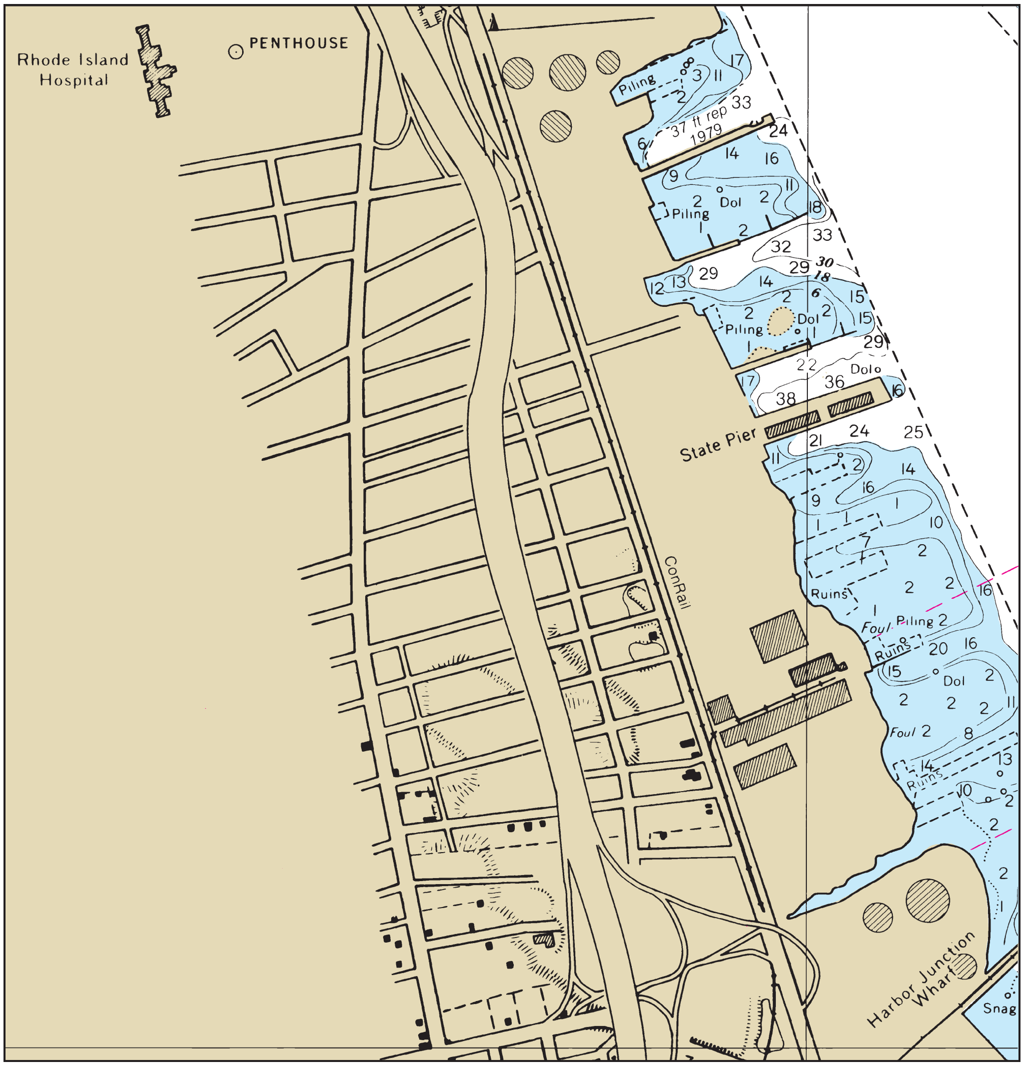

Fig. 3-11. Another Excerpt from NOS Chart No. 13225 (PROVIDENCE HARBOR) Showing Building Conventions

–USCG Stations (T 10, T 11)

USCG stations are particularly relevant to the mariner. These stations often have a commanding view and are visually prominent. Stations with lifesaving equipment are usually in relatively sheltered positions. The name of the station is shown on coastal series and larger scale charts (T 10). If the station is not a recommended landmark, a pictorial symbol (T 12) is used in lieu of the landmark symbol. On charts with smaller scales than the coastal series, the abbreviation "CG" is used with the pictorial symbol.

