APPENDIX 3

Evaluation of Derince Container Terminal Feasibility Study

Evaluation of Derince Container Terminal Feasibility Study

1 General

The study team has evaluated "DERINCE CONTAINER TERMINAL FEASIBILITY STUDY REPORT, December, 1995" and "DERINCE CONTAINER TERMINAL FEASIBILITY STUDY SUPPLEMENTARY REPORT, April, 1996" (hereinafter the Report), which had been implemented by Istanbul Technical University, Faculty of Civil Engineering on behalf of DLH. The target year of the former Report is 2025 to 2030 and that of the latter Report is 2015.

An outline of the Report is as follows;
1) Limitation of development area is shown in Figure A 3.1.
2) Contour line in the development area is shown in Figure A3.2.
3) Soil profiles in the area are shown in Figure A 3.3 (1), (2) and (3).
4) Layout plan of Derince Container Terminal is shown in Figure A 3.4.
6) Layout plan of access road is shown in Figure A 3.5.
7) Cross sectional view of container berth pier is shown in Figure A 3.6.
8) Plan of the pier is shown in Figure A 3.7.

The evaluation of the Report was conducted by the study team from the following five viewpoints, namely, "Demand, Forecast", "Port Planning", "Container Handling System", "Design & Construction", and "Financial Analysis".

The objective term for evaluation extends to the year 2015 equal to the target year of the Master Plan Study for the Ports Development at the Sea of Marmara in the Republic of Turkey.

2 Demand Forecast

(1) Hinterland

In the Report, the hinterland to be analyzed is only Kocaeli, Sakarya, Bolu, Eskisehir, Istanbul, Ankara, Bilecik and Bursa. However, Thrace Region and the west part of Marmara Region should be considered as part of the hinterland since Haydarpasa port collects cargoes from there.

(2) Total cargo volume projection of Turkey

In the Report, total cargo volume of Turkey is forecast by correlation analysis using cargo throughput in the period of 1984～1994. On the other hand, study team conducted correlation analysis using socioeconomic indices in the period of 1987～1995. The forecast cargo volume is shown in Table A 3.1.

TABLE A 3.1 Total Cargo Projection of Turkey

unit : ton

year	F.S. Report	Study Team		
		Low case	Med. case	High case
2000	126,370,324			
2005		188,900,000	206,900,000	223,900,000
2010	157,907,009			
2015		308,500,000	365,500,000	442,500,000
2020	193,005,030			

(3) Containerizable cargo volume in Hinterland

In the Report, containerizable cargo volume is forecast by correlation analysis using cargo throughput of Haydarpasa and Gulf Region in the period of 1987～1990. On the other hand, study team used the datum of whole Marmara sea ports hinterland in the period of 1987～1995. The result is shown in Table A 3.2.

TABLE A 3.2 Containerizable Cargo Volume Projection in Hinterland

unit : ton

year	F.S. report	Study team		
		Low case	Med. case	High case
2005	17,452,500	11,700,000	13,000,000	14,700,000
2015	23,012,500	23,400,000	27,900,000	35,700,000

(4) Containerization Ratio

In the Report, containerization ratio is forecast by correlation analysis using containerization ratio of 1987 ～1990. On the other hand, study team used the containerization ratio of 1989～ 993. Since 1990, containerization ratio has been increasing rapidly in Turkey. Result is shown in Table A 3.3.

TABLE A 3.3 Projection of Containerization Ratio

year	F.S. report	Study team	
		Import	Export
1995	0.1659	0.598	0.704
1996	0.1937	0.653	0.743
1997	0.2240	0.696	0.766
1998	0.2564	0.728	0.781
1999	0.2903	0.751	0.789
2000	0.3250	0.766	0.794
2005	0.4841	0.796	0.800
2010	0.5817	0.799	0.800
2015	0.6249	0.800	0.800

(5) Container cargo volume

Container cargo volume is calculated by multiplying containerizable cargo volume with containerization ratio. Container cargo volume projection is shown in Table A 3.4.

TABLE A 3.4 Container Cargo Volume Projection

unit : ton

year	F.S. report	Study team		
		Low case	Med. case	High case
2005	8,449,215	8,833,200	9,772,400	11,048,400
2010	11,769,485			
2015	14,379,753	18,000,000	21,360,000	27,360,000

(6) Container volume TEU

The estimation method of TEU in the Report is to divide container cargo volume by average TEU weight of 7.5 tons.

On the other hand , study team estimation method is the sum of domestic container cargo volume and 2 times of import container cargo volume divided by average laden container weight of 12.5 tons and increased by 5 % as an adjustment. The result is shown in Table A 3.5

TABLE A 3.5 Container Volume Projection

unit : TEU

year	F.S. report	Study team		
		Low case	Med. case	High case
2005	1,126,562	876,000	973,000	1,114,000
2010	1,569,265			
2015	1,917,300	1,606,000	2,070,000	2,654,000

3 Port Planning

1) Development area for new container terminal

The development area for the new container terminal in Derince is adjacent to the existing Derince port on the west and the Petrol Cfisi Facilities to the east, and to the existing railway line to the north.

Minimizing the construction cost of a quay in deep water over 15 m and on soft layer is very difficult. Even in Japan, the maximum depth of a public container berth is 15m. From the viewpoint of preserving the water quality in the Izmit Bay, reclamation offshore should be avoided, because the tide difference (about 30 cm) in the Bay is so small, and the width of the Bay at Derince is very narrow. Therefore, to ensure economical construction, a maximum depth of about 15 m should be set.

Within this limitation, an area of some 630,000 m^2 is available for development of a new container terminal. Of this area, 432,000 m^2 (720m×600m) is from reclamation and 200,000 m^2 is existing land area.

2) Maximum container vessel size

According to the container handling volume in 2015, deviation from main container vessel route and operation cost, it will be possible for the New Derince Terminal to build up its status as a container hub port by 2015.

Moreover, countries around the Black Sea and East Europe have large potential of economic growth and when these countries realize their expected economic growth in future, maritime cargo volume between the Black Sea and the Mediterranean passing through the Sea of Marmara will be also expected to increase.

To meet with the physical distribution after the year 2015, the size of mother container vessel with capacity of 3,000～4,000 TEU should be taken into consideration as a maximum container vessel, if container berth, which has about 14～15 m in water depth, could be easily constructed without additional cost.

3) Number of berth

The number of container berth depends on the container handling volume in the target year. If the average size of container vessel calling and the average handling volume per one berth at the New Derince Terminal would be 27,000 DWT(1,500TEU capacity) and 200,000TEU respectively, it will be necessary to construct 12 berths (berth length: 3,360 m) by 2030 and 8 berths (berth length: 2,240 m) by 2015 based on the container volume forecast in the Report.

On the other hand, since it is necessary to limit the construction cost of the quay as mentioned 1), only five(5) berths are possible if the necessary container yard area is to be secured.

4) Area of container terminal

Generally, depth of container yard of 27,000 DWT container vessel(1,500TEU capacity) is 300 m in Japan. Because the length of 27,000 DWT container berth is 280 m, the required area of container yard for one berth is around 84,000 m^2.

The development area mentioned in 1) can accommodate five(5) container berths at most, including supplementary area.

5) Layout of container port facility

The shape of reclamation area in the Report is rectangular. This shape is reasonable for a huge lot of land, efficient container handling and to layout continuous berths. According to the layout in the Report, if wind comes from SW or SSW, the reflected wave from the west side of reclaimed land may disturb the calmness of existing Derince port. Therefore, wave absorber structure like a pier with rubble mound should be considered at the west side of quay.

6) Timing of completion

According to cargo estimation, container handling volume at ports in the Sea of Marmara will increase rapidly, and the Haydarpasa port is terribly congested with container at present.

The capacity of new container terminal will be 1,050,000 TEU and container cargo demand will exceed terminal capacity at around 2005. Therefore, this new large scale container terminal should be constructed as soon as possible, because construction will take at least 3 years.

7) Access to main road

The treatment of road traffic from new container terminal at the crossing of the nearest existing road should be considered carefully. Especially, the north side of intersection should not be divided.

The layout of railway in the container terminal should be reconsiderd, since the railway on the apron of container berth will decrease container handling efficiency.

8) Width of Apron

For panamax type and over panamax type container vessels, apron of 30m in width is not sufficient for efficient handling. It should be 60m.

4 Container Handling System

The Report is comprised of two booklets, namely a main report, for which the target year is 2025 to 2030, and a supplement report, target year of which is 2015. Because basic design criteria is only mentioned in the main report, following evaluation is made for the main report regarding the basic design criteria and for the supplement report regarding the design value of the new container terminal.

(1) Basic Design of the New Container Terminal of the Report

Basic design criteria of the Report is as follows.

Main ship is 50,000DWT, 28000TEU container ship. Other large ship dimension is 25,000, 20,000, 15,000, and 5,000DWT respectively. Consequently, depth of the berth is 15m, 13m, 12m, 10-11m, 8m. Container traffic is 2,362,828 TEU in the year 2030 and 1,567,300 TEU in the year 2015. Daily practical handling capacity of a gantry crane is 480 TEU/day. (Theoretical capacity 600 TEU/day x 0.80) Working day is 330 days/year. Therefore, yearly handling capacity of a gantry crane is calculated as 330 x 480 = 158,400 TEU/year, and required number of gantry crane is 2,362,828/158,400 = 14 in the year 2030. (9 cranes for the year 2015.) Quay length for a gantry crane is assumed as 100 - 150 m, then, required total quay length is calculated as 14 x 125 = 1750 m. Considering sea service vehicle, quay length is decided as 2,000 m. Apron length is designed as 30m for 50,000 DWT ship and 20 m for others

Necessary terminal area is calculated as follows.
Volume of container : 2,362,828 TEU/year
Storage container in yard : 2,362,828 x 2/3 = 1,575,219 TEU/year
Dwelling time : 10 days in average
Container storage capacity : 1,575,219 x 10/ 365 = 43,157 TEU
Stacking height : 4 stacks
Number of slot : 43,157 / 4 = 10,790
Area for 1 TEU = 2.6m x 6m = 16 m², then terminal area is 10,790 x 16 = 172,626 m²
Include 50% of empty area, total area is 172,626 x 2 = 345,000 m²
Number of full container : 2/3 of total container, i.e.1,575,219 x 2/3 = 1,050,146 TEU/year
Number of CFS Service : 25%of total container, i.e. 1,050,146 x 0.25 = 262,356 TEU/year
CFS area and Empty container storage area : 345,000 x 0.25 = 86,250 m²
Total container storage area : 400,000 m²
Other area : 60,000 m²
TIR and terminal service vehicle : 50,000 - 60,000 m²
Total Terminal Area : 500,000 m²
Available Area : 200,000 m²
Reclaimed Area : 300,000 m²

(2) Evaluation of the Report

Because the target year of the JICA study is 2015, forecast figures of the year 2015 are used as the basis of the following evaluation .

Typical draft and required berth depth of container ship is as follows.
50,000DWT ---- d=13m, Berth depth =15m, 4000TEU class
40,000DWT ---- d=12.4m, Berth depth =14m
30,000DWT ---- d=11.6m, Berth depth =13m
20,000DWT ---- d=10.6m, Berth depth =12m
Therefore, design draft of the berth shall be 12m to 15m respectively.

Container traffic in 2015 at Derince Port will be 1,276,150 TEU. Daily practical capacity of gantry crane is calculated as 25 box/hour x19.5 hour/day x 0.8 = 390 box/day. Yearly handling capacity is 390 box/day x 330 days/year x 0.7(Berth Occupancy Ratio) = 90,090 box/year. Assuming the ratio of 40 feet container is 40% of the total container, yearly handling capacity is 126,126 TEU/year.
Apron length shall be 60m for smooth traffic behind the gantry crane.

Number of direct delivery container as 1/3 of total throughput might be an excessive assumption.

The required storage number of container is calculated by the following formula :

$$Ml = (My \times Dw) / Dy \quad \times P$$

where, Ml : Required storage number of containers (TEUs)
My : Annual container throughput (TEUs)
Dw : Average dwelling days (days)
Dy : Operating days (330 days)
P : Peak ratio (1.3)

The present average dwelling time of import container is about 20 days. This is rather long compared with other ports. However, the current customs law and legislation, which is the main reason for such a long dwelling time, is being changed in accordance with the European Customs regulations. Therefore this figure is assumed to be reduced to about 10 days in the year 2015 as described in the Report. Dwelling time of export containers and domestic containers is assumed as 5days, 3.5 days for transit containers, and 10 days for empty containers.

Import/export containers could be stacked at maximum four layers in the container yard if "1 over 4" type transfer cranes are used. However, operationally, it is desirable to stack 3 high on an average basis for import containers and 3.5 high for export and transit containers. The stacking height of empty containers shall be 4.

Required number of ground slots is calculated by the following formura.

$$Sl = Ml / L$$

where, Sl : Required number of ground slots (TEU)
Ml : Required storage number of containers (TEUs)
L : Stacking height of containers (box)

The results of the calculation are shown in Table A 3.6.

TABLE A 3 6 Required Storage Capacity of Derince Container Terminal

		Laden Containers				Empty	Total
		Import	Export	Domestic	Transit		
Annual Container	TEU	485,622	351,092	39,375	215,000	185,061	1,276,150
Dwell days	days	10	5	5	3.5	10	
Req. Storage	TEU	19,131	6,915	776	2,964	7,290	37,076
Ave. Stacking height	box	3.0	3.5	3.5	3.5	4.0	
Req. Ground Slot	TEU	6,377	1,976	222	847	1,823	11,244

Necessary area for one container (1 TEU) is about 27.73m² for the transfer crane of 6 rows and 1 traffic lane type. Therefore, necessary container storage area is :

$11{,}244 \times 27.73 = 311{,}800\ m^2$

Assuming that 33% of this storage area must be used for the movement of traffic, total storage area will be,

$311{,}800 \times 1.33 = 414{,}700\ m^2$

The required area for the CFS is calculated by the following formula.

$A = (Mc \times Dw \times P) / (w \times r \times Dy)$

where, A : Required floor area of CFS (m^2)

Mc : Annual handling volume of container cargo through CFS (ton)

Dw : Dwelling time at CFS (7 days)

P : Peak ratio (1.3)

w : Volume of cargo per unit area (1.3 ton / m^2)

r : Utilization rate of CFS floor (0.5)

Dy : Operating days of CFS (330 days)

Using the premises mentioned above and assuming CFS service ratio is 20 %, the required area of the CFS is calculated as follows.

$Mc = 1{,}276{,}150\ TEU \times 8.3\ ton/TEU \times 0.2 = 2{,}118{,}409\ (ton)$

$A = (2{,}118{,}409 \times 7 \times 1.3) / (1.3 \times 0.5 \times 330)$

$= 89{,}872\ m^2$

Although the above mentioned calculation is only basic calculation, required area of Derince Container terminal is larger than the planned area in the Report. In order to handle 1,276,000TEU per year, container terminal in the existing port area is necessary to be used.

5 Design & Construction

As concerns the design and construction of the Derince container terminal, the main comments regarding the report of the feasibility study are as follows:

1) Soft - very soft clay more than 20 m thick, exists on the hard clay or sand layer on the planned terminal area. Although the soft layer will be stabilized ahead of laying the infill, and the vertical drains method is recommended, detailed data related to the countermeasure is not mentioned in the report.

2) Quay foundation on soft clay layer shall be checked regarding the slope failure.

3) The pile length of the couple piles - a pair of one vertical pile and one batter pile are determined under the combination of vertical loads and lateral loads. In case of earthquake, the lateral loads - seismic force - not only the transverse direction but also the longitudinal direction should be taken into account in the pile calculation.

6 Financial Analysis

The results of financial indicators such as working ratios, operating ratios, rates of return on net fixed assets, debt service coverage ratios and the financial internal rate of return calculated from the data and conditions in the Report are shown in Table A 3.7. Since the interest rate of short term loans is not given, it is assumed to be the same as the interest of long term loans.

TABLE A 3.7 Results of Financial Indicators (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Working Ratio	22.6	19.9	17.8	16.9	20.3	18.9	17.5	17.4	16.6	16.3	16.2	15.7	15.6	15.2	14.8	14.6
Operating Ratio	77.3	61.1	50.5	44.0	43.4	39.1	35.4	33.6	31.5	17.5	16.2	15.7	15.6	15.2	14.8	14.6
Rate of Return on Net Fixed Asset	4.0	9.0	14.3	19.4	21.3	27.1	33.3	38.5	46.4	55.2	59.0	61.7	61.0	64.2	67.2	68.1
Debt Service Coverage Ratio	241.7	239.4	246.0	203.2	241.9	299.4	365.3	433.0	649.2	1,062.8						
Financial Internal Rate of Return	20.4%															

Although the method of calculating the financial internal rate of return in the Report is uncommon, the result is very close to the value calculated by the common method. In the Report the estimated container handling capacity is too high as described in 4 and administration cost is not included in the operating cost.

The results of the same indicators calculated from the data modified in accordance with the above mentioned points are shown in Table A 3.8. Every indicator, both in Table 6.1 and 6.2 is good, which results in an unnaturally good financial statement. This is assumed to be caused by factors such as lower operating costs and depreciation or higher operating income than is actually the case. The high share of own fund in the total investment costs may be also the cause of this statement.

TABLE A 3.8 Results of Financial Indicators Calculated from the Modified Data. (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Working Ratio	30.4	24.2	25.7	22.5	22.2	22.6	22.5	21.7	22.0	20.7	21.7	21.9	20.8	20.9	21.1	21.4
Operating Ratio	97.5	68.9	70.4	56.0	44.6	45.0	44.9	40.9	41.1	22.3	21.7	21.9	20.8	20.9	21.1	21.4
Rate of Return on Net Fixed Asset	0.4	6.6	6.2	12.3	21.6	22.1	22.8	29.0	30.9	42.7	42.2	41.2	43.9	43.7	43.4	42.0
Debt Service Coverage Ratio	177.3	208.6	162.7	153.1	243.8	257.7	275.0	347.2	470.9	825.0						
Financial Internal Rate of Return	15.7%															

In order to evaluate the financial statement accurately, it is necessary to examine the above mentioned data closely by comparing with the actual data.

7 Total Evaluation

1) The projected container cargo demand for ports in the Sea of Marmara in the Report is nearly same as that projected by the study team. However, the differences between the Report and the study team in terms of containerizable cargo volume and containerization ratio are noticeable.

2) Layout of container berth and revetment of reclaimed land are acceptable. However, the layout of container terminal, such as handling system, traffic flow in the terminal, width of apron and dock railway sidings, should be examined in more detail.

3) Design and construction works are not comprehensively treated in the Report. For example, whether soil improvement of soft layer and seismic force to pier are considered or not, is not mentioned nor is quantity and unit rate of works. Therefore, the team could not completely evaluate the feasibility of the Derince Container Terminal.

4) More detailed data of prerequisites for financial analysis, concerning operating cost, income, depreciation and interest of short term loan are also not mentioned in the Report. After review of above items including construction cost, financial analysis should be implemented again.

5) For the total evaluation of the Report, detailed information was insufficient. In spite of the growing container cargo demand in the Marmara region, construction of a new container terminal is not so urgent because there is sufficient capacity up to 2005 if private ports are included. To realize this project, supplementary feasibility study including site selection should be initiated by 2005.

