Plan A with respect to waves from all directions in that part of the basin located on the west of the line connecting the JCT No.3 Berth and the harbour entrance. Thus there are almost no difference between the wave height ratios under both alternative master plans.

On the other hand, that part of the harbour basin extending from the JCT No.1 Berth area to the Prince Vijaya Quay will be under the influence of the conditions of the North Harbor Entrance and the wave height ratio for that basin area takes substantially the same value as under the Short-term Plan which assumes the same harbor entrance conditions.

(iv) Future Plan A'

Under this plan, NNW waves will advance directly into the harbour basin despite the proposed rextension of the Southwest Breakwater and the construction of a new breakwater planned for a location offshore of the Northwest Breakwater. In consequence, the wave height ratio for the basin area will decrease slightly from that under Master Plan A and the new breakwater is not likely to have significant sheltering effects. With the westward shift of wave direction, however, the sheltering effects of the breakwater produced by its extension will tend to increase.

The area adjacent to the North Pier will be very calm as it will be well shielded against waves from all directions by the new offshore breakwater.

In the basin intervening between the Northwest Breakwater and the offshore breakwater, the contour line of the wave height ratio shows relatively moderate changes with varying wave directions.

(v) Future Plan B'

Under this plan, the layout of other breakwaters and the alignment of the reclamation areas in the harbour basin will remain the same with the exception of the Southwest Breakwater alignment. For this reason, the distribution of diffracted waves in the basin area under the Future Plan B' will be similar to that under the Future Plan A'.

(3) Degree of Calmnes in the Port

1) Critical Wave Height

Quayside cargo handling efficiency is affected by the motions of moored ships. The magnitude of ship motions varies widely depending on various factors including, among others, (1) the height, direction and period of waves, (2) direction and speed of winds, (3) type and size of ships moored, (4) method of taking mooring lines, and (5) stiffness of fenders. The variations are very complex. (*)

Table 6-3-3 summarizes the results of a survey conducted on the relationship between the motions of moored vessels and the operating efficiency of gantry cranes in the Port of Reykjavik, Iceland.

(*) Shigeru Ueda; "Analytical Method of Ship Motions Moored to Quay Walls and Applications".
Technical Note of the Port & harbour Research Institute. (Ministry of Transport) No. 504, Dec. 1984. (in Japanese)

Table 6-3-5 Acceptable Ship Motions during Operation of Gantry Cranes (**)

Motion	Efficiency of Gantry Crane	
	90 - 100 %	50 %
Surge	0.6 - 1.0 m	2.0 m
Sway	0.6 - 0.8 m	2.0 m
Yaw	0.5 deg.	1.5 deg.
Heave	0.6 - 0.9 m	1.2 m
Pitch	1.5 deg.	2.0 deg.
Roll	3.0 deg.	6.0 deg.

Table 6-3-6 presents the results of Japanese surveys on the relationship between cargo handling operations and ship motions. The data presented in the table are the modified amounts of ship motions allowing cargo handling as determined from numerical simulations performed on actual cases reported from various Japanese ports in which cargo handling had to be suspended due to the motions of the ships moored. The values determined from the simulations were modified to reflect the views of cargo handling operators obtained from questionnaires.

(**) Pre Study of Vessel Movements and Container Handling Rates. In Jaye Container Terminal, Colombo Port, Dec. 1987, Lanka Hydraulic Institute Ltd.

Reference: Ship Movement in Harbours
- A joint Nordic project involving Denmark, Finland, the Faroe Islands, Iceland, Norway and Sweden, Nov. 1986

Table 6-3-6 Allowable Ship Motions (*)

Type of Ship	Component of Ship Motions					
	Surging (m)	Swaying (m)	Heaving (m)	Rolling (deg)	Pitching (deg)	Yawing (deg)
General Cargo Ships	± 1.0	+ 0.75	± 0.5	± 2.5	± 1.0	± 1.5
Grain Carriers	± 1.0	+ 0.5	± 0.5	± 1.0	± 1.0	± 1.0
Ore Carriers	± 1.0	+ 1.0	± 0.5	± 3.0	± 1.0	± 1.0
Oil Carriers (D)	± 1.0	+ 0.75	± 0.5	± 4.0	± 2.0	± 2.0
Oil Carriers (F)	± 1.0	+ 0.75	± 0.5	± 3.0	± 1.5	± 1.5

1) D: Domestic F: Foreign
2) + of swaying means away from a berth

Of the five major factors affecting the amounts of ship motions earlier noted, the factor having direct bearing on the layout planning of breakwaters is the characteristics of incoming waves, of which the most critical is wave height.

Therefore, taking account of the relevant Japanese standards, we have defined the critical wave heights for cargo handling operations for different ship sizes, in order to compare the degree of calmness for the various points under the layouts discussed in 6-3-3 (1).

Ship Size (Gross Tons)	Critical Wave Height (H/3) (m)
Less than 1,000	0.3
1,000 to less than 5,000	0.5
5,000 and over	0.7

(*) Shigeru Ueda: "The Allowable Ship Motions for Cargo Handling at Wharves."
Report of the Port and Harbour Research Institute, Vol. 27, No.4, Dec. 1988

2) Degree of Calmness in the Port

The degree of calmness in respect of the different critical wave heights have been determined from the wave height ratios of Fig. 6-3-8 (1) to 6-3-8 (25), and the frequency of wave height occurrence by wave direction shown in Table 6-3-4. Table 6-3-7 gives the degree of calmness thus obtained. The points indicated in the table are given in Fig. 6-3-7.

(i) Critical Wave Height of 0.7 m

In the case of the critical wave height of 0.7 m, the degree of calmness is over 97.6 % for all the layouts and for points A to E. The lowest value is 93.1 % for Point F close to the North Entrance under the Short Term Plan and Master Plan B. With this degree of calmness, mooring, anchoring and loading/unloading of larger vessels would experience almost no difficulty.

(ii) Critical Wave Height of 0.5 m

In the case of this critical wave height, the degree of calmness is over 92.9 % for all the layouts and all points in the port except F, and loading/unloading of medium-size and larger vessels at these points would not be affected. The degree of calmness at Point F is 84.9 % under the Short-term Plan and under Master Plan B. This value may influence loading and unloading of medium-sized vessels to a certain extent. However, under Master Plan A calling for reducing the width of the North Harbour Entrance, the degree of calmness is 94.9 % and will not likely pose problems with cargo handling of ships at their moorings.

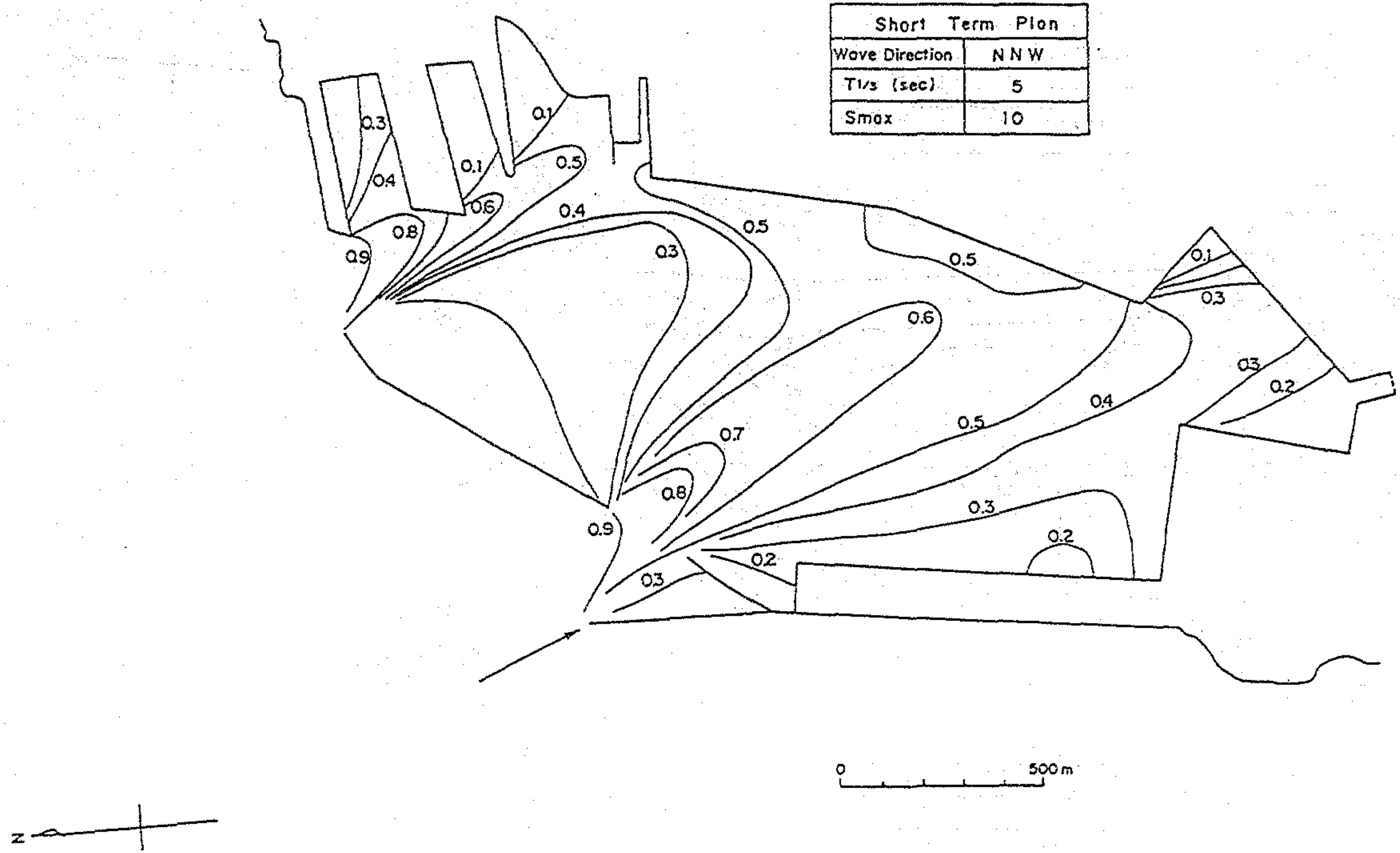
(iii) Critical Wave Height of 0.3 m

At Point A and in the boat basin in the innermost part of the port, the degree of calmness attains more than 95.7 %, but in other parts of the harbor basin mooring, anchoring and loading/unloading of smaller vessels may be affected more or less by incident waves from both entrances depending on the layout selected.

The Lanka Hydraulic Institute, at the request of SLPA, is currently carrying out hydraulic model tests in a wave basin in order to determine the degree of calmness of the harbor basin under the present conditions, the impacts of future facility layout planning on the calmness, and the effects on the loading/unloading of moored vessels by their motions (surging, swaying, etc.).

Table 6-3-7 Degree of Calmness in the Port (%)

Critical wave height	0.7 m					0.5 m					0.3 m				
Layout / Point	Short Term Plan	Master Plan A	Master Plan B	Future Plan A'	Future Plan B'	Short Term Plan	Master Plan A	Master Plan B	Future Plan A'	Future Plan B'	Short Term Plan	Master Plan A	Master Plan B	Future Plan A'	Future Plan B'
A	100	100	100	100	100	100	100	99.9	100	100	97.1	97.1	95.7	99.9	99.9
B	99.9	98.9	98.4	100	100	97.5	96.0	94.9	98.4	98.4	89.2	88.5	87.0	92.1	92.2
C	99.5	98.4	98.4	98.7	98.7	96.7	95.0	94.9	95.3	95.3	86.3	86.0	85.8	87.1	87.0
D	98.4	98.0	97.6	99.9	99.9	93.6	93.8	92.9	97.8	97.8	81.8	81.9	80.7	91.0	91.1
E	98.3	100	98.7	100	100	94.1	98.7	95.4	100	100	82.3	91.9	86.5	100	100
F	93.1	98.6	93.1	100	100	84.9	94.9	84.9	100	100	68.7	84.1	68.7	100	100
G	64.9	64.9	64.9	98.7	98.7	52.7	52.7	52.7	95.6	95.6	44.8	44.8	44.8	81.9	81.9
H	64.9	64.9	64.9	98.9	98.8	52.7	52.7	52.7	96.3	96.2	44.8	44.8	44.8	83.5	83.1



Short Term Plan	
Wave Direction	N N W
T1/3 (sec)	5
Smax	10

Fig. 6-3-8 (1) Wave Height Ratio

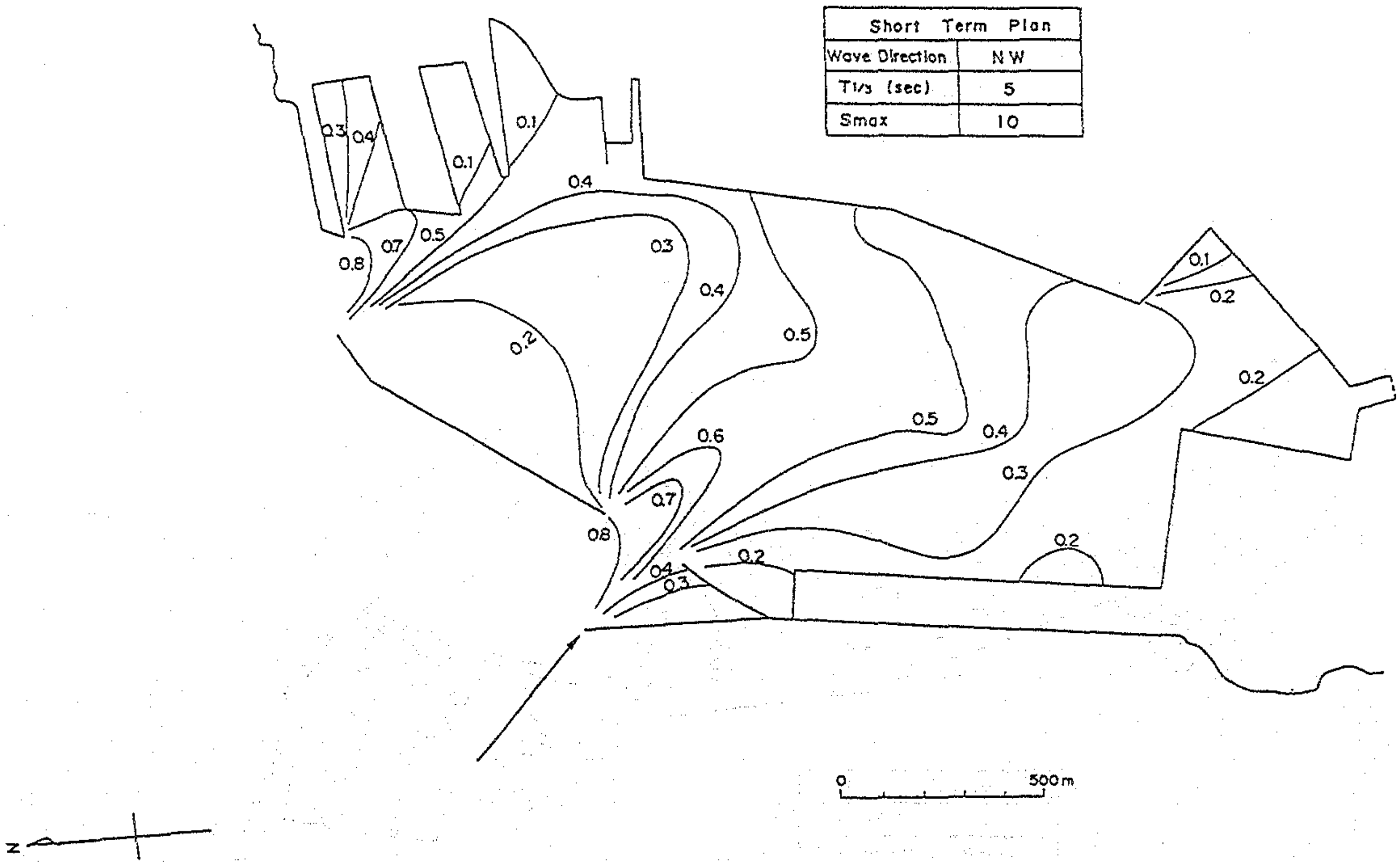


Fig. 6-3-8 (2) Wave Height Ratio

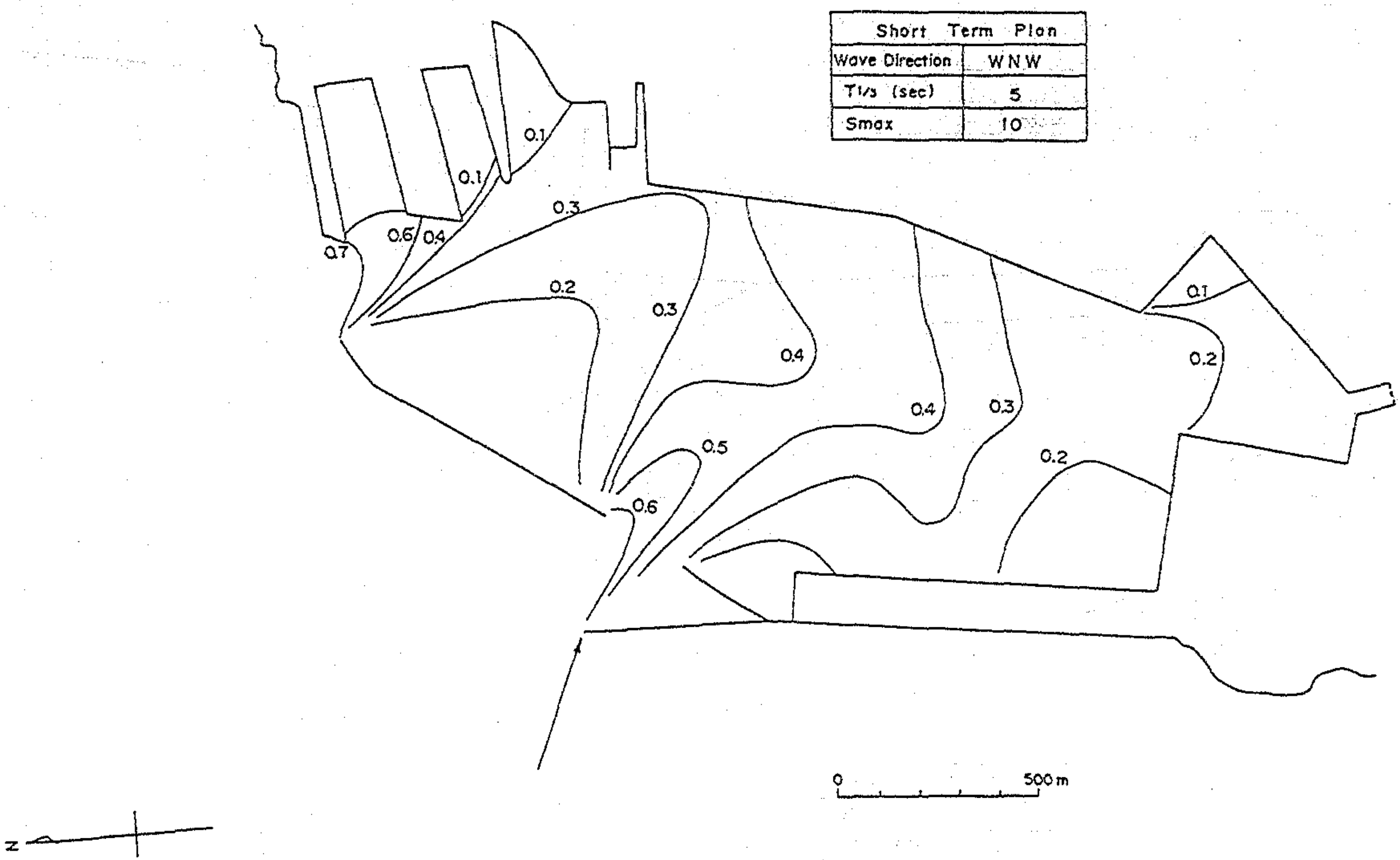
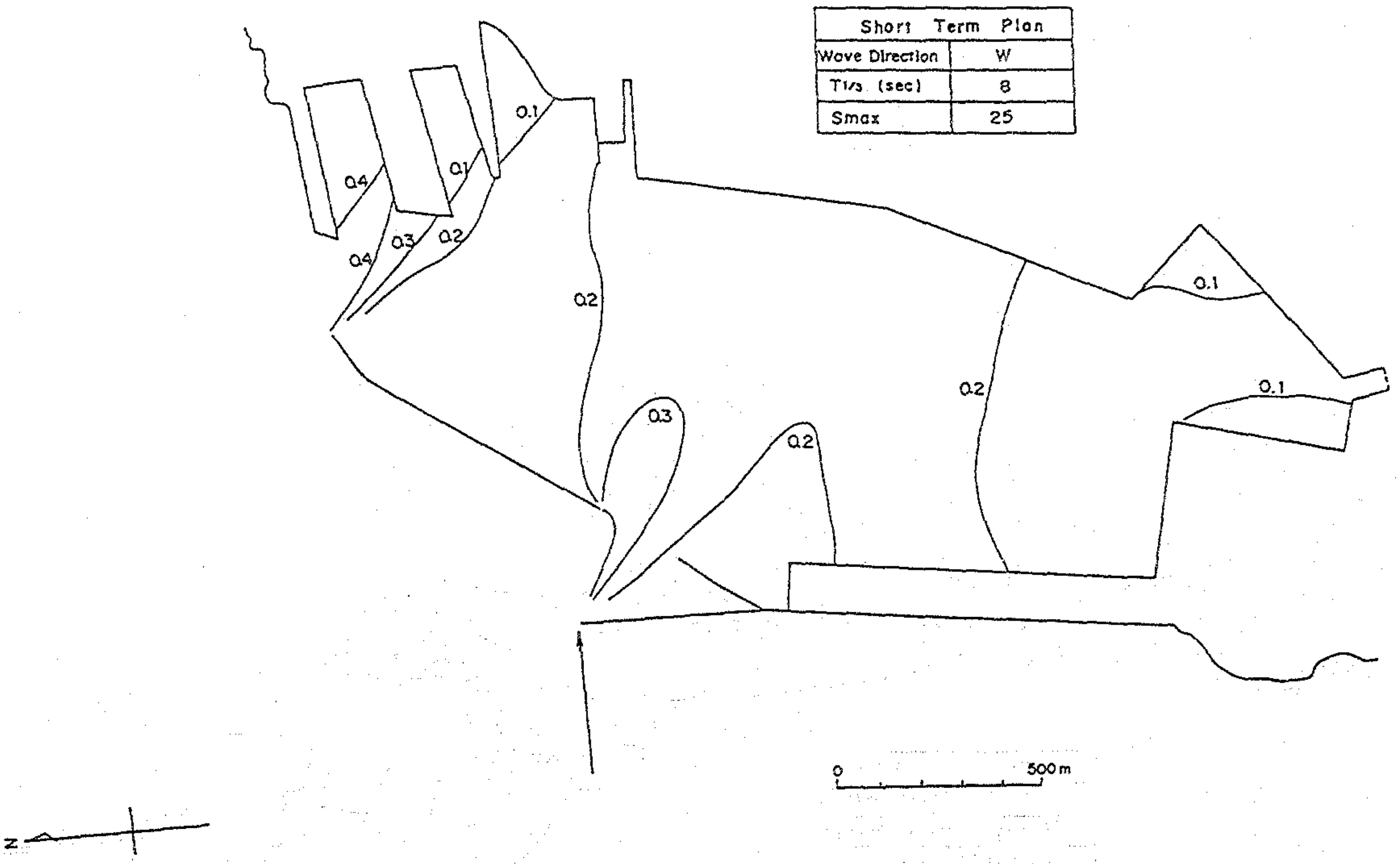


Fig. 6-3-8 (3) Wave Height Ratio



Short Term Plan	
Wave Direction	W
T1/3 (sec)	8
Smax	25

Fig. 6-3-8 (4) Wave Height Ratio

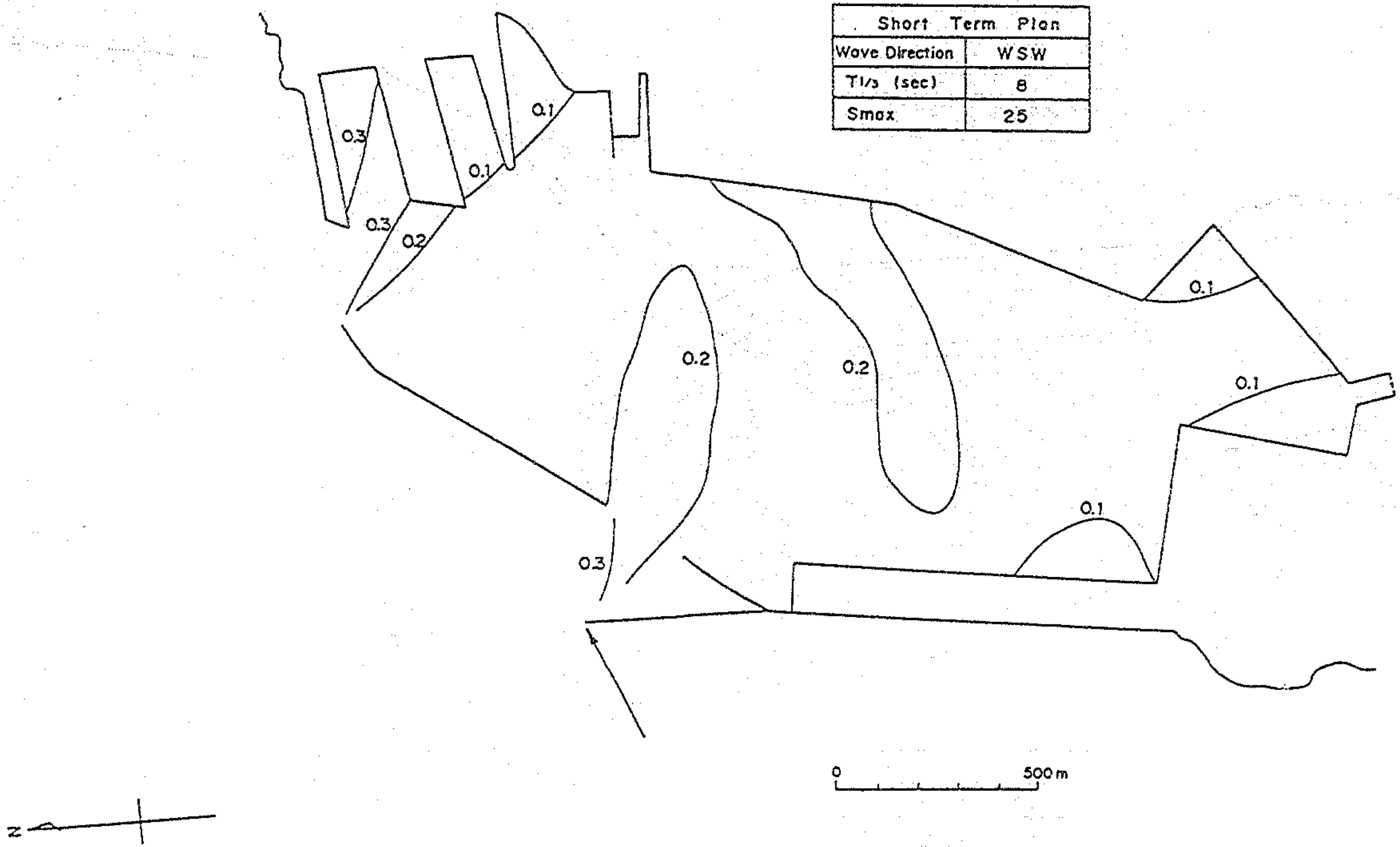


Fig. 6-3-8 (5) Wave Height Ratio

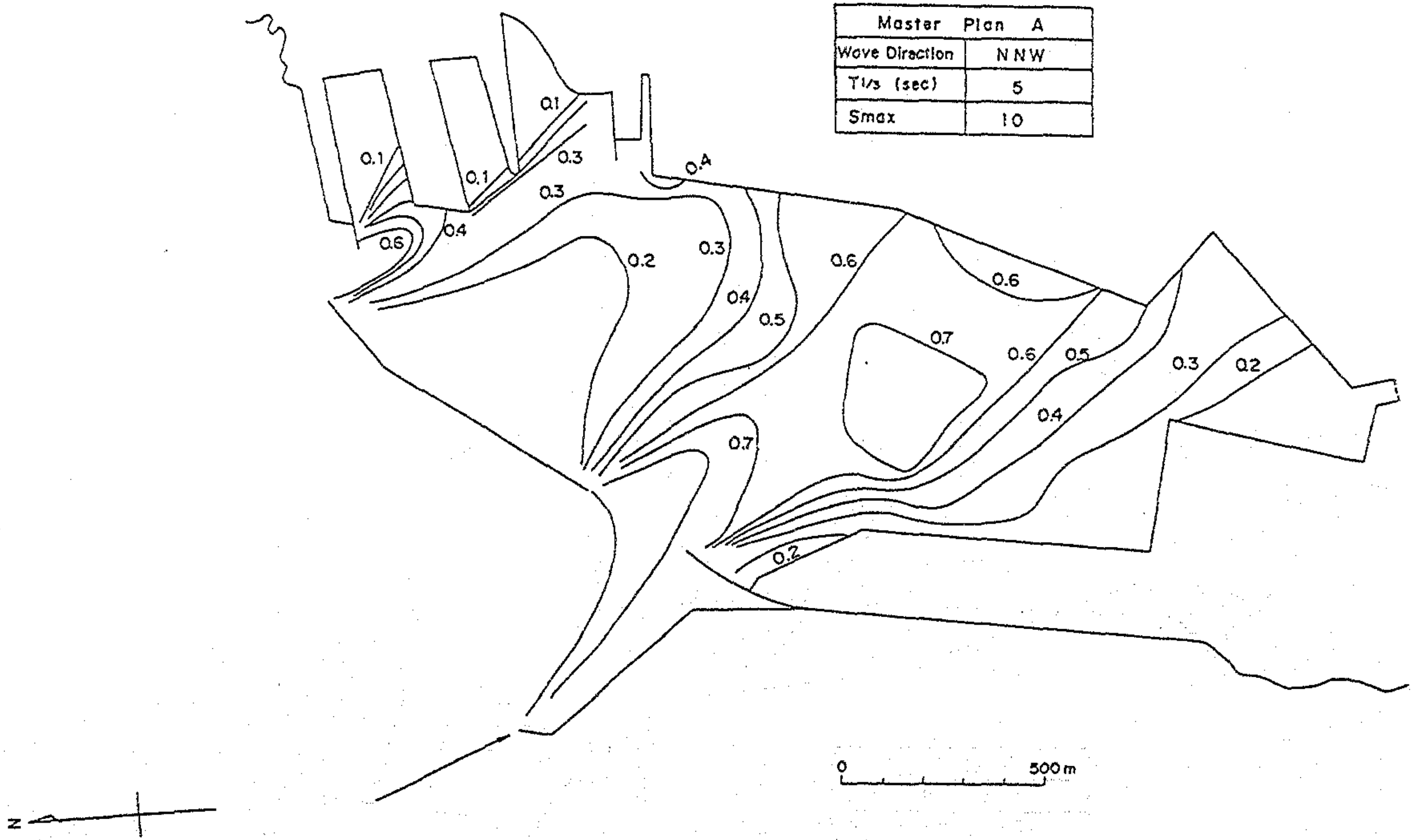
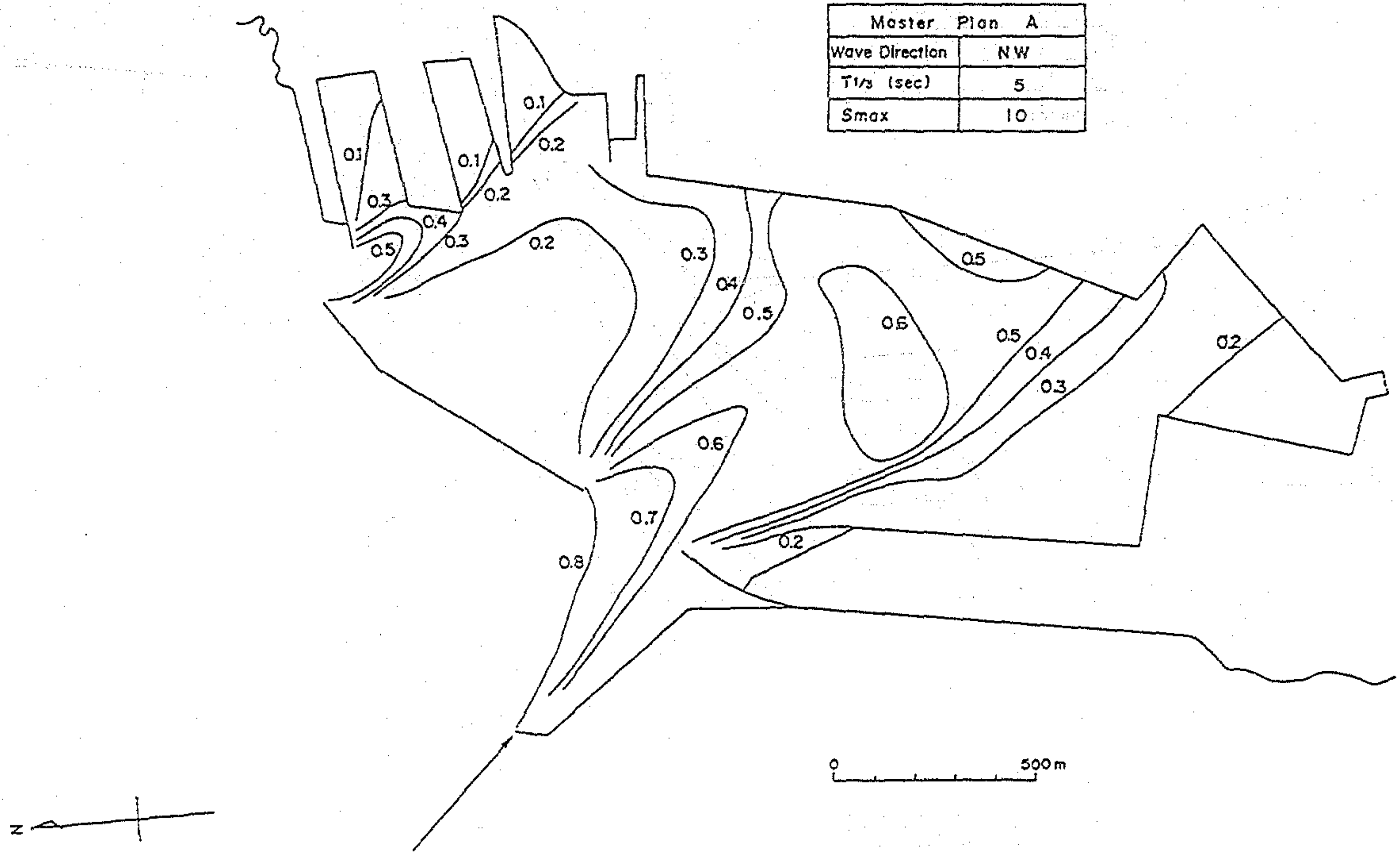
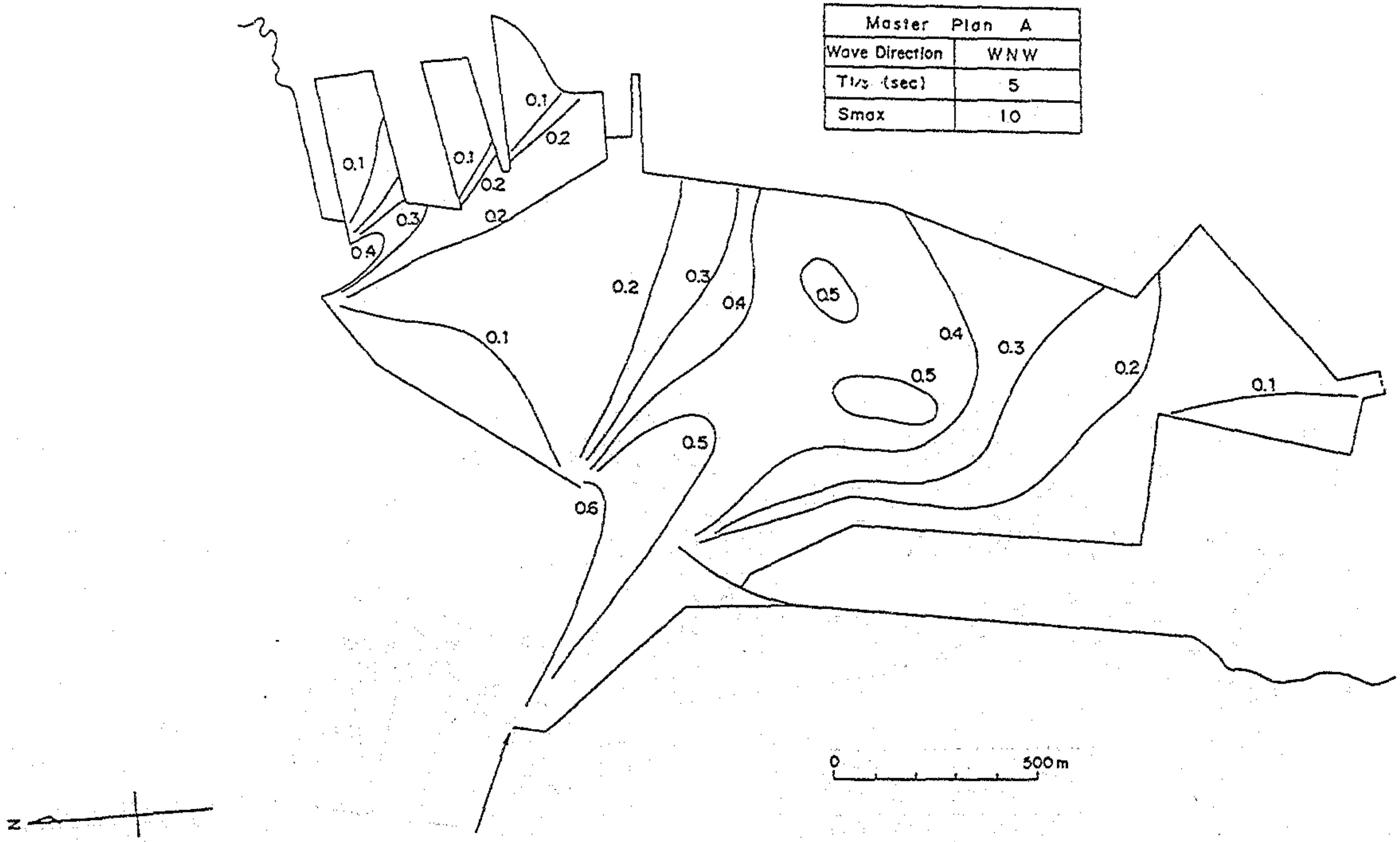


