CHAPTER 2

PORT SITE SELECTION

2-1. Basic port site selection considerations.

Unless the site is determined by military considerations, several locations of the harbor shall be studied to determine the most protected locations involving the relatively low dredging cost and with the most favorable bottom conditions, as well as a shore area suitable for the development of the terminal facilities. Generally, three distinct situations may result:

a. A natural setting along a shoreline, such as a bay, lagoon, or estuary, that would provide suitable protection.

b. A setting where natural barriers to the seaward side of port locations, such as land arms, reefs, spits, tombolos, and islands, are inadequate for protective purposes but have been modified by engineering methods to increase protection capabilities.

c. A setting where the port location is not provided natural protection by seaward barriers, and where artificial protective measures, such as the construction of breakwaters and jetties are required. The construction of artificial protective devices is time-consuming and should be avoided in military port construction when alternate locations are available. Such requirements, however, could represent one of the principal criteria in the evaluation of port site locations. The port facility should additionally be adequate to handle the volume of shipping required to sustain the theater activity and to accommodate the vessels that will transport the required cargo.

2-2. Factors affecting site selection.

a. *Access.* Direct access or connection with existing means of internal communication and dispersion, such as rivers, highways, canals, or railways, is a major factor in the location of the port. Where the topography at sites contiguous to inland communication facilities is adverse, the costs of providing connection to such facilities against the savings in development costs at remote sites should be investigated.

b. Water area. Adequate water area to accommodate expected traffic should be available. Where there is inadequate area for free-swinging moorings, vessels may be crowded in by using fixed moorings or moorings in which a vessel's swing is restricted. Berths and other facilities may be dredged from inshore areas. Breakwaters may be extended into deep water. The minimum and maximum area requirements shall be estimated in order to properly evaluate a proposed location. This requires estimating the capacity requirements, from which the area requirements for the anchorage, berthing, and other areas may be approximated.

(1) *Capacity requirements.* Ascertain the approximate, anticipated capacity requirements from the using agency, in terms of numbers, types, and sizes of vessels to be simultaneously anchored or moored within the harbor limits. Also, estimate the number of these vessels that must be simultaneously accommodated at pier or wharf berths.

(2) *Anchorage areas*.

(a) *Free-swinging moorings and standard fleet moorings*. The diameter of the swing circle and the area requirements per vessel are presented in tables 2-1, 2-2, and 2-3. Additional area allowance should be made for maneuvering vessels into and out of berths and for other space requirements necessary between adjacent berths.

(b) *Alternate method.* Requirements may also be approximated by comparison with areas provided in existing ports serving similar functions.

(3*) Berthing area*. See chapter 6 for the areas required for piers.

(4) *Other areas*. Allow additional area within the harbor limits for channels, special berths, turning basins, and other facilities.

(5) Total area requirements. Provide a total area inboard of breakwaters equal to the sum of the overall requirements set forth in b above.

(a) Generally, the total area should be available within the 50-foot depth contour to avoid breakwater construction in water of excessive depth.

(b) The area requirement can be considered in conjunction with the depth requirements to select a site requiring a relatively low dredging cost.

(c) In addition to the area requirements for anchorage areas, berthing areas, and other areas, space must be provided for future expansion and dispersion, where required for military considerations.

c. Water depth. Generally, the harbor area is of varying depth. Certain areas are set aside for small craft and other areas for larger ships. Provision for adequate water depth is essential to the functions of the port installation.

(1) *Anchorage and berthing areas*. For a given ship, the depth requirements at anchorage and berthing areas are the same. Except where heavy silting conditions require greater depth, at individual berths at low water, the depth should equal the maximum loaded draft of the largest vessel to be accommodated, plus 4 feet to protect the ship's condensers. For modern container ships, a water depth of 40 feet is required.

(2) *Channels*.

(a) Economic considerations can be weighed against depth requirements. In harbors where the tidal range is very large and particularly where an entrance channel is long, consider the possibility of restricting the entrance of the largest ships using the harbor to the higher tidal stages.

(b) Where hard bottoms exist and excavation costs are high, consider the exclusion of certain classes of deep draft vessels, with provisions of lighter service between deepwater anchorage and docks.

d. Physical and topographical features.

