4.6.3 Required Number of Berths

(1) Method of Determining Berth Number

For planning, various methods are used to determine the required number of berths. In this Study, a method considering the frequency of ship entry and cargo handling productivity is used for determining the number of berths where cargoes other than container cargo and passenger will be handled.

This method is summarized as follows:

Number of berths = (Total number of berthing days) / (Annual number of workable days × Berth occupancy ratio)

where

- Total number of berthing days:
  (Number of vessel calls) × (Average berthing days per vessel)
- Number of vessel calls:
  (Annual cargo volume handled) / (Average cargo volume handled per vessel)
- Average berthing days per vessel:
  (Average cargo volume handled per vessel) / (Average cargo handling productivity per vessel per day) + (Number of days necessary other than for cargo handling)

With regard to determining the required number of container berths, a method considering the cargo handling capacity per berth per year is adopted.

With regard to passenger berth, the required berth number is determined taking into account the carrying capacity of ferry boats.

(2) Berth Occupancy Ratio

According to the UNCTAD report ("Port development, A handbook for planners in developing countries"), the berth occupancy ratio for conventional general cargo operations should be set so as not to exceed the figures given in Table 4.6.7.

Table 4.6.7 Berth Occupancy Ratio

Number of Berths in the Group	Recommended Maximum Berth occupancy (%)
1	40
2	50
3	55
4	60
5	65
6 - 10	70

Considering competitive situation surrounding the port of Aqaba in future, high berth occupancy ratio will be required. The present performance is rather good. According to the statistics of The Ports Corporation, the values of almost all major berths exceeded 70 % from 1990 to 1993, and some were over 80 %. Therefore, 70 % is thought appropriate in this Study.

(3) Fundamental Conception in Terms of Port Operation

1) Annual number of workable days

Number of days available for using berths is set at 351 days considering two official holidays and non-working days due to maintenance of facilities and equipment. Although there are currently no non-working days for maintenance works at all, such works will become more and more important and take more time in order to increase cargo handling productivity. So it is assumed that one day per month will be set aside for maintenance works. Considering weather conditions in Aqaba, it is thought unnecessary to set non-working days due to bad weather.

2) Average cargo volume carried per vessel

Generally speaking, when cargo handling volume is increased, cargo volume carried per vessel is also increased so as to save transportation cost. Here, based on the analysis of statistics of calling vessels at present and practical projection on increase of cargo lot size carried per vessel, average cargo volume per vessel at the target year will be assumed by different kinds of cargoes.

3) Average cargo handling productivity per day by vessel

Cargo handling productivity is one of the key factors in making efficient use of port facilities. It is common sense that a more efficient cargo handling system be introduced so as to realize higher cargo handling productivity when cargo volume is increased and carrying vessel size is enlarged. In addition, the port of Aqaba requires higher performance because it is expected to play an important role as the transit port, in particular, in the field of container cargo handling. From the above viewpoint, average cargo handling productivity will be assumed at the target year, taking into account the present and likely future situation at the port of Aqaba. Productivity levels are rather higher than those at present. Ways to ensure that these levels are reached will be treated later.

4) The number of days necessary other than for cargo handling

The necessary days other than for cargo handling (such as vessels' maneuvering activities for berthing/deberthing and the procedure for vessels' entrance/departure) differ by kind of vessel, vessel size, loading/unloading or cargo handling system. Based on an analysis of the current situation, values at the target year will be set by major commodities. All of them are expected to be shortened as much as possible.

(4) Required Number of Berths

Following the method mentioned above, the total berthing days and required number of berths are calculated by major kinds of cargoes as follows.

1) Phosphate

The forecast cargo volume differs depending on which political and economic scenarios are adopted, i.e. alternative cases. Total berthing days and required number of berths are calculated individually.

Table 4.6.8 Required Number of Berth for Phosphate

Items	Case 1	Case 5	Case 9
Forecast Cargo Volume (,000 tons)	7,370	7,370	6,400
Average Cargo Volume per Vessel (tons)	55,000	55,000	40,000
Average Cargo Handling Productivity (tons/day)	53,760	53,760	53,760
Number of Days Necessary other than Cargo Handling per Vessel	0.15	0.15	0.15
Total Berthing Days per Vessel	1.17	1.17	0.89
Total Berthing Days	157	157	143
Annual Workable Days	351	351	351
Berth Occupancy Ratio	0.7	0.7	0.7
Required Number of Berth	0.64	0.64	0.58

The above calculation results show that all three cases require just one berth for phosphate to be discharged. It means that there are currently two berths operating but only one berth is required to handle the forecast cargo volume on condition that the assumed cargo handling capacity will be secured.

2) Vegetable Oil

The forecast cargo volume of vegetable oil is the same for the three alternative cases.

Table 4.6.9 Required Number of Berth for Vegetable Oil

Items	Case 1,5,9
Forecast Cargo Volume (,000 tons)	400
Average Cargo Volume per Vessel (tons)	15,000
Average Cargo Handling Productivity (tons/day)	6,451
Number of Days Necessary other than Cargo Handling per Vessel	0.15
Total Berthing Days per Vessel	2.48
Total Berthing Days	66
Annual Workable Days	351
Berth Occupancy Ratio	0.7
Required Number of Berth	0.27

Vegetable oil is presently loaded at the "Phosphate Berth A". The above result shows that vegetable oil can be handled in a similar way as at present, that is to say, it does not require an exclusive berth and can be handled at berths which accommodate vessels carrying other cargoes.

3) Grain

The forecast cargo volume of grain is the same for the three alternative cases.

Table 4.6.10 Required Number of Berth for Grain

Items	Case 1,5,9
Forecast Cargo Volume (,000 tons)	2,010
Average Cargo Volume per Vessel (tons)	40,000
Average Cargo Handling Productivity (tons/day)	9,677
Number of Days Necessary other than Cargo Handling per Vessel	0.2
Total Berthing Days per Vessel	4.33
Total Berthing Days	218
Annual Workable Days	351
Berth Occupancy Ratio	0.7
Required Number of Berth	0.89

The above calculation result shows that one berth for grain is not sufficient, as grain ships which call the berth have to wait more than vessels carrying other cargoes. However, if two berths are assigned to load grain exclusively, it is evident that they would be obliged to be idle for long periods. Therefore, it is desirable that one berth be assigned for grain exclusively and another berth be used for other cargoes as well as grain.

4) General Cargo

General cargo includes many kinds of commodities such as sugar, frozen cargo, tea, potato, timber, cattle, construction materials, steel and so on. Because of the wide variety of cargoes, there are many kinds of package types, different cargo lot sizes, cargo handling productivities. Berth requirements are, however, generally discussed collectively because individual cargo volume by type is not large and these cargoes, excluding such cargoes as livestock and cars, are basically thought to be handled at the same quay.

Table 4.6.11 Required Number of Berth for General Cargo

Items	Case 1	Case 5	Case 9
Forecast Cargo Volume (,000 tons)	4,340	3,330	2,540
Average Cargo Volume per Vessel (tons)	3,500	3,500	3,000
Average Cargo Handling Productivity (tons/day)	3,000	3,000	3,000
Number of Days Necessary other than Cargo Handling per Vessel	0.1	0.1	0.1
Total Berthing Days per Vessel	1.27	1.27	1.10
Total Berthing Days	1,205	1,571	931
Annual Workable Days	351	351	351
Berth Occupancy Ratio	0.7	0.7	0.7
Required Number of Berth	6.39	4.90	3.79

As mentioned before, one grain berth will be insufficient and a vegetable oil berth should be secured. Those berths will not be used exclusively because of their expected berth occupancy ratios. Considering an allotment of those berths from a practical point of view, it is reasonable that those cargoes be handled at Main Port together with general cargoes. Taking into account such a condition, the above calculation results should be examined. As a result, when eight, six and five berths for general cargoes are individually secured for Case 1, 5 and 9, no problems will arise even though vegetable oil and a part of grain are to be handled as well.

5) Fertilizer-related cargoes and Potash

Fertilizer-related cargoes (fertilizer products, sulphur and liquid ammonia) and potash are to be handled at Industrial Port. They are currently handled at the same dolphin berth (JFI West and East). Taking into consideration that such a berth assignment will not change even in future, required number of berths for those cargoes will be examined.

The forecast cargo volume of fertilizer-related cargoes is the same for the three alternative cases but not for potash. The calculations are executed separately.

Table 4.6.12 Required Number of Berth for Fertilizer-related Cargoes

Items	Phosphoric Acid	Surfur	Liquid Ammonia
Forecast Cargo Volume (,000 tons)	1,500	1,400	490
Average Cargo Volume per Vessel (tons)	20,000	20,000	20,000
Average Cargo Handling Productivity (tons/day)	15,053	13,440	9,140
Number of Days Necessary other than Cargo Handling per Vessel	0.15	0.15	0.15
Total Berthing Days per Vessel	1.48	1.64	2.34
Total Berthing Days	111	115	57
Annual Workable Days	351	351	351
Berth Occupancy ratio	0.7	0.7	0.7
Required Number of Berth	0.45	0.47	0.23

Table 4.6.13 Required Number of Berth for Potash, NPK, Salt, DAP and MgO

Items	Case 1	Case 5	Case 9
Forecast Cargo Volume (,000 tons)	6,490	6,490	5,500
Average Cargo Volume per Vessel (tons)	20,000	20,000	20,000
Average Cargo Handling Productivity (tons/day)	20,160	20,160	20,160
Number of Days Necessary other than Cargo Handling per Vessel	0.1	0.1	0.1
Total Berthing Days per Vessel	1.09	1.09	1.09
Total Berthing Days	354	354	300
Annual Workable Days	351	351	351
Berth Occupancy ratio	0.7	0.7	0.7
Required Number of Berth	1.44	1.44	1.22

There are presently two exclusive berths, operated by JPMC, where fertilizer-related cargoes and potash are handled. The above results show that two berths, the same as at present, are insufficient and would result in port congestion as ships would be forced to wait for berths. Thus the required number of berths is three for the three alternative cases. If three berths are provided, these facilities will have the capacity to deal with cargo beyond the volume forecast.

6) Oil

There are four kinds of cargoes which will be handled at the exclusive berth for oil: crude oil, fuel oil, mineral oil and chemical oil. The forecast cargo volume differs among the three alternative scenarios.

Table 4.6.14 Required Number of Berth for Crude Oil or Fuel Oil

Items	Case 1 (Crude Oil)	Case 5	Case 9
Forecast Cargo Volume (,000 tons)	34,000	720	720
Average Cargo Volume per Vessel (tons)	195,000	25,000	25,000
Average Cargo Handling Productivity (tons/day)	180,000	20,000	20,000
Number of Days Necessary other than Cargo Handling per Vessel	0.2	0.15	0.15
Total Berthing Days per Vessel	1.28	1.40	1.40
Total Berthing Days	224	40	40
Annual Workable Days	351	351	351
Berth Occupancy Ratio	0.7	0.7	0.7
Required Number of Berth	0.91	0.16	0.16

Table 4.6.15 Required Number of Berth for Mineral Oil and Chemical Oil

Items	Case 1	Case 5	Case 9
Forecast Cargo Volume (,000 tons)	1,250	1,140	900
Average Cargo Volume per Vessel (tons)	20,000	20,000	20,000
Average Cargo Handling Productivity (tons/day)	10,000	10,000	10,000
Number of Days Necessary other than Cargo Handling per Vessel	0.1	0.1	0.1
Total Berthing Days per Vessel	2.10	2.10	2.10
Total Berthing Days	131	120	94
Annual Workable Days	351	351	351
Berth Occupancy Ratio	0.7	0.7	0.7
Required Number of Berth	0.5	0.5	0.4

The above results show that Case 1 requires two berths while other cases one berth. There is one berth (Oil Jetty) which can accommodate 400,000 DWT tanker according to PC. Except in Case 1, existing berths satisfy the required berth dimensions. In Case 1, berth must be able to accommodate an oil tanker carrying 200,000 tons on average.

7) Cement

The forecast cargo volume of cement differs for the three alternative scenarios.

Table 4.6.16 Required Number of Berth for Cement

Items	Case 1	Case 5	Case 9
Forecast Cargo Volume (,000 tons)	200	700	1,200
Average Cargo Volume per Vessel (tons)	20,000	20,000	20,000
Average Cargo Handling Productivity (tons/day)	5,376	5,376	5,376
Number of Days Necessary other than Cargo Handling per Vessel	0.2	0.2	0.2
Total Berthing Days per Vessel	3.92	3.92	3.92
Total Berthing Days	39	137	235
Annual Workable Days	351	351	351
Berth Occupancy Ratio	0.7	0.7	0.7
Required Number of Berth	0.16	0.56	0.96

The above results show that one berth which can accommodate vessels carrying 20,000 tons on average is sufficient. In Case 9, cargo handling productivity is expected to be improved.

8) Rice

There are two kinds of rice to be handled in the port of Aqaba, one is bagged cargo consumed in Jordan and the other is imported in bulk and exported after packaging. The former is included in general cargoes. The latter, which is processed by Rice Packing Factory, is handled at Muta Floating Berth. Here, required berths for the latter case are discussed. The forecast cargo volume is the same for three alternative cases. Bagged cargo is categolized in general cargo and usually handled in the Main Port.

Table 4.6.17 Required Number of Berth for Rice and Livestock

Items	Rice in bulk	Livestock
Forecast Cargo Volume (,000 tons)	745	110
Average Cargo Volume per Vessel (tons)	18,000	300
Average Cargo Handling Productivity (tons/day)	6,720	860
Number of days Necessary other than Cargo handling per Vessel	0.20	0.15
Total Berthing Days per Vessel	2.88	0.50
Total Berthing Days	119	183
Annual Workable Days	351	351
Berth Occupancy Ratio	0.7	0.7
Required Number of Berth	0.48	0.74

The above results show that required number of berth is one.

9) Livestock

The forecast cargo volume of Livestock is the same for three alternative cases. The details of this cargo are described in Chapter 5.4 and 5.5.

According to the result of the above Figure 4.6.17, required number of berth for livestock is one, assuming JFI-1 berth would be enlarged up to 200 m in length and 11 m in depth.

10) Container

Required number of container berths is determined based on container cargo volume in terms of TEUs and cargo handling capacity. Cargo handling capacity is mainly controlled by container crane capacity. Two container cranes are usually installed at each berth though container berths with three cranes are increasing, in particular, at ports in developed countries. This Study will be carried out on the basis that one container berth with two container cranes is a standard system. Cargo handling capacity per berth per year is calculated by the following formula:

$$Qy = n \times Nh \times Kc \times Hd \times Dy \times Ew$$

where Qy : Cargo handling capacity (TEUs/berth/year)
n : Number of container cranes (unit)
Nh : Number of container boxes to be handled per crane per hour (boxes/unit/h)
Kc : Conversion ratio from boxes to TEUs
Hd : Working hours per day (h/day)
Dy : Annual operation days (days/year)
Ew : Working time efficiency

Substituting the above parameters for practical and probable values at the port of Aqaba, cargo handling capacity at the target year can be obtained as follows;

$$Qy = 2 \times 20 \times 1.3 \times 18 \times 351 \times 0.7$$
$$= 229{,}975 \text{ (TEUs/berth/year)}$$

The above result shows that one container berth has the capacity to handle about 230,000 TEUs a year on condition that marshaling, storing and transportation system behind container berths work reasonably well.

Required number of container berths is calculated by the following formula.

$$N > My / Qy$$

where N : Required number of container berth
My : Annual container throughput (TEUs/year)

According to the results of demand forecast, container throughput at the target year is shown in Table 4.6.18.

Table 4.6.18 Results of Container Cargo Volume Forecast

	Case 1	Case 5	Case 9
Loaded container (TEUs)	214,500	216,400	211,800
Empty container (TEUs)	195,000	200,000	200,000
Total (TEUs)	409,500	416,400	411,800

Required number of container berths is estimated as two for all three cases following the above calculation method.

11) Passenger

Required number of passenger berth is determined based on forecast passenger and vehicle traffic volume and passenger boat carrying capacity by passenger boats. Passenger boat carrying capacity per year is calculated by the following formula.

$$Qp = Qv \times R \times Dy \times Ew$$

where Qp : Passenger boat carrying capacity (passenger and vehicle)
Qv : Carrying capacity by total ferry boats per day
R : Revolving frequency per day
Dy : Operating days per year
Ew : Working time efficiency

Two ferry boats can presently accommodate 3,000 passengers and 250 cars per voyage individually. They are run twice a day all the year round. On top of that, there is another ferry boat with capacity of 1,000 passengers and 23 trucks used during the high season or in case of emergency. Although information on working time efficiency, which includes days necessary to maintain or repair regularly in dock, is not known in detail, non-working days a year is not thought to exceed one month.

One a per annum basis, the two ferry boats can carry about four million passenger and about 167 thousand vehicles as demonstrated below:

$$Qp = 6{,}000 \times 2 \times 365 \times 11/12$$
$$= 4{,}015{,}000 \text{ (for passenger)}$$

$$Qp = 250 \times 2 \times 365 \times 11/12$$
$$= 167{,}291 \text{ (for vehicle)}$$

Compared with the results of the demand forecast, present passenger boat carrying capacity largely exceeds the number of passengers, but the vehicle carrying capacity is insufficient for Case 1 and 5. However, additional service by another ferry boat, mainly to accommodate vehicle, can be expected, or revolving frequency per day could easily be increased from twice to three times, without causing serious problems to passenger port facility operation judging from its capacity.

Table 4.6.19 Results of Passenger and Vehicle Traffic Volume Forecast

	Case 1	Case 5	Case 9
Passenger	960,000	2,150,000	1,500,000
Vehicle	240,000	200,000	140,000

As a result, present passenger boats in service are more than capable of handling the forecast traffic volume in terms of passenger as well as vehicle by using the existing number of passenger berths.

12) Summary of the results

Table 4.6.20 shows the summary of the results of required number of berths.

Table 4.6.20 Required Number of Berth in 2010

Major Commodity or Passenger	Case 1	Case 5	Case 9	Utilized Facility	Remarks
Phosphate	1	1	1	2	Existing berth (A) is used for vegetable oil loading.
Grain	1	1	1	usually 2	A part of grain is to be handled at other berths.
General Cargo, Vegetable Oil	8	6	5	usually 7 at Main Port and another (JFI.1)	Berth depth and length of some existing berths are not sufficient to accommodate vessels of Panamax.
Fertilizer, Potash	3	3	3	2	
Crude Oil, Mineral Oil	2	1	1	1	
Cement	1	1	1	1	
Livestock	1	1	1	1	Existing berth can not accommodate livestock vessels of more than 80 m in length.
Rice	1	1	1	1	
Container Cargo	2	2	2	usually 3 (total length 540 m)	Existing berths can not accommodate two container vessels with 2,000 TEUs simultaneously.
Passenger	3	3	3	3	

4.6.4 Required Scale of Facilities

(1) Required Scale of Berths

Required maximum scale of berth (berth length and depth) is decided on the basis of expected maximum calling vessel size at the target year. As mentioned in the previous sections, average cargo volume per vessel by major commodities is assumed at the target year, taking forecast cargo volume and cargo handling productivity etc. by major commodities into consideration with regard to berths at Main Port and Industrial Port.

Table 4.6.21 Average Cargo Volume per Vessel

(unit: tons)

Commodities	Case 1	Case 5	Case 9
Phosphate	55,000	55,000	40,000
Vegetable Oil	15,000	16,000	15,000
Grain	40,000	40,000	40,000
General Cargo	3,500	3,500	3,000
Fertilizer-related cargo	20,000	20,000	20,000
Sulphur	20,000	20,000	20,000
Liquid Ammonia	20,000	20,000	20,000
Phosphoric Acid	20,000	20,000	20,000
Crude or Fuel Oil	195,000	25,000	25,000
Mineral or Chemical Oil	20,000	18,000	20,000
Cement	20,000	20,000	20,000
Rice in Bulk	20,000	20,000	20,000
Livestock	300	300	300

Maximum vessel sizes by major commodities are assumed corresponding to average cargo volume per vessel by major commodities. In case that the existing berths cannot accommodate expected maximum vessels, projects to newly develop or extend berths should be proposed. In addition to berths at Main Port and Industrial Port, container berths should also be redeveloped or extended in order to meet future cargo demand, promote port activities and reinforce the competitive position as a transit port.

Considering the conception on functional allotment of port activities, which is mentioned in the section 4.6.1, existing facilities' dimension, required number of berths and the above average cargo volume per vessel by commodities, cargoes, which cannot be handled at existing berths, and berth requirement by major commodities are as follows:

Table 4.6.22 Future Berth Requirements

Major Commodity	Conception	Place	Remark
Grain	to accommodate vessels of Panamax	Main Port	Currently Panamax type vessels call and the trend will continue.
General Cargo	to accommodate vessels up to 30,000 DWT class	Main Port	Currently 30,000 DWT class vessels call and maximum vessel size is thought to nearly remain in 2010. 10,000 DWT class vessels is thought to be usual.
Livestock	to accommodate vessels up to 20,000 GRT with draft 10m	Industrial Port	Currently vessels of 206 m in length and 9.8 m draft call and the trend will continue.
Fertilizer-related Cargo and Potash	to accommodate vessels up to the same size as at present	Industrial Port	With increase of cargo traffic volume, another berth will be needed.
Crude Oil	to accommodate tankers up to 250,000 DWT class	Industrial Port	only for Case 1
Container Cargo	to simultaneously accommodate two container vessels with 2,000 TEUs	Container Port	In order to promote as the transit port, the port of Aqaba has to provide higher service.

Dimension of berths which will accommodate vessels with vessel size mentioned above should be determined.

