## 2-4 Basic Concept of the Project

### 2-4-1 Examination of the Request

All the facilities requested by the Government of the Republic of Kiribati have been examined through discussion with the government staffs, site surveys and home office works, and the results are described in the following.

**(1) Maintenance Dredging Equipment**

A maintenance dredging equipment was requested in the project proposal by the Government of the Republic of Kiribati. The study team advised that the port authority has not been established yet and even though the port authority will be established upon the completion of the project, the maintenance, operation and management for the said special equipment will be difficult at the beginning of the establishment. The Government of the Republic of Kiribati emphasized the necessity of the maintenance dredging equipment, but agreed that the equipment be excluded in the project hoping the realization in the future project.

According to "The Study on Ports Development in Kiribati" in March, 1995, the annual shoaling volume in the new Betio Port proposed in this project has been estimated as approximately 1,000 $m^3$ and the annual shoaling height in the basin as about 3 cm. And there are five outerislands suffering from siltation in their channel and basin and needing dredging, where the cargo landing is executed at high tide. In consequence, as mentioned above, the frequency required for the maintenance dredging in the new port is low and those outerislands have not much cargo volume with low frequency for cargo handling activity, thus the study team concluded that the urgent necessity for the introduction of the maintenance dredging equipment in this project is low.

**(2) Dredging of Basin and Approach Channel in the present Betio Port**

In "The Study on Ports Development in Kiribati", it was planned that the Government of the Republic of Kiribati would dredge the basin and approach channel in the present Betio Port by themselves by using the maintenance dredging equipment to be provided in this project. But pursuant to the exclusion of maintenance dredging equipment as mentioned above, the Government of the Republic of Kiribati requested that the said dredging work be included in this project. The study team accepted this request considering that the present Betio Port will have to function in the future as a supplementary port to the new Betio Port.

## 2-4-2 Basic Concept of the Project

Betio Port is a sole gate of the country for foreign trade and plays a key role as the center of domestic sea transport for cargo and passenger. But the port was built in 1950's and has a serious deterioration. Further the port has already reached to saturation in handling capacity to accommodate the recent increasing cargo volume.

The problems and constraints in the port are summarized as follows:

a) Since the length of the existing wharf is about 100 m and the depth is about 2.5 m, which is not enough to accommodate the international vessels, cargoes between wharf and vessels anchoring offshore are transferred by barge. This makes a higher transportation cost and results in the price rise of import goods and the interference to the promotion of export industries such as copra and seaweed.

b) There are about 300 containers stored in the existing container yard, where the containers are stacked 6 high, though the normal stacking height is 2, due to the insufficient container yard with only 3,000 $m^2$ area, which results in inefficient and unsafe port operation.

c) Main cargo handling equipment in the port is the fixed tower crane. Given the limited lifting reach, the laden containers are stacked high around the tower crane and the empty containers are moved by a small size mobile crane. Further a large size forklift to handle the laden containers is not available, which lowers the cargo handling efficiency and results in the unsafe works in unstuffing the high stacked containers and moving the empty containers.

d) The steel sheet piles of the existing wharf have been badly corroded to the extent that the backfill soil is escaping from holes endangering structural stability. Both east and west breakwaters have been badly damaged on their bagged concrete slopes with many bags displaced allowing the backfill to escape.

e) The fairway running from the opening at the west of Tarawa Lagoon facing the ocean to the port has navigational aids, which are lost at high waves every year because the connection between the locally made buoys and old rusted anchor chains of ship is insufficient in structure. All buoys are not equipped with lanterns and radar reflector and the navigation through the fairway in an inclement weather and at night is impossible.

f) The water area in the port has been shoaled from the original depth 3 m to 2 or 2.5 m depth due to a long term sedimentation. Betio Shipyard located at the inner basin is not fully utilized due to limitation of ship's draft in the basin.

g) Betio Port is now being operated and managed by Kiribati Shipping Services Limited (KSSL) owned by the Government of the Republic of Kiribati. But the main activities of KSSL is its shipping and agency services, with less attention given to the port services and maintenance.

To cope with the above problems and constraints and encourage nation's economic development through the port development, this study will propose the adequate improvement plan to meet the cargo volume to be forecast in the target year 2000 in the subsequent sections.

## (1) Planning Policies of Port Facilities

### 1) Fairway and Basin

The present fairway running to the port takes the route from the opening at the west of Tarawa Lagoon facing the ocean towards Bikeman Island's beacon and shifting Bairiki's beacon and then to the port. The fairway utilizes the natural topography and has enough depth and width. A new proposed Betio Port is planned to locate 200 m east of the present port and most part of the present fairway can be utilized for a new port with a minor change of shifting point. The present navigational aids are of floating buoy and beacon type, but the connection part between the buoys and anchor chains is rusty and insufficient in structure and those buoys are replaced every year. Therefore, new navigational aids having enough durability will be installed in the type of floating buoy equipped with lantern to enable the navigation at night.

A basin inside a new port will be planned to have enough area that the design ship, medium size international cargo vessels such as Matangare, can maneuver.

### 2) Wharf

A wharf will be planned to have enough length and depth that the design ship, medium size international cargo vessels, can berth alongside. While, the large size international cargo vessels, which have a lower frequency in ships' call, will have to perform the same cargo transfer by barge as it is now.

The existing wharf and fishery jetty are of steel sheet pile and steel pipe pile structure, respectively. For a new wharf, the adequate structural type will be adopted considering the soil conditions, difficulty in construction, cost and calmness in the basin.

Auxiliary function such as water and power supply to vessels will be planned on the wharf.

### 3) Container Yard

A container yard will be planned to have enough area to accommodate the estimated cargo volume of the target year 2000. A lighting system will be also planned so as to enable cargo handling at night. And considering the increasing demand for reefer containers, a power supply system for them will be planned. The container allocation to store the laden and empty containers separately will be considered to make efficient yard use plan. The finishing of yard surface will be of coral sand and rocks compaction leaving the future concrete pavement to port business profits.

### 4) Revetment

Revetments will be planned along the basin, container yard and access road. The adequate structural type will be adopted considering wave and tidal forces, difficulty in construction and cost.

### 5) Access Road

The adequate route of an access road will be selected considering the structural stability and width of the circumferential existing roads and the availability of land use at the junction of a new access road.

### 6) Rehabilitation of present Betio Port

The present Betio Port will be utilized as a supplementary port to the new Betio Port after the completion of the Project and will be rehabilitated as follows:

#### a) Wharf

The steel sheet piles of the existing wharf, more than 30 years passed since the completion, have been badly corroded and deteriorated to the extent that the backfill soil is escaping from holes endangering structural stability. Urgent rehabilitation work is required. The thickness survey on those piles shows that the thickness near D.L. 0 m has reduced about 50 % and the deeper part thereof about 10 %. Therefore, those piles under the water still have enough durability and will be fully utilized in the rehabilitation work.

#### b) Basin and Approach Channel

The basin and approach channel in the port have been shoaled at D.L. -2.5 m to -2.0 m due to a long term sedimentation. To enable the navigation of small size vessels, those water areas will be dredged to D.L. -3.0 m.

### 7) Cargo Shed and Administration Office

#### a) Cargo Shed

There are eight sheds in the existing container yard and they are fully occupied by import break bulk cargoes and export copra with insufficient space for container cargoes. Therefore, the LCL containers are unstuffed and sorted in the open yard, which results in the congestion in cargo handling and difficulty in rainy day works. A cargo shed will be planned in a new container yard to facilitate the unstuffing and sorting of LCL container cargoes in terms of high efficiency of cargo handling.

#### b) Administration Office

As will be discussed in the subsequent sections, a port authority will be established for adequate port operation and management and an office space to accommodate the port management staffs will be planned.

### 8) Passenger Terminal

Given the geographical nature of the country consisting of a lot of islands scattered in the vast ocean, Betio Port plays a key role as the center of sea transport not only for the international cargoes but also for the interisland passengers. Passengers are transported with general cargoes by medium size cargo vessels rendered to the interisland sea transport, but since those vessels can not berth alongside in the port due to the small and shallow basin, passengers are obliged to be transferred by barge between shore and vessels anchoring offshore. Further an adequate facility for waiting is not available there, and in some cases, passengers have to wait on barge in a strong sunshine for a long time until the vessel becomes ready for boarding. In this project, a new wharf will accommodate medium size cargo vessels berthing alongside and a passenger terminal will be planned for passengers' waiting room. The structural type will be of "Mancaba" type meeting local life style.

## (2) Planning Policies of Cargo Handling Equipment

In the present Betio Port, the 32.5t tower crane fixed on the wharf handles most of containers, but those containers are stacked 5, 6 high due to the limited lifting reach, which results in the inefficient and unsafe cargo operation. Upon the completion of a new Betio Port, medium size international and domestic cargo vessels will be able to berth alongside and cargo transport by barge will decrease, which will improve the cargo handling efficiency. Further, to improve cargo handling efficiency on land, a large size mobile crane and forklifts will be introduced.

### (3) Design Ship

#### 1) Ships' Call at Betio Port

The container cargo transport services to Betio Port are rendered by the following shipping lines:

- Chief Container Services (CCS): Monthly call from Australia
- Bali Hai Line (BHL): Bimonthly call from Japan
- Kiribati Shipping Services Ltd. (KSSL): Biweekly call from New Zealand

Table 2-4-1 shows the cargo throughput and ships' call by year and shipping line.

**Table 2-4-1 Cargo Throughput and Ships' Call by Year and Shipping Line (1991 to 1995)**

| | Cargo Throughput (F.T.) | | | Ships' Call | | |
|---|---|---|---|---|---|---|
| | CCS | BHL | KSSL | CCS | BHL | KSSL |
| 1991 | 14,521 | 6,035 | 8,299 | 9 | 6 | 15 |
| 1992 | 15,547 | 5,700 | 6,269 | 11 | 6 | 11 |
| 1993 | 22,136 | 6,922 | 6,737 | 11 | 6 | 11 |
| 1994 | 20,837 | 7,324 | 11,114 | 11 | 6 | 23 |
| 1995 | 23,486 | 8,277 | 12,148 | 10 | 6 | 26 |
| Average | 19,305 | 6,852 | 8,913 | 10.4 | 6 | 17.2 |
| Share | 55.0 | 19.5 | 25.4 | --- | --- | --- |

Source: KSSL Cargo Statistics

From the table, three shipping lines, CCS, BHL and KSSL have shares of approximately 55%, 20% and 25%, respectively. The dimensions of their principal vessel calling at Betio Port are as shown in Table 2-4-2.