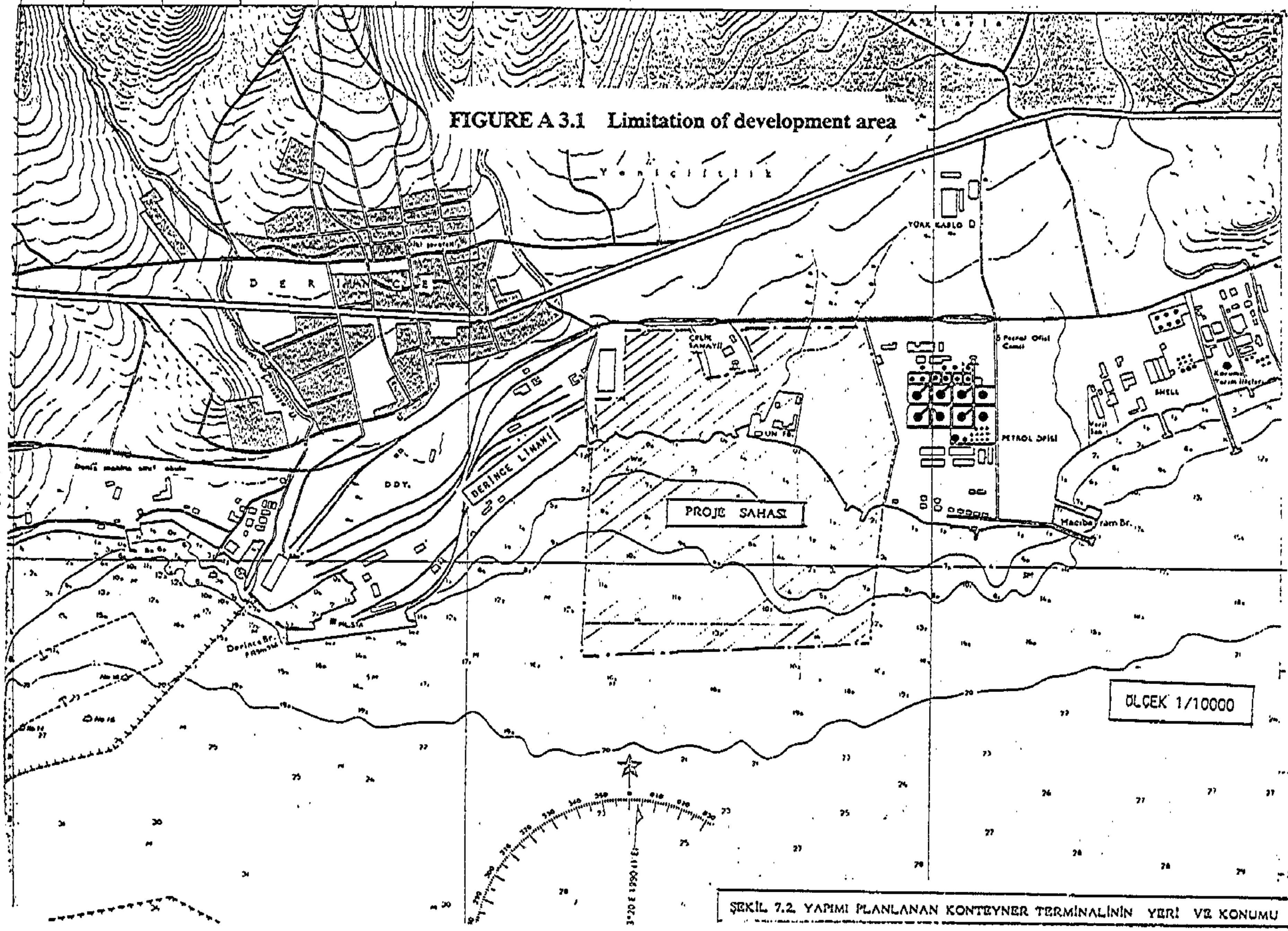


FIGURE A 3.1 Limitation of development area

ŞEKİL 7.2. YAPIMI PLANLANAN KONTEYNER TERMİNALİNİN YERİ VE KONUMU

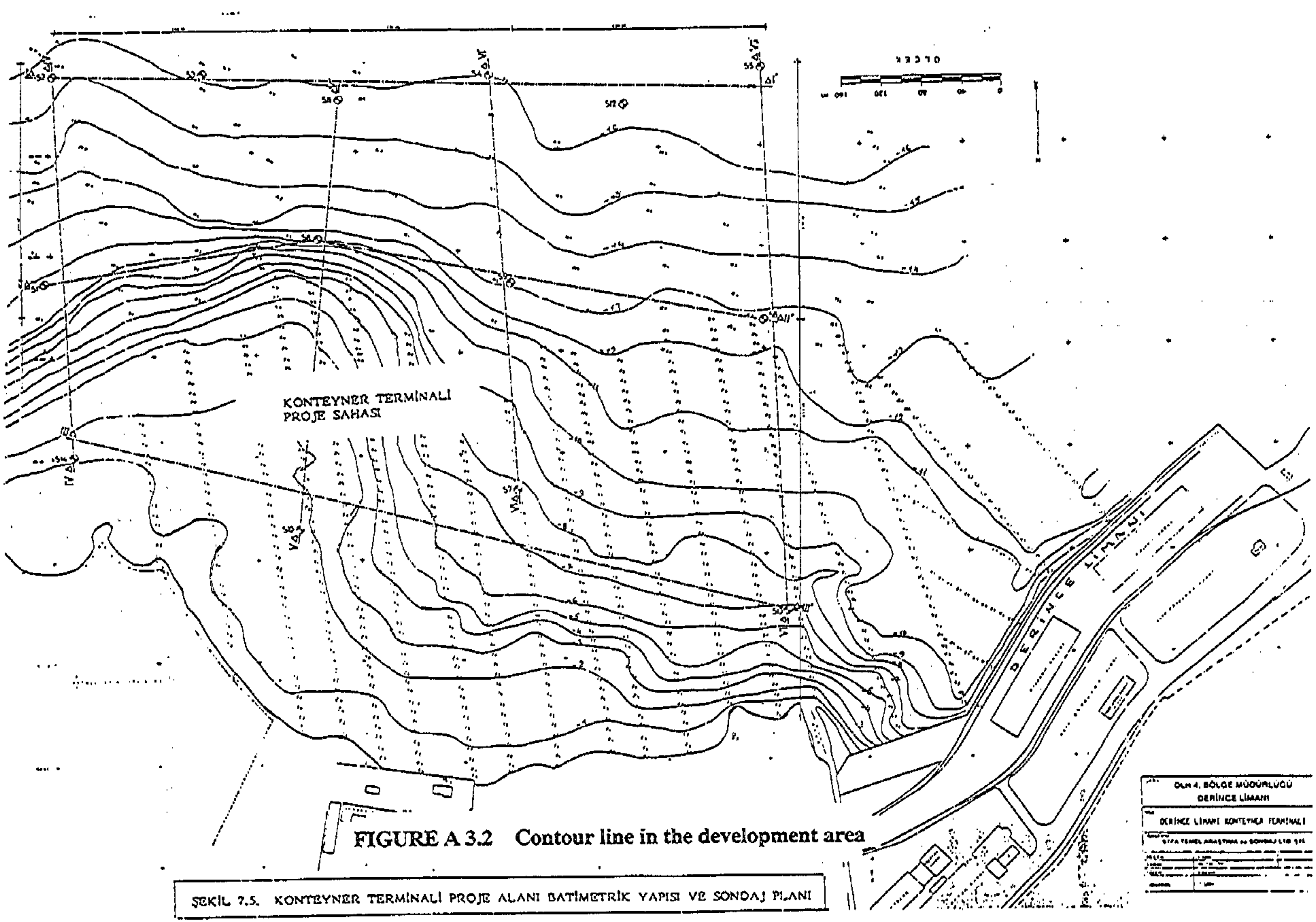


FIGURE A 3.2 Contour line in the development area

ŞEKİL 7.5. KONTEYNER TERMİNALİ PROJE ALANI BATİMETRİK YAPISI VE SONDAJ PLANI

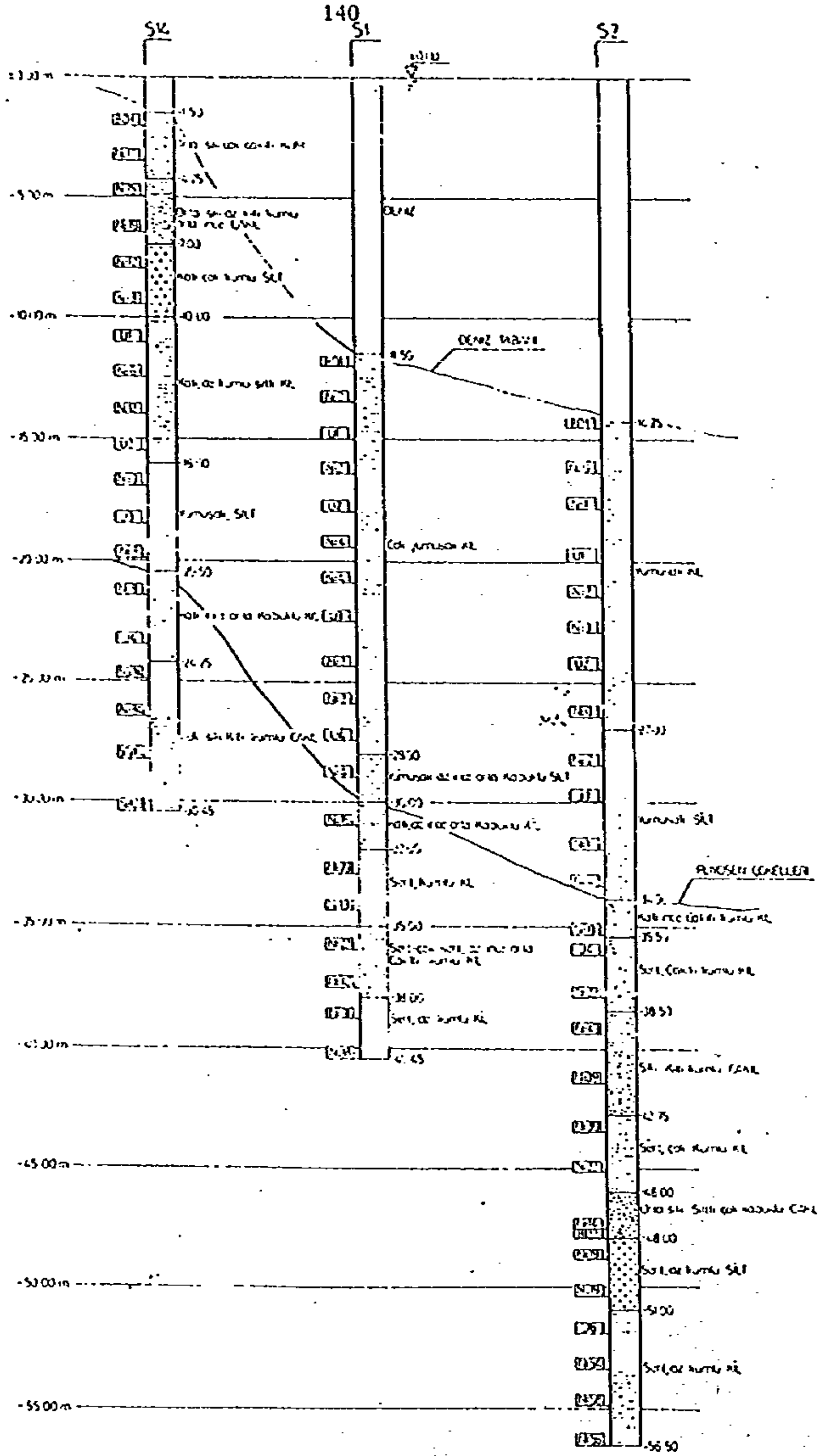
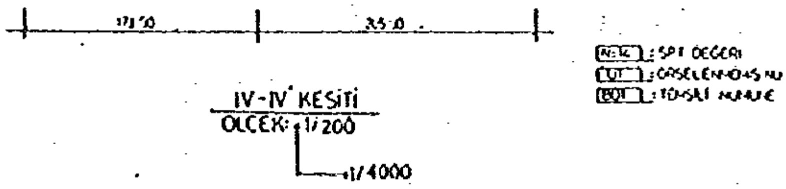


FIGURE A 3.3 (1) Soil profiles in the area



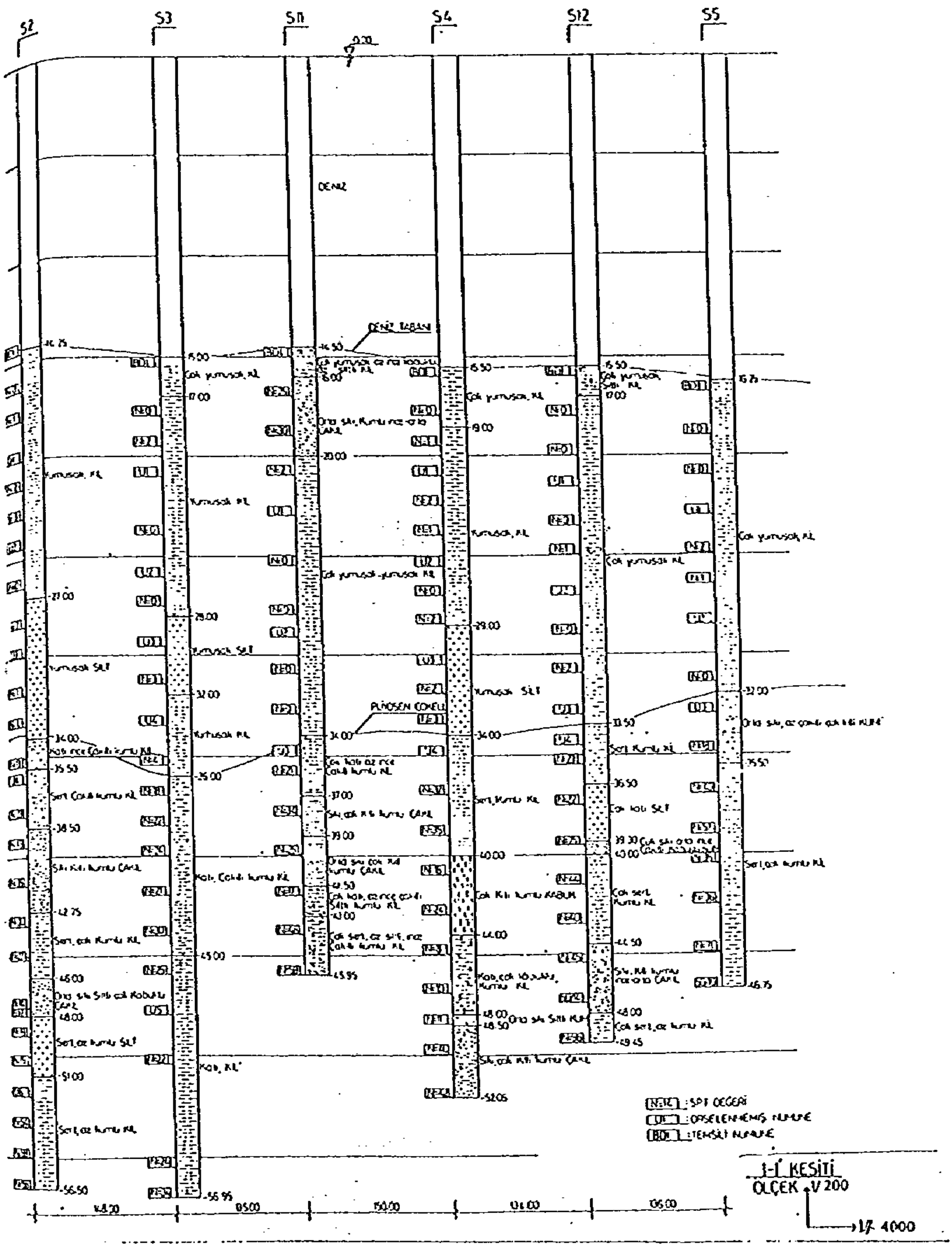
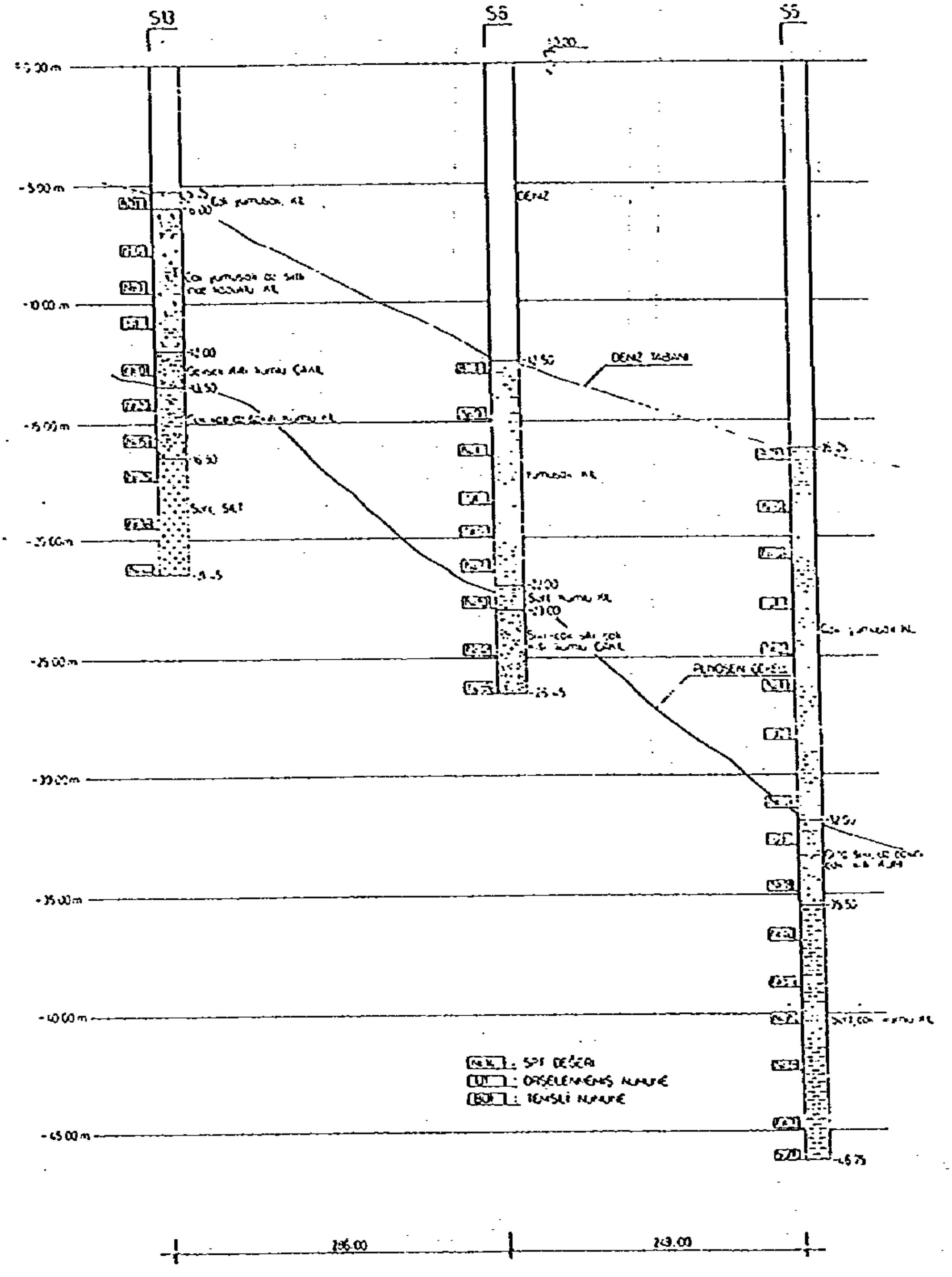


FIGURE A 3.3 (2) Soil profiles in the area



VII-VII' KESİTİ
ÖLÇEK 1/200
→ 1/4000

ŞEKİL 7.6. (DEVAM)