Fig. 6-3-8 (6) Wave Height Ratio



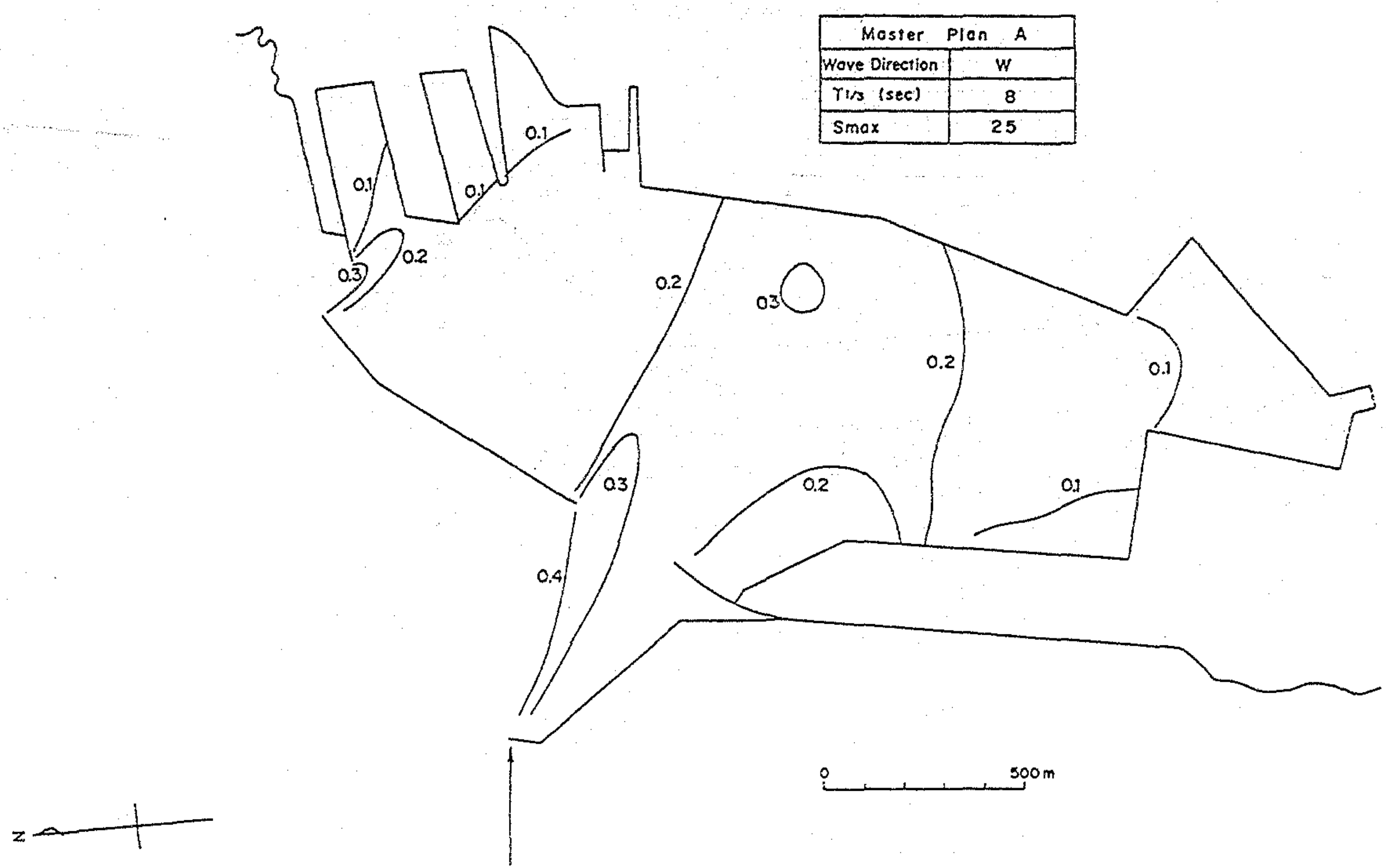
Master Plan A	
Wave Direction	NW
T1/3 (sec)	5
Smax	10

Fig. 6-3-8 (7) Wave Height Ratio



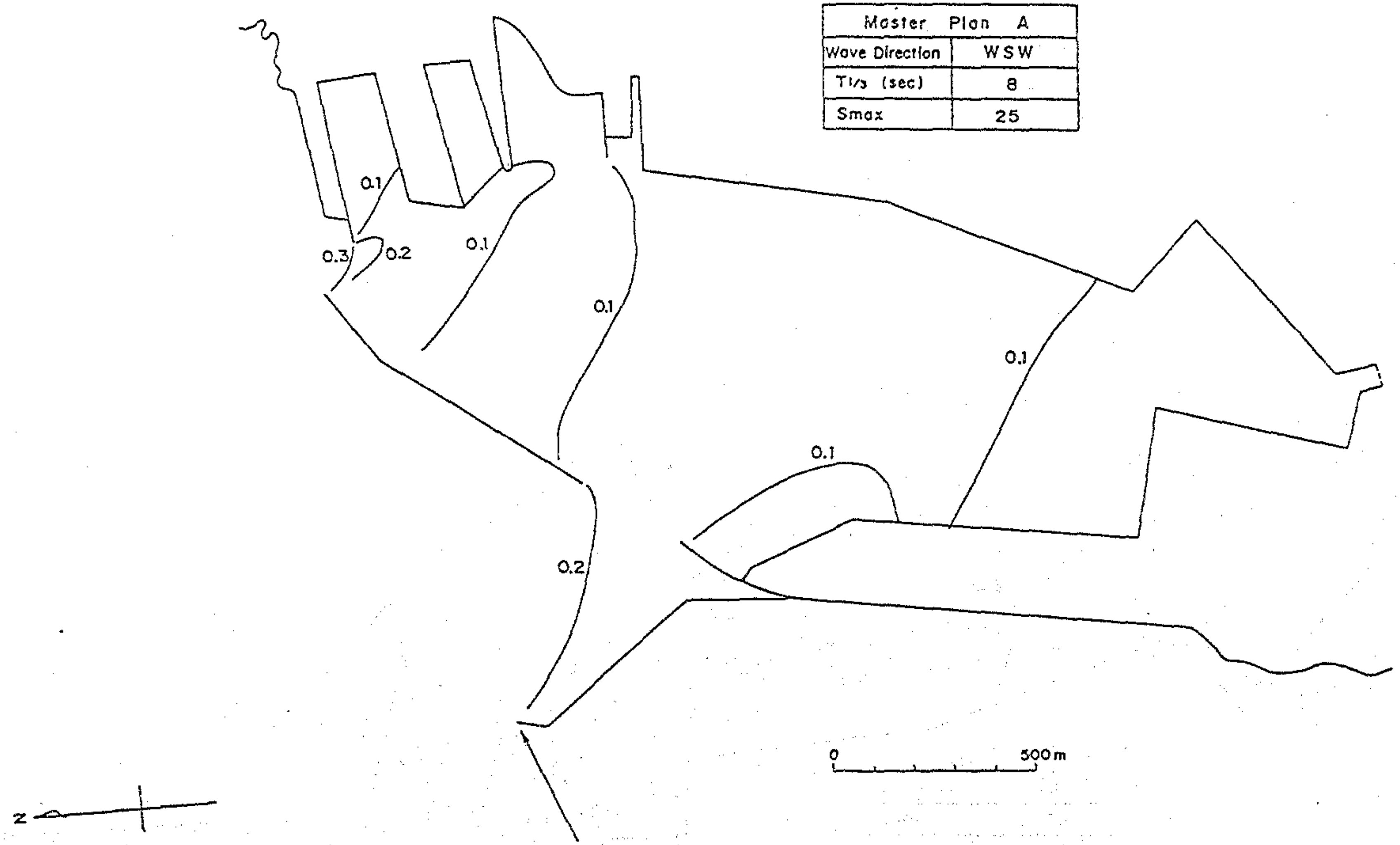
Master Plan A	
Wave Direction	WNW
T1/3 (sec)	5
Smax	10

Fig. 6-3-8 (8) Wave Height Ratio



Master Plan A	
Wave Direction	W
T1/3 (sec)	8
Smax	25

Fig. 6-3-8 (9) Wave Height Ratio



Master Plan A	
Wave Direction	WSW
T1/3 (sec)	8
Smax	25

Fig. 6-3-8 (10) Wave Height Ratio

Master Plan B	
Wave Direction	NNW
T1/3 (sec)	5
Smax	10

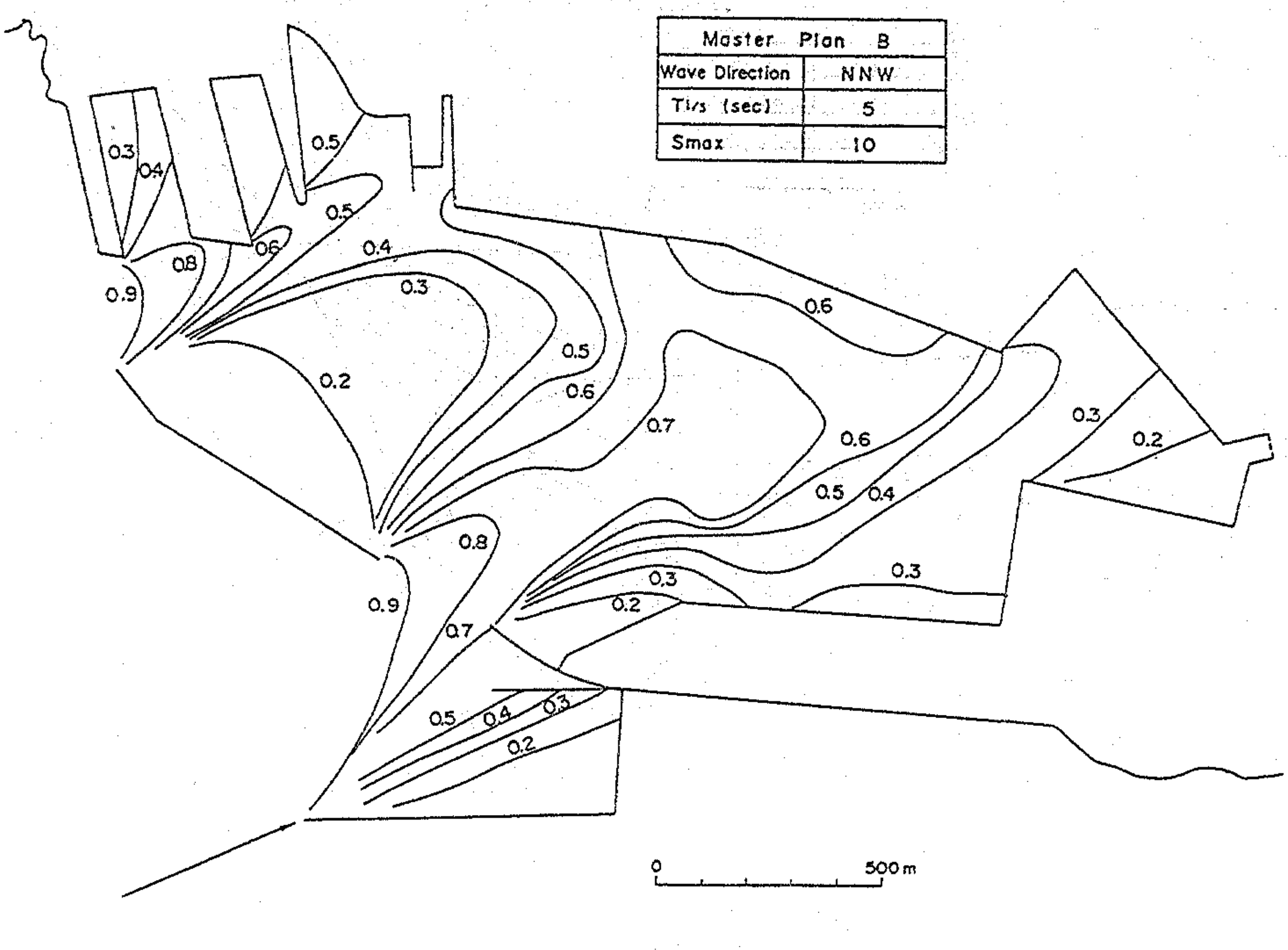


Fig. 6-3-8 (11) Wave Height Ratio

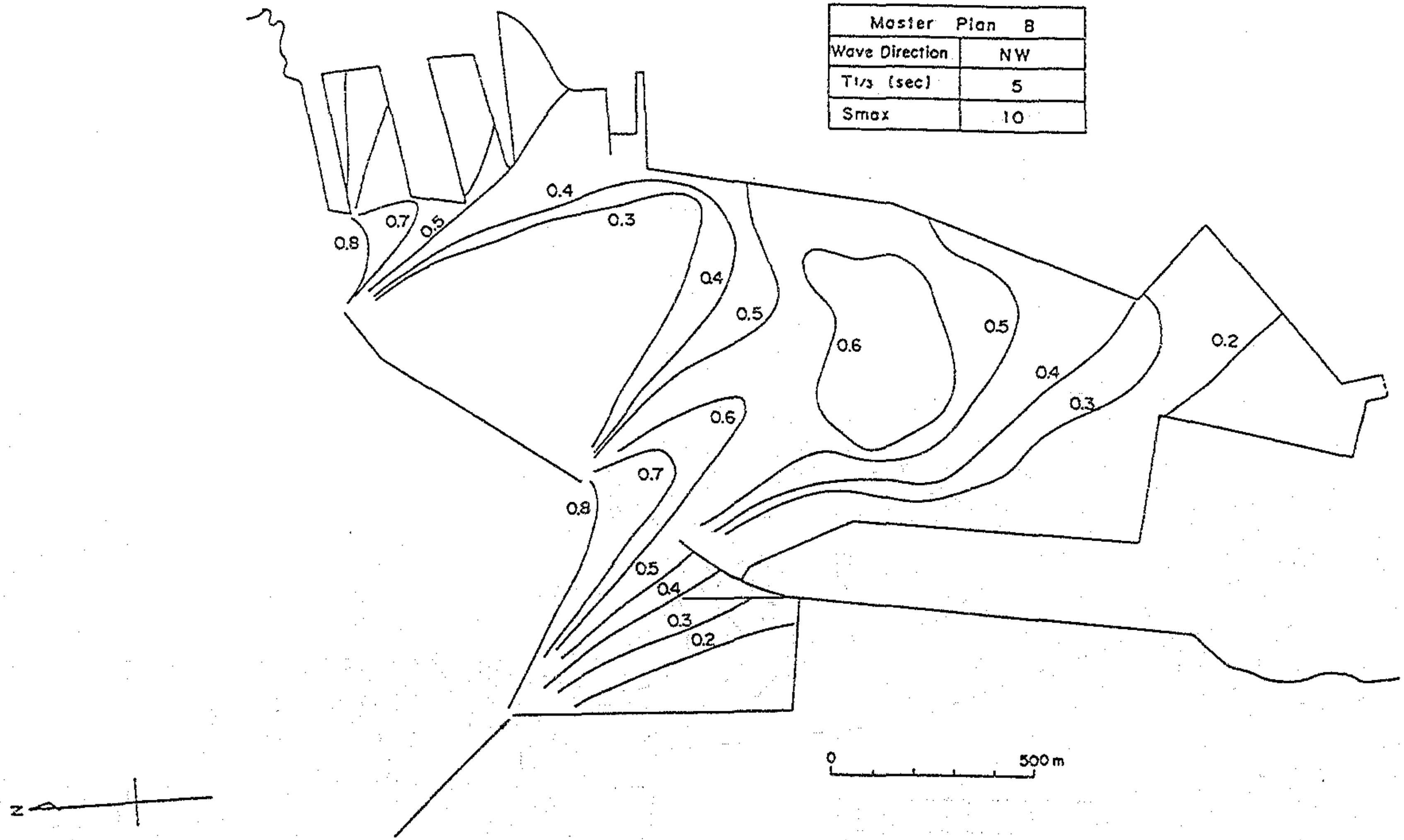


Fig. 6-3-8 (12) Wave Height Ratio

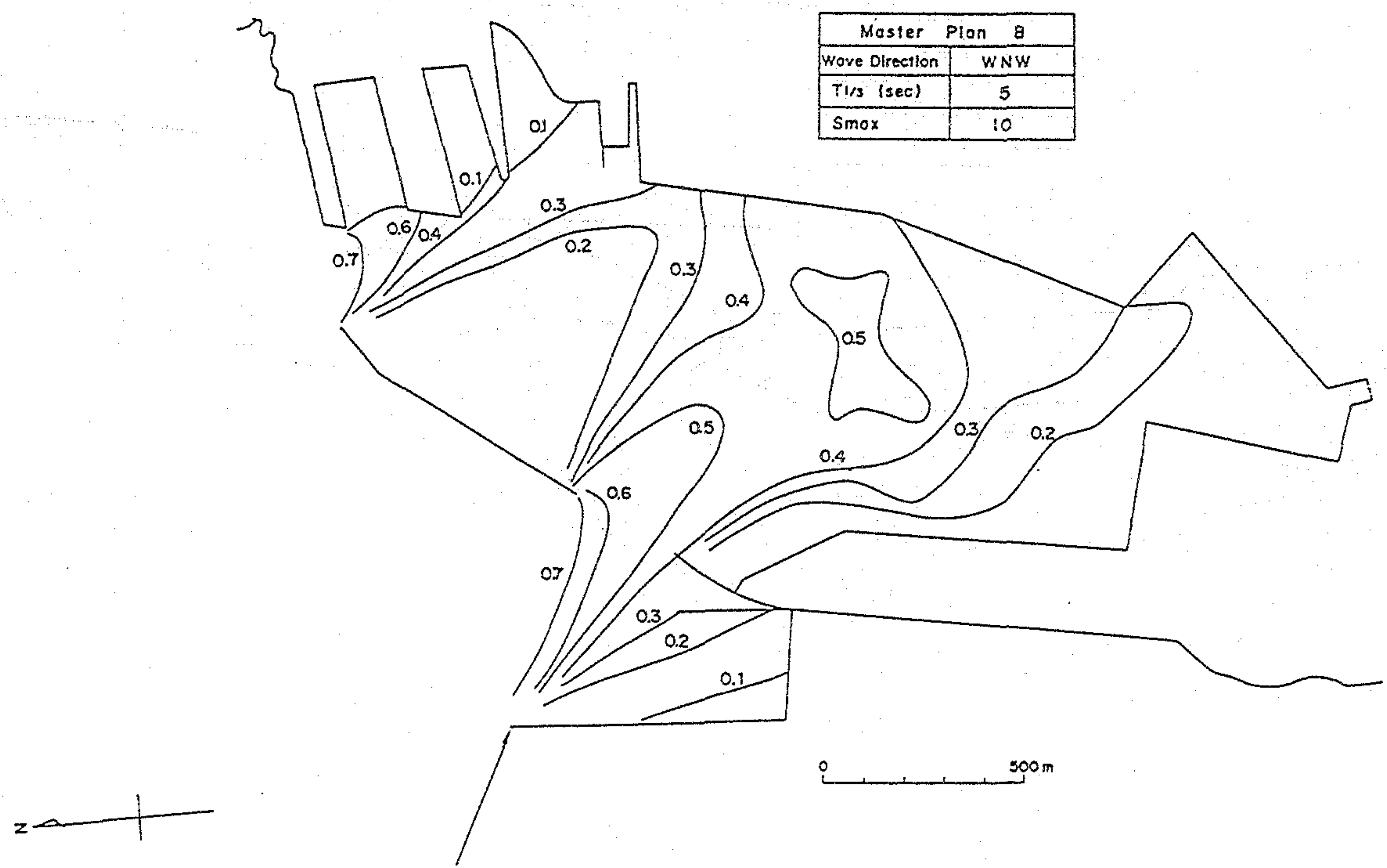


Fig. 6-3-8 (13) Wave Height Ratio

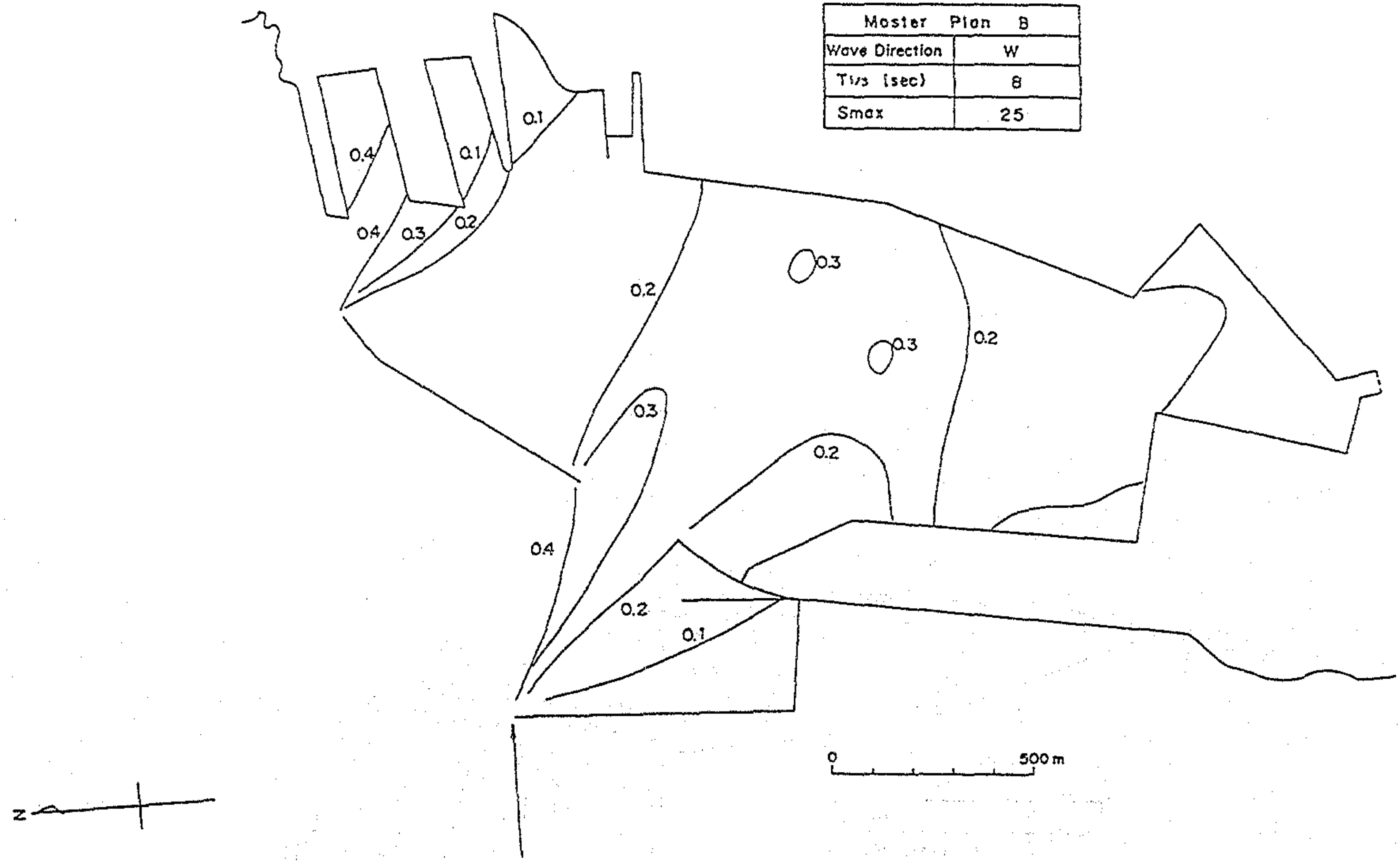
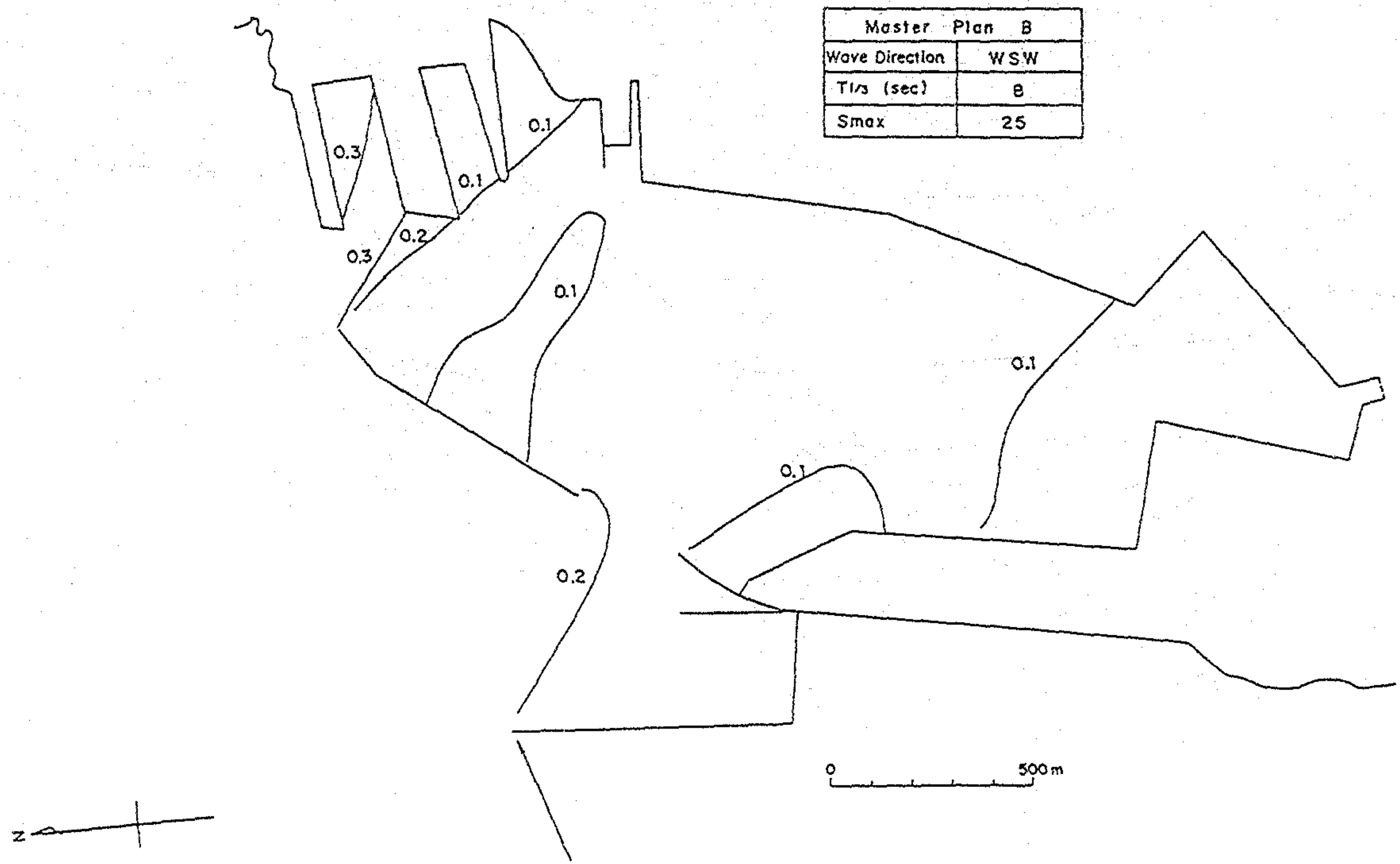
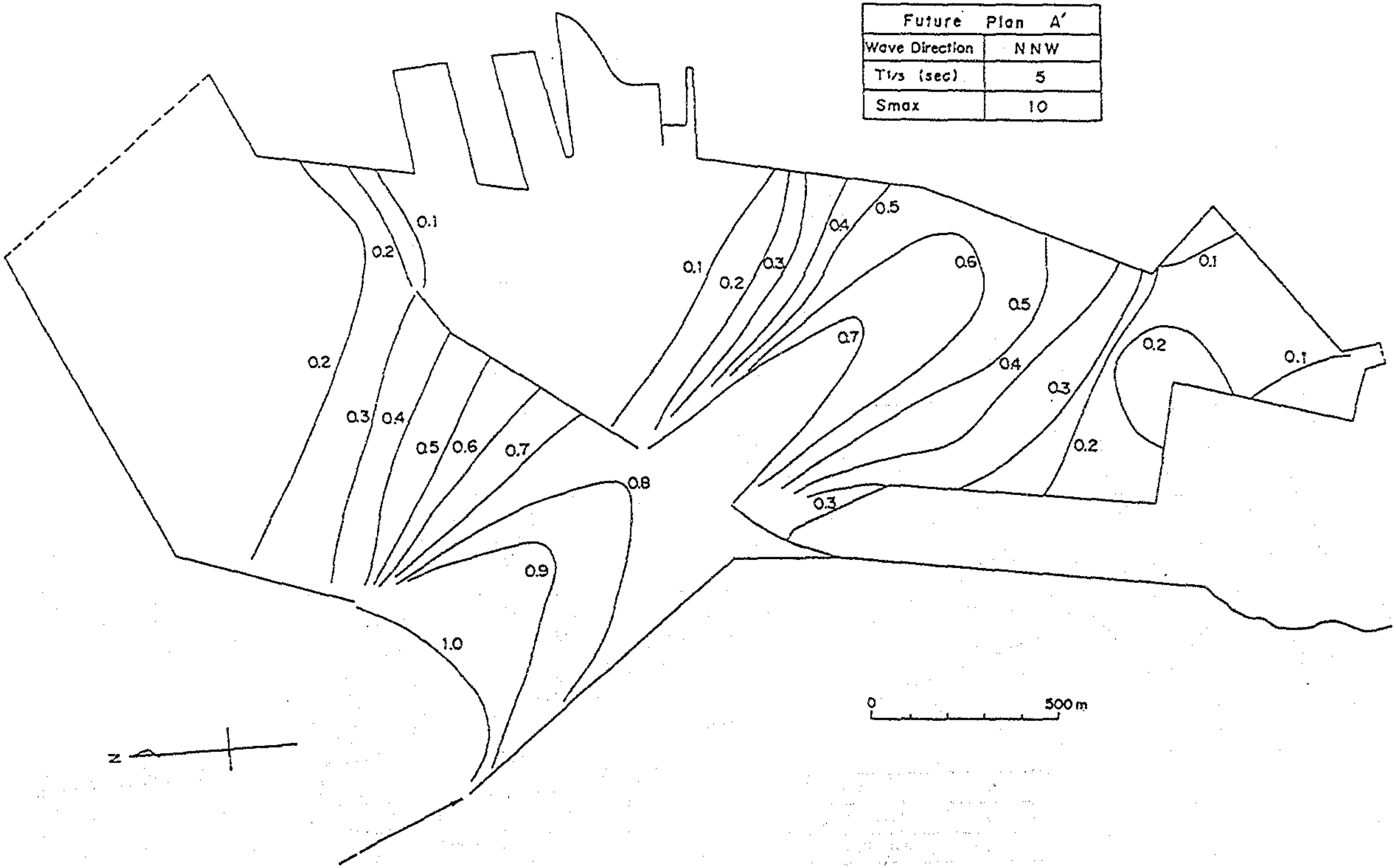


Fig. 6-3-8 (14) Wave Height Ratio



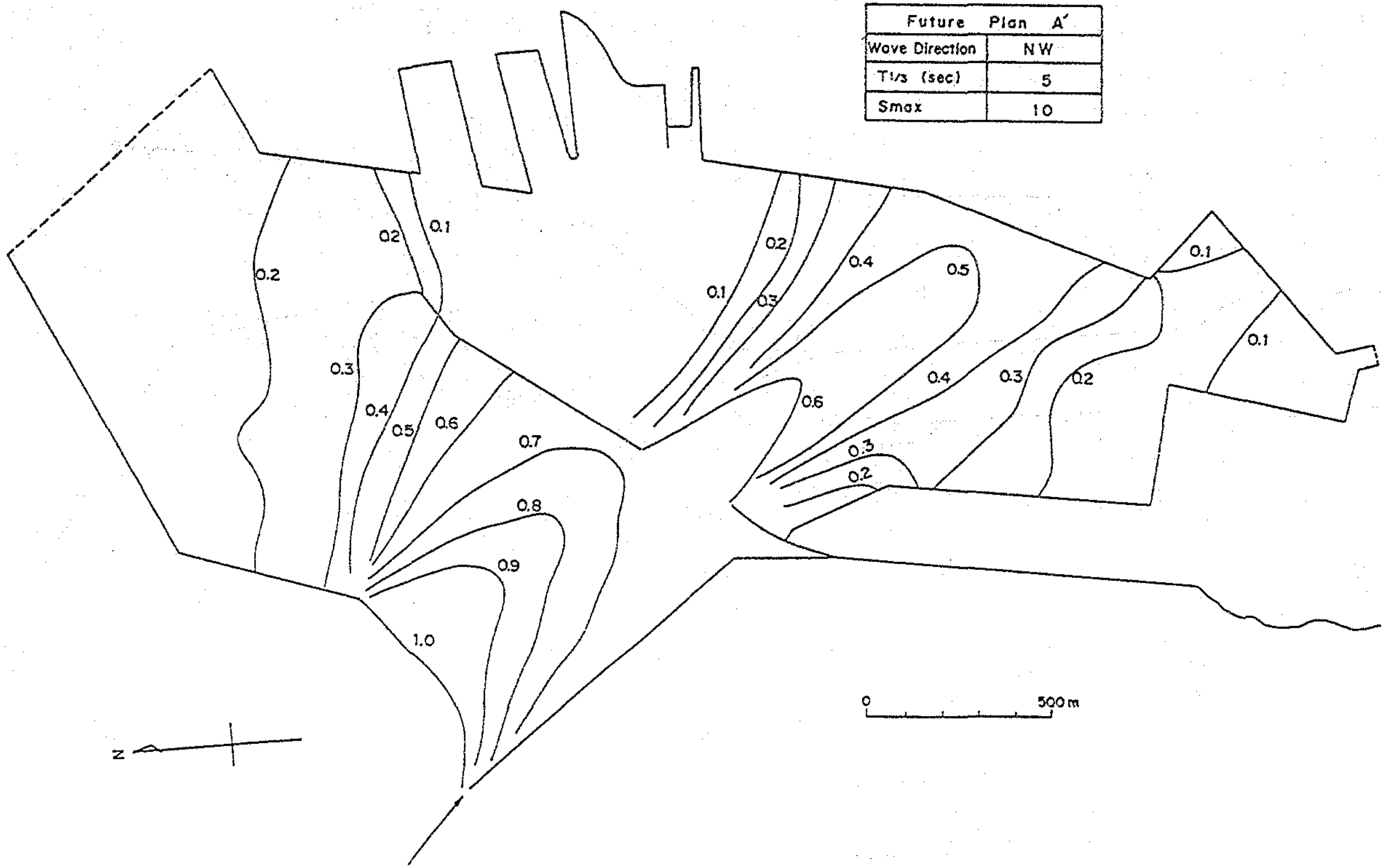
Master Plan B	
Wave Direction	WSW
T1/3 (sec)	8
Smax	25