**Table 2-4-2 Dimensions of 3 Lines' Principal Vessel Calling at Betio Port**

| Shipping Line | Principal Vessel | Overall Length (m) | Breadth (m) | Full Draft (m) | Dead Weight Ton |
|---|---|---|---|---|---|
| CCS | Papuan Chief | 130.0 | 22.5 | 8.0 | 10,683.2 |
| BHL | Pacific Islander | 144.93 | 25.0 | 9.0 | 15,567.0 |
| KSSL | Matangare | 68.0 | 11.8 | 4.2 | 1,295.0 |
| | Novikovo | 97.8 | 16.8 | 5.0 | 4,160.0 |

Matangare was provided by Japan's Grant Aid Programme in 1993 and is now owned by KSSL. Novikovo has been chartered by KSSL allowing the renewal of contract or replacement with another vessel in the near future.

In addition to the above container cargo vessels, other international vessels such as copra ships and tankers make a call. Arrival draft of some of copra ships exceed 8 m and that of all the tankers is less than 5 m.

Further, domestic cargo vessels make a call for domestic cargo and passenger transport. Their arrival drafts are all less than that of Matangare.

**2) Design Ship**

Port planning normally requires that a design ship be determined as the maximum size among vessel sizes forecast in a target year. In "The Study on Ports Development in Kiribati", Matangare was selected as the design ship determining the berthing length.

While this study provides that a vessel calling at the port most frequently is Matangare with a little more than 60 % among the medium size vessels call at the port and the situation has still the same trend as the time of the previous study, "The Study on Ports Development in Kiribati". Therefore, Matangare is selected as the design ship to determine the berthing length. And as for the design depth for port area, Novikovo is selected with the following consideration.

During the previous study, "The Study on Ports Development in Kiribati", each shipping company had the following performance to charter the international cargo vessels.

- KSSL has taken over sea transport services connecting New Zealand and Fiji from Pacific Forum Line in September, 1994 with putting a chartered vessel of Arktis Trader (full draft: 5 m). And KSSL was scheduled to charter a vessel named Micro Kiss (full draft: 5.3 m) in 1995 replacing Arktis Trader.
- CCS placed Baltimar Boreas (full draft: 4.9 m) on the line from Australia replacing Papuan Chief in July, 1994.

However, this study updates that the said 2 shipping lines have changed their schedule; i.e. KSSL has chartered Novikovo (full draft: 5.0 m; 0.8 m deeper than Matangare's full draft 4.2 m) replacing Arktis Trader in February, 1996 and CCS has placed Papuan Chief(full draft 8.0 m) again replacing Baltimar Boreas. And CCS made an answer, responding to the study team's question, that they will plan to place shallow draft vessels such as Baltimar Boreas in the future to meet the new port design depth.

Also KSSL planes to charter the medium size vessels with a full draft of less than 5 m for the future

From the above discussions, it is obvious that if this study adopts the full draft of Novikovo as the design depth, then CCS's vessels and all the KSSL's vessels can berth alongside and approximately 80 % of all the import cargoes in Betio Port can be landed without barge transport.

**(4) Dimensions of Wharf**

**1) Length**

A berth requires a length of LOA plus allowance for mooring of 20% of LOA as indicated on the "Technical Standard for Port and Harbour Facilities in Japan". The design ship for determination of the berth length is set as "Matangare" and thus the required berth length is given as below:

68m x 1.2 = 81.6m = rounded to 80m

Considering the number of ships' call, the length of wharf is set as one berth having 80m length.

**2) Depth**

Required wharf depth is given as summation of full draft and allowance of 10% of full draft. The design ship for determination of the wharf depth is set as "Novikovo" and thus the required wharf depth is given as below:

5.0m x (1 + 0.1) = 5.5m

Furthermore, lower tide level below Port Datum Line frequently occurs in Betio Port due to the influence of tropical tide and atmospheric pressure and the difference is 0.4m at maximum. Adding this 0.4m, design wharf depth is given to be 6.0m as below:

5.5m + 0.4m = 5.9m rounded to 6.0m

**(5) Container Yard, Cargo Shed and Cargo Handling Equipment**

**1) Container Yard**

Import container cargo statistics from 1990 to 1993 are shown in Table 2-4-3. The annual average number of imported container by three shipping lines is 1,401 TEUs and the total of average number of imported container landed per ship of three shipping lines is 140.5 TEUs.

**Table 2-4-3 Imported Container Cargo Statistics (1990 to 1993)**

| Shipping Line | TEU/Year | Share (%) | Annual Average Ships' Call | TEU/Ship |
|---|---|---|---|---|
| CCS | 808 | 57.7 | 10.3 | 78.8 |
| BHL | 164 | 11.7 | 6 | 27.4 |
| KSSL | 429 | 30.6 | 12.5 | 34.3 |
| Total | 1,401 | 100.0 | --- | 140.5 |

In "The Study on Ports Development in Kiribati", according to the field survey counting the number of containers stored in the existing container yard in April, 1994, the ratio of non-working TEUs against working TEUs has been set as 58.6% and the average number of TEUs stored in the existing container yard has been given as 223 TEUs adding non-working TEUs to the above working TEUs, 140.5 TEUs.

140.5 TEUs x (1 + 0.586) = 223 TEUs

The above number of TEUs, 223 TEUs, has been defined in the said study as the average TEUs stored in the yard in annual average imported containers of 1,401 TEUs.

In this study, the field survey counting the number of containers stored in the yard was conducted in August, 1996 and the 292 TEUs was given. As shown in Table A-8-13 of Appendix 8, the number of annual imported containers in 1995 about half years ago is 1,917 TEUs. Following the above definition, the number of TEUs stored in the yard is given to be 305 TEUs as below:

1,917 TEUs x (223 TEUs/1,401 TEUs) = 305 TEUs

Since this 305 TEUs is almost the same as 292 TEUs given in the said field survey conducted in August, 1996, it is concluded that the above definition set in "The Study on Ports Development in Kiribati" can be still applied to this study.

Accordingly, the design number of containers to be stored in the target year 2000 is estimated as bellow by using the number of imported containers, 2,741 TEUs, forecast in Appendix 8:

2,741 TEUs x (223 TEUs/1,401 TEUs) = 436 TEUs

Average tiers of containers in a new container yard is planned to be 2.5 for laden and 3 for empty containers and necessary ground slots is calculated at 166. Required area of container yard is calculated as about 17,000 m2 including area for other purposes like cargo shed, open storage, car park, etc.

### 2) Cargo Shed

Local importers and their share of incoming cargoes are categorized as shown in Table 2-4-4.

**Table 2-4-4 Local Importers and Share**

| Importers | Share (%) |
|---|---|
| a) Kiribati Supplies Co., Ltd. | 10 |
| b) Kiribati Cooperative Wholesale Society | 15 |
| c) Abamakoro Trading Ltd. | 21 |
| d) Private Enterprises | 54 |

Note: Bulk fuels are excluded

Cargoes imported by the large importers from a) to c) share about 50% of all imported cargoes and about 50% of the cargoes for those large importers, that is, about 25% of total imported cargoes is assumed to be handled as FCL containers, based on the interviews by the study team with KSSL and large consignees.

Dwelling period of containers in the yard will be shortened as the container storage fee will increase in proposed port tariff system for containers.

The followings are assumed to estimate cargo movement in a cargo shed.

- 25% of imported TEUs are delivered as FCL containers and will be excluded in the estimation of required floor area in cargo shed.
- Remaining 75% of all imported TEUs are handled as LCL containers and all the LCL containers are unstuffed in the first 7 days, of which 70% are carried out of the cargo shed and the remaining 30% are stored in the cargo shed. And 90% of all the LCL containers are carried out by 14th day and all by the 30th day.

The number of LCL containers in the target year 2000 is applied for calculation of required floor area of cargo shed. The maximum number of imported containers per ship is given by CCS shipping line among three lines and the average number of imported containers per ship carried in by CCS excluding TEUs for tranship in the year 2000 is forecast at 141.9 TEUs as shown in Table 2-4-5. And 106.4 TEUs which is equal to 75% of 141.9 TEUs is LCL containers. Container cargoes dwelling in the cargo shed are 30% of unstuffed 106.4 TEUs at the peak time on the 7th day; i.e. 31.9 TEUs. Peak factor to allow fluctuation of import containers is found to be 1.4 times of the average based on the statistics. Therefore, possible container cargoes to be stored in a cargo shed in terms of TEUs are estimated at 55.3 TEUs as below by adding container dwelling from previous ship assumed to be 10% of 106.4 TEUs on the 14th day.

31.9 TEUs x 1.4 + 10.6 TEUs = 55.3 TEUs

**Table 2-4-5 Imported Container by Shipping Line in Target Year 2000**

| Shipping Line | TEU/Year | Annual Average Ships' Call | TEU/Ship |
|---|---|---|---|
| CCS | 1,606.2<br>(1,461.5) | 10.3 | 155.9<br>(141.9) |
| BHL | 315.2 | 6 | 52.5 |
| KSSL | 819.6 | 12.5 | 65.6 |
| Total | 2,741.0 | --- | 273.9 |

Note: ( ) shows TEUs excluding containers for transship

19 freight ton per TEU and 2.5 F.T./m$^2$, average cargo weight per square metres in a cargo shed, are assumed and the required floor area of the cargo shed including passage of 50% of floor area is given as 800 m$^2$ as below:

55.3 TEUs x 19 F.T./(2.5 F.T./m$^2$) x 2 = 840.6 m$^2$ rounded to 800 m$^2$

### 3) Cargo Handling Equipment

The present project focuses that the medium size cargo vessels such as Matangare class will berth alongside and unload cargoes in a new port apart from the existing port, which requires the introduction of large size cargo handling equipments to handle such heavy cargoes as containers. Table 2-4-6 shows the required cargo handling equipments including equipments presently owned by KSSL.

**Table 2-4-6 Required Cargo Handling Equipments**

| Required Equipment | Nos. | Container Cargo Movement |
|---|---|---|
| a. 80 t Mobile Crane | 1 | Barge <---> Wharf |
| b. Tractor/Trailer | (3) | Wharf <---> Yard |
| c. 25 t Forklift | 1 | In Yard |
| d. 6 t Forklift | 2 | In Shed |

Note: ( ) shows tractor/trailer presently owned by KSSL

The present project includes all the equipments listed in the above table except tractor trailers owned by KSSL.

Each equipment type is selected from the following considerations.

#### a) 80t Mobile Crane

Even when a new Betio Port will be built, large size cargo vessels of BHL will not be able to berth alongside in a port, they will have to perform the same cargo transfer by barge as it is now. To land and load those cargoes transferred by barge, a mobile crane having the same lifting capacity as the 32.5 t tower crane fixed on the existing port is selected. Landing/loading laden container cargoes from/to barge requires 80t mobile crane having lifting capacity of 20 t at outer reach of 6 m.

This mobile crane will be also utilized to load on a trailer the containers which are landed from the cargo vessels berthed alongside.

#### b) 25t Forklift

To offload laden containers (maximum weight: 20 t) brought in a container yard by trailer and stack them 3 high or vice-versa, a 25 t forklift is selected.

#### c) 6t Forklift

To move to a cargo shed the LCL container cargoes unstuffed in a container yard and stack empty containers 2 high, 2 numbers of 6 t forklifts are selected.