In general, required berth length and depth are estimated as follows;

Berth length > (Length of vessel) + (Breadth of vessel)

Berth depth > (Draft of vessel) + (allowance: 0.5 m to 1.5 m)

When maximum calling vessel is specified, required berth dimension is determined by substituting the vessel dimension in the above mentioned formula. Otherwise, in order to determine vessel dimension, it is necessary to conduct a statistical analysis using extensive data on the same kind of vessels. Here, statistical analysis will be adopted excluding vessels for fertilizer-related cargoes and potash and crude oil tankers (Vessel dimension for fertilizer-related cargoes and potash is likely to radically change in future while the dimension of dolphin type or mooring buoy type berth used by large crude carriers will be determined through design examination).

Regarding cargo vessels, by analyzing statistics of Lloyd's Register, standard dimensions of vessels by type and standard berth dimensions are indicated in " TECHNICAL STANDARDS FOR PORT AND HARBOUR FACILITIES IN JAPAN". Berth dimension by vessel size mentioned above is as follows:

Table 4.6.23 Berth Dimension by Vessel Size

Tonnage (DWT)	Vessel Size (m)			Berth Dimension (m)	
	Overall Length	Moulded Breath	Full Load Draft	Length of Berth	Water Depth of Berth
10,000	137	19.9	8.5	170	10.0
15,000	153	22.3	9.3	190	11.0
30,000	186	27.1	10.9	240	12.0
50,000	216	31.5	12.4	280	14.0

Note: To be exact, Panamax type vessels are defined as the maximum size of vessels which can pass through the Panama canal, which means 289.6 m (950 feet) for container vessels and passenger boats or 274.32 m (900 feet) for other vessels in terms of overall length and 32.309 m (106 feet) in terms of moulded breath. For examining berth dimension, Panamax type vessels can be regarded as similar to 50,000 DWT class vessels.

As to container vessels, typical vessel size and berth dimension required to accommodate container vessels are summarized as follows:

Table 4.6.24 Berth Dimension by Container Vessel Size

Typical Size of Container Vessels					Berth Dimension		Remark
Number of loaded containers (TEU)	Tonnage (DWT)	Full Load Draft (m)	Overall Length (m)	Moulded Breath (m)	Water Depth of Berth (m)	Length of Berth (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	Panamax
2,000	35,000	12.0	260	32.2	13.0	300	Panamax
3,000	50,000	13.0	290	32.2	14.0	350	Panamax
4,400	60,000	13.5	290	39.4	15.0	350	Over Panamax

Based on the above mentioned berth dimension and the result of required number of berths in the section 4.6.3, also taking into account present situation of calling vessels and its future projection, planned berths at the target year are as follows:

Table 4.6.25 Required Scale of Berths

Major Commodity or Passenger	Place	Case 1	Case 5	Case 9	Remarks
Phosphate	Main Port	Existing Phosphate Berth (B)	Existing Phosphate Berth (B)	Existing Phosphate Berth (B)	No need to develop new berth
Grain	Main Port	One berth to accommodate 50,000 DWT vessel (L:280 m, D:14 m)	One berth to accommodate 50,000 DWT vessel (L:280 m, D:14 m)	One berth to accommodate 50,000 DWT vessel (L:280 m, D:14 m)	A part of grain is to be handled at other berths.
General Cargo, Vegetable Oil	Main Port, Industrial Port	One berth to accommodate 30,000 DWT vessel (L:240 m, D:12 m), two extension berths of 10,000 DWT vessel (L:170 m, D:10 m for one berth) and existing berths	One berth to accommodate 30,000 DWT vessel (L:240 m, D:12m) and existing berths	One berth to accommodate 30,000 DWT vessel (L:240 m, D:12 m) and existing berths	Berths from No.1 to No.6 at Main Port are to be utilized after improvement, if necessary. No. 7 Berth is to be used in Case 1. and 5.
Fertilizer-related cargoes, Potash	Industrial Port	One extension berth to accommodate 50,000 DWT vessel (L:230 m, D:15 m) and existing berths	One extension berth to accommodate 50,000 DWT vessel (L:230 m, D:15 m) and existing berths	One extension berth to accommodate 50,000 DWT vessel (L:230 m, D:15 m) and existing berths	Existing berths (JFI. West and East) are to be used successively.
Crude Oil	Industrial Port	One extension berth to accommodate 250,000 DWT oil tanker and existing oil berth	Existing oil berth	Existing oil berth	
Cement	Container Port	Existing berth	Existing berth	Existing berth	No need to develop new berth
Rice	Container Port	Existing berth	Existing berth	Existing berth	No need to develop new berth
Livestock	Industrial Port	One extention berth to accommodate 20,000 GRT vessel	One extention berth to accommodate 20,000 GRT vessel	One extention berth to accommodate 20,000 GRT vessel	To enlarge existing JFI-1 up to 200 m in length and 11 m in depth
Container Cargo	Container Port	60 m extension of the existing berth	60 m extension of the existing berth	60 m extension of the existing berth	Two container vessels loaded with 2,000 TEUs will call.
Passenger	Container Port	Existing berth	Existing berth	Existing berth	No need to develop new berth

(2) Required Scale of Water Basin

The water basin for vessels' turning should ensure an area larger than a circle with a diameter of 3×L(L:overall length of maximum vessel size for the berth), in case of vessels' maneuvering by themselves, to allow the safe turning of vessels. In case of using tugboats to assist, the water basin of a circle with a diameter of 2×L should be secured.

In general, up to 5,000 D/W class vessels can maneuver without assistance of tugboats.

When water basin in front of the quay is shallower than the full load draft of maximum vessel, water area to be dredged should be planned.

In the port of Aqaba, water depth rapidly increases offshore except for the northern area of Main Port. Therefore, removal of coral patch (according to the chart, the shallowest point is 7.6 m depth) is necessary to ensure water basin in case that No.7 berth at Main Port will be used by over 5,000 DWT class vessels with full load.

As mentioned later, No.7 berth will be assigned for 5,000 DWT class vessels, of which full load draft is 7.5 m. So there is no need to remove coral patch if No.7 berth is used exactly as in the proposed plan.

Generally speaking, however, such shoals in the sea cause anxiety for ship operators. Therefore, to ensure that the port's reputation does not suffer, organizations and people concerned with marine activities have expressed a desire to remove the patch.

Accordingly, dredging plan of coral patch for Case 1 and 5 will be proposed.

(3) Required Scale of Storage Area at Main Port

In order to ensure smooth and efficient cargo handling in port area, storing facilities with required scale and proper location are indispensable. The port of Aqaba has currently already many storing facilities or factories with warehouses behind their berths. Here, required scale of storage area for general cargoes at Main Port is examined. As to Container Port, required scale of container terminal including container yard will be examined later.

Other commodities are bulk cargoes. They usually have conveying system directly connected between berth and storing facility or factory. When there are any increased production and transportation plans, it can be expected that they will be accompanied by improvement or development projects related to cargo handling capacity and storing system. For example, JPMC and APC already own their factory area for expansion including storage area. When Iraq-Jordan Oil Pipeline Project commences, oil storage tanks will surely be constructed, wherever the storage area is located. On top of that, many of those cargoes can be directly delivered to/from port area so that they do not always need to come with storing facilities near the port area.

There are two kinds of cargo to be handled and be stored temporarily at Main Port, one in transit sheds and the other in open yards.

Steel or iron, timber and cars are stored in open yards, while almost all other cargoes are usually in transit sheds.

Required area of storage facilities is calculated by the following formula:

$$A = (W \times p) / (R \times a \times w)$$

where A : Storage area (m^2)
W : Annual cargo volume to be stored (ton/year)
p : Peak ratio
R : Revolving frequency per year
a : Utilization ratio
w : Unit storage cargo volume per area (ton/m^2)

Annual cargo volume to be stored (W) is given based on the result of forecast cargoes in 2010, the standard of unit storage cargo volume per area (w) is proposed by the kind of cargo, utilization ratio (a) is usually 0.5-0.7 and peak ratio (c) and revolving frequency per year (R) are determined by the characteristics of the port.

Considering cargo volume delivered directly to/from the port, cargo volume stored in transit sheds and covered hangers is forecast as follows:

Table 4.6.26 Cargo Volume stored in Transit Sheds

	Case 1	Case 5	Case 9
Import Cargo (,000 tons)	1,290	1,590	1,800
Export Cargo (,000 tons)	140	140	140
Total (,000 tons)	1,430	1,730	1,940

Parameters in the formula are assumed as follows:

Peak ratio	: 1.1
Revolving frequency per year	: 24.0
Utilization ratio	: 0.6
Unit storage cargo volume per area	: 2.0

Maximum required scale of storage area for Case 9, the case requiring the largest area, is 74,100 m^2. In addition to that, the storage area for oil spill combat equipment is planned to be about 450 m^2. The total area of existing transit sheds and covered hangers is about 74,000 m^2 according to PC's data. So, in this case, storage area may be slightly insufficient. However, it will rarely cause any serious shortage of transit sheds because there are some means to deal with such a situation, for instance, by making efforts to acquire higher utilization of existing transit sheds and covered hangers or using open yards temporarily (since the fine weather conditions would seem to allow it).

As a result, expansion plan of transit sheds and covered hangers is not needed for all alternative cases.

Required area of storage for cargoes which are to be stored in open yards, that is to say, steel or iron, timber and car, is also estimated by a similar method. Since the port of Aqaba already has a large open yard behind berths, it is clear that additional space will not be required in 2010.

(4) Required Scale of Container Terminal

Container terminal should be provided with the following main facilities.

Container berth
Container yard
Container freight station (CFS)
Maintenance shop
Container cleaning space
Terminal Gate
Terminal office

The required number and dimensions of the above facilities are already proposed so that the remaining facilities will be examined here.

1) Container Yard

Required storage number of container at peak time is calculated by the following formula.

$$Ml = (My \times Dw \times p) / Dy$$

where Ml : Required storage number of container (TEUs)
My : Annual container throughput (TEUs)
Dw : Average dwelling time (days)
p : Peak ratio
Dy : Operating days per year (days)

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

$$Sl = Ml / L$$

where Sl : Required number of ground slots (TEUs)
L : Stacking height of container

Average dwelling time (Dw) is one of the most important factors, when the above formula is adopted. As mentioned many times, current dwelling time for both imports and exports is extraordinarily long, over 20 days for both cases, which leads to higher transportation costs, in particular, for shipping companies. If the port of Aqaba strongly desires to establish itself as a transit port, dwelling time has to be decreased to match levels at competing ports. In most developed ports, dwelling time is within one week more than 70 % of the time. From such a point of view, average dwelling time at the target year, 2010, is assumed as below:

Dw : 10 days for laden containers
: 7 days for empty containers

Annual container throughput (My) is given from the result of forecast cargo volume in 2010, peak ratio (p) may be thought to be similar at most container ports and operating days per year (Dy) may be the same as annual workable days mentioned in the section 4.6.3. So peak ratio and operating days per year are set as 1.3 and 351.

After comparing alternative systems, it is recommended that the trahsfer crane system be mainly introduced in the container yard. Considering transfer crane's capability, stacking height of containers (L) may be assumed on average below, (it can stack four layers high and six lines):

L : 3 for laden containers
: 4 for empty containers

Since 108 TEUs per layer is the standard container stacking block (six lines × eighteen rows), required number of container stacking blocks (Bl) can be calculated by dividing 108 into the required number of ground slots.

By substituting the above parameters into the formulas, the required number of container stacking blocks is as follows:

Table 4.6.27 Required Number of Container Stacking Blocks

Item	Case 1	Case 5	Case 9
Ml (laden containers)	7,945	8,015	7,845
Ml (empty containers)	5,056	5,186	5,186
Sl	3,913	3,969	3,912
Bl	37	37	37

The result shows that all alternative cases require 46 container stacking blocks.

2) Container Freight Station (CFS)

Required area of CFS is calculated by the following formula.

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

where A : Required area of CFS (m^2)
Mc : Annual handling volume of container cargo through CFS (tons)
Dw : Dwelling time at CFS (days)
p : Peak ratio
w : Volume of cargo per unit area (tons/m^2)
r : Utilization ratio of CFS
Dy : Operating days per year (days)

Annual handling volume of container cargo through CFS (Mc) is given based on the result of forecast annual container cargo volume. Mc of Case 1, 5 and 9 is about 230,000 tons for all three cases. Other parameters are assumed referring to values in similar container ports. Required area of CFS is as follows:

$$A = (230,000 \times 7 \times 1.3) / (1.5 \times 0.5 \times 351)$$
$$= 8,000\ m^2$$

The result shows that required area of CFS is smaller than the existing CFS (18,587 m^2) so that an additional plan is not needed.

3) Maintenance Shop

Required area of maintenance shop depends upon factors such as rate of damaged containers, kind, type and number of cargo handling vehicles and machines to be used in the terminal. In general, size of maintenance shop is 800 to 1,000 m^2 per berth. So maintenance shop of 2,000 m^2 is proposed.

4) Container Cleaning Space

For washing and cleaning of empty containers, container cleaning space should be planned at the container terminal. Container cleaning space of 1,500 ^{2} is planned in the Master Plan.

5) Terminal Gate

Required number of truck lanes is calculated by the following formula:

$$N = (Mc \times p \times s) / (Dy \times H \times 60)$$

where N : Required number of truck lanes
Mc : Annual container throughput (TEUs)
p : Peak ratio
s : Necessary procedure time per truck (4.0 min.)
Dy : Operating days per year (days)
H : Operating hours per day (hours)

Assuming that necessary procedure time per truck (s) is four minutes and then substituting the same values as mentioned previously into the above formula, required number of truck lanes for Case 5 , the case with the highest annual container throughput at the target year, is calculated as follows:

$$N = (416,400 \times 1.3 \times 4) / (351 \times 18 \times 60)$$
$$= 5.7$$

As a result, required number of truck lanes for all alternative cases is six by similar calculation.

6) Terminal Office

Terminal office is usually planned next to the terminal gate for management and operation of container terminal. In general, area of terminal office is 1,200 m^2 to 1,500 m^2 per berth. So terminal office of 3,000 m^2 is proposed.

(5) Protective Facilities for Harbours

As to calmness of basin, reference is made to "TECHNICAL STANDARDS FOR PORT AND HARBOUR FACILITIES IN JAPAN", which states:

"A basin in front of a pier should secure the calmness to allow mooring for days corresponding to 95 to 97.5 % or more of the year (of each season, too, when the seasonal variation of calmness is extreme). However, this may not apply when the frequency of

mooring is low and when special mooring rules have been established."

Judging from the weather conditions in the Gulf of Aqaba, it is thought unnecessary to plan a breakwater even for small water basin in the Master Plan.

4.6.5 Cargo Handling System

As described in the above 4.6.2 and 4.6.3, berth capacity and required number of berths are determined not only based on average cargo handling productivity of ship operation, but also on total cargo handling system including the arrangement of appropriate berth, cargo storage and cargo handling equipment.

In this connection, an investigation of the cargo handling system by cargo type is executed.

(1) Phosphate

Two phosphate loaders with choke feeders are installed in Berth B and each loader capacity is 2,000 tons per hour. Although loading productivity by these loaders is estimated at about 40,000 tons per day, actual productivity depends on conditions of phosphate stock pile.

There are 6 stock pile stores, capacity 410,500 tons, for phosphate rock nearby the berth and according to PC, nearly ten kinds of phosphate qualities will be produced in near future for export which will further complicate the stock operation.

If the improvement of total operation system including berth and stock pile could be achieved, one berth ,existing Phosphate Berth B (New Phosphate Berth), would be sufficient for exporting all phosphate rock in bulk, even if cargo volume will have doubled by the target year, 2010.

The capacity of storage facilities is calculated using the following formula ;

Mb = (Cw x Rt x r) / p
Mb ; Capacity of storage facilities per year (tons / year)
Cw ; Capacity of storage facilities (tons)
Rt ; Turnover ratio (times / year)
r ; Utilization ratio (0.7)
p ; Peak ratio (1.3)

Mb = (410,500 tons x 40 times x 0.7) / 1.3
= 8,840 thousand tons / year

As a result, assuming turnover of phosphate rock in the stock pile is more than 40 times per year, capacity of existing storage facilities will be sufficient, even in Case 1 and Case 5 in the target year. In other words, the turnover is the most important element to improve total operation system.

Existing Old Phosphate Berth (Berth A) will be utilized for the vessels of vegetable oil, bunkering and general cargoes as it is now in Case 5 and 9 in the target year.

(2) Grain

Grain unloading operation mainly consists of berth productivity and shore condition to receive cargo. As described in the above 4.6.2, two systems to discharge grain were suggested in order to improve productivity. One is the utilization of 3 unloaders and the other is of 7 evacuators.

The grain handling system is analyzed as follows ;

1) Operation at specialized grain berth

As mentioned in the above 4.6.2, the capacity of railed pneumatic unloaders will be required to be more than 800 tons per hour to cover 2 million tons per year.

First capacity of existing grain silos is calculated ;

Mb = (Cw x Rt x r) / p
= (150,000 x 25 times/year x 0.7) / 1.3
= 2,019 thousand tons per year
Cargo dwelling days = 365 days / 25 times = 15 days

As a result, existing capacity of silos is just enough in the target year under the condition that capacity of unloaders and conveyor connecting with silos is more than 800 tons per hour, and cargo dwelling days are the above 15 days.

2) Operation at general cargo berth

In this case, grain is usually unloaded directly on trucks by as many evacuators as possible placed on the deck of vessel. To achieve high productivity, trucks must be always ready for cargo to be received at ship side.

For instance, required number of trucks is calculated according to the following conditions.

- To use 7 evacuators (7 gangs) at 7 hatches
- Designed capacity of evacuator ; 100 tons per unit
- Load capacity of truck ; 30 tons per truck
- Working hours per day ; 2 shifts (8 hours) + two hours overtime

Bp = Qn x En x Nn
= 100 tons x 0.7 x 1 unit = 70 tons / gang

Qd = Bp x Hd x Ew
= 70 tons x 18 hours x 0.8
= 1,008 tons / day - gang

Qd7 = Qd x 7 gangs
= 7,056 tons / day
Required number of trucks = Qd7 / 30 tons
= 236 trucks per day

As a result, unless 236 trucks could be prepared in time for cargo to be unloaded, berth productivity of over 7,000 tons per day could not be attained.

Cargo handling productivity can be improved by appropriate coordination with shore arrangement as mentioned in the above 1) and 2).

(3) General cargo

Cargo volume of general cargo in the target year is forecasted as 4.34 million tons in Case 1, 3.33 million tons in Case 5 and 2.54 million in Case 9. It is 1.45 times in Case 1, 1.11 times in Case 5 and 0.85 times in Case 9, compared with that in 1993. Case 1 which has the largest volume of the three cases is analyzed below.

1) Basic concept of cargo handling system

- Cargo operation should be basically commenced on vessel arriving by preparing attending gangs and necessary equipment in advance.

- Heavy hatch by which large cargo volume is loaded should be attended by at least 2 gangs and completion of each operating hatch should be simultaneous as much as possible.

- Discharged cargo should be stored in the storage near the related berth.

- Cargo handling equipment such as tug master with flat bed chassis, trucks and forklifts should be always ready for cargo to be discharged at shipside.

- Some of discharged cargoes assigned for a storage near the related berth should be carried by forklifts directly to the storage without using tug master with chassis in order to minimize number of equipment and improve handling productivity.

- Cargo handling gears should always be in good condition; the safety factor should be considered prior to their utilization to avoid any accident.

2) Number of tractor and trailer

Towing tractor (hereunder called tractor) with trailer is usually used for general cargo operation in the Main Port, while some tug masters with low bed chassis also is used for storage area on high hill. This study is excuted regarding to number of tractor with trailer.

The handling productivity of bagged cargo to be discharged is calculated as follows ;-

$$Bp = W \times Np \times Cy \times Ng \ / \ hour$$
$$= 50 \ kgs \times 36 \ bags \times (60/2)$$
$$= 54 \ tons \ / \ hour \ / \ gang$$

The round trip time of tractor between a related berth and storage shed is examined as follows ; -

Speed of tractor ; 10 km / h
Average distance between berth and storage ; 750 meters

Load capacity per tractor with trailer ; 25 tons

Round trip time of tractor = (0.75 km x 2 x 60 minutes) / 10 km
= 9 minutes
Required time to connect/release trailer at quay and storage area = 6 minutes
Productivity of tractor per hour = 25 tons x (60/15)
= 100 tons /h
Number of gangs capable to be covered by one tractor per hour = 100 / 54
= 1.85
Required number of tractor for five gangs per hour = 5 / 1.85
= 2.70 < 3 tractors

As a result, three tractors is capable to attend more than 5 gangs. In other words 3 tractors will be sufficient for one vessel operation to be attended.

In case of steel products, as the number of gangs to be used may be usually fewer than of bagged cargo, three tractors will be enough for one vessel operation.

In conclusion, when five vessels are operating at five berths in the Main Port, 15 tractors will be required for ship operation. Therefore, total required number of tractors will be expected to be about 25 units because they must attend shore operation and require maintenance.

Three times as many trailors will be required as tractors, because they will also be engaged in stuffing / unstuffing cargo operation in the storage area.

(4) Livestock

The details of this cargo is described in Chapter 5.4.

(5) Container

As mentioned in the above 4.6.2, container operation system in the Container Terminal must be improved to cope with the future increase of container cargo volume. Therefore, the new operation system is introduced as follows ; -.

1) Facility of Container Terminal

There are many handling systems at container terminals throughout the world such as straddle carrier system, transfer crane system, chassis system, and combined system. The comparision of these systems is as follows.