FIGURE A 3.3 (3) Soil profiles in the area

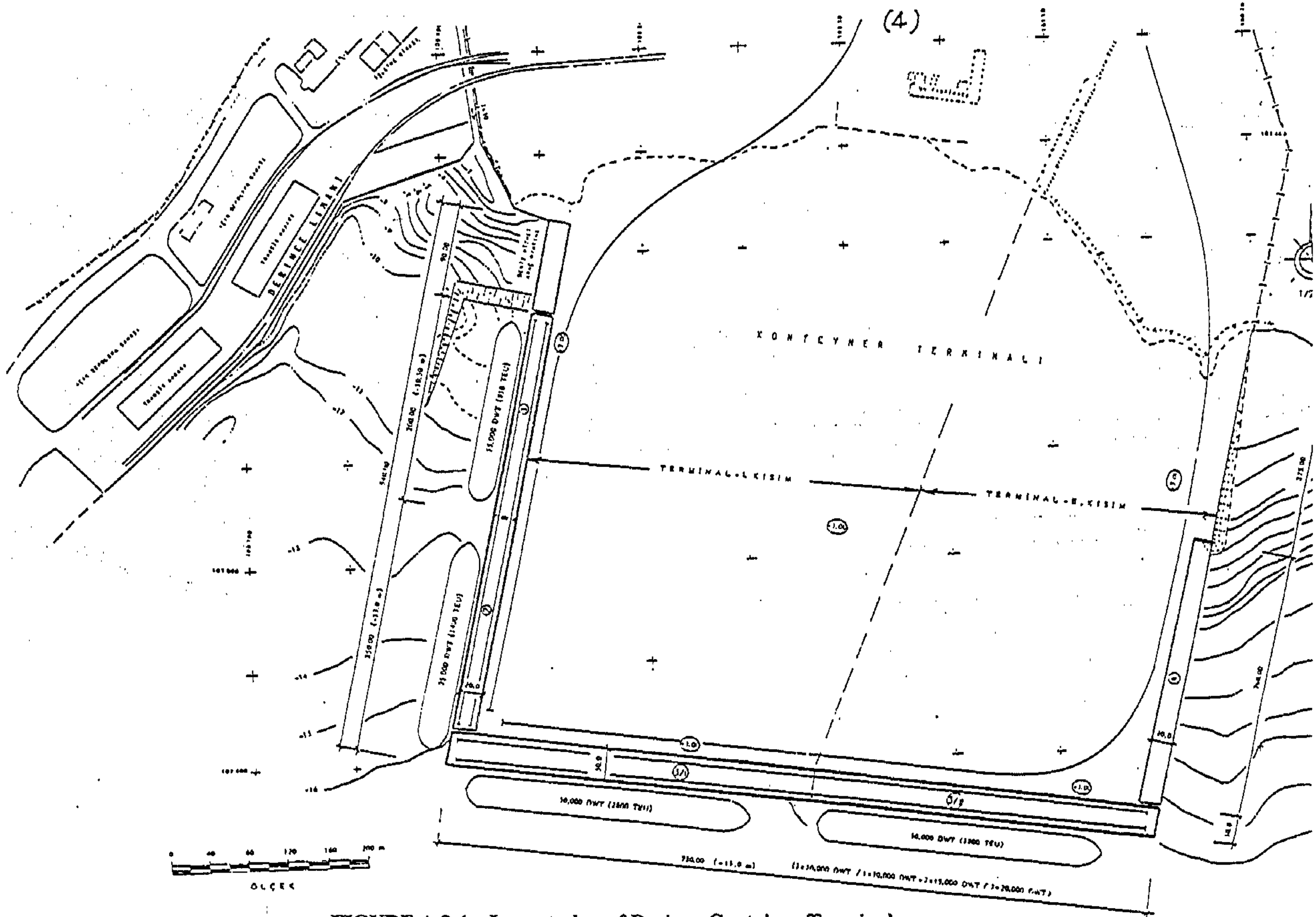


FIGURE A 3.4 Layout plan of Derince Container Terminal

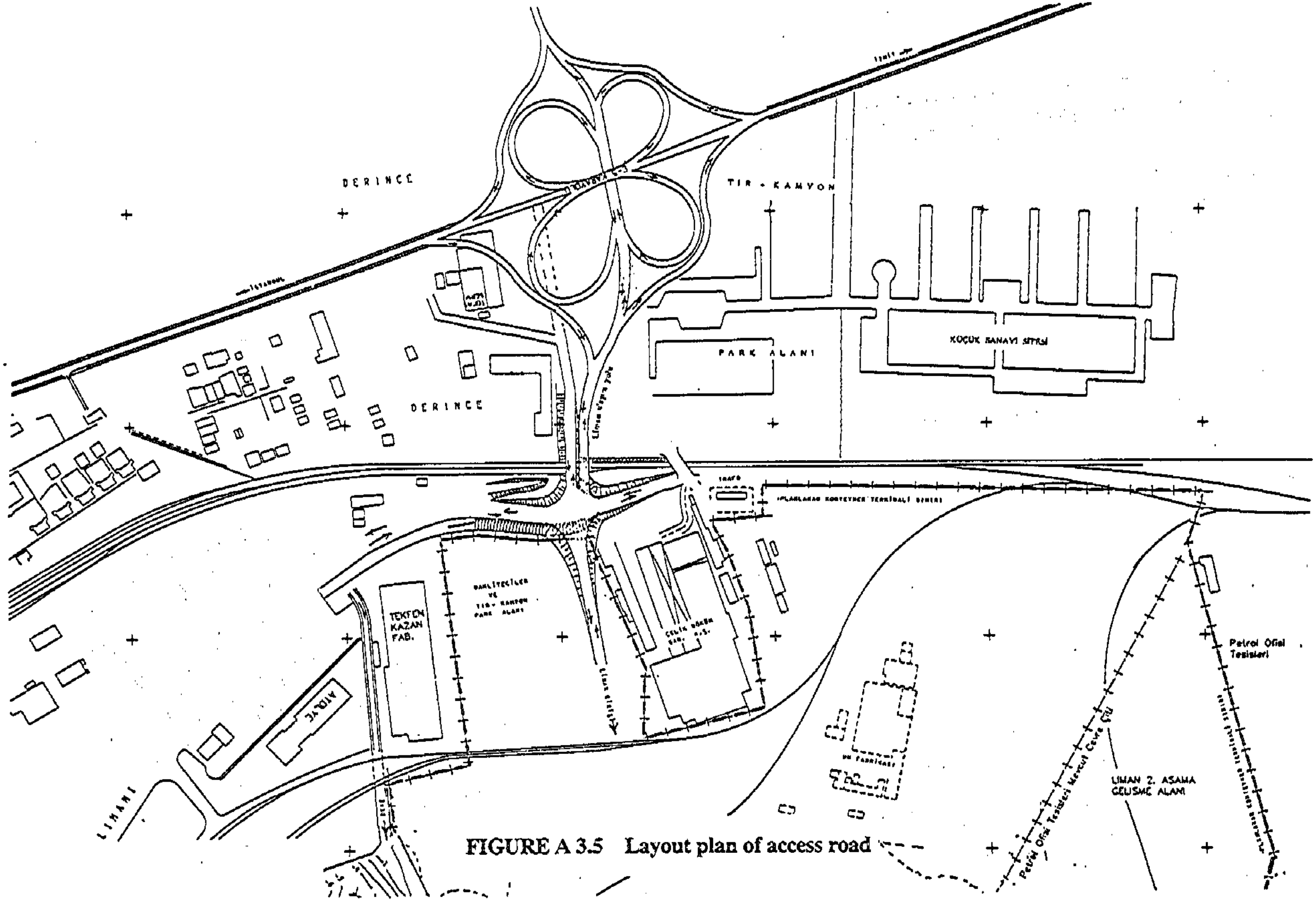


FIGURE A 3.5 Layout plan of access road

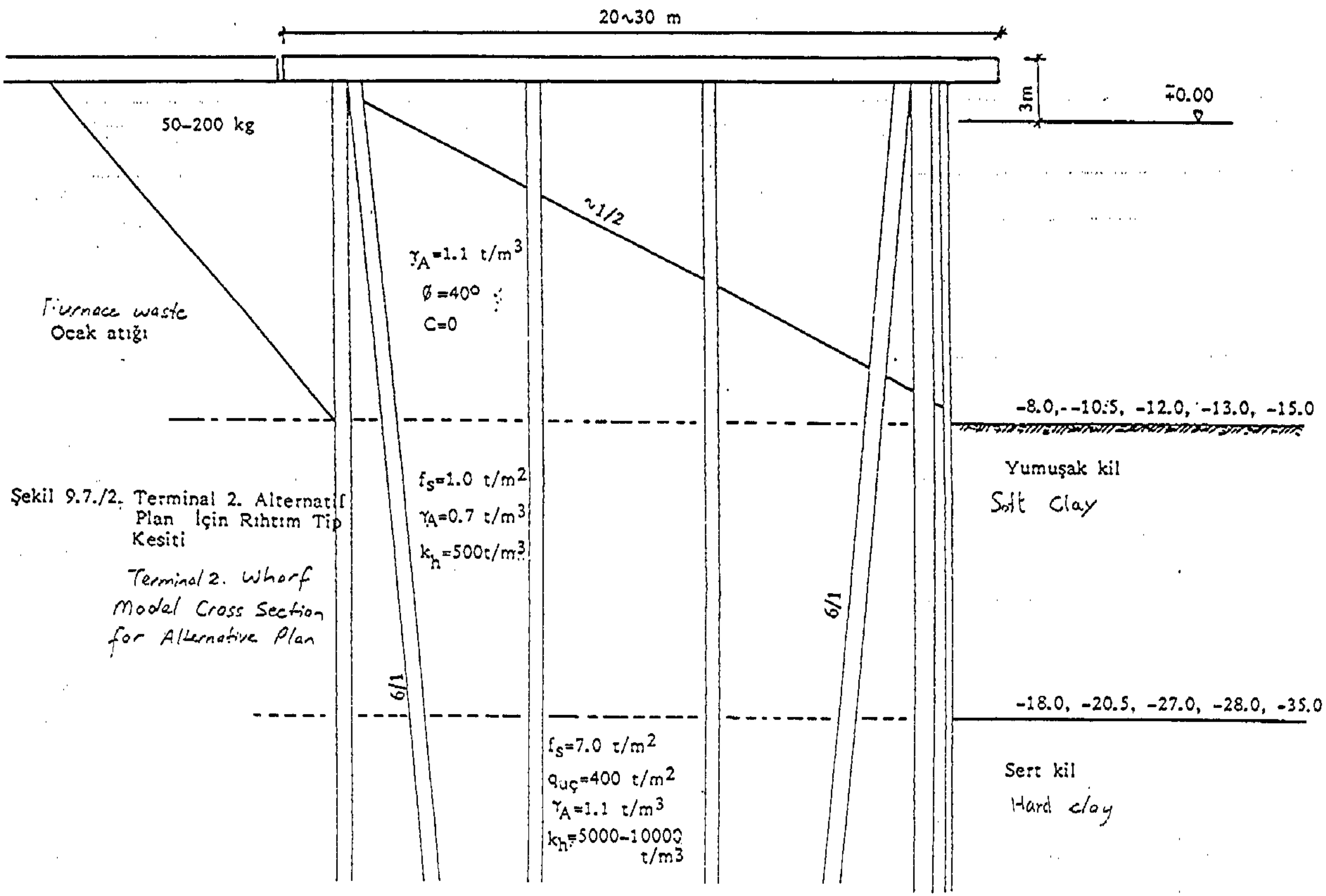
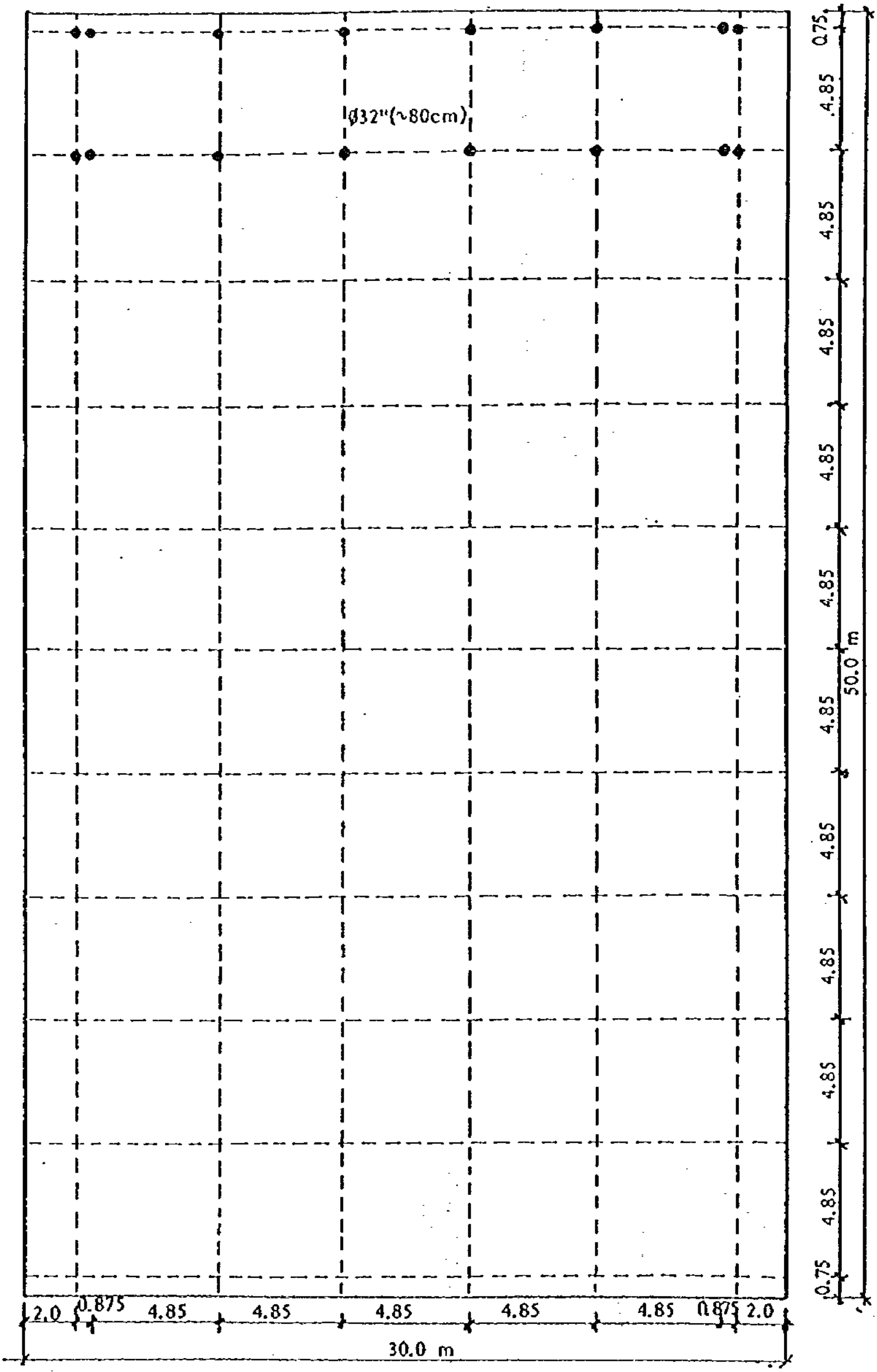


FIGURE A 3.6 Cross sectional view of container berth pier



Şekil 9.4./2. Terminal 2. Alternatif için 3 no.lu Rıhtımda 30x50 m'lik bir "Ano Planı"

FIGURE A 3.7 Plan of the pier

APPENDIX 4

Dimension of Container Vessel and Container Berth

Dimension of Container Vessel & Container Berth

1. Container Vessel

The relations between the overall length and the dead weight tonnage of worldwide container vessels currently in operation are shown in FIGURE A 4.1.

The relations between the breadth and the dead weight tonnage of worldwide container vessels currently in operation are shown in FIGURE A 4.2.

The relations between the full-load draft and the dead weight tonnage of worldwide container vessels currently in operation are shown in FIGURE A 4.3.

The relations between the dead weight tonnage and the hold capacities of worldwide container vessels currently in operation are shown in FIGURE A 4.4.

2. Container Berth

TABLE A 4.1 Dimension of container vessel and container berth

Size & Dimension of Container Vessels					Dimensions of Quay		Remarks
Capacity (TEU)	DWT	Full load Draft (m)	Overall Length (m)	Breadth (m)	Berth Depth (m)	Berth Length (m)	
300	6,500	6.7	120	19.0	7.5	150	
500	12,000	8.0	140	21.0	9.0	170	
800	16,000	9.0	170	23.0	10.0	200	
1,200	22,000	10.0	210	31.0	11.0	250	
1,500	27,000	11.0	230	32.2	12.0	280	
2,000	35,000	12.0	260	32.2	13.0	300	
3,000	50,000	13.0	290	32.2	14.0	350	P'max
4,400	60,000	13.5	290	39.4	15.0	350	Over P'max