Some mariners (see Emery) have suggested that, since USCG stations are charted, it should be possible to obtain radio bearings on these facilities using direction-finding equipment, and thus obtain a line of position. *Mariners should avoid this practice! The location of the transmitting antenna may be located some distance from the Coast Guard station* (see Johnson), *and may or may not be charted.* Lines of position developed on the assumption that the antenna is at the USCG station could be seriously in error!

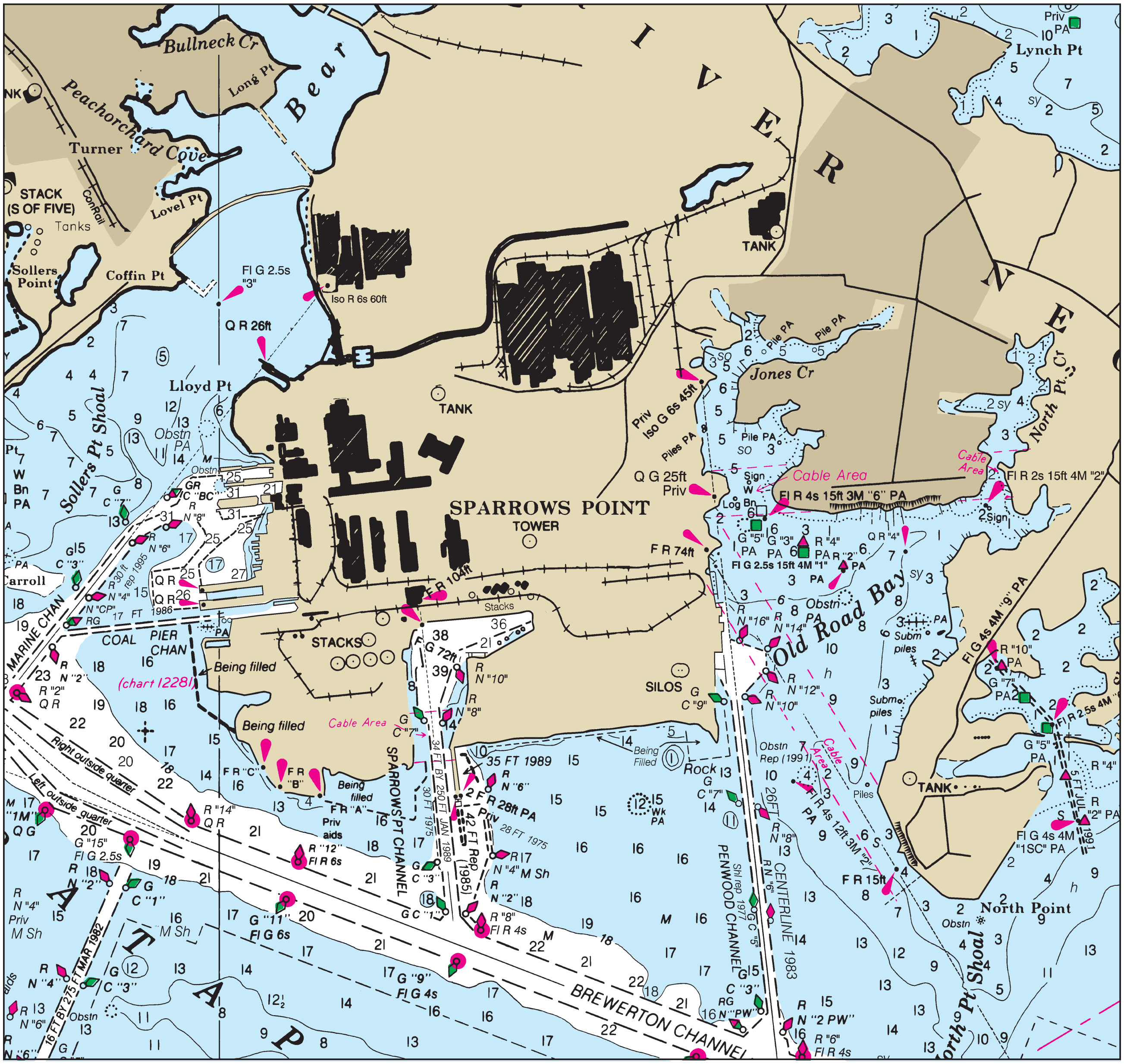

Fig. 3-12. Excerpt from NOS Chart No. 12278 (Approaches to Baltimore Harbor) showing dark gold urban screen and other features of interest

–Fireboat Station (T d)

These stations are shown on the largest scale charts of the area and labeled “FIREBOAT STATION” in vertical black capital letters.[10] The landmark symbol or approximate landmark symbol (see Chapter 6) may also be used as appropriate.