Table 4.6.28 Comparision of Three Container Handling System

	Item	Stradle Carrier System	Transfer Crane System	Chassis System
1	Basic operation of Handling equipment	Stradle carrier	Combined with shassis /transfer crane	Chassis
2	Mobility	Large	Small	Large
3	Investment	Medium	Large	Large
4	Space efficiency	Medium (3 level stack)	High (More 3 level stack with small clearance)	Small (1 level stack)
5	Safety	Worse (High skill driver)	Better (Depending on traffic control)	Best (Easy to control traffic)
6	Container carrying distance, in and out	Long	Short	Long
7	Flexibility of yard positioning	Better	Worse	Best
8	Work force	Small	Small	Medium
9	Heavy pavement	Required	Partially required	None
10	Safety of container against damage	Worse	Better	Best
11	Maintenance rate of equipment	Large	Small	Small
12	Probability of damage at Gate	Large	Medium	Small
13	Noise	Noisy	Quiet	Less noisy
14	Safety within container yard	Dangerous	Safe	Less dangerous
15	Fatigue of driver	Large	Small	Medium
16	Follow-up to G. Crane capacity	Possible	Difficult	Possible
17	Container shifting	Medium	large	None

From operational and economical viewpoints, the following facilities based on the utilization of transfer crane are introduced.

a) Number of berths

- Two berths with 600 meters in length for two Panamax container vessels

In this connection, berth must be extended by 60 meters in length because existing berth is 540 meters. Considering the trend of future container service, it is necessary that berth specification will be planned to accommodate Post - Panamax type as well as Panamax type.

b) Container equipment

- Number and type of transfer cranes

10 transfer cranes
Rubber - tyred transfer crane
Four stacks and one over
Six lanes for stacking containers and one lane for vehicle traffic within its span

The ratio of transfer cranes, to gantry cranes is usually 3:2 due to the difference in handling productivity, therefore six transfer cranes are required for four gantry cranes, while remaining four are for yard operation.

- Four gantry cranes

As two gantry cranes are already equipped at the port, additional two cranes must be installed after the completion of berth extension. At least one of the new cranes should be the fourth generation gantry crane for Post (Over) Panamax container vessel.

- Number of tug masters and chassis

Number of tug masters and chassis for vessel operation depends on the handling productivity of gantry crane. The following study is achieved regarding the number of tug master in attendance on vessel operation.

- Speed of tug master ; 15 km / h
- Average distance of round trip between related gantry crane and transfer crane ; 1,000 meters
- Operation time for tug master by Gantry crane ; 3 minutes
- Operation time for tug master by Transfer crane ; 5 minutes
- Handling productivity of gantry cranes ; 20 boxes / h = 3 minutes / box = Gp

Required time per round trip ; Rt = (1.0 km x 60 minutes)/15 + 3 + 5 = 12 minutes
Required number per gantry crane = Rt / Gp = 4 tug masters / crane.
Required number for four cranes = 4 x 4 cranes = 16 units

As a result, at least 16 tug masters with chassis will be required for vessel operation. Otherwise, another 10 units will be required for CFS and yard operation. In conclusion, total required number of these units is 26 units for container operation in case of this study.

- Other container equipment

There are presently 9 straddle carriers and 16 container top lift handlers.
Although they should be utilized basically for CFS and yard operations, it will be necessary for them to assist transfer cranes on vessel operation, when two vessels are loading / unloading containers with four gantry cranes.

2) Container operation system

The following basic methods of container operation in regard to the new system are recommended.

a) Calling container vessels must make fast berth on her starboardside alongside.

b) 4 tug masters with chassis and 1 or 2 transfer cranes will be engaged in vessel operation for each quayside gantry crane.

c) Tug master traffic circle should be made clockwise for vessel operation and anti-clockwise for yard operation separately for the purpose of smooth traffic in the container yard. On the other hand, the door of stacked container in the yard will usually face to the north.

d) Trucks which are arranged by shipping agents will come alongside related transfer crane to load imported container or to unload exporting container, according to the instruction of Container Control Center. These trucks should move anti-clockwise in the container yard.

e) Imported and exporting LCL containers are carried by tug masters with chassis between container yard and CFS.

f) Special containers such as reefer, overheight, oversized and dangerous cargo containers are carried by straddle carriers or top lift handlers into specialized area.

g) Container position to be stacked in the yard should be decided by computer.

(See Figure 4.6.1)

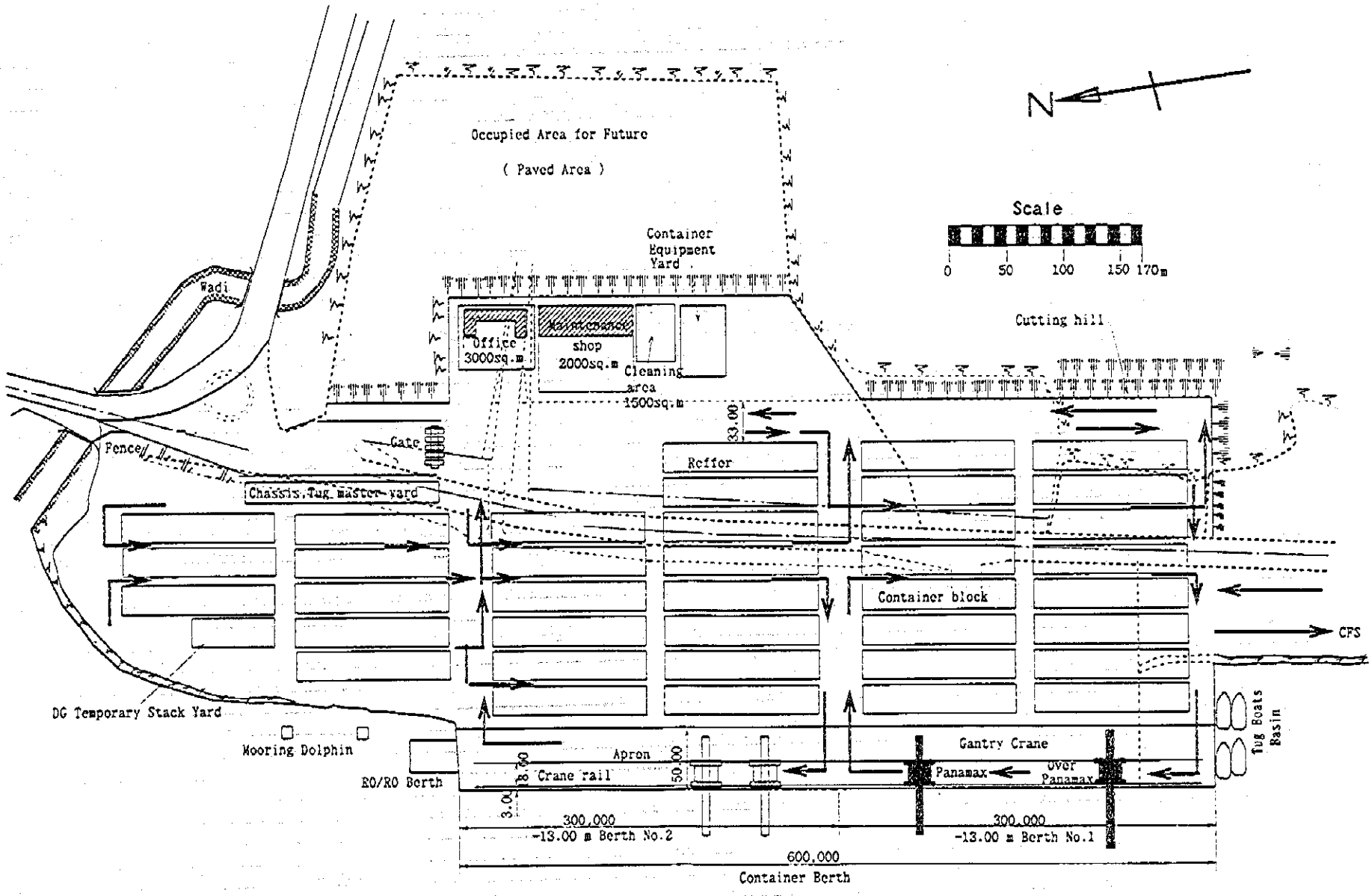

Figure 4.6.1 Container Operation System

4.6.6 Safety Back-up Facilities

(1) Tugboat

Large ocean-going vessels, over 10,000 DWT class, are apt to face difficulty in maneuverability of the main engine and the rudder. A tugboat to assist the vessel, particularly, in the final phase of the manoeuvering, is indispensable as the lateral and turning force source. So the port of Aqaba will need to have a capable tugboat fleet to secure safe and efficient port operation.

According to accepted wisdom, the total necessary towing (pushing) force to move the vessel athwart ships is given by the empirical formula below (See Figure 4.6.2):

Total Towing Force (ton) = (DWT of vessel / 100,000 × 60) + 40 (ton)

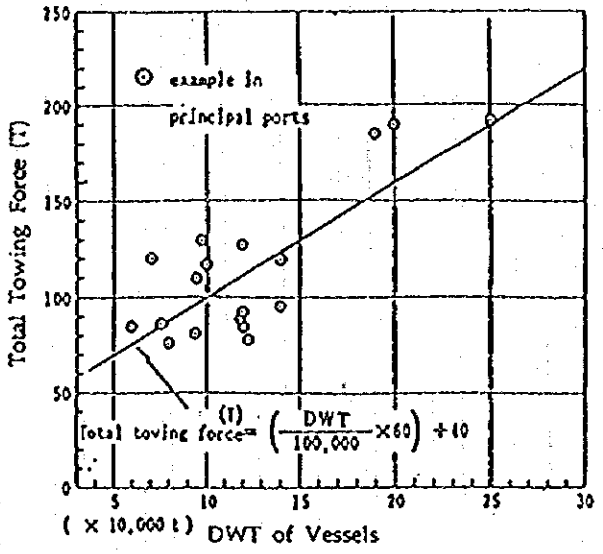

Figure 4.6.2 Total Towing Force to Vessel Size

The towing force (ps) of a tug boat by propulsion type per 100 ps is given in Table 4.6.28.

Table 4.6.29 Towing Force of Tugboat by Propulsion Type

Propulsion Type	Towing Force / 100 ps
F.P.P	1.1
F.P.P nozzle	1.3
C.P.P	1.3
C.P.P nozzle	1.4
V.S.P	1.0
Z	1.3

Based on the above relation and then categorizing forecast calling vessels by vessel size, required towing force and number of tugboats are as follows:

Table 4.6.30 Required Towing Force and Number of Tugboat by Vessel Size

Vessel Size (DWT)	Total Towing Force (ton)	Towing Force of Tugboat (ps)	Number of Tugboat
200,000	160	3,000	4
50,000	70	3,000	2
40,000	64	3,000 2,000	1 1
30,000	58	2,000	2
20,000	52	2,000	2

Forecasting calling vessel size to each berth at the target year, required tugboat fleet is estimated as follows:

Table 4.6.31 Required Tugboat Fleet by Each Berth

		Main Port (No.1-3)	Main Port (No.4-7)	Phosphate Berth	Mo'ta Mosh	Container Berth	Oil Berth	JFI Berth
Case 1	2,000 ps 3,000 ps	- 2	1	2 2	2	- 2	2 4	2
Case 5	2,000 ps 3,000 ps	- 2	1	2 2	2	- 2	2	2
Case 9	2,000 ps 3,000 ps	- 2	1	2 2	2	- 2	2	2

However, the required number of tugboats is not obtained by simply adding up the figures in the above table. Time necessary to assist vessels can be thought as about one hour. So a tugboat can usually serve three or four times a day. Considering such a common use condition and anticipated calling frequency by kinds of vessels which need tugboats in a practical sense, required number of tugboats is as follows:

Table 4.6.32 Required Number of Tugboat Fleet

	Case 1	Case 5	Case 9	Remarks
2,000 ps	3	3	3	In the existing fleet, two tugboats of 3,200 ps and two of 800 ps are considered capable at the target year.
3,000 ps	4	3	3	

The difference between required and existing workable number of tugboats is the number to be introduced at the target year. Towing force of two tugboats of 800 ps can be regarded as that of one tugboat of 2,000 ps. Therefore, purchasing scheme of tugboats

is as follows:

Two tugboats of 2,000 ps for all alternative cases
Two tugboats of 3,000 ps for Case 1 and one for Case 5 and 9

In 2000, the target year of Short-Term Improvement Plan, almost all existing tugboats will function provided regular maintenance is carried out.

A base at which increased tugboat fleet can moored should be studied. The distance between Main Port and Industrial Port is about ten miles, less than one hour navigation by ordinary speed. Taking into consideration acting areas of tugboats, it is desirable to secure additional base. Judging from water supply, oil supply, convenience for crews to commute and so on, it is thought appropriate that main base be set at Main Port and additional sub base be around Container Port.

(2) Radar

As mentioned in "Identification of Problems", there is no radar at the port of Aqaba. The depth of the Gulf of Aqaba sharply increases offshore. Because of this bathymetric condition, many vessels are presently waiting for berthing without anchoring. With more cargoes to be handled, more vessels will call. Although there are not serious problems such as vessel drift, ensuring vessels' safety and avoiding emergency situations is one of the most important issues.

The port of Aqaba has a good place to install radar system and make best use of it. That is the Port Control Tower. Therefore, radar system with computerized vessel traffic management will be introduced.

4.6.7 Other Infrastructures and Utilities

The number and scale of major facilities for the Master Plan have been decided. In addition to these facilities, other infrastructures and utilities are necessary to operate and manage the port since berth extension, development, relocation project and increase of port activities are expected in future. These main infrastructures and utilities are shown below while construction costs are estimated later.

Power supply cable and lighting
Water supply pipeline
Oil supply pipeline
Sewage treatment pipeline
Drainage

4.7 Proposed Master Plan

4.7.1 Basic Concept

In examining layout plan of port facilities, attention should be given to the following matters to ensure that:

1) various demands in regard to port activities are met
2) port area (land, sea space and waterline) is utilized efficiently and properly
3) conflicts with natural, geographical, meteorological and sea conditions do not arise
4) port functions necessary to support various port activities are well organized
5) optimum use can be made of related port facilities and equipment
6) port safety is secured and emergency and disaster situations will be unlikely to occur
7) the environment in and around port area is not neglected
8) operation, management and maintenance of port facilities are conducted smoothly
9) space for future expansion is available

Previous discussions on the functional allotment of port activities and alternative sites for the port development sufficiently took the above matters into account. Detailed layout plan will be, therefore, proposed in accordance with the conception of functional allotment and site selection, considering the following items in addition to the above matters.

1) To make best use of as many existing facilities and as much equipment as possible
2) To examine quantity and location of construction works in order to keep construction costs as low as possible and also to grasp the environmental impact

4.7.2 Layout of Facilities

Facilities described here are berths at Main Port and Industrial Port and berths, container yard and other attached facilities at Container Port. Planned facilities differ according to the three alternative cases. In cases where existing facilities are to be retained and extension berths are not required, no layout plans are prepared.

Main Port

Planned berths by major commodities to be handled at the target year, 2010, are as follows:

Table 4.7.1 Planned Berths by Major Commodities

	Phosphate	Grain	General Cargoes & Vegetable Oil	Remarks
Case 1	Existing (8) Berth	one berth (L:280 m, D:14 m)	one berth (L:240 m, D:12 m), five berths (L:170m×5=850 m, D:10 m) & one berth (L:130 m, D:7.5 m)	Existing berth length from No.1 to No.6 is 1,060 m and that of No.7 is 150 m. Maximum berth depth is 12.5 m.
Case 5	Existing (8) Berth	one berth (L:280 m, D:14 m)	one berth (L:240 m, D:12 m), three berths (L:170m×3=510 m, D:10 m) & one berth (L:130 m, D:7.5 m)	ditto
Case 9	Existing (8) Berth	one berth (L:280 m, D:14 m)	one berth (L:240 m, D:12 m) & three berths (L:170m×3=510 m, D:10 m)	ditto

Judging from the required number of berths for phosphate, it is not necessary to retain the existing Phosphate Berth (A). However, since vegetable oil, bunker oil, etc. are presently handled at Berth (A), it is desirable for Phosphate Berth (A) to be retained unless it will obstruct another usage in future. Comparing required berths at the target year with the existing berths (No.1 to No.7), Case 1 needs a new extension berth while Case 5 and 9 do not. Therefore, new extension berth is planned only in Case 1.

It is thought appropriate that the new berth is extended southward from the No.1 berth, taking into account its expected function and cargo handling and storing system. This means that the new extension berth is to be constructed at the place of Berth (A).

There are two alternative layout plans with regard to the new extension berth, depending on where the largest berth (berth length: 280 m, berth depth: 14 m for 50,000 DWT grain vessels) will be located. In one alternative, the largest berth will be secured at the place where the existing general cargo berths are currently located by deepening. Although the probable site for the largest berth is presently thought to be at Berth No.1 and No.2 so as to utilize existing discharging equipment, the final selection will be made considering results of coming site investigation and after gaining more information about implementation and operation. In this case, based on the idea that the easiest way to enlarge (deepen) the existing berth is to move the existing berth face line ashore, the structural design would require the quay line to be moved 2 m ashore, and thus the quay line connecting the existing berths would not be straight. In the other, the largest berth will be constructed at the place where Phosphate Berth (A) presently exists. Both alternatives require reallotment of cargo handling system.

Two alternatives are shown as follows (Figure 4.7.1 and 4.7.2). In these figures, new berth names by relocation and planning are shown in gothic by comparison with the existing facilities. Such indications are made in similar figures later.

Comparing the two alternatives, Alternative 2 is thought to be slightly better for the following reasons:

1) The quay face line for Alternative 2 is straight from the existing berths to extension berths while that for Alternative 1 is not, being 2 meters ashore from grain berth to southward berths.

2) Alternative 1 divides general cargo berth by grain berth while berth assignment of Alternative 2 is continuous.

Layout plans for Case 5 and 9 are the same. The only difference is that the former includes the existing Berth No.7 for general cargo berth while the latter doesn't. They are shown in Figure 4.7.3.

As to the place of the largest berth of both cases, too, final decision will be made after site investigation and other technical and operational eximinations, etc..

Container Port

The scale of berths required at the target year means that 60 m extension of container berths is necessary. The need for efficient cargo handling should be considered when determining the extension direction. Based on layout of current and future possible container

yard, CFS and existing Ro-Ro berth, it is appropriate for the container berths to be extended southward.

The layout of container yard is examined from various points of view such as smooth, efficient and safe movement of containers, computerization of container handling, good operation and management, construction cost and so on.

The proposed layout plan of container terminal is shown as follows (Figure 4.7.4).

As mentioned before, the existing passenger berths are over 540 m from the passenger halls so that berth replacement plan has been discussed by relevant authorities. While this situation undoubtedly inconveniences many passengers, the replacement plan is not proposed for the following reasons:

1) According to a relevant report, The Ports Corporation assigned a consultant to make a technical study on a new passenger berth and the report was presented to PC in 1988. The consultant reportedly proposed that new passenger berth was to be constructed with permanent structure near the existing passenger terminal to handle some cargoes as well as passenger and that the existing passenger berth was to be relocated to serve as another cargo handling berth. Regretfully, the report is not currently available so that basic conception (perspective of number of passenger, cargo handling volume, calling vessel size and their frequency, etc.) cannot be provided.

2) Although passenger traffic volume through the port of Aqaba has been increasing, it is uncertain whether this trend will continue in the long term. With the progress being made in the peace process in the Middle East, land transportation between Jordan and Egypt via Israel may possibly be opened. Bus service will be a strong competitor for ferry boat service by virtue of the lower fares, as Arab Bridge Maritime Company recognizes. Under such a situation, it is better to be prudent to prevent over-investment.

3) According to the results of required number of passenger berths, the existing berths will be able to meet the forecast future demands for passengers as well as vehicles.

4) If construction of a new passenger berth and relocation of the existing berth will be implemented outside the framework of the proposed Master Plan, cargo handling productivity will be increased. Port capacity would be raised to a level beyond that required at the target year. Implementation of the above projects would thus become incompatible with the Master Plan as over-investment world occur.

5) It is said that the replaced passenger berth will be located opposite the existing passenger terminal. Facilities to be constructed must not adversely affect the environment because there is a good coral colony. Therefore a thorough field investigation to examine the environmental ramifications of the passenger berth plan should be conducted. Site investigation on environment for the Short-Term Improvement Plan, contents of which were determined through consultation with PC, does not include a survey of this area.

6) In order to provide passengers with more comfort, covered corridor connecting passenger halls and berths with air-conditioned system can be equipped. Introduction of the system is thought appropriate in future, especially, if the number

of passenger continues to increase.

As a result, other than container berth, port facilities at Container Port will remain unchanged.

Industrial Port

An additional berth for fertilizer-related cargoes and potash will be required for all alternative cases and a tanker berth to accommodate 250,000 DWT class vessels will be required for Case 1.

Considering the function of both berths, their structure must be dolphin type, as mentioned in detail later. The location of both berths is decided taking into account bathymetry, soil condition and distance between berths and land area.

Improvement of JFI. 1 Berth (the Timber Berth) will be proposed for all cases based on the result of berth requirement.

The proposed layout plan is shown as follows (Figure 4.7.5).