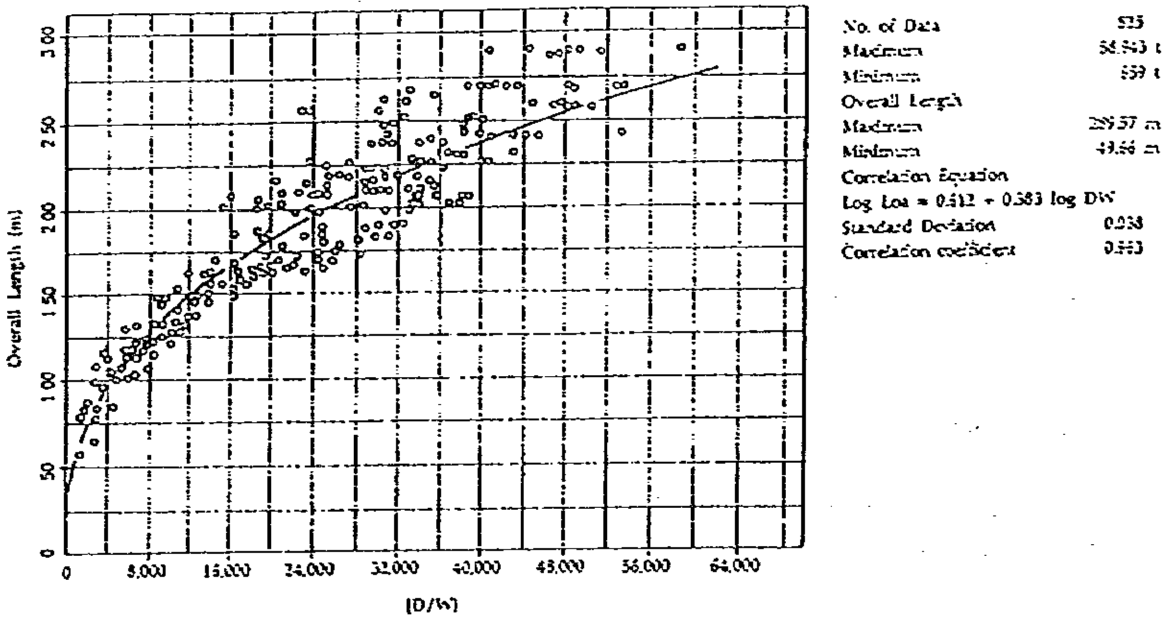


FIGURE A 4.1 Relations between the Overall Length and DWT

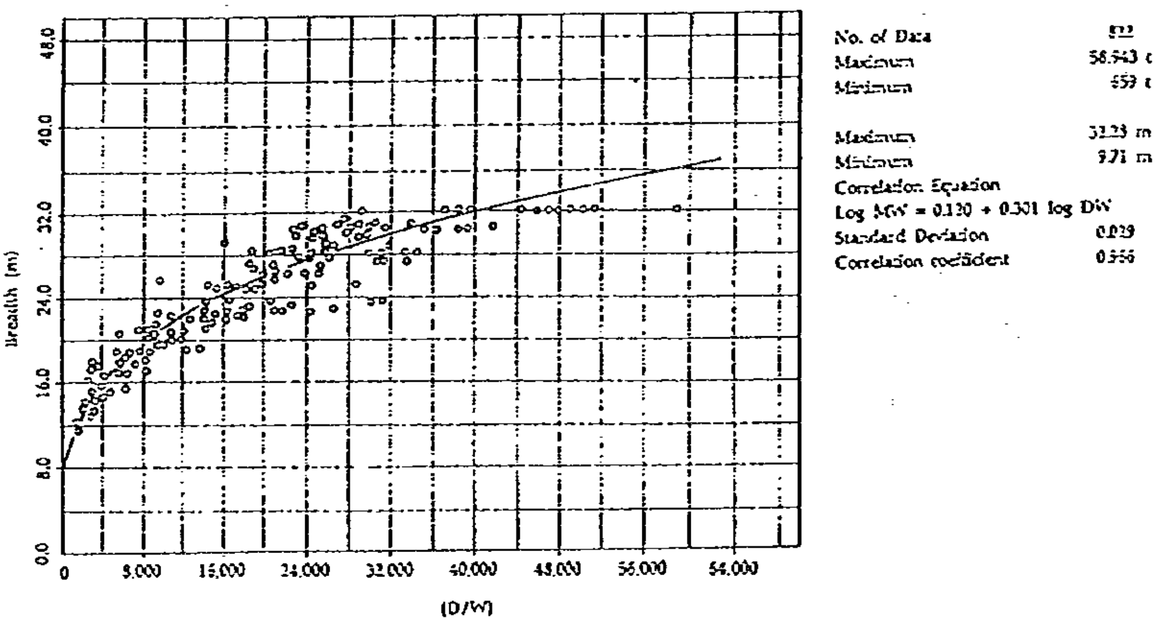


FIGURE A 4.2 Relations between the Breadth and DWT

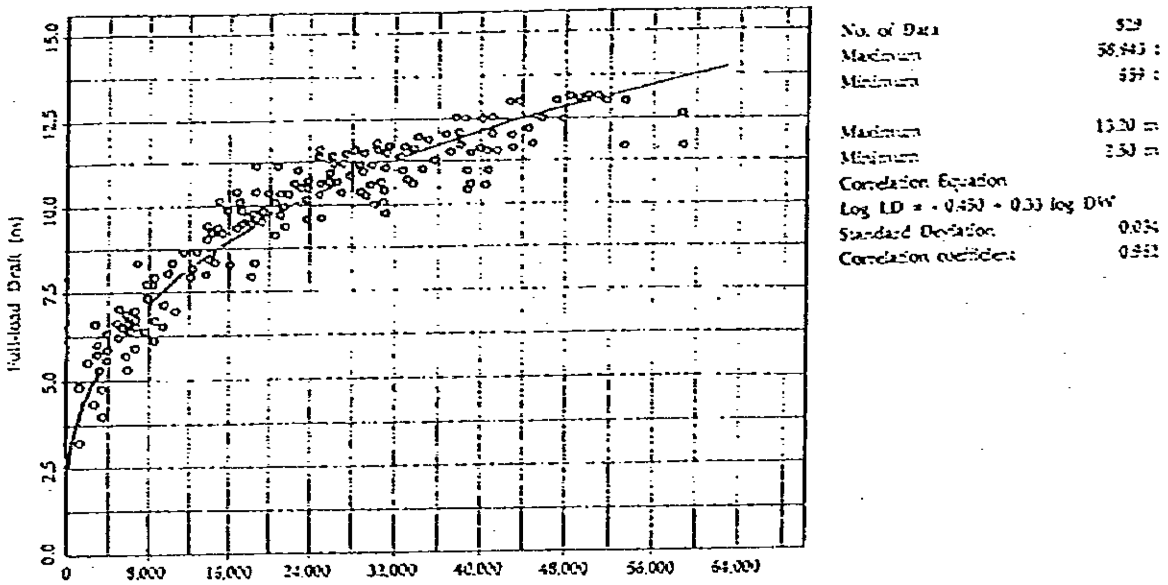


FIGURE A 4.3 Relations between the Full-Load Draft and DWT

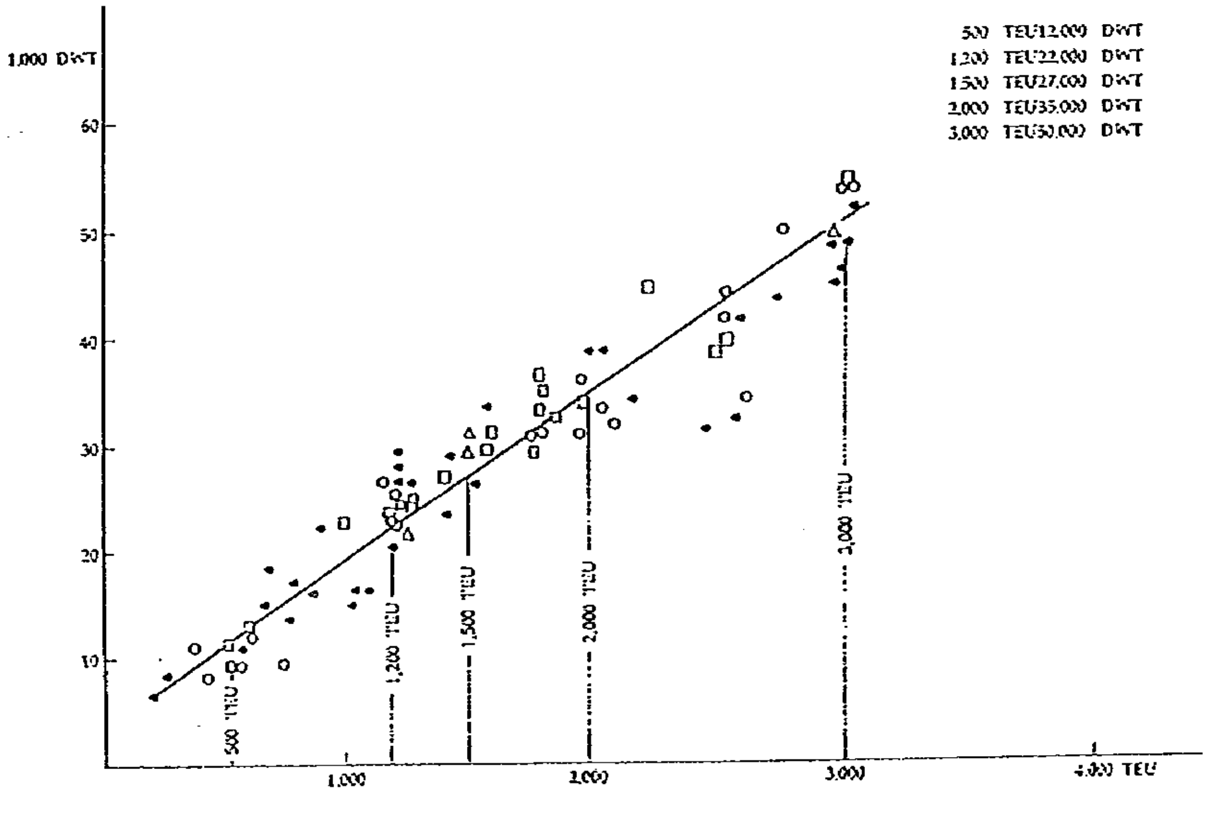


FIGURE A 4.4 Relationship between DWT and TEU

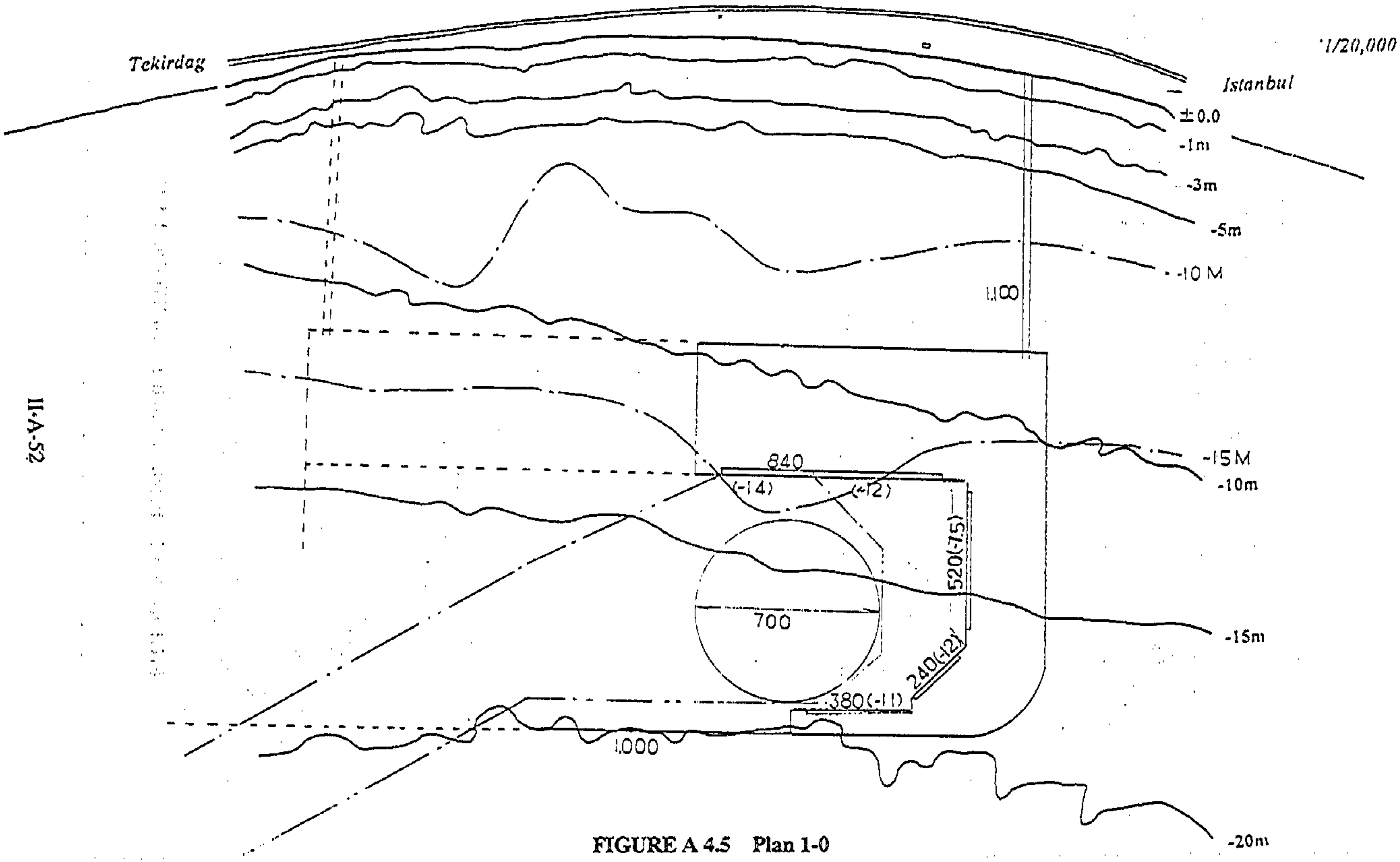


FIGURE A 4.5 Plan 1-0

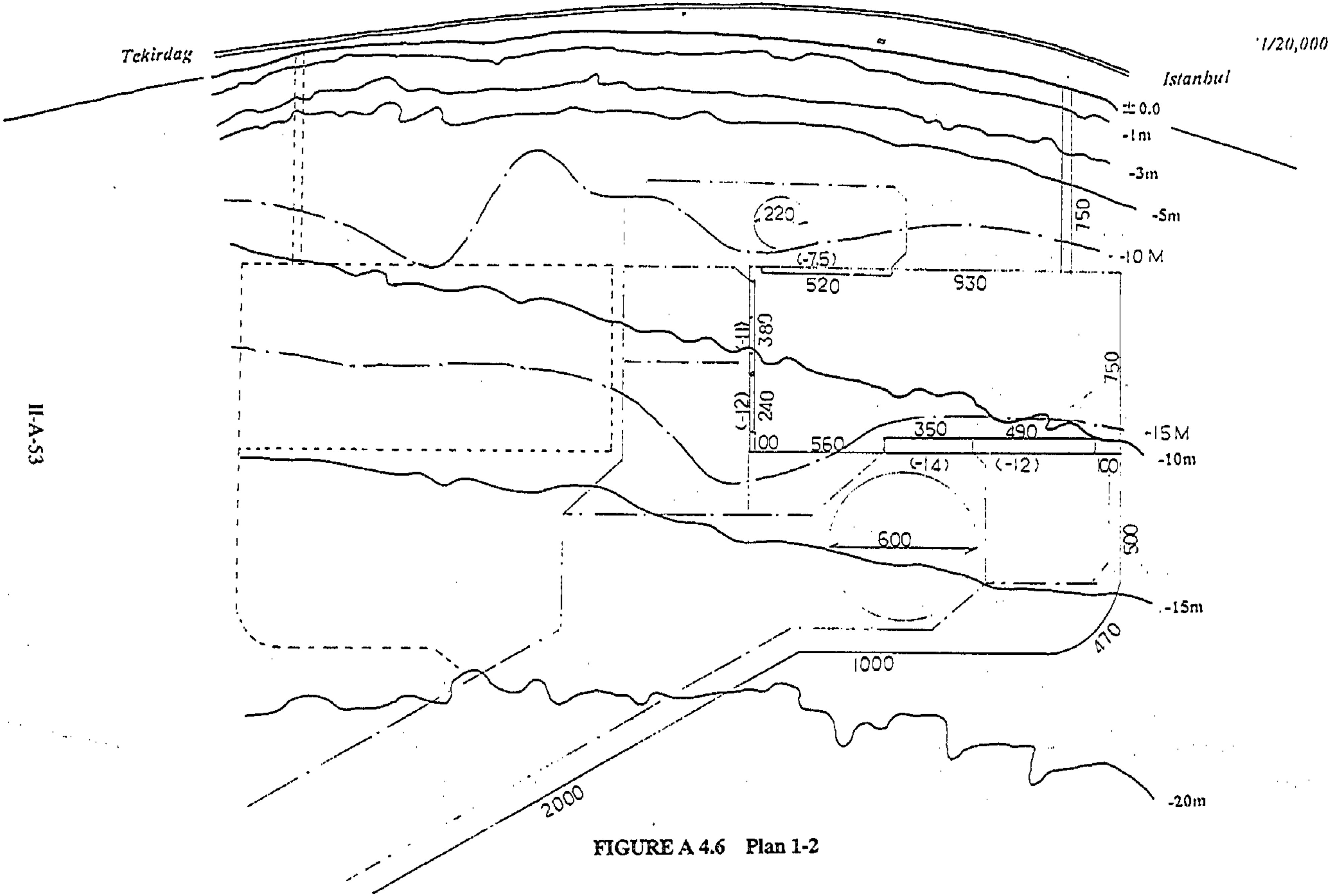


FIGURE A 4.6 Plan 1-2

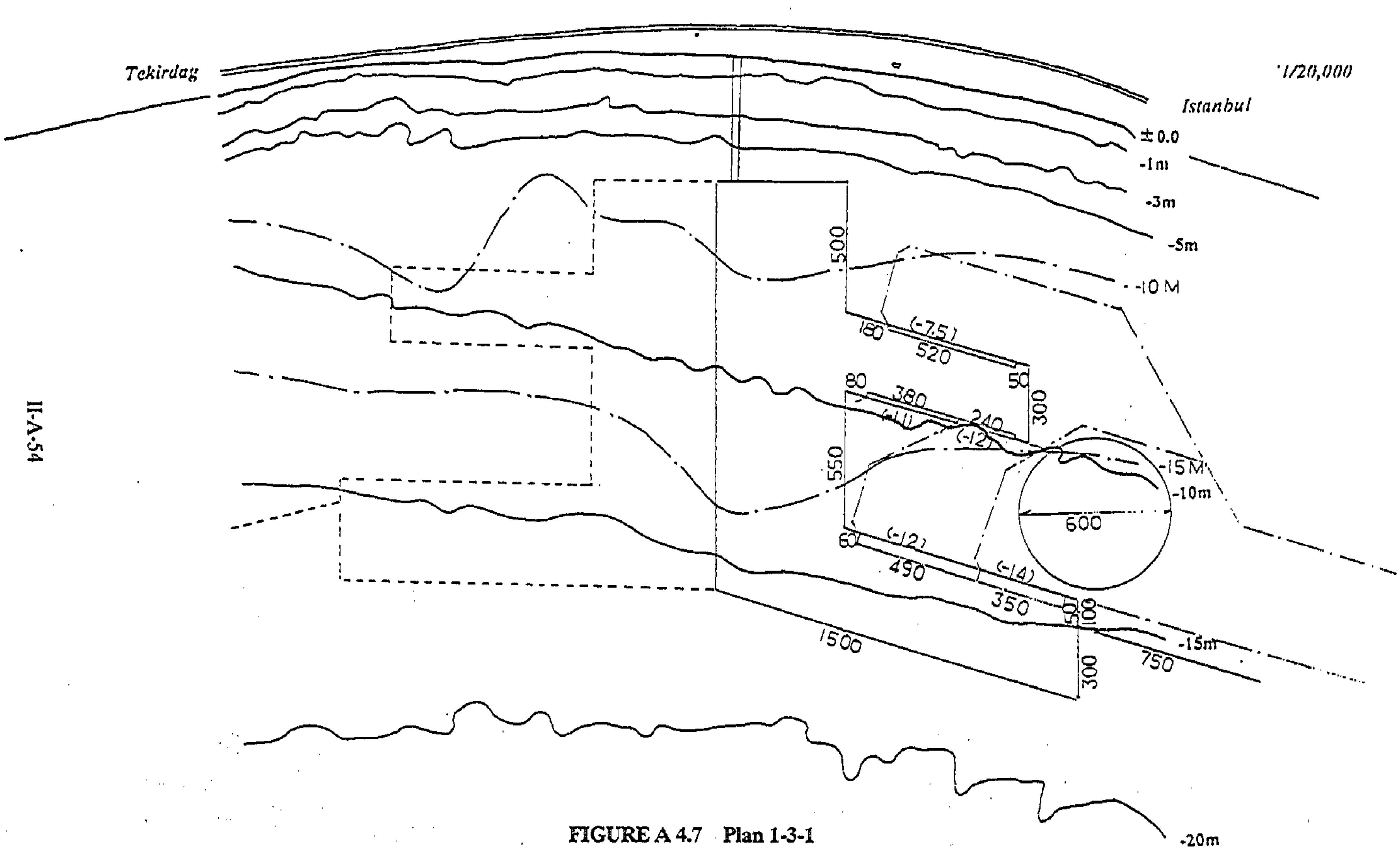


FIGURE A 4.7 Plan 1-3-1

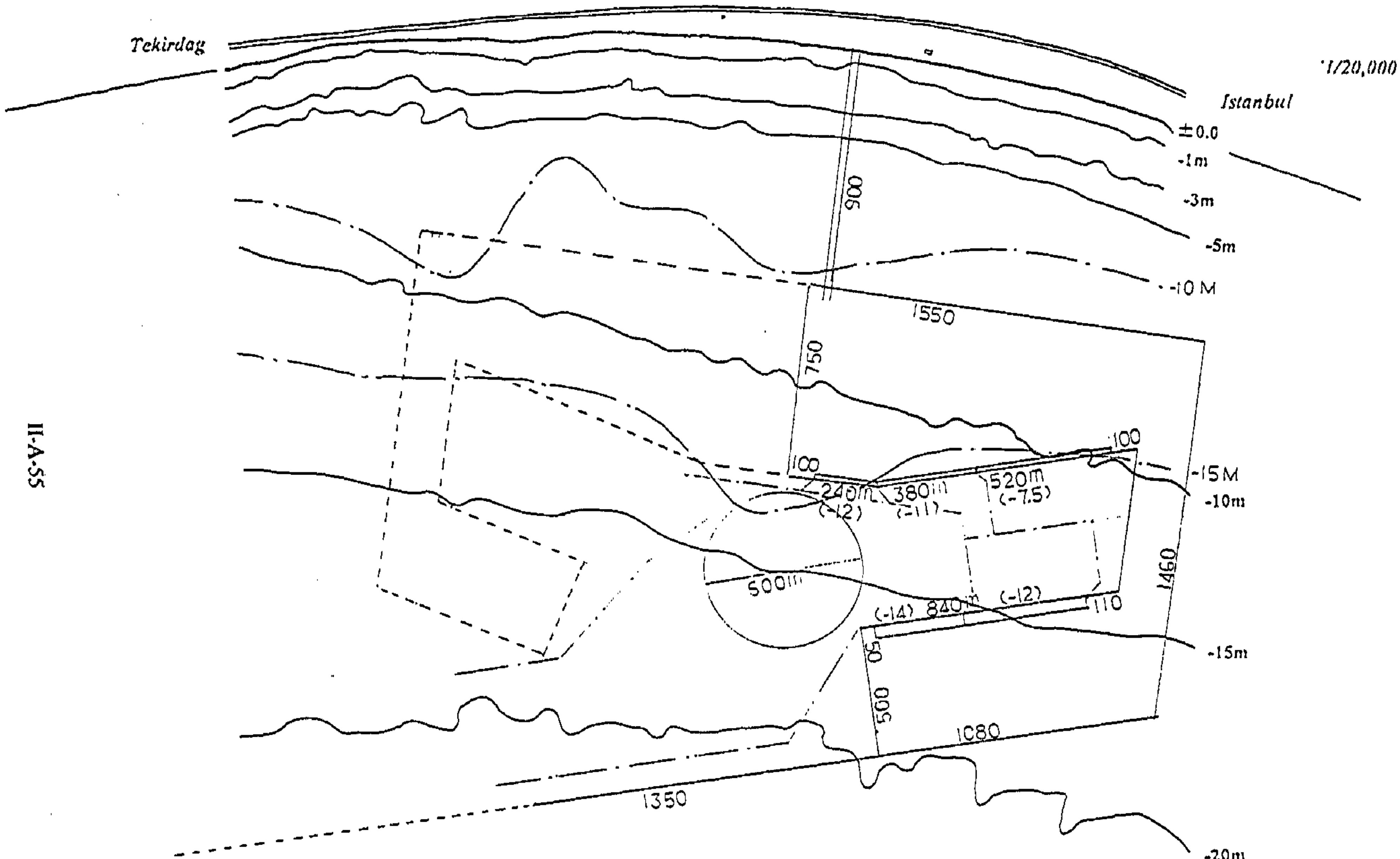


FIGURE A 4.8 Plan 1-3-2

APPENDIX 5

Chart of the Bosphorus and the Dardanelles

FIGURE A 5.1 Chart of the Bosphorus (a)