Fig. 6-3-8 (15) Wave Height Ratio



Future Plan A′	
Wave Direction	NNW
T1/3 (sec)	5
Smax	10

Fig. 6-3-8 (16) Wave Height Ratio



Future Plan A'	
Wave Direction	NW
T1/3 (sec)	5
Smax	10

Fig. 6-3-8 (17) Wave Height Ratio

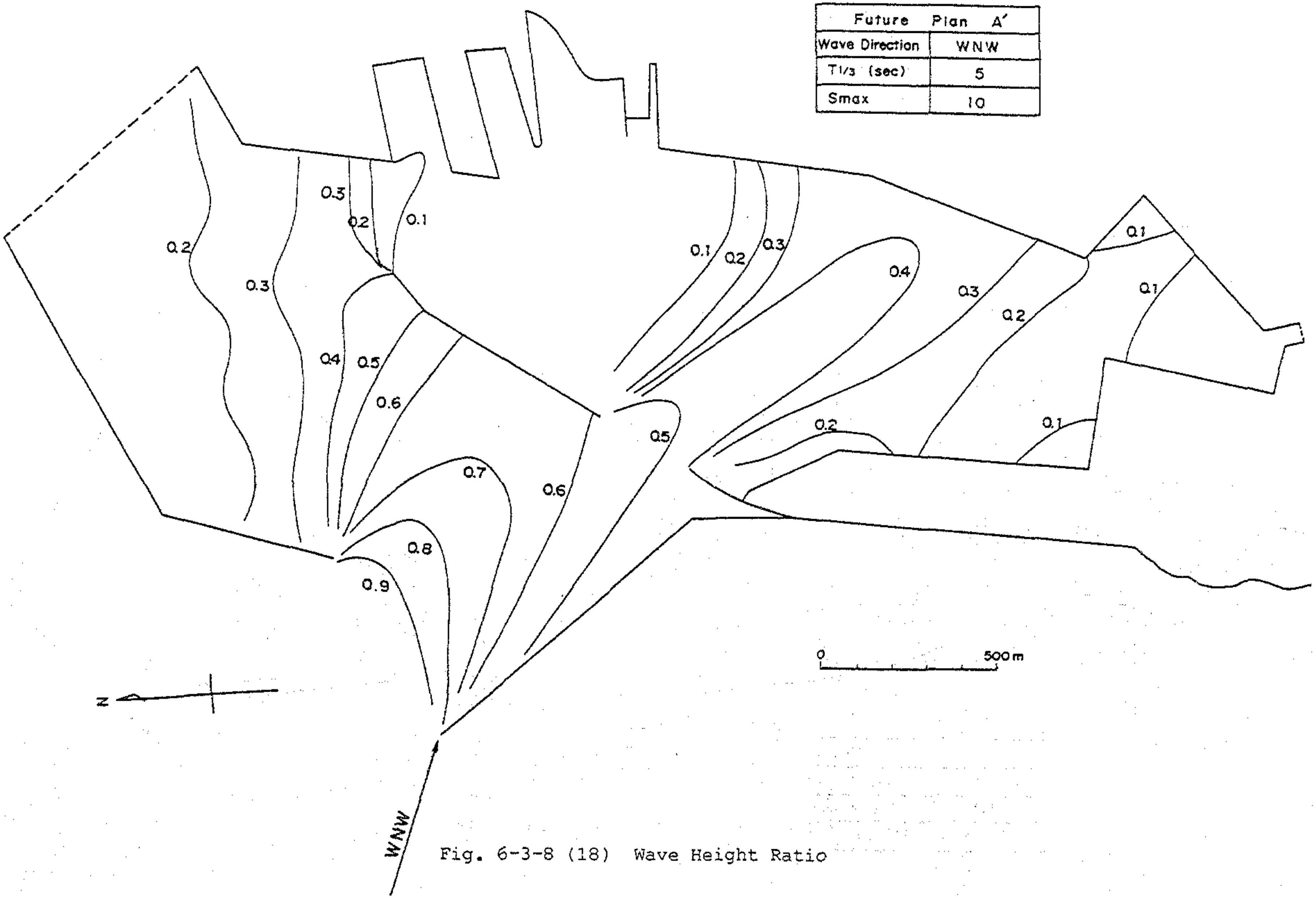


Fig. 6-3-8 (18) Wave Height Ratio

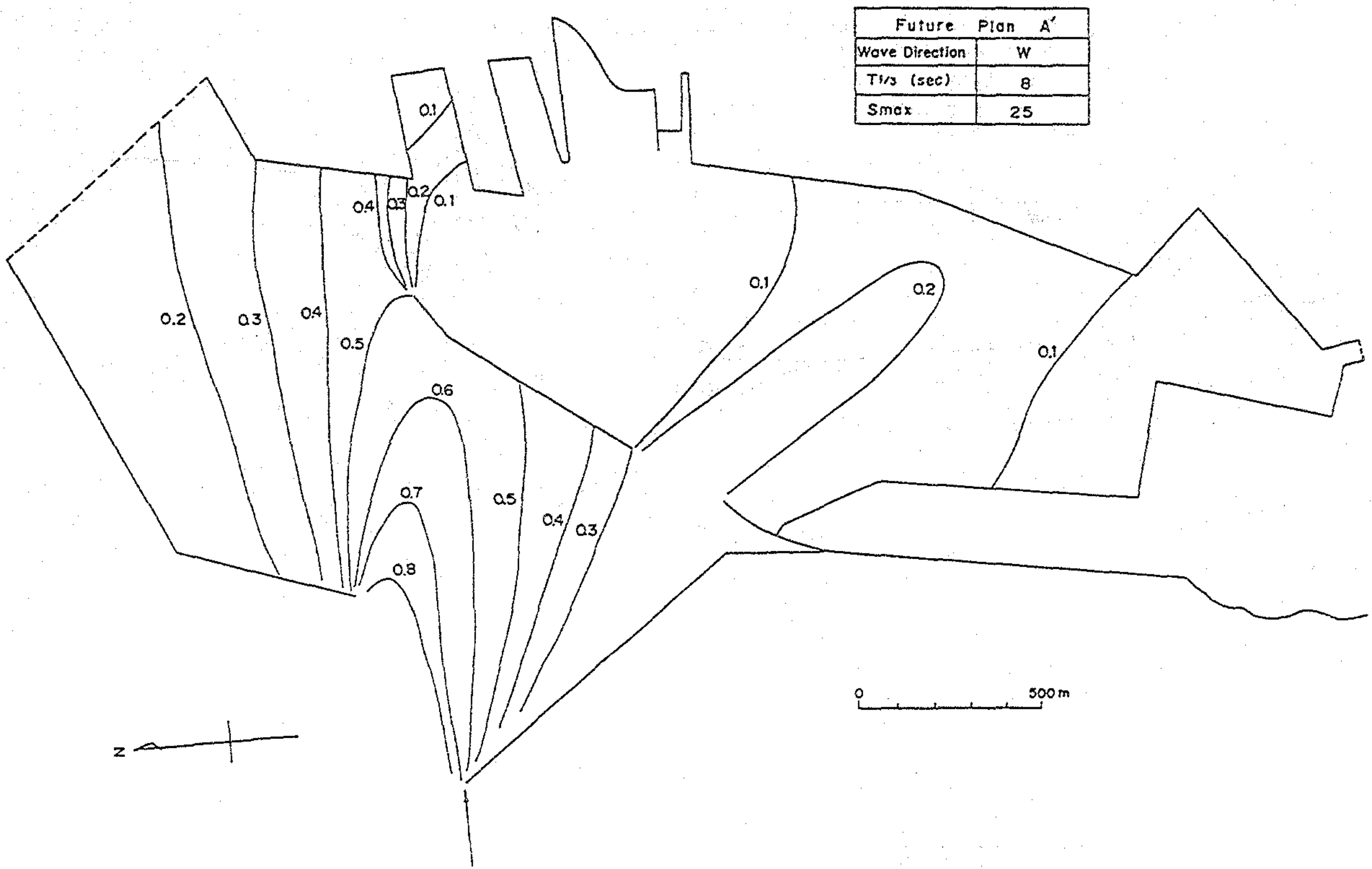


Fig. 6-3-8 (19) Wave Height Ratio

Future Plan A'	
Wave Direction	WSW
T1/3 (sec)	8
Smax	25

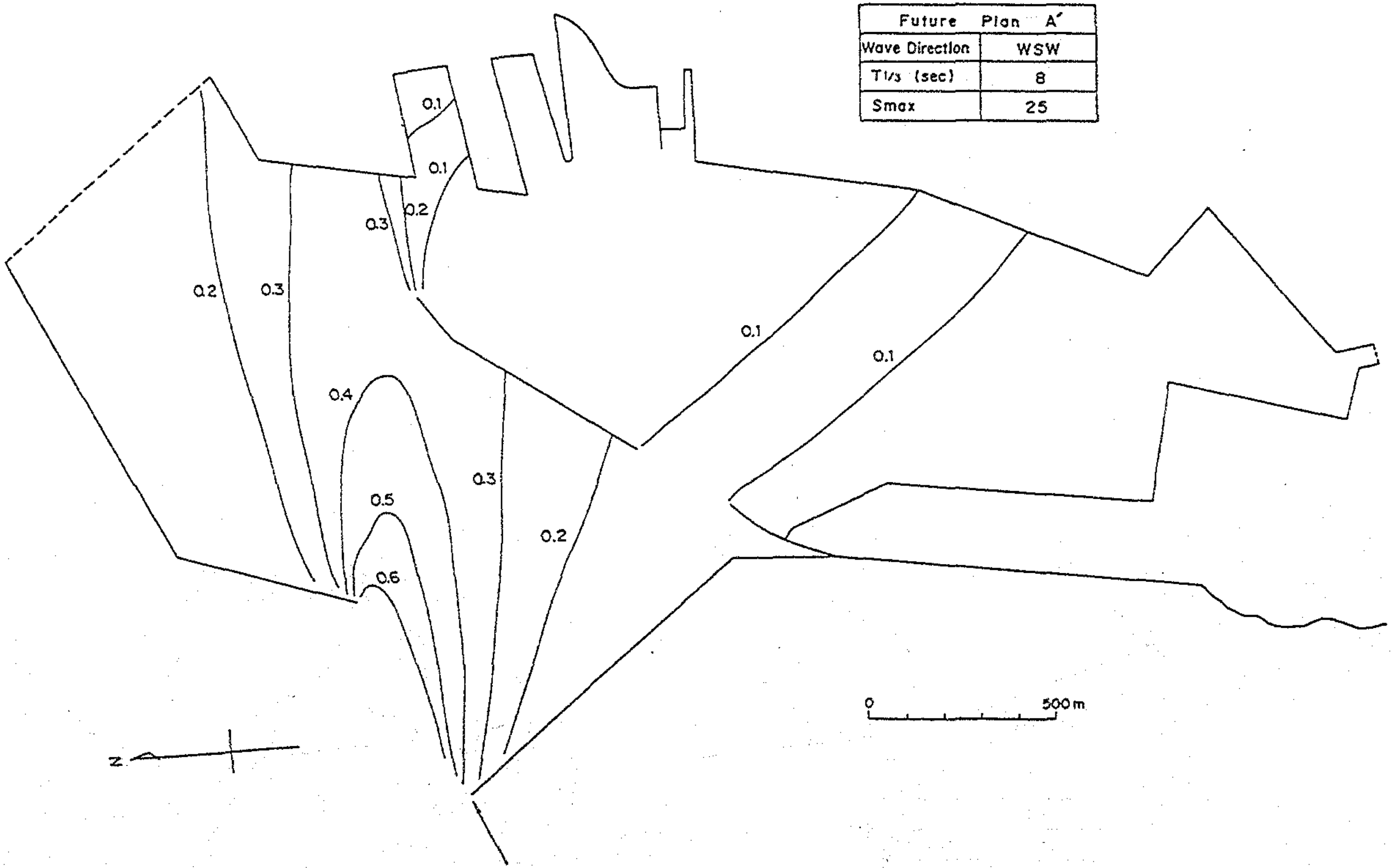


Fig. 6-3-8 (20) Wave Height Ratio

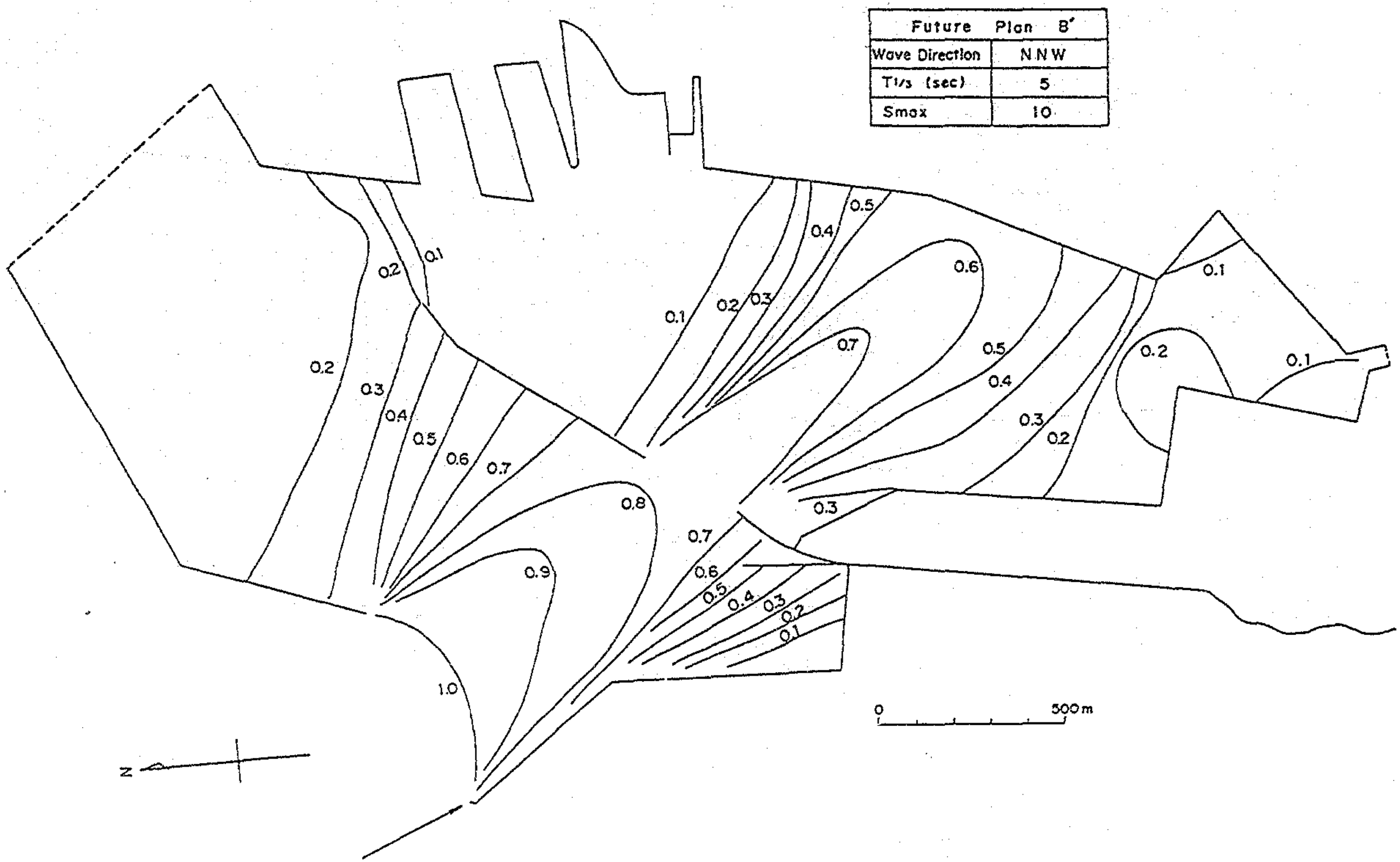


Fig. 6-3-8 (21) Wave Height Ratio

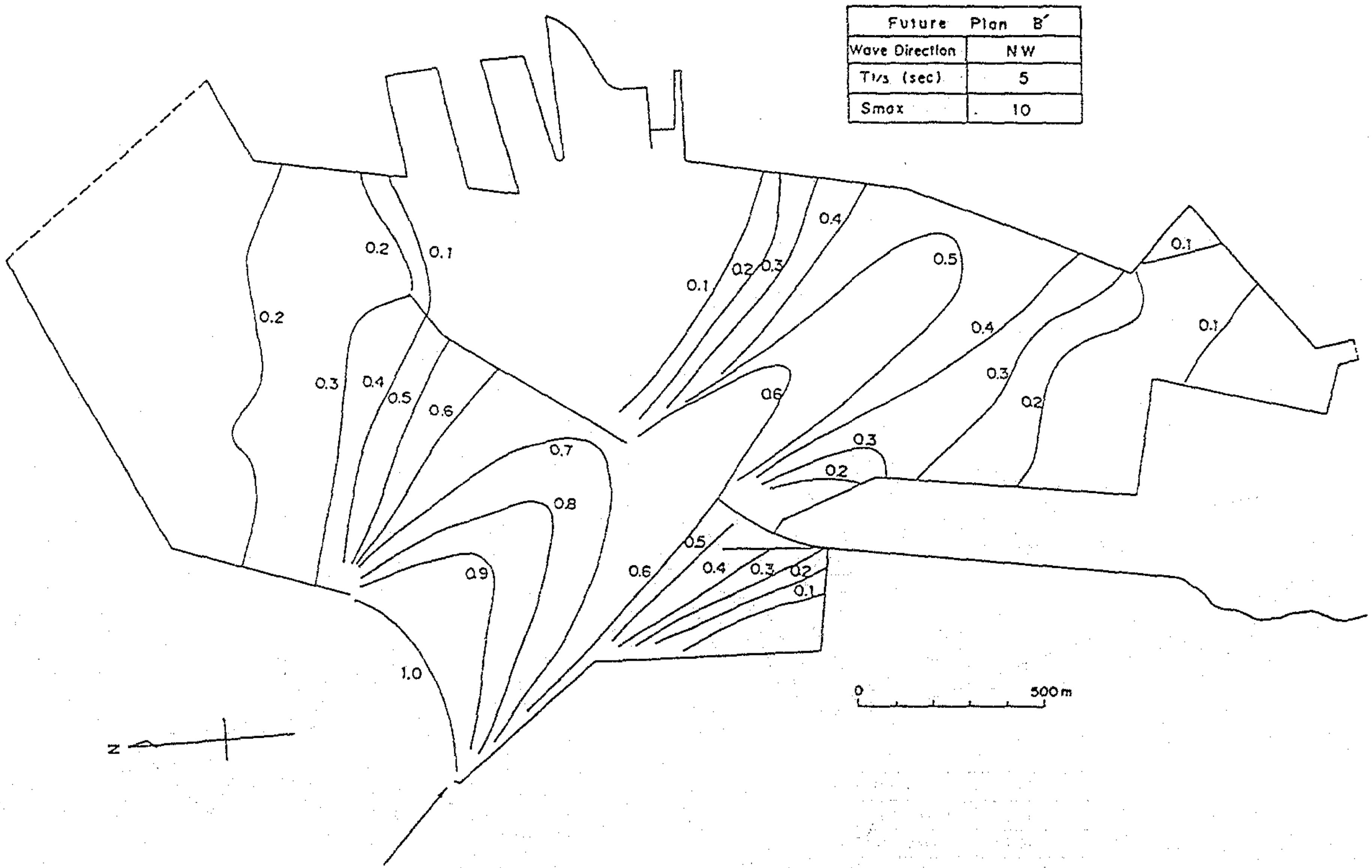
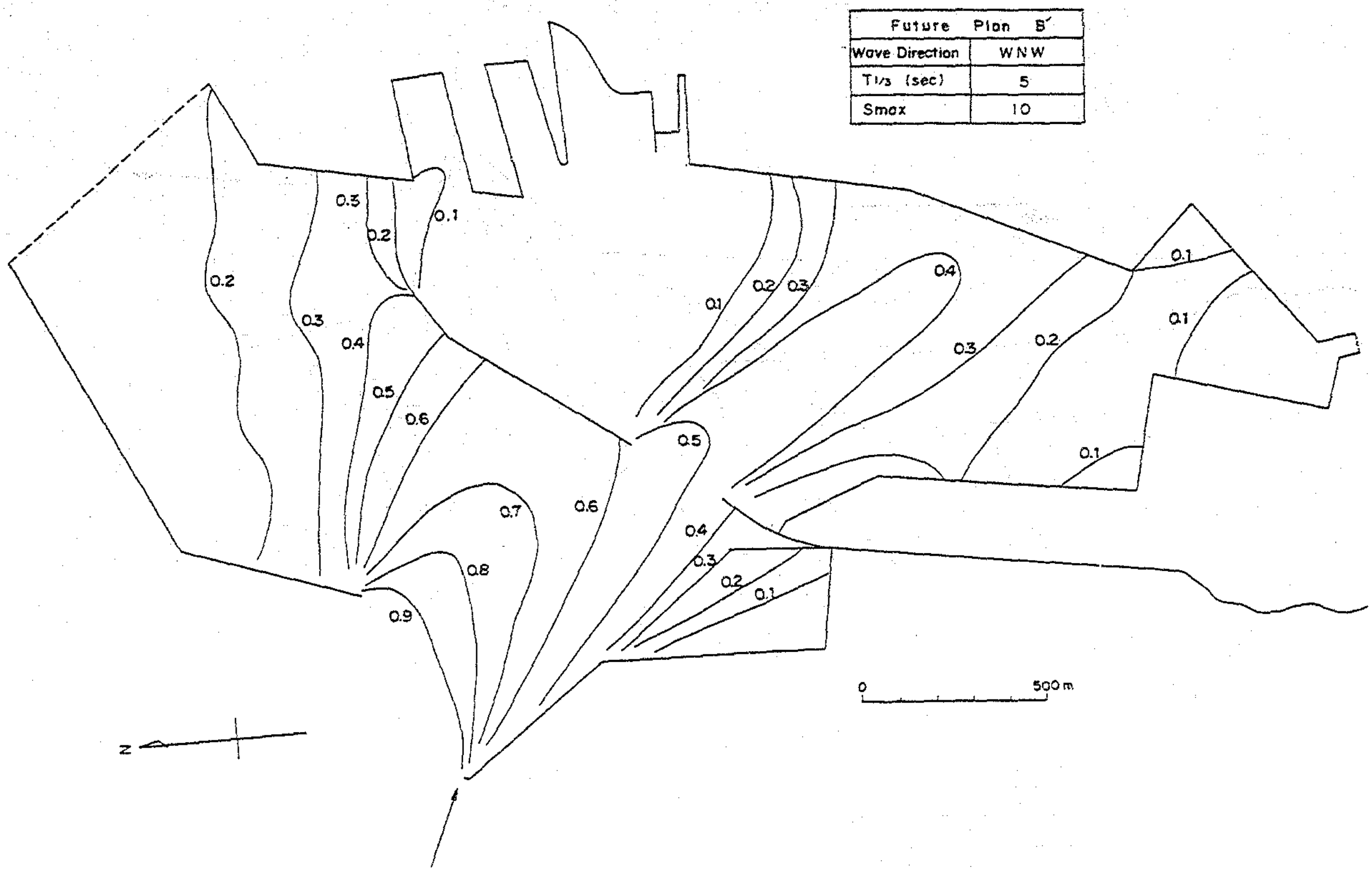


Fig. 6-3-8 (22) Wave Height Ratio



Future Plan B′	
Wave Direction	WNW
$T_{1/3}$ (sec)	5
Smax	10

Fig. 6-3-8 (23) Wave Height Ratio

Future Plan B′	
Wave Direction	W
T1/3 (sec)	8
Smax	25

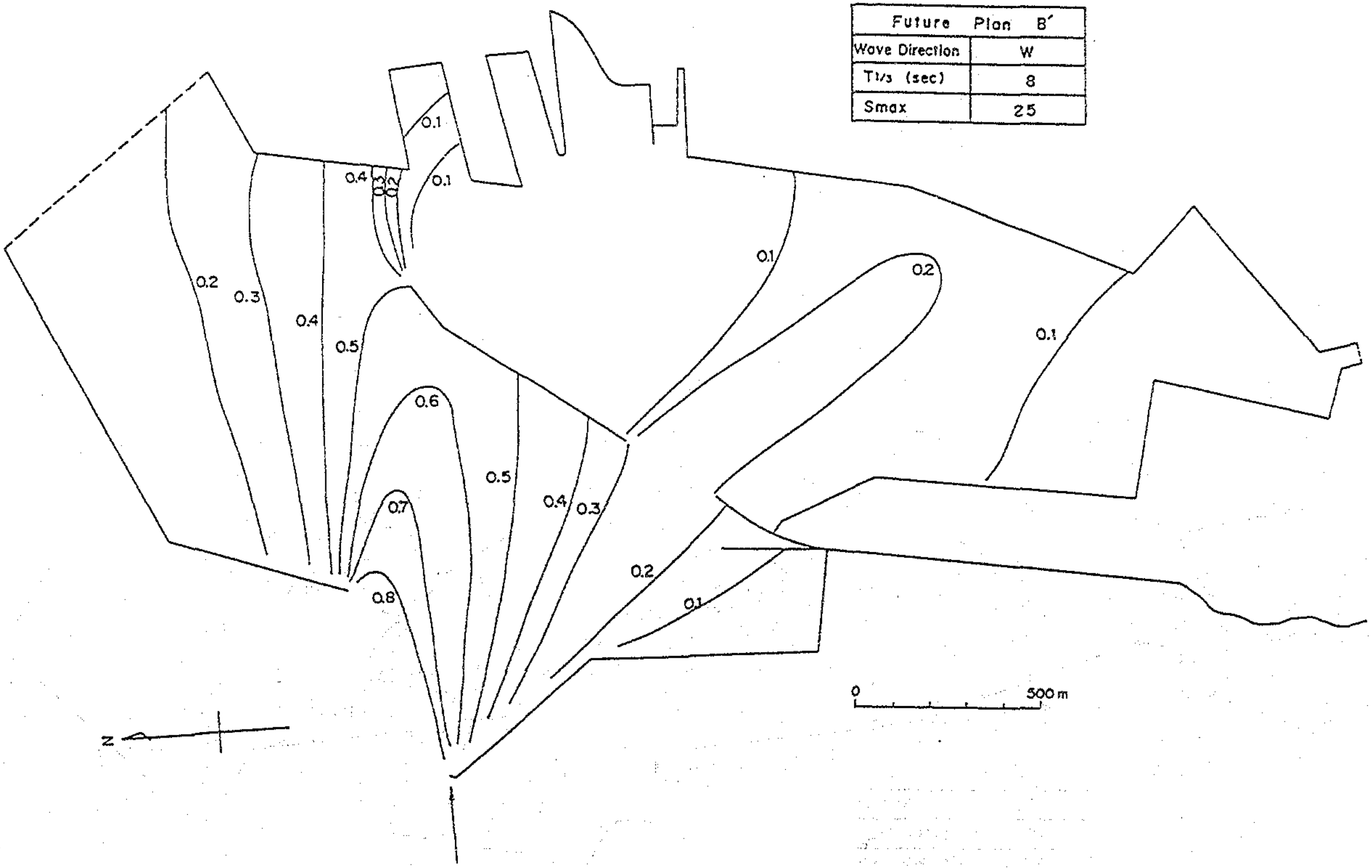


Fig. 6-3-8 (24) Wave Height Ratio

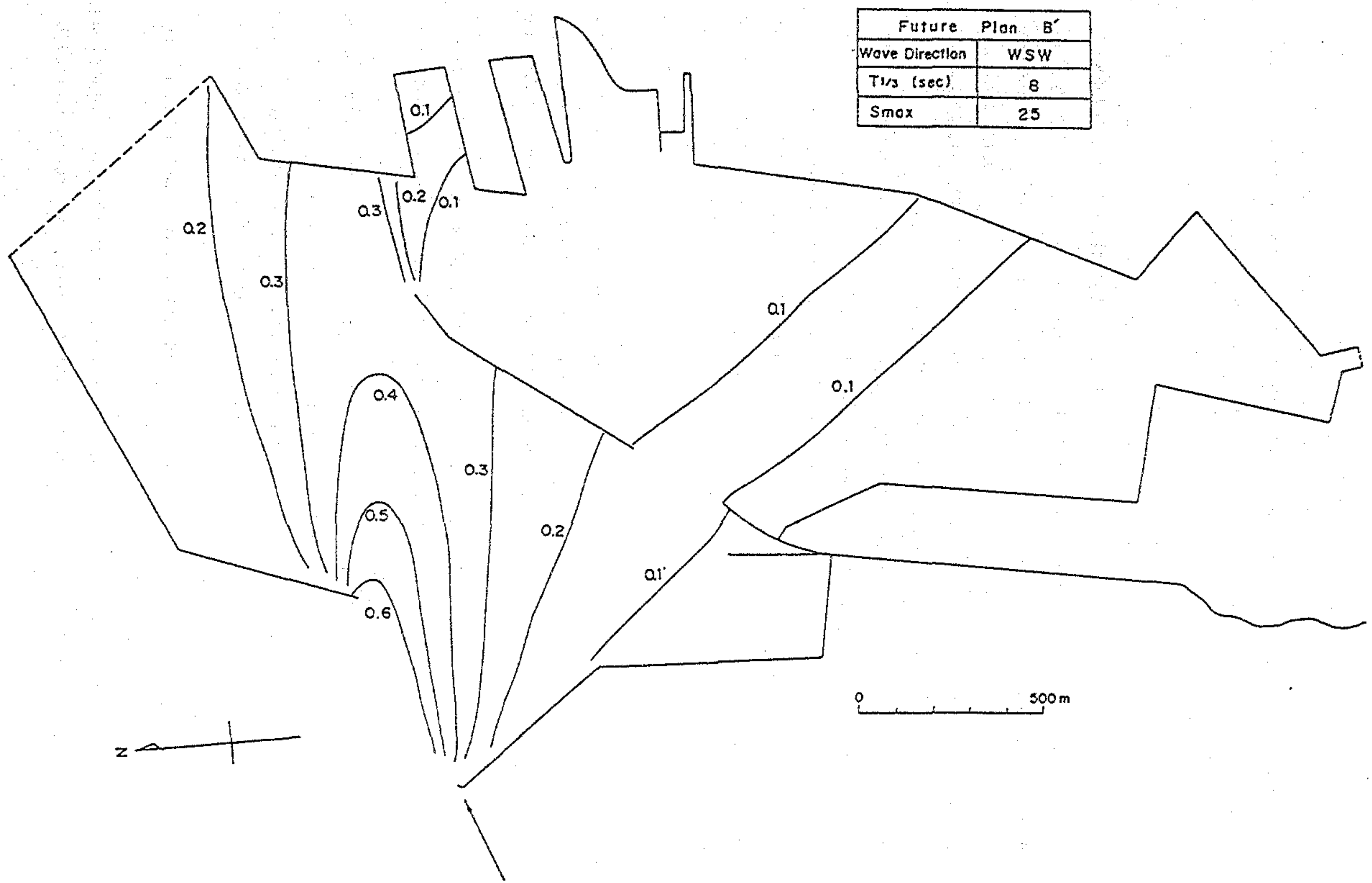


Fig. 6-3-8 (25) Wave Height Ratio

6-4 Implementing Steps of the Master Plan

The implementing steps of the Master Plan are set in accordance with the cargo demand.

Short Term (before 1995)

It is obvious that the construction of JCT No.3 berth should be started as soon as possible, and this must be carried out as a crash project.
The actual construction at the site should start, at the latest, in April 1990 and be completed within 32 months.
This schedule is considered very tight and re-location of existing facilities becomes a very urgent matter accordingly.
Considering that the cargo demand is so strong, construction of the next new berth, (JCT #4), shall be started on the following year.
In the meantime, the rehabilitation of QCT shall be executed to meet the urgent cargo demand. If the rehabilitation of QCT, which consists of preparing smooth road and yards, can be expedited, the congestion will be eased in 1992.

Plan - A

In case of Plan-A, the reclamation of the Fort area needs a lot of time, because it involves a long series of works, such as demolition of existing wharves (QEQ #1, BQ #1, #2) and the compensational construction of wharves at North Pier.
To use the New North Pier, the extension of Island breakwater and Northeast breakwater and the relocation of oil handling facilities must be completed in advance.
For those reasons, the first steps of the reclamation of the Fort area (extension of the Island and NE breakwaters) have to be started in 1993.
When JCT #3 and #4 are completed, the deepening and widening of the entrance channel and extension of SW breakwater must be executed for the safe and smooth maneuvering of vessels.
The New QCT (Expansion works) will be commenced after the completion of the Fort Container Terminal (FCT).
During the various construction works, the renovation of the port functions such as computer communication system, navigation aids, and roads should be

carried out.

The relation between planned capacity and estimated demand in chronological order is shown in Fig. 6-4-1 (1), based on the implementing steps of the Master Plan - A shown in Fig. 6-4-2 (1).

Plan - B

As explained in section 6-3-1, Plan-B is the simple straight foward proposal. The plan will not require any preliminary works or adjustment. Only problem anticipated with the plan is the restriction of site condition for the construction of sea-protection work which shall be constructed open sea and therefore construction period shall be limited for the calm sea condition.

The relation between planned capacity and estimated demand in chronological order is shown in Fig. 6-4-1 (2), based upon the implementing steps of the Master Plan - B shown in Fig. 6-4-2 (2).

Fig. 6-4-1 (1) Demand and Planned Capacity Plan - A

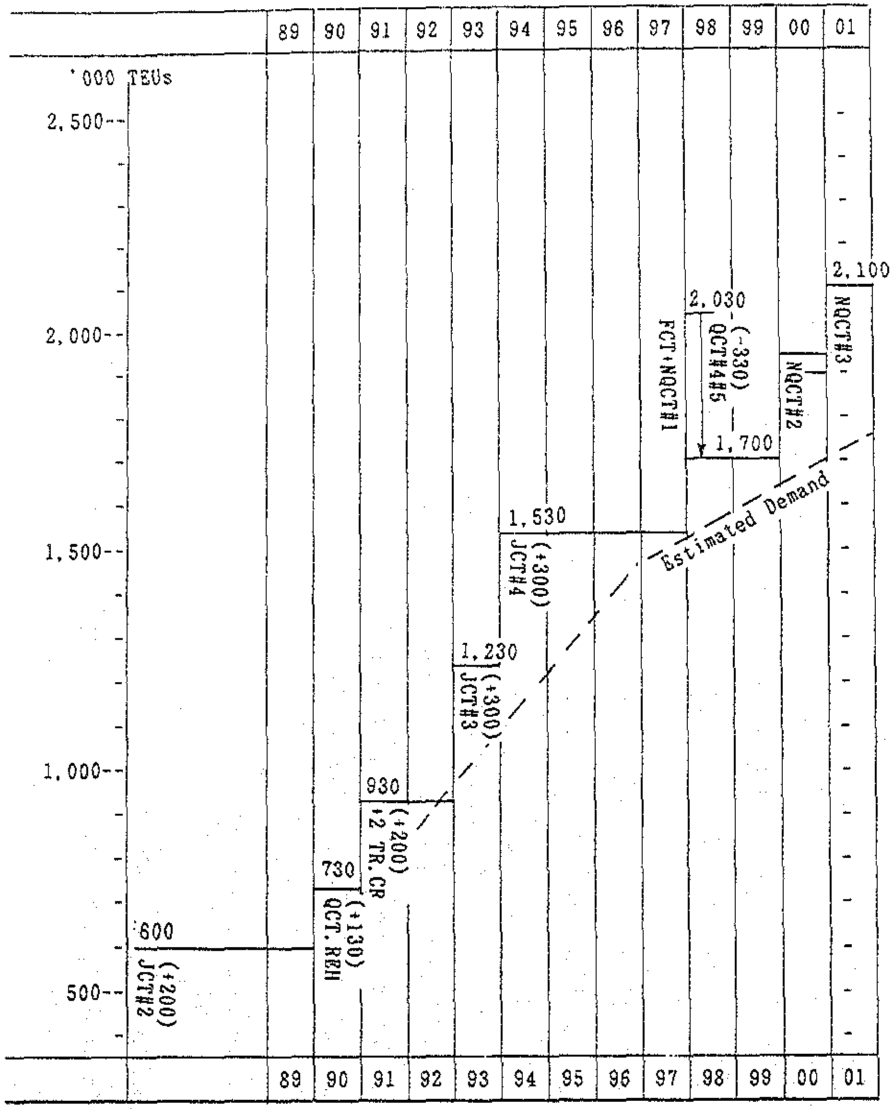


Fig. 6-4-1 (2) Demand and Planned Capacity Plan - B

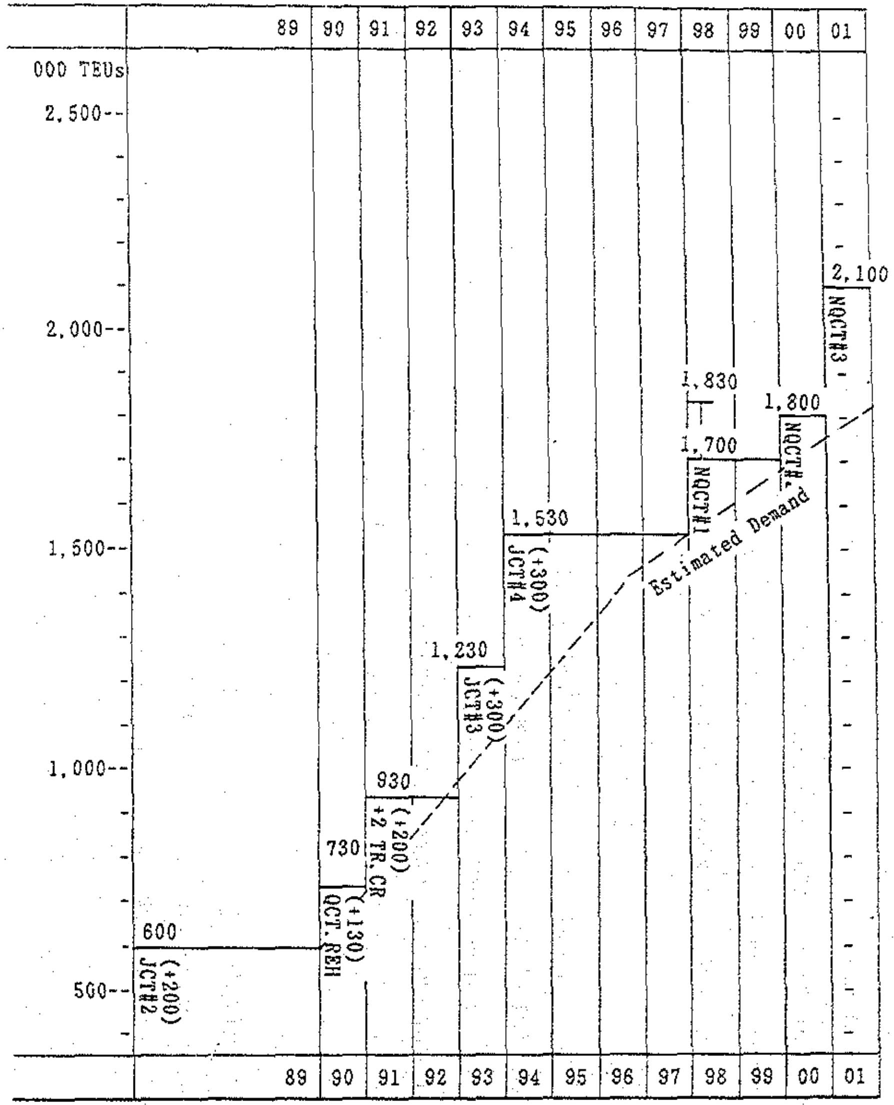


Fig. 6-4-2 (1) Implementing Steps for Master Plan - A

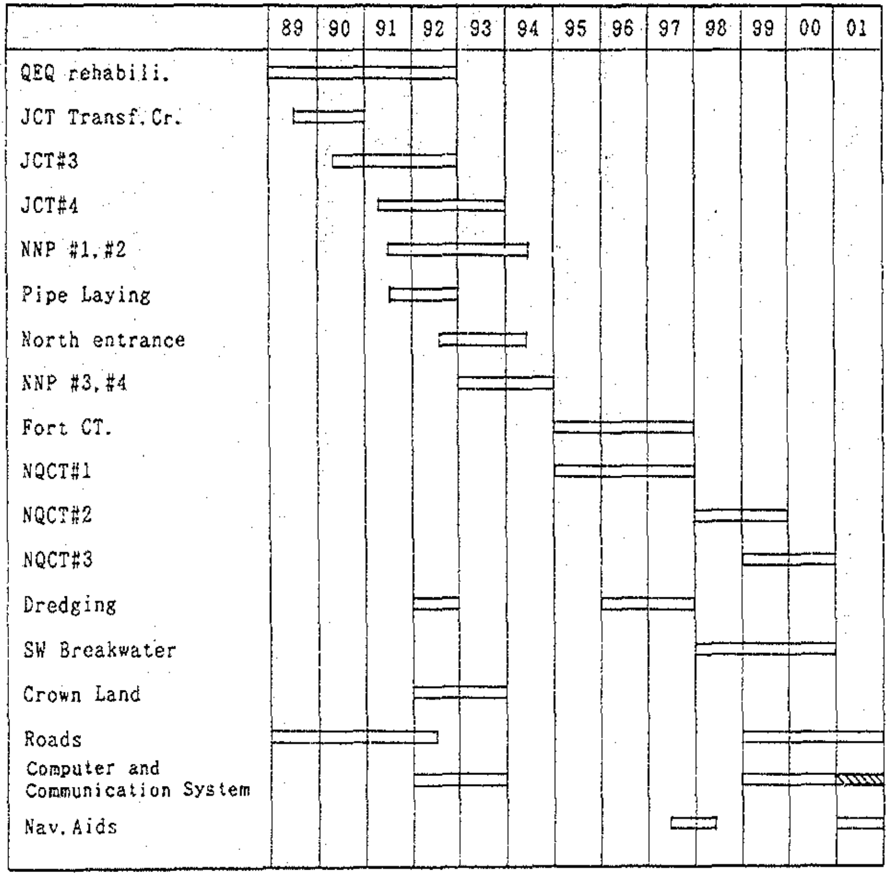
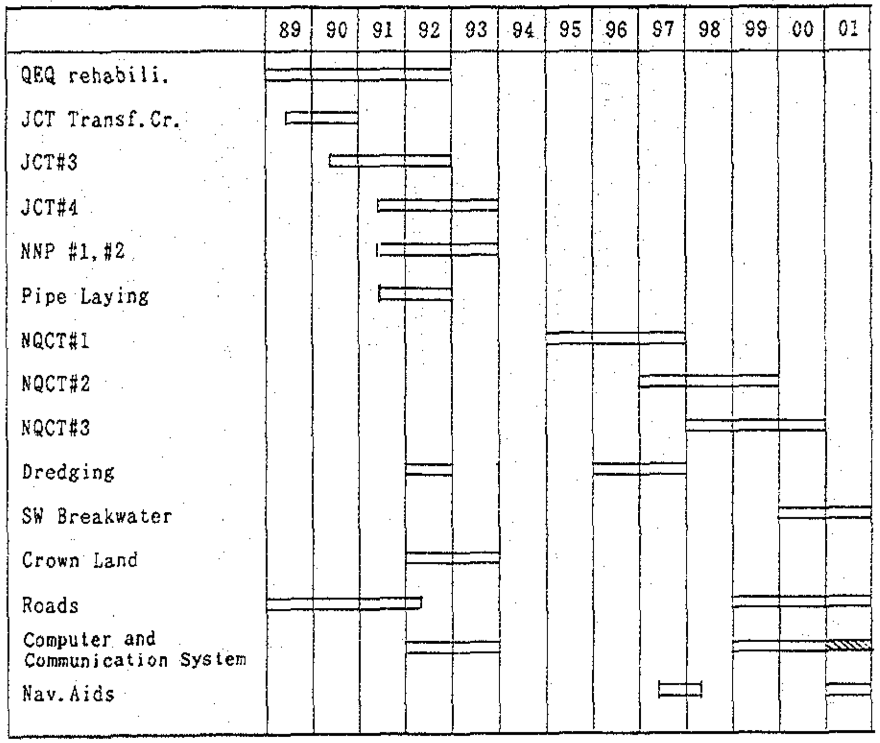


Fig. 6-4-2 (2) Implementing Steps for Master Plan - B



6-5 Preliminary Design and Cost Estimate

6-5-1 Design Criteria

This subsection describes the design criteria established on the basis of the data contained in Chapter 3 NATURAL CONDITIONS and additional information obtained during the site investigation carried out as part of the Study.

1. Tide Levels

The tide levels in Colombo Port are given below:

Highest High Water Level	+ 1.14 m (Dec. 9, 1958)
Mean High Water Level	+ 0.77 m
Mean Sea Level	+ 0.43 m
Low Water Level	+ 0.11 m
Datum Level	+ 0.00 m

The Datum Level is the standard level for all the Port facilities and the Mean Sea Level is the datum level for structures on shore in Sri Lanka.

2. Existing Water Depths

The existing water depths in Colombo Port, shown in Fig. 3-5-2, are based on the results of sounding surveys carried out by SLPA in 1984 and 1988.

3. Waves

The design wave characteristics with a 50-year return period have been established as follows:

	Direction	Height (H 1/3)	Period (T)
Outer harbour (1)	W - SW	6.1 m	9 sec
Outer harbour (2)	NW	3.5 m	7 sec
Inner harbour	-	1.0 m	7 sec

4. Geology

The bedrock of the inner harbour and adjacent area consists of gneiss whose superficial layer is weathered in varying degrees. In some parts of the layer no weathering is observed. Generally, the gneiss formation lies at a limited depth in the east of the inner harbour, but occurs at greater depths in the west.

The bedrock is overlain by alternate layers of compact silty sand and sand with N-values of about 20.

The top layer of the sea bottom consists of mud deposits which vary in thickness from place to place. The thickness exceeds 3 m in the innermost part of the harbour, but is not more than tens of centimeters in the central part of the harbour area and in the vicinity of the deep-water quays.

Designs of the proposed individual structures are based on the soil conditions described in Chapter 3.

5. Earthquakes

Earthquakes were not considered in designing the Project facilities.

6. Wind

A wind speed of 40 m/sec has been adopted for design purposes.

7. Ship Data

(1) Container Ship

i) Panamax Type

The characteristcs of container ships capable of passing through the Panama Canal are as follows:

Length overall : Max. 900 ft.
Breadth, extreme: Max. 107 ft.
Draft, max. : 37 ft. (in fresh water)

ii) Over-Panamax Type

The over-Panamax type container vessel, introduced into service on the North Pacific run by the American President Line in 1988, is considered for the design of the new quay structure.

It is deemed that the above mentioned vessel, known as C-10, can represent the super container vessels, the capacity of which is 4,000 TEU Class, planned by other major shipping lines. Ship data for over-Panamax container vessels are shown in Table 6-5-1.

Ship Data of C-10 (American President Line)

- Length overall : 275.2 meters
- Breadth : 39.4 meters
- Depth : 23.6 meters
- Draught, Max. : 12.5 meters
- Capacity : 4,300 TEU

(2) Oil Tankers

The standard sizes of oil tankers are given below.

Dead Weight Tonnage	30,000	40,000	60,000
Length, overall (m)	194	211	240
Breadth, molded (m)	27.2	29.9	34.0
Depth, molded (m)	14.1	15.4	17.5
Full-load draft (m)	10.9	11.7	13.0

(3) General Cargo Vessels

The designs have taken into account general cargo vessels of the following standard sizes:

Dead Weight Tonnage	5,000	10,000	20,000	30,000
Length, overall (m)	103	144	177	199
Breadth, molded (m)	15.4	19.4	23.4	26.1
Draft, max (m)	6.8	8.2	10.0	11.0

8. Crown Height of Quays

Basically, the following crown heights, the same as for the existing quays in the Port, are taken for the proposed quays.

For quays of -7.5 m or more : + 9.0 ft. (2.7 m)
For quays of -7.0 m or less : + 7.0 ft. (2.1 m)

9. Surcharge on Quay Faceline

The surcharge load to be imposed shall in principle be 1.5 tons/m^2 (uniformly distributed load).