–Marine Police Stations (T c)

These stations are also shown on the largest scale charts of the area and labeled “MARINE POLICE” in vertical black capital letters. The landmark symbol or approximate landmark symbol may also be used.

[10] For eagle-eyed readers, the “Fire Boat Sta,” shown on figure 3–8, is in error. It should be shown in capital letters. Presumably this minor error will be corrected in subsequent editions.

–Pilot Stations (T 3)

The most important feature of a pilot station is the position of the meeting or boarding place (see Chapter 7 for charting conventions). The shore station may also be charted with a landmark symbol and the label "PIL STA," in vertical black capital letters.

Overhead Cables and Crossings (D 26, D 27)

Overhead cables are shown across all charted waterways, even those so small as to be shown by a single line at chart scale. Overhead cables are charted with a black dashed line (D 26 or D 27). An identifying label is charted with each cable, or group of cables. The label identifies the type of cable, e.g., "OVERHEAD POWER CABLE" or "OVERHEAD TELEPHONE CABLE," "OVERHEAD TV CABLE," etc., in vertical black lettering, all capitals. Labels may be abbreviated, e.g., "OVHD PWR CAB." Mariners should be aware that cables differ significantly in terms of hazard potential; power cables involve thousands of volts and sometimes high amperage as well, telephone cables 0.95 volts and 0.3 milliamperes while ringing. Clearances are added, using the same conventions as those used for bridges, if the waterway is known to be used for navigation.

Figure 3–10 provides an illustration of how power cables are charted. Note the power cable running from the vicinity of **Fort Hill** to **India Pt.** This cable is labeled:

OVHD PWR CAB
AUTH CL 130 FT.

In this example, each of the towers are marked as a landmark, using the accurate landmark symbol explained in Chapter 6.

–Overhead Cable Cars (D 26)

Overhead cable cars are charted using the same short dashed black lines used for an overhead power cable. If the source material indicates that the cable suspending the car does not carry electric power, it is labeled "OVERHEAD CABLE" in vertical black lettering, all capitals. Otherwise, it is assumed that the cable may carry power and is labeled "OVERHEAD POWER CABLE" in vertical black lettering, all capitals. The vertical clearances of both the car and the cable are charted if available as follows:

OVHD CABLE CAR
AUTH CL 37 FT
OVHD PWR CAB
AUTH CL 49 FT.

Land Boundaries and Limits

Boundaries and limits are discussed in more detail in Chapter 7. However, it is appropriate to mention land boundaries in this chapter. These are shown in black on nautical charts. State boundaries are shown over land areas only, stopping at the shoreline. International boundaries are shown over land areas and may extend over water areas as well. Along this border line, the name of the state or nation is shown at appropriate intervals in vertical type.

State boundaries are shown by a dashed line, and international boundaries are shown by a black dashed line of crosses (N 40, N 41).

Key Points and Miscellaneous Comments

There are some differences in the key points applicable to each chapter of this manual, but many are common and bear repetition:

Take time to learn the various chart symbols for topographic and other features. Although numerous, these are relatively intuitive and easily learned.

Always use the latest edition of a nautical chart, and keep the chart updated with information from the NM (see Chapter 1). It is true that some gross terrain features change little over time; Gibraltar looks more or less the same today as it did to Admiral Nelson, and the White Cliffs of Dover differ little from the telescope view of German soldiers contemplating the invasion of England during the early days of World War II. But manmade features are in a constant process of change. Buildings are constructed and demolished, piers and wharfs fall into ruin, overhead power cables are added, ATONs are moved, etc. Natural forces working upon inlets create a constantly shifting arrangement of channels; these cause inlets to open, move, or close and readjust the shoreline.