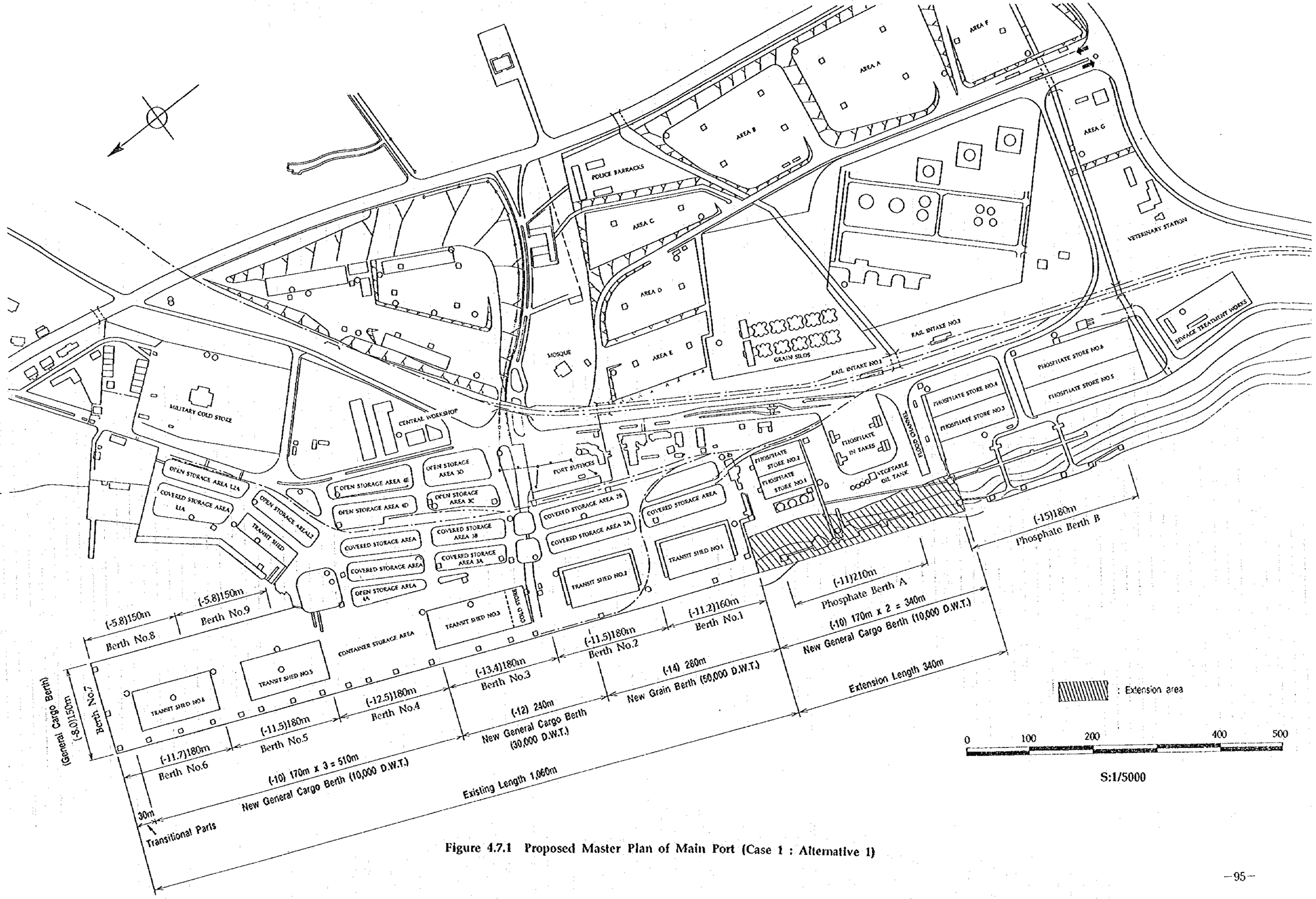

Figure 4.7.1 Proposed Master Plan of Main Port (Case 1 : Alternative 1)

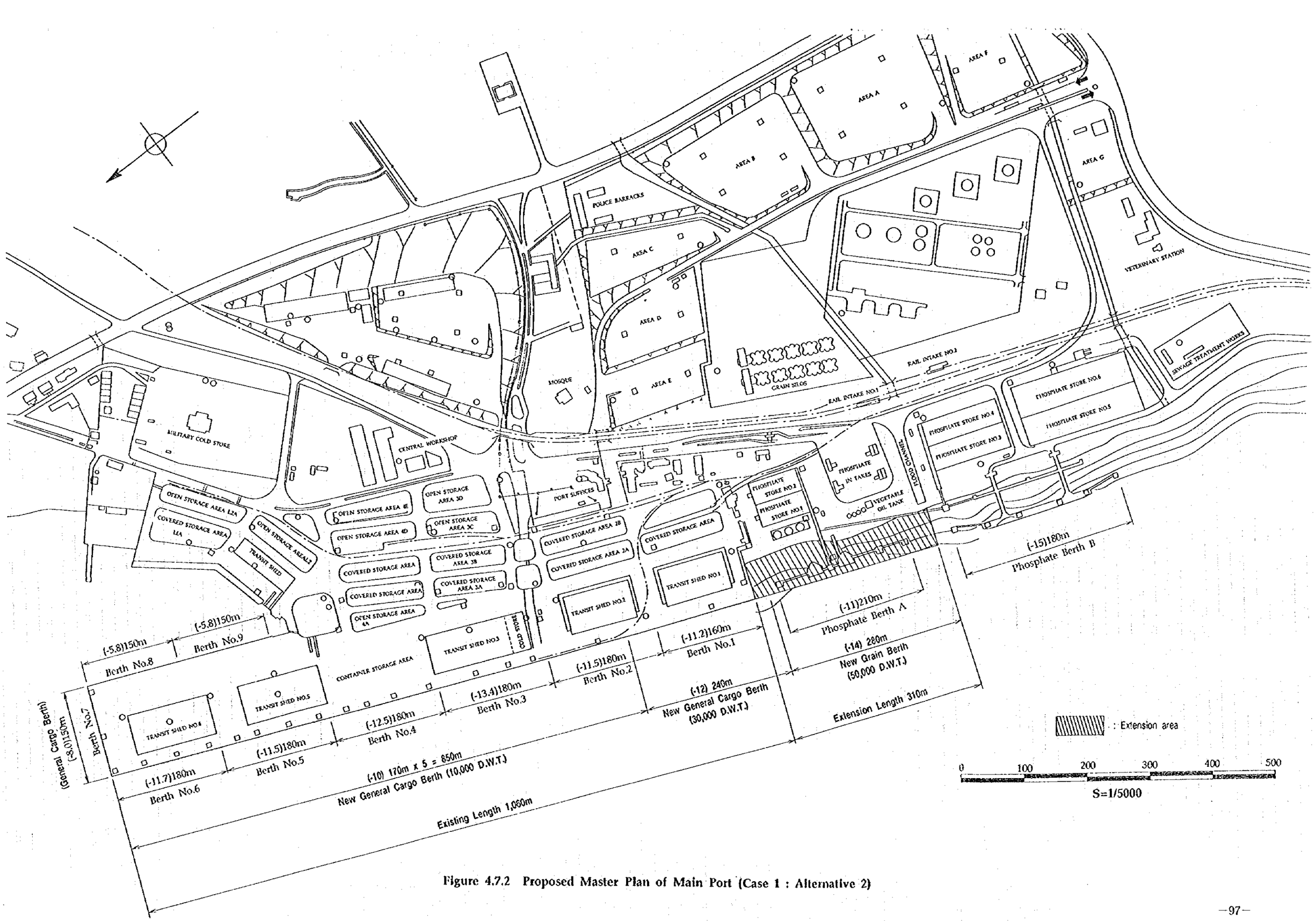

Figure 4.7.2 Proposed Master Plan of Main Port (Case 1 : Alternative 2)

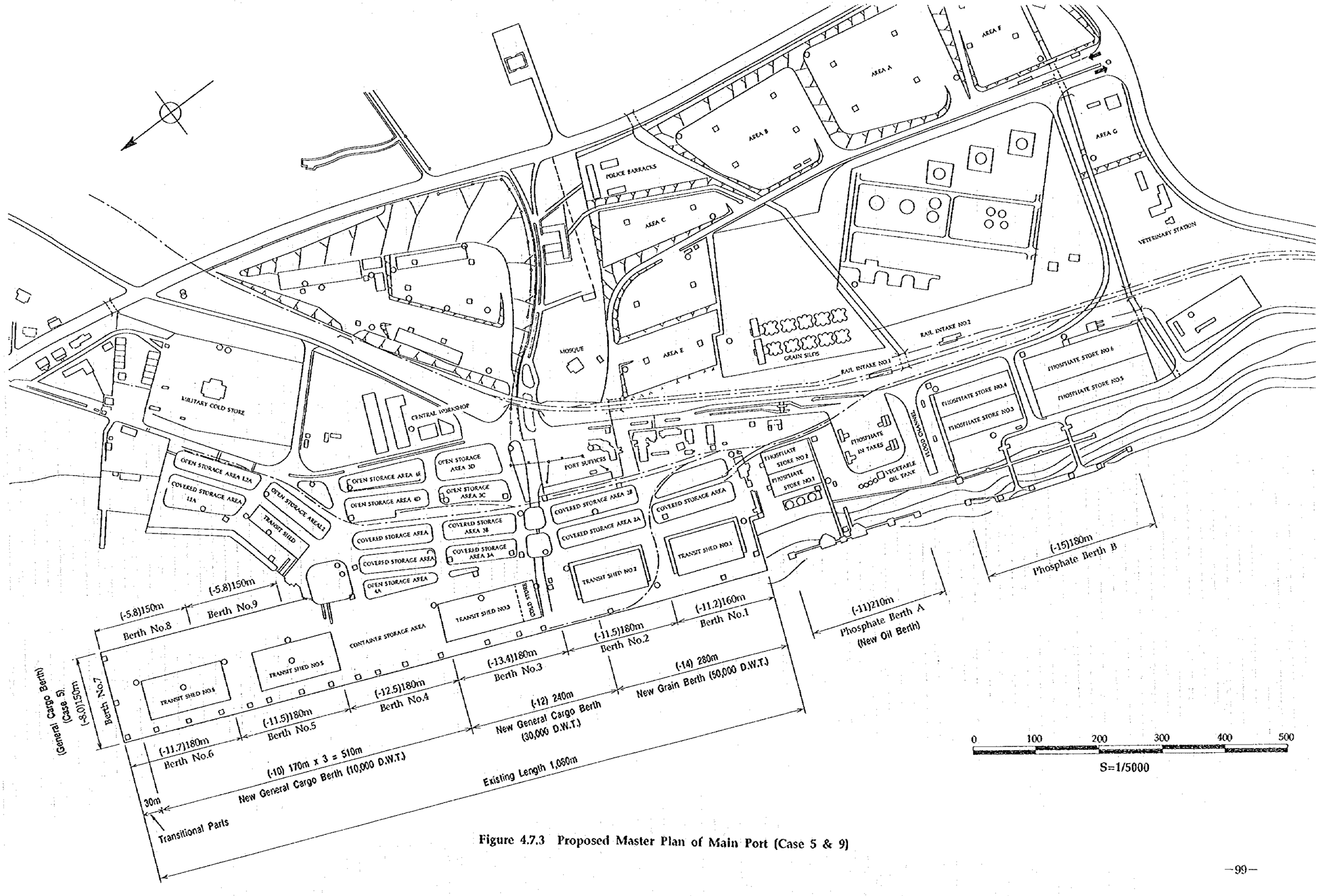

Figure 4.7.3 Proposed Master Plan of Main Port (Case 5 & 9)

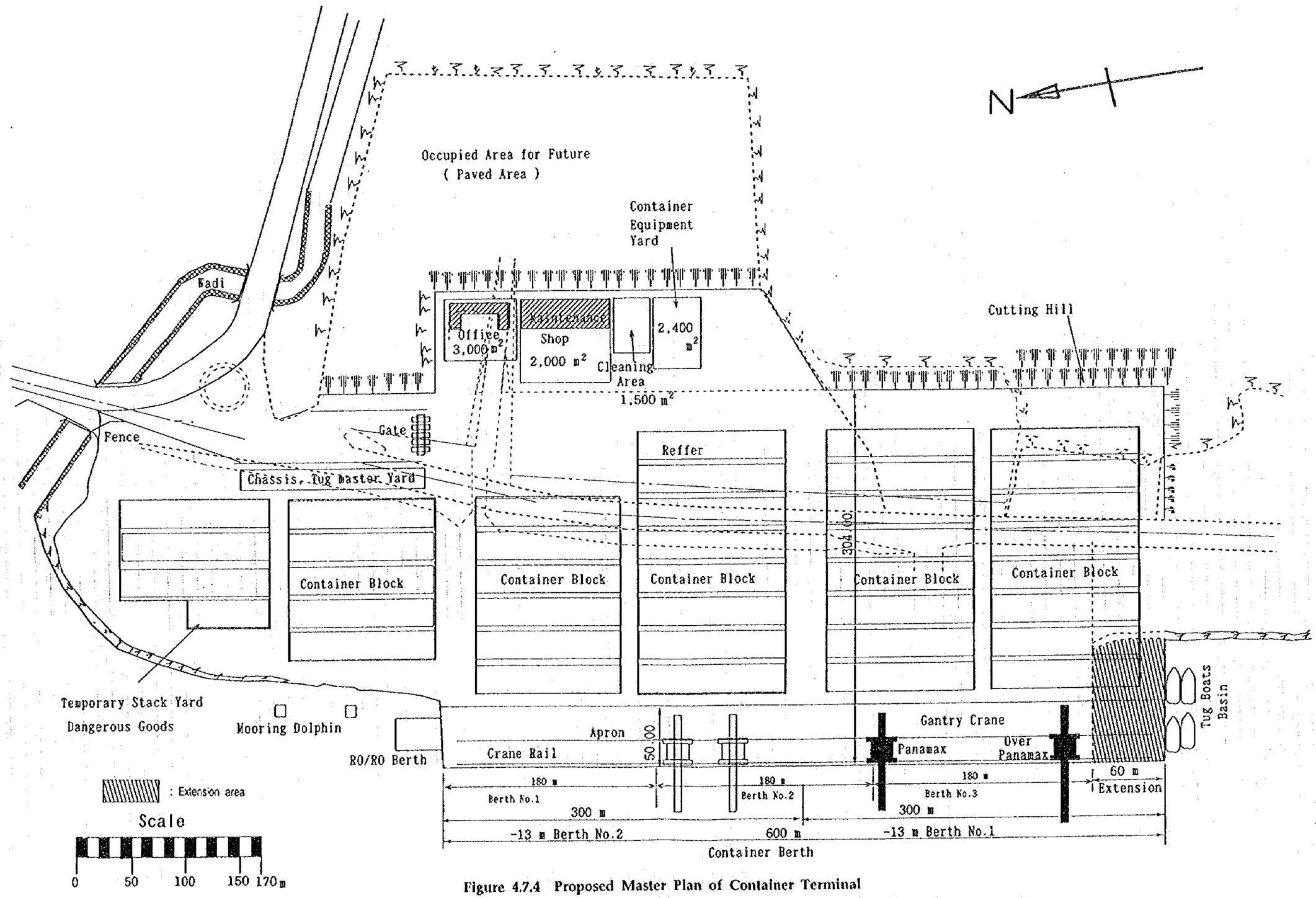

Figure 4.7.4 Proposed Master Plan of Container Terminal

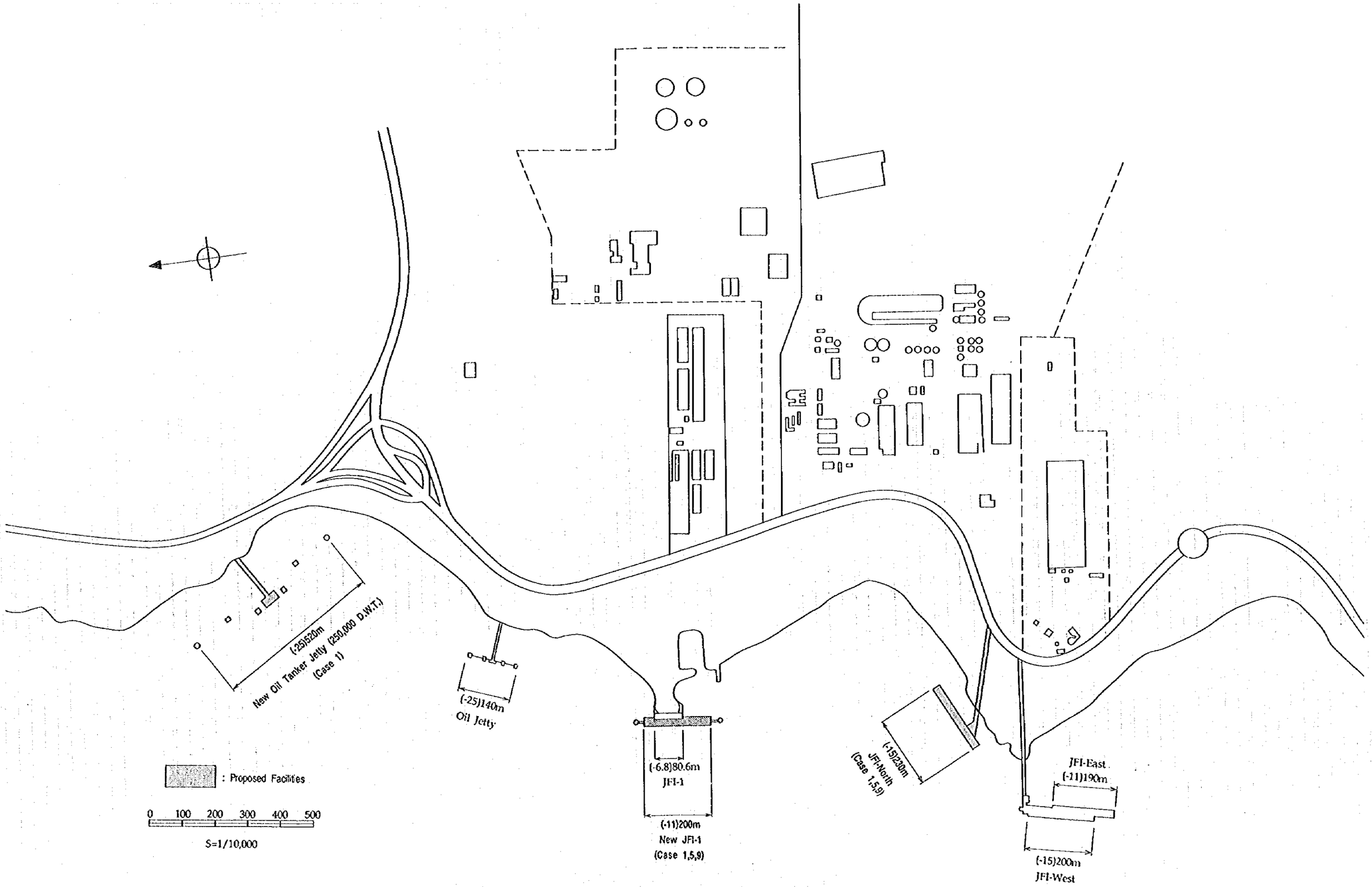

Figure 4.7.5 Proposed Master Plan of Industrial Port

4.8 Information System

4.8.1 Electronic Data Processing

Many kinds of computer systems are used in highly integrated business and scientific fields. A computer is a machine that can perform logical, arithmetic, and data processing operation, and can also record a huge number of data and results for immediate or future reference.

In proportion to the development of electronic technology of semiconductor like IC and LSI, computer business and science has been growing and growing day by day. Main frame computers, servers, work stations, personal computers, high speed printers, and combined systems are also evolving.

By using a computer system, it is now possible to process a large number of data and information in a short time span. Integration of computer system means that computer can process many jobs and tasks much more quickly and correctly than manual process, and integrated computer systems are being used in many offices and organizations. Modern integrated computer system is very useful as a means to save time and manpower in daily routine works and jobs.

4.8.2 Strong and Weak Points of Computer System

A computer system has the following strong and weak points;

High speed processing at electrical speed
High quality of accuracy
Capability of processing of large number data
No thinking power

A computer system can process and calculate a large number of data and arithmetic formula in a very short time. When data is input accurately, and software is programmed correctly for computer user, a computer system can process, calculate and output all necessary data in a moment.

However, as a computer system has no capability for logical thought, when data is input inaccurately, or software is programmed incorrectly, a computer system will proceed notwithstanding. Naturally output data will not be correct.

It is laborious to make a program for an individual task or job initially, and to input all data correctly and perfectly. Initial troubles that are caused by mistakes of programming can not be avoided. Initial trouble caused by mis-programming, so called "bug", should be amended and corrected according to trial operation and daily operation.

4.8.3 Preparation for Computerization

A computer system is a only combination system of electronic equipment such as main frame computer, server, keyboard, and printer. As described above, computer system has no ability to think by itself; computer operator and user must make program appropriately for their needs and conveniences.

The daily routine work should be systemized as tasks and jobs of computer system. To operate computer system usefully and conveniently, it is very important to analyze the daily routine works prior to introduction.

As described in the progress report, following items are required for the preparation of computerization;

List of all paper works which are processed as daily routine work
List of all daily office work procedures
List of all current data which are input and output by hand writing
List of all necessary data are required by computer user

After putting these data and procedures in order, the computer system and program can be designed.

4.8.4 Computer System

A computer system means the total system of computer hardware and it's operating software. The arrangement and combination of computer hardware should be determined to complement design details after preparing and studying current procedure of daily works. There are many items to be studied for each piece of equipment.

Main frame computer
- Capacity of main memory
- Capacity of cache memory
- Access time
- Cycle time
- Operating software

Storage device
- Magnetic drum
- Magnetic disk(Hard disk)
- Flexible disk(Floppy disk)

Printer
- Impact serial printer
- Non-impact serial printer
- Impact line printer
- Non-impact line printer

Reader
- Magnetic disk reader
- Flexible disk reader
- Optical character reader
- Optical mark reader

Display
- Character display(Cathode ray tube)
- Graphic display

4.8.5 Programming

There are many programming languages for a computer system. Each language has its characteristic for the purpose of hardware or process.

Fortran····· Science technology
Algol····· Science technology
Cobol····· Office process
Pascal
C

As the language of UNIX operating system, language "C" is mainly used as a common language.

The typical procedure of self-development programming design is as follows;

Unity of intention
Study of the interior design of the organization, and confirmation of an indispensable condition for dividing of the program to module.

Constructional design of programming
Dividing of the program to module. Processing this work step by step, and programming will be storied to constructional way.