Special cargo handling vehicles and crane wheel loads must be considered where appropriate.

Table 6-5-1 Trend of Container Ships (Over-Panamax Type)

Owner	Type	Dimensions (m)				DWT	Capacity (TEU)			Stacking				Containers to be handled	Remarks
		Length	Bredth	Depth	Draught		On Deck	In hold	Total	On Deck		In Hold			
										Rows	Tiers	Rows	Tiers		
APL	C-10	275.2	39.4	23.6	12.5	42,600	2,200	2,100	4,300	16	4	12	8	20',40' 45',48'	Under Construction (1988.3.E)
Sealand	A Series	279.0	37.2	21.0	11.0	42,100	2,348	1,994	4,342	15	5	12	8	20',40' 45'	Under Study
	B ditto	279.0	39.7	21.0	11.0	43,200	2,464	2,176	4,640	16	5	13	8		
	C ditto	279.0	42.2	21.0	11.0	44,100	2,610	2,286	4,896	17	5	14	8		

6-5-2 Preliminary Design

1. Jaye Container Terminal No.3 and No.4

(1) Terminal Layout

The proposed container terminal will be constructed immediately south of Terminals No.1/No.2, both of which are currently in operation, to form a continuous structure. The new terminal will be equipped with a 690 m quay with a depth alongside of -13.5 m providing two berths and will have a container yard of approx. 25 ha. A 170 m quay of -9 m in depth alongside will be built at the south end of the container yard of No.4 to accommodate 10,000 DWT class vessels for feeder services. Fig. 6-5-1 illustrates the facility layout of the proposed container terminal JCT No.3 and Fig. 6-5-2 shows the final layout of both JCT No.3 and No.4 together.

(2) -13.5m Quay

i) Design Conditions

a. Design vessel:

Over-panamax Type Container Vessel

b. Water Depth : -13.5 m

The design water depth has been decided considering about 10% over the maximum draught as an allowance.

12.5 m x 1.1 = 13.5 m

c. Crown Height : + 2.7 m

The same height as JCT No.1 and No.2 is adopted.

d. Length : 330 m

The required length of quay is calculated as given below:

L = Ship length + 2 (Breadth/2 + Height of fender) Cot θ

Yard Stacking Capacity

(1) JCT NO.3

Dry Container	132 x 15 =	1,980
	48 x 1 =	48
Reefer Container	72 x 1 =	72
Total		2,100 Slots

(2) JCT NO.1 and NO.2

	JCT NO.1	JCT NO.2
Dry Continer	1,680 Slots	1,752 Slots
Reefer Continer	72 "	72 "
Existing Total	1,752 "	1,824 "
Additional Slots	228 "	432 "
Total	1,980 "	2,256 "

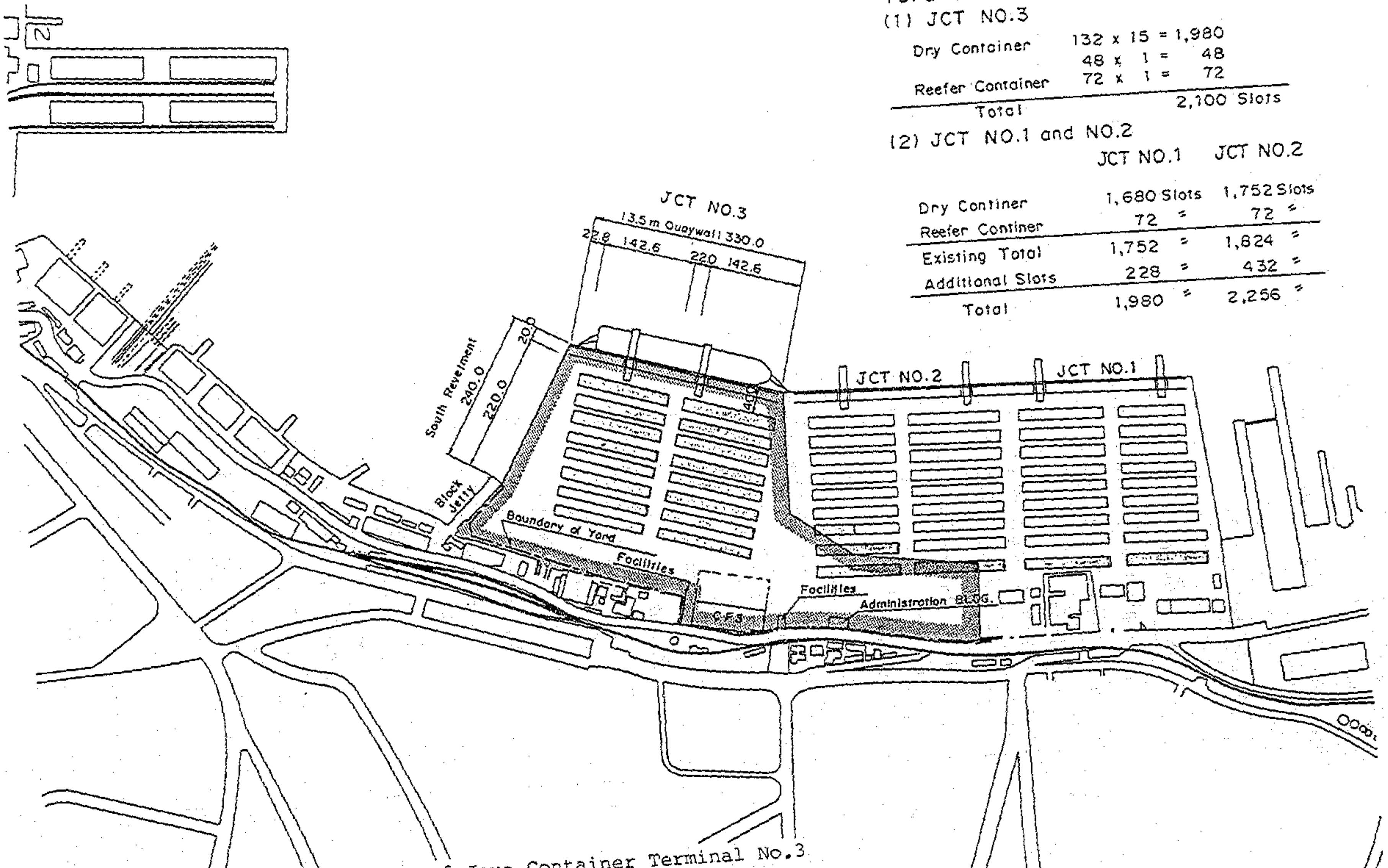


Fig. 6-5-1 Layout of Jaye Container Terminal No.3

unit : meter

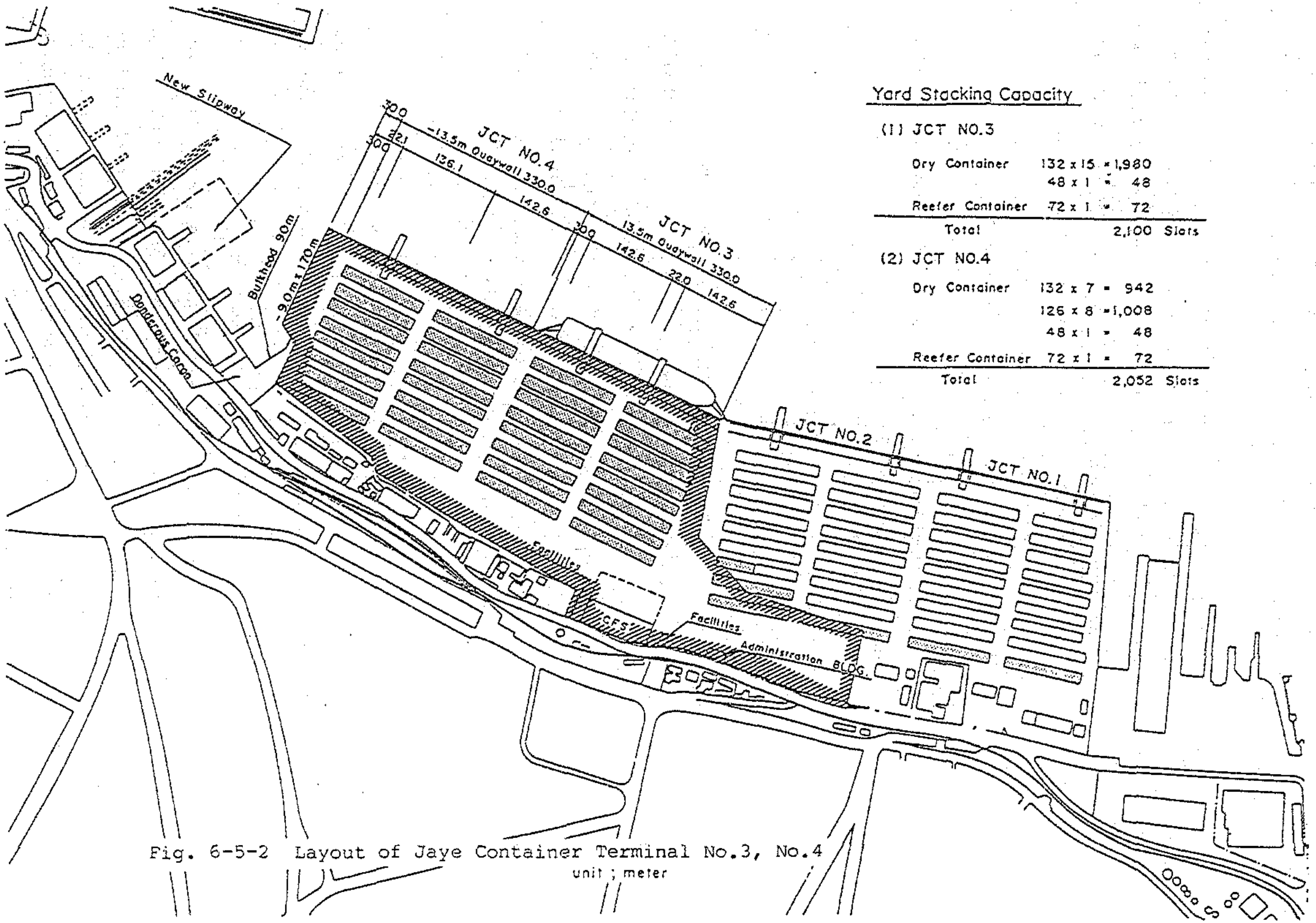


Fig. 6-5-2 Layout of Jaye Container Terminal No.3, No.4
unit ; meter

θ = angle between mooring rope and quay face line.

L = 275.2 + 2(39.4/2 + 1.5) Cot 35 = 336 m

The 100 ton Bitt, which is located at the southern end of JCT No.2 (the distance from the boundary between JCT No. 2 and No.3 is 8 m), can be used as a northern end bitt of JCT No.3. Therefore, the required length of quaywall is 330 meters.

L = 336 - 8 = 328 meters < 330 meters

The berth allocation for container vessels at the quays is shown in Fig. 6-5-3.

e. Surcharge 1.5 t/m^2 (uniform)

f. Soil Conditions

Soft silt deposits are formed on the seabed of the project area in a thickness of 2 to 3 m. Weathered rocks, or the bedrock which obviously constitutes the bearing stratum for shore structures, are encountered at a depth of -15 to -20 m. There are intervening sand layers between the bearing stratum and the bottom silt layer (See Fig. 3-4-6).

ii) Structural Type of Quays

The solid wall type concrete caisson structure was adopted for both quays JCT No.1 and No.2 considering the soil conditions in the project area and for reasons of economy.

When the quay structure of JCT No.3 is considered, the proposed location is just in front of the main harbour entrance and the incoming waves will be reflected by the newly constructed quay. So, it is expected that the reflected waves will badly affect the calmness inside the harbour.

$$L1 = 275.2 + 2(39.4/2 + 1.5) \times \cot 35° = 336m$$

$$L2 = 336m - 8m = 328 < 330m$$

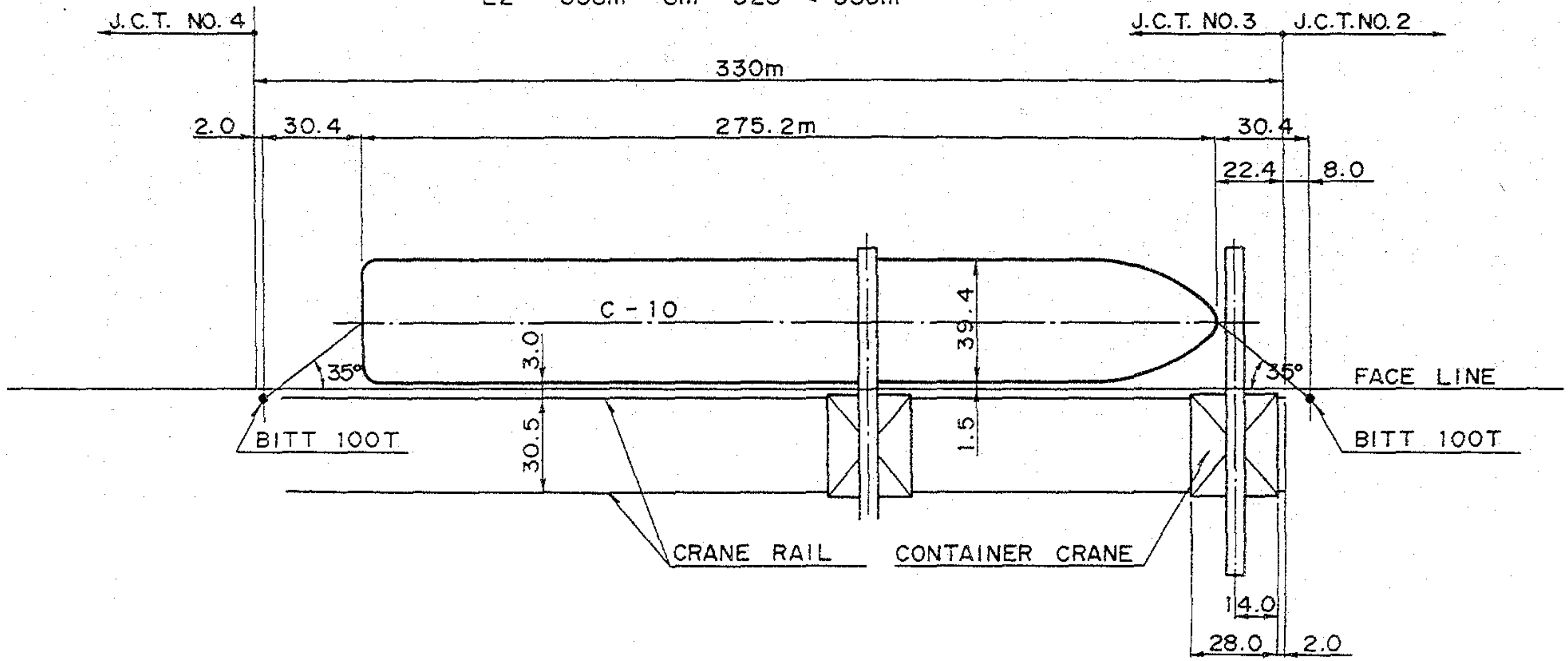


Fig. 6-5-3 Berth Allocation Plan for Container Vessels at JCT No.3

Unit: meter

Therefore, the adoption of wave dissipating type quay structures which would absorb the wave energy has been studied. Two popular types of wave dissipating quays are described below.

a. Wave Dissipating Type Concrete Caisson Structure

This structure consists generally of a front perforated wall, wave chamber and rear wall, and is intended to reduce the reflection coefficient through loss of energy due to the horizontal jet flow in passing through the front wall and from the roughness resistance inside the structure.

The wave dissipating capacity depends on the shape of the front wall and the voids of the wave chamber. Therefore, it is preferable to determine the structural form through a model study. A small reflection coefficient cannot be expected for long-period waves.

b. Deck Slab Structure

The wave energy is absorbed through the gradual slope formed by the graded rocks due to the roughness resistance.

Although a decrement of the reflection coefficient is not expected for short-period waves, the slope structure under the deck slab is similar to the existing structure of Kochchikade shoreline. Therefore, it can be said that the calmness in the harbour is maintained at least at the same level as under the present conditions when the deck slab structure is adopted.

c. Comparison of Construction Costs

Construction costs of the three types of structures (a solid wall type concrete caisson quay is included in addition to the above structures) are estimated.

1. Solid wall type concrete caisson — 55,100 US$ per meter
2. Wave Dissipating type concrete caisson structure — 65,474 US$ per meter
3. Deck Slab type structure — 65,039 US$ per meter

The typical cross sections of the above quay structures are shown in Fig. 6-5-4, 6-5-5, and 6-5-6.

d. Selection of Quay Structure

From the above considerations, the deck slab structure has been adopted for reasons of the high wave dissipating efficiency.

In case the pulling resistance of the concrete piles is inadequate because of shallow rocks in part of the quay face line, anchors shall be driven into the rigid rocks to compensate for the insufficient pulling resistance.

Despite the selection of the deck slab structure for the proposed JCT No.3 and No.4 Berths as mentioned above, the cost differential between this structural type and the wave dissipating type concrete caisson structure is not very substantial. It is advisable, therefore, to undertake an in-depth study at the detailed design stage for the purpose of evaluating the two distinct types of quay structure in further detail and to make a final selection of the structural type for the proposed quays on the basis of such evaluation.

(3) Container Yard

The container yard is to be constructed on reclaimed land filled with sea sand. The design CBR = 6 on the surface of

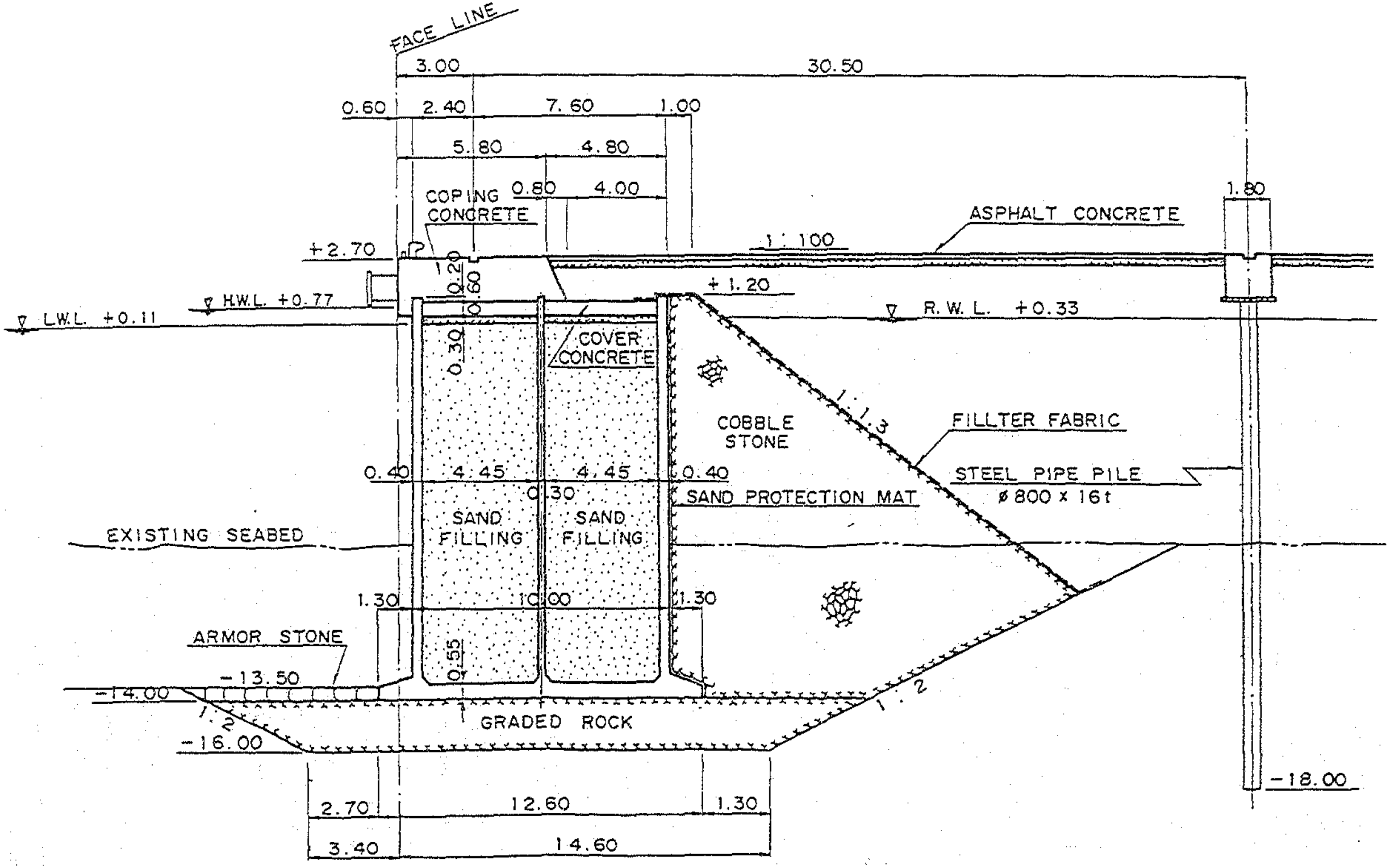


Fig. 6-5-4 Typical Cross Section of JCT -13.5 m Quaywall
(Solid Wall Type Concrete Caisson)

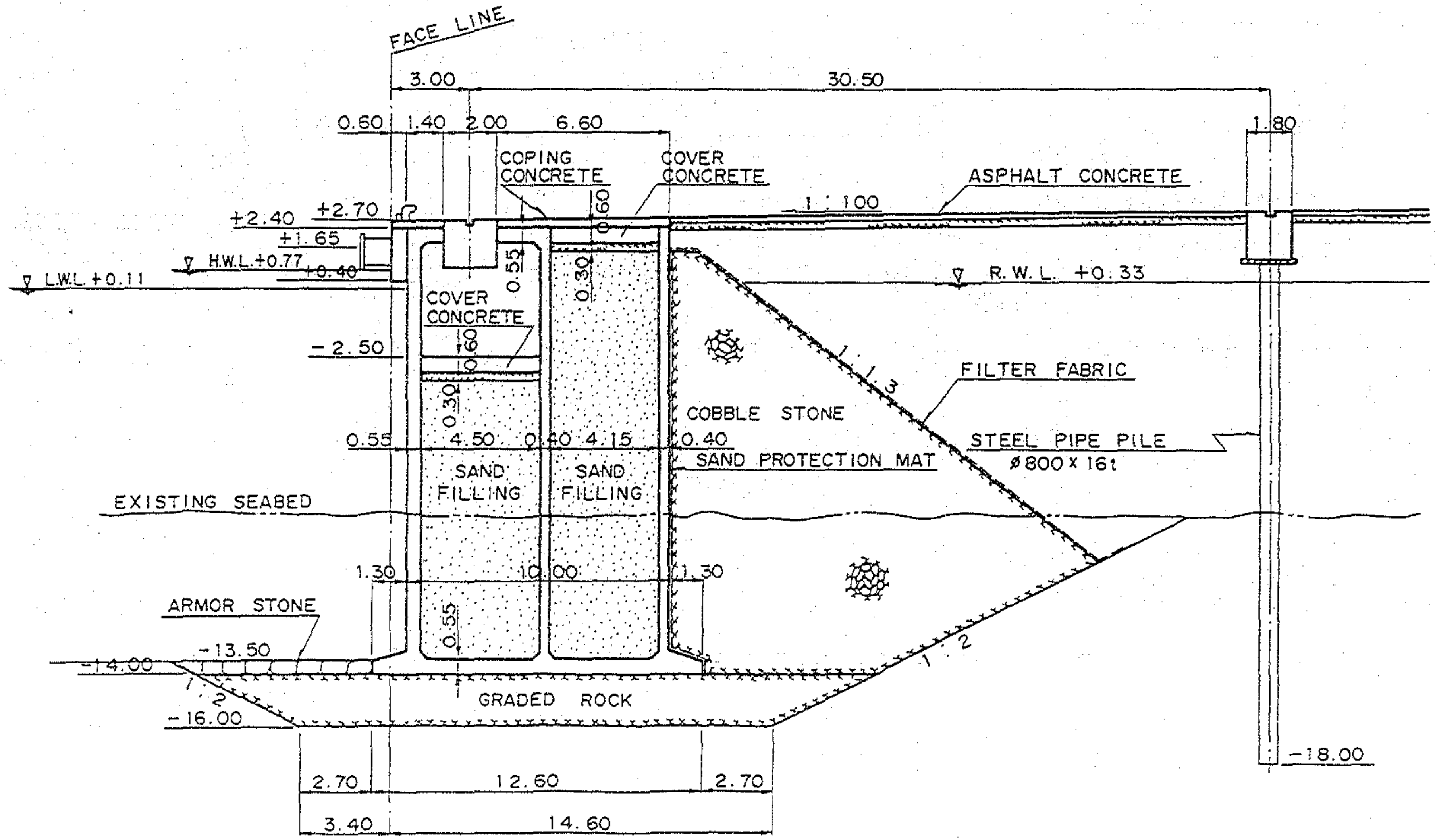


Fig. 6-5-5 Typical Cross Section of JCT -13.5 m Quaywall
(Wave Dissipating Type Concrete Caisson)

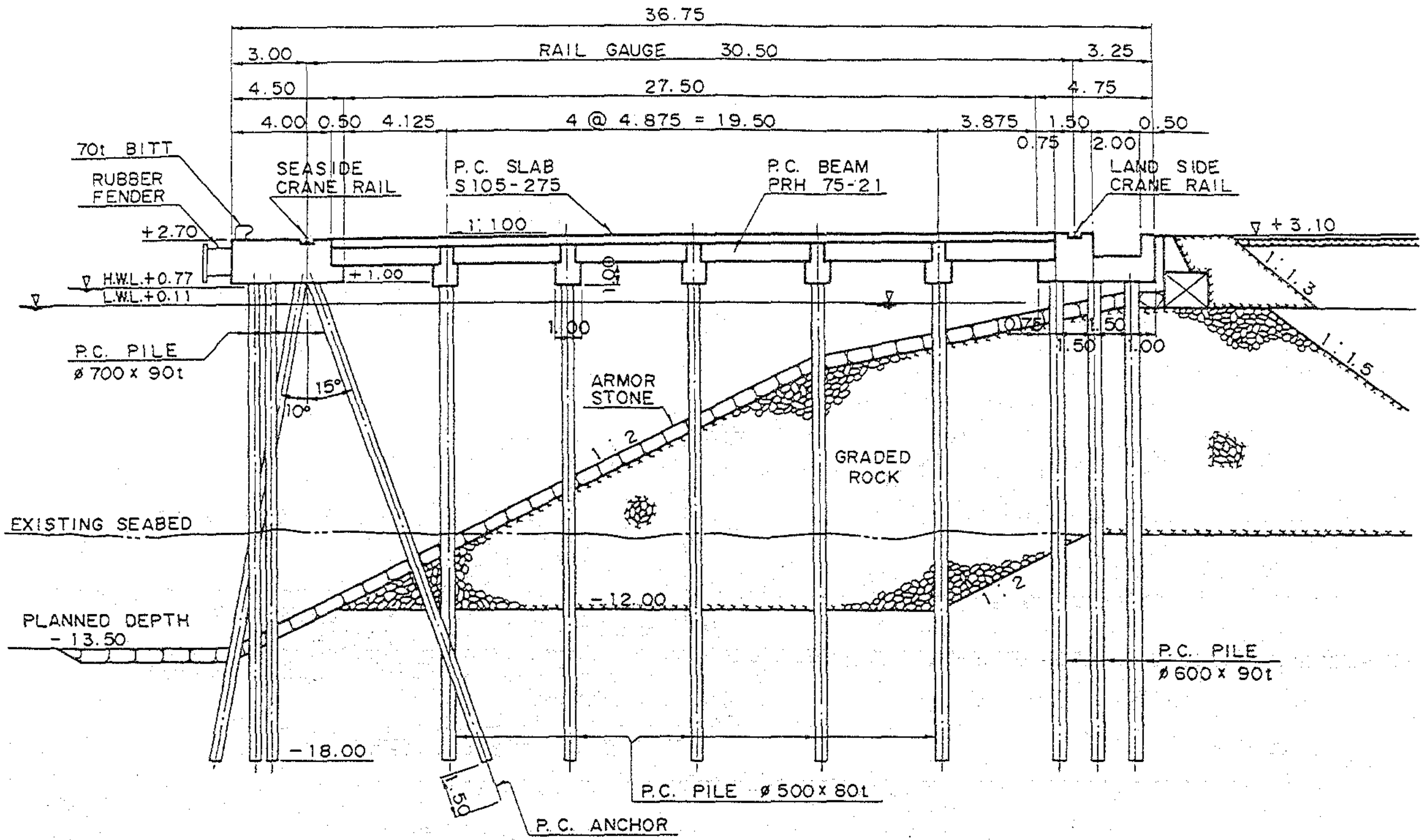


Fig. 6-5-6(a) Concrete Piled Deck type for JCT -13.5m Quay

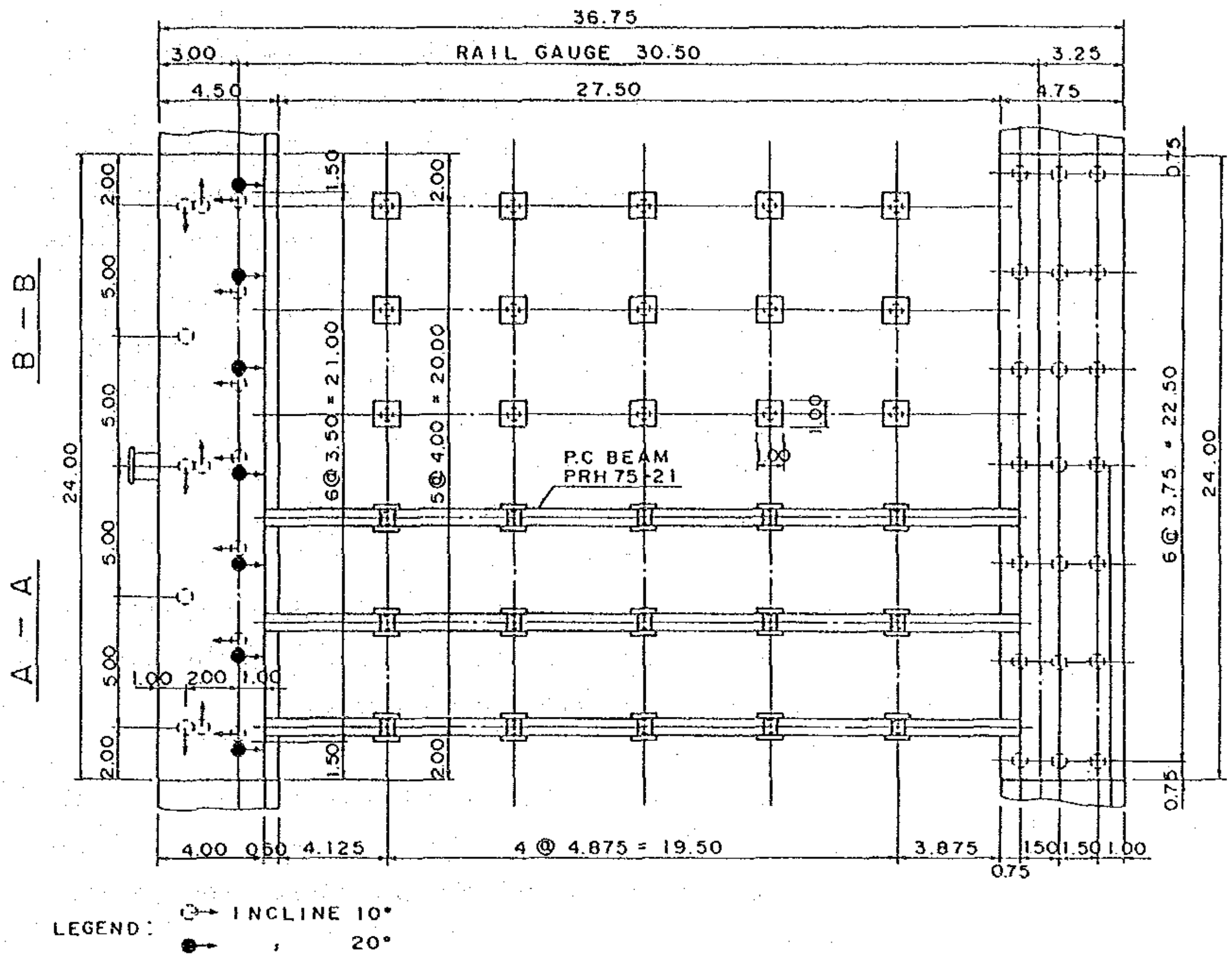


Fig. 6-5-6(b) Jaye Container terminal -13.5 m Berth
Plan of Concrete Pile and Beam Arrangement

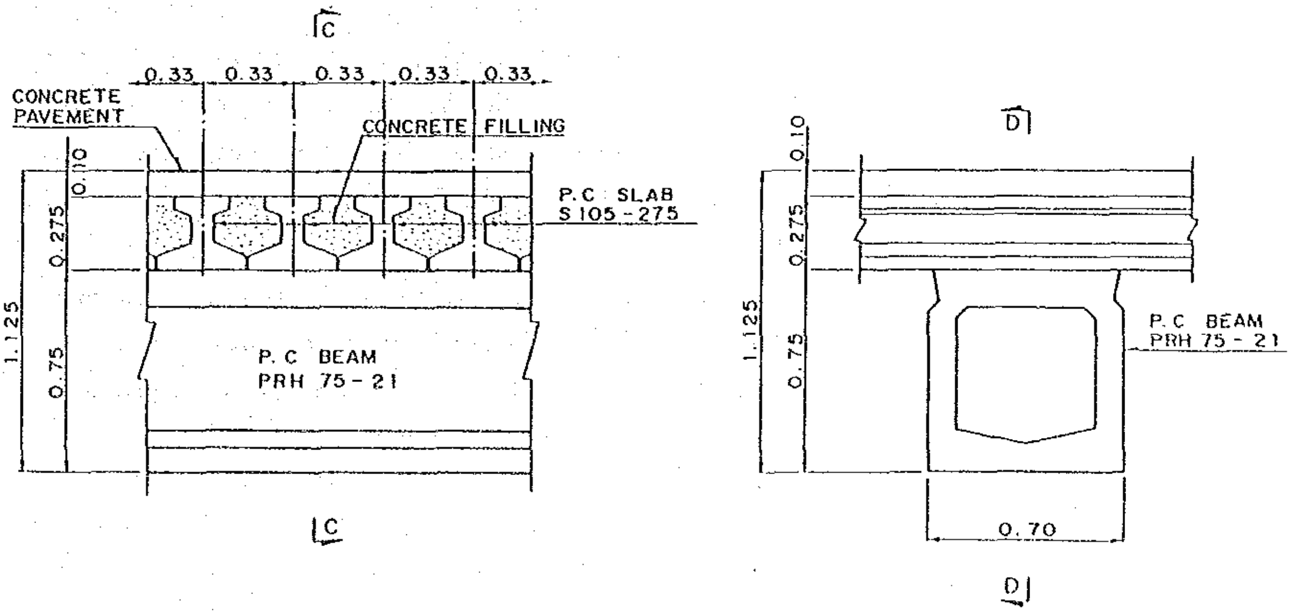


Fig. 6-5-6(c) Detail of Prestressed Concrete Beam
& Slab for JCT -13.5m Quaywall

the reclaimed land shall be adopted on the basis of the experience with the JCT No.1 and No.2 projects.

The sub-base course and base course will be constructed of mixed stone, and asphalt concrete will be placed as the binder and surface course.

Sub-base Course	250 mm thick
Base Course	150 mm thick
Binder and surface	100 mm thick
Total	500 mm thick

The transfer crane track is to be constructed using prestressed concrete slabs which will be manufactured at the casting yard in the construction site.

Generally, containers are stacked at specified slots in the container yard. It is normal practice, therefore, to embed concrete slabs at the slots for protecting the pavement against damage.

Where a container yard is built on a filled site which is likely to experience consolidation settlement, it is difficult to make proper adjustments for the irregularity in concrete slabs and, moveover, such adjustments are costly. For this reason, the normal practice calls for stacking containers directly on asphalt yard pavement until the foundation settlement ceases.

In the proposed JCT No.3/No.4 Container Terminal, prestressed concrete slabs will not be used for the stacking yard for reasons of the urgency of the project. Instead the yard will be asphalt paved.

(4) Container Handling Equipment

The container handling equipment mentioned below shall be procured and installed for the container terminal operation.

i) Container Cranes

A total of four (04) large container cranes other than those which are being operated at JCT No.1 and No.2 shall be recommended to meet the handling requirements for over-Panamax container vessels. Major particulars of the recommended container cranes, given below, are adopted taking account of the performance of leading container cranes throughout the world (Table 6-5-2).

Lifting Capacity	:	56 MT
Rated Load (under spreader)	:	41 MT
Outreach (from sea-side rail)	:	45 M
Rail span	:	30.5 M
Trolley speed	:	150 MPM
Hoist speed (rated)	:	50 MPM
Hoist speed (empty)	:	120 MPM

ii) Transfer Cranes

Six (06) transfer cranes shall be procured for each berth. Their basic dimensions are proposed to be the same as the cranes installed at JCT No.1 and No.2, But the lifting capacity and trolley speed shall be so designed as to be higher than those of the present cranes to suit the high speed operation in the yard.

iii) Tractors and Chassis

Twelve (12) tractors with chassis (20' + 20' or 40' container) shall be procured for each berth.

(5) CFS and Office

The Kochchikade Warehouse (4,000 sq.m) shall be renovated

Table 6-5-2 Data on Super Container Cranes

Supplier	User	No.	Date of delivery	Spreader SWL	Rail gauge (ft)	Outreach (ft)	Lift height (ft)	Trolley speed (fpm) (fpm)	Hoist speed rated /empty (fpm)
Morris/HUD	Modern Term	4	1/86-4/89	40LT	-	135	88	500	160/400
Morris	Southampton	1	12/88	50MT		148	100	500	160/400
Ederer/KSEC	Oakland	3	1987	50LT	100	150	100	500	180/
Hitachi	APL/Yokohoma	1	imminent	40LT	98	141	104	590	164/394
IHI	ITS/L Beach	2	Spring 88	40MT	100	137	100		
	APL/Yokohoma	1	imminent	40LT	98	141	104	590	164/394
Kone	VPA/P mouth	1	1987	40MT	50	150	108	690	164/41o
	VPA/Norfolk	3	1987	40MT	50	150	108	690	164.410
MGM	Fujairah	1	11/88	40LT		145	95	600	173/
Mitsubishi	Singapore	10	6/88-2/89	40MT	77	154	112	590	174/427
	APL/OAkland	3	imminent	40LT	100	152	105	600	170/365
	APL/Los-Ang	5	imminent	40LT	50	145	109	600	170/365
	APL/Kobe	3	Imminent	40LT	100	146	103	590	170/365
	APL/Yokohoma	1	imminent	40LT	98	141	104	590	170/365
MES	Mitsui/LA	1	10/87	40MT	100	135	100	522	164/394
	Colombo	2	2/87	35.5MT	52	125	96	410	148/296
	HIT	7	1988	40LT	80	146	100	502	174/420
	APL/Kaoshsiung	3	imminent	40LT	80	145	110	600	170/365
Hyundai/Paceco	San Francisco	2	6/87	40LT	100	130	95	500	150/360
	Portland	1	1988	50LT	100	145	95	575	220/385
Paceco	Seattle	2	1/88	50LT	100	145	95	500	160/385
	Maher	6		50LT	50	135	100	500	150/394
Sumitomo	Baltimore	6	12/88-12/89	50LT	100	156	110	700	170/365
Vulkan Kocks	Miami	3	9/88-12/88	50LT	100	151.5	100	500	140/336
V Kocks/Samsung	Oakland	2	1989	50LT	96	150	100	600	220/365

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March 1988

in order to utilize it as a CFS for the stuffing and unstuffing of transhipment container cargo, and therefore, both container bays and truck bays will be provided on the sea side of the CFS.

The floor level will remain as it is, because if a platform is constructed the overhead clearance for the containers on chassis will not be sufficient and also the formation of a slope from the platform to the cargo floor in the CFS will be very difficult.

The required number of overhead sliding doors will be constructed at the container bay and truck bay, and the bays shall be covered by eaves.

A new sub-station building shall be constructed for the purpose of receiving the main 11 KV cable from the Ceylon Electricity Board House in JCT No.1 and distribution of power to the container cranes and yard shall be made after the voltage is stepped down.