## (6) Administration Office and Passenger Terminal

### 1) Administration Office

According to a port authority to be proposed in the subsequent sections, an administration office to accommodate the port management staffs will be planned. The office will be located at second floor of a cargo shed to enable the port staffs to grasp the whole port activities.

The administration office functions as follows:

- To control the incoming and outgoing of vessels
- To arrange and operate pilot boats and service boats
- To maintain port facilities

Room allocation is planned as follows considering to render the efficient services to customers and allow the convenient usage of staffs:

| Room | Persons | Unit Area ( m² /person) | Required Area (m²) | Planned Area (m²) |
|---|---|---|---|---|
| a. Board of Directors /Conference Room | 3 | | 20.52 | 20.48 |
| b. General Manager | 1 | 18.0 | 18.00 | 18.20 |
| c. Other Managers | 2 | 13.0 | 26.00 | 26.04 |
| Port Master | | | | |
| Operation Manager | | | | |
| d. Civil Engineer | 1 | 13.0 | 13.00 | 13.02 |
| e. Sn. Marine Radio Officer | 2 | 5.2 | 10.40 | 13.02 |
| f. Marine Radio Officer | 3 | 5.2 | 15.60 | 16.98 |
| g. Office | 22 | 5.2 | 114.40 | 115.26 |
| Marine Engineer | 1 | 13.0 | 13.00 | 13.02 |
| Accountant | 1 | 13.0 | 13.00 | 13.02 |
| Admin. Manager | 1 | 13.0 | 13.00 | 13.02 |
| Computor Room | 2 | 5.2 | 10.40 | 10.20 |
| Sub-total | 39 | | 267.32 | 272.26 |
| h. Toilet | | | 13.00 | 13.68 |
| i. Kitchinette | | | 6.00 | 6.30 |
| j. Storage | | | 13.00 | 13.00 |
| k. Corridor | | | 50.00 | 44.76 |
| Total | | | 349.32 | 350.00 |

Note: Rooms for Senior Marine Radio Officers and Marine Radio Officers are exclusive use for 24 hour's working.

### 2) Passenger Terminal

Required area for passenger terminal is estimated as follows:

The passenger records from 1983 to 1993 in the present Betio Port are shown in Table 2-4-7.

**Table 2-4-7 Annual Passenger Records (1983 to 1993)**

| Year | Annual Passengers | Growth Rate |
|---|---|---|
| 1983 | 2,362 | |
| 1984 | 2,603 | |
| 1985 | 3,184 | |
| 1986 | 3,505 | |
| 1987 | 4,375 | |
| 1988 | 4,486 | 3.60% |
| 1989 | 4,356 | |
| 1990 | 8,093 | |
| 1991 | 7,787 | |
| 1992 | 6,514 | |
| 1993 | 4,696 | |

Source: KSSL Passenger Statistics

The average increase rate was obtained as 3.6% in "The Study on Ports Development in Kiribati" with regression analysis omitting the singular data in 1990, 1991 and 1992. Following the rate, the number of passengers at the target year 2000 has been forecast to be about 7,000 as shown in Figure 2-4-1. Updated data obtained in this study for 1994 and 1995 are 5,220 and 3,618 passenger per year, respectively. Comparing with the forecast, 1994 has a good coincidence, but 1995 record has dropped down about 30% of the forecast because the resettlement to Line Islands was completed at the end of 1994. The resettlement to Phoenix Islands however has commenced in 1996 and the number of passenger is expected to move upwards.

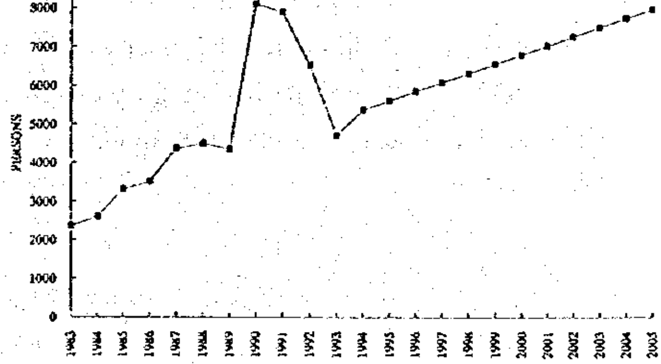



**Figure 2-4-1 Forecast of Passenger Traffic**

The principal domestic cargo vessels to transport interisland passengers, as shown in Table 2-4-8, are 4 vessels owned by KSSL, and those transporting capacities per trip are between 150 and 500 passengers. Average number of passenger per trip is between 90 and 250 passengers, and Matangare makes a bimonthly trip and the other vessel less than 1,000 GRT a monthly trip.

**Table 2-4-8 Dimensions of Principal Domestic Cargo Vessels and Passenger Statistics (1993 to 1994)**

| Vessels | GRT (mt) | Overall Length (m) | Breadth (m) | Full Draft (m) | Maximum Nos. of Passengers | Average Nos. of Passengers | Average Number of Annual Trips |
|---|---|---|---|---|---|---|---|
| Matangare | 1,295.0 | 68.64 | 11.80 | 4.2 | 515 | 254 | 6 |
| Moanaraoi | 721.0 | 59.92 | 9.61 | 4.0 | 182 | 120 | 10 |
| Momi | 450.4 | 42.50 | 9.60 | 3.0 | 146 | 87 | 13 |
| Mataburo | 524.0 | 42.50 | 9.61 | 3.2 | 148 | 92 | 12 |

Source: KSSL Passenger Statistics

Passenger statistics show that the largest number of passengers per trip is 515 in 1991 and even the third one is 508 in 1990. Those singular records occurred due to the resettlement to Line Islands from 1990 to 1992. Those data are not suitable to estimate the future passenger number for the determination of floor area of a passenger terminal.

Annual average number of trips is 41 and expected to have little fluctuation from now. Matangare transports a large number of passenger with low frequency, but the other three vessels transport less number of passengers with the double frequency of Matangare. Since the number of passenger has a large fluctuation depending on the destination and the year, the average number of passengers per trip by other three vessels except Matangare will be adopted for the design, giving 100 passengers as below:

Design number of passengers = (120 x 10 + 87 x 13 + 92 x 12)/(10 + 13 + 12) = 100

Assuming a floor area required for one passenger is 1.2 $m^2$ based on Japanese Standard, the total required floor area is calculated as 120 $m^2$.

The location will be sited at the west next to a container terminal and an access road to a wharf will be aligned along the north end of a container yard. The passenger terminal area shall be separated by fence to be installed by the Government of the Republic of Kiribati from a bonded area such as container yard considering the security and efficiency in port operation.

### (7) Utilization of Existing Betio Port

The port facilities of the existing Betio Port are, though being obsolescent and insufficient, still serviceable if properly rehabilitated. To avoid unnecessary investment in the project, the existing facilities are planned to efficiently supplement a newly developed facilities proposed in this study.

#### 1) Ships to be accommodated

A new Betio Port shall be utilized mainly by international cargo vessels and KSSL domestic cargo vessels, while the existing Betio Port shall serve such small local ships as those owned by private ship operators and informal sector, fishing boats, tugs and barges, landing crafts, ships to be repaired in the shipyard and leisure boats. This separation will increase productivity of cargo handling operation in the proposed new port.

#### 2) Container Yard

The existing container yard shall be utilized as open storage for both foreign and domestic cargoes, garage for cargo handling equipment, car park, etc.

#### 3) Sheds

The existing sheds shall be utilized for storing export copra, cargoes of KCWS and Supply Division of MWE, long term staying cargoes and a waiting room of passengers with minor repair and remodeling to be done by the government.

### (8) Layout Plan

The general layout plan of this project is shown in Figure 2-4-2.

The present project site has been selected in "The Study on Ports Development in Kiribati" with consideration of three candidate sites such as west, middle and east of the existing port. Betio Town Council has planned a new port area to be located east side to the existing port in their land use plan and the environmental impact assessment has indicated that the east side has less impact on lagoon ecology with little alive coral to be influenced by construction works such as dredging and reclamation. And the examinations on the construction cost, traffic flow, possibility of future expansion, etc. has evaluated that the east side has more advantage. Further, this study has confirmed that the present socio-economic conditions have little change from the time of previous study. With consideration of all the conditions stated above, this project site is determined at east side to the existing port.

The layout of main facilities are determined with the following considerations:

### 1) Wharf

The present project site is influenced by easterly trade winds throughout the year with ordinary wave height being about 50 cm. This sea conditions allow the ordinary wind waves to come in directly to the shore. To maintain the calmness at the level of more than 95% of occurrence in wave height less than 50 cm, a basin to accommodate the vessels requires a breakwater at the east side to a basin. In this project, an impermeable jetty, as shown in Figure, is located to shelter the west side wharf and basin. This creates, as shown in Appendix-6 of Appendices A, more than 95% of operational days having less than 50 cm wave height in the basin and water area just in front of the wharf.

Furthermore, the above-mentioned easterly wind waves generate suspended sediments at the reef edge and bring them to the existing basin and approach channel, where the depth of water has shoaled about 1 m in more than 30 years. A new basin in this project may possibly have the same situation, but such a wharf layout as mentioned above can shelter the easterly wave action and is advantageous as countermeasures against shoaling. "The Study on Ports Development in Kiribati" has evaluated that this proposed wharf layout is the most adequate to minimize the shoaling with minimum construction cost based on the computer simulation results, that is, the annual shoaling volume is about 1,000 m3 and the annual shoaling height is about 3 cm thereon.

From the above discussions, the wharf layout is planned as shown in Figure.

### 2) Container Yard

To minimize the filling soil volume, a container yard is planned to locate in the shallow reef flat

### 3) Cargo Shed and Administration Office

A cargo shed and an administration office are planned at the back of a container yard to prevent the interference with cargo handling operation. The administration office is allocated at the first floor in the cargo shed.

### 4) Passenger Terminal

Considering that a passenger terminal area must be separated from a bonded area, the passenger terminal is allocated at the west next to the container yard with separation by fence.

### 5) Access Road

The present study has examined the possibility to take the existing road on the east breakwater as a route of access road for a new port area but concluded it is impossible from the following reasons:

- Forecasting from the present traffic congestion, the existing road on the east breakwater will have about 630 car traffic per day at the target year 2000 including cargo truck and trailer traffic from a new port. Especially the morning, lunch and evening time will have most congested traffic of about 90 car traffic per hour. To prevent such congestion, the road will require 2 lanes enabling a large size vehicle to pass the both ways at the same time.
- The south end of the road has only 4 m width and has structural trouble of circular rupture at the slope shoulder by common vehicles' traffic load, thus the structural stability is questionable.
- The above-mentioned narrow part of the road is bounded on the west by the slipway and buildings and bounded on the east by the tank yard. There is no more space to expand the road because the removal or relocation of those existing facilities are impossible. Therefore it is impossible to secure 2 lanes.