Always use the largest scale chart of the area. Large-scale charts present more detail and are easier to use. A minimum chart complement includes large-scale charts of each harbor to be visited and smaller scale charts appropriate to the enroute segment. This selection of charts may be adequate in the event of a routine passage, with no diversions for weather, mechanical difficulties, etc. Unplanned diversions to alternate harbors can be a real problem to the mariner who takes only the "minimum" number required. Consider taking extra large-scale charts of alternate destinations as an insurance policy.

Recognition and identification of topographic and other related features discussed in this chapter using radar, rather than visual means, requires specific training and experience. Mariners sometimes ask why special charts are not produced which portray shoreline and terrain features as observed using radar. The answer to this question is that the appearance of these features on radar is a function of many variables, such as the distance-off, angle, antenna height, and specific technical characteristics of the radar (such as the horizontal beam width). No one chart could capture this dependence, so there is no series of "radar charts" produced. Mariners should note the correspondence between charted features and their appearance on radar to learn "first hand" the "radar signature" of these features under varying conditions. Radar is an invaluable navigational aid as well as collision-avoidance system.

Mariners relying on charted terrain features for navigation soon learn that there areas which are "feature rich" (i.e., have an abundance of readily identifiable features, such as are depicted in figure 3–12) and areas with few prominent or "chartworthy" features. Most voyages involve a combination of "feature rich" legs interspersed with "barren" legs. Maintenance of a DR plot, updated with fixes whenever available, provides DR position estimates even in the "barren" stretches which facilitate orientation and position fixing. (DR is discussed in nearly every text on marine navigation, including most of the references given at the end of this chapter.) Even if the mariner is fortunate enough to cruise only in "feature rich" environments, the DR plot is invaluable. Fog, rain, darkness, or other phenomena that reduce visibility can transform any environment into a "barren" area in less time than it takes to read this paragraph; the DR plot is essential in such cases.

The prudent mariner studies the nautical charts beforehand to become familiar with the waters to be travelled, identifying hazards to be avoided, ATONs to be encountered, and features suitable for orientation and position fixing. With practice, the "Gedanken" or "armchair imagination" voyage serves as a useful simulation for the real voyage, without the distracting inconveniences of inoperative heads, failed electronics, rough running engines, spray on the chart table, etc. Do not be afraid to place marks and notes on the chart—it is after all a tool to be used, rather than an object to be framed and venerated. Pick out candidate landmarks for LOPs, look up unfamiliar symbols in Chart No. 1, and read the commentary in the *U.S. Coast Pilot*.

Further to the above point, valuable as they are, charts do not present all the information useful for a voyage. Do not overlook the *U.S. Coast Pilot* and other sources of supplementary information.

In identifying candidate terrain features, landmarks, etc., for navigation, allow for contingencies and do not focus on only a few features. Locally reduced visibility, confusion over landmark identification, and other contingencies may mean that other features are ultimately used for navigation.

It is important to emphasize a point made throughout this manual that the prudent mariner does not rely on any one means of navigation. LOPs and fixes based upon topographic and related features should be compared with information derived by other means, e.g., soundings, observation of ATONs, and electronic aids.

Finally, another point repeated in subsequent chapters: mariners should note any discrepancies or possible errors in charts and forward these to NOS for possible incorporation in the NM or corrections to subsequent charts.

Concluding Comments

This chapter presents a wealth of detailed information on the cartographic depiction of land features on nautical charts. The features discussed help the mariner (directly and indirectly) determine the vessel's position at sea in relation to various fixed objects. Features included in this chapter also acquaint the mariner with various port facilities and other services. Valuable collateral information is contained in the *U.S. Coast Pilot.*

To beginning mariners, the vast array of symbols used to depict these features is formidable. With experience, mariners are able to recognize and interpret more and more of these symbols. More important, the experienced mariner is able to visualize an unfamiliar coastline and relevant land features from a study of the chart.

The ability to correlate the charted feature with a mental image of the physical object comes with experience. But, the learning process can be expedited; time alone provides no guarantee of learning. As the old saw goes, there is a vast difference between 20 years of experience and 1 year repeated 20 times!