Existing buildings which are located on both sides of Kochchikade Warehouse shall be remodelled into facilities buildings (400 sq.m) in order to accommodate the yard staff.

An existing Navy Building can be utilized as a sub-administration building for yard control after minor modifications.

The communication system between the main administration building and the above building will be by telephone.

The water supply system for the modified buildings will be reviewed and fire hydrants in the yard and ship supply hydrants will also be provided at the quay. A sump will be required for the hydrants due to the lack of sufficient water pressure from the municipal main line.

(6) South Revetment of JCT No.3 Container Yard

A rubble mound revetment is to be constructed at the south end of the JCT No.3 Container Yard. This structure will be used temporarily until the Construction of JCT No. 4 Container Project is started.

When the construction works on JCT No.4 Container Yard are carried out as a continuation of the works on the No.3 Container Yard, the South Revetment will not be required. Fig. 6-5-7 shows the cross section of this revetment.

(7) -9 m Quay

The -9 m quay is designed as a pier type supported on prestressed concrete piles, the same type as the -13.5 m quay, to accommodate 10,000 d.w.t. class cargo vessels. Fig. 6-5-8 illustrates the standard cross section of the -9 m quay.

(8) Bulkhead of JCT No.4 Container Yard

A bulkhead of 90 m in length is planned for the area between the proposed -9 m quay and the existing shoreline. This structure will form a part of the dangerous cargo area which will be relocated.

A vertical wall type structure has been designed for the proposed bulkhead to permit mooring barges. The cross section of this structure is shown in Fig. 6-5-9.

(9) Increased Container Handling Capacity for JCT No.1/No.2 Container Terminal

The JCT No.1/No.2 Container Terminal will have its yards expanded eastward to provide an additional stacking space with 660 slots. As a result the present stacking capacity will be increased by nearly 18%.

Two (2) additional transfer cranes will be procured for the JCT No.1/No.2 Container Yards.

The container stacking capacities as planned for the JCT No.1 and No.2 Container Yards are as follows:

Type of Container	JCT No.1	JCT. No.2
Dry container	1,680 slots	1,752 slots
Reefer container	72 slots	72 slots
Total - existing	1,752 slots	1,824 slots
Additional (Dry)	228 slots	432 slots
Total - planned	1,980 slots	2,256 slots

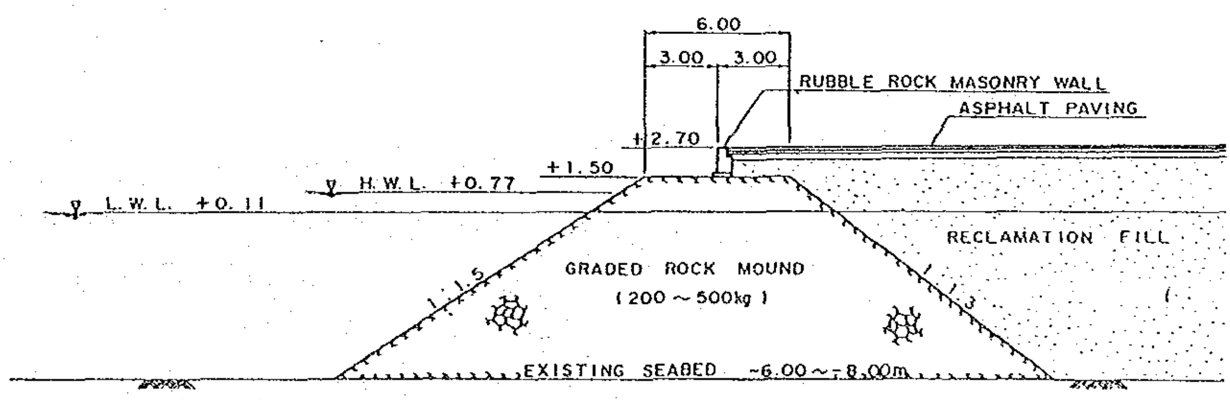


Fig. 6-5-7 South Revetment of JCT No.3

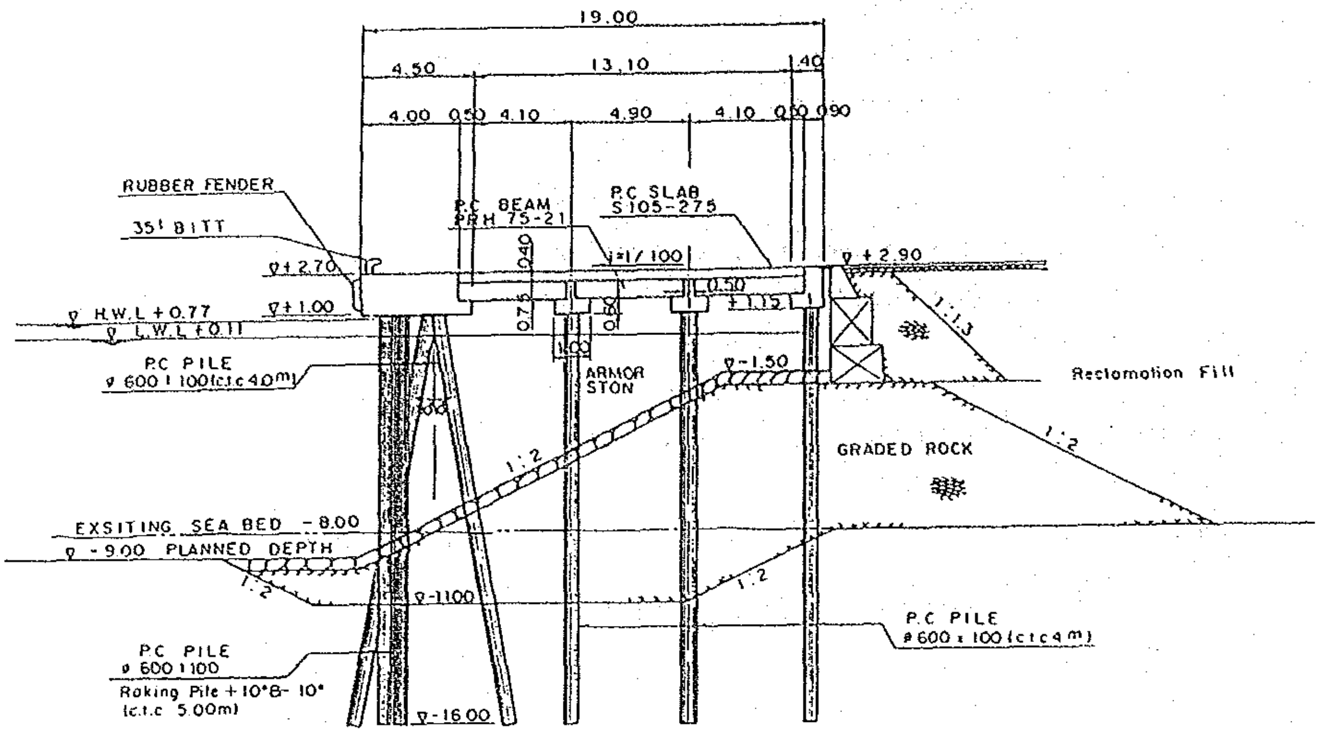


Fig. 6-5-8 Typical Cross Section of JCT -9.0 m Quaywall

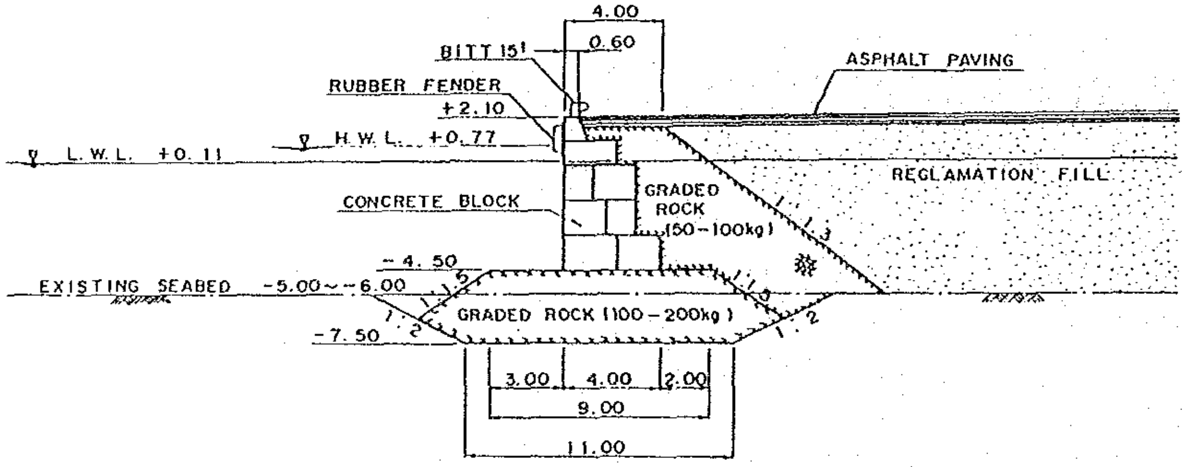


Fig. 6-5-9 Bulk head of JCT No.4

2. Redevelopment of North Pier Area

(1) Procedure of Redevelopment

The North Pier area will be redeveloped into a conventional cargo terminal through remodeling of the existing South Quay which currently serves as an oil jetty. The existing quay, a gravity type structure, will be remodeled to provide No.1 Berth -7.5 m deep alongside and 130 m in length and No.2 Berth -11.0 m deep alongside and 210 m in length.

On the north of the North Pier a rubble mound revetment will be built parallel to the South Quay and the water area between the pier structure and the revetment will be filled to create a jetty type quay of 90 m in width.

The new North Pier, along with the new jetty type structure, is intended for bulk handling of fertilizers. For this purpose, two level luffing cranes are to be installed on No.1 and No.2 Berths. In addition, two warehouses, each with 6,400 m^2 of floor space, will be constructed in the filled area, and fertilizers in bulk offloaded by the two level luffing cranes will be brought to the warehouses by a belt conveyor for bagging.

These works are included in the Short-term Plan.

When the Master Plan "A" is implemented following the completion of the Short-term Plan, two new quays, one -11.0 m deep alongside and 210 m long and the other -7.5 m deep alongside and 130 m long, will be built along the rubble mound revetment on the north of the jetty type quay planned under the Short-term Plan.

Prior to the construction of the two new quays, the Northeast and Northwest Breakwaters will each be extended by 60 m to narrow the North Entrance Channel. Figs. 6-5-10 and 6-5-11 illustrate the layout plans under the Short-term Plan and the Master Plan "A", respectively.

(2) No.1 and No.2 Berths

For constructing the No.1 and No.2 Berths, the main structure of the existing gravity type quay of concrete blocks will be used as it is but with the coping concrete to be reconstructed (see Fig. 6-5-12).

The superstructure of the new berths will also serve as the foundations for crane rails. No reinforcement is contemplated for the foundation of the gravity type quay structure, because it rests on a bearing stratum of adequate hardness. Nevertheless, it is still considered advisable to undertake an in-depth geological exploration prior to the construction of the No.1 and No.2 Berths in order to ensure that the quay structure is sufficiently solid.

(3) Revetments

For the revetment planned for the west side of the pier facing the North Waterway, a vertical gravity type structure has been chosen, while a rubble mound type is selected for the north revetment with a view to reducing the reflection of waves coming from the North Entrance Channel.

The two distinct types of revetment strucure are illustrated in Figs. 6-5-13 and 6-5-14, respectively.

(4) Bulk Handling System

Equipment listed below will be provided for bulk handling of fertilizers.

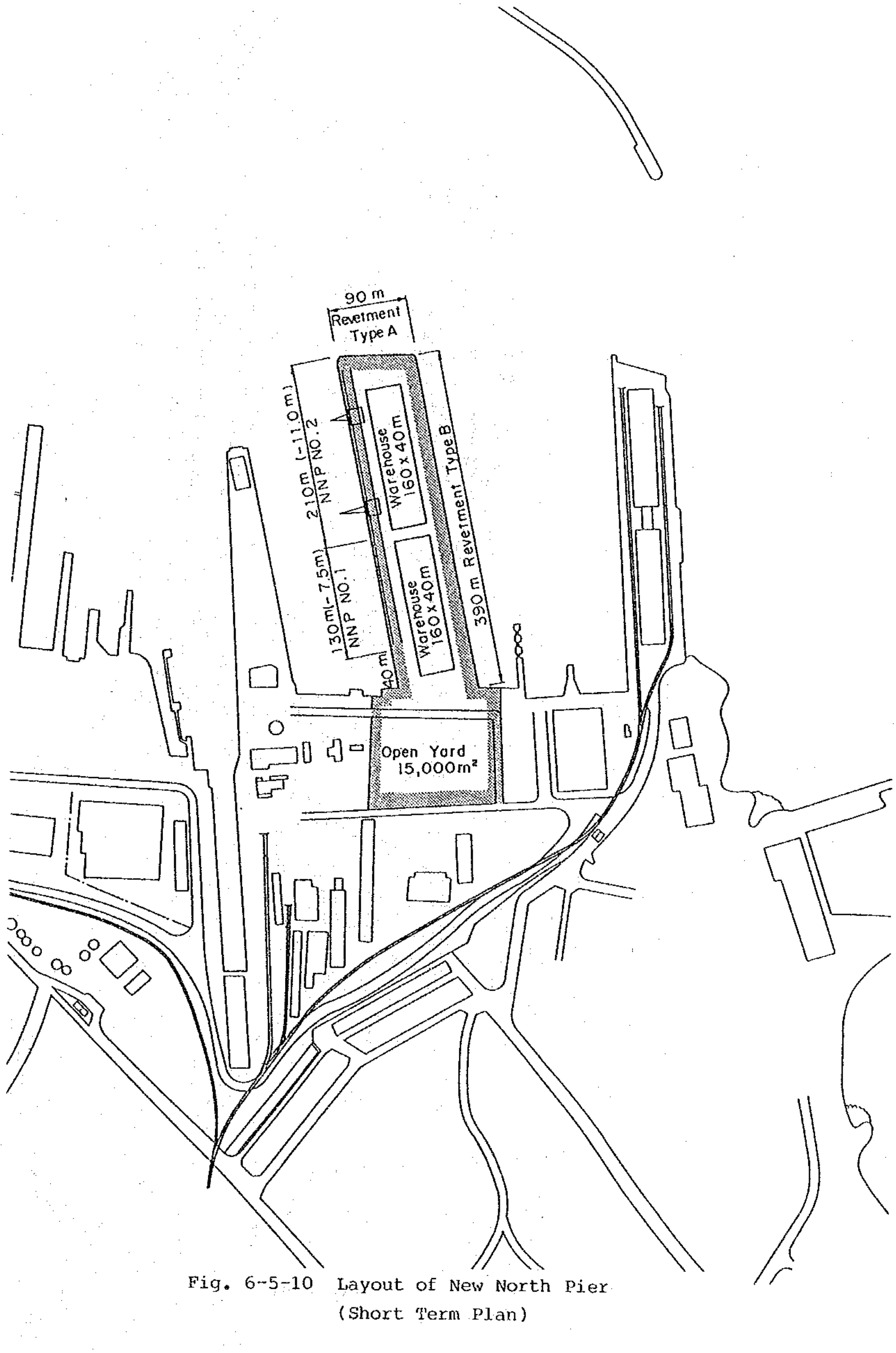


Fig. 6-5-10 Layout of New North Pier
(Short Term Plan)

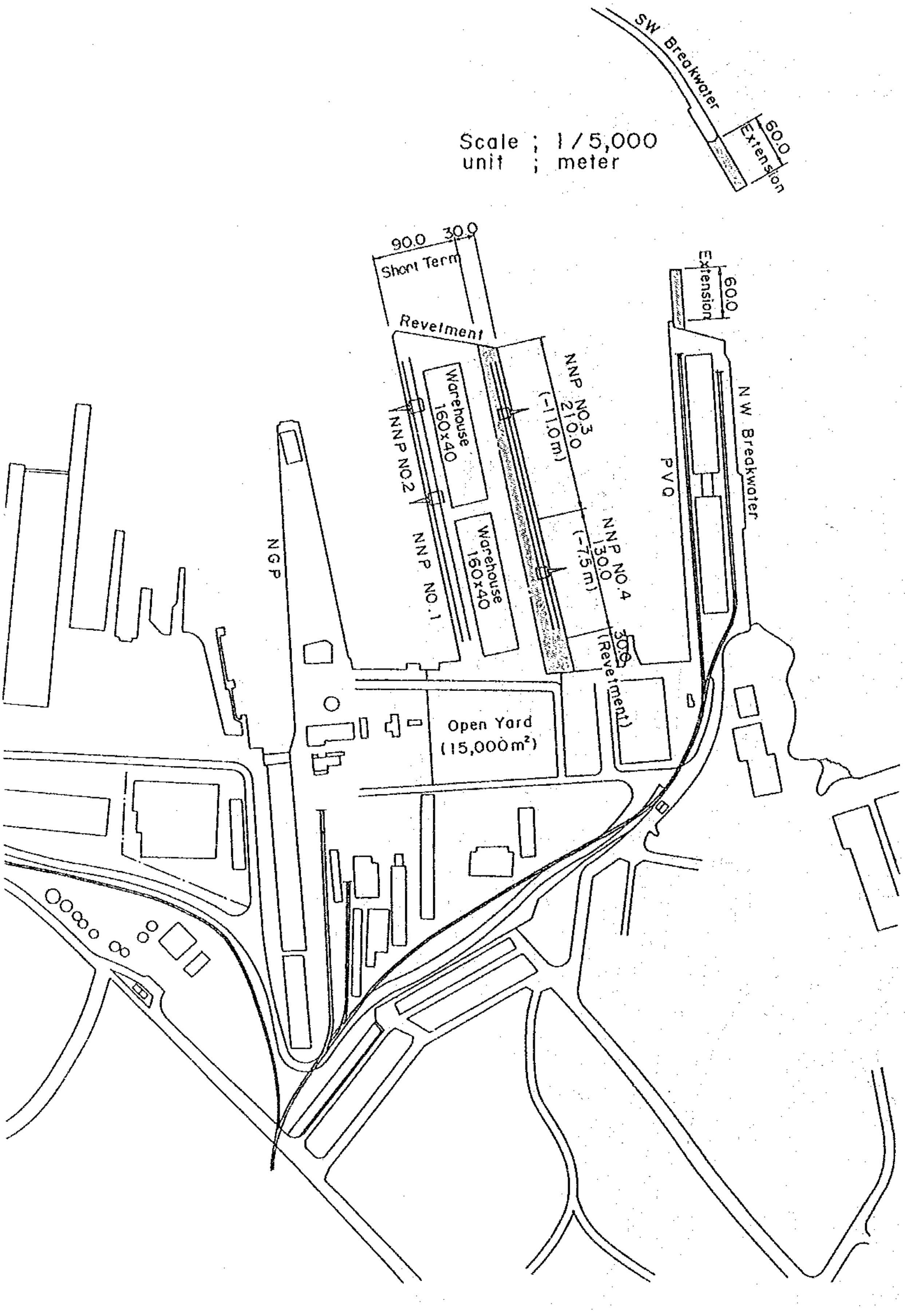


Fig. 6-5-11 Layout of New North Pier
(Master Plan -A-)

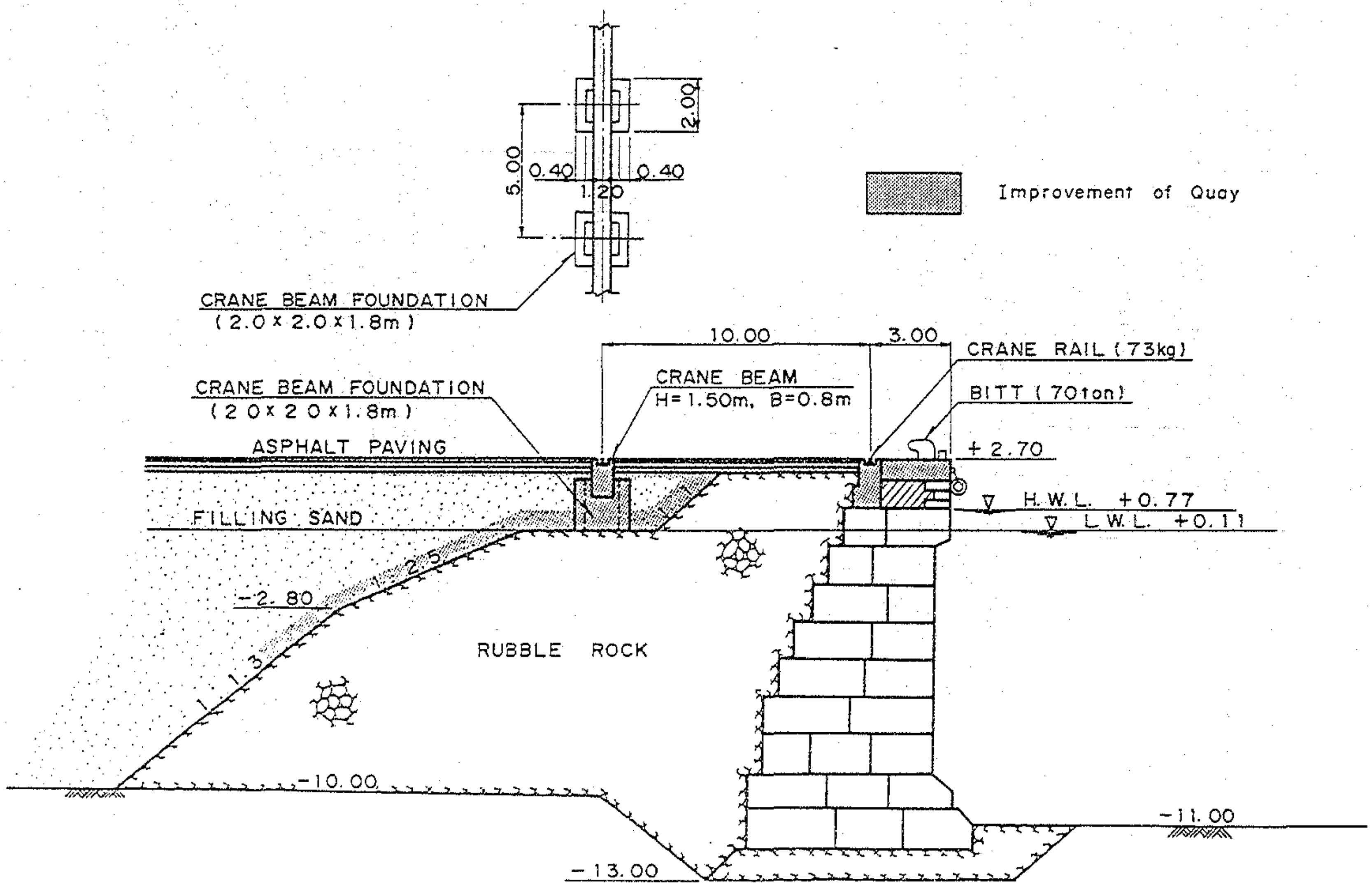


Fig. 6-5-12 Quay Structure of New North Pier (No. 1 & No. 2 Berth)

Unit: meter

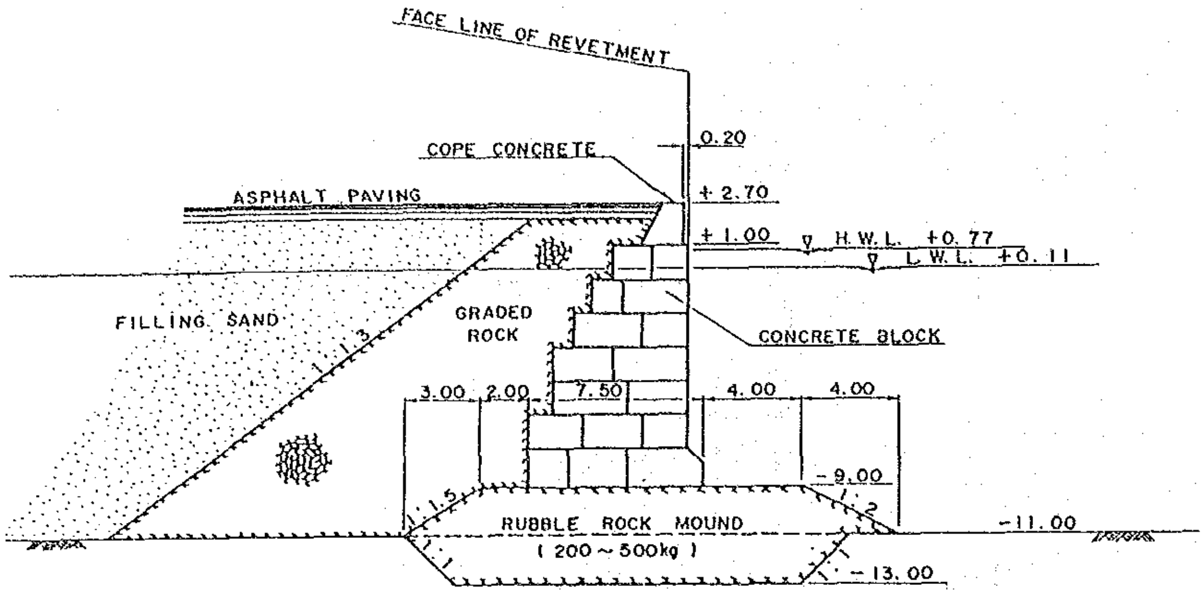


Fig. 6-5-13 New North Pier Revetment - Type A

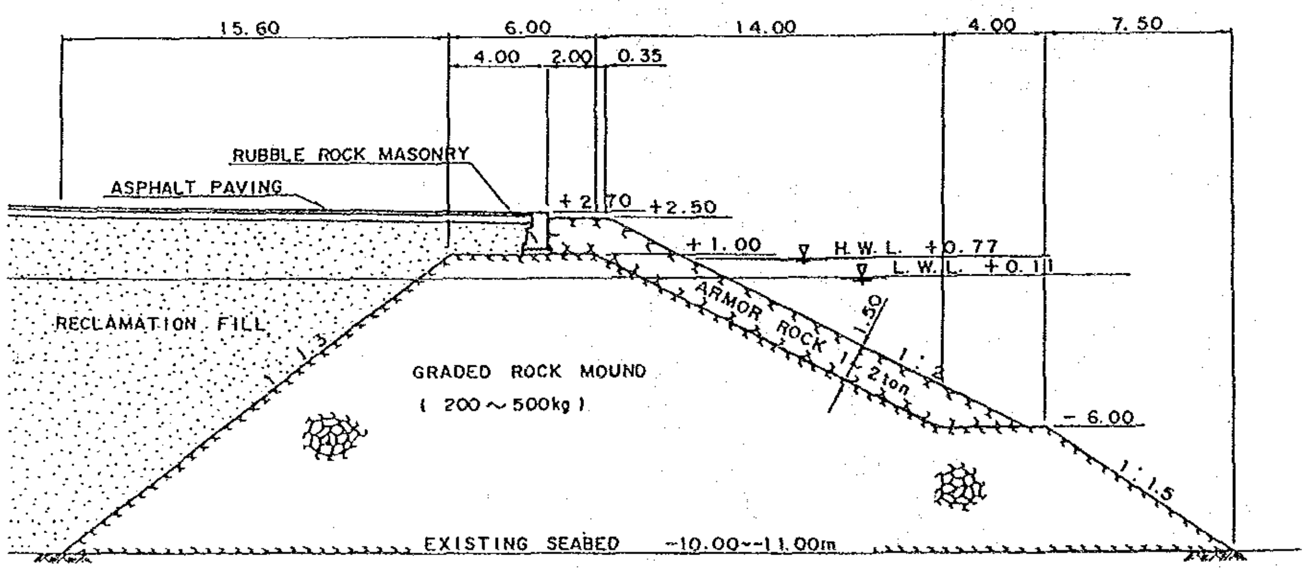


Fig. 6-5-14 Typical Cross Section of North Pier Revetment - Type B

Equipment	Capacity	No. Required
(a) Level luffing crane	200 tons/hr	2
(b) Belt conveyor 350 m long	200 tons/hr	2
(c) Packer	24 tons/hr	6
(d) Palletizer	24 tons/hr	6
(e) Wheel loader	2.0 tons	8
(f) Forklift	1.5 tons	40

(5) Warehouses

The two proposed warehouses will be of such construction as will permit temporary storage of bulk fertilizers separately according to type. The external wall on the south will also serve as the support for belt conveyor system. Fertilizers will be carried directly from ships to the internal storage area of the warehouse where the cargo will fall from overhead.

The warehouses will be provided with spaces accommodating an office, electrical equipment and bagging operations.

(6) No.3 Berth

This quay is designed to serve cargo vessels in the 20,000 d.w.t. class. Because of its location facing the front of the North Entrance Channel, it is preferable for the quay structure to be of such construction as to minimize the impacts of reflected waves so that calmness may be maintained in the water area between this quay and PVQ.

Considering the foregoing point, provision is made for the same pier type structure supported on prestressed concrete piles at JCT No.3 and No.4 Berths. Rubble slope will be provided below the deck slab system to absorb incident wave energy (see Fig. 6-5-15).

Rail beams will be arranged on the quay deck to permit the travel of 10-ton capacity quay cranes. Uniformly distributed superimposed loads of 1.5 tons/m^2 are considered for this quay structure.

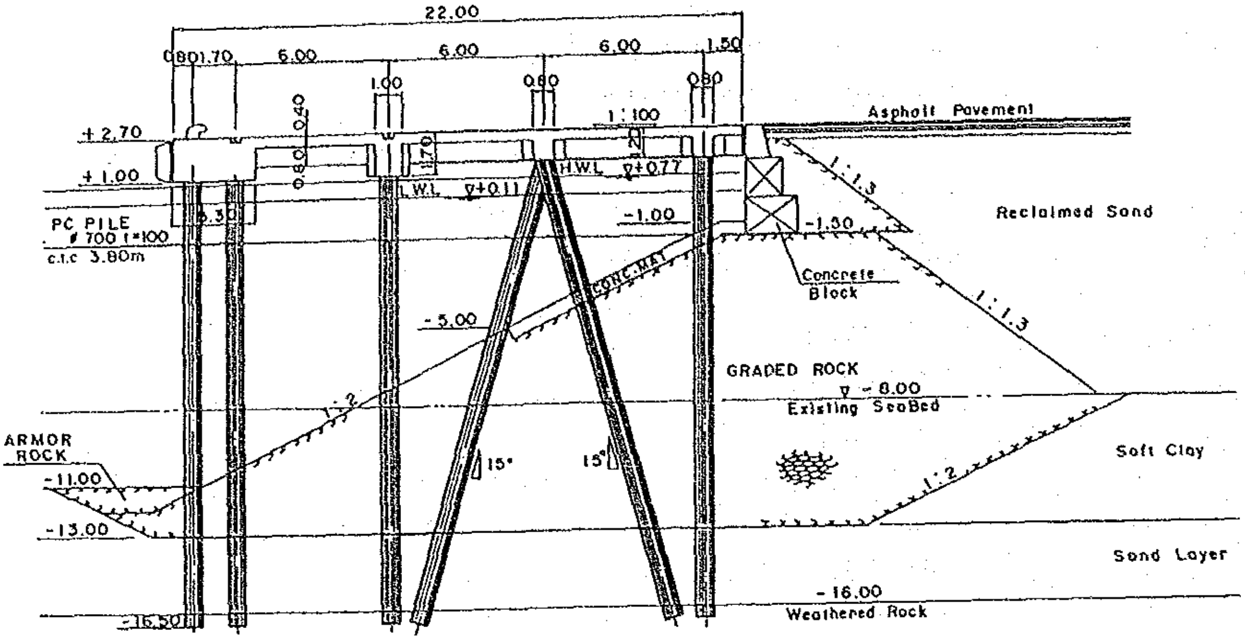


Fig. 6-5-15 Typical Cross Section of North Pier No. 3 Berth
(-11.0 m Depth)

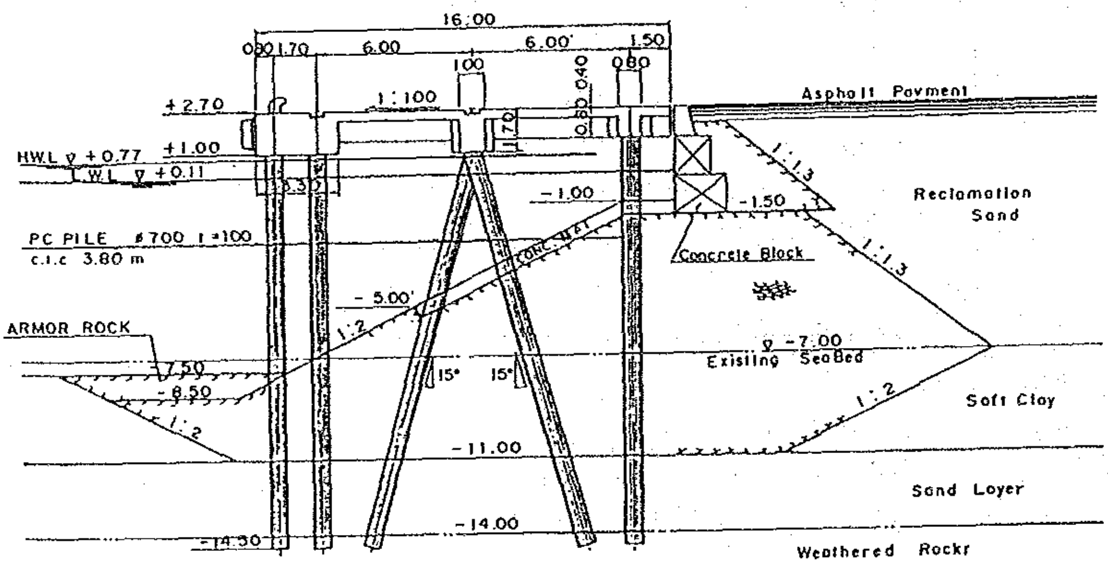


Fig. 6-5-15 Typical Cross Section of North Pier No. 4 Berth
(-7.5 m Depth)

From the soil data derived from two existing boreholes at the site, it is presumed that bedrock or weathered rocks are formed at a depth of -12 or -13 m. If the preconstruction soil exploration reveals the occurrence of bedrock or weathered rocks at a shallower depth, a quay structure supported on concrete caissons with wave dissipating effects may be considered instead of the pier type structure. The adoption of the concrete caisson type structure would be advantageous in that it will result in lower construction cost only if the quay construction coincides with the proposed breakwater extension which will involve the use of concrete caissons and which could share a floating dock with the quay construction for caisson manufacture.

(7) No.4 Berth

Designed for serving cargo vessels in the 5,000 d.w.t. class, the -7.5m quay will be of the pier type, the same type as the -11.0 m quay, to ensure calmness in the narrow water area where it is to be located.

The typical cross section of -7.5 m quay is shown in Fig. 6-5-16. As in the case of the -11.0 m quay, however, a concrete caisson supported structure may be considered for the - 7.5 m quay depending on the results of the preconstruction soil exploration.

(8) Extension of NE and NW Breakwater

Under the following seabed charactaritics, Sand; depth: -12 to -13m; slope: 1/100, two alternative structural types were evaluated for the breakwater extensions to be built in a marine environment which is exposed to weak wave force: (1) Structure incorporating concrete caissons and (2) Structure consisting of a rubble mound armored with wave dissipating concrete blocks.

The typical cross sections of the two different types of structures, known to be secure against external forces, are illustrated in Fig. 6-5-17 and Fig. 6-5-18, respectively.

The estimated costs of the structures are compared below.

Concrete caisson type structure	:	US$ 30,374/m
Rubble mound armored with wave dissipating concrete blocks	:	US$ 37,490/m

The structure incorporating concrete caissons is less costly because it requires a smaller quantity of rubble stones. Another advantage of this structural type is that the rubble mound slope will offer less interference with the operation of the access channel because of its vertical wall. A further advantage is that the concrete caisson type structure will make it easier to build a lighthouse at the tip of the extended breakwater.

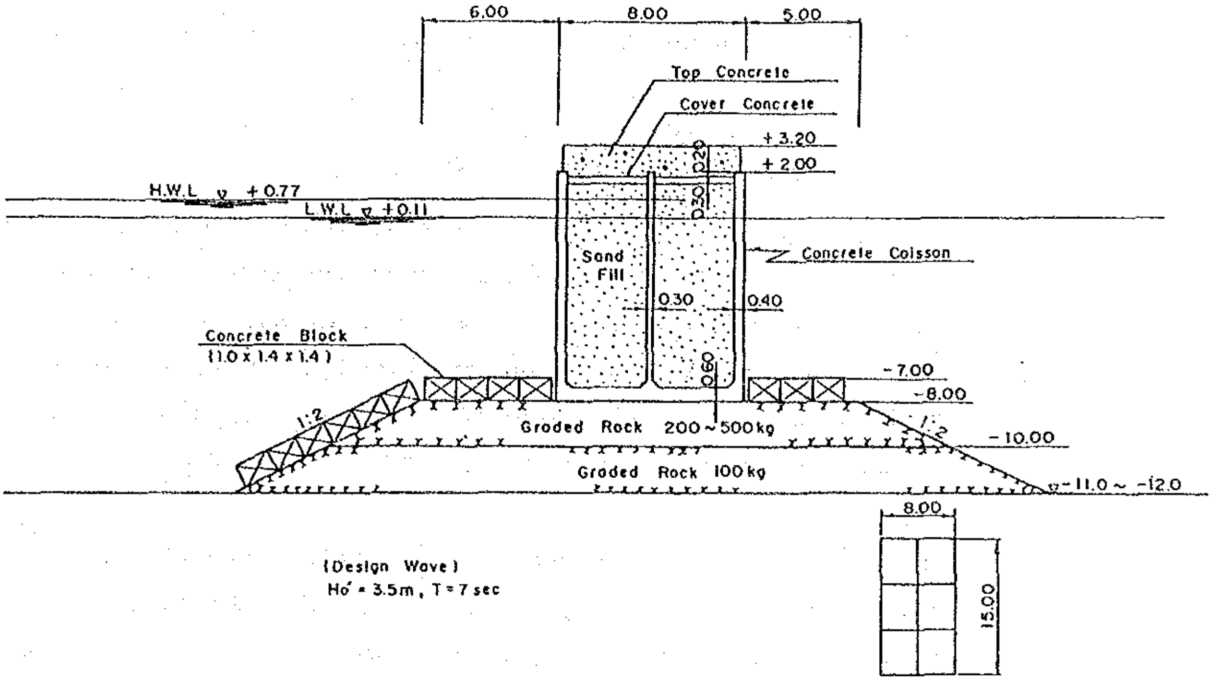


Fig. 6-5-17 Extension of Northwest and Northeast Breakwaters
(Concrete Caisson Type)

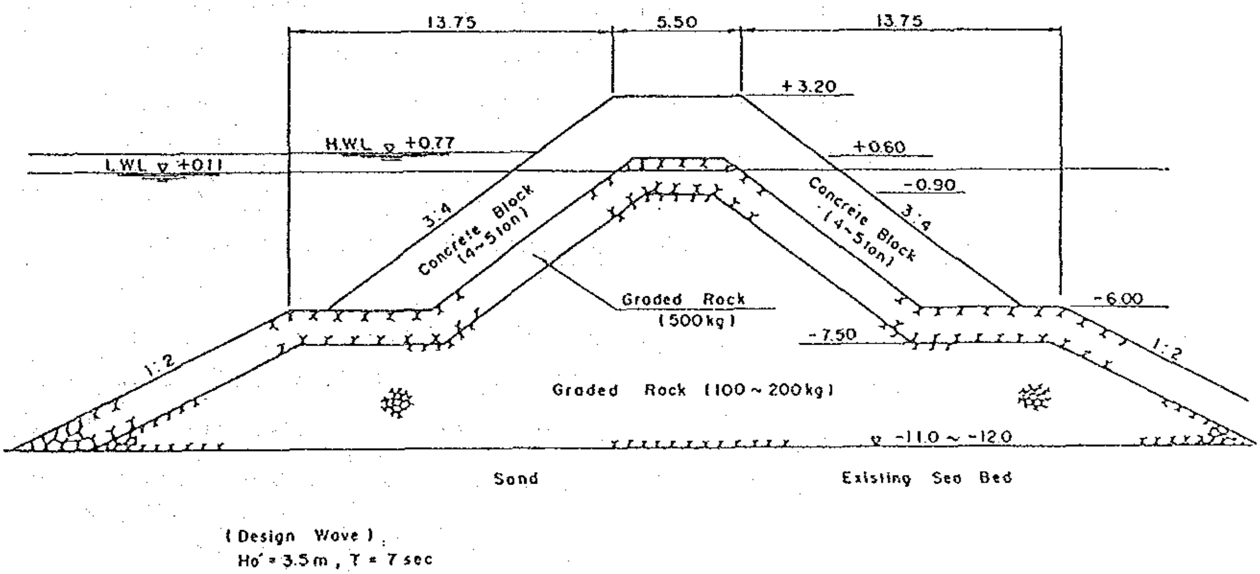


Fig. 6-5-18 Extension of Northwest and Northeast Breakwaters
(Rubble Rock mound Type)

3. Pipe line to dolphin berth for oil handling

(1) Outline of project

This Oil pipeline Project is for laying oil pipelines to the New Oil Wharf in conjunction with the relocation of oil cargo handling facilities proposed as part of the port facilities improvement plan contained in the feasibility Study Report for "The Development Project of the Port of Colombo" carried out by JICA in 1980.