With consideration of all conditions stated above and the future land use plan by Betio Town Council, this study has proposed another route of access road as shown in Figure allowing future reclamation of 33,000 $m^2$. The south end of a new access road will be connected to the existing highway near the district court. The land use at this junction have been examined to be available.

This proposed route has a lot of advantages such that port cargoes can be smoothly brought out not through the central town but directly to the highway and the wide space to enable the future reclamation for power plant, reservoir and park can be provided, thus this project can contribute to the improvement of nation's infrastructure.

Summary of proposed components in this project is shown in Table 2-4-9.

**Table 2-4-9 Summary of Proposed Components in the Present Project**

| Components | Outline |
|---|---|
| a. Wharf | 80 m long, 6m deep |
| b. Container Yard | 17,000 m² |
| c. Basin | 6m and 4m deep basins |
| d. Access Road | 630m (7m wide) |
| e. Navigational Aids | 8 Light Buoys and a Light Beacon |
| f. Rehabilitation of Existing Port | Repair of wharf, Dredging of basin and channel |
| g. Administration Office | 350 m² |
| h. Cargo Shed | 800 m² |
| i. Passenger Terminal | 120 m² |
| j. Cargo Handling Equipment | a 80t Mobile Crane, a 25t Forklift and two 6t Forklifts |

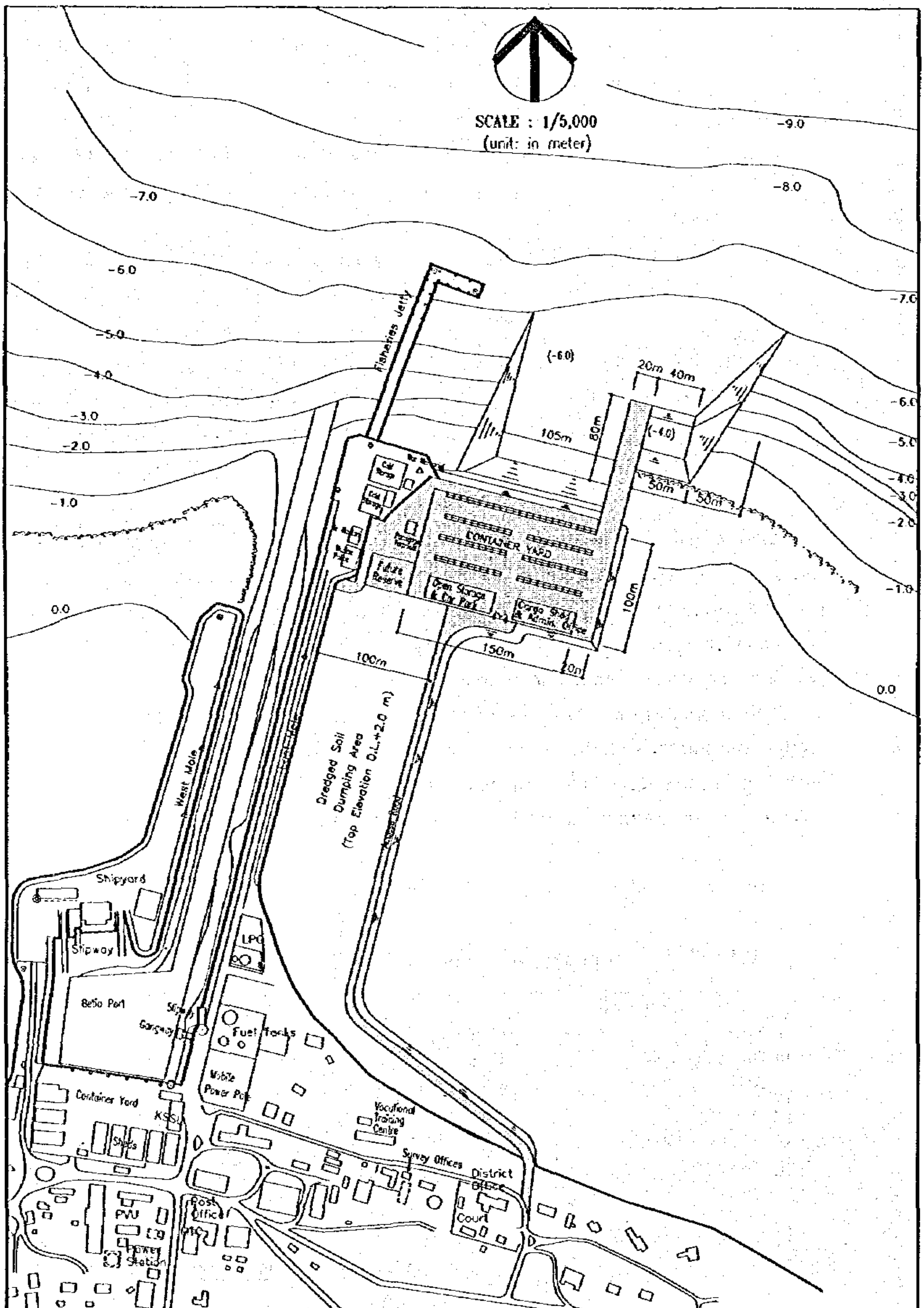



Figure 2-4-2 General Layout Plan

## 2-5 Basic Design

### 2-5-1 Design Policies

(1) Local design standards on port facilities and buildings have not been established and Japanese design standards are applied.

(2) Construction materials which are procurable in Kiribati are sand and aggregates for concrete and appropriate structural types with maximizing usage of those materials are adopted to minimize the construction costs.

(3) Appropriate structural types with fully utilizing soil materials to be dredged in the project are adopted to minimize the construction costs.

(4) Such a wharf structure as maintains the calmness in a basin and shelters a basin from incoming suspended sediments is adopted.

(5) According to the design criteria for other existing facilities, the seismic factor is considered in designing.

(6) Easy repairs, low maintenance costs and less impact to the environment are considered in designing.

(7) Such allocation of office space as enables the efficient usage by user and customers is considered in designing buildings.

(8) Local working and life styles are considered in designing.

The allocation of facilities designed with the above policies is shown in Figure 2-5-1.

### 2-5-2 Basic Design of Civil Engineering Structures

#### (1) Design Conditions

1) **Design Ship**

| | |
|---|---|
| – Overall length: | 68 m (Matangare class) |
| – Breadth: | 11.8 m (Matangare class) |
| – Full draft: | 5 m (Novikovo class) |

2) **External Force**

| | |
|---|---|
| – Surcharge: | 3.0 t/m$^2$ (at ordinary time), 1.5 t/m$^2$ (at earthquake) |
| – Berthing velocity: of vessels | 20 cm/sec |
| – Seismic coefficient: | 0.05 |

3) **Sea Conditions**

| | |
|---|---|
| – M.H.W.S: | + 1.8 m |
| – M.L.W.S: | + 0.1 m |
| – C.D.L.: | – 0.4 m |
| – Design wave: | 1.54 m high<br>4 seconds period<br>North direction |

4) **Soil Conditions**

* Backfilling

| | |
|---|---|
| – Bulk density: | 1.8 t/m$^3$ (above water)<br>0.8 t/m$^3$ (underwater) |
| – Angle of internal: friction | 30° |

* Under the sea bottom: as shown in boring survey results

#### (2) Wharf

For the structural type of wharf, three alternatives are considered, namely steel sheet pile type, steel pipe pile type and gravity type. As compared in Table 2-5-1, a steel sheet pile type has more advantages than other two alternatives in terms of soil conditions, difficulty in construction, construction period and construction cost. Therefore, double wall type of steel sheet piles is selected and the apron at the crown of wharf is of concrete pavement type with a thickness of 35 cm considering heavy traffic loads such as forklift, mobile crane, etc. The typical cross sections are shown in Figure 2-5-2.

The crown height is set at 4 m based on Japanese design standards for ports and harbours as below:

1.8 m (M.H.W.S) + 2.0 m = 3.8 m rounded to 4 m

Consequently, the height is the same as that of fisheries jetty next to a new port.

The width of apron is set at 20 m as a minimum turning radius required by the tractor trailer for 20 feet containers.

**Table 2-5-1 Comparison of Structural Type of Wharf**

| Conditions | | Steel Sheet Pile | Steel Pipe Pile | Gravity |
|---|---|---|---|---|
| ① | Soil Foundation | Suitable for pile driving and having enough bearing streng-th | Depth expected for bearing stratum is too deep, D.L. - 15 m | Soft soil layer, N<10, lies shallower and is unreliable |
| ② | Difficulty in Construction | Worldwide common type with simple construction activities | Connection between pile top and coping concrete requires high skills | Requires large construction equipments and wide yard for concrete caisson or blocks |
| ③ | Construction Period | Rapid construction is possible | Needs longer period than steel sheet pile type | Needs longer period for temp-oraly works |
| ④ | Cost Ratio of Construction | 1 | 1.3 | 1.3 |
| Evaluation | | Selected | | |

**(3) Revetment**

Two different types of revetment are adopted in the present project as follows:

**1) Revetment facing the Basin**

The wave conditions in a basin have been forecast by using wind records in Tarawa Lagoon (See Appendix-5 of Appendices A). As a result, a maximum wave occurs at the south-east corner of basin and is adopted as a design wave for revetment. The dimensions are as follows:

- Wave Height: 1.54 m
- Direction: North
- Period: 4 seconds

The revetment planned in front of such a basin as have rough wave conditions requires functions such as reducing the reflection of high incident waves to maintain the calmness and protecting the overtopping waves.

For such a revetment, a one ton armour stone slope protection type is ordinarily adopted, but there are no such heavy stones in Kiribati. Therefore, as shown in Figure 2-

5-3, adopted is slope protection type with wave dissipating concrete blocks.

The weight of wave dissipating concrete block is calculated applying the Hudson's formula, in which the required weight is given as 0.36 t and the minimum unit type of wave dissipating concrete block having one ton weight is adopted.

As shown in Figure, the revetment will be equipped with foot protection and filter sheet to prevent the erosion and scouring of backfill.

For the other sections than the south-east corner of the basin, adopted is the same fabric mat revetment type as adopted to the access road mentioned in the next section.

**2) Revetment along the Access Road**

The east side along the access road is exposed to the wind waves generated in Tarawa Lagoon, but the depth thereon is shallower than D.L. 0 m and most wave forces are reduced, thus the wave conditions thereon are much more gentle than the basin. However, the revetment thereon will have to be protected from a long term erosion and scouring due to the continuous low wind wave and tidal current forces. The same fabric mat revetment type as adopted in the construction of causeway between Betio and Bairiki islets is the most adequate to such site conditions as the east side along the access road with consideration of limited procurability of local stones. As shown in Figure 2-5-4, the fabric mat revetment type is adopted with sufficient foot protection. Also for the slope along the container yard, the same type is adopted with reinforcing the deeper part fitting to the wharf with the same wave dissipating concrete blocks as the south-east corner of the basin.

**(4) Access Road**

The access road will accommodate tractor trailers loaded with 20 feet containers and the road width is designed as 7 m with 2 lanes of 3.5 m each. Finishing of road surface is of coral sand and rocks compaction with no pavement (See Figure 2-5-4).