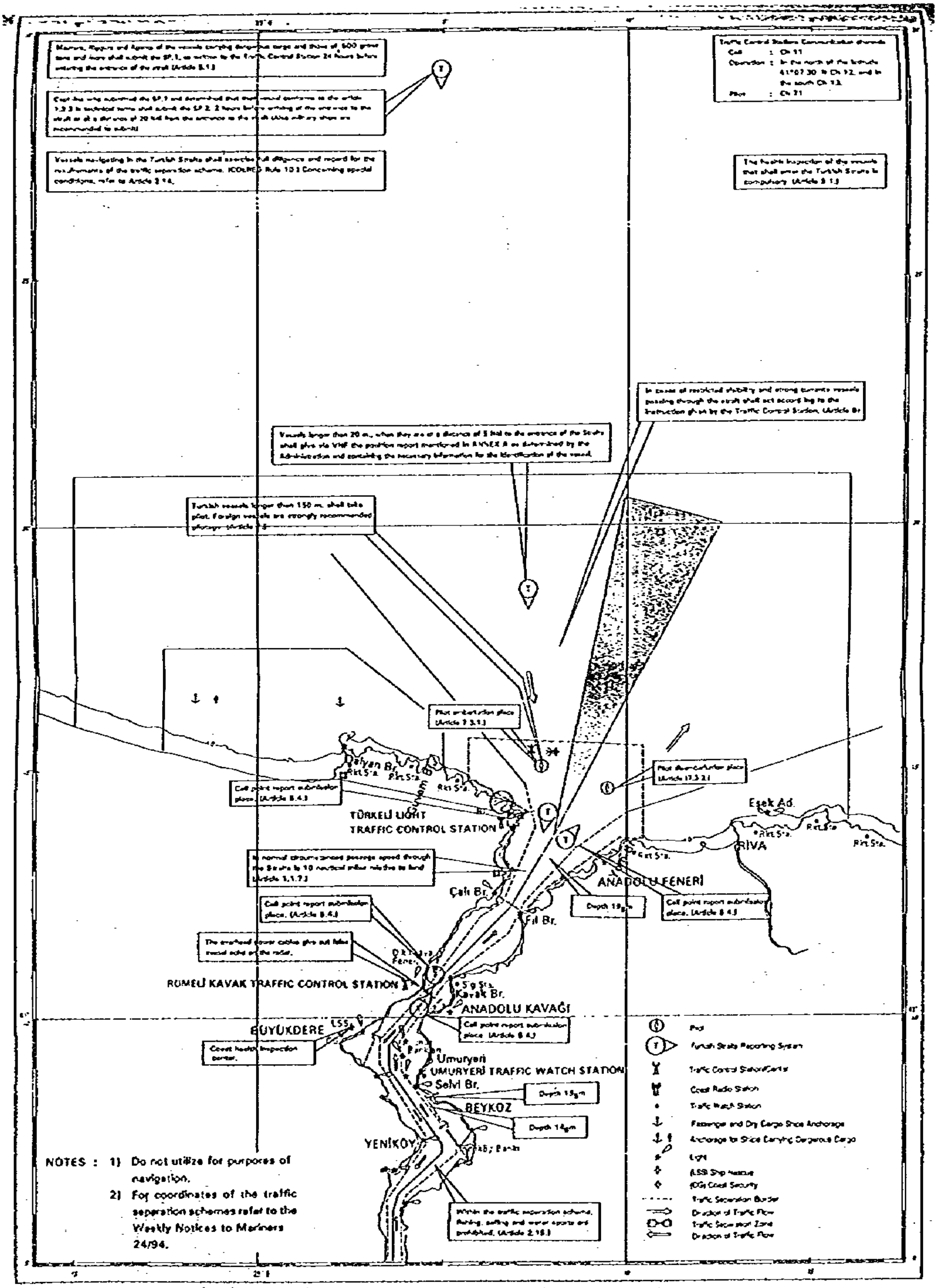


FIGURE A 5.2 Chart of the Bosphorus (b)

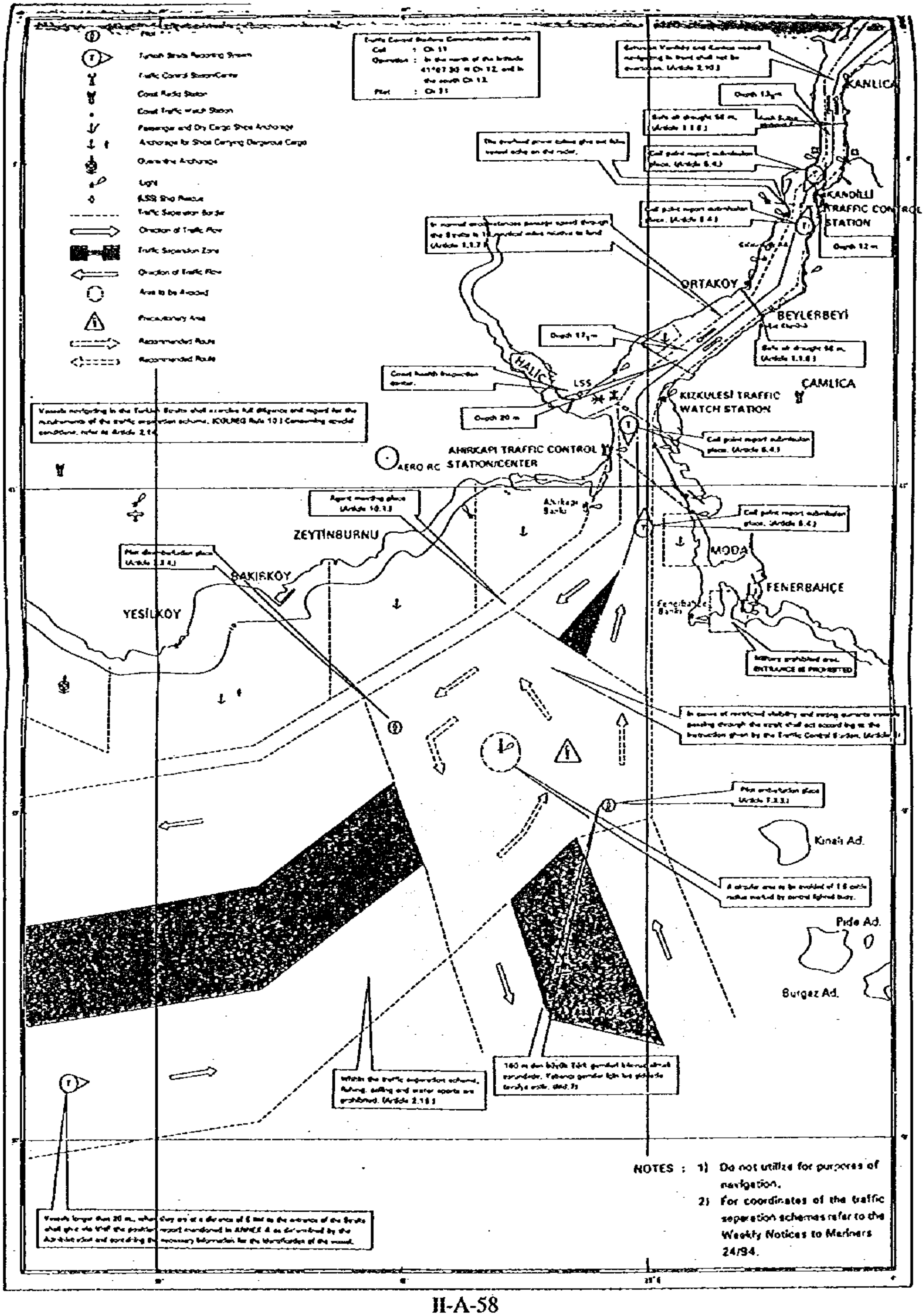


FIGURE A 5.3 Chart of the Dardanelles (a)

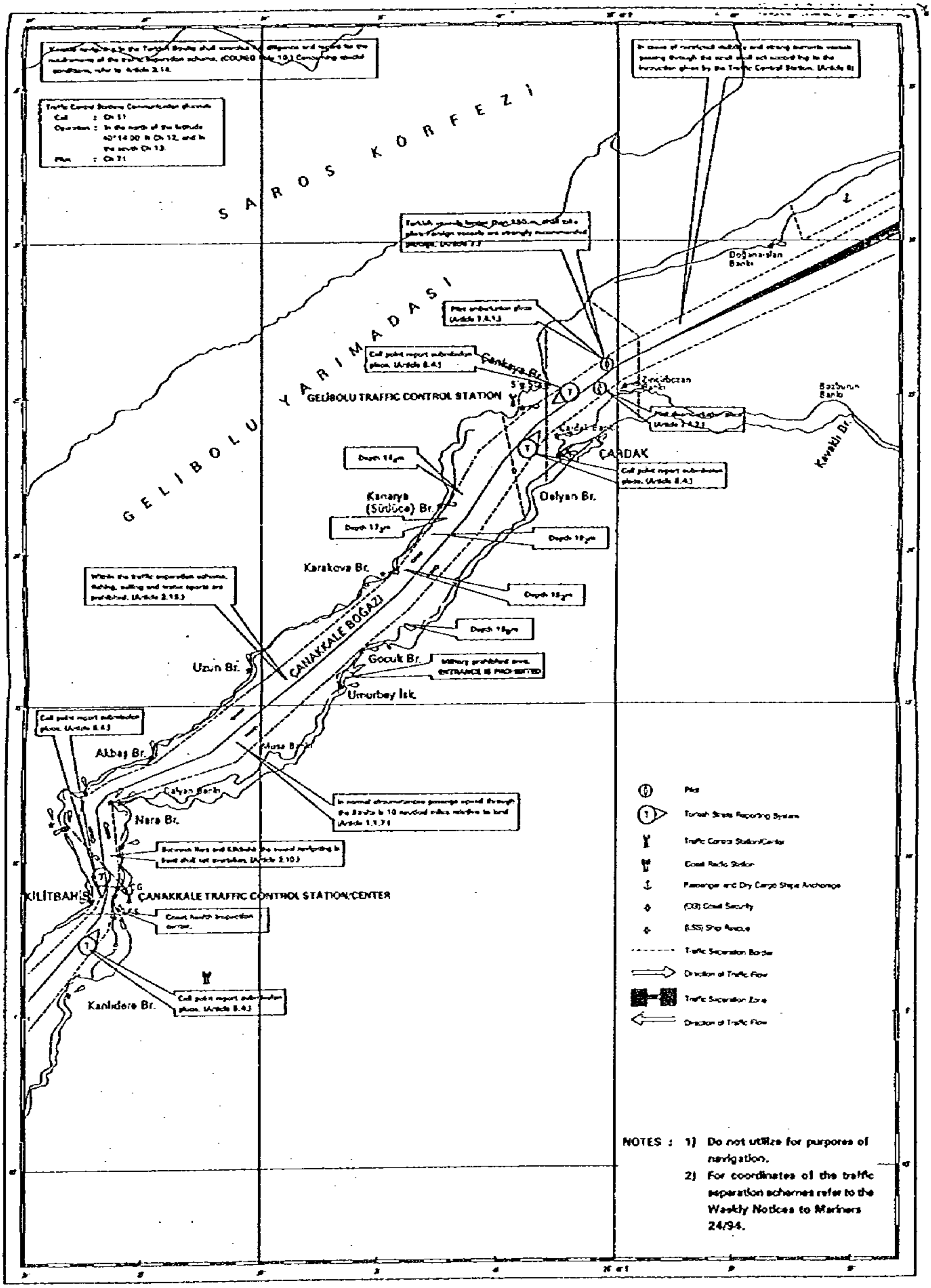
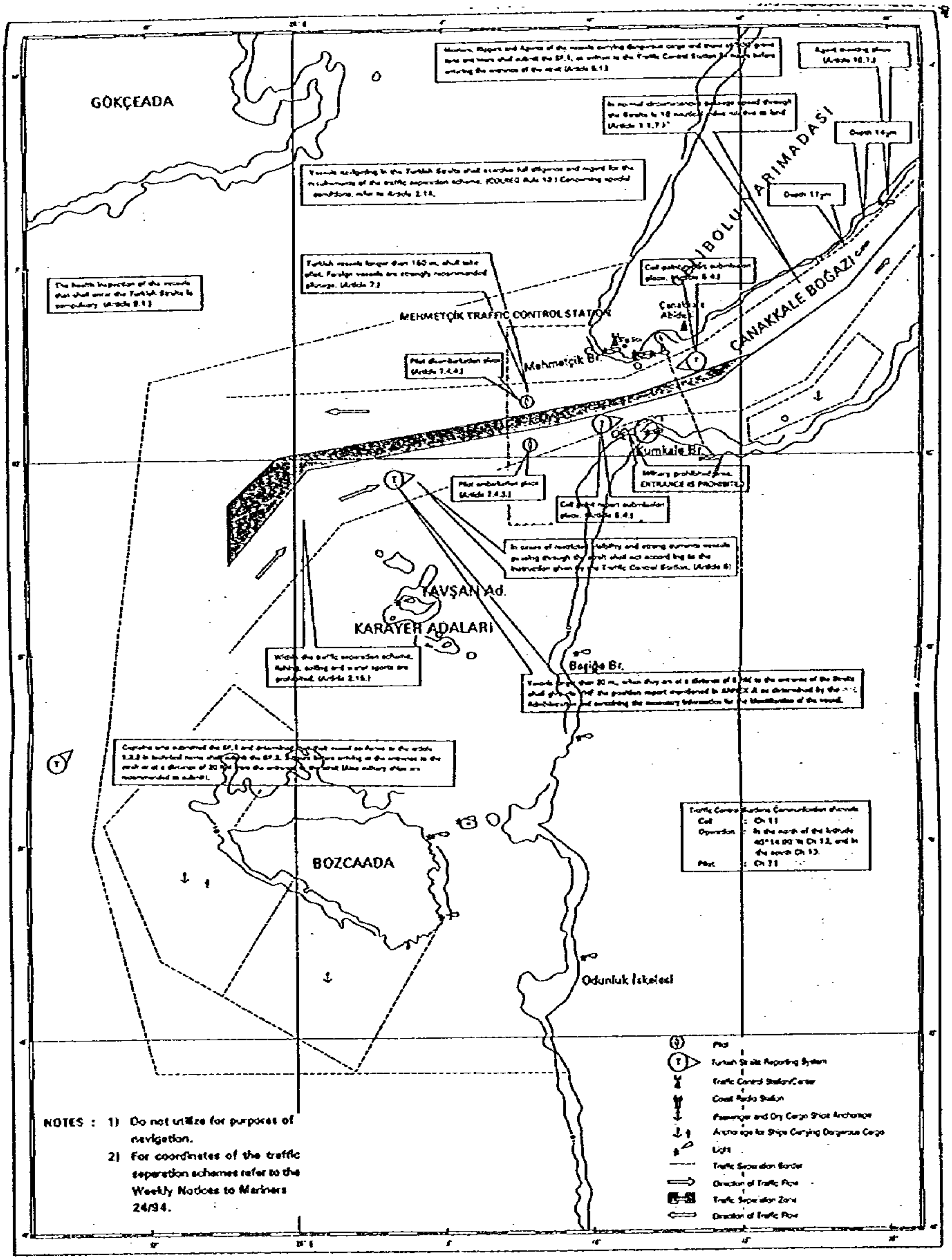


FIGURE A 5.4 Chart of the Dardanelles (b)



APPENDIX 6

Operation Cost

[illegible]

[illegible]

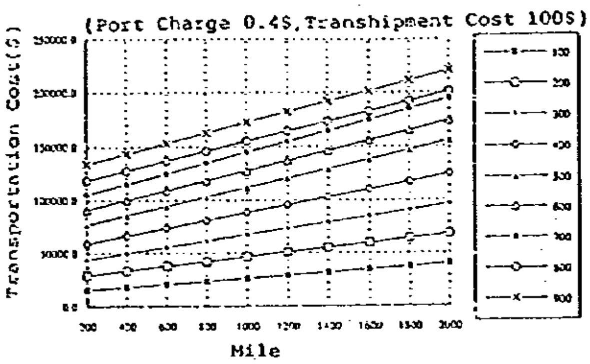


FIGURE A 6.1
Operation Expense of Feeder Ship (1)

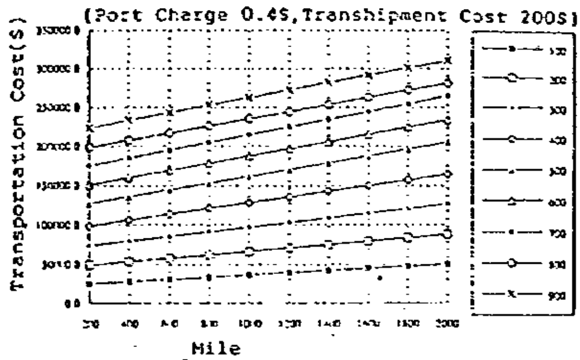


FIGURE A 6.2
Operation Expense of Feeder Ship (2)

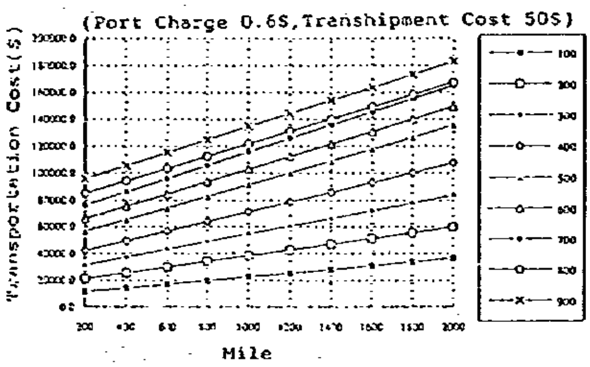


FIGURE A 6.3
Operation Expense of Feeder Ship (3)

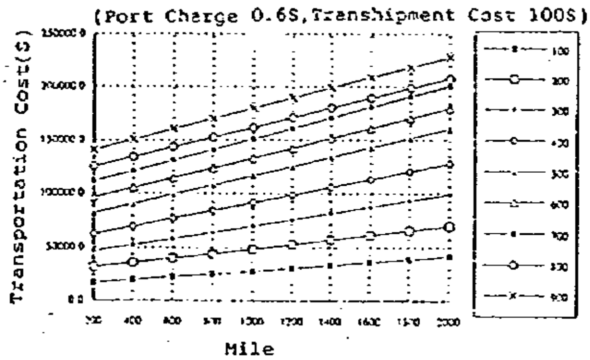


FIGURE A 6.4
Operation Expense of Feeder Ship (4)

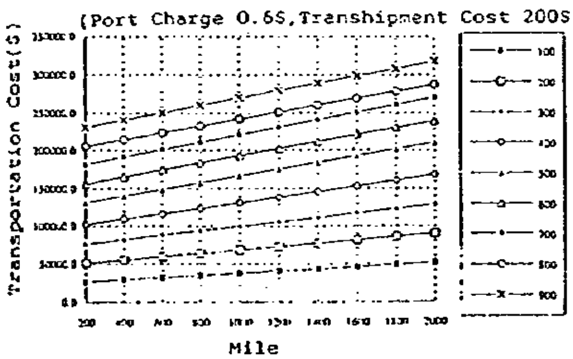


FIGURE A 6.5
Operation Expense of Feeder Ship (5)

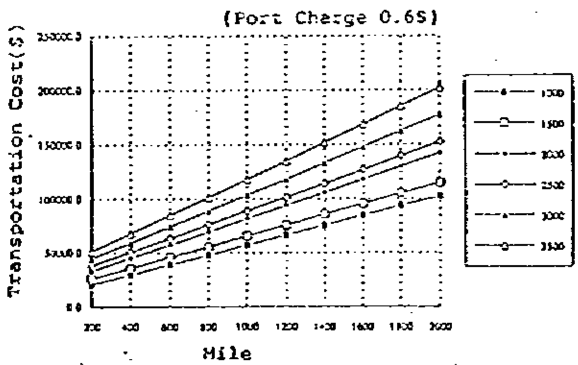


FIGURE A 6.6
Increment of Expense necessary for Direct Call of Main Ship

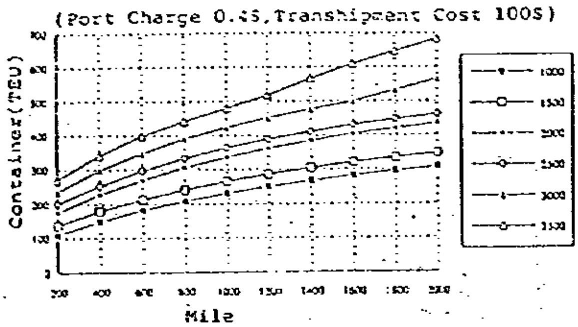


FIGURE A 6.7
Container (TEU) necessary for Direct Call of Main Ship (1)

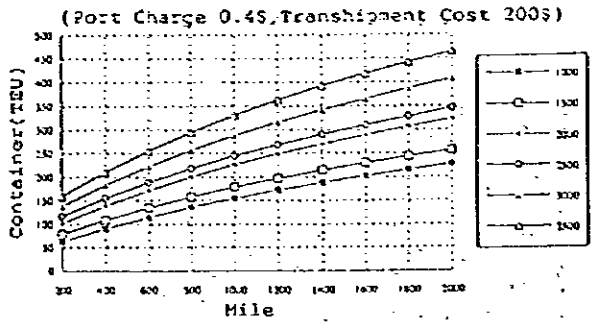


FIGURE A 6.8
Container (TEU) necessary for Direct Call of Main Ship (2)

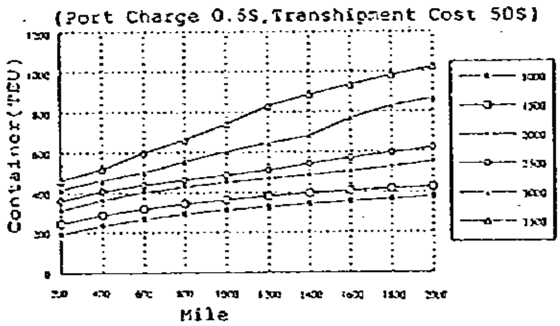


FIGURE A 6.9
Container (TEU) necessary for Direct Call of Main Ship (3)

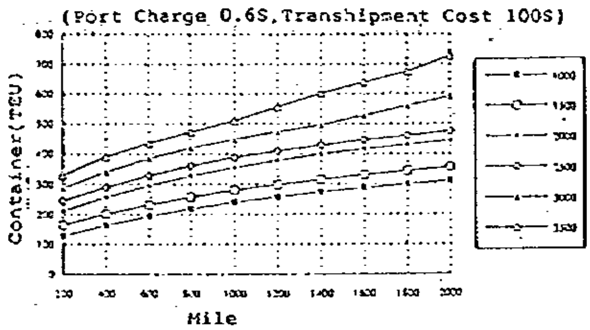


FIGURE A 6.10
Container (TEU) necessary for Direct Call of Main Ship (4)

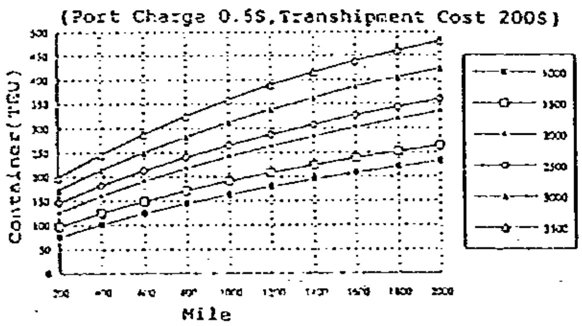


FIGURE A 6.11
Container (TEU) necessary for Direct Call of Main Ship (5)

APPENDIX 7

Maritime Traffic Capacity of the Straits

[illegible]

[illegible]

Maritime Traffic Capacity of the Straits

1 General

(1) Purpose of Congestion Analysis

The dimensions of the Bosphorus and the Dardanelles Straits are shown in Table 1. These two straits are important passage not only to Turkey but also to countries around the Black Sea from the Mediterranean and they separate the Continents of Europe and Asia. At present, around 100~150 vessels pass the Straits daily including some tankers. Recently, a fire broke out following collision involving a tanker in the Bosphorus and the Strait was closed. If traffic through the Straits increases in future, likelihood of accidents would also increase, because of the narrowness of the Straits. The study team thus examined the congestion in the Straits in future, according to the cargo estimation in 2015.