(1) *Sheltering from winds and ocean waves*. Natural sheltering features, such as headlands, promontories, offshore shoals, and bars, will substantially reduce artificial sheltering requirements (breakwaters) and overall project cost.

(2) *Bottom conditions*. Clay or other firm-tenacious materials furnish the best holding ground for anchors. Avoid sites where the bottom does not provide suitable holding ground for anchors. When very hard or soft bottoms exist, costly provisions (mooring islands, etc.) must be provided for securing ships.

(3) *Dredging.* Sites requiring excessive dredging of large quantities of rock or other hard bottoms should be avoided.

(4) *Shoreline relief*. Land adjacent to shorelines can gradually slope away from the beach. Avoid locations with pronounced topographic relief (cliffs) adjacent to shoreline.

(5) *Upland drainage.* Preferably the upland area shall be naturally well drained.

e. *Hydrographic and hydrological factors*.

(1) *Tidal range*. Tidal range should be minimum.

(2) *Bore.* Locations with a tidal bore should be avoided.

(3) *Currents.* Current velocity should be minimum. Except for the localized area or special considerations, should not exceed 4 knots.

(4) *Fouling rate*. Site should have a low fouling rate, be relatively free of marine borers, and have sufficient water movement to remove contaminations.

(5) *Stable shorelines*. Avoid locations having unstable shorelines or pronounced littoral drift. The history of erosion and deposition (shoreline changes) in the area should be thoroughly studied.

(6) *Tributary streams*. Location and depth of all streams emptying into the harbor should be determined. Depth and flow can be maintained in the final design to prevent a grading.

f. Meteorological factors.

(1) *Storm*. Avoid locations subject to pronounced, severe, and frequent storms.

(2) *Temperature*. Ocean temperature should be moderate to warm, and temperature range should be moderate.

(3) *Fog.* Avoid locations with a predominance of fog.

(4) *Ice.* Avoid locations that might be ice locked for several months a year.

g. Other factors.

(1) *Availability of construction materials*. Determine the availability of construction materials, particularly rock for breakwater and jetty construction.

(2) *Freshwater availability*. Ensure the availability of a potable water supply.

Table 2-1.
Diameter of Berth (in Yards) Using Ship's Anchor and Chain

	Length of various vessels in ft									
Depth of water in ft at MLW	100	200	300	400	500	600	700	800	900	1,000
10	165	235	300	365						
20	205	270	340	405	470	540				
30	245	310	380	445	510	580	645	710	780	
40	285	350	420	485	550	620	685	750	820	885
50	325	390	455	525	590	655	725	790	885	925
60	365	430	495	565	630	695	765	830	895	965
70	405	470	535	605	670	735	805	870	935	1,005
80	445	510	575	640	710	775	840	910	975	1,040
90	480	550	615	680	750	815	880	950	1,015	1,080
100	520	590	655	720	790	855	920	990	1,055	1,120
110	560	630	695	760	830	895	960	1,030	1,095	1,160
120	600	665	735	800	865	935	1,000	1,065	1,135	1,200
130	640	705	775	840	905	975	1,040	1,105	1,175	1,240
140	680	745	815	880	945	1,015	1,080	1,145	1,215	1,280
150	720	785	850	920	985	1,050	1,120	1,185	1,250	1,320
160	760	825	890	960	1,025	1,090	1,160	1,225	1,290	1,360
170	800	865	930	1,000	1,065	1,130	1,200	1,265	1,330	1,400
180	840	905	970	1,035	1,105	1,170	1,235	1,305	1,370	1,435
190	875	945	1,010	1,075	1,145	1,210	1,275	1,345	1,410	1,475
200	915	985	1,050	1,115	1,185	1,250	1,315	1,385	1,450	1,515

This table is based on the following assumptions:

(a) Length of chain is equal to 6 times depth of water.

(b) Anchor drags 90 ft from initial position.

(c) Basic formula B = 2/3 (0.987 x 6D + L + C) for scope of chain of 6 times the depth of water. Correction to scope to get radius of swing = 0.987. Where:

B = diameter of berth in yd.
D = depth of water in ft at MLW.
L = length overall of vessel in ft.
C = 90 ft allowance for drag of anchor.