The road at west and north of the container yard will accommodate 2 ton tracks for passengers and the road width is designed as 6 m with 2 lanes of 2.5 m each and a sidewalk of 1 m. The finishing of the road surface is of the same type as the access road (See Figure 2-5-3).

**(5) Container Yard**

The groud elevation of container yard is planned to be D.L.+3.25m to meet the ground elevation of adjacent east breakwater. As mentioned in the previous section, the container yard will accommodate 436TEUs at the target year 2000. The average tiers of containers is 2.5 for laden and 3 for empty containers and necessary ground slots are 166. Required area per slot is 15 $m^2$ (= 2.45 m x 6.1 m) and the total slot area is given as 2,490 $m^2$ (= 15 $m^2$/slot x 166 slots). As shown in Figure 2-5-5, the slots for empty containers are allocated at north end to make an easy access to the wharf and those for laden containers are allocated at the center of the container yard to make an easy delivery out of the yard.

The width of passage between 2 bays is designed at 15 m as below so that two forklifts holding containers can pass each other and the total passage area is 11,042 m$^2$ (170 m x 79.6 m – 2,490 m$^2$) as shown in Figure:

> 2 x 6 m (container length) + 1 m (clearance for pass each other) + 2 x 1 m (side clearance at passage end) = 15 m

For the area for a cargo shed, an open storage, a car park and reefer containers, an area covering 3,468 m$^2$ (=170 m x 20.4 m) is secured as shown in Figure. In consequence, the total area for the container yard is 17,000 m$^2$ as below:

| | | |
|---|---|---|
| – Slot Area: | | 2,490 m$^2$ |
| – Passage Area: | | 11,042 m$^2$ |
| – Area for cargo shed, open storage, car park and reefer containers: | | 3,468 m$^2$ |
| Total | (170 m x 100 m =) | 17,000 m$^2$ |

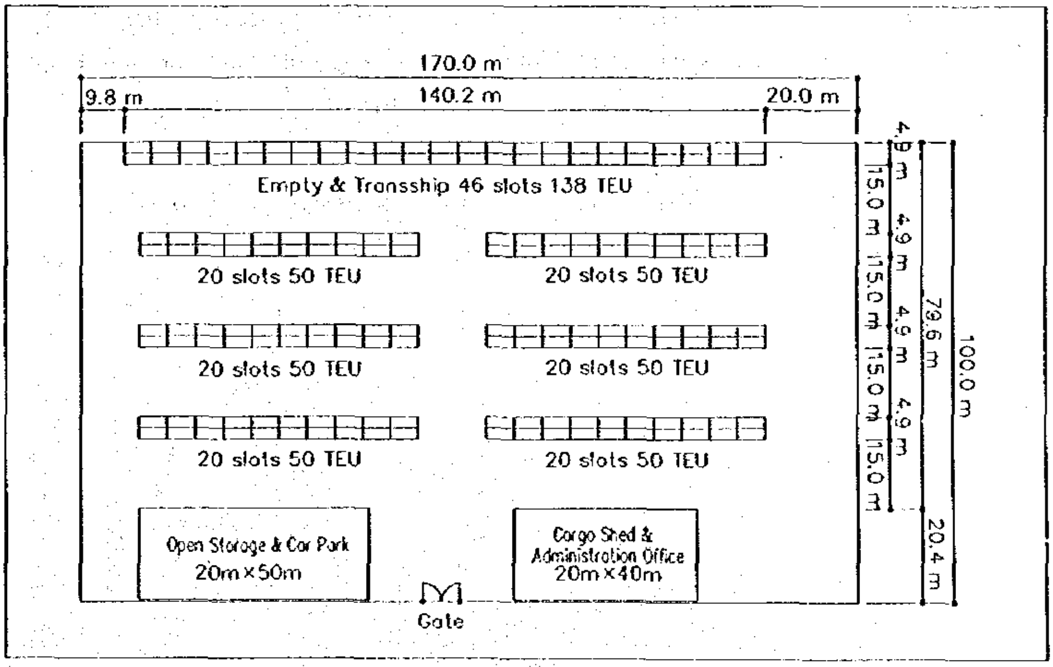



**Figure 2-5-5 Allocation of Container Slots and Bays**

### (6) Basin and Navigational Aids

The depth of basin is designed as the same 6 m as that of wharf. The width of basin is designed as 1.5 L = 105 m so that the design ship, Matangare (L = 68 m), mooring head in can turn and depart the port based on the "Technical Standards for Ports and Harbours Facilities in Japan".

The navigational aids, as stated in the previous section of planning policies, are all equipped with lanterns to enable navigation at night. From the wave and topographical conditions, all are of floating buoy type except for a beacon on the wharf. As shown in Figure 2-5-6, eight buoys and one beacon are arranged. Buoys No.1 and No.2 at the mouth of fairway will have a range of 5 nautical miles and the other buoys have 2 nautical miles. The beacon on the wharf will have 5 nautical miles. Further, all the buoys and beacon are equipped with anti-theft nets and bars to prevent from occasional incidents by small boats.

### (7) Rehabilitation of the present Betio Port

The steel sheet piles above sea level in the existing wharf have been badly corroded with some parts being holed and the coping concrete and fender have been all broken and torn down. The piles in splash zone near D.L. 0 m is specially corroded with the thickness of piles being reduced 50 % to the extent that the backfill soil is escaping from holes. While the piles below sea level still have enough thickness and sufficient durability.

In repairing the existing wharf, it is focused that those deteriorated coping concrete and fenders will be restored by fully utilizing the piles below sea level. As shown in Figure 2-5-7, new sheet piles, III type, will be driven 70 cm in front of the wharf with connecting to the existing piles by tie rod and sand will be filled till D.L. + 0.7 m between two walled piles. And concrete will be filled above the filled sand together with forming the coping concrete so as to reduce the backfilling soil pressure.

The bitt will be relocated and fenders will be newly installed. Further, water area of the basin and approach channel will be dredged till D.L. - 3 m.

## 2-5-3 Basic Design of Architectural Facilities

### (1) Structural Design

Most buildings in Kiribati are of a wooden structure and of a pandanus leaves roof. Public buildings and government buildings are of a combination type of a wooden truss roof with colored steel sheet roofing and reinforced concrete block wall. Concrete blocks are locally produced, but major building materials are imported.

There is no supplier of ready mixed concrete and therefore large reinforced concrete buildings are very few. Also steel structural buildings are very few, except warehouses in the existing port.

Since a cargo shed which is the main building proposed in the present study needs to have a wide span and a high eave height, a steel structure is selected. This structure enables a lighter load and a shorter construction period.

Outline of the cargo shed and administration office is summarized as follow:

- Building Area: 800 $m^2$
- Floor Area: 1,150 $m^2$
- Structural Type: Steel Structure

General drawings are shown in Figures 2-5-8 to 2-5-11 including passenger terminal.

### (2) Finishing Materials

The following conditions are taken into consideration in selecting finishing materials of each building part:

- Buildings are highly influenced by corrosion because the site is close to the sea.
- Local climate is of high temperature and high humidity throughout the year.
- Major building materials are to be imported.
- Construction period is limited.

#### 1) Exterior Finish

Most of the building roofs in Kiribati are of a gable roof or gambrel roof type. The proposed cargo shed is of steel structure and will be designed with colored and V-beamed steel sheets for its roofs and walls since they are commonly used locally and are easy to be maintained.

To design the exterior finish materials, durability and anti-corrosion will be considered to prevent damage from salty sea water permeation. Roof and wall insulation will be planned to keep away heat transmission from the outside, and louvers will be planned on the gables for ventilating.

### 2) Interior Finish

Floor finish for the cargo shed will be of concrete steel troweled and hardener finish will be applied to floor to prevent abrasion. In office area, carpet tiles or vinyl composition tiles will be adopted for floor finish, and exposed concrete wall with paint finish or gypsum wall boards with paint finish on light gage steel stud wall will be adopted for walls, and acoustical rock wool boards is adopted for ceilings. The rooms for cicil engineer, administration manager, accountant and computor will be separated by movable partitions or low partitions for multi purpose space.

In restrooms, ceramic tiles will be adopted for floor and wall, and waterproofed gypsum board with paint finish will be adopted for ceilings considering easy cleaning and maintenance in terms of sanitation.

Interior finish schedule is as follows:

| Room Name | Floor | Wall | Ceiling |
|---|---|---|---|
| Cargo Shed | CST. | ---- | ---- |
| Administration Office | | | |
| General Office | VCT. | GWB. | ACST. |
| Private Rooms | CT. | GWB. | ACST. |
| Storage | VCT. | GWB. | ACST. |
| Corridor | VCT. | GWB. | ACST. |
| Kitchenette | VCT. | GWB. | ACST. |
| Restrooms | CFT. | CWT. | WGB. |

Abbreviations:

| | |
|---|---|
| ACST.: | Acoustical Board |
| CFT.: | Ceramic Floor Tile |
| CST.: | Concrete Steel Troweled |
| CT.: | Carpet Tile |
| CWT.: | Ceramic Wall Tile |
| GWB.: | Gypsum Wall Board |
| VCT.: | Vinyl Composition Tile |
| WGB.: | Waterproofed Gypsum Board |

### 2-5-4 Basic Design of Mechanical Facilities

#### (1) Water Supply Facilities

##### 1) City Water

A 40 ton water tank will be installed for water supply to cargo vessels. Water is fed by automatic supply pump system.

##### 2) Rain Water

Rain water is collected from a roof of the cargo shed and stored in a rain water tank. Water is fed to sanitary ware, kitchenette through an elevated tank.

#### (2) Drainage Facilities

Sanitary sewage and miscellaneous waste water will be treated in a septic tank of a micro-organisms smell killing system to minimize a value of biochemical oxygen demand. Then the treated water will be able to be discharged into ground.

#### (3) Sanitary Ware

Sanitary wares are made in Japan or their equivalents.

#### (4) Ventilation Facilities

To remove radiant heat from a roof surface, louvers will be installed on an upper part of gable so that air is ventilated through a loft. A natural ventilation will be first employed, but a mechanical ventilation is also used in a mechanical room and restrooms to remove offensive odor.

#### (5) Air-conditioning Facilities

A split type cooler will be installed in an office area for cooling and ventilating.

#### (6) Electrical Wiring Work

##### 1) Electrical Building

An electrical building will be built of reinforced concrete blocks to prevent electrical wires from corrosion and injury from salt because the site is close to the sea. Special equipments to be installed are as follows:

a) **Transformer**

An electric supply power will be stepped down from 11 kv in primary line to 415 v. The required electric power capacity is estimated as 400 kva.

b) **Distribution System**

A incoming panel is to receive power from both a commercial source and an emergency generator. Each source will have a main switch with interlocking device. A power board will be installed on a power circuit and a panel board will be installed on a lighting circuit.

c) **Emergency Generator**

As a countermeasure against power failure, a 45 kva generator and automatic switch will be installed in the electrical building.