TABLE A 7.1 Dimensions of the Bosphorus and the Dardanelles Straits

	Bosphorus	Dardanelles
Length	29 km	62 km
Width(Maximum)	3,500 m	8,725 m
Width(Narrowest)	760 m	1,375 m
Average Depth	55 m	65 m

(2) Present Situation of Traffic

The charts of the Straits are shown in Appendix. The number, cumulated gross ton and average size (GRT) of vessels passing through the Bosphorus Strait and the Dardanelles Strait which are located at the gate of the Sea of Marmara for the Mediterranean and the Black Sea, between 1980 and 1995, are shown in Table A 7.2. According to the Table, average size of vessels passing through the two Straits had gradually increased to 11,200 GRT in 1990 from 9,000 GRT in 1980. After that, the average size of vessels went down to some 8,000 GRT in 1992 and has remained constant until now..

There is a difference about 10% concerning the average GRT of the two Straits, in past 10 years. Number and cumulated GRT also show a few differences, however, There is a difference about 10% concerning the average GRT of the two Straits, in past 10 years. Number and cumulated GRT also show a few differences, however,

FIGURE A 7.1 Number of vessels passing through the Straits

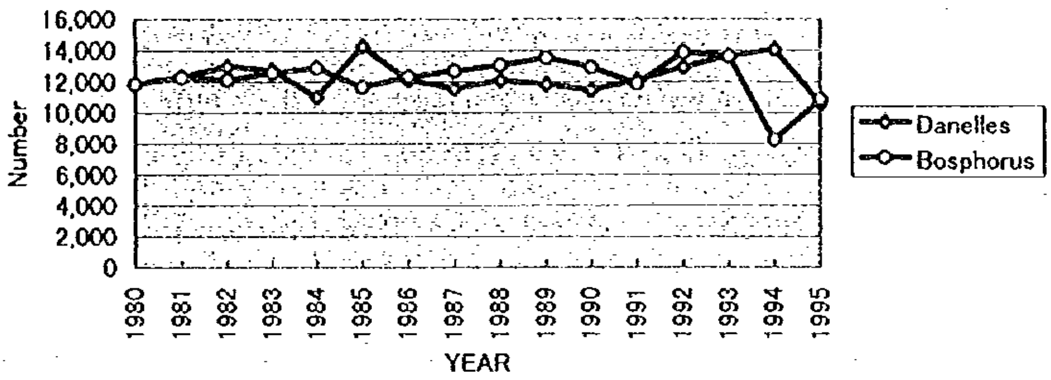
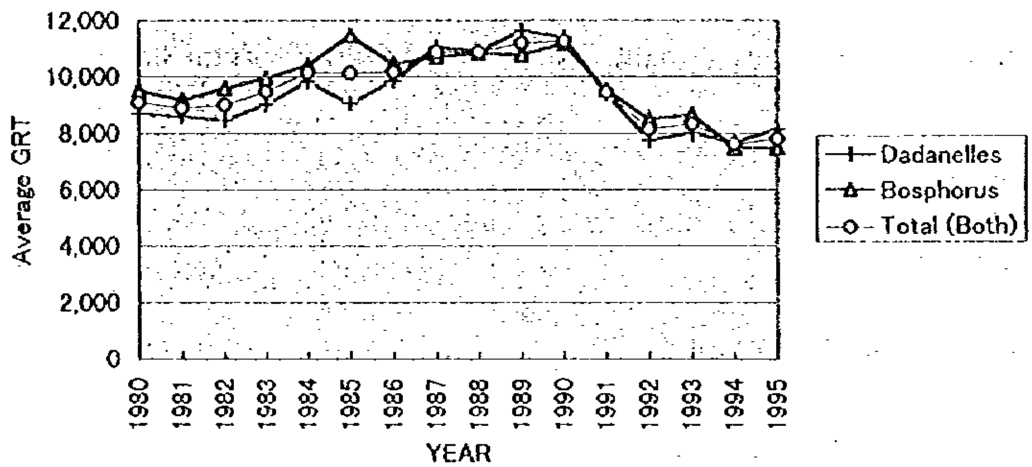


FIGURE A 7.2 Average GRT of vessels passing through the Straits



the number of vessels passing through the Bosphorus largely decreased in 1994. It seems that trade between Turkey and countries around the Black Sea fell in 1994.

The number of vessels by type passing through the Dardanelles Strait is shown in Table A 7.3 and Table A 7.4. According to these Tables, approximately 36,000 vessels passed through the Straits in 1995, which is 3.4 times the figure in Table A 7.2. The ratios of tanker are about 16% and the ratios of large vessels over 200m in length are 23%.

(3) Methodology of Congestion Analysis

A flowchart to analyze congestion of the Straits is shown in Figure 3.

TABLE A 7.2 Trends of vessels passing through the Straits

Year	Dardanels Strait			Bosphorus Strait			Two Straits			Ratio(Bo/Da)		
	Number	Cumulated GRT	Average GRT	Number	Cumulated GRT	Average GRT	Number	Cumulated GRT	Average GRT	Number	Cumulated GRT	Average GRT
1980	11,833	102,859,191	8,688	11,849	112624690	9,505	23,688	215483881	9,097	1.094	1.001	1.095
1981	12,320	106,009,392	8,605	12,298	112968528	9,186	24,618	218977920	8,895	1.068	0.958	1.066
1982	12,983	109,742,254	8,453	12,130	116378364	9,594	25,113	226120618	9,004	1.135	0.934	1.060
1983	12,767	115,128,593	9,018	12,565	125047618	9,952	25,332	240176211	9,481	1.104	0.981	1.086
1984	11,006	108,299,930	9,840	12,884	134168535	10,414	23,890	242468465	10,149	1.058	1.171	1.239
1985	14,271	129,305,580	9,061	11,650	133419411	11,452	25,921	262724991	10,136	1.264	0.816	1.032
1986	12,103	119,380,692	9,864	12,305	128773258	10,465	24,408	248153950	10,167	1.061	1.017	1.079
1987	11,557	127,607,974	11,042	12,685	135761472	10,703	24,242	263369446	10,864	0.969	1.058	1.064
1988	12,092	131,739,874	10,895	13,046	141277593	10,829	25,138	273017451	10,861	0.934	1.079	1.072
1989	11,805	137,088,767	11,613	13,508	145628241	10,781	25,313	282717008	11,169	0.928	1.144	1.062
1990	11,445	130,123,182	11,369	12,912	144109840	11,161	24,357	274233022	11,259	0.982	1.128	1.101
1991	12,085	113,590,963	9,399	11,880	113160023	9,525	23,965	226750086	9,462	1.013	0.983	0.996
1992	12,913	100,203,218	7,760	13,866	117592698	8,481	26,779	217795915	8,133	1.093	1.074	1.174
1993	13,612	108,927,128	8,002	13,635	117858759	8,644	27,247	226785887	8,323	1.080	1.002	1.082
1994	14,075	108,050,230	7,677	8,281	61924855	7,478	22,356	169975085	7,603	0.974	0.588	0.573
1995	10,569	88,053,050	8,142	10,845	81068733	7,475	21,414	167119783	7,804	0.918	1.026	0.942

Source: Maritime Affairs Organization, MOT

TABLE A 7.3 Breakdown of Vessels passed the Dardanells Strait (1995)

Month	No. of countries passed	No. of vessels passed	Guide area	SP-1 given	Large vessel (Over 200m)	Share(%) of Large vessel	Over 500GRT	Share(%) of over 500GT	Passed by Transition
January	52	2746	583	970	567	20.65	2446	89.08	1674
February	50	2625	524	981	500	19.05	2345	89.33	1735
March	62	2787	612	962	560	20.09	2358	84.61	1697
April	55	2807	542	729	724	25.79	2392	85.22	1944
May	54	2855	564	632	719	25.18	2333	81.72	2021
June	65	3138	620	672	774	24.67	2476	78.90	2032
July	61	3280	748	1226	896	27.32	2685	81.86	2054
August	62	3315	824	1224	761	22.96	2818	85.01	2024
September	62	3214	815	1293	665	20.69	2992	93.09	1970
October	56	3253	824	1259	728	22.38	3065	94.22	2122
November	63	3003	791	1193	645	21.48	2845	94.74	1991
December	67	3037	847	1242	635	20.91	2908	95.75	2004
Annual total		36060	8294	12383	8174	22.67	31663	87.81	23268
Monthly Average		3005	691	1032	681	22.67	2639	87.81	1939
Daily Average		99	23	34	22	22.67	87	87.81	64

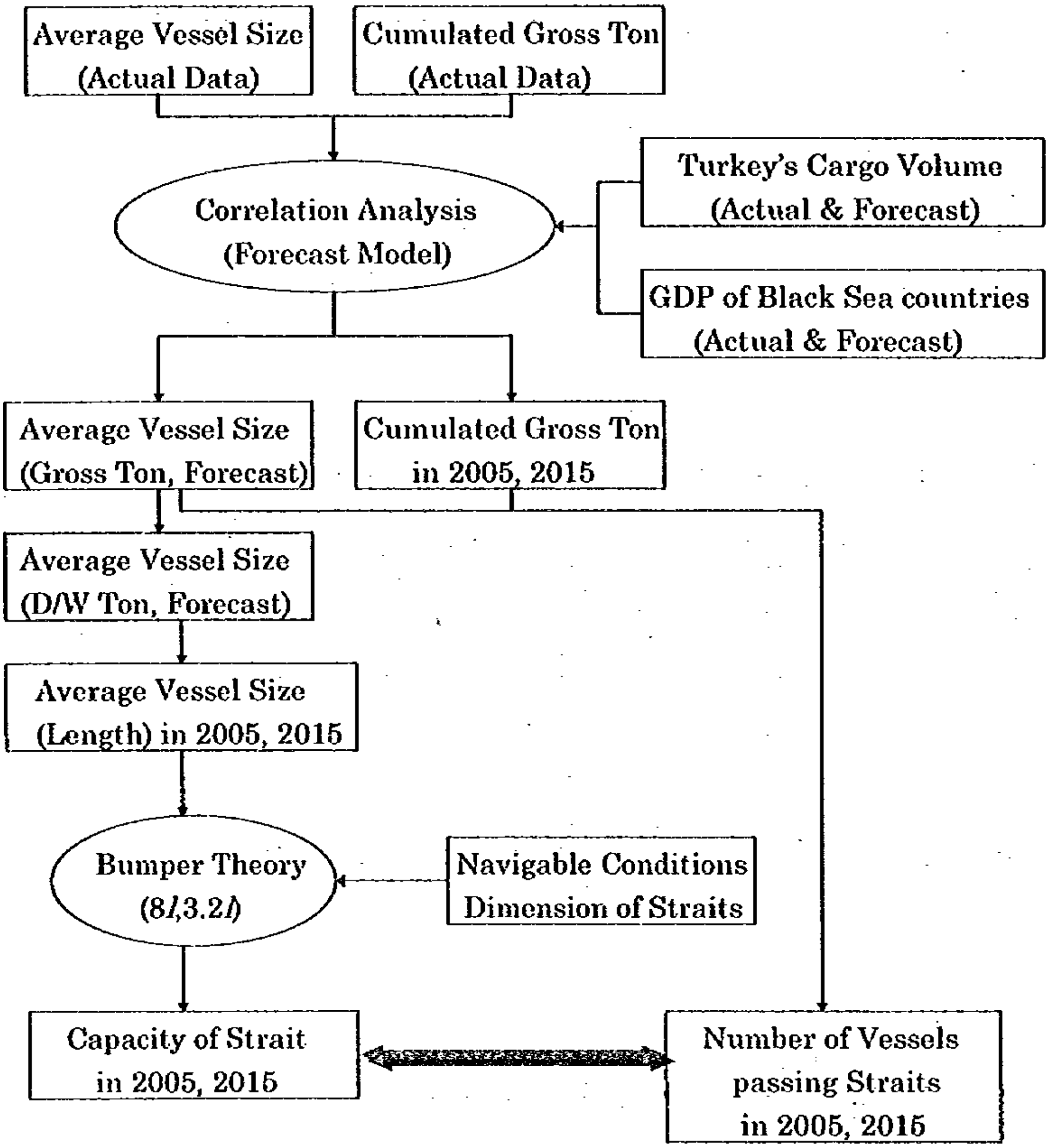
Source: Chanakkale Maritime Affairs Organization

TABLE A 7.4 Vessels passed the Dardanells Strait (1996)

Month	Direction	No. of Vessels	Total	Tanker	Sub total	Raitio of Tanker
January	North-South	1464		225		15.37
	South-North	1316	2780	205	430	15.58
February	North-South	1256		204		16.24
	South-North	1290	2546	219	423	16.98
March	North-South	1544		266		17.23
	South-North	1558	3102	263	529	16.88
April	North-South	1605		238		14.83
	South-North	1589	3194	257	495	16.17
		11622		1877		16.15

Source: Chanakkale Maritime Affairs Organization

FIGURE A 7.3 Flowchart of Congestion Analysis



3.2.2 Forecast for Vessel passing

The cargo carried by vessels passing through the Straits is originated to/from ports in the Sea of Marmara and transported between the Mediterranean and the Black Sea. Therefore, it is possible to assume that cumulated gross tons of ships passing through the Straits, which has close relationship with total cargo volume carried by the vessels, has a correlation with above two cargoes. Moreover, average size of the vessels generally becomes large according to cargo volume because of transportation efficiency.

This will have a great bearing on how oil from the Baku oil field in the Caspian Sea will be treated. The study team didn't examine this matter. In this examination, cumulated gross ton and average gross ton of vessels passing through the Straits is estimated on assumption that these have some relation with the cargo volume handled in ports in Turkey and countries around the Black Sea.

To forecast above two parameters, multi-correlation analysis is employed and its variables of function, which present the cargo originating to/from ports in the Sea of Marmara and transporting between the Mediterranean and the Black Sea, and are able to be calculated at the target 2015, are used.
Basic formulation is as follows:

Cumulated gross ton of vessels passing through two straits (Y_1)
=Function(Cargo volume in Turkey: X_1, GDP of Black Sea countries: X_2)

Average gross ton of vessels passing through two straits (Y_2)
=Function(Cargo volume in Turkey: X_1, GDP of Black Sea countries: X_2)

The results of multi-correlation analysis using data from 1987 to 1995 are as follows:

$$Y_1=2.178X_1+246.5X_2-206300000 \quad \text{(Formula - 1)}$$
(correlation coefficient R=0.9580)

$$Y_2=2.80E\text{-}05X_1+0.00798X_2-110.4 \quad \text{(Formula - 2)}$$
(correlation coefficient R=0.9696)

Y_1 :Cumulated gross ton of vessels passing through two straits (GRT)
Y_2 :Average gross ton of vessels passing through two straits (GRT)
X_1:Total cargo volume in Turkey (except transit) (ton)
X_2:GDP of Black Sea countries (million US$)

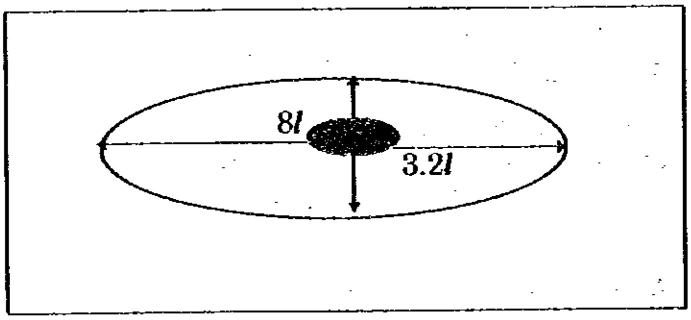
According to these formulas, cumulated gross ton and average gross ton in future are as follows:

TABLE A 7.5 Caluculation Results of Gross Tons

Variable	2005	2015
Total cargo volume in Turkey(Medium Case) (ton)	209,900,000	373,900,00
GDP of Black Sea countries (High Case)(mil. US$)	740,400	1,108,000
Cumulated Gross Ton(GT)	433,370,800	881,176,200
Average Gross Ton(GT)	11,675	19,200

3 Congestion Analysis

FIGURE A 7.4 Occupancy Area



When a vessels navigates a waterway, her occupancy area is affected by vessel's speed, tidal current, visibility, distance from coastal line and so on. However, affect of tidal current is not so large within navigable speed of .current. According to observation of vessel's action along narrow channel, in case of nearly same size, occupancy area closely resembles an oval with a long diameter of 8 *l* and a short diameter of 3.2 *l* as shown in Figure A 7.4. So far, the bumper theory mentioned above has been applied for these examination. In this section, capacity of the straits was estimated using this theory.

As shown in Appendix, the Bosphorus has a narrow section (narrowest part: 700 m) between Vanikoy and Kanlica of 3.7 km in length. However, it assumed in the examination that each lane could be used simultaneously, because the length of the narrow section is comparably short, around 10% of the total, and large vessels could avoid encounters within the section, if traffic control was introduced.

Vessels are divided into tanker and other vessel(general cargo ship), because regulations require that tankers carrying dangerous cargo must navigate the straits during the daytime. The share of tanker in future is assumed 15% according to Table A 7.4.

According to the hearing in the first field survey and Table 3, the number of passing vessels is approximately 100 a day, therefore, number extra ratio is assumed 3, compared with Table A 7.2 and Table A 7.3.

The cumulated GRT of vessels passing through the Bosphorus is assumed 50% of total based on Table A 7.2.

The DWT of vessel is calculated by using formula between GRT and DWT mentioned in Technical Standards for Port and Harbour Facilities in Japan.