Logical design of module
Module specification and test specification
Dividing of each module to some pieces of segment and part, and making of processing procedure inside of module.

Specification of programming design

Design review

4.8.6 Packaged Application Software

There are two ways for a development of computer programming. One is development of computer programming privately, and the other is a purchasing and arrangement of packaged application software.

There are many kinds of packaged application software in the market, for example;

Operating software
Assistant software for development of programming
Mapping software
Word processor software
Data base software
Scientific software
Engineering software
Business package software
Accounting
Salary payroll

Financial affairs
Inventory control of goods
Personnel affairs

Packaged application software is very useful to introduce computer system into non-computerized office and organization. The market price of software is proper and not so expensive. Especially, from view point of required time of self-development, computer operator can minimize and save the time for development of their programming.

On the other hand, packaged application software has not so much flexibility to meet the exact requirements and needs of computer user. Packaged application software is designed and programmed to be in conformity with wide needs of unspecified user.

4.8.7 Computer System of PC

(1) Computer System of PC

There is, at present, a large volume of works and jobs which are processed as a daily routine work at PC. Almost all of these works and jobs can be systemized and computerized, but the total volume of these target objectives for computerization is large and cover a wide range of tasks.

These objectives of computerization can be classified to two categories. One category is calculation process of many data, such as port charge, stevedoring charge, storage charge, employee payroll, accounting and financial affairs, and so on. The others is data base process, such as inventory control of port state control, registered vessel, cargo handling equipment, spare parts, and so on. Some tasks and jobs are mixed with calculation and data base process.

Calculation process sometimes needs and requires rather complex system or program. To clarify and simplify the process, preparation for computerization is very important as described in the progress report and 4.8.3.

At PC there is a large number of jobs and tasks which are required to be computerized as data base. The process of data base is no so complex, but it requires time to complete inputting all necessary data.

(2) Procedures for Computerization of PC

PC intends to introduce a computer system in their business to increase economic efficiency of their daily works and operation, provide good service and keep close communication with the customers.

The jobs, works, form of documents and procedures are different from Department to Department Each Department manually prepares documents containing necessary data, but these documents aren't circulated which makes coordination difficult.

Each Department seems to have some independent ideas for their computerization to perform their works and jobs more effectively. For an effective usage of a computer, it is better to minimize the total number of programs and data files. It is also recommendable to collect all current document, data, and information at one place, and analyze and arrange

again according to requirements of each Department.

To streamline different opinions, demands and requirements of each Department and other offices, one coordinating group which is organized from each Department together with person who have sufficient knowledge of computer technology must be organized, that organization called as "computer project team".

(3) Priority

Each Department should have a clear idea of how computerization will be utilized, that is,

"What and Which works/jobs procedures must be computerized" and
"How to computerize"

At the organization meeting, each Department states its vision and objectives of computerization. A project team for computerization would discuss and select the objectives from the many ideas. Possible computer systems of each Department are as follows;

1) Marine Department

Ship's movement control system
Port State Control (PSC) system
Jordanian registered vessel control system

(See Table 4.8.1)

① Ship's movement control system

a) Marine Department checks and gets information of vessels which are scheduled to arrive and depart at port.

b) Marine Department makes a plan to arrange tug boat, pilot and line's man according to the information.

c) Marine Department contacts and master of vessel confirms ETA by VHF prior to arrival according to the information of vessel schedule.

d) Marine Department inputs the following data into computer for port due claim which are prepared by Finance Department.

Code number
Ship's particulars
Date and time of vessel arrival/departure
Data of pilot usage
Data of tugboat usage
Data of line's man usage
Arrival draft
Name of master

e) Marine Department has 7 tugboats and 6 pilots. Marine Department has a plan to increase the number of pilots.

f) In 1994, about 2,500 vessels called Port of Aqaba including ferry boats which are servicing between Aqaba and Nuweiba. The number of the ferry boat call is, in 1994, about 1,000 vessels.

(See Appendix 4.8.1)

② PSC control system

a) Marine Department inputs all data of ship's name and ship's particulars which called Port of Aqaba, and makes files of these vessels.

b) Marine Department refers to the files and inspects periodically the vessels every six months or 1 year interval.

c) Marine Department inspects apparatus of safety equipment of a vessel for Port State Control, and files all data of the inspection including the results.

d) The number of vessel which are inspected by Marine Department is about 400 vessels per year for PSC control.

(See Appendix 4.8.2)

③ Jordanian registered vessel control system

a) Marine Department controls Jordanian registered vessel.

b) Marine Department inputs all data of Jordanian registered vessels, and makes a file of these vessels.

c) Marine Department refers to the file and inspects periodically the vessels for annual survey.

d) Marine Department inspects ship's hull, engine, radio, safety apparatus and etc, and files the results.

e) The number of vessels which are registered in Jordan is about 500 including small pleasure boats.

f) The data of registration and inspection are transferred to Finance Department, and Finance Department submits a bill to the vessel owner.

(See Appendix 4.8.3)

2) Operation Department

Berth decision control system
Stevedoring control system
Warehouse and shed control system

(See Table 4.8.2)

① Berth decision control system

a) Operation Department controls not only berth usage but also vessel schedule.

b) Operation Department gets a schedule list of arrival vessel on 1 month in advance from shipping agents.

c) Operation Department gets and confirms information of arrival vessel on six days and two days advance from shipping agents, and makes a plan of berth usage.

d) For making a plan of berth usage, following items should be taking into consideration;

Kind of cargo commodity
Length of vessel
Draft of vessel
Volume of cargo
Number of discharging hatch
Priority of cargo discharging

e) Operation Department can get information of an arrival vessel by telex or fax machine instead of documents which are written by hand.

f) After berthing/unberthing of a vessel, Operation Department inputs the exact time of berthing/unberthing of the vessel.

g) The time of berthing/unberthing is transferred to Finance Department for port charge bill.

(See Appendix 4.8.4)

② Stevedoring control system

a) Operation Department controls arrangements of stevedoring and cargo discharging equipment.

b) Operation Department makes a plan for stevedoring and cargo discharging equipment in two days advance of vessel arrival.

c) Operation Department should take into consideration the following items when they arrange stevedoring and cargo discharging equipment.

Kind of cargo commodity
Volume of cargo
Type of cargo package
Number of discharging hatch
Number of cargo discharging equipment
Priority of cargo discharging

d) Operation Department records the following items for the bill of stevedoring;

Number of stevedoring (gang)
Working hours of stevedoring
Number of cargo discharging equipment
Special charge

e) In 1994, the number of stevedoring workers is about 2,500, and the number of cargo discharging equipment is about 300.

(See Appendix 4.8.5)

③ Warehouse and shed control system

a) Operation Department controls arrangements of warehouses and sheds for cargo storage.
Storage space is addressed and controlled by number of a storage section.

b) Operation Department makes a plan for available space to store cargoes in the warehouse and shed.

Number of warehouses and sheds
Utilized space for storage per each warehouse and shed
Available space for storage per each warehouse and shed
Total number and volume of cargoes

c) Operation Department should take into consideration the following items when they arrange the storage space;

Kind of cargo commodity
Volume of cargo
Type of cargo package
Distance between berth and storage space

d) Operation Department records the following items for the bill of cargo handling;

Name and volume of cargo
Name of a vessel and consignee
The date and time of cargo receiving/delivery
(Total storage days)

e) These data are transferred to Finance Department for the bill of cargo storage.

f) Operation Department controls 36 warehouses and shed of 281,000 m2 in total. In 1994, about 250 conventional cargo vessels called at Port of Aqaba.

(See Appendix 4.8.6)

3) Finance Department

Port charge collecting system

Stevedoring charge collecting system
Storage charge collecting system
Container charge collecting system
Payroll and wage adjustment system
Accounting system

(See Table 4.8.3)

① Port charge collecting system

a) Collecting system of port charge, which consists of;

Wharfage
Tonnage
Quarantine charge
Tugboat charge
Pilotage
Line's man charge

b) All data for collecting of port charge are transferred from Marine Department.

c) The bills of port charge are calculated and prepared automatically by computer, and issued to a shipping agent.

(See Appendix 4.8.7)

② Stevedoring charge collecting system

a) Collecting system of stevedoring, which consists of;

Equipment charge
Stevedoring charge
Stevedoring extra charge

b) All data for collecting of stevedoring charge are transferred from Operation Department.

c) The bills of stevedoring charge are calculated and prepared automatically by computer, and issued to a shipping agent.

(See Appendix 4.8.8)

③ Storage charge collecting system

a) Collecting system of storage charge, which consists of;

Quay charge
Lighterage
Storage
Portage

b) All data for collecting of storage charge are transferred from Operation Department.

c) The bills of storage charge are calculated and prepared automatically by computer, and issued to a customs clearing company.

(See Appendix 4.8.9)

④ Container charge collecting system

a) Collecting system of container handling and storage, which consists of;

Discharging/loading charge
Storage
Re-handling charge
Extra storage (Reefer, Dangerous cargoes, etc.)

b) All data for collecting of container charge are transferred from Operation Department.

c) The bills of container charge are calculated and prepared automatically by computer, and issued to a shipping agent.

(See Appendix 4.8.10)

⑤ Payroll and wage adjustment system

a) Payroll calculation

Staff's and worker's payroll calculation
Basic salary, over time compensation, other compensation
Income tax, welfare pension, other deduction

b) All data for payroll calculation are transferred from Administrative Department and Audit & Control Department.

c) Detailed statement for payroll are calculated and prepared automatically by computer, and printed out.

d) In 1994, about 2,500 persons are registered as "staff", and other 2,500 persons are registered as "worker".

(See Appendix 4.8.11)

⑥ Accounting system

a) Profit and loss statement

Operation revenue
Operating expense
Net operating income
Non operation revenue

Non operating expense
Non operating income
Net income before contribution
Contribution
Net income after contribution

b) Balance sheet

Assets	Current assets
	Fixed assets
	Other assets
Liabilities	Current liabilities
	Fixed liabilities
Capital	Capital
	Net income
	Retained earnings

(See Appendix 4.8.12)

4) Technical Department

Equipment inventory control system
Equipment maintenance control system

(See Table 4.8.4)

① Equipment inventory control system

a) Technical Department controls all equipment for cargo handling.

b) Technical Department keeps the inventory list of equipment for cargo handling. Possible items for the list are as follows;

Code number
Name of equipment
Name of manufacturer
Manufactured date
Type of model

Type of power
Dimension
Type of fuel, lubricating oil

c) Technical Department updates the inventory list of equipment when they introduce new equipment or write-off the old-one.

d) Technical Department controls 300 units of equipment, in 1994.

(See Appendix 4.8.13)

② Equipment maintenance control system

a) Technical Department maintains all equipment for cargo handling.

b) Technical Department keeps the maintenance list of equipment for cargo handling. Possible items for the list are as follows;

In addition to the items of the inventory list,
History of past maintenance and repair records
Date of maintenance
Detail of maintenance
Replaced spare parts
Due date of next periodical maintenance
Records of working hour

c) Technical Department renews the maintenance and repair records when they maintain and repair the equipment.

d) Technical Department checks and lists the kind and number of equipment which are available to use for cargo work operation.

e) Operation Department gets the information of equipment which are available for use, and makes an arrangement for cargo work operation.

f) Operation Department maintains inspects, repairs and replaces the parts, etc periodically in accordance with a recommendation of manufacturer

(See Appendix 4.8.14)

5) Supplies & Purchases Department

Spare parts inventory control system
Spare parts order/receiving control system

(See Table 4.8.5)

① Spare parts inventory control system

a) Supplies & Purchases Department controls all spare parts of equipment for cargo handling and facilities in their 12 stores.

b) Supplies & Purchases Department keeps the inventory list of equipment for cargo handling and facilities. Considerable items for the list are as follows;

Code number
Name or number of stored store
Name or number of stored section
Name and number of spare part
Name of manufacturer
Manufactured date
Type of model

Dimension

c) Supplies & Purchases Department handles about 48,000 units of spare parts, in 1994.

(See Appendix 4.8.15)

② Spare parts order/receiving control system

a) Supplies & Purchases Department receives an order of a requisition of spare part from each Department and orders the spare part from the supplier.

b) Supplies & Purchases Department makes a file of order list, which records;

Code number
Name, type, model and number of ordered spare parts
Name of supplier
Date

c) Supplies & Purchases Department deletes the item of the order list of the requisition when they receive the ordered spare part.

d) Supplies & Purchases Department updates the inventory list of spare parts for cargo handling when they receive the spare parts which were ordered from supplier.

(See Appendix 4.8.16)

6) Administrative Department

Personnel control system

(See Table 4.8.6)

① Personnel control system

a) Administrative Department controls all employees of PC.

b) In 1994, following employees are registered in PC.

Staff : 2,500
Worker : 1,300
Casual : 1,200

c) Possible personnel data are as follows;

Name of person
Date of birth
Rank
Address
Working experience
Skill/Ability
License

Rewards/Penalties

d) Personnel data which are necessary for payroll calculation are transferred automatically to Finance Department.

e) Personnel data should be strictly controlled to maintain confidentiality.

(See Appendix 4.8.17)

7) Specialized Berth Department

Cargo(Phosphate) receiving system
Cargo(Phosphate) delivery system
Cargo(Fertilizer) delivery system
Cargo discharging system
Oil tanker loading system

(See Table 4.8.7)

① Cargo receiving system

a) Phosphate in bulk is transported to the storage shed from Phosphate mines by rail and truck.

b) Storage area of Phosphate in bulk is about 22,500 m2.

c) Average weight of cargo is about 43 tons per wagon car, and 1,400 tons per rail fleet. 7 fleets of trains are operated per day.

d) Considerable items for cargo receiving system are as follows;

Grade of cargo
Volume of received cargo
Inventory of stocked cargo
Cargo transfer system from dumping site to storage shed

e) In 1993, about 3,600,000 tons of Phosphate are exported.
(2,600,000 tons by rail, and 1,000,000 tons by truck)

(See Appendix 4.8.18)

② Cargo (Phosphate) delivery (loading) system

a) Phosphate in bulk is loaded to a vessel by belt conveyer and choke feeder from the storage shed.

b) Average 250 vessels are called to load Phosphate in bulk per year.

c) In 1994, Phosphate in bulk about 3,800,000 tons per year, 10,000 tons per day is exported.

d) Possible items for cargo loading system are as follows ;

Grade of cargo
Volume of loaded cargo
Cargo transfer system from storage shed to loader

(See Appendix 4.8.19)

③ Cargo (Fertilizer) delivery (loading) system

a) Fertilizer in bulk is loaded to a vessel by belt conveyer and spout loader from storage shed.

b) Average 200 vessels call to load fertilizer in bulk per year.

c) In 1993, about 400,000 tons of fertilizer are exported.

d) Possible items for cargo loading system are as follows;

Grade of cargo
Volume of loaded cargo
Inventory of stocked cargo
Cargo transfer system from storage shed to loader

(See Appendix 4.8.20)

④ Cargo discharging system

a) Sulphur in bulk is discharged by chain bucket elevator to storage shed.

b) Possible items for cargo discharging system are as follows;

Grade of cargo
Volume of discharged cargo
Inventory of stocked cargo
Cargo transfer system from vessel to storage shed

(See Appendix 4.8.21)

⑤ Oil tanker loading system

a) Crude oil will be exported by oil tanker.

b) Possible items for cargo loading are as follows;

Grade of Cargo
Volume of loaded cargo
Inventory of stocked cargo
Cargo transfer system from shore tank to vessel
Gravity unit
Power pump unit
Main remote valve/local valve
Flow meter

Thermometer
Pressure Gauge

8) Project Department

Blue print file system
Construction contract index system

(See Table 4.8.8)

① Blue print index system

a) Project Department files all blue prints of building, berth, and other facilities of PC.

b) Project Department controls many sheets of blue prints.

c) Possible items for systemized index system are as follows;

Code number
Name of print
Date of completion
Name of constructor

(See Appendix 4.8.22)

② Construction contract index system

a) Project Department files all construction contracts of building, berth, and other facilities.

b) Possible items for systemized index system are as follows;

Code number
Name of construction contract
Date of completion
Name of constructor

(See Appendix 4.8.23)

9) Training & Development Department

Statistics file system

(See Table 4.8.9)

① Statistics system (vessel, cargo)

a) Training & Development Department prepares and takes statistics of port activities.

b) Possible items for statistics of port activities are as follows;

Name of vessel, arrival date, vessel size, dwt, flag

Cargo of volume, commodity, style
Local cargo/transit cargo
Origin and destination of cargo
Container cargo in 20'/40', in TEUs
FCL/LCL, Kind of container, commodity
Name of berth, berth occupancy rate
Name of shed, shed occupancy rate

(See Appendix 4.8.24)

10) Office of Director General

Mail sending/receiving control system
Circular letter/document control system

(See Table 4.8.10)

① Mail sending/receiving control system

a) Office of Director General controls and files the mail list which is sent and received.

b) Possible items for the index mail list are as follows;

Code number
Date
Name and address
Sender
Ordinary/Registered mail

(See Appendix 4.8.25)

② Circular letter/document control system

a) Office of Director General controls and files the list of circular letter/document.

b) Possible items for the list are as follows;

Code number
Kind of circular letter/document
Date of issue
Notified party

(See Appendix 4.8.26)

11) Container Terminal

Gate control system
Yard control system
Ship's discharging/loading system
CFS control system

(See Table 4.8.11)

① Gate control system

a) Automatic capture of container's data at gate in/out

The information of containers are gathered and captured at gate in/out operation.

Container number
Place of delivery
Date and time
Carrier
Status
Purpose of gate in/out
Scheduled line, vessel, voyage number
Port of destination
Scheduled place of return
Inspection at the time of receipt/delivery

(See Appendix 4.8.27)

② Yard control system

a) Inventory control of in-yard containers to and from vessels

Matching of receipt containers with booking list
Matching of delivery containers with container manifest

b) Determination or checking of yard stacking address of receiving and delivery containers.

Receiving container:
Full or Empty
FCL/LCL
Dry container or reefer container
Shipping line/shipping agent
Name of vessel/voyage

Delivery container:
Full or Empty
FCL/LCL
Dry container or reefer container
Name of vessel/voyage
Customs clearing company
Consignee

(See Appendix 4.8.28)

③ Ship's discharging/loading system

a) Making of a discharging and loading cargo work sequence list of containers to and

from vessels.

Container booking list
Container receiving list
Container cargo manifest
Container bay plan
Container schematic plan
Cargo work sequence list

(See Appendix 4.8.29)

④ CFS control system

a) Making of a receiving and delivery sequence list of containers to and from CFS.

CFS container list
CFS container receiving list
CFS container delivery list
CFS cargo manifest

b) CFS cargo

Determination or checking of CFS storage address

Block address
Commodity
Cargo volume
Number of package
Shipper/Consignee
Shipping agent/Customs clearing company
Container number
Vessel name

(See Appendix 4.8.30)

4.8.8 Computerization of Container Terminal

(1) Applicable Objectives

There are many objectives for computerization in PC as described above. PC bought a host computer, HP-9000 800/827, to introduce a computer system into their daily works and jobs in 1991, and that computer was installed in their office in 1993 without any software.

The total volume of objectives for computerization is very large, and it seems very difficult to introduce a computer system in their business at one time from scratch. To start a computer system practically soon in PC, PC should select the applicable objectives for a computer system.

A computer system is important for many port activities, but the container terminal should be given top priority. It is said that one container terminal (350 m x 300m) can handle only about 1,000 to 1,500 TEUs per week, or 60,000 TEUs per year without a computer system.

In 1994, container port of Port of Aqaba handled 54,759 TEUs for import, 7,920 TEUs for export, 48,138 TEUs empty for export, totalling 110,817 TEUs. These figures show that Port of Aqaba has almost reached the limit of its handling capacity. Considering the limited volume that can be handled manually, PC should immediately start computerization of management and operation.

(See Appendix 4.8.31)

(2) Project Team

The establishment of a project team is necessary to start a computer system in the container terminal as a general procedure for computerization. The project team will be constituted by persons who have enough knowledge about container terminal operation and computer technology.

Container terminal staff have a meeting together with computer specialists, and study and analyze the procedure of the container terminal. To analyze the procedure of the container terminal, all current documents and formats should be collected firstly. All collected documents and formats will be checked and studied to determine whether the documents can be combined together to reduce the number of documents. Some data, which are input and output, might be duplicated in several documents, and there are some possibilities to minimize the number of papers.

After collecting the current documents, the project team analyzes the time sequence of each document.

"What kind of and which documents are necessary to process"
"When is the document processed from one section to the other section."
"Which section processes the document"

(3) Introduction of Computer System

The project team will determine all necessary documents and procedures for computerization, and the total required capacity of computer memory can be determined. The capacity of computer should be calculated and concluded by the total number of necessary data. And then, type of model is selected based on required capacity.

Required equipment of computer system for container terminal is as follows;

Host computer(Server)
Work station
Personal computer
Display
Keyboard
High speed page printer
Line printer

(4) Training of Computerized Container Terminal

The yard operation of a container terminal is different from terminal to terminal. There are also differences both in manual and computerized operation. Key staff should not only have sufficient container terminal experience, but also be familiar with computerized container terminal operation.