2) **Distribution System**

Power circuits

| | |
|---|---|
| for reefer containers: | AC 415 v, 3 phases, 3 wires, 50 Hz |
| for shore power: | AC 380 v, 3 phases, 3 wires, 50 Hz |
| Lighting and outlet circuits: | AC 240 v, 3 phases, 3 wires, 50 Hz |

3) **Lighting Facilities**

Fluorescent lamp will be mainly used. Intensities of illumination at various places are as follows:

| | |
|---|---|
| Office room: | 300 Lux |
| Cargo Shed: | 150 Lux |
| Others: | 100 Lux |

4) **Lighting in Container Yard and Apron of the Wharf**

Lighting system with high pressure mercury lamp will be introduced for cargo handling at night. Intensities of illumination at various places are as follows:

| | |
|---|---|
| Container Yard: | 20 Lux |
| Wharf Apron: | 30 Lux |

5) **Power Supply for Reefer Container and Shore Power Facility**

Five units of power supply stands for reefer containers will be installed at the south-east corner of container yard. Shore power outlet will be installed on the wharf for power supply to cargo vessels such as Matangare and repair and maintenance of vessels. Each voltage is as stated in above section of "Distribution System".

### 2-5-5 General Drawings

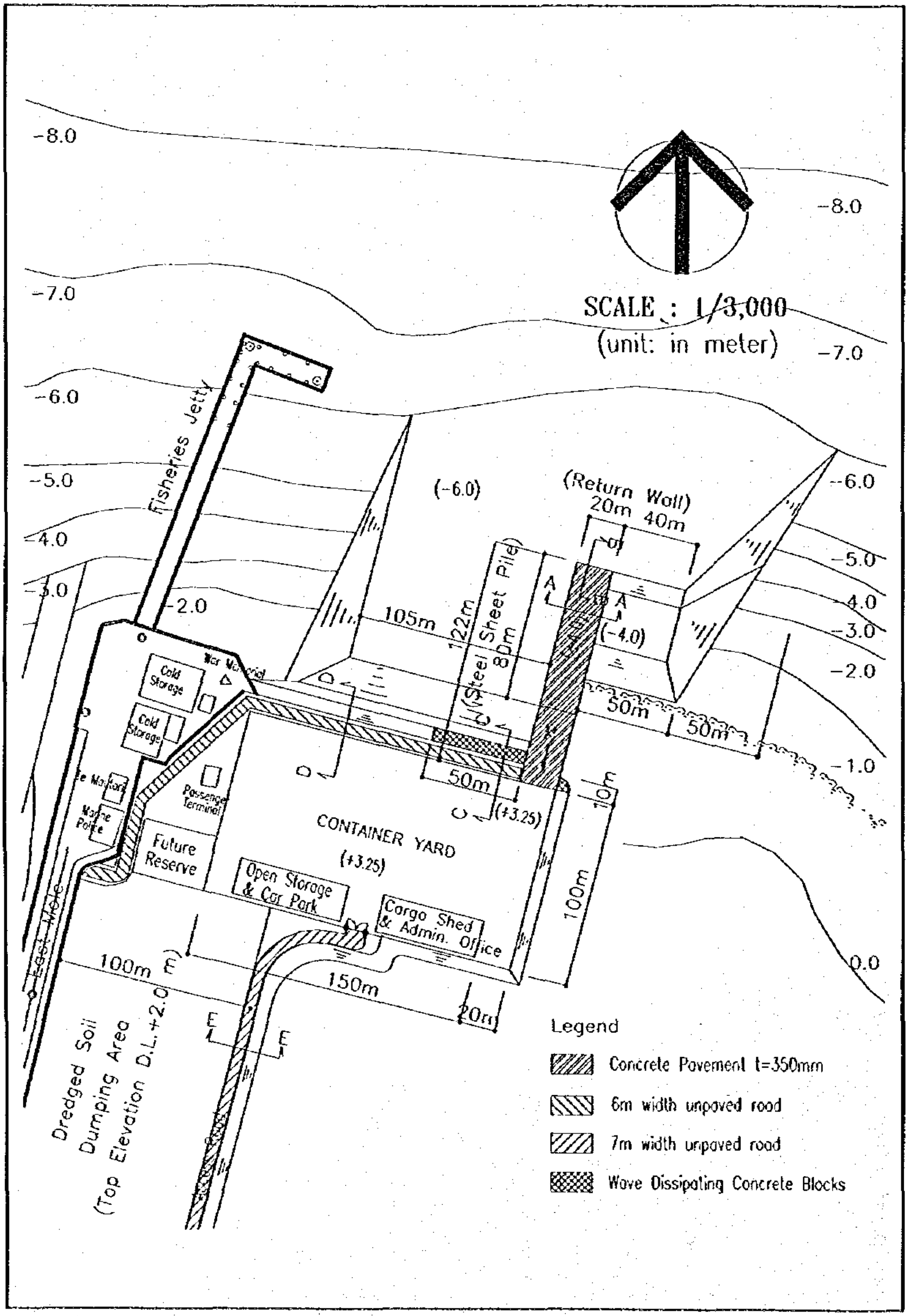
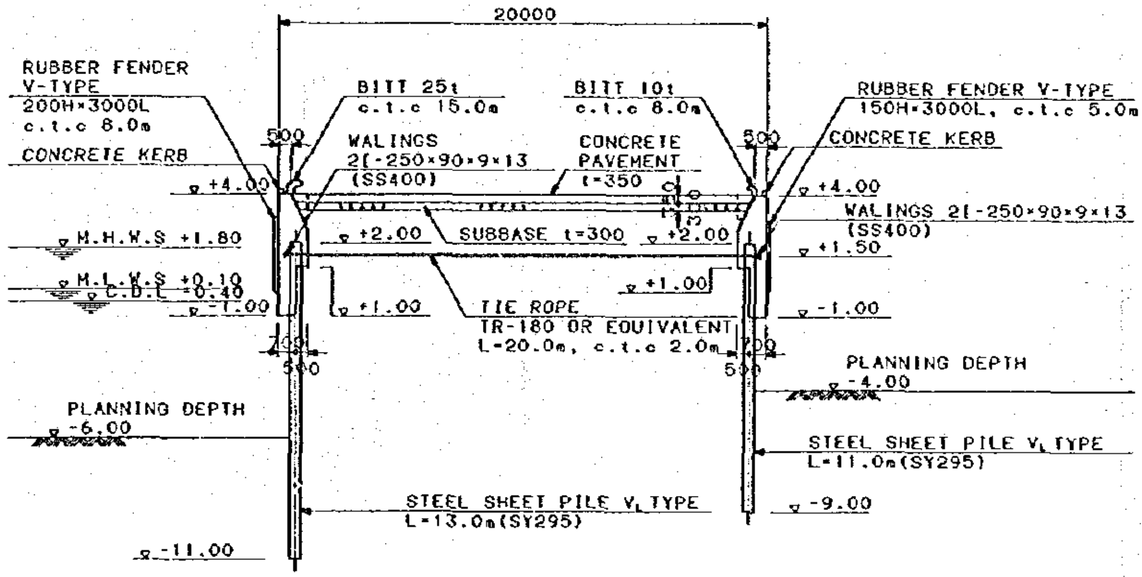
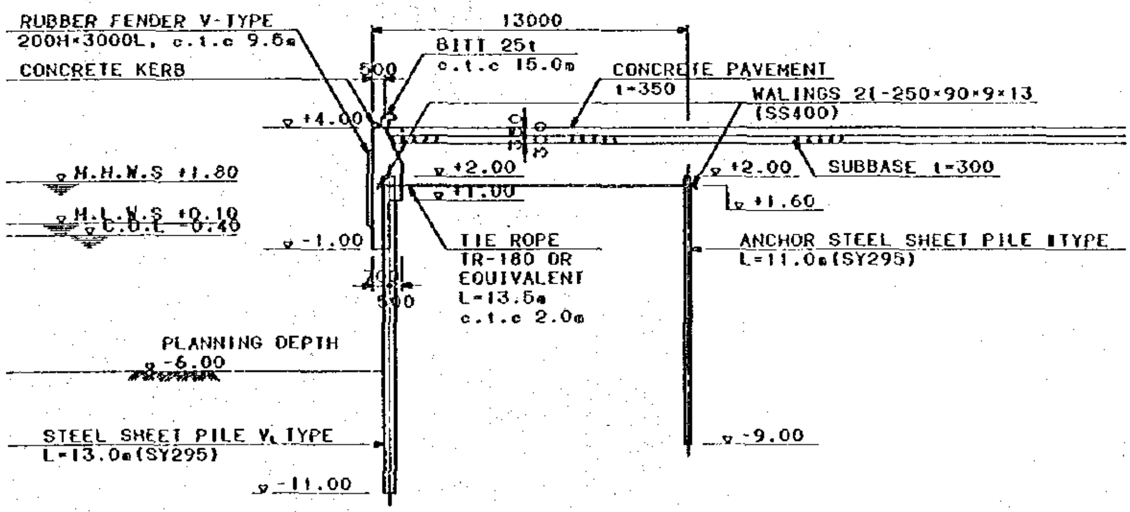