Tanker : *log G.T. = -0.336+1.014 log D.W.*

General Cargo Vessel : *log G.T. = 0.162+0.915 log D.W. (D.W.≧6,000)*

The length of vessels is calculated by using formula between DWT and vessel length which is analyzed in PHRI papers, No.652(June 1989).(Figure A 7.5 and Figure A 7.6)

Total available days to pass the strait are assumed 346 days in a year, on assumption of 5% of foggy days and strong tidal current days in a year.
The occupancy time for ferry to cross the waterway in Istanbul is 8 minutes in one hour,

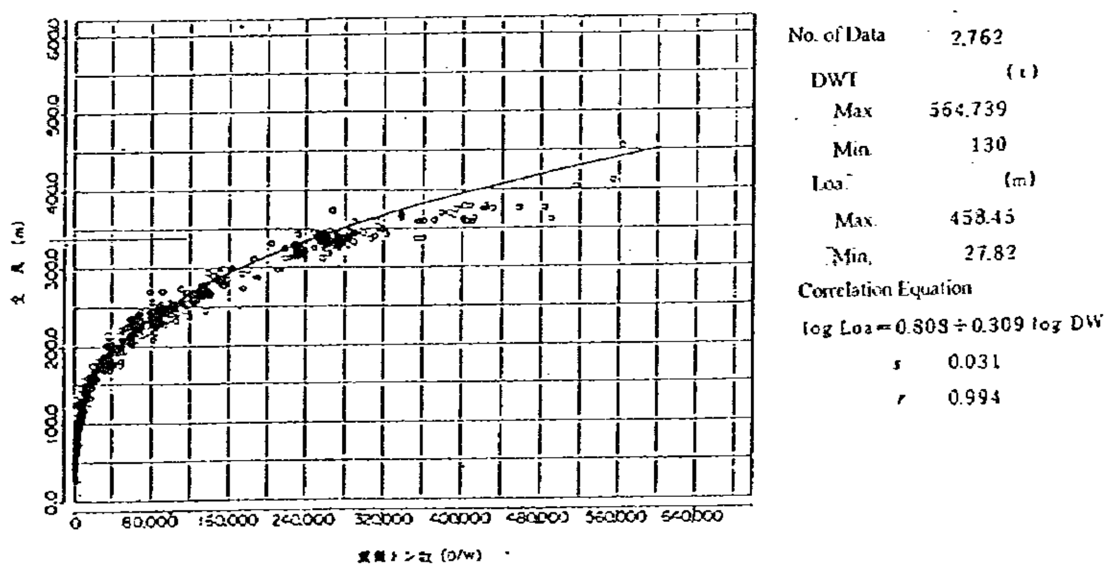


FIGURE A 7.5 Relationship between Overall length and DWT of Tanker

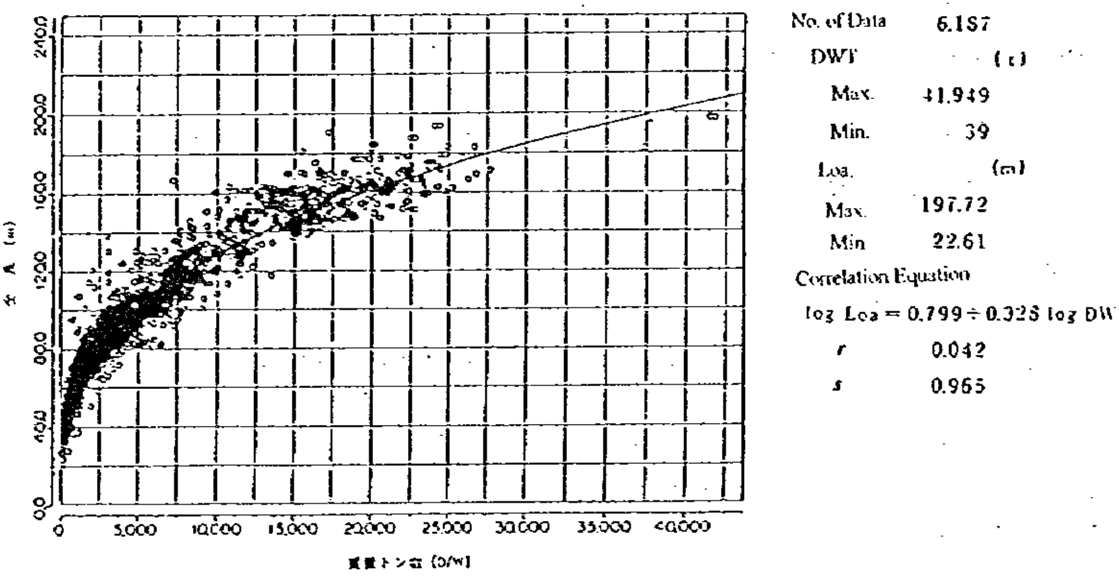


FIGURE A 7.6 Relationship between Overall length and DWT of General cargo vessel

that is, ferry is operated for 16 hours a day and departs from both sides every 30 minutes, and it takes 2 minutes (4 minutes by both ferries in every 30 minutes) to cross the waterway.

The average speed of a vessel along the Strait is assumed at 10 nautical miles per hour, because of speed limitation in the regulation.

In the calculation for passing capacity of vessel, tanker is assumed to have a priority for navigation. Calculate method is as follows:

For tanker — Available pass time in daytime ÷ Passing time for one tanker

For other vessel — (Available pass time − Occupied time by tanker) ÷ Passing time for one general cargo vessel

Day time — 12 hours

Available passing day time — 624 minutes(12×(60−8))

Occupancy time for tanker — 12×number of vessel×number extra ratio(3) ÷ Passing capacity of tanker

Available passing time for general cargo vessel — 16 hours − Occupancy time for tanker + 8 hours(mid night)

TABLE A 7.6 Results of Calculation

Item	Tanker	Others	Remarks
Ratio of Ship Type(%)	15	85	
Yearly available passing days	346		
Cumulated GRT in 2005 (ton)	216,685,400		
GRT(ton)	11,675		
DWT(ton)	22,000	18,540	
Length of Vessel (*l*: *m*)	141	158	
Number of vessels passing in a year	2,780 (8,340)	15,780 (47,340)	(55,680)
Passing time per vessel (minute)	3.65	4.10	
Capacity per year	59,150	103,300	111,640
Cumulated GRT in 2015 (ton)	440,588,100		
GRT(ton)	19,200		
DWT(ton)	35,935	31,925	
Length of Vessel (*l*: *m*)	164	189	
Number of vessels passing in a year	3,440 (10,320)	19,510 (58,530)	(68,850)
Passing time per vessel (minute)	4.25	4.90	
Capacity per year	50,800	83,690	94,010

The results are shown in Table 6. Accordingly, about 200 vessels with an average size of 30,000DWT~35,000DWT will navigate through the Strait in 2015. The capacity of Strait will not be exceeded in 2005 or 2015, according to these results.

To guarantee this result, traffic control which is a prerequisite for this calculation, should be implemented and a suitable number of pilot boats and tug boats should be arranged to assist large vessels over 150 m in length.

APPENDIX 8

Present Situation and Development Plan of Private Ports

Present Situation and Development Plan of Private Ports

1. DEMPORT

The planned berth extension length of DEMPORT is about 600m. Therefore three berths will be available, namely container 1.5 berth, RO/RO 0.5 berth, and General Cargo (timber) 1 berth. Container handling capacity will be 300,000 TEU assuming that 200,000 TEU can be handled by one berth. Container storage area of 150,000 m^2 will be sufficient for this handling capacity. RO/RO cargo handling capacity will be 35,000 units per year based on the estimation of DEMPORT. Volume of RO/RO cargo will be 450,000 tons, assuming that unit weight is 8.6 ton/TEU and 40 feet truck ratio is 50 %, the same as a container.

As for timber handling, 400,000 tons per berth is the maximum capacity in general. Therefore, only their own cargo will be handled.

Planned layout of DEMPORT is shown in Figure A 8.2.

2. ROTA

Existing port facility is one jetty of 300 m length. Two more jetties are planned to be constructed by the year 1999. Handling commodity of this port is dry bulk cargo. Assuming 1 million tons of bulk can be handled by one jetty, a total of 3 million tons of bulk cargo will be handled by this port, 600,000 tons of their own cement bulk and 2,400,000 tons of public cargo.

Layout of the port of ROTA is shown in Figure A 8.3.

3. Alemdar

Alemdar port has four berths, namely one liquid cargo berth and three general cargo berths. The handling capacity of liquid cargo is 6-10 times the volume of storage tank capacity (70,000 m^3 in total). Therefore, it is assumed that the liquid cargo handling capacity is about 450,000 tons per year, and their own cargo accounts for 50,000 tons while public cargo is 400,000 tons respectively.

General cargo handling capacity will be 1,350,000 tons considering the size of the port and past record of cargo volume (1,210,000 tons). Main commodity is timber. Their own cargo accounts for 50,000 tons while public cargo is 1,300,000 tons respectively.

Layout of the port of Alemdar is shown in Figure A 8.4.

4. BELDE

The port will start operation in 1997 September with a berth of 150m length, two Gantry Cranes and container storage area of 65,000 m². Container handling capacity at this point will be about 100,000 TEU per year. The port has an extension plan consisting of two construction phases. After this first phase, berth length will be 400m with four Gantry Cranes, and 3500 TEU ground slots. Expected container handling capacity is about 360,000TEU per year. Second phase plan is to extend the berth length up to 900m with eight Gantry Cranes, and the expected capacity is about 600,000TEU per year. However, detailed construction schedule of these two phases is not yet decided.

From a topographical view point, there is a small hill just behind the shore side area while TCDD railway runs between the hill and shore side area. Container storage areas are divided into three areas, namely at shore side area, hill top area and east shore area. Given this arrangement, the smooth movement of containers seems to be difficult. As for the container handling capacity in the year 2015, it is judged to be about 360,000 TEU per year assuming the first phase of the extension plan will be completed at that time.

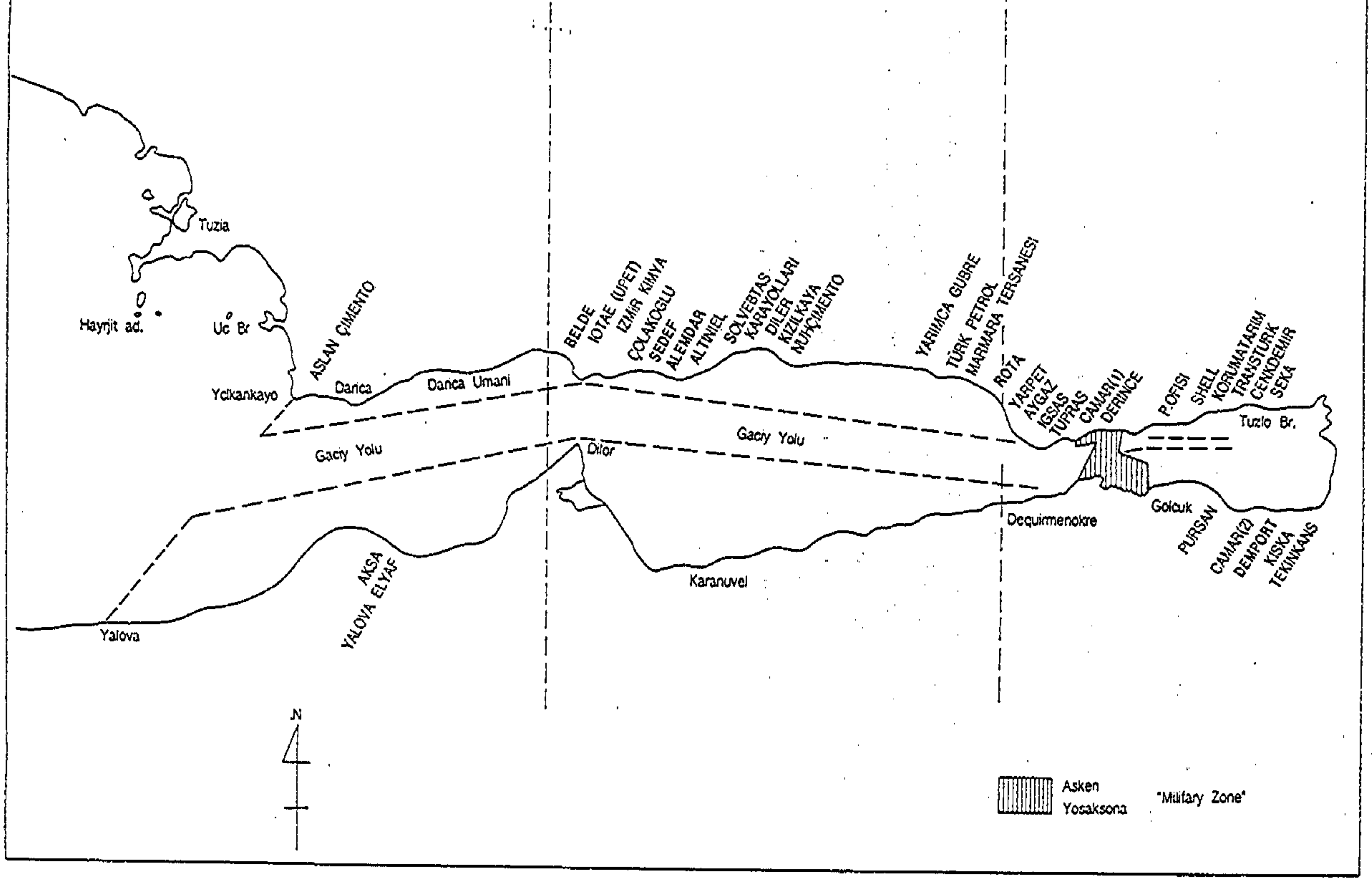
Planned layout of the port of BELDE is shown in Figure A 8.5.

5. SEDEF

SEDEF port has three berths, namely two general cargo berths and one container berth. Total length of the berths is 407m. General cargo handling capacity is about 600,000 tons per year assuming 300,000 tons can be handled at each berth. Container storage terminal is about 55,000 m² and there is an inland depot of 25,000 m² at 1.2 km away from the terminal. There is no room for extension of the storage area. Containers are handled by ship gear because there is no gantry crane. Considering above mentioned circumstances, container handling capacity of SEDEF port is about 50,000 TEU per year.

Layout of the port of SEDEF is shown in Figure A 8.6.

FIGURE A 8.1 Location of Ports in the Izmit bay



6. Ambarli

Ambarli port will start container handling operation from November of 1996. Container storage area of about 22,000 m² is prepared behind the No.2 to No.7 piers. A certain number of containers will be handled at No. 1 pier by mobile crane and/or ship gear. Container handling capacity will be about 50,000 TEU per year considering this situation.

Layout of the port of Ambarli is shown in Figure A 8.7.

7. MARTAS

Martas Port has one jetty of 25m width, which is divided into four berths. Total length of the berths is about 527m. Public general cargo and dry bulk cargo is handled in addition to their own cargo. Cargo handling capacity of their own cargo and public cargo is assumed as follows.

General Cargo	(Public Cargo)	about 260,000 ton
Dry Bulk	(Own Cargo)	about 1,500,000 ton
Dry Bulk	(Public Cargo)	about 1,500,000 ton

Layout of the port of Martas is shown in Figure A 8.8.