The New Oil Wharf construction plan is designed to improve safety in the port by relocating the facilities for handling explosive or combustible materials to the North West Breakwater area separating from the Dry Cock Area and general cargo handling facilities, and to redevelop the remaining hinterland of North Pier for increasing the general cargo handling capacity in the future.
In the 1980 report, it is proposed that the oil handling facilities for large crude oil tankers, be relocated to the new offshore Single Point Buoy Mooring berth, and that the oil handling facilities for small and medium size oil tankers up to 60,000 DWT be relocated to the New Oil Wharf within the port.
The construction of the new offshore berth, associated pipelines and the New Oil Wharf have been completed.

Since the New Oil Wharf was constructed at the back (port side) of North West Breakwater, an island breakwater, the pipelines connecting the New Oil Wharf with the existing onshore pipelines shall be laid across the water way in the port.

This Pipeline Project involves laying of pipelines connecting the New Oil Wharf as shown in Fig. 6-5-19 and the Tie-in Point with the existing pipelines near the hair pin curve in the vicinity of the inner Dock.

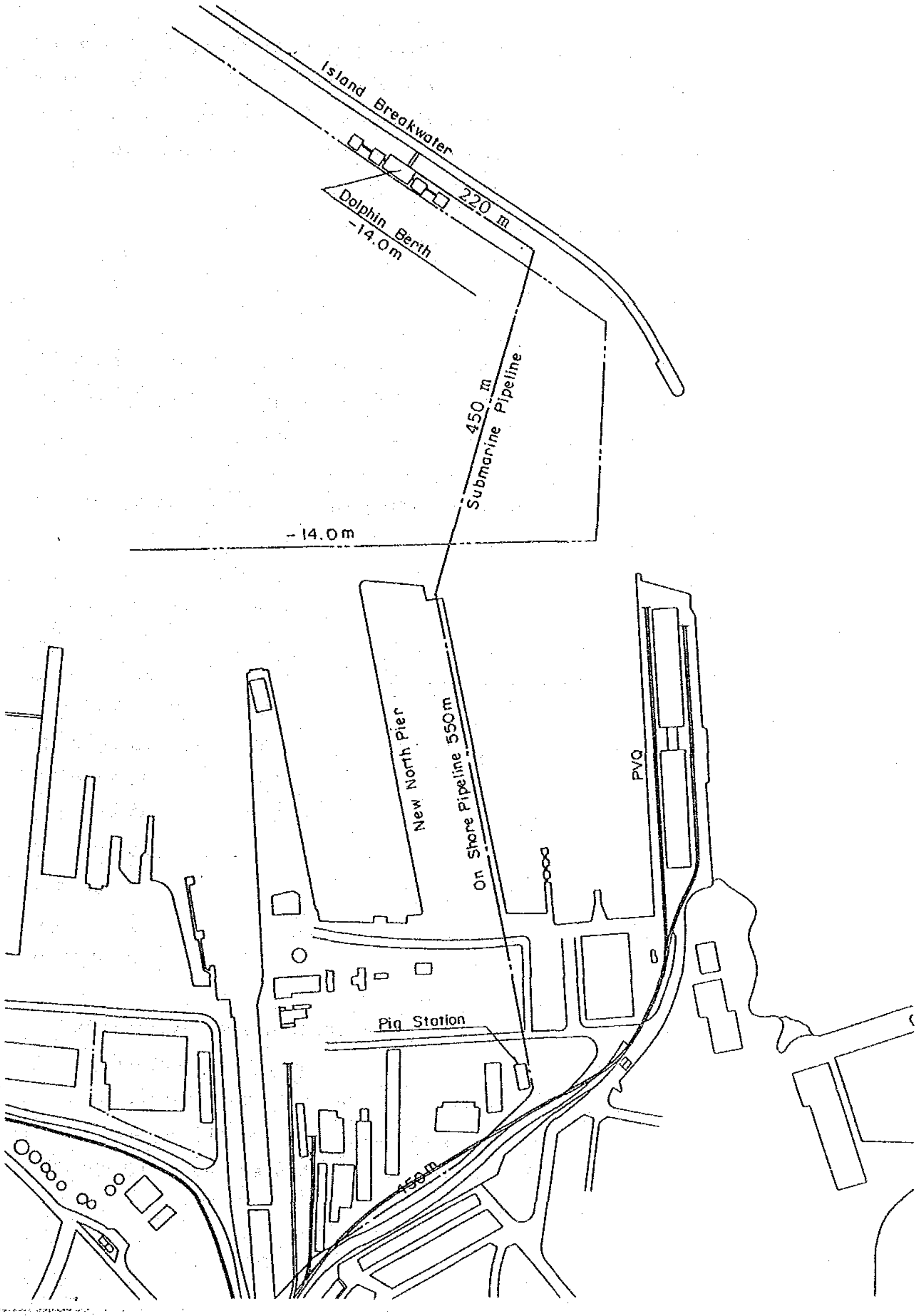


Fig. 6-5-19 Pipe laying for Oil Handling at Dolphin

The proposed pipelines are designed to transport crude oil (for emergency cases only) and 10 kinds of petroleum products, and to include such ancillary lines as a power cable, communication cable and a fresh water pipeline.

(2) Submarine pipelines

i) Number of pipelines

The submarine pipelines, a power cable and a communications cable will be installed in the dredged trench approx. 700 meter in length.

The total number of pipes shall be 10 as shown below:

Fluids	Pipe dia.	Design Pressure
Fuel Oil (Export)/Crude Oil (Import)	24"	25 kg/cm^2G
Jet Fuel (Import)/Gasoline (Import)	12"	25 kg/cm^2G
Gas Oil (Import)	12"	25 kg/cm^2G
Naphtha (Export)	12"	25 kg/cm^2G
Base Lube Oils (Import)	10"	25 kg/cm^2G
Bunker Fuel Oil (Export)	12"	25 kg/cm^2G
Marine Diesel Oil (Export)	6"	25 kg/cm^2G
Bunker Gas Oil (Export)	6"	25 kg/cm^2G
LPG-Butane (Import)	6"	35 kg/cm^2G
Fresh Water (Supply)	3"	9 kg/cm^2G

Note: The standard design pressure for loading and unloading oil pipelines in the international petro chemical industry is around 15 kg/cm^2G. Therefore, the above design pressure may be changed subject to SLPA/CPC's approval, depending on the actual shut off pressures of tanker pumps and the existing cargo pumps.

ii) Corrosion protection

a. The corrosion protection for the submarine pipelines shall be provided by applying external protective coating and cathodic protection (sacrificed anode method).

b. The corrosion protection for the riser pipes in the splash zone shall be provided by applying external protective coating and concrete coating.

iii) Concrete protection

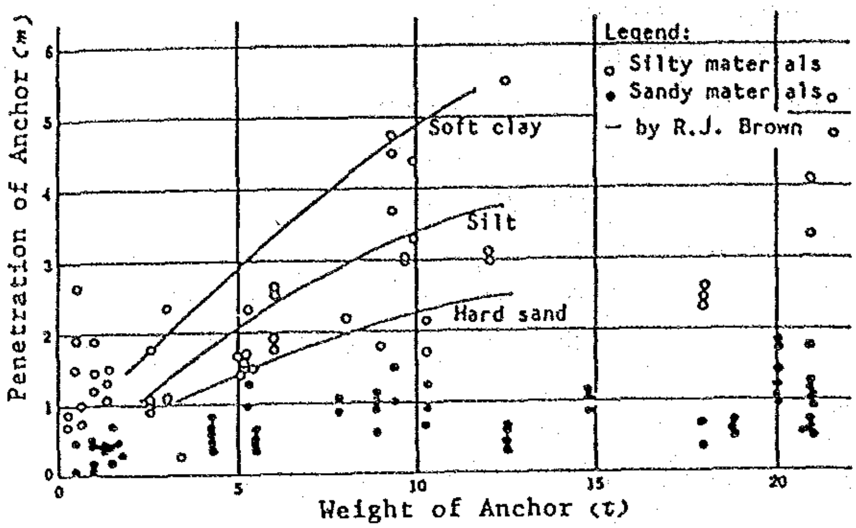
Submarine pipelines, which will be laid in the trench bottom during the bottom pull operation, shall be concrete coated to prevent the external protective coating from damage.

iv) Earth cover of pipelines

Relations between anchor weight and penetration depth into the sea bed of silty and sandy materials, obtained from various experimental tests executed in Japan and by R.J.Brown, are shown in Fig. 6-5-20.

The penetration depth by R.J.Brown includes the additional penetration due to anchor drag.

In the design, vessels in the 60,000 d.w.t. class are considered for anchoring operations with anchors of 10 tons. Therefore, the minimum earth covering thickness shall be 2.5 m, if the selected backfill sand is of acceptable quality.



Source: Technical Standards for Port and Harbour Facilities in Japan 1980

Fig. 6-5-20 Penetration Depth of Anchors

(3) Onshore Pipeline

i) Trench Excavation and installation of Pipeline

The total length of the pipeline trench shall be approx. 1,000 meters on land starting from the shore line to the Tie-in point with existing CPC pipelines near the hair pin curve in the vicinity of the Inner Dock.

ii) Connection to the CPC Pipeline and Others

All pipelines shall be connected to the existing CPC pipelines at the Tie-in Point near the hair pin curve except the Base Lube pipe, Fresh Water Pipe and LPG Pipe.

The LPG Pipe shall end with a blind flange at the Tie-in Point near the hair pin curve.

The Base Lube Pipe shall be connected to the existing

CPC pipelines near the base of the North Pier. The Fresh Water Pipe shall be connected to the Fresh Water Storage.

(4) Piping, instruments and equipment on New Oil Wharf

i) Loading arm and handling system

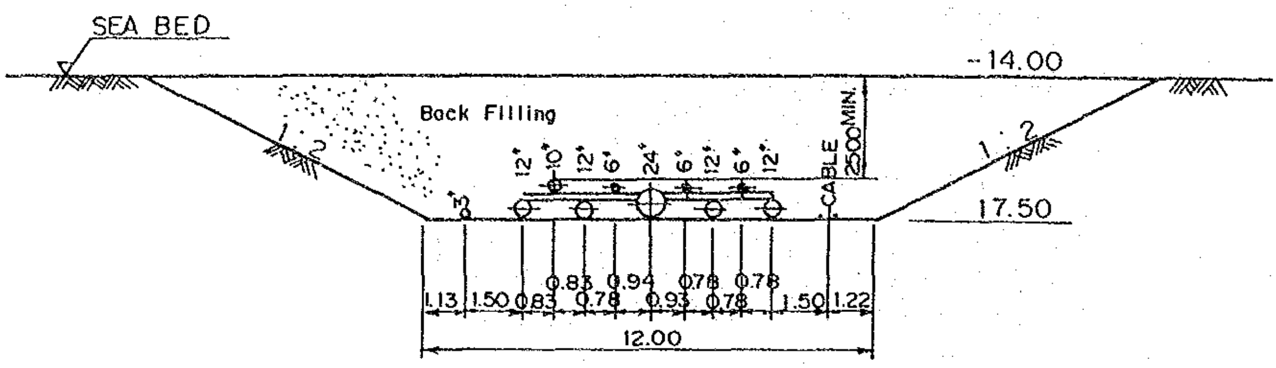
The pipe specification, size of loading arms and handling system are shown in Table 6-5-3.

Table 6-5-3 Loading Arms on Oil Berth

No.	Type of Fluid	Discharging or Receiving	Pipe Size	Loading Arm	Remarks
1	Crude Oil Fuel Oil	Receiving Discharging	24"	12"	Sea water is used for oil purging
2	Gasoline Jet Fuel	Receiving Receiving	12"	8"	Sea water is used for oil purging
3	Gas Oil	Receiving	12"	8"	
4	Naphtha	Discharging	12"	(8")	Commonly used with No.2 loading arm
5	Base Lube Oil A Base Lube Oil B Base Lube Oil C	Receiving Receiving Receiving	10"	8"	Pigging system is used
6	Bunker Fuel Oil	Discharging	12"	-	Rubber Hose
7	Marine Diesel Oil	Discharging	6"	-	
8	Bunker Gas Oil	Discharging	6"	-	
9	LPG	Receiving	6"	6"	

Note: All loading arms will be operated manually.

STANDARD SECTION OF SUBMARINE PIPELINES



STANDARD SECTION OF ONSHORE PIPELINES

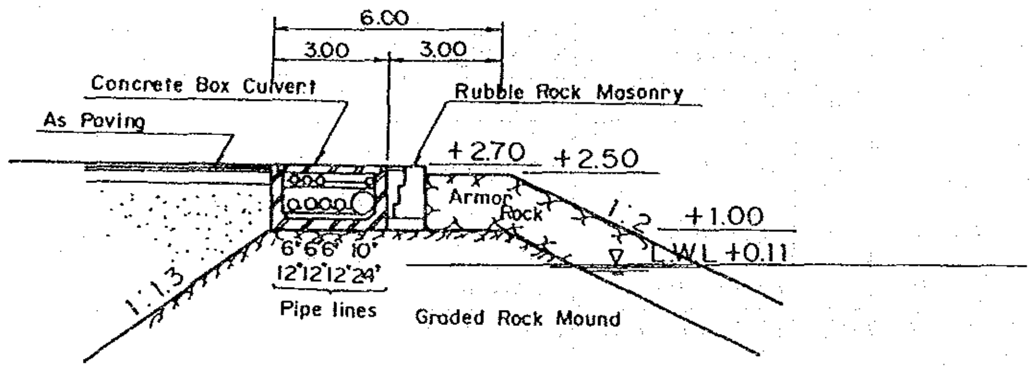


Fig. 6-5-21 Pipelines to Dolphin Berth

ii) Pipeline for New Bunkering Berth

The pipeline for the new bunkering berth shall be suitably arranged and installed on the New Oil Wharf to facilitate piping connections.

Discharging of bunker oil to the berthing tankers shall be carried out by cargo hoses to be installed on the New Oil Wharf.

iii) Pigging System

A launcher for sphere pigs shall be provided for the 10" Base Lube Oil line on the New Oil Wharf for separating different kinds of base lube oil.

iv) Fire Fighting System

Fire fighting facilities using air foam mixed with sea water including fire hydrants shall be provided on the New Oil Wharf.

v) Safety Devices

The following safety devices shall be provided on the New Oil Wharf.

. Gas detection system
. Marine navigational light

vi) Communication System

The following communication system shall be provided on the New Oil Wharf.

. Telephones connected with land offices
. Paging devices

vii) Lighting System

Required lighting equipment for night operation shall be provided on the New Oil Wharf.

viii) Control Room

A control room with adequate space for accommodating the facilities for operation control and monitoring shall be constructed on the New Oil Wharf.

ix) Power Supply and Substation

The required electric power for lighting and electrical equipment on the New Oil Wharf shall be received at 11 KV at the base of South Jetty and supplied through a submarine power cable to be newly laid.

A building with adequate space for a substation to receive and distribute the electric power shall be constructed on the North West Breakwater.

x) Fresh Water Supply

Required fresh water for the New Oil Wharf and berthing tankers shall be received at a designated location around the Warehouse near North Jetty and supplied through a submarine polyethylene pipeline to be newly laid. A fresh water storage tank and a water pump may be required to secure the specified flow rate.

4. Port Access Road and Development of Crown Land

(1) Port Access Road

The Port Access Road Project, targeted for completion in 1992, is currently in the process of implementation with an OECF loan. The road, 1.5 km in total length, will start in the immediate vicinity of the Inner Dock and link with Prince of Wales Road by way of the Crown Land area, a marshland, behind the port. It is a 4-lane carriage way with two lanes on each side. Fig. 6-5-22 illustrates the access road route.

(2) Development of Crown Land

The marshy Crown Land area extending along the port access road will be filled to provide a site for future port expansion projects. The area, when filled, is to accommodate those existing facilities in the narrow port area which will not need shoreline zones and thus can be relocated.

Once the access road construction is completed, it is preferable to undertake soil improvement and filling works to permit the use of the same construction plants and equipment so as to achieve a reduction in the development cost of the Crown Land area.

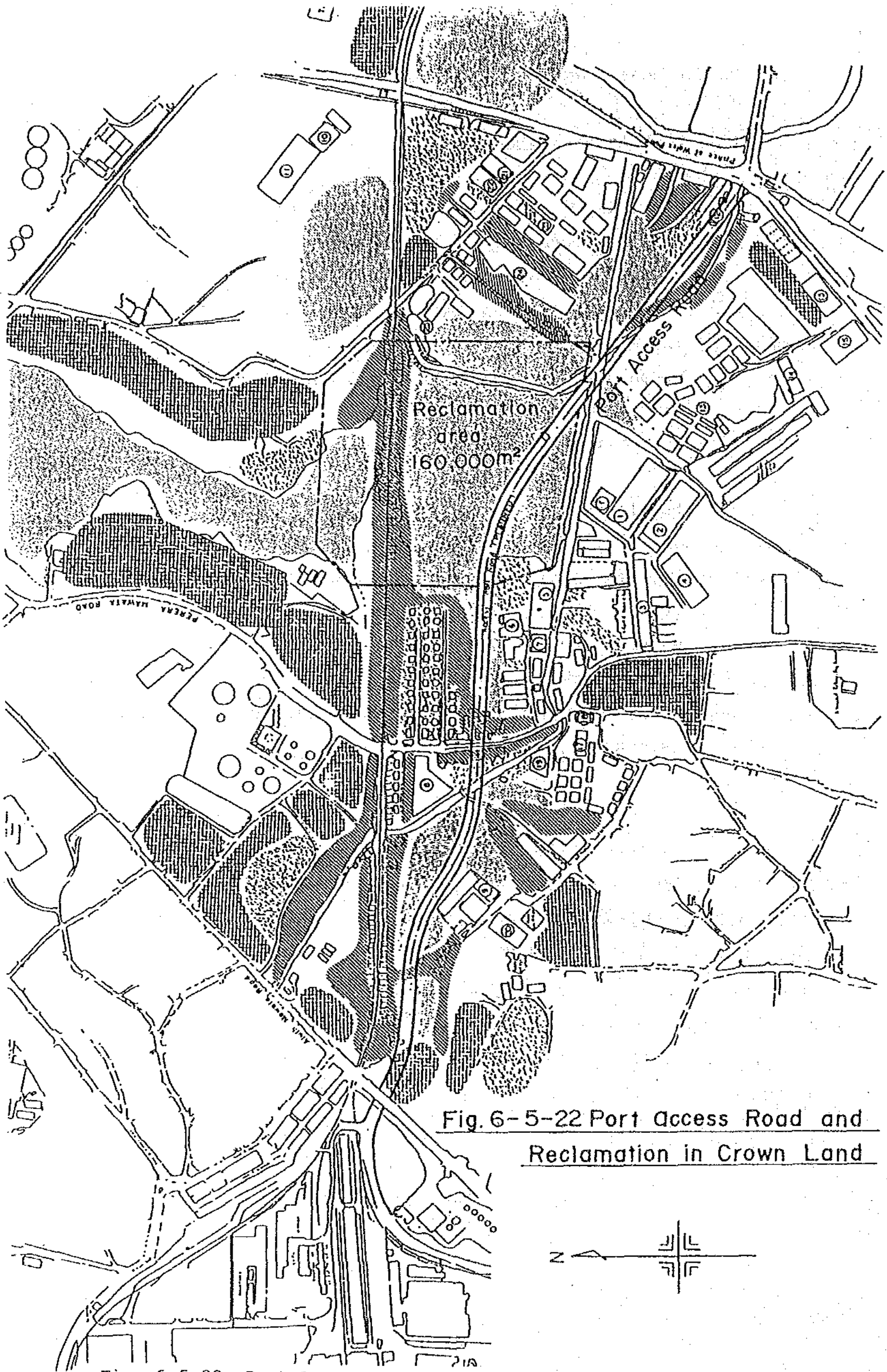


Fig. 6-5-22 Port Access Road and Reclamation in Crown Land

5. Development of Queen Elizabeth Container Terminal

(1) Outline of Project

This project consists of repavement of the existing QEQ Container Terminal as an urgent requirement and the construction of a new modern container terminal which will constitute the major works under the Master Plan.

The repavement works are called the Rehabilitation Project for QEQ Container Terminal and the new container terminal construction is called the QCT Project. Two alternative plans, Alternative A and Alternative B, are studied for the QCT Project.

(2) Rehabilitation Project for QEQ

This project involves the reconstruction of the pavements of the QEQ No.4/No.5 Container Yard which is currently in service. In addition to reconstructing the yard pavement, the container stacking positions will be readjusted, road space for equipment operation secured and yard drainage and lighting systems constructed to facilitate container handling operations.

Moreover, the forklift repair shop located near the QEQ container gate will be relocated and the vacated lot will be used for road construction which will provide access to the QEQ area, thereby separating it from cargo handling operations at the No.1 Warehouse. Fig. 6-5-23 illustrates the facility layout under the Rehabilitation Project.

Yard Stacking Capacity at QCT

①	192	Slots
②	152	Slots
③	252	Slots
④	345	Slots
⑤	148	Slots
⑥	154	Slots
Total	1,243	Slots

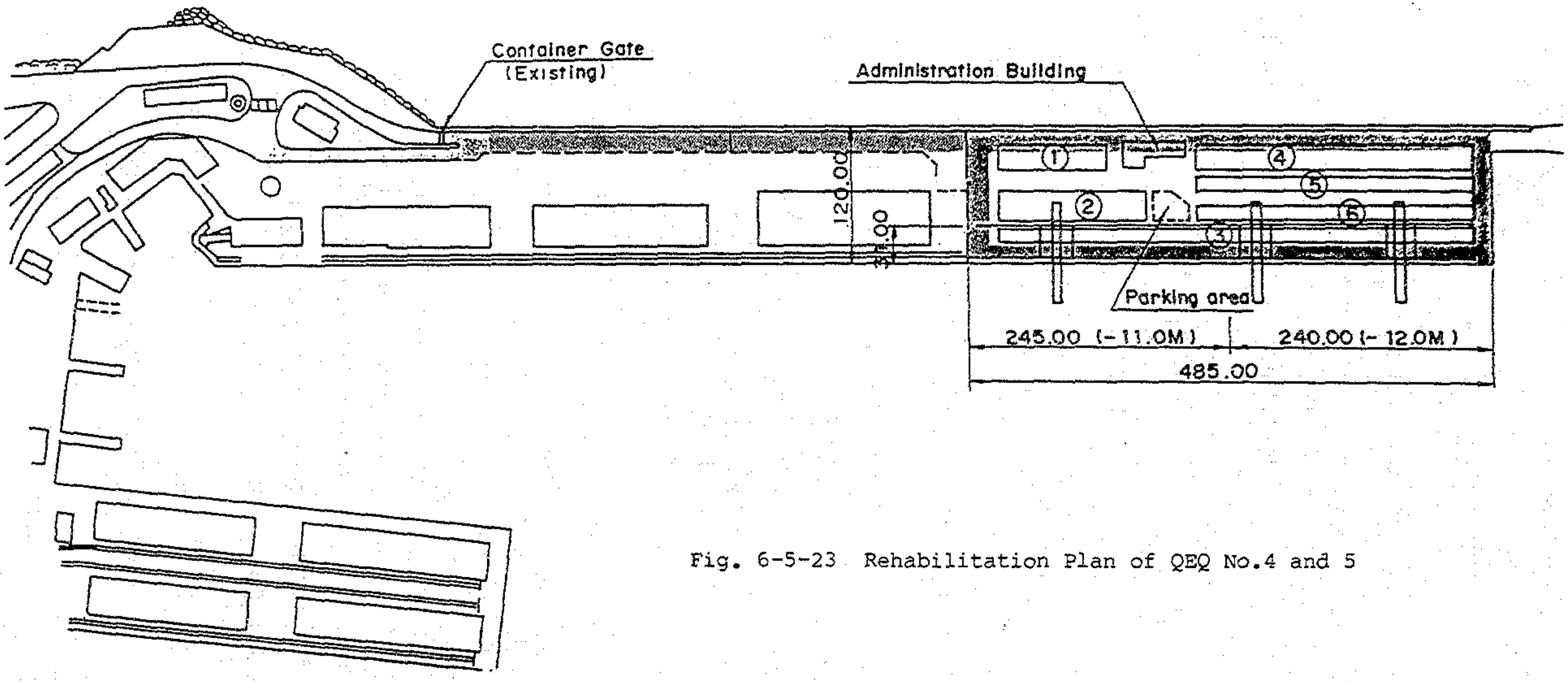


Fig. 6-5-23 Rehabilitation Plan of QEQ No.4 and 5

(3) QCT Project (Alternative A)

i) Layout

The water area sandwiched between Bandaranaike Quay and QEQ will be filled and a 300 m container quay (FCT Berth) with a depth alongside of -14m will be built at the end of the filled area.

A 350 m quay with a depth alongside of -14 m providing two berths and a 300 m quay of -12 m depth alongside providing one berth will be constructed 75 m ahead of the existing Queen Elizabeth quay alignment.

The QCT as planned under Alternative A will have a container yard of nearly 30 ha in total area, which means 7.5 ha of yard area per berth.

This project should preferably be constructed in stages to minimize the impact on the existing cargo handling activities. The Proposed sequence of the project construction calls for first building the container stacking yard in the filled area between Bandaranaike Quay and QEQ, followed by the construction of FCT Berth, QCT No.1 Berth, QCT No.2 Berth and QCT No.3 Berth in that order.

The layout of the FCT yard and the layout of all the project facilities as completed are illustrated in Figs. 6-5-24 and 6-5-25, respectively.

Fig. 6-5-24 Layout of Fort container Terminal

Scale ; 1 / 5,000

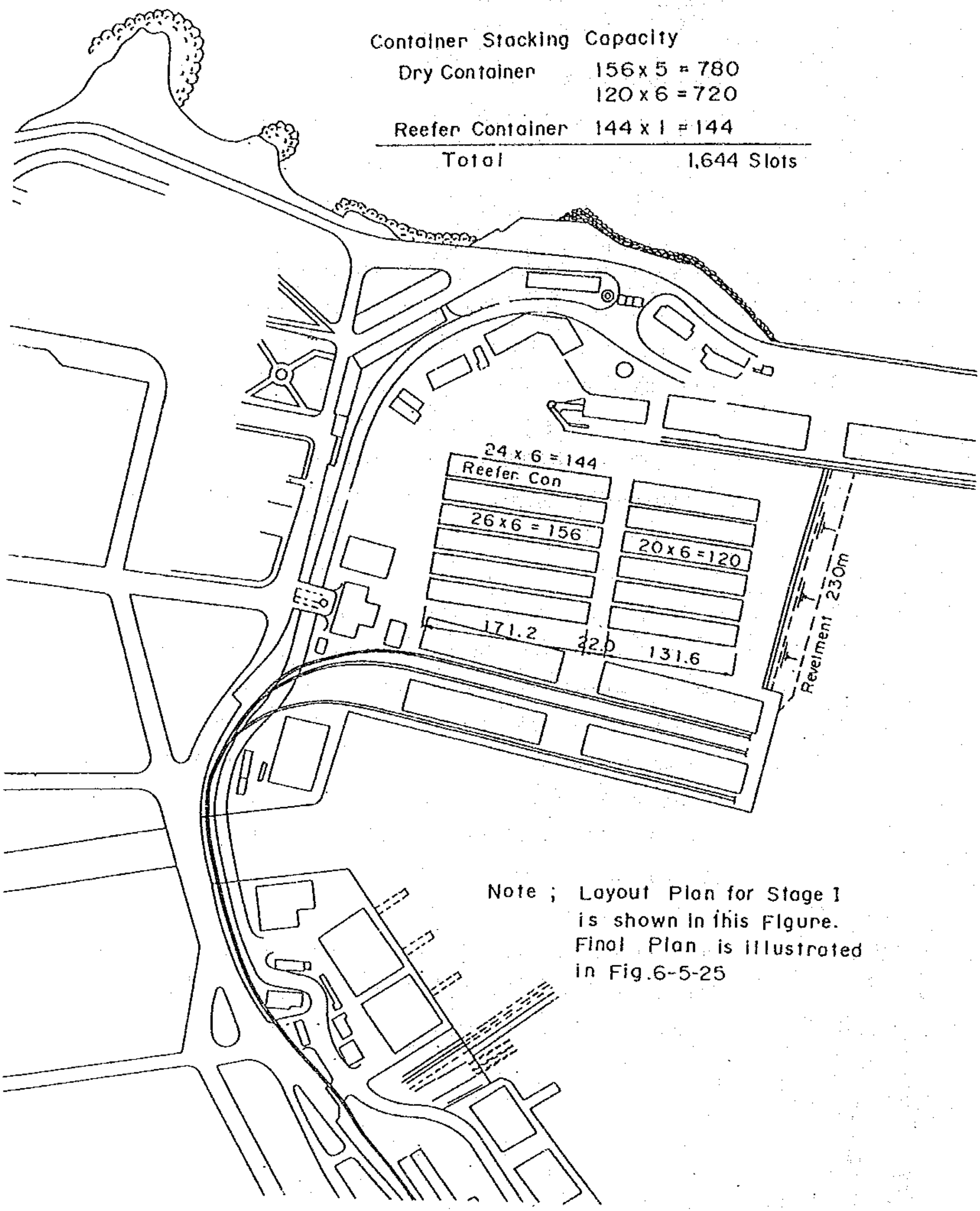
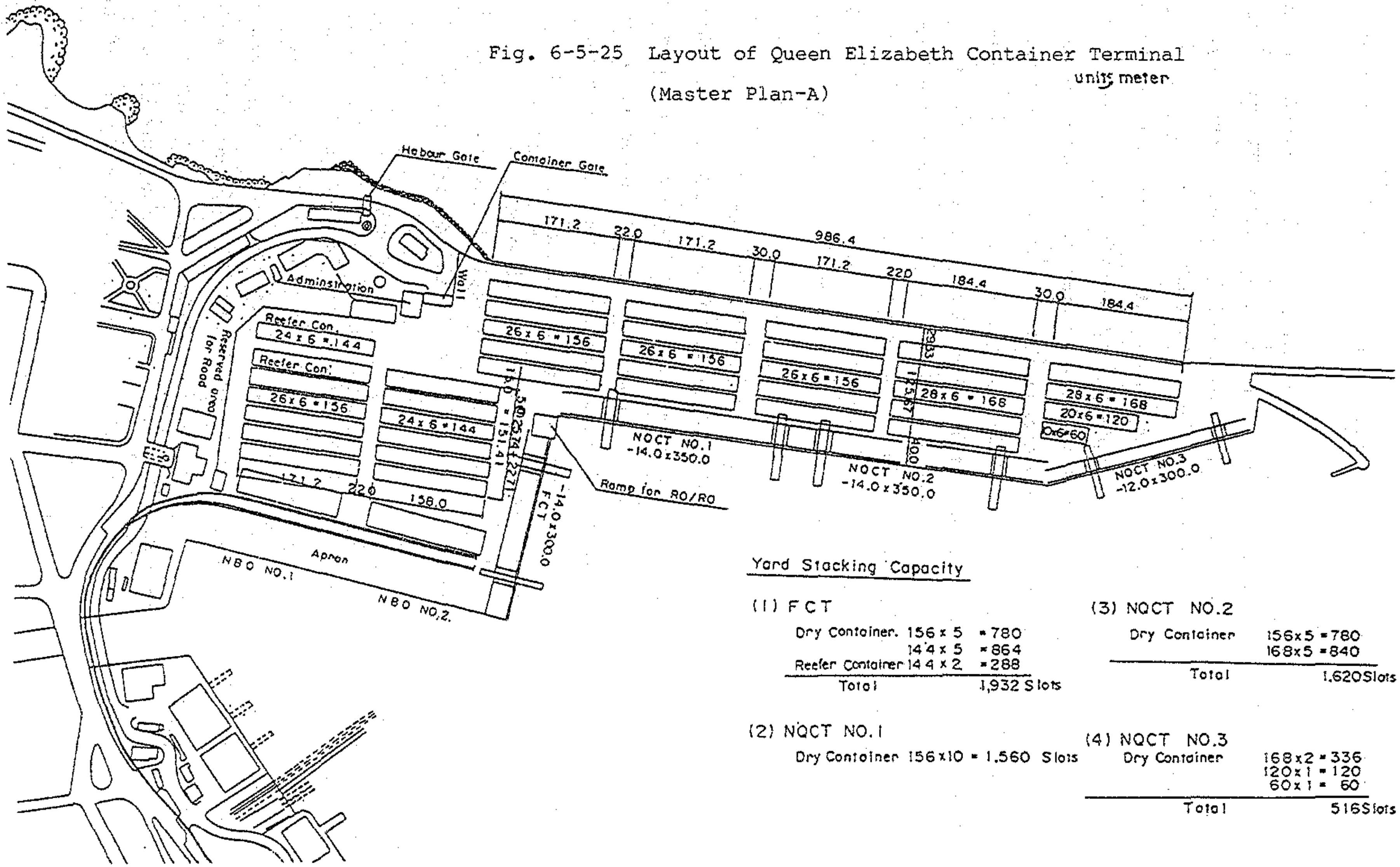


Fig. 6-5-25 Layout of Queen Elizabeth Container Terminal

(Master Plan-A)



ii) Fort Container Terminal

The Fort Container Terminal is to be constructed in two stages on a site prepared by filling the water area between Bandaranaike Quay and Queen Elizabeth Quay.

Stage I comprises the reclamation of the site including a temporary rubble mound revetment to serve as a retaining wall and the construction of a container stacking yard where transfer cranes will be used for container handling. In Stage II, a quay with a depth alongside of -14.0 m will be constructed in front of the revetment and two container cranes will be installed.

a. Revetment and Quay

In the proposed temporary revetment, a relatively steep slope of 1 on 1.5 is provided for the rubble mound to economize on the quantity of rubble stones to be placed. In this area, soft material has been removed from the seabed by maintenance dredging, but if a preconstruction geological survey reveals a problem with the stability of the mound slope, then it may be necessary to replace the soft subbottom material. Fig. 6-5-26 is the cross section of the revetment.

The -14 m quay, planned for construction 60 m ahead of the revetment, will be a pier type structure, the same type as JCT No.3/No.4 Berths, to help maintain clamness in the harbor basin which will become narrower as a result of the series of redevelopment projects planned for the harbor. Fig. 6-5-27 illustrates the typical cross section of the proposed quay.

Fig. 6-5-26 Typical Cross Section of Revetment at Port Container Yard

unit;meter

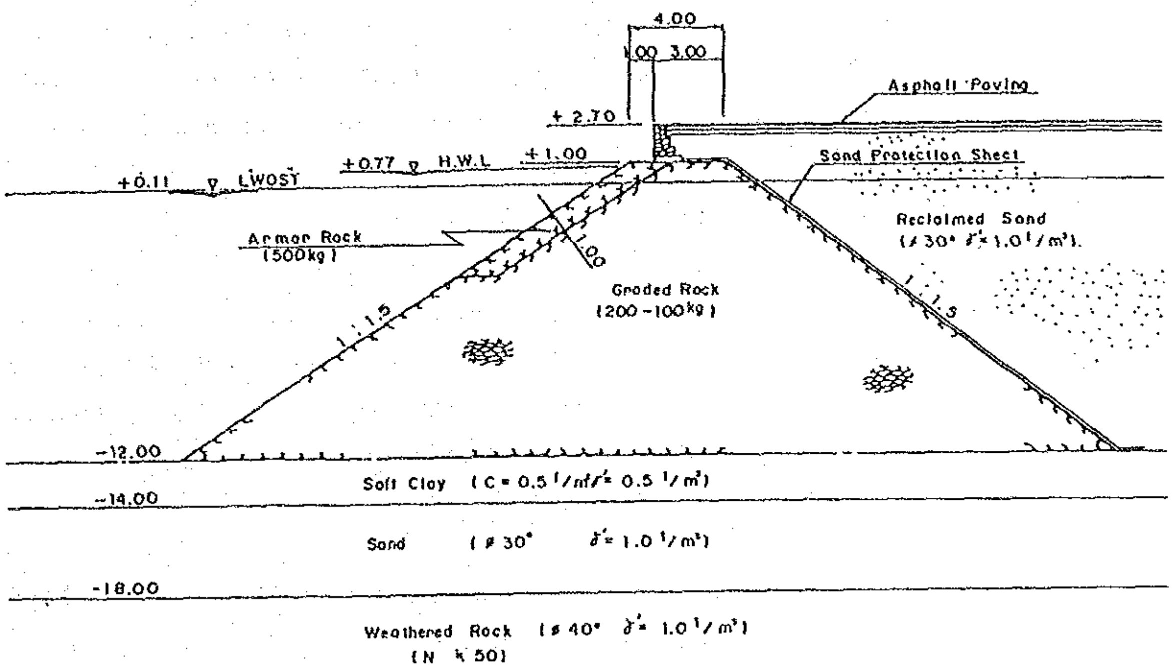
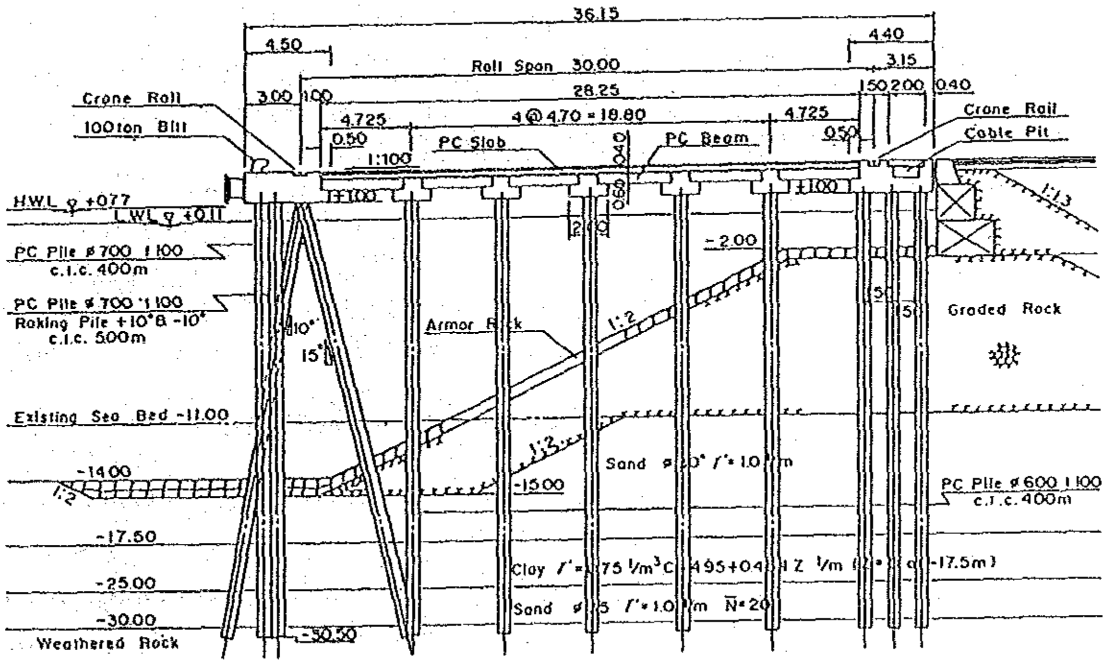


Fig. 6-5-27 Typical Cross Section of FCT -14.0 m Quay

unit ; meter



b. Container Yard

The whole container yard area will be asphalt paved as in the Jaye Container Yard. Prestressed concrete slabs are to be used for the transfer crane lanes.

c. Container Handling Equipment

Completion of the container yard will see the introduction of six transfer cranes and 12 tractors with chassis, all of which will be used to handle containers destined for the QCT until it is completed in its entirety.