(d) To maintain scope of chain of 6 tines depth for rise in tide, add 2/3 (5.92 T) to berth diameter where T = height of tide in ft.

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Table 2-2.
Diameter of Berth (in Yards) Using Standard Fleet Moorings, Telephone Buoy

	Length of various vessels in ft									
Depth of water in ft at MLV	100	200	300	400	500	600	700	800	900	1,000
10..	245	315	380	445						
20..	250	315	380	450	515	580				
30..	250	315	380	450	515	580	650			
40..	250	315	385	450	515	585	650	715	785	850
50..	250	320	385	450	520	585	650	720	785	850
60..	255	320	385	455	520	585	655	720	785	855
70..	255	325	390	455	525	590	655	725	790	855
80..	260	325	395	460	525	595	660	725	795	860
90..	265	330	395	465	530	595	665	730	795	865
100......................................	265	335	400	465	535	600	665	735	800	865
110......................................	270	335	405	470	535	605	670	735	805	870
120......................................	275	340	410	475	540	610	675	740	810	875
130......................................	280	345	415	480	545	615	680	745	815	880
140......................................	285	350	420	485	550	620	685	750	820	885
150......................................	295	360	425	495	560	625	695	760	825	895
160......................................	300	365	435	500	565	635	700	765	835	900
170......................................	310	375	440	510	575	640	710	775	840	910
180......................................	320	385	455	520	585	655	720	785	855	920
190......................................	330	400	465	530	600	665	730	800	865	930
200......................................	350	420	485	550	620	685	750	820	885	950

This table is based on the following assumptions:

(a) Chains are of the length called for by the drawings and are pulled out to obtain chain tension of about 12,000 lb with anchor in initial position.

(b) Anchor drags 90 ft from initial position.

(c) 180 ft of ship's chain used between vessel and buoy.

(d) Basic formula D = 2/3 (R + L + C2). Where:

D = diameter of berth in yd.
R = radius of swing of buoy in ft.
L = length overall of vessel in ft.
C2 = 270 ft (includes 180 ft from buoy to ship and 90 ft allowance for anchor drag). No correction for drop in waterline due to tide is required.

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Table 2-3.
Diameter of Berth (in Yards) Using Standard Fleet Moorings, Riser Chain

Depth of water in ft at MLV	Length of various vessels in ft									
	100	200	300	400	500	600	700	800	900	1,000
10	275	340	405	475						
20	280	345	415	480	545	615				
30	285	355	420	485	555	620	685			
40	295	360	425	495	560	625	695	760	825	895
50	300	365	435	500	565	635	700	765	835	900
60	305	375	440	505	575	640	705	775	840	905
70	315	380	445	515	580	645	715	780	845	915
80	320	385	455	520	585	655	720	785	855	920
90	325	395	460	525	595	660	725	795	860	925
100	335	400	465	535	600	665	735	800	865	935
110	340	405	475	540	605	675	740	805	875	940
120	345	415	480	545	615	680	745	815	880	945
130	355	420	485	555	620	685	755	820	885	955
140	360	425	495	560	625	695	760	825	895	960
150	365	435	500	565	635	700	765	835	900	965
160	375	440	505	575	640	705	775	840	905	975
170	380	445	515	580	645	715	780	845	915	980
180	385	455	520	585	655	720	785	855	920	985
190	395	460	525	595	660	725	795	860	925	995
200	400	465	535	600	665	735	800	865	935	1,000

This table is based on the following assumptions:

(a) Length of riser chain is equal to the depth of water at mean high water.
(b) Ground chains are of length called for by drawings and are pulled taut when installed.
(c) Anchor drags 90 ft from initial position.
(d) 180 ft of ship's chain used between vessel and buoy.
(e) Basic formula B = 2/3 (D + L + C1). Where:

B = diameter of berth in yd.
D = depth of water in ft at MHW.
L = length overall of vessel in ft.
C1 = 300 ft (includes 30 ft allowance for increase in radius of berth for drop in waterline due to fall of tide, 180 ft from buoy to ship, and 90 ft allowance for drag of anchor.