FIGURE A 8.2 Layout of Demport

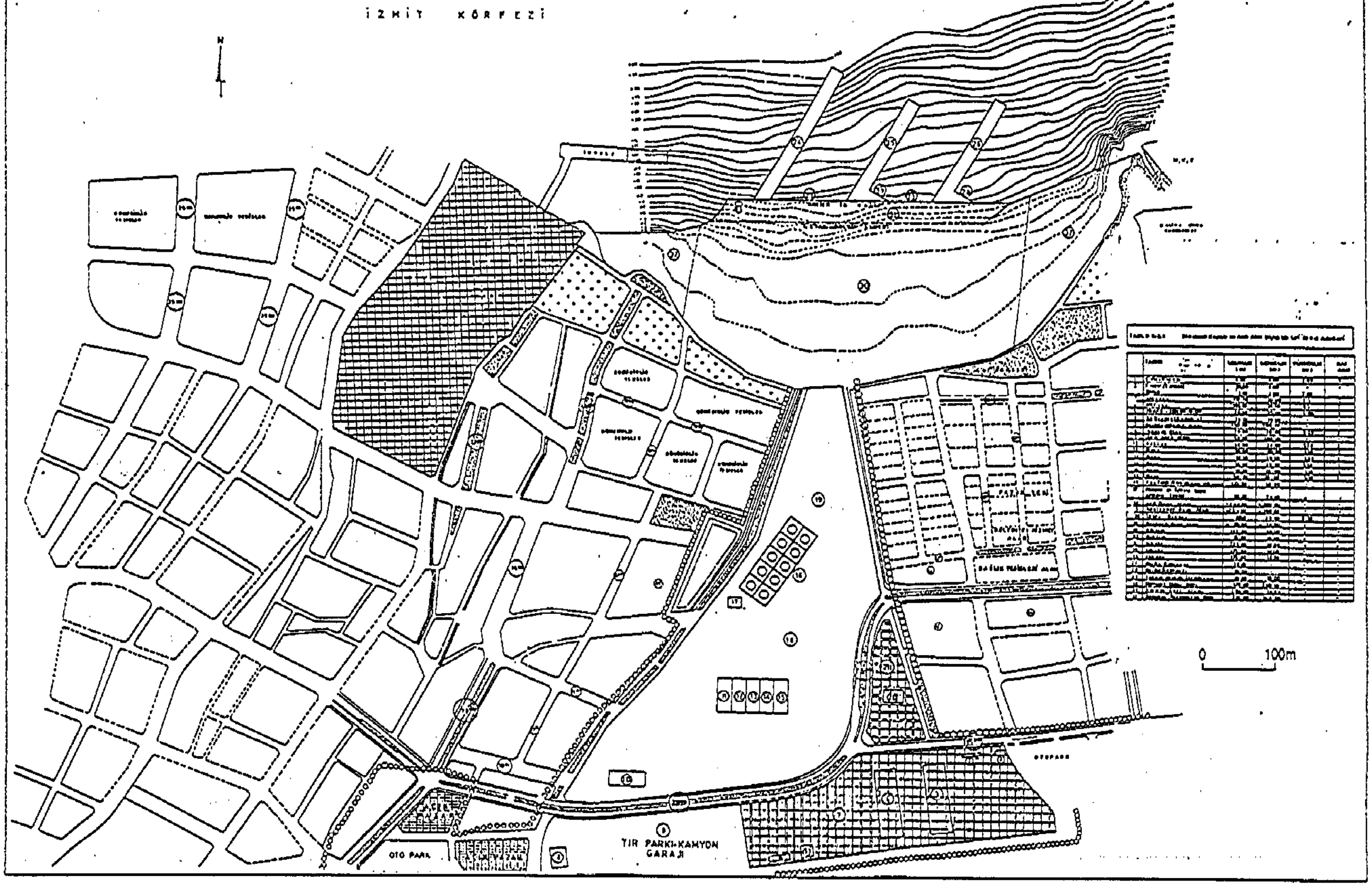


FIGURE A 8.3 Layout of Rota Port

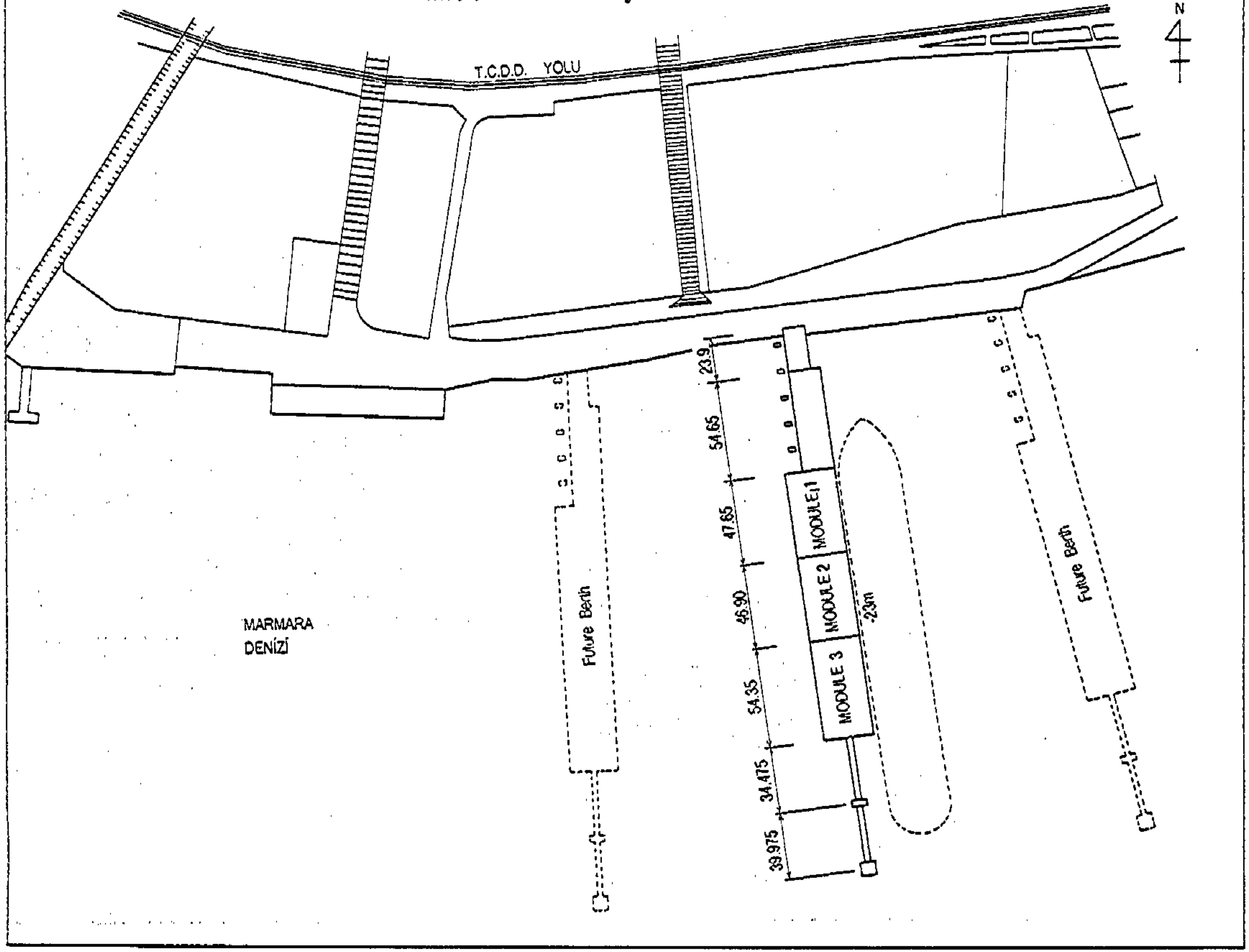


FIGURE A 8.4 Layout of Alemdar Port

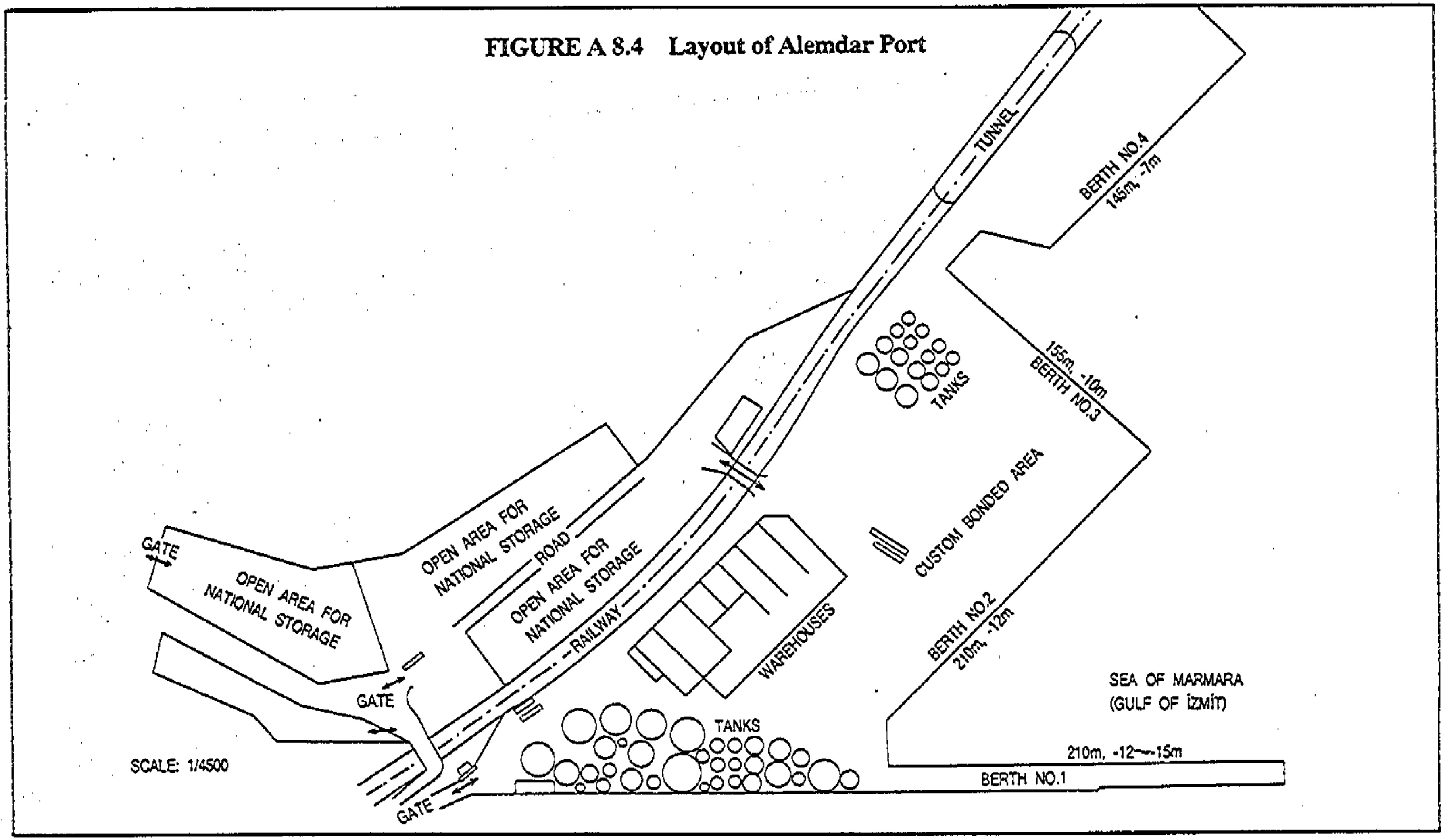


FIGURE A 8.5 Planned Layout of Belde Port

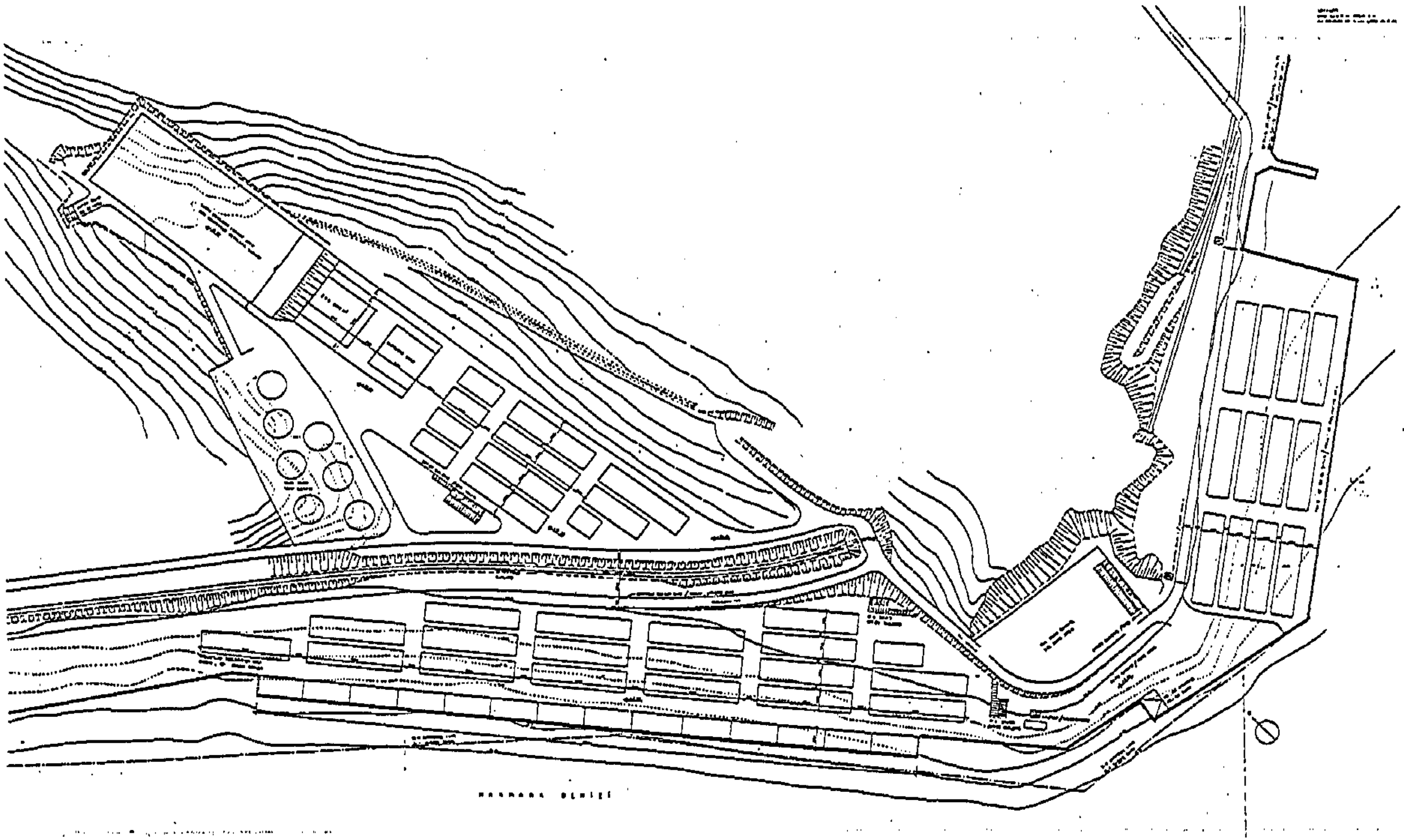


FIGURE A 8.6 Layout of Sedef Port

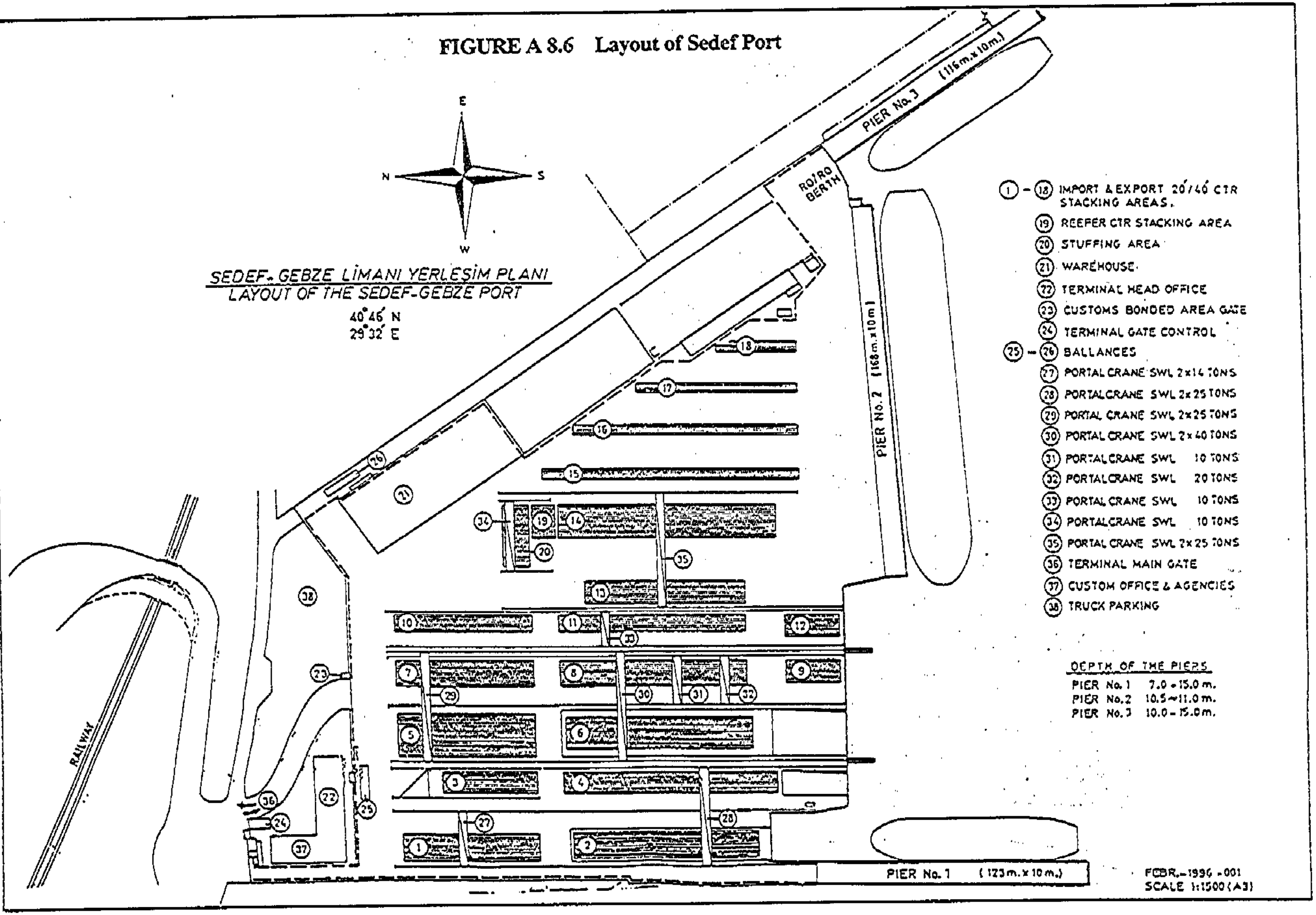


FIGURE A 8.7 Layout of Ambarli Port

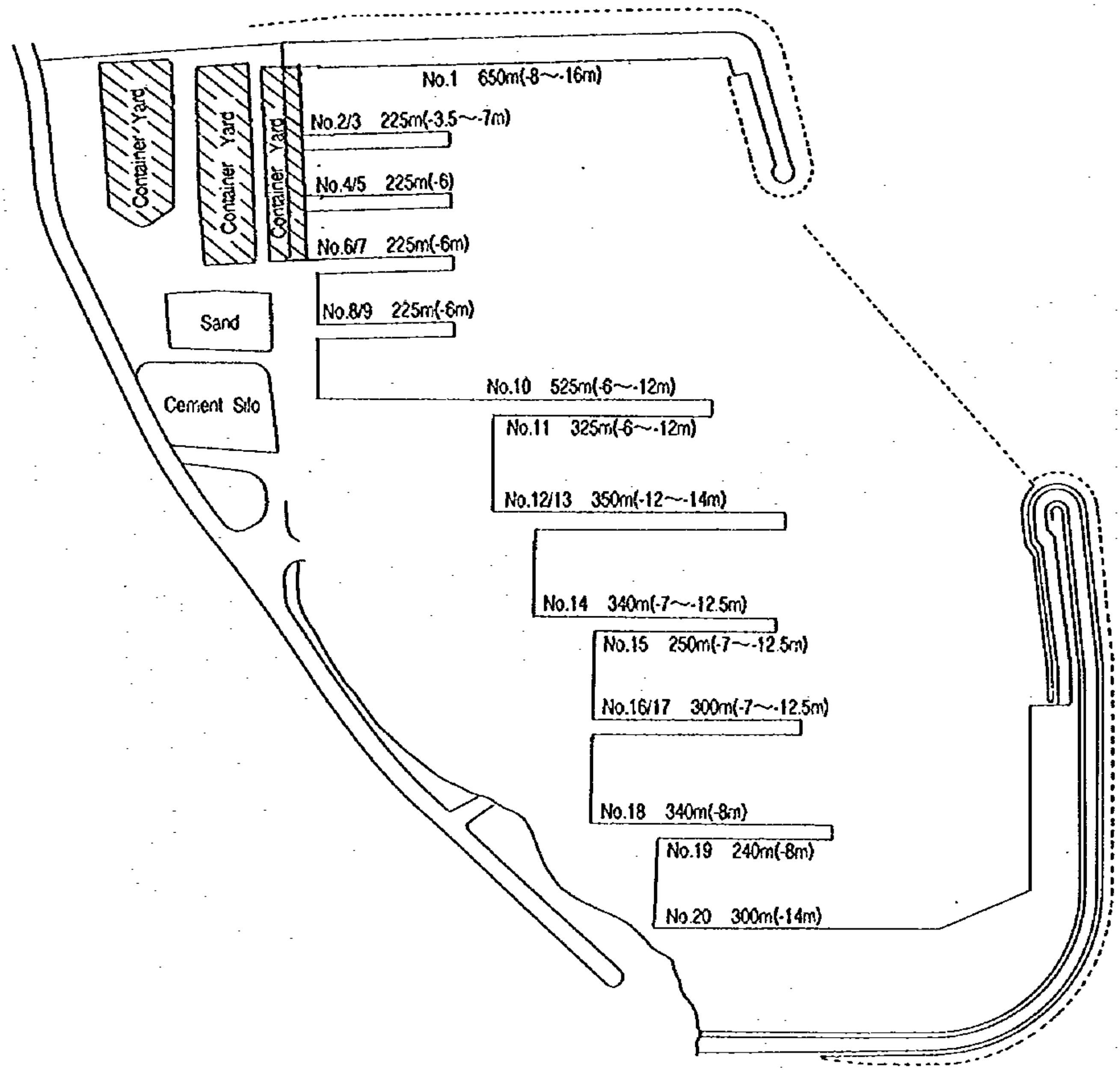
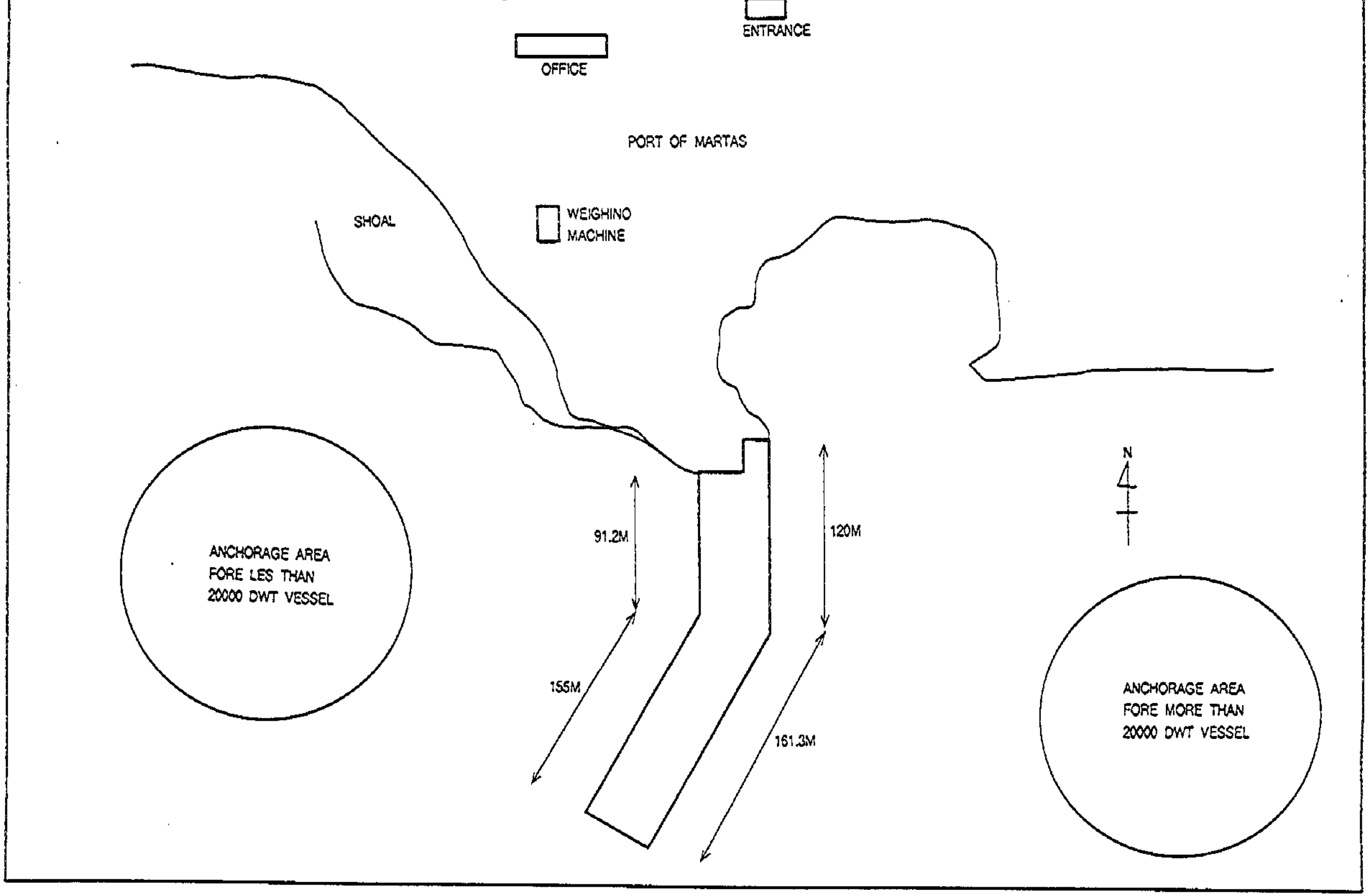


FIGURE A 8.8   Layout of Martas Port



APPENDIX 9

Lowering of Container Handling Productivity in Case of Separation from Container Berth and Container Yard

Lowering of container handling productivity in case of separation from container berth and container yard

1. Caluculation of container handling capacity

Container handling capacity is estimated as follows;

$N = 60/((L+l)/v + t_1 + t_2 \times 0.7)$

N	:Hourly container handling capacity per one trailer(box/hr)
L	:Average running distance in container yard(1.5km)
v	:Average trailer spped(0.25km/min.=15km/hr)
l	:Distance between container berth and container yard(km)
t_1	:Time to lift on and off(4 minuets)
t_2	:Working time of crane side(3 minutes)
0.7	:Working efficiency

2. Result of calculation

One-way distance(km)	Handling No. of Box / vehicle hour	Necessary No. of trailers to handle container box per one crane
0	4.95(1/1.00)	5 vehicle/crane(1.00)
0.5	3.73(1/1.33)	7 vehicle/crane(1.4)
1	2.98(1/1.67)	9 vehicle/crane(1.8)
2	2.14(1/2.33)	12 vehicle/crane(2.4)
3	1.66(1/2.94)	15 vehicle/crane(3.0)

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