Mariners should use each voyage as a learning opportunity by continually comparing the observed land features with those shown on the chart. The mariner should also learn the important lesson that, although most features are drawn to scale on the chart, the size of the charted feature is not always an indication of the visual prominence of the object or suitability of the object for orientation and position fixing. Some large features on the chart (e.g., breakwaters) are not prominent features as seen from the vessel. Some small features (e.g., certain landmarks) may appear small on the chart but are readily observed and identified. Other features are virtually invisible (e.g., a dock in ruins, a partially submerged groin or other erosion control device), but critically important to avoid. Charts depict features in plan (overhead) view, but mariners see these features in profile view. It requires experience and study to translate one view to another.

"Sight is a faculty,
but seeing is an art."

Anonymous

"I am told that there are people who do not care for maps, and I find it hard to believe."

R.L. Stevenson, quoted in Heinl

References

Admiralty Charts and Publications, *Symbols and Abbreviations Used on Admiralty Charts, Chart 5011,* Edition 1, Hydrographic Office, Taunton, Somerset, TA 1 2DN, United Kingdom, 1991.

Bottomley, T., *Practical Piloting,* Tab Books Inc., Blue Ridge Summit, PA, 1983.

Canadian Hydrographic Service, *Chart No. 1/ Carte No. 1 Symbols Abbreviations Terms,* Minister of Fisheries and Oceans Canada, January 1992.

Defense Mapping Agency Hydrographic/ Topographic Center, *American Practical Navigator, An Epitome of Navigation (Bowditch),* Publication No. 9, DMA Stock No. NV PUB 9 VI, Bethesda, MD, 1995.

—*Radar Navigation Manual,* Publication No. 1310, DMA Stock No.NV PUB 1310, Sixth Edition, Bethesda, MD, 1994.

Emery, N., "On Stealing Bearings from the Coast Guard," *Navigator,* Vol. 1, No. 1, May/June 1985, pp. 53–54.

Eyges, L., *The Practical Pilot, Coastal Navigation by Eye, Intuition, and Common Sense,* International Marine Publishing, Camden, ME, 1989.

Graves, F., *Piloting,* International Marine Publishing Co., Camden, ME, 1981.

Heinl, R. D., *Dictionary of Military and Naval Quotations,* United States Naval Institute, Annapolis, MD, 1966.

Hobbs, R. R., *Marine Navigation: Piloting and Celestial and Electronic Navigation,* Third Edition., Naval Institute Press, Annapolis, MD, 1990.

Human Technology, Inc., *Desk Reference Guide: Specifications Unit, Chart and Map, Feature: Berthing Structure.* Report developed for National Ocean Service, Charting and Geodetic Services, Marine Chart Branch, Under Contract OPM–85–77, McLean, VA, October 1985.

———: *Boundary.*
———: *Breakwater.*
———: *Bridge.*
———: *Buildings.*
———: *Dam.*
———: *Dike.*
———: *Dry Dock.*
———: *Jetty*
———: *Landmark.*
———: *Marine Railway.*

Johnson, D. P., "C.G. Stations Use Remote Transmitters," *Navigator,* Issue No. 3, September/October 1985, p. 7.

Mellor, J., *The Art of Pilotage,* Sheridan House, Dobbs Ferry, NY, 1990.

Maloney, E. S., *Chapman Piloting,* 60th Edition, Hearst Marine Books, New York, NY, 1991.

———. *Dutton's Navigation and Piloting,* Fourteenth Edition, Naval Institute Press, Annapolis, MD, 1985.

Markell, J., *Coastal Navigation for the Small Boat Sailor,* Tab Books, Inc., Blue Ridge Summit, PA, 1983.

Maxim, L. D., *Advanced Coastal Navigation,* Second Edition, United States Coast Guard Auxiliary, Coast Guard Auxiliary National Board, Inc., Washington, DC, 1990.

Norville, W., *Coastal Navigation Step by Step,* International Marine Publishing Co., Camden, ME, 1975.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, and Department of Defense, Defense Mapping Agency Hydrographic/ Topographic Center. *Chart No. 1 United States of America Nautical Chart Symbols Abbreviations and Terms,* Ninth Edition, Washington, DC, January 1990.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. *Coast Pilot Manual,* 5th Edition, Rockville, MD, 1994.

U.S. Department of Commerce, Coast and Geodetic Survey, *Nautical Chart Manual, Volume One: Policies and Procedures,* Seventh Edition, Washington, DC, 1992.

Wright, F. W., *Coastwise Navigation,* Cornell Maritime Press, Centreville, MD, 1980.