The Port of Aqaba container terminal is not computerized, nor does the terminal have enough experience to operate a computerized terminal. To operate a computerized terminal smoothly, staff of the following should be trained prior to actual terminal operation;

General/Assistant manager
Superintendent and Foreman

The items of training course for container terminal are as follows;

General information
- General arrangement of container terminal
- Terminal gate
- Container storage yard
- Container berth
- Container handling equipment
- Container flow chart
- Container document

Container gate in/out control
- Container flow
- Container document(EIR, Container slip)
- Communication with yard control

Container yard control
- Yard arrangement(Storage address, full/empty)
- Communication with other section

Ship's cargo work
- Container loading sequence plan
- Container discharging sequence plan
- Pre-stowage plan
- Final stowage plan
- Final bay plan/schematic plan
- Communication with other section

Document control
- Document for receiving/delivery
- Container cargo manifest
- Bay plan, Schematic plan
- Customs clearance
- B/L

(See Table 4.8.12)

(5) Time Schedule

Generally speaking, it takes a long time to establish and complete computer system in an organization or office from scratch. At present, there is no project team for computerization, nor has preparation for a computer system begun. PC should commence preparation to start computer system as soon as possible because of time restrictions. Cargo volume of container at Port of Aqaba will increase gradually, and they have to introduce many kind of cargo handling equipment to improve and solve increased and congested cargo, such as transfer crane, new gantry crane, by the year 2000.

From past records and experience, it takes about 2 to 3 years to introduce a new computer system into a container terminal. The typical time schedule for building up computer system is as follows;

(See Table 4.8.13)

(6) Equipment of Container Yard Handling

There are three systems used for container yard handling; chassis system, straddle carrier system and transfer crane system. At port of Aqaba, this terminal currently employs the straddle carrier system. For introducing of computer system into their container terminal, there are two choices of container handling system, one is straddle carrier system and the other is transfer crane system.

Both systems have their merits and demerits for terminal operation, and many terminal operators have not reached to the final clear conclusion. But, in proportion of development of computerization of a container terminal, many container terminals choose the transfer crane system. It is said that transfer crane system can be controlled by computer easier and more efficientlly than straddle carrier system.

4.8.9 Personal Computer

In proportion to the development of electronic technology of semiconductor, a personal computer has been growing the same as main frame computer. And as there has been a trend of down sizing in main frame computers, personal computers have become increasingly important. Constitution of new a computer system is main frame computer, personal computers, printers, and so on.

A personal computer has many functions in a modern computer system, and the function is grading up. To operate a modern computer system, it is very important to know how to use and operate a personal computer.

Items of efficiencies and functions of a personal computer are as follows;

Bit of CPU
Memory of capacity
Clock cycle(MHz)
CPU accelerator
Hard disk
MO-disk (Magneto-Optical disk)
CD-ROM
Operating system
  MS-DOS
  Windows

Table 4.8.1 Marine Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
MARINE	SHIP'S MOVEMENT CONTROL SYSTEM	ETA ARRIVAL VSL ETD DEPARTURE VSL	CONTROL OF VSL ETA/ETD	2,500 VSL PER YEAR	INFORM TO OPERTN. DEPT. FOR ARRANGE STEV.
		TUGBOAT PILOT LINE'S MAN	ARRANGE OF TUGBOAT PILOT LINE'S MAN	7 VSL 6 PERSONS	
	SHIP'S MOVEMENT CONTROL SYSTEM	ARRIVAL/DEPARTURE TIME OF VSL	CONTROL OF VSL ARRIVAL/DEPARTURE TIME	2,500 VSL	INFORM TO FINANCE DEPT. FOR PORT DUE CLAIM.
	PSC CONTROL SYSTEM	INSPECTION RECORD INDEX OF INSPECTION VSL	INSPECTION DATE SHIP'S PARTICULAR INSPECTION RECORD NEXT INSPECTION DATE	400 VSL PER YEAR	INSPECTION INTERVAL: 6 MONTH OR 1 YEAR
	JORDANIAN REGISTERED VSL CONTROL SYSTEM	INDEX OF REGISTERED VSL INDEX OF INSPECTION VSL	SHIP'S DATA OF REGISTERED VSL INSPECTION DATE INSPECTION RECORD NEXT INSPECTION DATE	500 VSL	INFORM FINANCE DEPT. OF COLLECT INSPECTION CHARGE.

Table 4.8.2 Operation Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
OPERATION	BERTH DECISION CONTROL SYSTEM	BERTH DECISION	NO. OF BERTH : 25 DEPTH , LENGTH, COMMODITY, PRIORITY ETC.	2,500 VSL/YEAR	INFORM MARINE DEPT. OF BERTHING PLAN
	STEVEDORING CONTROL SYSTEM	STEVEDORING GANG EQUIPMENT	ARRANGEMENT OF STEVE. CONSTITUTION NO. OF WORKER NO. OF EQUIPMENT COMMODITY RECORD OF WORKING HOURS	WORKER: 1,300 CASUAL: 1,200 EQUIPMENT: 300	INFORM FINANCE DEPT. OF RECORD OF WORKING HOURSFOR COLLECTING CHARGE
	WAREHOUSE/SHED CONTROL SYSTEM	WAREHOUSE SHED	DECISION OF WAREHOUSE/SHED CONTROL RECEIVING/DELIVERY CARGO INVENTORY CONTROL (CONSIGNEE ALPHABETICAL CONTROL) RECORD OF CARGO INVENTORY CONTROL	NO. OF WAREHOUSE/ SHED: 36 AREA TOTAL :281,000 M2 NO. OF CONV'TIONAL VSL:250 VSL	INFORM FINANCE DEPT. OF RECORD OF CARGO INVENTORY CONTROL FOR COLLECTING CHARGE

Table 4.8.3 Finance Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
FINANCE	PORT CHARGE COLLECTING SYSTEM	COLLECTING PORT CHARGE	WHARFAGE TONNAGE QUARANTINE TUGBOAT PILOT LINE'S MAN	2,500 VSL/YEAR	RECEIVE INFORMATION FROM MARINE DEPT. TO SHIPPING AGENT
	STEVEDORING CHARGE COLLECTING SYSTEM	COLLECTING STEVEDORING CHARGE	EQUIPMENT STEVEDORING STEVEDORING EXTRA	EQUIPMENT: 300 WORKER: 2,500	RECEIVE INFORMATION FROM OPERATION DEPT. TO SHIPPING AGENT
	STORAGE CHARGE COLLECTING SYSTEM	COLLECTING STORAGE CHARGE	QUAY LIGHTERAGE STORAGE PORTAGE	2,500 VSL/YEAR	RECEIVE INFORMATION FROM OPERATION DEPT. TO CUSTOMS CLEARING COMPANY
	CONTAINER CHARGE COLLECTING SYSTEM	COLLECTING CONTAINER HANDLING CHARGE, STORAGE CHARGE	LOADING/DISCHARGING STORAGE REEFER STORAGE	100,000 TEU PER YEAR	
	PAYROLL AND WAGE ADJUSTMENT SYSTEM	STAFF'S PAYROLL CALCULATION WORKER'S PAYROLL CALCULATION WAGE ADJUSTMENT CALCULATION	WORKING HOURS DEDUCTION TAX	STAFF : 2,500 WORKER : 1,300 CASUAL : 1,200	RECEIVE DATA FROM AUDIT & CONTROL DEPT.
	ACCOUNT SYSTEM	ACCOUNTING FINANCE BALANCE SHEET	PROFIT AND LOSS STATEMENT REVENUE INCOME EXPENSE CONTRIBUTION BALANCE SHEET ASSETS LIABILITIES CAPITAL		

Table 4.8.4 Technical Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
TECHNICAL	EQUIPMENT INVENTORY CONTROL SYSTEM	EQUIPMENT FOR CARGO HANDLING MOBILE CRANE FORK LIFT TUG MASTER GANTRY CRANE STRADDLE CARRIER TOP LIFTER ETC	KIND OF EQUIPMENT NAME OF MANUFACTURER DATE OF PURCHASE TYPE OF MODEL DIMENSION TYPE OF ENG. ETC	300	
	EQUIPMENT MAINTENANCE CONTROL SYSTEM	EQUIPMENT FOR CARGO HANDLING	LAST MAINTENANCE DATE NEXT MAINTENANCE DATE HISTORY OF REPAIR RECORD OF WORKING HOURS	300	

Table 4.8.5 Supplies & Purchases Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
SUPPLIES & PURCHASE	SPARE PARTS INVENTORY CONTROL SYSTEM	SPARE PARTS	SPARE PARTS NAME OF SPARE PARTS TYPE OF MODEL SIZE/DIMENSION RECEIVING CONSUMPTION INVENTORY	SPARE PARTS:48,000	SPARE PARTS STORE: 12
	SPARE PARTS ORDER/RECEIVING CONTROL SYSTEM	SPARE PARTS	SPARE PARTS PURCHASE ORDER RECEIVING		RECEIVE PURCHASE ORDER FROM EACH DEPT.

Table 4.8.6 Administrative Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
ADMINISTRATIVE	PERSONNEL CONTROL SYSTEM	PERSONNEL DATA	PERSONNEL DATA NAME BIRTH DATE RANK ADDRESS WORKING EXPERIENCE SKILL/ABILITY LICENSE REWARDS AND PENALTIES	STAFF : 2,500 WORKER : 1,300 CASUAL : 1,200	

Table 4.8.7 Specialized Berth Department.

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
SPECIALIZED BERTH	CARGO RECEIVING SYSTEM	PHOSPHATE IN BULK	GRADE OF CARGO RECEIVING STOCK INVENTORY CONVEYER TRANSFER RECEIVED QUANTITY	10,000 TON/DAY	RECEIVING FROM RAIL WAGON AND TRUCK
	CARGO DELIVERY SYSTEM (CARGO LOADING SYSTEM)	PHOSPHATE IN BULK	GRADE OF CARGO DELIVERY(LOADING) STOCK INVENTORY CONVEYER TRANSFER LOADING QUANTITY	200 VSL/YEAR	BERTH A: 20,000DWT BERTH B: 100,000DWT
	CARGO DELIVERY SYSTEM (CARGO LOADING SYSTEM)	FERTILIZER IN BULK	GRADE OF CARGO DELIVERY(LOADING) STOCK INVENTORY CONVEYER TRANSFER LOADING QUANTITY	200 VSL/YEAR	JFI EAST:120 VSL JFI WEST: 80 VSL JFI EAST:30,000DWT JFI WEST:50,000DWT
	CARGO DISCHARGING SYSTEM	SULPHUR IN BULK	GRADE OF CARGO DISCHARGING STOCK INVENTORY CHAIN BUCKET ELEVATOR CONVEYER TRANSFER DISCHARGING QUANTITY		

Table 4.8.8 Project Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
PROJECT DEPT.	BLUE PRINT FILE SYSTEM	BLUE PRINT	BLUE PRINT OF PORT FACILITIES	2,000	COPY TO MICRO FILM
	CONSTRUCTION CONTRACT FILE SYSTEM	CONSTRUCTION CONTRACT	CONSTRUCTION CONTRACT OF PORT FACILITIES		

Table 4.8.9 Training & Development Department

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
TRAINING & DEVELOPMENT DEPT.	STATISTICS FILE SYSTEM (VSL,CARGO)	STATISTICS OF PORT ACTIVITIES	VSL: NAME, DATE, SIZE, DWT, CARGO, BERTH, LAST PORT, NEXT PORT, ETC CARGO:NAME VOLUME/WT CARTON/BAG ORIGIN DESTINATION CONTAINER ETC BERTH:BERTH OCCUPANCY RATE WAREHOUSE/SHED: OCCUPANCY RATE	2,500 VSL 25 BERTH	
	STATISTICS FILE SYSTEM	STATISTICS OF PORT ACTIVITIES	REVENUE EXPENSE PERSONNEL		

Table 4.8.10 Office of Director General

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
OFFICE OF DIRECTOR ENERAL	MAIL SENDING/RECEIVING CONTROL SYSTEM	MAIL	MAIL DELIVERY/RECEIVING FILE INDEX OF FILE	800/DAY	
	CIRCULAR LETTER, DOCUMENT CONTROL SYSTEM	CIRCULAR LETTER DOCUMENT	CIRCULAR LETTER FILE DOCUMENT FILE INDEX OF FILE		

Table 4.8.11 Container Terminal

NAME OF DEPT.	NAME OF SYSTEM	OBJECT	CONTENTS	NO. OF CONTENTS	REMARKS
CONTAINER TERMINAL	GATE CONTROL SYSTEM	CONTAINER RECEIVING CONTAINER DELIVERY	CONTAINER RECEIVING CONTAINER DELIVERY CONTAINER NUMBER SHIP'S NAME WT DISH. PORT ETC	110,000 TEU	
	YARD CONTROL SYSTEM	YARD STORAGE LOCATION IMPORTED CONTAINER EXPORT CONTAINER	KIND OF COMMODITY DRY REEFER DANGEROUS STORAGE LOCATION YARD PLAN		
	SHIP'S DISCH./LOADING CONTROL SYSTEM	DISCHARGING CONTAINER LOADING CONTAINER BAY PLAN SCHEMATIC PLAN CONTAINER DISCHARGING/LOADING LIST REEFER LIST DANGEROUS CARGO LIST	CONTAINER NUMBER SIZE COMMODITY SHIP'S NAME LOADING/DISCHARGING PORT SHIP'S LOCATION YARD LOCATION		
	CFS CONTROL SYSTEM	CFS STORAGE SPACE CFS CARGO CFS CONTAINER	CFS STORAGE SPACE SPACE LOCATION CONTROL CFS CARGO COMMODITY SHIPPER/CONSIGNEE WT/NUMBER CFS CONTAINER CONTAINER NUMBER	108 X 60 108 X 60 39 X 98 95 X 19 20' 2,000 UNIT 40' 800 UNIT	

Table 4.8.12 Training Program of Container Terminal

	1 month	2	3	4	5	6
General information	* * * *					
Gate in/out control	* * * *	* * *				
Container yard control		* * *	* * * * * * *			
Ship's cargo work				* * * * * * * *	* * * * * * * *	
Document control						* * * * * * * *

Table 4.8.13 Time Schedule for Computer System

	Items	2 months	4	6	8	10	12	14	16	18	20	22	24
System design	Analysis of current procedure	*	*	*	*								
	System design (Outline)				*	*							
	System design (Details)					*	*	*					
	Spec. of system							*					
Programing	Spec. of program							*	*				
	Programing							*	*	*	*		
	Test data								*				
	Program test									*	*		
Operation	Operation guide							*	*				
	Arrangement of master file							*	*				
	Registration of master file								*	*			
	Plan for practice									*	*		
	Test run										*		
	Test run back up										*		
	Operation												*

4.9 Preliminary Design of Port Facilities

4.9.1 Design Conditions for Port Facilities

(1) Design Wave Height

Waves used in design of protective facilities for a harbor such as breakwater shall be determined by using measured and hindcast data. An appropriate statistical processing should be applied for the hindcast and the transformation of waves taken into account.

There is no wave protective facility in harbors of the port of Aqaba. The basin of lighters berth and slipway at Main Port is protected by the general cargo berths No. 5 & No. 6. However, coast guard and pleasure boats harbors are provided with breakwaters. This means that wave protective facilities are not necessary for ocean going cargo vessels at the Port of Aqaba but they are required for the small crafts such as tug boats, pilot boats and barges. Protective facilities, therefore, shall be taken into account in the Study where required.

According to the information obtained through interviews with captains who are in charge of Marine Department of The Ports Corporation, maximum waveheights experienced offshore in the Gulf of Aqaba far from the Port are approximately 3.0 meters. Regarding the offshore significant waveheights, a consultant previously estimated that an offshore significant waveheight of 10 year return period was 2.8 meters corresponding to 38.3 knots of 10 year return period windspeed in South-Southwest(SSW) direction. It also estimated that the significant waveheight at the harbor entrance, located between Container Port and Industrial Port was 1.0 meters. In addition, the consultant estimated that the wind of 50 year return period was only 10 % faster than that of 10 year. By use of wave hindcast curves prepared in S-M-B Method, the significant waveheight of 50 year return period is estimated as 3.2 meters offshore and 1.1 meters at the harbor.

Design Wave Height	1.1 meters	At Berthing Facilities

(2) Design Tidal Level

Tidal levels at Aqaba

MHWS	+1.10 meters	Mean Springs High Water Level
MHWN	+0.90 meters	Mean Neaps High Water Level
MSL	+0.70 meters	Mean Sea Level
MLWN	+0.50 meters	Mean Neaps Low Water Level
MLWS	+0.30 meters	Mean Springs Low Water Level
LAT	0.00 meters	Lowest Low Astronomical Tide
CDL	0.00 meters	Chart Datum Level

(3) Wind Velocity

Wind speeds for building and cargo handling equipment design are based on a 3 second gust speed. According to the data previously prepared by a consultant, the mean hourly 50 year return wind speed in any direction at Aqaba is 49.2 knots. This estimate was made according to data from the UK Meteorological Office. Conversion applied in Shore Protection Manual of US Army Corps gives the design speed of 38.2 meters per second for buildings.

Design wind velocity 38.2 m./sec.

(4) Rainfall

Rainfall at Aqaba is negligibly slight and irregular. Paved area shall be given a good run of slopes of 1:60 etc to adjacent sandy areas. Gargoyles shall be provided from building roofs. Main drainage pipes will not be installed.

(5) Temperature

Temperature difference between maximum and minimum in different months varies from 20 to 30 degree centigrade. Temperature range of 30 degree centigrade will be used for design purpose.

(6) Earthquake

The seismological activity risk in Aqaba is high and it is considered in zone "A" according to the map zoning of Jordan. The intensity of earthquakes in zone"A" is assumed to be of a scale greater than 8.0 based on Mercalli Scale. Therefore, it is necessary to consider seismic loads and to follow the seismic provisions and details recommended by international codes.

All the buildings will be designed to resist earthquake intensity of (>8.0) according to Mercalli Scale.

Intensity Coefficient = 0.75

In design of port and harbor facilities, seismic effects must be taken into consideration so that the facilities have an appropriate earthquake resistance. The earthquake-proof design shall be made in accordance with the following method.

a) Seismic force=Deadweight × **Design seismic coefficient
b) Seismic force=(Deadweight+Surcharge) × **Design seismic coefficient

** Design seismic coefficient = *Regional seismic coefficient × Factor for subsoil conditions × Coefficient of importance

* Regional seismic coefficient : The coefficients of 1/15~1/20 are applied for important facilities at The Gulf of Suez.

Design seismic coefficient is applied only to the horizontal coefficient.

Design seismic coefficient = 0.07 ; 1/15 which is applied for important facilities at the Gulf of Suez.

4.9.2 Design Criteria

(1) Standards, Codes, etc to be Applied

Technical Standards for Port and Harbour Facilities in Japan will be, in principal, used in the structural design of port facilities. The Jordanian codes and standards in addition to other international codes will be also applicable in the structural design for building, road and other civil facilities.

Since the ports areas are located along the coastal area and exposed to hard environmental conditions such as high temperature and absolute evaporation, it is important to take precautions, especially in designing the concrete structures. All concrete elements will be designed to resist the effect of thermal loads due to temperature range and to improve the quality and weather resistance of concrete. Sulphate resistant cement (type V) or Portland cement (type II) will be employed, to avoid chloride penetration and resist other chemical reactions.

(2) Background Knowledge in Selecting an Optimum Structural Type for Quaywalls

The structural types of mooring facilities should be determined by considering the characteristics of the respective structural types and examining the following items.

1) Natural conditions : Steep seabed, Hard surface soils, High salinity & inorganic seawater and soils, Comparatively small significant waveheights, etc.
2) Conditions of use : Berthing conditions of objective ships, Type of cargos, etc.
3) Conditions of execution : Utilization of local material and skilled labors, Easiness of method of works, etc.
4) Construction period : Introduction of large-scale & modern construction machinery and equipment, Continuous execution from extensive areas, etc.
5) Construction cost : Economical, stable and reliable structural design.
6) Others : Similar design of existing structures Environmental consideration of living coral & coral reef.

There are many structural types of mooring facilities. However, applicable structural types for standard size of container ships or large-scale bulk carriers to berth at the Port of Aqaba are limited as shown below. Bold letters show recommendable structural types, and they might be compared to select the most suitable type through evaluations.

Gravity type quaywalls **Caisson type**, **Concrete block type**
Sheet pile type quaywalls **Sheet pile type**, **Sheet pile with a relieving platform**
Steel sheet pile cellular cofferdam type of quaywalls
Steel plate cellular cofferdam type quaywalls
Open-type piers **Open-type with vertical piles**, **Open-type with coupled batter piles**
Dolphin, **Detached piers**, **Floating piers**, **Cantilever sheet pile quaywalls**,
Double-wall cofferdam type quaywalls, Open-type piers on cylinders.

4.9.3 Port Facilities to be Improved

According to the required port improvement plan and it's facility layout plan for Master Plan, the objective port facilities shall be improved.

(1) Main Port

Two(2) alternatives are considered in the case of political and economic scenario (1), which are based on the difference of functional berth alignment regarding to the required number of berths. Table 4.9.1 and 4.92 show the facility items to be improved, location and construction item including quantities for alternative 1 and 2 respectively.

Table 4.9.1 Facility Item of Main Port (Case 1 - Alternative 1)

Facility Item to be improved	Location	Construction Item	
		Construction facility	Quantity
-14m Grain berth	GC No.1&2	Quay-front reinforcement	280 l.m
		Dredging of basin up to -14.0m	30,000 m^3
-10m GC berths	Phosphate A	New quay construction 2 berths	340 l.m
		Sheet piling	390 l.m
		Reclamation 1.7 ha.	200,000 m^3
		Vegetable & banker oil piping/outlet	70 l.m
		Demolish of dolphins	3 units
		Pavement of yard & road	1.9 ha
		Utilities	1.6 ha
		Quay,yard & street lighting	2.5 ha

Remarks : 1. The works of quay-front reinforcement include;
- Demolition of existing fenders and fitting of new fenders
- Slope protection after dredging such as concrete blocks, stone works

2. Reclamation works
- Fill material shall be brought from near hills elsewhere cutting works are available.

3. Dredging material : Dredging material shall be used for reclamation fill.
4. Flood channel shall be constructed outward of the reclamation area.