**Figure 2-5-1 Allocation of Port Facilities**




## Cross Section A – A

S=1:300




## Cross Section B – B

S=1:300

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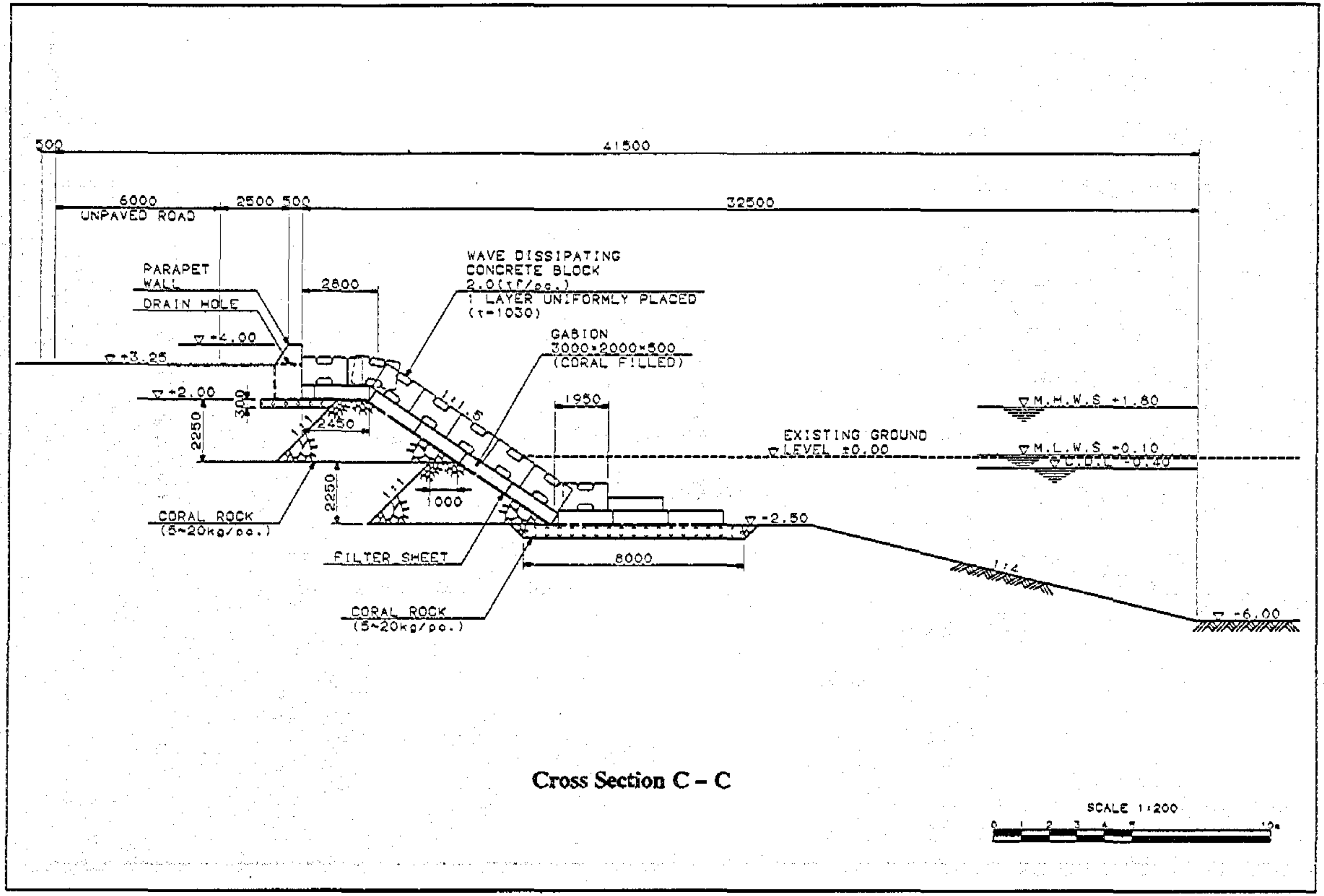
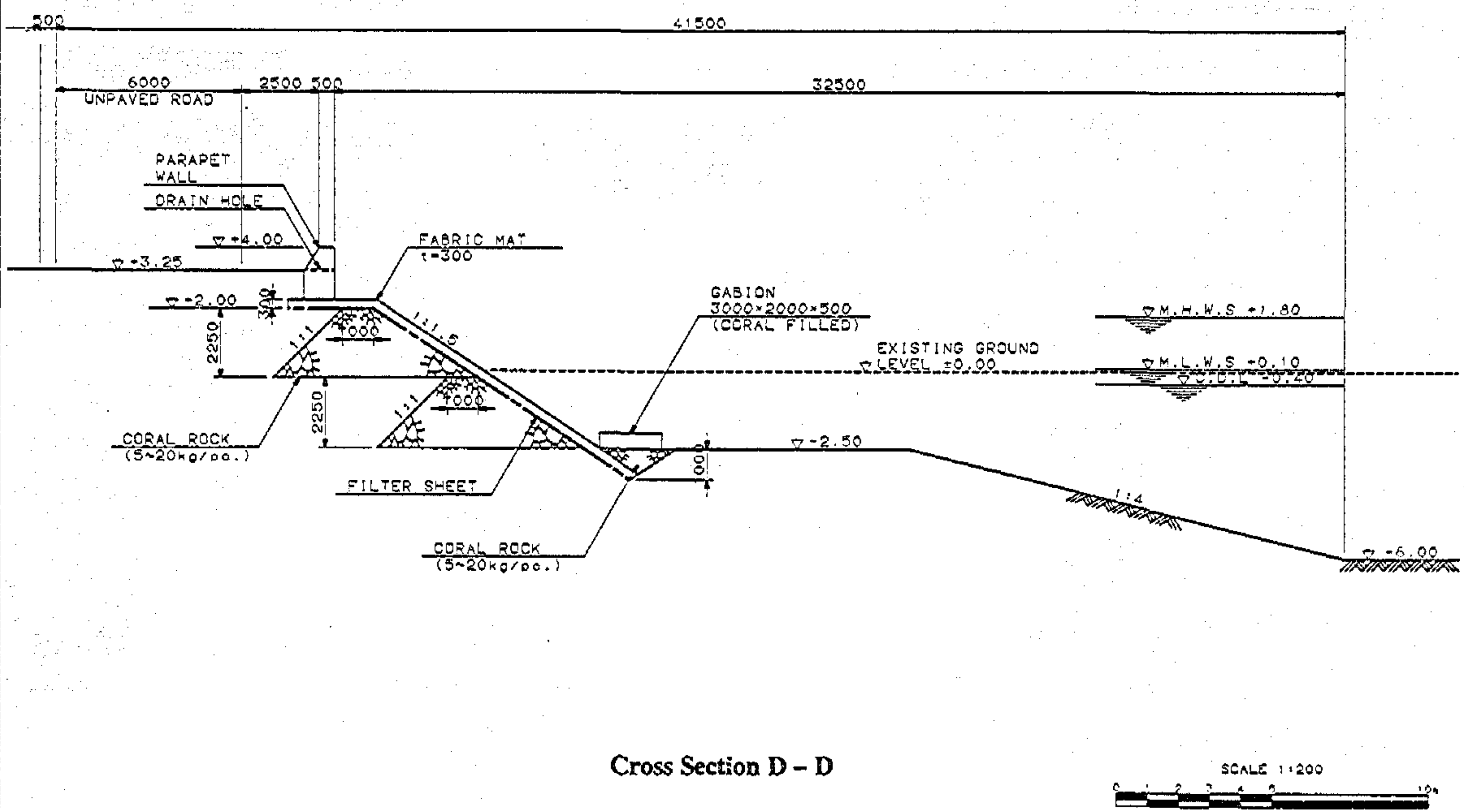
Figure 2-5-2 Typical Cross Section of Wharf



Cross Section C – C

Figure 2-5-3(1) Typical Cross Section of Revetment facing the Basin (South-East Corner)