Two container cranes will be installed on the -14 m quay planned for Stage II to render the Fort Container Terminal a complete facility.

iii) Qeen Elizabeth Container Terminal

a. Quay Structure

The new quay will consist of a deck slab system supported on prestressed concrete piles, the same type as the adopted JCT quays.

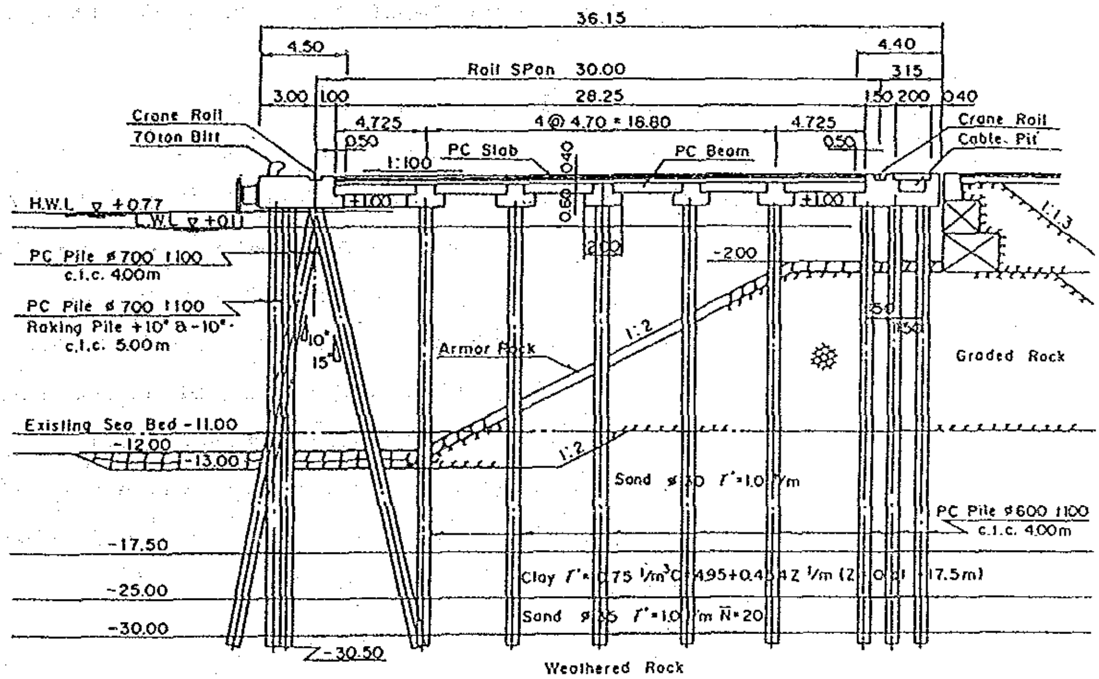
This pier type structure is considered to be an appropriate choice in view of the bearing stratum for piles in this area lying at a depth of -20 to -30 m.

The selection of the same pier type structure was considered for the area about 37 m wide between the rear of the proposed pier type structure and the existing quay line. The pier type will provide a gentle rubble mound slope (1/4) which would allow the energy of inshore waves to be absorbed adequately. However, this advantage is set off by the construction cost of the pier type structure estimated at \$ 1,200/m^2 as against the cost of filling the area behind the new quay estimated at only \$ 240/m^2. Another offsetting factor is that the pier type structure, if used as a container facility, will undergo various operational constraints. For these reasons, it was not considered preferable to adopt a pier type for this part of the new quay structure. As a result, it was decided to select the pier type for the main quay structure only and to fill up the area behind the quay.

Fig 6-5-28 is the cross section of the -12 m quay, and the -14 m quay structure will be the same as the FCT -14 m quay structure.

Fig. 6-5-28 Typical Cross Section of QCT -12.0 m Quay

unit ; meter



b. Container Yard

The major part of the proposed container yard area will rest on a tract of land which was reclaimed over 10 years ago and which is not likely to manifest any major consolidation settlement in the future.

Therefore, the design provides for the use of prestressed concrete slabs for the transfer crane lanes and container stacking slots. The remaining area of the yard will be asphalt paved.

c. Container Handling Equipment

Two container cranes will be installed at each of the proposed quays, but only three new container cranes need be procured due to the continued use of the three existing cranes. The entire yard area will be served by a total of 12 transfer cranes and 30 tractors with chassis for container handling.

d. Offices and Buildings

The existing QEQ No.1 to No.3 terminal warehouses are to be demolished. A power station will be built to supply the container cranes and the yard with CEB power after stepping down and two generators will be provided to enable a minimum of three container cranes to be operated during power failure.
Moreover, an administration building and a container gate are also planned with a view to operation as a modern container terminal.

e. Bandaranaike Quay (BQ)

The warehouses in BQ No.3/No.4 are to be demolished and the vacated area will be paved with asphalt to provide an open storage yard in order to enable the new BQ No.1/No.2 Berths to better perform their functions.

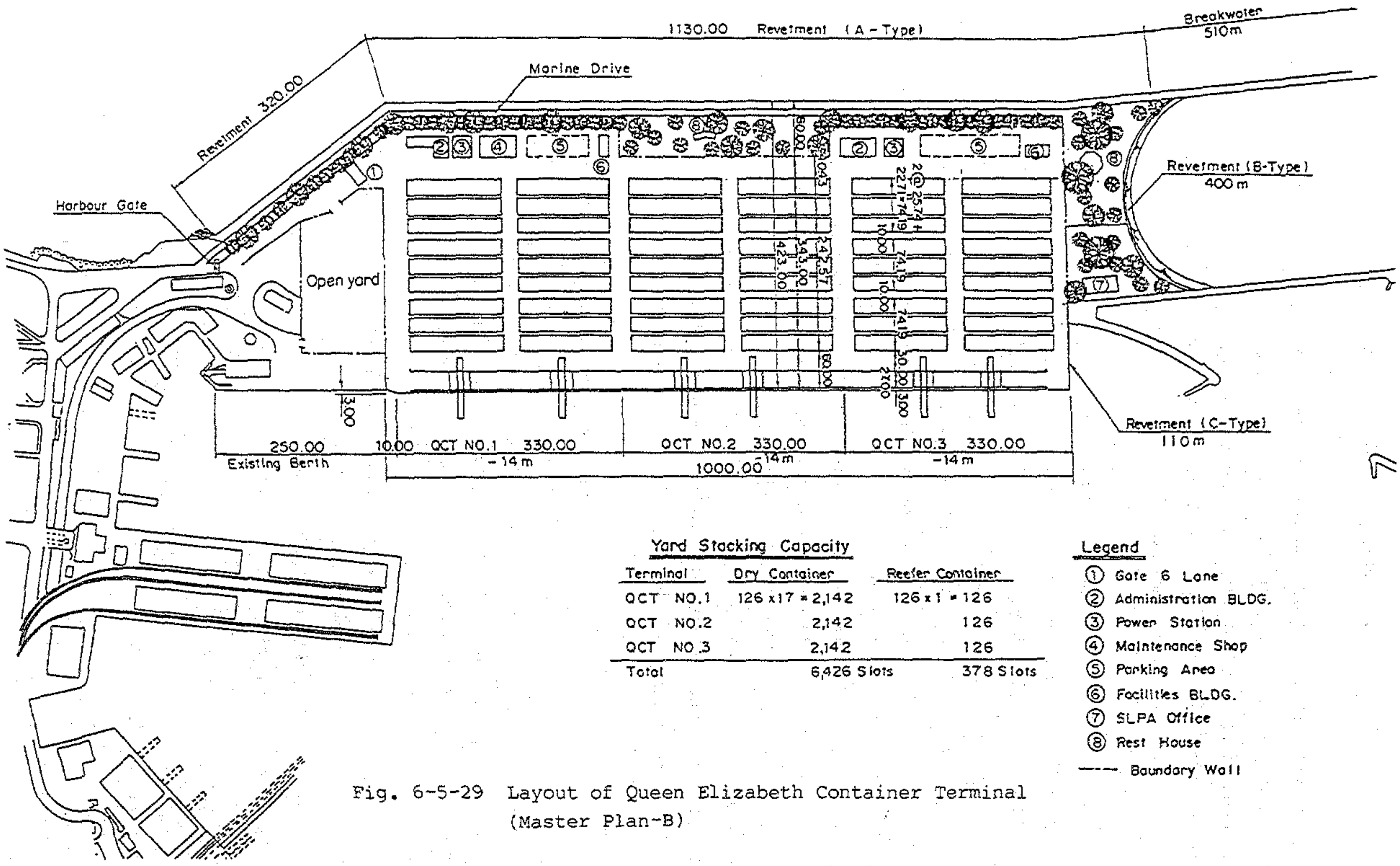
(4) QCT Project (Alternative B)

i) Layout

A new revetment will be built 300 m offshore of the existing QEQ revetment and the water area between the two structures will be filled to provide a container yard with a width of 420 m inclusive of the 120 m width of the existing QEQ quay. Further, it is planned to remodel the existing quay into a new 330 m quay -14 m in depth alongside providing three berths. It is also proposed to construct a Southwest Breakwater on the north of the new revetment structure.

The container yard, when completed, will be nearly 43 ha in total area. On the west of the yard a green belt will be constructed near the new revetment line to prevent splashing of waves and thereby protect container handling equipment from salt damage.

Fig. 6-5-29 illustrates the layout plan of the Queen Elizabeth Container Terminal facilities.



Yard Stacking Capacity

Terminal	Dry Container	Reefer Container
QCT NO.1	126 x 17 = 2,142	126 x 1 = 126
QCT NO.2	2,142	126
QCT NO.3	2,142	126
Total	6,426 Slots	378 Slots

Fig. 6-5-29 Layout of Queen Elizabeth Container Terminal (Master Plan-B)

ii) QEQ Revetment

Construction of the QEQ Revetment (Type "A") as planned under Alternative B will witness several monsoon seasons.

In view of this, a concrete caisson type structure has been selected for the proposed revetment for the dual purposes of reducing the construction time and ensuring its stability relative to wave action even during periods when there is hardly any possibility of fill material entering the area behind the structure.

Deformed concrete blocks will be placed on the front of the revetment to prevent wave overtopping and thereby reduce splashing.

The proposed QEQ Revetment (Type "B") will be a solid structure constructed of rubblework for the primary purpose of protecting the main entrance channel against shoaling due to leaching of fill material. The revetment must serve this primary purpose since the existing Southwest Breakwater 250 m in length will have to be demolished in order to enable the main entrance channel to have a straight alignment.

Figs. 6-5-30 and 6-5-31 show the standard cross sections of the revetments Type "A" and Type "B", respectively.

iii) Improvement of Quay Structure

The new QEQ quay must be of such construction as will be capable of being built in a relatively short space of time, since it will be essential to execute the construction works while commissioning berths as they are completed. Moreover, the structural type of final

Fig. 6-5-30 QEQ Revetment (A - Type)

Unit ; meter

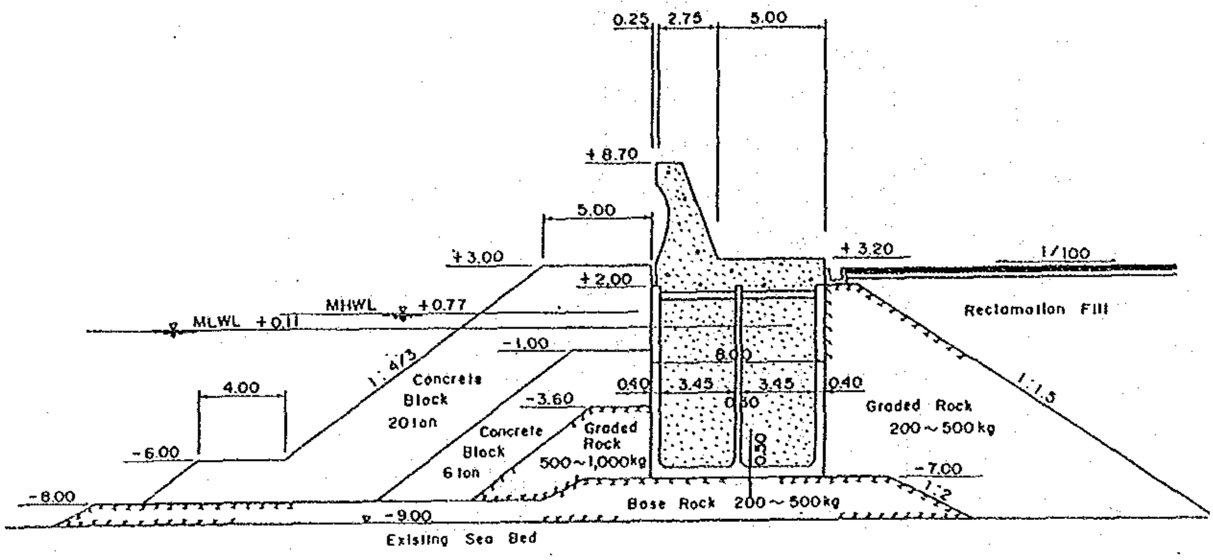
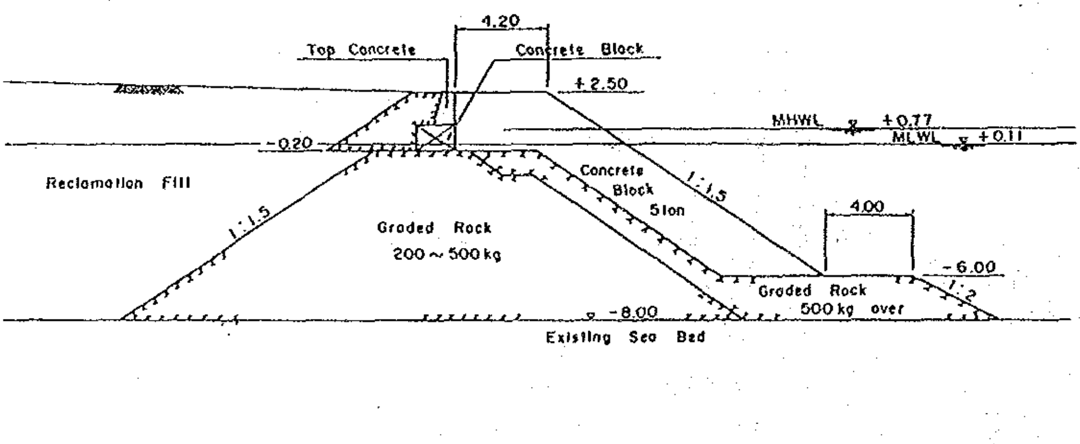


Fig. 6-5-31 QEQ Revetment (B - Type)

Unit ; meter



choice must be such as will allow construction activities to be carried out in limited site spaces resulting from the establishment of a new quay faceline 3 m offshore of the existing quay line, and will provide adequate structural stability for the new quay.

With all these factors taken into full account, a structure supported on piles of concrete placed continuously in situ has been chosen for the proposed QEQ quay. The standard cross section of the new quay is illustrated in Fig. 6-5-32.

Existing soil boring data indicate that sandy subsoils predominate at the quay construction site with limited distribution of cohesive soils below the planned water depth of -14.0 m. For this reason, the cast-in-place concrete pile supported structure is expected to provide adequate stability for the new quay structure.

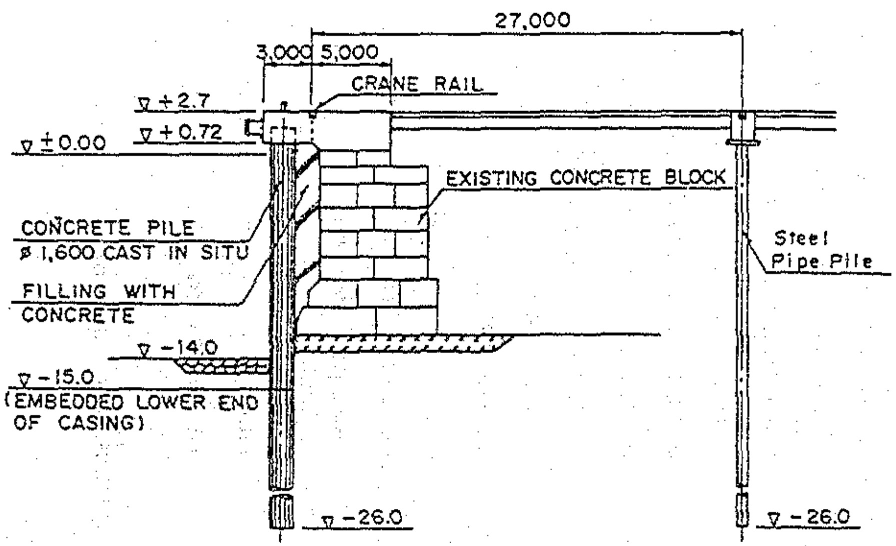
Steel corrosion surveys undertaken during the construction of the JCT Project revealed high corrosion rates for the steel members incorporated in harbor structures in the Port of Colombo. Besides, there is a strong probability that the length of steel piles as actually driven will vary from the pile length as designed as a consequence of the substantial irregularity of the bedrock level at the site. For these reasons, the use of steel pipe piles has been ruled out.

Concrete will be placed continously in situ using casings, which will be left in position after the concreting in order to enable them to perform the added function of protecting the piles installed permanently in position.

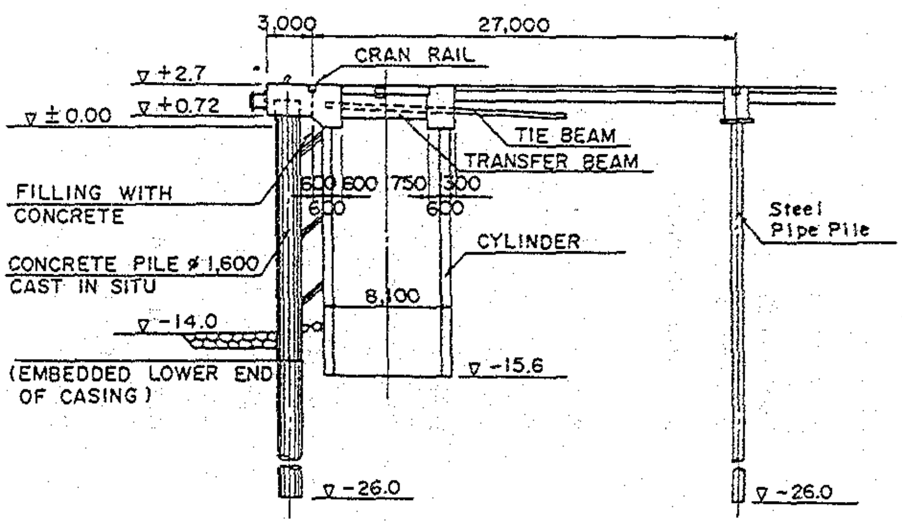
Since the new crane rails will be laid along the

Fig. 6-5-32 Improvement of Quay Structure

CROSS SECTION OF BERTHS NO.2～NO.3 QEQ BERTH



CROSS SECTION OF BERTH NO.4,NO.5 QEQ BERTH



existing quay face line, the area between line of in-situ concrete piles and the existing quay structure will be filled with in-situ concrete.

The crane rail foundation in the rear will be supported on steel pipe piles as in the JCT Berths.

iv) Container Yard

The new container yard will be paved with asphalt concrete of the same cross section as that used in the JCT Project and prestressed concrete slabs will be placed to construct transfer crane lanes.

v) Container Handling Equipment

Two container cranes will be installed at each of the proposed quays, but only three new container cranes need be procured due to the continued use of the three existing cranes. The entire yard area will be served by a total of 18 transfer cranes and 36 tractors with chassis for container handling.

vi) Offices and Buildings

The QEQ Container Terminal will be constructed in stages starting with No.1 Berth and progressing to No.2 and No.3 Berths in that order. In view of the staged construction the following buildings will be constructed in such a way as to permit efficient container handling at the modern terminal.

Building	QCT No.1	QCT No.2	QCT No.3
Gate (with 6 lines)	20 x 40 m	-	-
Admin. building	30 x 55 m (3-story)	-	20 x 50 m (3-story)
Power station with generator	30 x 30 m	-	20 x 20 m
Maintenance shop	30 x 60 m	-	-
Facilities building	30 x 15 m (3-story)	-	20 x 30 m (3-story)

6. Realignment of Main Entrance Channel and Dredging Plan

Figs. 6-5-33, 6-5-34 and 6-5-35 illustrate the entrance channel and harbour basin dredging plans under the Short-term Plan and the Master Plan (Alternatives A and B).

(1) Main Entrance Channel

As shown in Fig. 6-5-33, under the Short-term Plan the existing breakwaters will be left as they are, but the main entrance channel will be widened and dredged to the planned depth of -15m and three sets of navigation buoys will be installed along the channel.

On the other hand, Alternatives A and B of the Master Plan call for constructing a new entrance channel of 250 m in width at the same location. Under both alternatives, a 250 m long section of the existing Southwest Breakwater and a 50 m long section of the Northwest Breakwater will be demolished and the channel will be religned to run straight in the direction of N139°E. The channel depth will also be -15.0 m.

(2) Extension of Southwest Breakwater

The Southwest Breakwater was studeid based on the following design criteria.

i) Design Wave with a 50-Year Return Period

H 1/3 : 6.1 m
T : 9 sec
Direction : W-SW

ii) Bottom Characteristics

Sand; depth: -13 to -14m; slope: 1/100

The breakwater structure will consist of concrete caissons installed on a rubble mound and will be armored on the front with wave dissipating concrete blocks so as to reduce

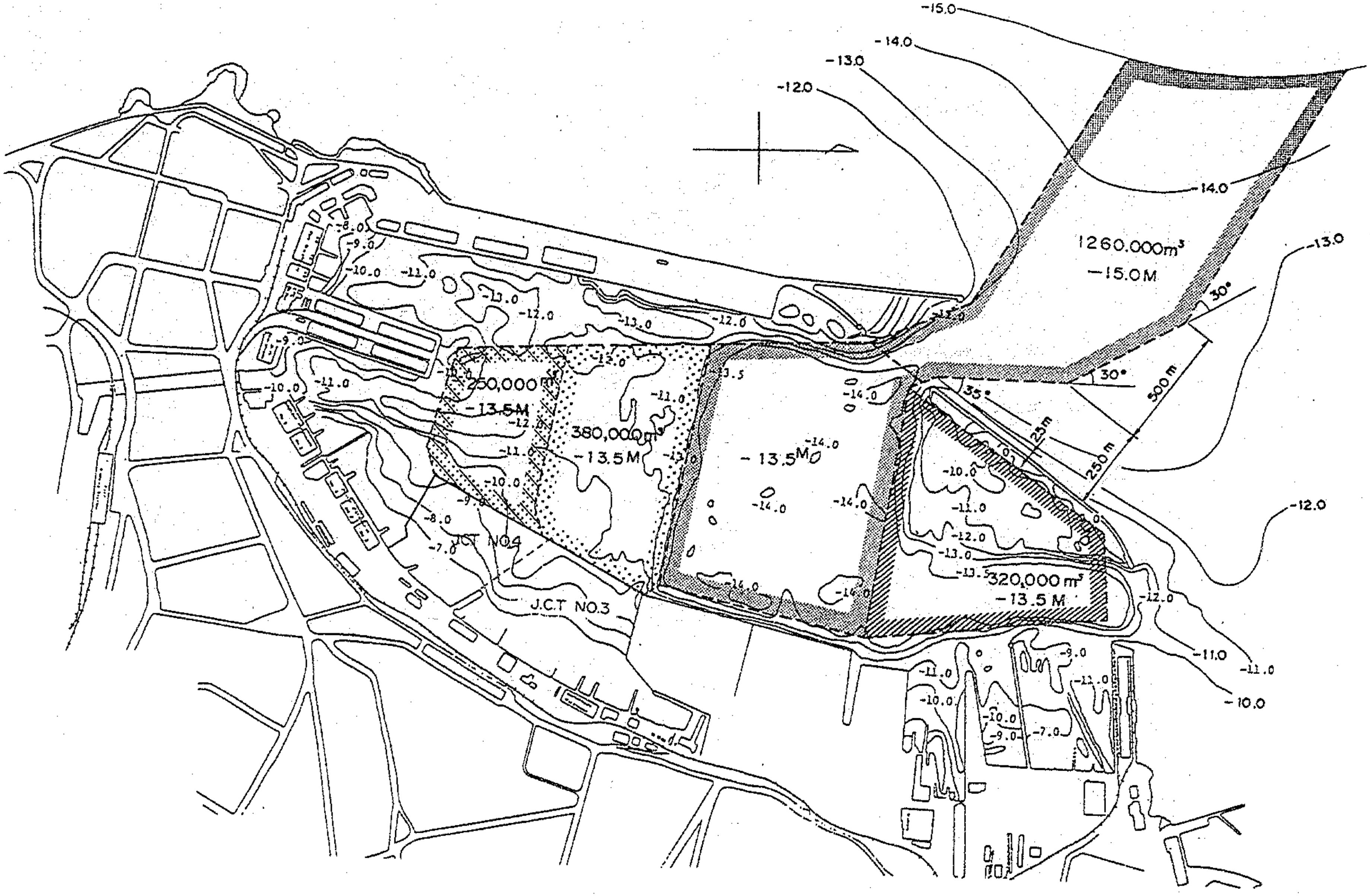


Fig. 6-5-33 Dredging Plan (Short Term)

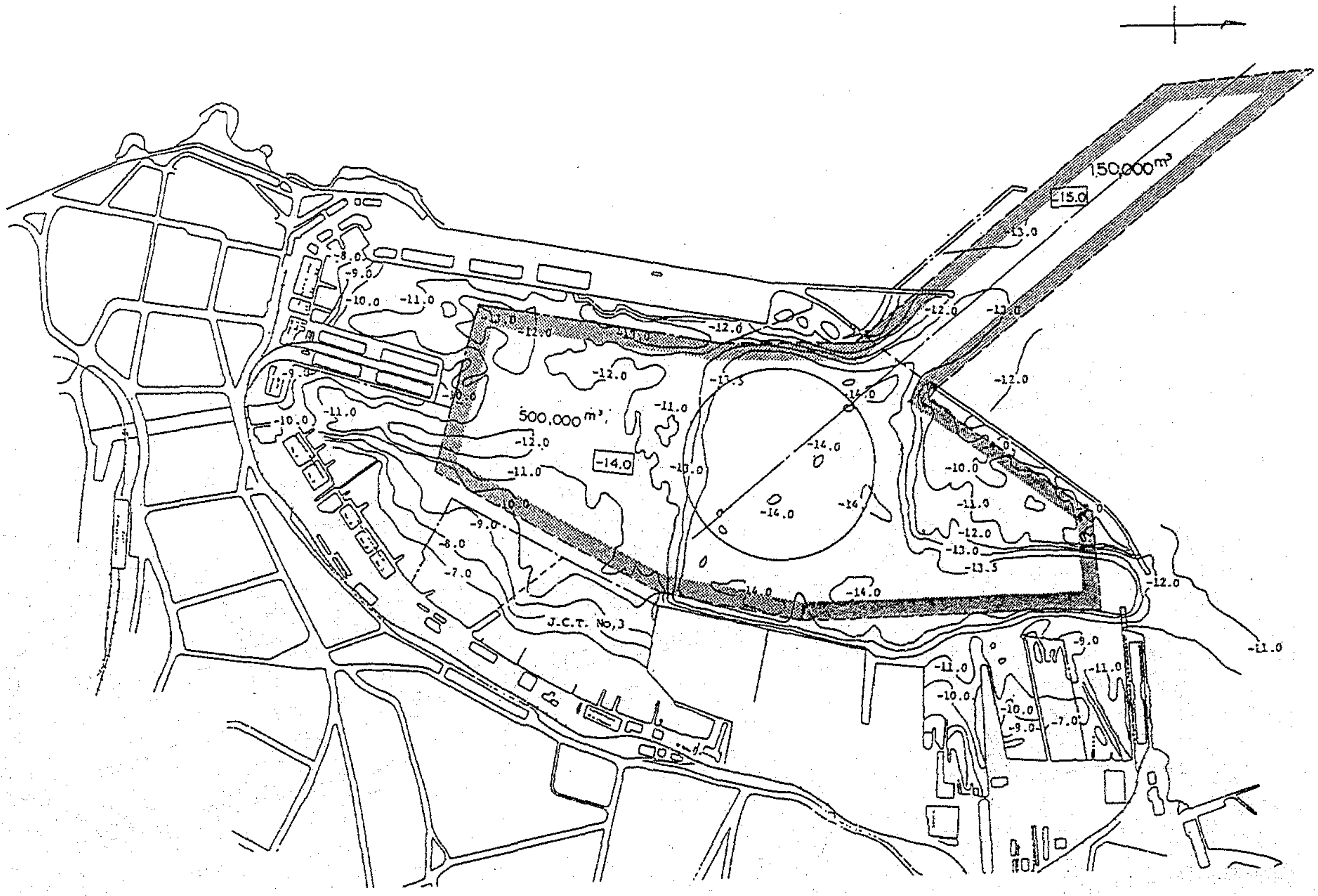


Fig. 6-5-34 Dredging Plan (Alternate - A)

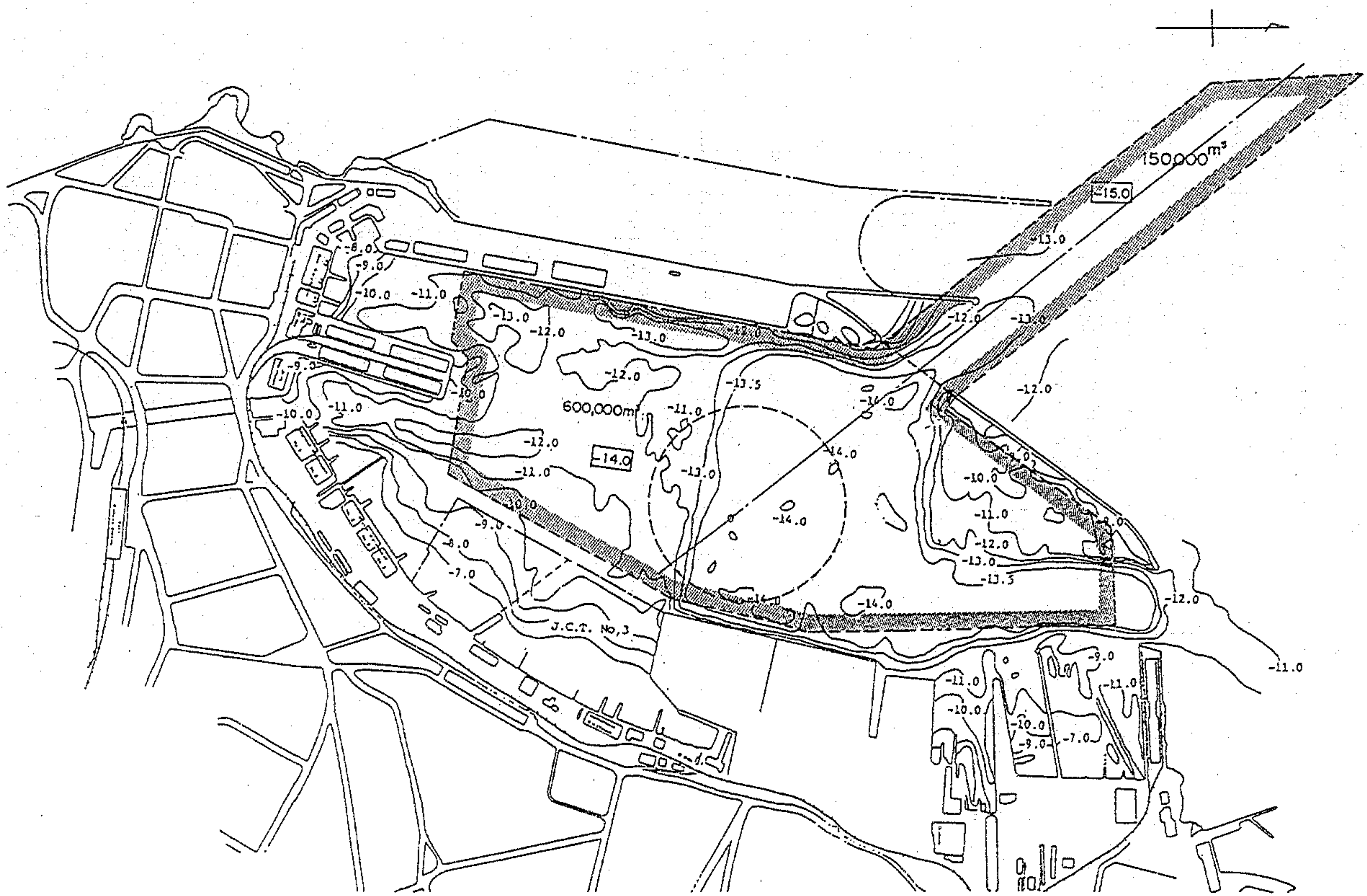


Fig. 6-5-35 Dredging Plan (Alternate - B)

the caisson width. Fig. 6-5-36 shows a typical cross section of the extended breakwater.

In the case of Alternative-A the section joining the existing Southwest Breakwater and the extended structure will form an angle of about 140° which will produce a concentration of wave energies. Therefore, it is planned to place wave dissipating concrete blocks widely in the connecting section to reduce wave force acting directly on the breakwater structure.

A lighthouse is to be installed at the tip of the extended breakwater.

(3) Dredging in Harbour Basin

Under the Short-term Plan, that part of the harbour basin adjacent to the proposed berths will be dredged to -13.5 m in turn with the completion of each berth. Under the Master Plan, on the other hand, the basin in to be dredged down to -14.0 m with the completion of the FCT and QCT Berths.

(4) Volume of Dredging

The volumes of dredged material under the Short-term Plan and the Master Plan are estimated as follows:

Estimated Dredging Volume under Short-Term Plan

JCT No.3	JCT No.4	Oil Berth	Channel	Total
380,000 m^3	250,000 m^3	320,000 m^3	300,000 m^3	1,250,000 m^3

Estimated Dredging Volume under Master Plan

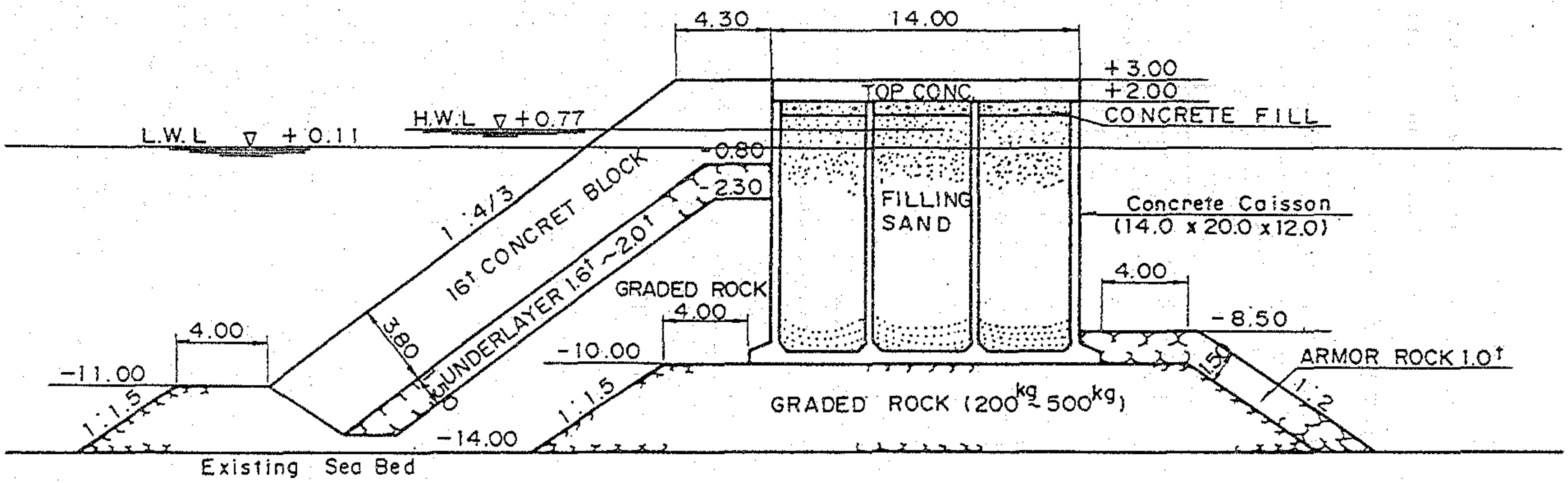
(a) Alternative A

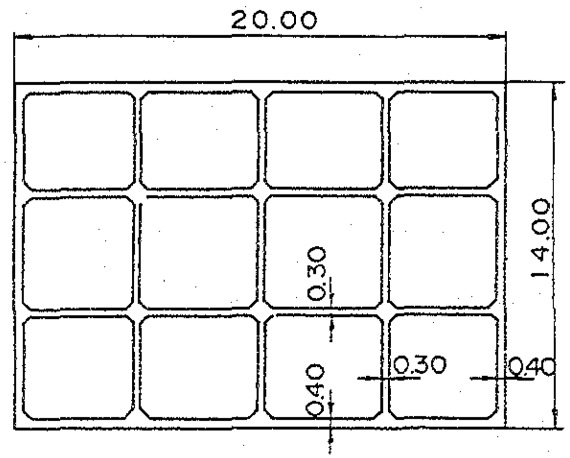
Harbour Basin	Channel	Total
500,000 m^3	375,000 m^3	875,000 m^3

(b) Alternative B

Harbour Basin	Channel	Total
600,000 m^3	375,000 m^3	975,000 m^3

Fig. 6-5-36 Typical Cross Section of Southwest Breakwater
(Concrete Caisson Type)





Plan of Concrete Caisson

7. Port Highway

The plan is to construct an elevated motorway connecting the base of Queen Elizabeth Quay, Fort Area, Baghded Area, and Pettah Area. The total highway length will be approx. 2,000 m including the ramp areas.

6-5-3 Construction Schedule

The construction schedule of the Project under Master plan A and Master Plan B are shown in Figs. 6-5-37 and 6-5-38 respectively.

1. Salient Points of the Construction Schedule under Master Plan A

(1) The Short-term Project is planned for completion at the end of 1995.

- JCT No.3 Berth to go into service in 1993
- JCT No.4 Berth to go into service in 1994
- Oil cargo handling to start at Dolphin Berth at the beginning of 1993
- Handling of general cargo to start at New North Pier (NNP) No.1 and No.2 Berths in late 1994 and bulk handling of fertilizers to start at the same berths in 1996.

(2) Construction of the FCT planned under Master Plan A can only start after the completion of the four NNP berths. In order to complete the FCT in 1997, the construction of NNP No.3 and No.4 Berths must be started in 1993.

(3) Quay side cargo handling at the Queen Elizabeth Container Terminal (QCT) will be restricted by the construction works at this terminal. In 1995, 1996 and 1997, cargo handling operations can be carried out at the Queen Elizabeth Quay (QEQ) No.4 and No.5 Berths only.