Table 4.9.2 Facility Item of Main Port (Case 1 - Alternative 2)

Facility Item to be improved	Location	Construction Item	
		Construction facility	Quantity
-12m GC berths	GC No.1&2	Vegetable oil piping/inlet	110 l.m
		Dredging of basin up to -12m	20,000 m^3
-14.0m Grain berth	Phosphate A	New quay construction 1 berth	310 l.m
		Sheet piling	360 l.m
		Reclamation 1.55 ha.	183,000 m^3
		Relocation of belt conveyor	160 l.m
		Banker oil piping/outlet	60 l.m
		Demolish of dolphins	3 units
		Pavement of yard & road W=30m	1.1 ha
		Utilities	1.55 ha
		Quay,yard & street lighting	1.6 ha

Remarks : 1. Pavement of yard : Pavement shall be done for the area of truck parking & waiting.

Table 4.9.3 Facility Item of Main Port (Case 5 and 9)

Facility Item to be improved	Location	Construction Item	Quantity
		Construction facility	
-14.0m Grain berth	GC No.1&2	Quay-front reinforcement	150 l.m
		Widening Deck.	160 l.m
		Pein forcement of Deck	200 l.m
		Conveyor Line	260 l.m
		Dredging of basin up to -14.5m	6,400 m^3
-12.0m GC berth	GC No.2&3	Dredging of basin up to -12.5m	none
Rehabilitation of phosphate Berth A	Between GC No.1 and Phosphate A	Mooring delphin	1 unit

Figure 4.9.1 & 4.9.2 show Facility layout of Main Port for Master Plan ; Case 1 - Alternative 1 & 2.

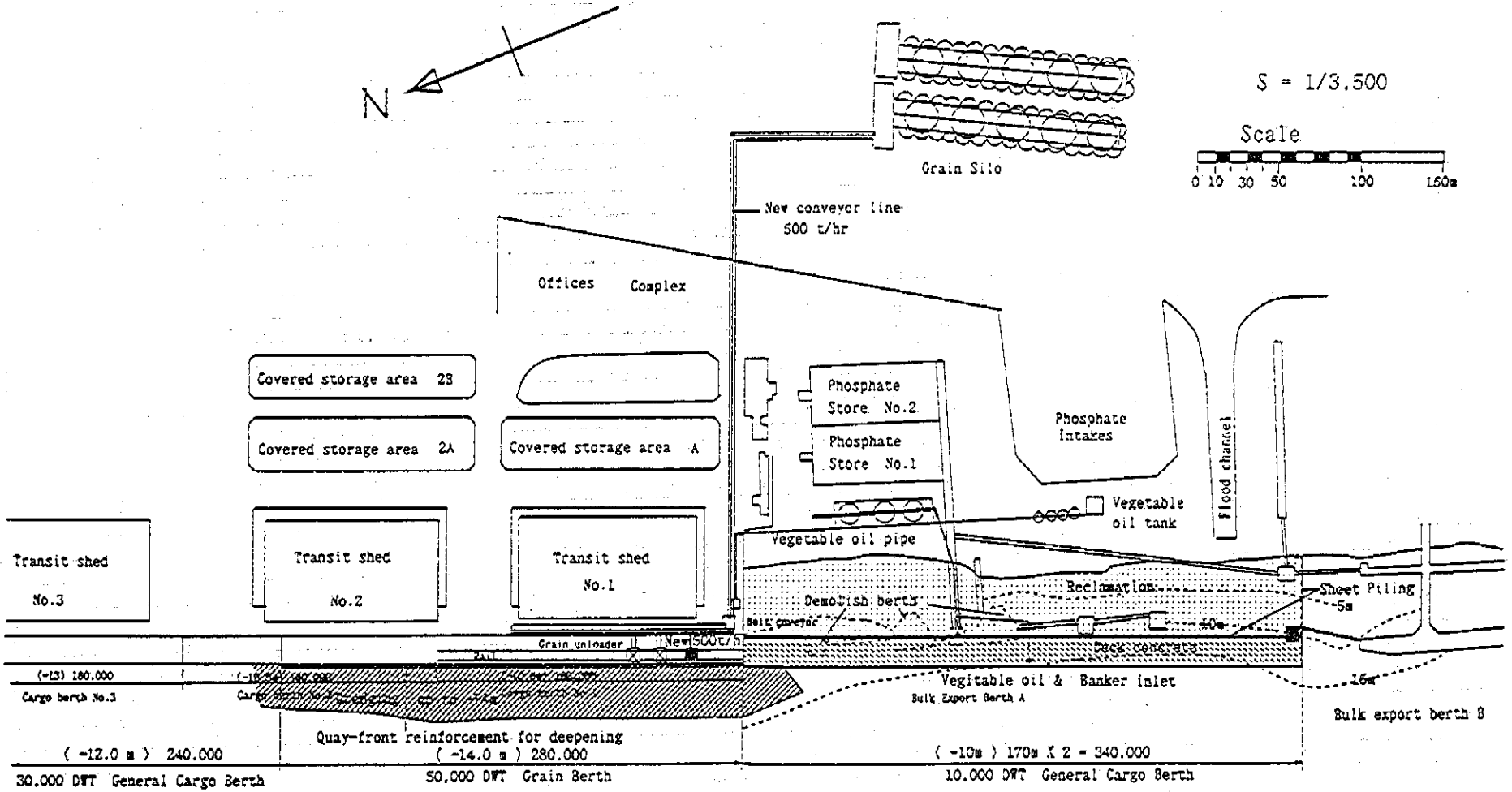

Figure 4.9.1 Facility Layout of Main Port (Case 1 : Alternative 1)

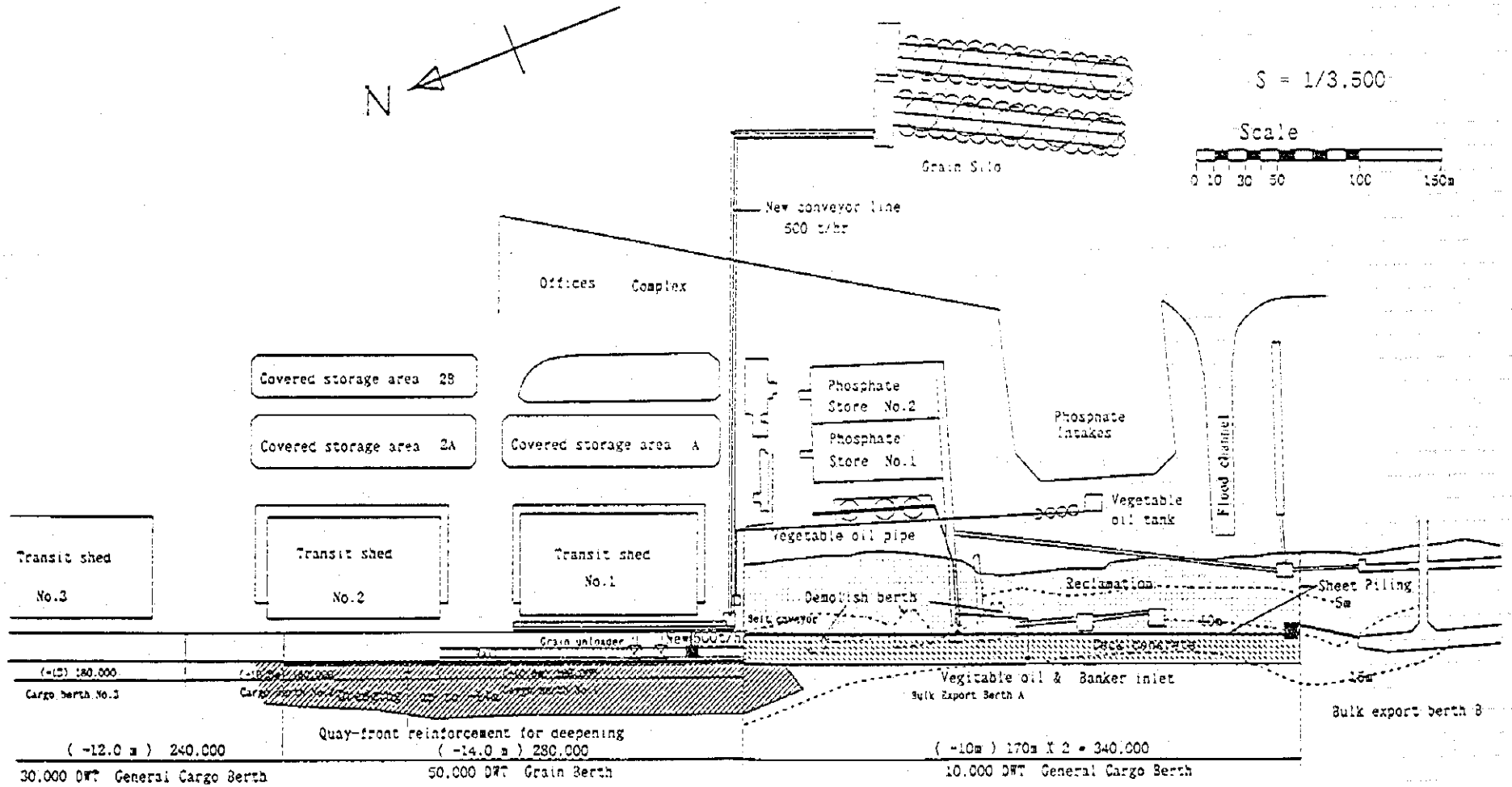

Figure 4.9.1 Facility Layout of Main Port (Case 1 : Alternative 1)

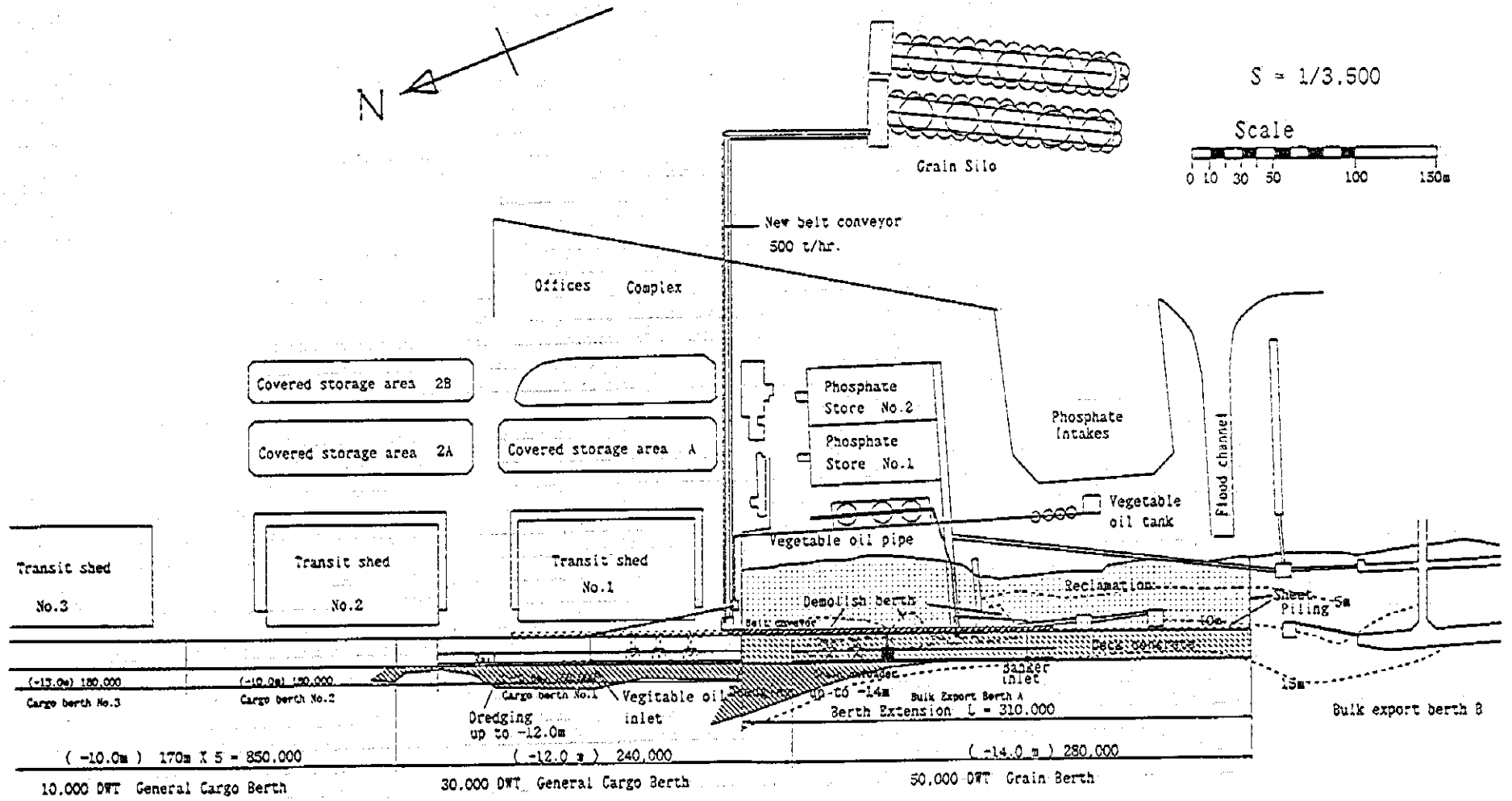

Figure 4.9.2 Facility Layout of Main Port (Case 1 : Alternative 2)

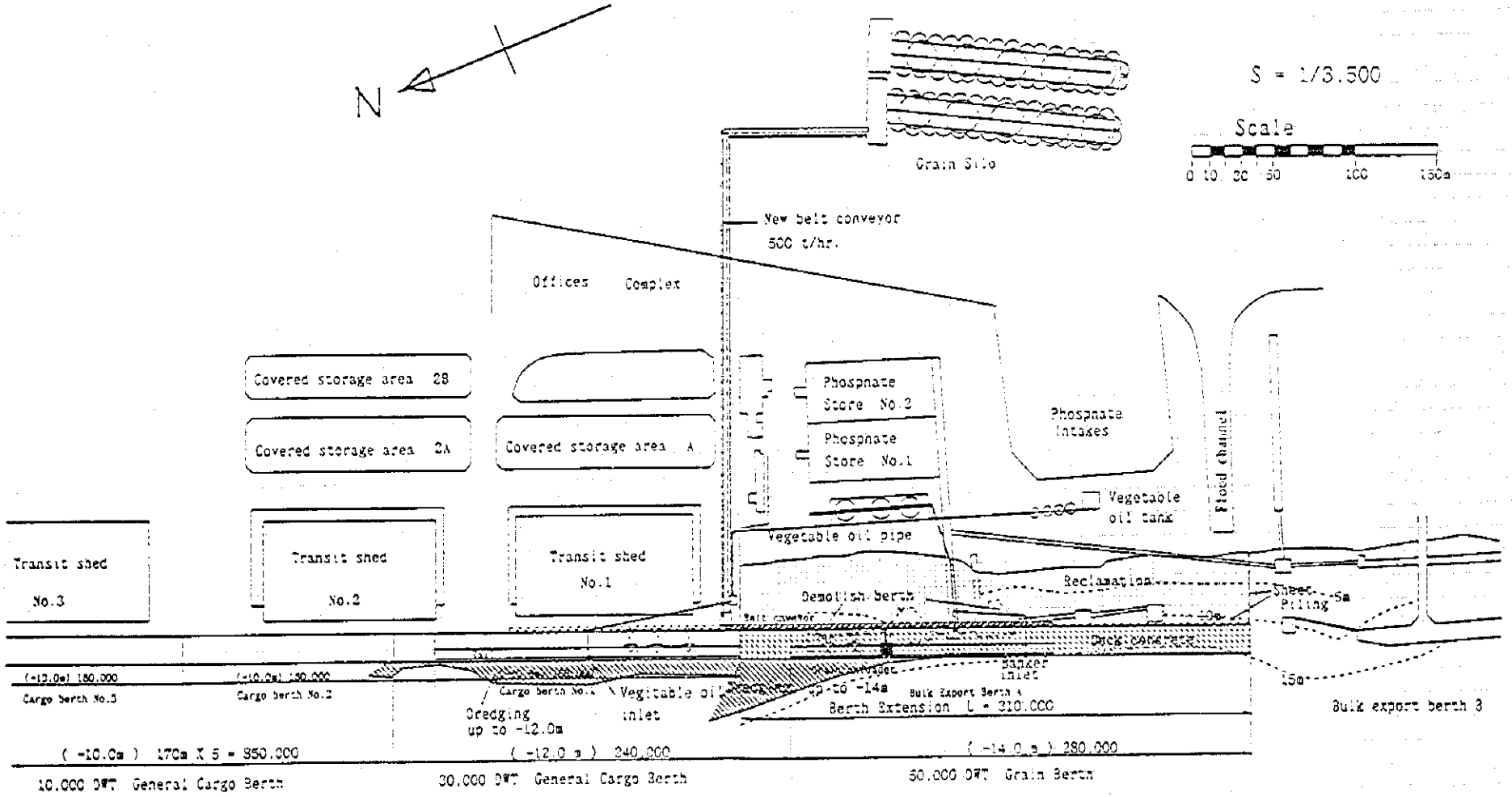

Figure 4.9.2 Facility Layout of Main Port (Case 1 : Alternative 2)

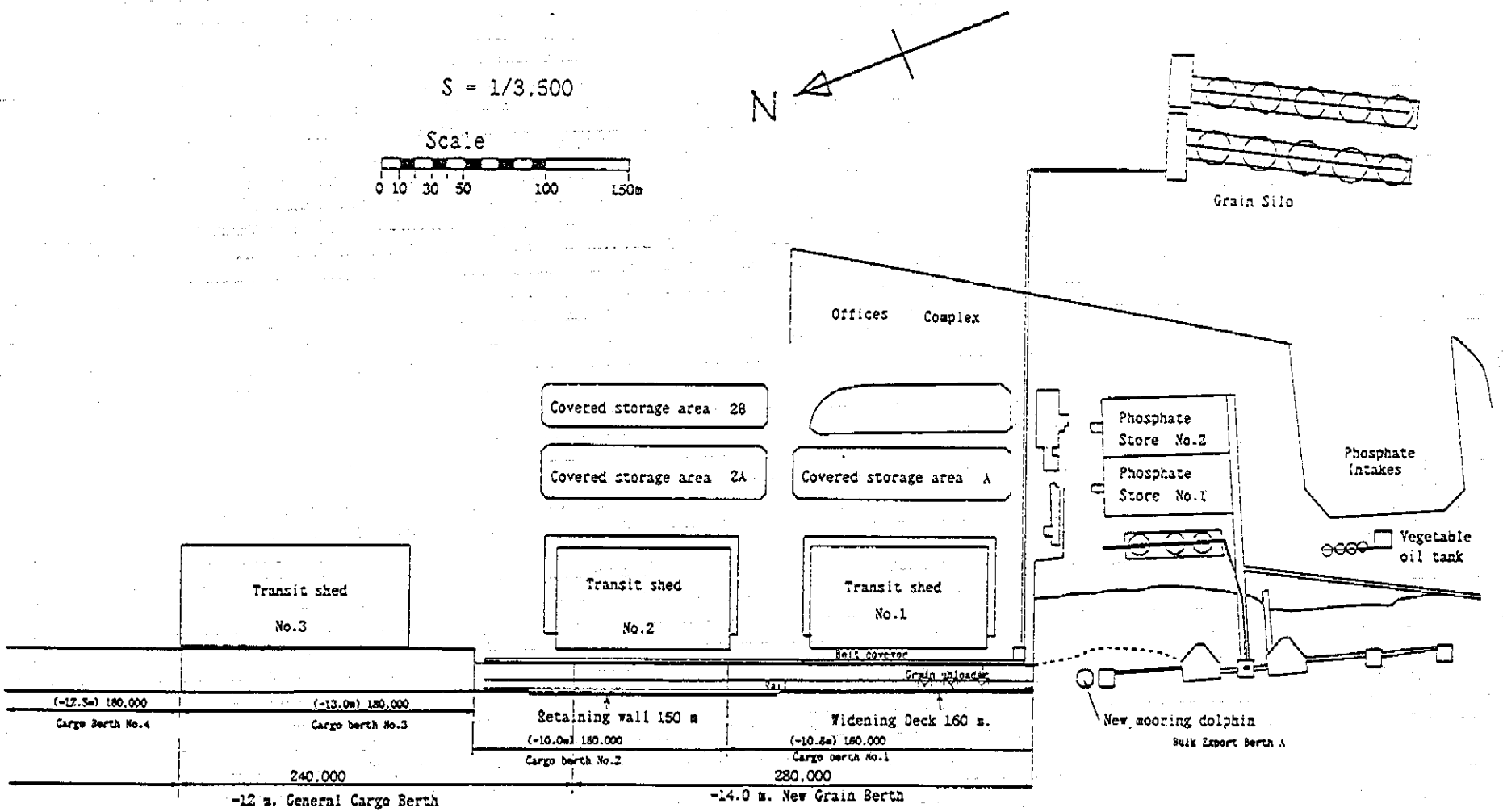

Figure 4.9.3 Facility Layout of Main Port (Case 5 & 9)

(2) Container Port

There are five(5) berth complexes in the container port. No improvement plan of Mo'ta floating berth and Bulk cement berth is proposed by the Master Plan. Regarding the passenger berth, Aqaba port project for construction & operation of a passenger berth at Aqaba Port is proposed by the Government of Jordan. Jordanian Government is looking for foreign investors. The project is not involved in the Master Plan of the JICA study.

The improvement of Ro-Ro berth is not necessary for the Master Plan. However, as the Ro-Ro berth is located at the North extremity of Container berth, access road and necessary facilities for cargo traffic from/to Ro-Ro berth shall be proposed in the facility plan & layout of container terminal.

Container terminal shall be improved for all cases of Master plan, and the facilities and the layout to be improved are the same to every case of Master plan.
Facilities to be improved and equipment to be procured in 2010 are listed in Table 4.9.4.
Alignment of container blocks, buildings and yards in the port area and rough sketch of connecting road to existing roads outside of the port area, etc. is shown in Figure 4.9.4.
Figure 4.9.5 shows topography around container yard.
Figure 4.9.6 shows the plan of earth works and extension of berth, and Figure 4.9.7 shows sections of cutting.

Table 4.9.4 Facility Item of Container Port

Facility Item to be improved	Location	Construction Item	
		Construction facility	Quantity
Extension of berth	South end	Berth construction	60 l.m
		Reclamation 0.6 ha	30,000 m^3
		Revetment/retaining wall	120 l.m
		Facilities for tug boats mooring	80 l.m
Outside road	North	Construction road	300 l.m
Buildings	North	Office & Maintenance shop	8,250 sq.m
Yard area		Earth works	1,000,000 m^3
		Pavement of yard,road	50 ha
Cargo handling equipment		see Table 4.9.5	

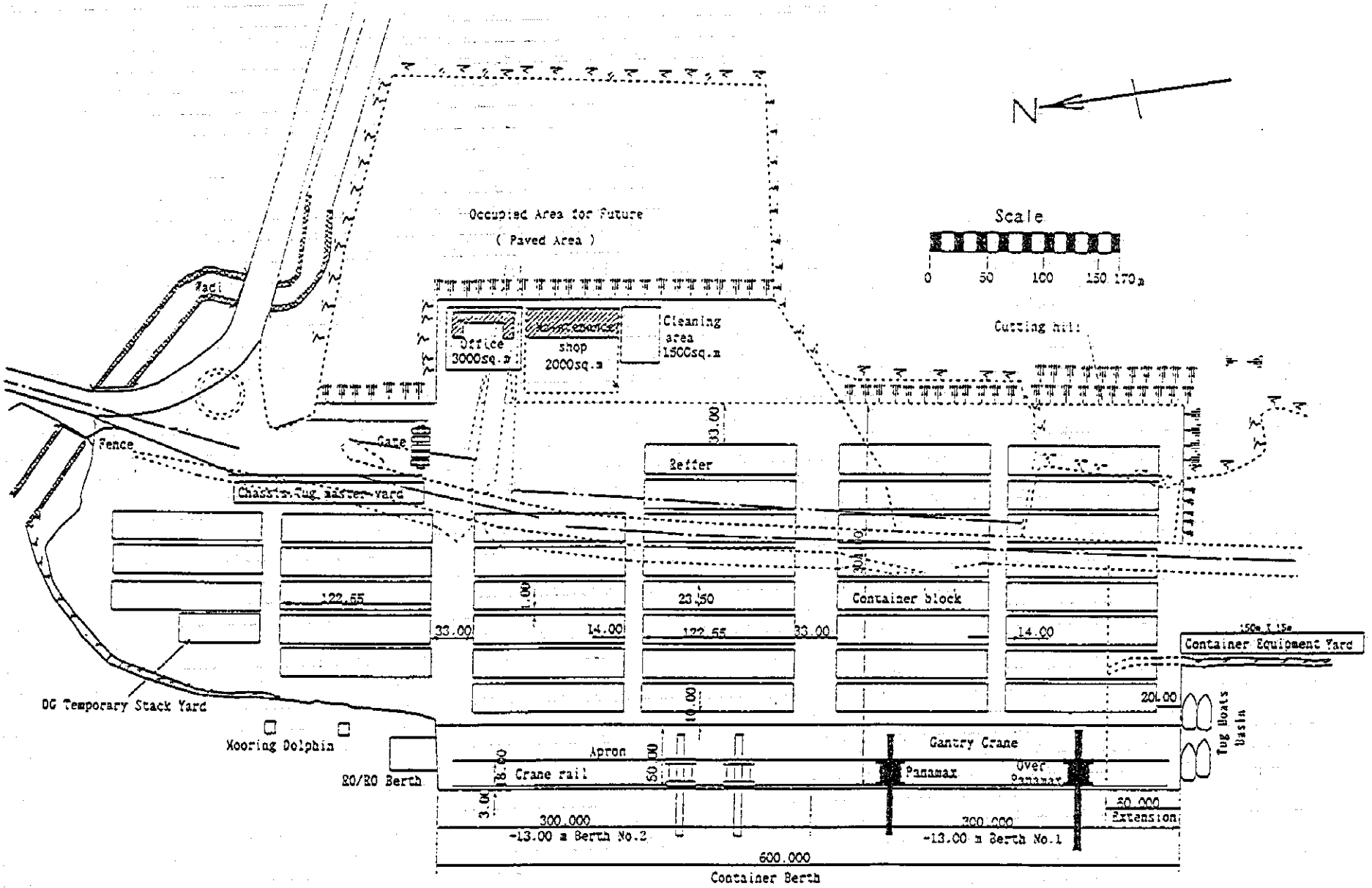

Figure 4.9.4 Facility Layout of Container Terminal

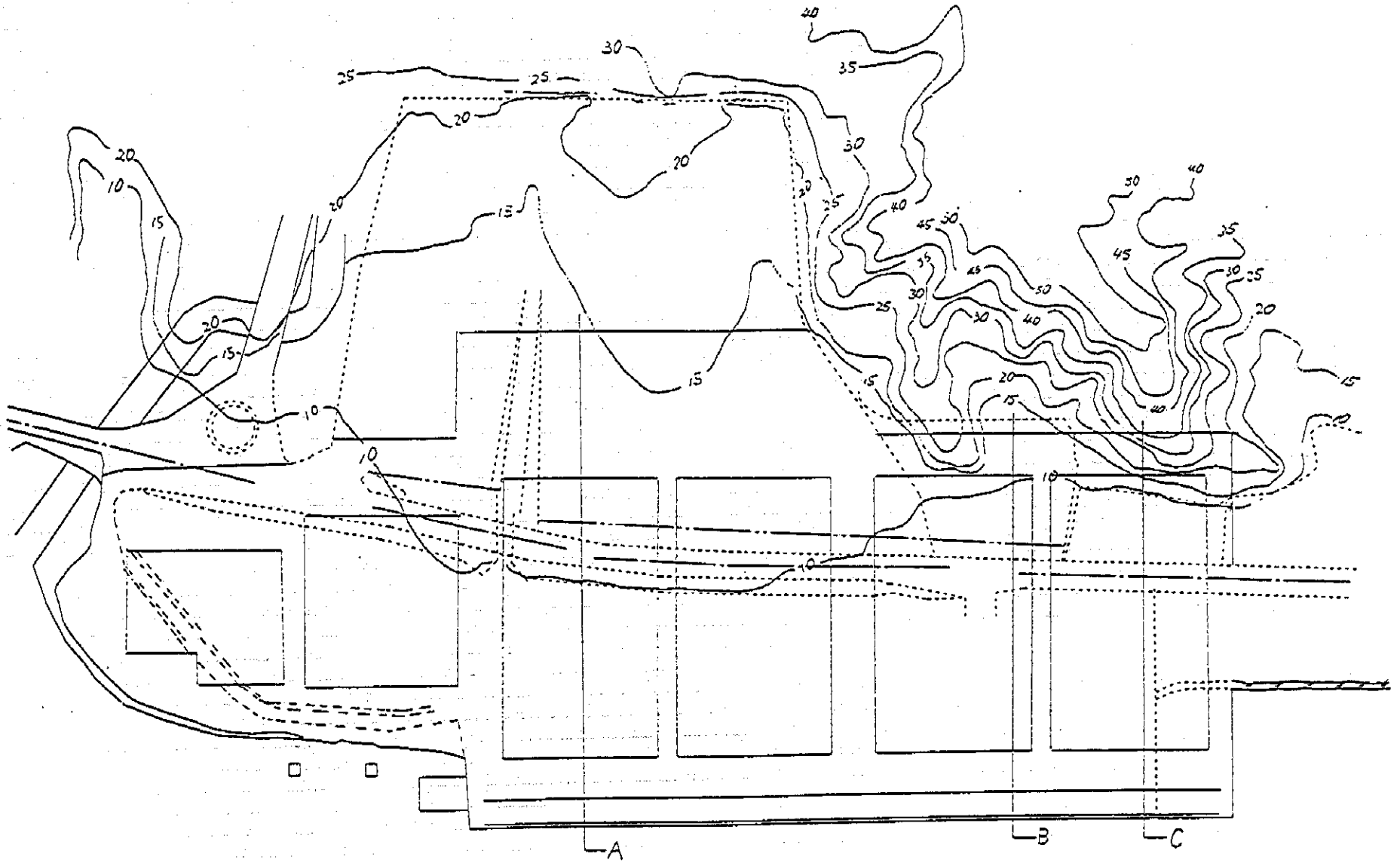

Figure 4.9.5 Topography around Container Yard

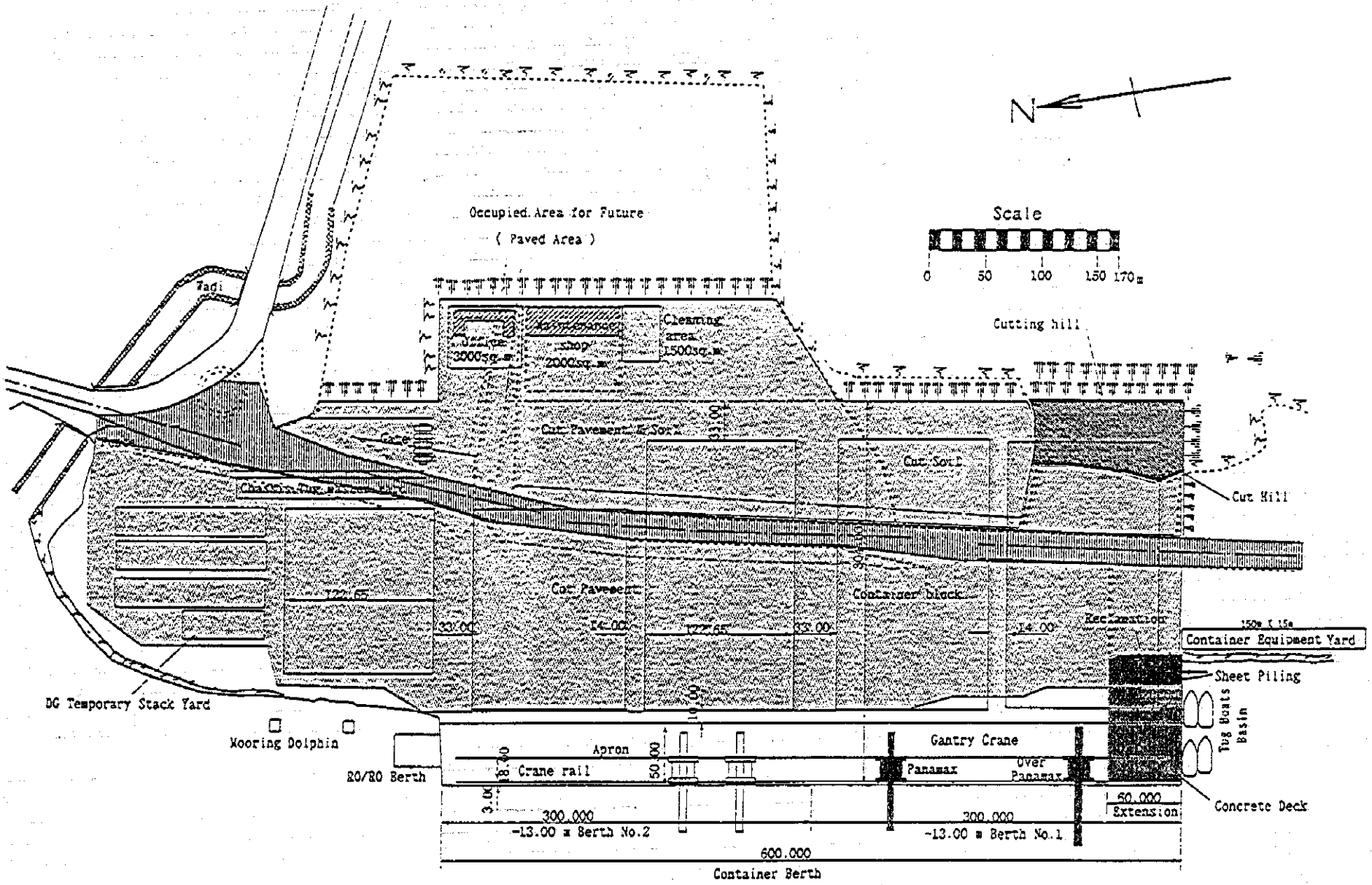

Figure 4.9.6 Land Preparation of Container Yard & Extension of Berth

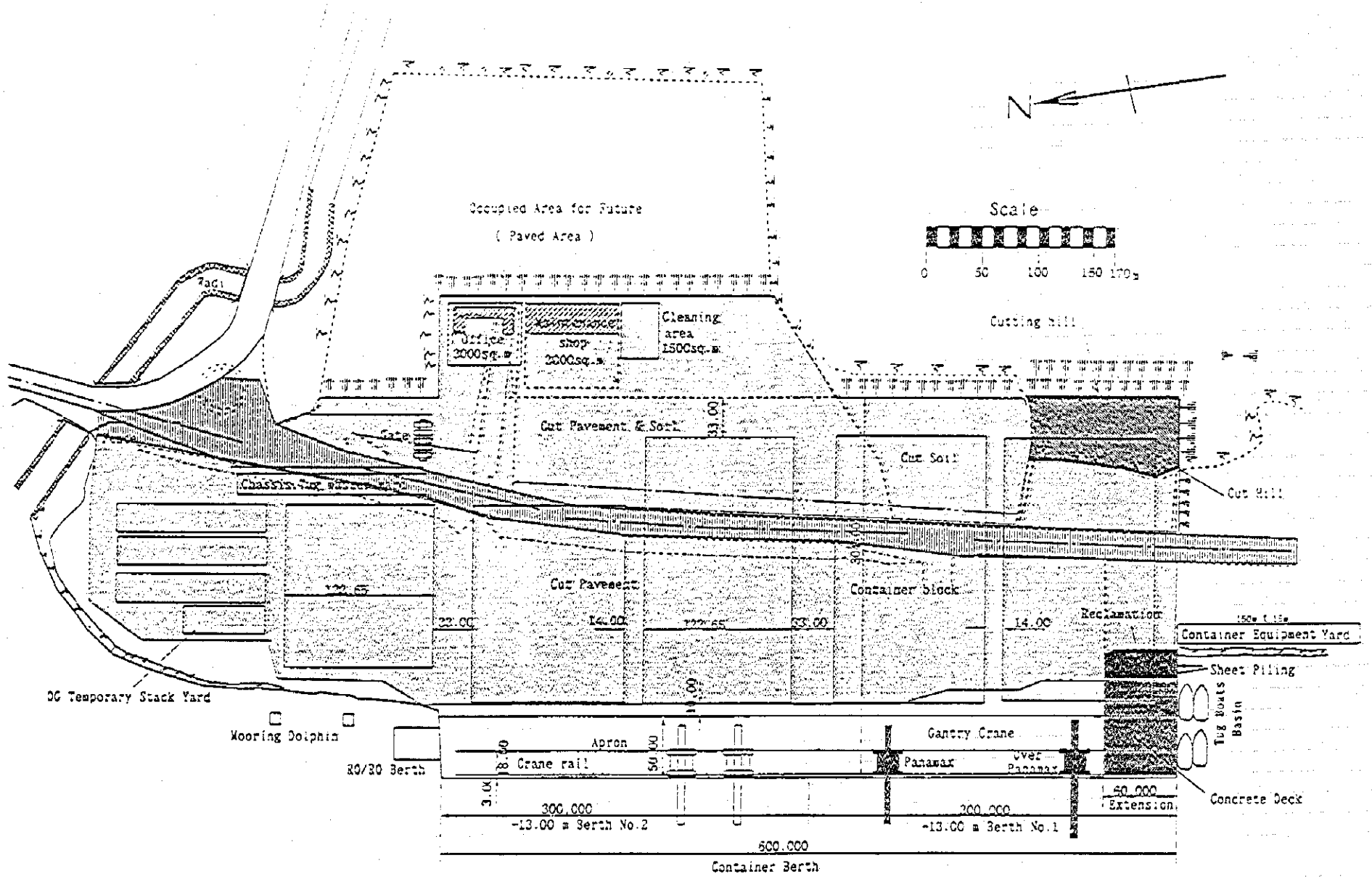

Figure 4.9.6 Land Preparation of Container Yard & Extension of Berth

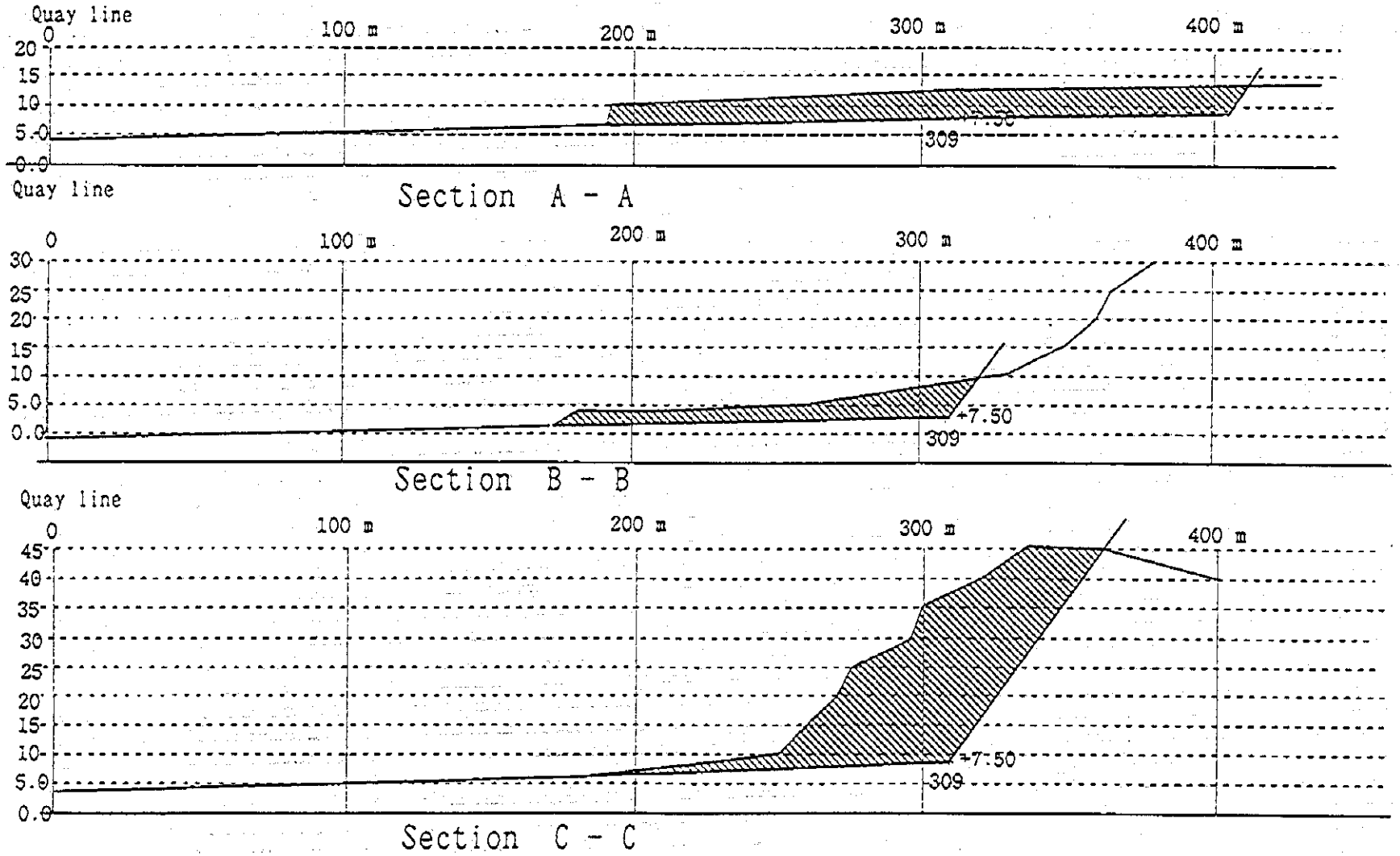

Figure 4.9.7 Section of Cutting at Container Yard

Table 4.9.5 Equipment to be procured

Name of equipment	Spec. of equipment	Necessary number	Procured number
Gantry Crane	Panamax Type	3	1 unit
	Over Panamax Type	1	1 unit
Transfer Crane	Tire-amount Type	10	10 unit
Forklift	40 ton/lifting cap.	0	00 unit
	15-25 ton/lifting cap.	5	00 unit
	7-14 ton/lifting cap.	10	00 unit
	5 ton/lifting cap.	0	00 unit
Trailer	Tug Master	26	20 unit
	Chassis	36	31 unit
(for All the Ports)			
Tug Boat	2000 ps	3	1 fleet
	3000 ps	*(4) 3	(3)2 fleet

Note : In case of Scenario(1), 4 tugboats are required.

(3) Industrial Port

A berth for export of fertilizer and phosphate is planned nearby existing industrial berth in all political and economic scenarios of Master Plan. Facilities to be improved in the master plan involve the construction of jetty, trestle, control & angle tower and cargo handling machinery & equipment on the jetty.

A berth for import of live-stock is planned at existing Timber Jetty in all political and economic scenarios of master Plan. Facilities to be constructed in the Master Plan involve Jetty of 200 m. in Length, 2 mooring dolphins, road and necessary utilities.

In the scenario of case (1), the construction of a new oil berth is planned for accommodating 250,000 DWT oil tanker. Facilities to be improved in the Master Plan involve only the construction of berth and trestle, and exclude land preparation of tank yard & piping area, tanks, pipes, loading arms, fire fighting facilities and so on that might be prepared and constructed by the investor.