Fig. 6-5-37 Construction Shcedule (Alternative - A)

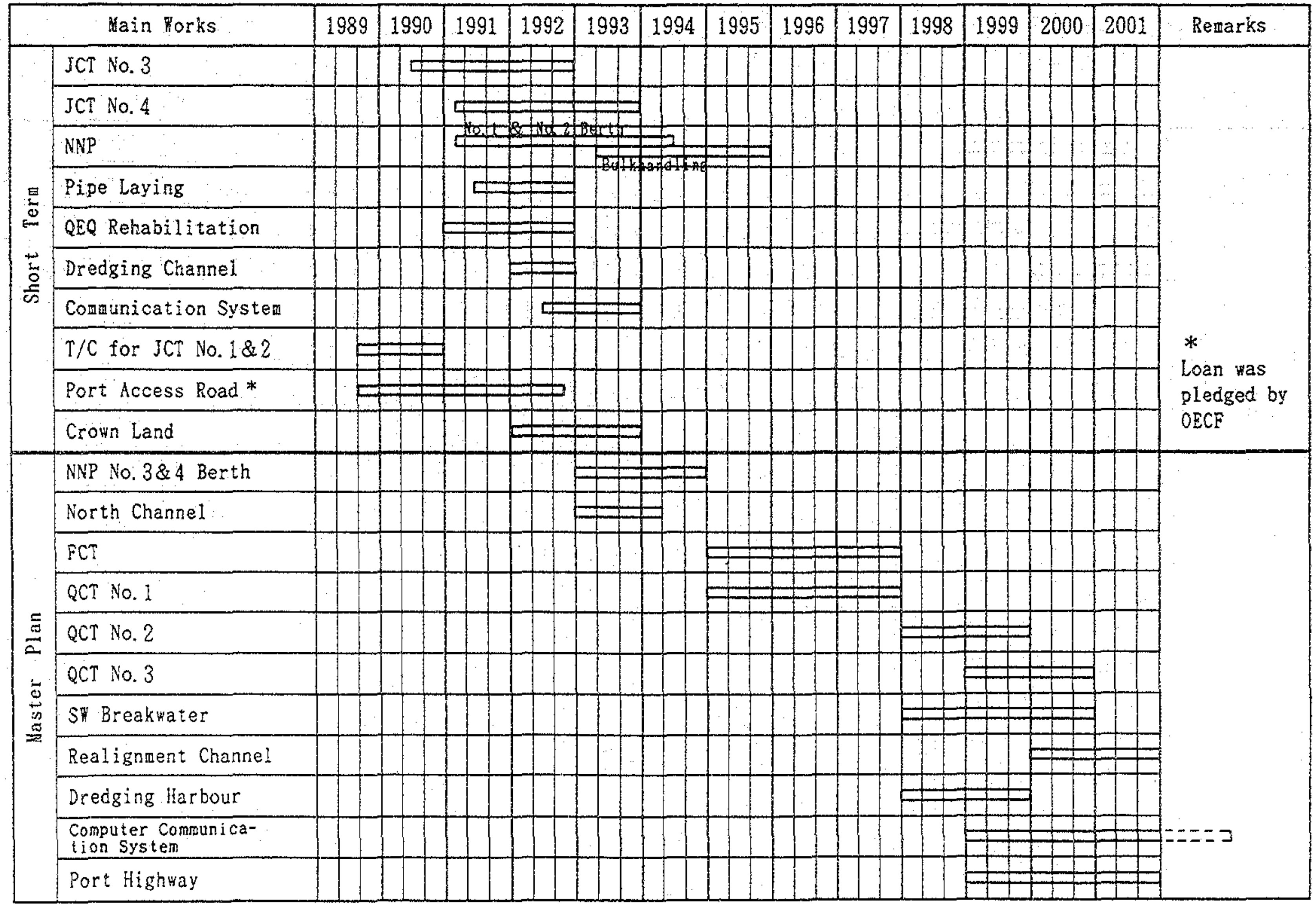
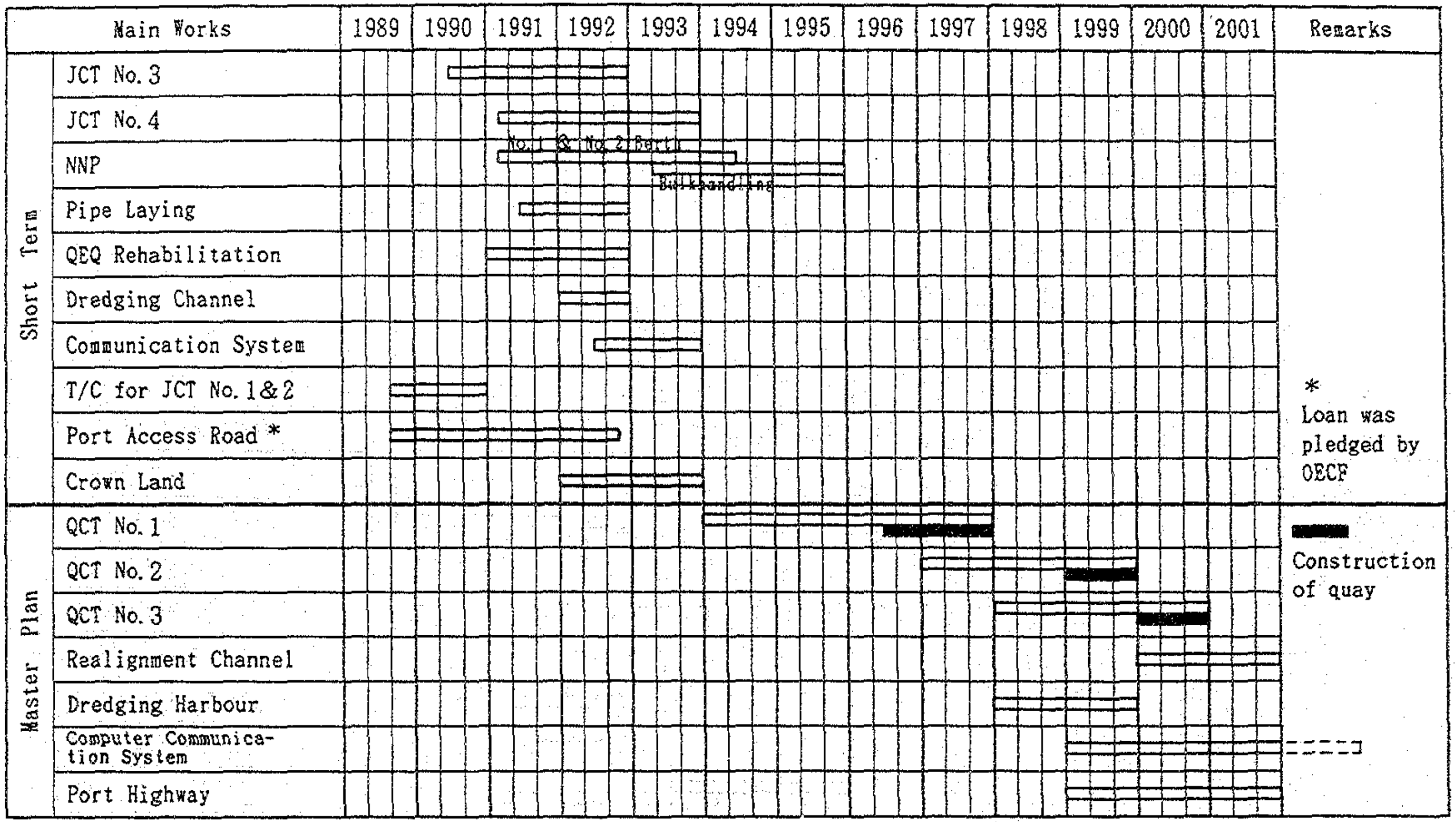


Fig. 6-5-38 Construction Shcedule (Alternative - B)



2. Salient Points of the Construction Schedule under Master Plan B

(1) The Short-term Project is planned for completion at the end of 1995, the same as under Master Plan A.

(2) The construction works at the QCT must be started in 1994, since they include the time-consuming revetment works.

(3) Construction of QCT No.1 Berth and its container yard is planned for 1996 and 1997. Therefore, only QEQ No.1, No.4 and No.5 Berths can be used during these periods.

6-5-4 Project Cost

1. The costs of the major items of work under the Short-term Project, Master Plan A and Master Plan B are given in Tables 6-5-4, 6-5-5 and 6-5-6, respectively.

2. The total project cost are as shown below.

Short-term Project	US$ 257,849,000
Master Plan A	US$ 409,376,000
Master Plan B	US$ 478,534,000

3. The cost estimates are based on the following exchange rates ruling as of December 1988.

US$ 1.00 = Rs. 33.03 = ¥ 125.50

4. The cost breakdowns for Master Plan A and Master Plan B are shown in Table 6-5-7 and Table 6-5-8, respectively, and the cost breakdowns of the individual items of work comprising the Short-Term Project are given in Chapter 7.

Table 6-5-4 Summary of Project Cost (Short Term 1995)

No.	Project	Project Cost (1,000 US$)	Target year	Main Item of Project: Description	Quantity	
1	Jaye Container Terminal	173,958				
	(1) JCT NO.3	93,783	1992	-13.5m Quay	330	m
				Container Yard	159,000	m^2
				Container Crane	2	NO
				Transfer Crane	6	NO
				Dredging	380,000	m^3
	(2) JCT NO.4	80,175	1993	-13.5m Quay	360	m
				-9.0m Quay	170	m
				Bulkhead	90	m
				Container Yard	86,000	m^2
				Container Crane	2	NO
				Transfer Crane	6	NO
				Dredging	250,000	m^3
2	New North Pier NO.1 & 2	45,429	1994	-11.0m Quay	210	m
				-7.5m Quay	130	m
				Revetment	480	m
				Yard	45,750	m^2
			1995	Warehouse	12,800	m^2
				Level Luffing Crane	2	NO
				Bulk Handling Equipment	1	Set
3	Pipe Laying For Oil Handling	13,803 (23,303)	1993	Submarine Pipe	700	m
				Onshore Pipe*	1,000	m*
				Loading Arm, etc.		Set
4	QEQ Rehabilitation (NO.4 & 5)	11,197	1992	Yard Paving	83,000	m^2
				Road Alignment		SUM
5	Dredging of Main Channel	7,848	1993	Dredging -15m	1,260,000	m^3
6	Improvement of Communication System	3,016	1993			
7	Transfer Crane for JCT NO.1 & 2	2,598	1990			
8	Port Access Road ** (Loan was pledged by OECF)	(14,025)	1992	Road	1,500	m
9	Reclametion of Crown Land **	(14,400)	1993	Reclamation	160,000	m^2
10	Grand Total	257,849	Financial Project Cost.			
		(295,774)	Total Project Cost up to 1995.			

Note ; * The construction of the onshore pipeline, which costs approx. 9.5 million US$, will be carried out by Ceylon Petroleum Corporation.

** The construction costs for items No. 8 and 9 are not considered in the feasibility study of Short Term Project.

Table 6-5-5 Summary of Project Cost (Master Plan Alternative - A)

No.	Project	Project Cost (1,000 US$)	Target year	Main Item of Project Description	Quantity	
1	New North Pier	25,703	1994			
	(1) North Entrance Channel	5,223		Breakwater	120	m
	(2) -11.0m and -7.5m Quay	20,480		Quaywall	340	m
				Wharf Crane	2	NO
2	Fort Container Terminal	(78,534)	1997	-14.0m Quay	300	m
				Container Yard	121,000	m²
				Container Crane	2	NO
				Transfer Crane	6	NO
3	Queen Elizabeth Container Terminal	(142,696)		Note;Three existing container cranes will be utilized.		
	(1) QCT NO.1	69,471	1997	-14.0m Quay	350	m
				Container Yard	105,800	m²
				Container Crane	2	NO
				Transfer Crane	6	NO
	(2) QCT NO.2	35,198	1999	-14.0m Quay	350	m
				Container Yard	53,000	m²
				Transfer Crane	3	NO
	(3) QCT NO.3	38,027	2000	-12.0 Quay	300	m
				Container Yard	25,200	m²
				Container Crane	1	NO
				Transfer Crane	3	NO
4	SW Breakwater	40,545	2000	Extension	550	m
5	Realignment of Main Channel	12,351	2001	Dredging etc.	150,000	m³
6	Dredging of Harbour up to -14m	5,000	1999	Dredging	500,000	m³
7	Computer Communication & Radar System	12,357	2000			
8	Port Highway	92,190	2001	Highway	2,000	m
9	Grand Total	409,376				

Table 6-5-6 Summary of Project Cost (Master Plan Alternative - B)

No.	Project	Project Cost (1,000 US$)	Target year	Main Item of Project		
				Description	Quantity	
1	Queen Elizabeth Container Terminal	355,636		Note;Three existing container Cranes will be utilized.		
	(1) QCT NO.1	155,215	1997	-14.0m Quay	340	m
				Revetment	980	m
				Container Yard	194,100	m^2
				Container Crane	2	NO
				Transfer Crane	6	NO
				Office Building	9,800	m^2
	(2) QCT NO.2	81,103	1999	-14.0m Quay	330	m
				Revetment	330	m
				Container Yard	138,600	m^2
				Container Crane	1	NO
				Transfer Crane	6	NO
	(3) QCT NO.3	119,318	2000	-14.0m Quay	330	m
				Revetment	650	m
				Breakwater	510	m
				Container Yard	138,600	m
				Transfer Crane	6	NO
				Office Building	5,200	m^2
2	Realignment of Main Channel	12,351	2001	Dredging etc.	150,000	m^3
3	Dredging in Harbour upto -14m	6,000	1999	Dredging	600,000	m^3
4	Computer Communication & Radar System	12,357	2000			
5	Port Highway	92,190	2001	Highway	2,000	m
6	Grand Total	478,534				

Table 6-5-7 Rough Cost Estimate of Master Plan Project (Alternative - A)

NO.	Facility	Main Item	Quantity		Cost (1,000US$)	Target Year
1ⓐ	North Entrance Channel	NE and NW Breakwater	120	m	3,645	1994
		Lighthouse	2	NO	168	
		Engineering and Contingency			1,410	
		(Sub-Total)			(5,223)	
1ⓑ	New North Pier No.3 and No.4 Berth	−11.0m Quay	210	m	8,250	1994
		−7.5m Quay	130	m	3,967	
		Reclamation and Paving	3,700	m²	649	
		Wharf Crane	2	NO	4,200	
		Engineering and Contingency			3,414	
		(Sub-Total)			(20,480)	
2	Fort Container Terminal	−14.0m Quay	300	m	19,512	1997
		Reclamation	1,360,000	m³	9,152	
		Yard Paving and Utilities	121,000	m²	18,279	
		Container Crane	2	NO	13,274	
		Transfer Crane	6	NO	7,794	
		Tractor Chassis	12	Set	1,746	
		Engineering and Contingency			8,777	
		(Sub-Total)			(78,534)	
3ⓐ	Queen Elizabeth Container Terminal QCT NO.1	−14.0m Quay	350	m	22,764	1997
		Reclamation	190,000	m³	1,277	
		Yard Paving and Utilities	81,000	m²	11,374	
		Office and Buildings	1	SUM	3,460	
		Container Crane	2	NO	13,274	
		Transfer Crane	6	NO	7,794	
		Tractor Chassis	12	Set	1,746	
		Engineering and Contingency			7,782	
		(Sub-Total)			(69,471)	
3ⓑ	QCT NO.2	−14.0m Quay	350	m	22,763	1999
		Reclamation	190,000	m³	1,277	
		Yard Paving and Utilities	11,000	m²	1,545	
		Transfer Crane	3	NO	3,897	
		Tractor Chassis	12	Set	1,746	
		Engineering and Contingency			3,970	
		(Sub-Total)			(35,198)	
3ⓒ	QCT NO.3	−12.0m Quay	300	m	17,560	2000
		Reclamation	190,000	m³	1,276	
		Yard Paving and Utilities	9,000	m²	1,264	
		Container Crane	1	NO	9,027 *	
		Transfer Crane	3	NO	3,897	
		Tractor Chassis	6	Set	873	
		Engineering and Contingency			4,130	
		(Sub-Total)			(38,027)	
3ⓓ	TOTAL QCT				142,696	
4	SW Breakwater	Extension of Breakwater	550	m	40,545	2000
5	Main Entrance Channel	Removal Existing Breakwater	300	m	9,804	2001
		Dredging of Channel(−15m)	150,000	m³	750	
		Engineering and Others			1,797	
		(Sub-Total)			(12,351)	
6	Dredging in Harbour	Up to −14.0m	500,000	m³	5,000	1999
7	Computer Communication	Data Processing and Radar System	1	SUM	12,357	2000
8	Port Highway		2,000	m	92,190	2001
9	Grand Total				409,376	

* Including replacement cost of existing cranes.

Table 6-5-8 Rough Cost Estimate of Master Plan Project (Alternative - B)

NO.	Facility		Main Item	Quantity		Cost (1,000US$)	Target Year
1ⓐ	QCT NO.1	Reclamation	Revetment Type-A	980	m	50,597	1997
			Reclamation	1,930,000	m^3	14,668	
			Yard Paving and Utilities	136,500	m^2	15,997	
			(Sub-Total)			(81,262)	
		On Land	-14.0m Quay	340	m	12,176	
			Yard Paving and Utilities	57,600	m^2	6,751	
			Office Building	9,800	m^2	10,797	
			(Sub-Total)			(29,724)	
		Equipment	Container Crane	2	NO	13,274	
			Transfer Crane	6	NO	7,800	
			Tractor Chassis	12	Set	1,746	
			(Sub-Total)			(22,820)	
		Engineering	Engineering and Contingency			(21,409)	
	Total					155,215	
1ⓑ	QCT NO.2	Reclamation	Revetment Type-A	330	m	17,038	1999
			Reclamation	1,090,000	m^3	8,284	
			Yard Paving and Utilities	99,000	m^2	11,603	
			(Sub-Total)			(36,925)	
		On Land	-14.0m Quay	330	m	11,817	
			Yard Paving and Utilities	39,600	m^2	4,641	
			(Sub-Total)			(16,458)	
		Equipment	Container Crane	1	NO	6,637	
			Transfer Crane	6	NO	7,800	
			Tractor Chassis	12	Set	1,746	
			Replacement of existing crane	1	SUM	350	
			(Sub-Total)			(16,533)	
		Engineering	Engineering and Contingency			(11,187)	
	Total					81,103	
1ⓒ	QCT NO.3	Reclamation	Revetment Type-A	140	m	7,229	2000
			Breakwater	510	m	31,140	
			Revetment Type-B	400	m	9,398	
			Reclamation	1,090,000	m^3	8,284	
			Yard Paving and Utilities	99,000	m^2	11,603	
			(Sub-Total)			(67,654)	
		On Land	-14.0m Quay	330	m	11,817	
			Revetment Type-C	110	m	2,584	
			Reclamation	130,000	m^3	871	
			Yard Paving and Utilities	39,600	m^2	4,641	
			Office Building	5,200	m^2	5,748	
			(Sub-Total)			(25,661)	
		Equipment	Transfer Crane	6	NO	7,800	
			Tractor Chassis	12	NO	1,746	
			(Sub-Total)			(9,546)	
		Engineering	Engineering and Contingency			(16,457)	
	Total					119,318	
1ⓓ	Total QCT					355,636	
2	Main Entrance Channel		Removal Existing Breakwater	300	m	9,804	2000
			Dredging Channel(-15m)	150,000	m^3	750	
			Engineering and Others			1,797	
			(Sub-Total)			(12,351)	
3	Dredging in Harbour		Up to -14.0m	600,000	m^3	6,000	1999
4	Computer Communication		Data Processing and Radar System	1	SUM	12,357	2001
5	Port Highway			2,000	m	92,190	2001
6	Grand Total					478,534	

CHAPTER 7 SHORT TERM DEVELOPMENT PLAN

7-1 The Short Term Development Plan

7-1-1 General

The present and anticipated problems of the port in the short term are pointed out hereunder together with proposed countermeasures.

Some of the problems are to be solved in an immediate and temporary manner, and others are to be solved gradually during the course of a long term development.

(1) QEQ

Problems:

i) Salt water spray in the SW monsoon season causing corrosion of steel and breaking out of machinery.

ii) Shortage of space for stacking and marshaling containers.

iii) Uneven ground and roads.

The above listed problems have serious ramifications for the daily operations, because they affect the quality of service. Countermeasures for the salty water spray have been taken by SLPA, but there remain a few areas where waves jump up.

The study team suggests a suitable section of breakwater including deformed blocks should be studied through hydraulic model tests at the Lanka Hydrawlic Institute.

If a small rehabilitation can prevent salty water spray, the improvement will be justifiable. On the other hand, if this requires a lot of money, it can not be justified.

The countermeasures for the shortage of space at QCT would preferably utilize adjacent areas, but this is not so advantageous owing to the high cost for the reclamation. Some countermeasures must be taken considering the seriousness of the situation at QCT.

One of the ideas for them is to efficiently utilize Crown Land. It would be effective to relocate the sheds at QEQ which are used for the stuffing and unstuffing of containers for export and import cargo.

Another idea is to utilize the new north pier. The conventional cargo should be shifted to the NNP wharves as much as possible. By doing so, sheds for the break bulk cargo can be removed from the QEQ area to the NNP area. The shortage of stacking and marshaling spaces for containers will be eased by the clearing off of the sheds at the QEQ area.

(2) JCT new Terminal Construction (countermeasure for future demand for container handling)
If no preparation are made to meet the future demand, customers will lose their business and the good reputation of the port will be lost. It would cause tremendous economic/ financial loss for SLPA.

Compared with the redevelopment of the QEQ, we can expect a far better return from the new construction of JCT#3, and #4. By this reason the construction of JCT #3 and #4 will be given high priority in the short term development plan.

(3) New North Pier Area

The forecasted volume of conventional break bulk cargo would increase substantially, if no countermeasures were taken for converting fertilizer handling from present bagged form to fully mechanized bulk handling system.

The oil handling operation at north pier will be shifted to the dolphin berth inside the island breakwater by the completion of connecting oil pipelines.

After the redevelopment of NNP, the cargo handling will be executed in the following manner.

i) Fertilizer will be handled in the form of bulk cargo at NNP #2. By this, the transportation cost and vessel time will be reduced substantially.

ii) Break bulk cargo from QEQ will be handled at NNP#1.

iii) Cement will be handled in the front area of NNP#4, in an effort to decrease the congestion at PVQ, and to reduce the cost for chartering the cement vessels.

(4) Development of Bleumendhal (Crown Land) area and The Port Road to Weragoda

The construction of the port highway to Weragoda should be expedited and the reclamation of the Crown Land should be done in parallel in order to obtain CFS space for the demand in the short term. In addition, it may be possible to relocate the sheds at QEQ, as well.

(5) Computer and Communications Systems

Computer and communications systems are getting cheaper and cheaper. So it is generally advantageous to obtain new, lower cost equipment.

First of all, the QCT terminal should have connections to the JCT system. Secondly, a private online and/or wireless system for SLPA use should be installed to cope with the increasing demand for communications in the port.

(6) Traffic Safety

Presently, large vessels over 270 meters length but less than 12 meters in draft enter the existing entrance channel safely.

The stopping distance of container vessels is very short (1L-

1.5L) by using astern power.

As this is the actual ship manueving, the study team proposes deepening the main channel up to -15.0 meters for the short term development plan.

The study team also recommends that SLPA should purchase powerful tug boats when, it is time to replace the existing tug boats because assisting the big vessels to enter the port will greatly improve the safety of navigation.

It is also important to provide necessary navigation aids such as marker buoys in position to guide the ships.

After 1995 (or possibly before 1995), when big vessels over - 12.5 meters in draft come to the port, the straightening of the channel and the widening of the entrance will be necessary. Our study, using a ship simulator, indicated that it would be difficult to operate larger vessels at the narrow and curved channel, especially during inclement weather and unfavorable ocean conditions.

(7) Buoy Berths

Buoy berths inside the port are used for cargo handling, bunkering, waiting and resting.

Although the frequency of utilization is getting smaller year by year, the roles of these berths are very important.

Thus, a minimum of two buoy berths will be maintained inside the port for each monsoon season.

7-1-2 The Scope of Project

Based upon the necessary priolities, the scope of the short term development is established as follows.

i) Rehabilitation of QCT

Leveling and paving of open space.
Simplifying of moving lines of vehicles.
Connecting of computer lines to the JCT system.

In addition to the above,
Diminishing the salty water spray shall be studied.
Clearing of the sheds at QEQ by relocating them to the New North Pier or Crown Land shall be examined.

ii) Construction of JCT #3 and #4

Construction of two -13.5 x 330 meter berths with sufficient back up space, and a fully equipped container terminal.
The end side of the JCT #4 will be used as an extra feeder berth. The main quay wall will be of the wave dissipating type.

iii) Construction of a New North Pier (NNP)

#1 berth... break bulk cargo with 6,400 m^2 shed and forklifts.
#2 berth... fertilizer in bulk with 6,400 m^2 shed and full sets of bulk handling and bagging machines.

front area of #4 berth... cement bulk will be handled.

iv) Dredging

The port basin up to -13.5 meters.
The main channel up to -15.0 meters.

v) Laying of pipelines to the dolphin berth.

24" for crude oil receiving.
12" for gasoline or jet fuel receiving.
12" for gas oil receiving.
12" for naptha discharging.
10" for Lube receiving.
etc.

The investment cost for relocation and renovation will be allocated between SLPA and the Petroleum Corporation.

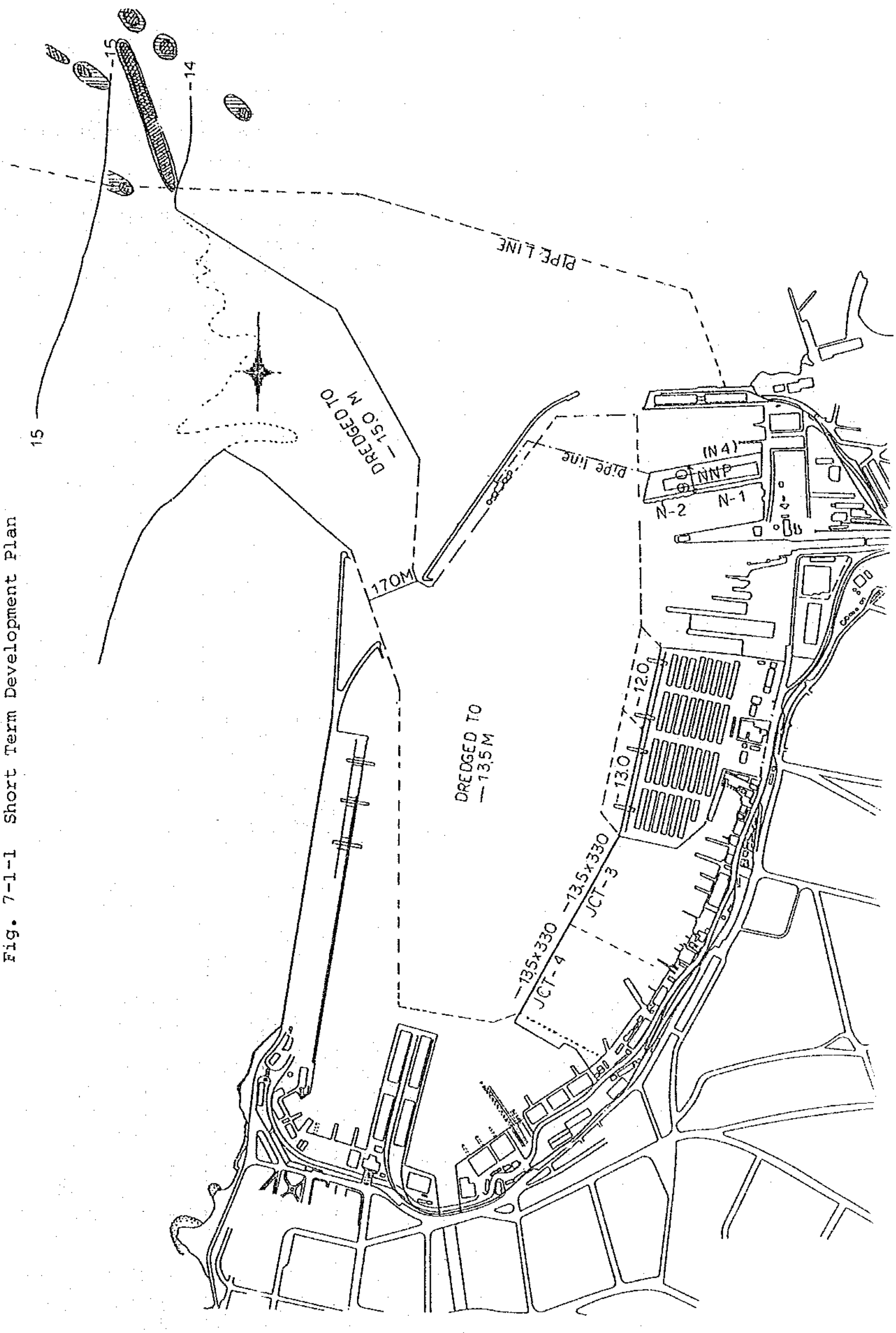
vi) Development of the port highway to Weragoda and development of Bloemendhal (Crown land) area.

Construction of the port highway to Weragoda (approx. 1.9 km, ongoing project) Development of Crown land (reclamation 160,000 m^2)

vii) Computer and communication system

Expansion of the number of private telecommunication lines.
High power VHF sets for ship communication (rage = 40 miles)

Fig. 7-1-1 Short Term Development Plan



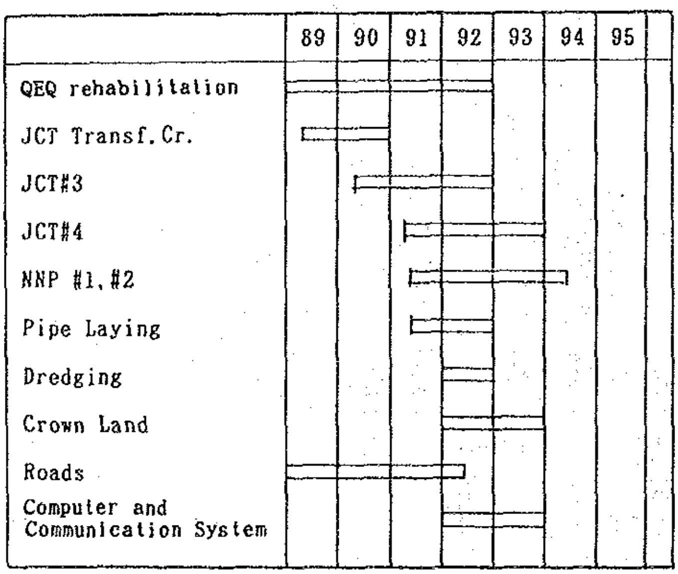
7-1-3 Implementing Steps for the Short Term Development Plan

The Implementing Schedule is indicated in the Fig. 7-1-2.
The development order is planned based mainly upon the cargo demand as examined in the master plan.

Table 7-1-1 Berths and Handling Capacity <u>Short Term Plan (1995)</u>

Name of Berth	Size (m)	Containers (TEUs)	Break Bulk (Tons)	Dry Bulk (Tons)	Liquid Bulk (Tons)
QCT #4	-11x150	110,000			
QCT #5, #6	-12x270	220,000			
(QEQ#1, #2, #3)			(750,000)		
BQ #1, #2, #2'			650,000		
BQ #3, #4			500,000		
JCT #1	-12x300	300,000			
JCT #2	-13x332	300,000			
JCT #3	-13.5x330	300,000			
JCT #4	-13.5x330	300,000			
NNP #1	-7.5x130		250,000		
NNP #2	-11x210			600,000	
(NNP #3)					
(NNP #4)				600,000	
PVQ #1	-9.5x150		250,000		
PVQ #2	-8.0x135		190,000	150,000	
CB #1	-5.0x70		100,000		
CB #2	-5.0x70		100,000		
GP #2	-9.5x150		150,000		
South pier					100,000
Dolphin	-14x185				2,000,000
SPMB	-29				2,000,000
Total Capacity		1,530,000	(750,000) 2,190,000	1,350,000	4,100,000
Forecast Volume		1,360,000	2,100,000	960,000	2,400,000

Fig. 7-1-2 Implementing Steps for Short Term Development Plan



7-2 Project Implementation

Designs for the project construction are described in Section 6-5, Chapter 6. Therefore this section deals only with the implementation of the project.

7-2-1 Construction Schedule

As detailed in Fig. 7-2-1, the construction of the Short-term Project will be carried in the sequence indicated below.

(1) Construction of JCT No.3 Berth will be started in mid-1990 and completed in 1992.

(2) Construction of JCT No.4 Berth will be started in early 1991 and completed in 1993.

(3) Works on the B Type Revetment at the NNP will be started in early 1991 and completed at the end of 1991. Reclamation works in this area will be started following the completion of the B type revetment and completed in mid-1992.

(4) The oil pipeline construction will start with the shore work in mid-1991. The submarine pipeline will be constructed on the B Type revetment and reclaimed ground in the NNP area used as the operation base. The entire pipeline construction will be completed at the end of 1992.

(5) handling of oil cargo is to start at the Dolphin Berth in early 1993. Then the rehabilitation of NNp No.1 and No.3 Berths will be started in early 1993 and completed in late 1994.

(6) On completion of the pipeline works at NNP, the construction works of the warehouses and bulk handling facilities will be started in early 1993 and completed at the end of 1995.

(7) A period of two years is allowed for the QEQ rehabilitation

	Work Item	Quantity		1990 (1 6 12)	1991 (1 6 12)	1992 (1 6 12)	1993 (1 6 12)	1994 (1 6 12)	1995 (1 6 12)	Remarks
JCT No. 3	−13.5M Quaywall	330	m							Placing graded rock 10,000m³/month Reclamation 85,000m³/month Yard paving Base course 5.000m³/M PC Slab 1.500m /M As.concrete 20.000m²/M
	South Revetment	220	m							
	Reclamation	1.400.000	m³							
	Yard Paving	159.000	m²							
	Dredging	380.000	m³							
	Building	7.300	m²							
	Handling Equipment	1	SUM							
JCT No. 4	−13.5M Quaywall	360	m							−do−
	−9.0M Quaywall	170	m							
	Bulkhead	90	m							
	Reclamation	990.000	m³							
	Yard Paving	86.000	m²							
	Dredging	250.000	m³							
	Handling Equipment	1	SUM							
NNP	Quaywall No. 1 & 2	380	m							Oil handling at Dolphin Berth shall be commenced in early 1993.
	Revetment A and B	480	m							
	Reclamation	280,000	m³							
	Yard Paving	45.750	m²							
	Warehouse	12.800	m²							
	Handling Equipment	1	SUM							
Pipe Laying for Oil Handing		1.700	m							
Rehabilitation of QEQ		83.000	m²							
Channel Dredging		1,260,000	m³							
Communication System		1	SUM							
T/C for JCT No. 1 & 2		2	NOS							
Port Access Road		1.500	m							
Crown Land		160,000	m²							

Fig. 7-2-1 Construction Schedule of Short Term Plan

works which are likely to progress at a slower pace because they will have to be executed in a limited space currently in use.

The rehabilitation works are to be started in 1991 and completed in 1992.

(8) The entrance channel dredging will be completed at the end of 1992, and the communications system will be timed to be completed simultaneously with the completion of the JCT No.3 and No.4 Berths.

(9) Provision of two transfer cranes at JCT No.1 and No.2 Berths is planned for 1990. However, the construction of the lanes for the crane travel is included in the No.3 Berth works and will not be completed until 1992. For this reason, the transfer cranes will be operated at the existing JCT No.1 and No.2 Container Yards pending the completion of the crane lanes.

7-2-2 Construction Work Sites

1. JCT No.3 and No.4 Berths

(1) Construction of the -13.5 m JCT No.3 Berth will require nearly 100,000 m^3 of rubble stones for foundations, 1,100 prestressed concrete pipe piles and 7,500 prestressed concrete beams.

It will be necessary to secure spaces for fabrication or storage of these construction materials in large quantities.

(2) For consumption of rubble stones estimated at a monthly volume of about 10,000 m^3, it is necessary to obtain an open storage space of nearly 15,000 m^3 at a shoreline location convenient for loading the stones to floating craft.

Because of the current lack of a suitable site for the rubble storage, it is suggested that the shallow area at the base of the existing NP in the NNP Project site be filled to provide the necessary storage space.

(3) For obtaining supplies of the necessary concrete products, there are two conceivable alternative methods: (a) importing from overseas sources and (b) fabrication at the project site with manufacturing plants brought into the county. However, it is considered advisable to fabricate concrete products at the site, in view of the fact that they can be supplied economicaly due to the continuous construction of JCT No.3 and No.4 Berths.

The fabrication yard for concrete products should be located close to the shoreline to facilitate handling of the completed products. The necessary space is about 10,000 m^2. It is suggested that the Chalmers Quay area be used for the fabrication of concrete products.

(4) Floating pile drivers, barges, tugboats, diver boats and other construction craft will be moored at the north end of QEQ.

(5) After the construction works of the Project have progressed nearly halfway, the filled area, the former site of the Barge Repair Basin, can be used as a site for activities associated with shore works and building construction.

This area is originally intended to serve the purpose of temporary storage of empty containers once JCT No.3 Berth is completed. It is one of the few sites available for accommodating construction activities related to further development of the Port of Colombo. It is suggested, therefore, that this area be left unpaved to permit its use for these activities.

(6) Plants required for asphalt production for paving works

should be located in the space near the No.8 Container Gate.

(7) The layout of the work sites described above is illustrated in Fig. 7-2-2.

2. NNP

(1) Rubble stones will be required in a total volume of 120,000 m^3 for the construction of the NNP. The reclaimed area at the base of the North Pier referred to in paragraph (2), Section 1 above will be used for storage of the rubble stones.

(2) Plants, equipment and materials necessary for the shore works and building construction will be deployed in the reclaimed area noted in paragraph (5), Section 1 above.

3. Oil Pipeline Construction

The submarine pipeline will be assembled at the North Pier, then floated on the sea and finally submerged into the trench.

Pipes for the submarine and shore pipelines should preferably be stored temporarily at Chalmers Quay on delivery at the site.

4. Other Work Sites

(1) An SLPA-owned vacant lot of nearly 4,000 m^2 at the north approach to Victoria Bridge across the Kelani River can be used for storage of construction materials including concrete products.

(2) When the master plan is implemented, a caisson fabrication yard will be necessary for the construction of breakwaters and revetments.

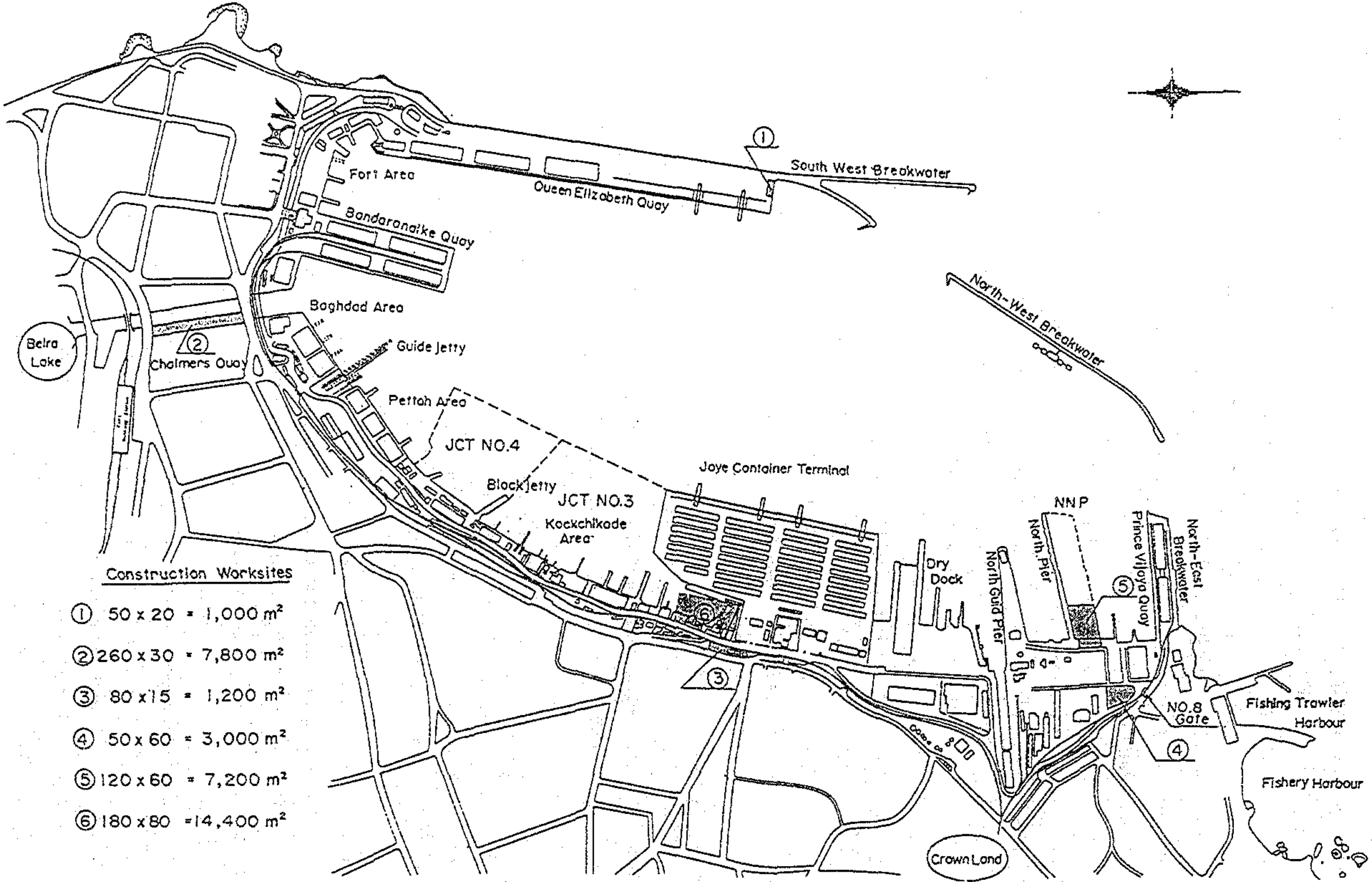


Fig. 7-2-2 Construction Worksites