Cross Section D – D

Figure 2-5-3(2) Typical Cross Section of Revetment facing the Basin

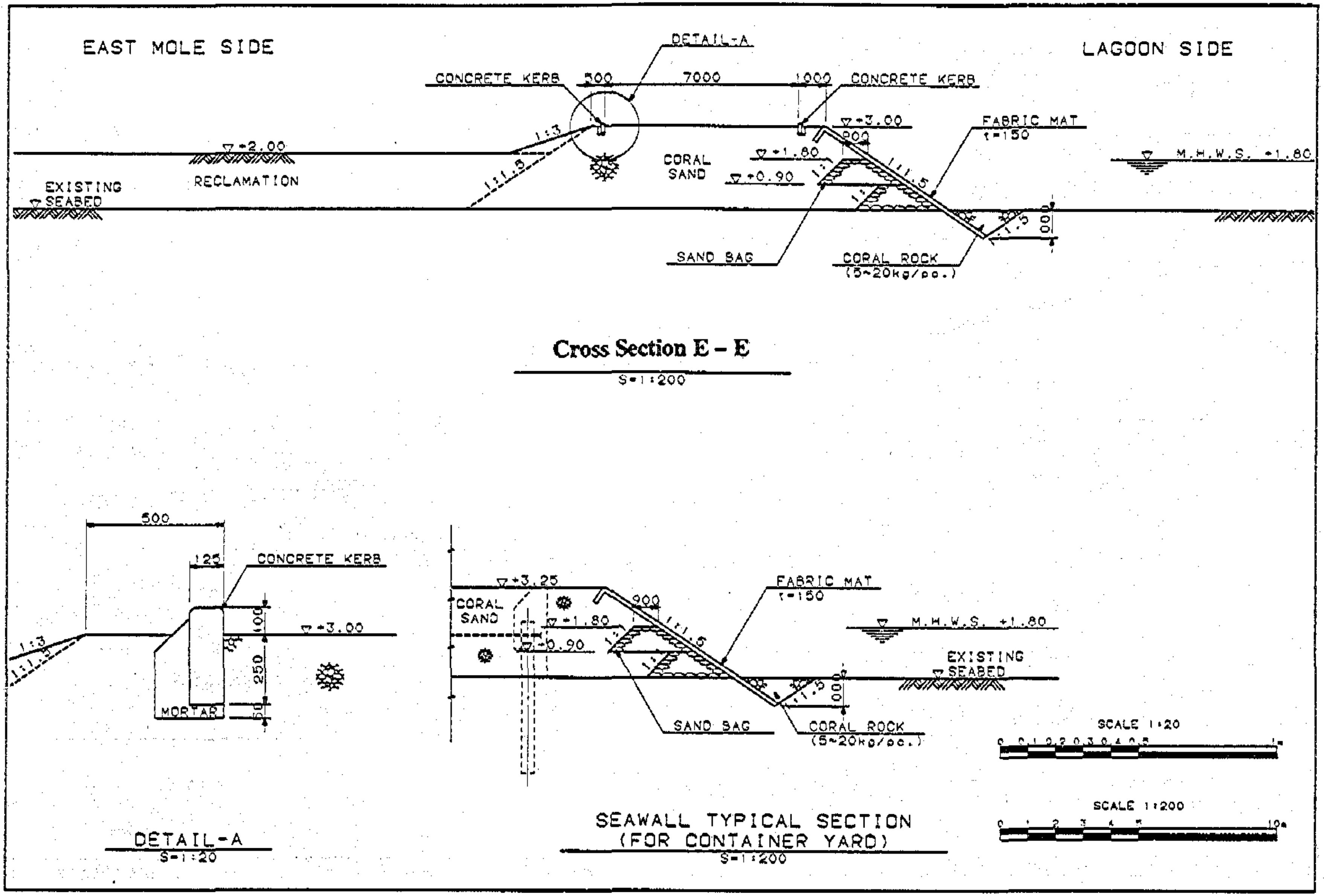



Figure 2–5–4 Typical Cross Section of Revetment along the Access Road

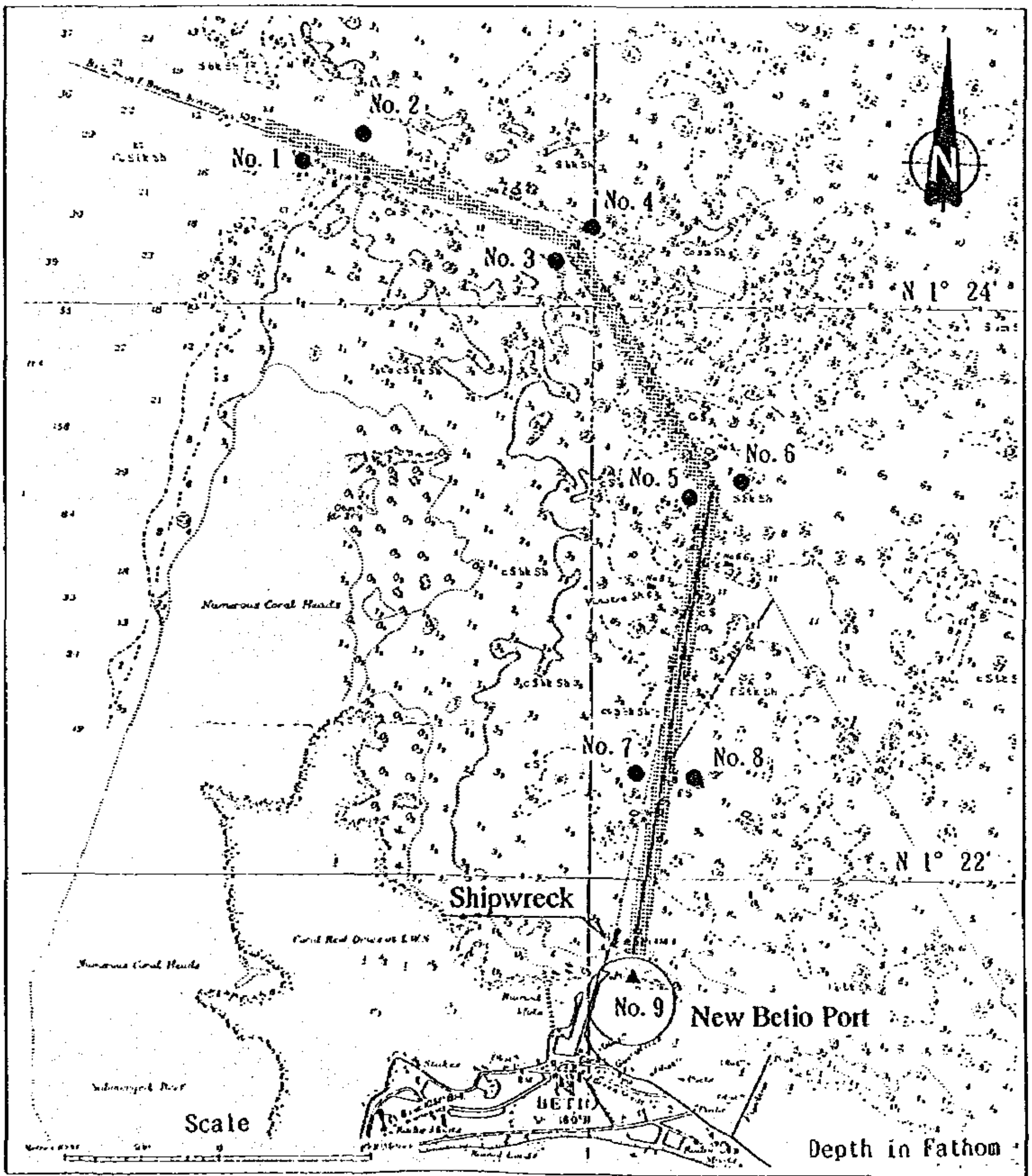



**Figure 2-5-6 Arrangement of Navigational Aids**

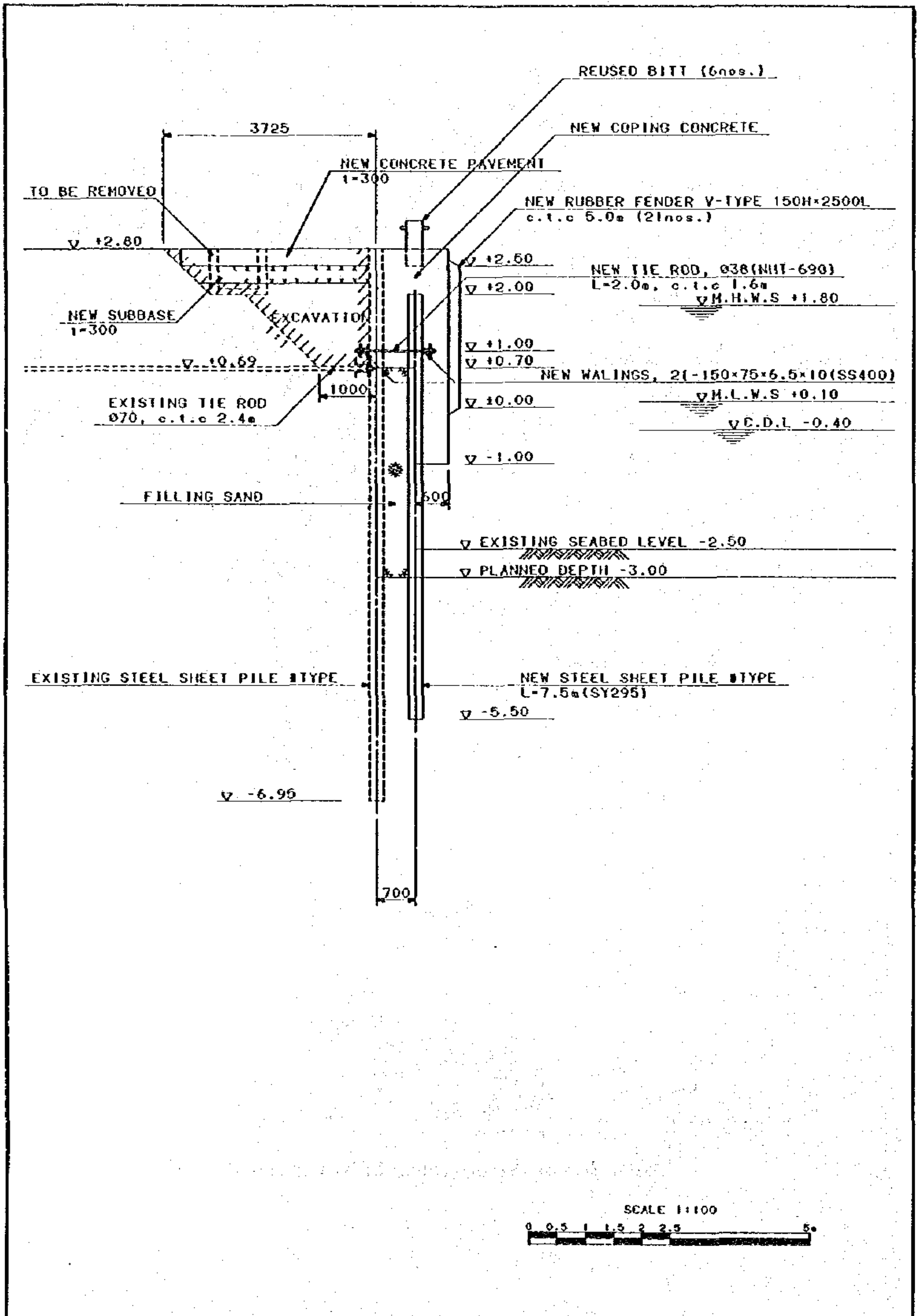



**Figure 2-5-7 Typical Cross Section of Rehabilitation of the Existing Wharf**

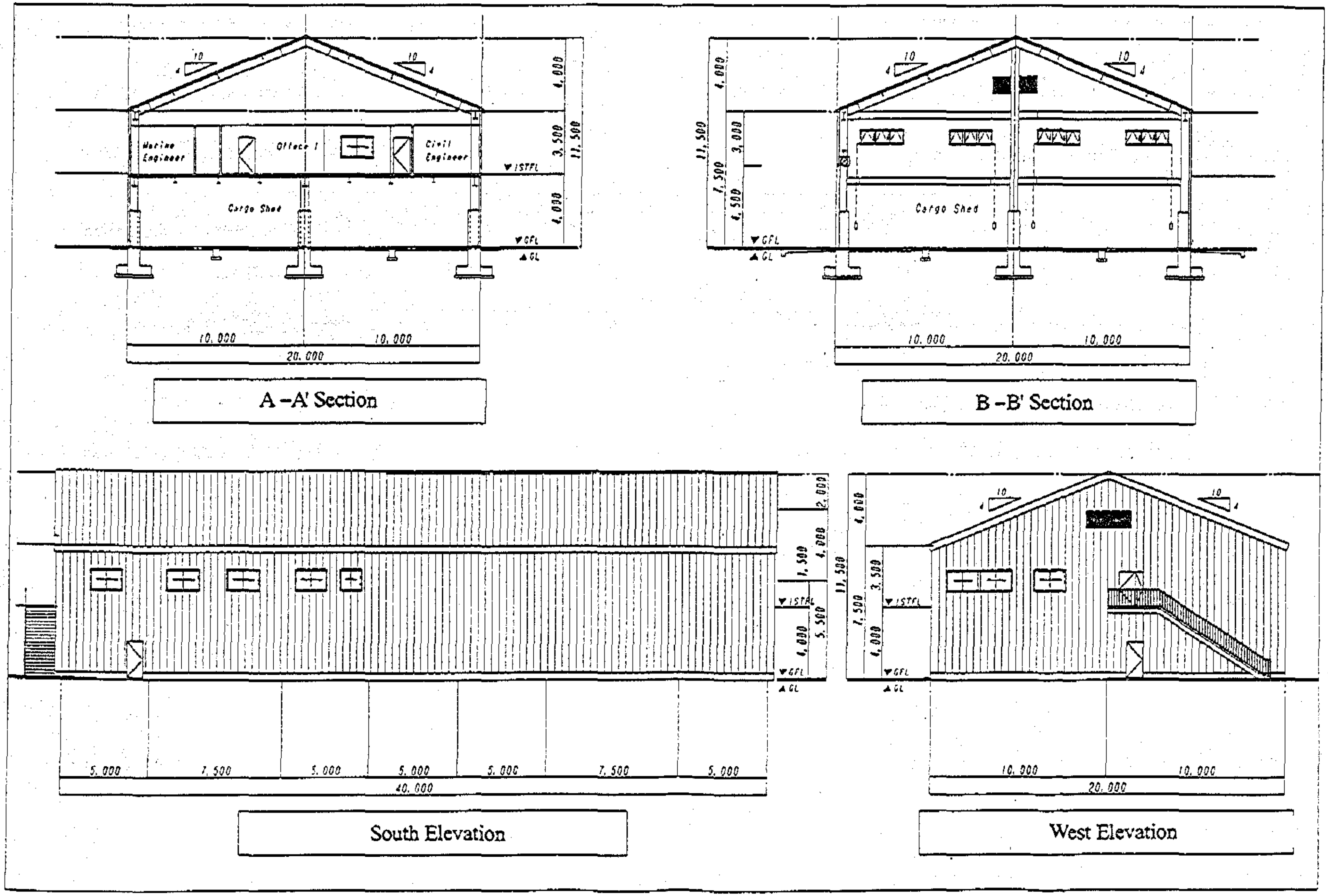



Figure 2-5-8 Elevation of Cargo Shed and Administration Office

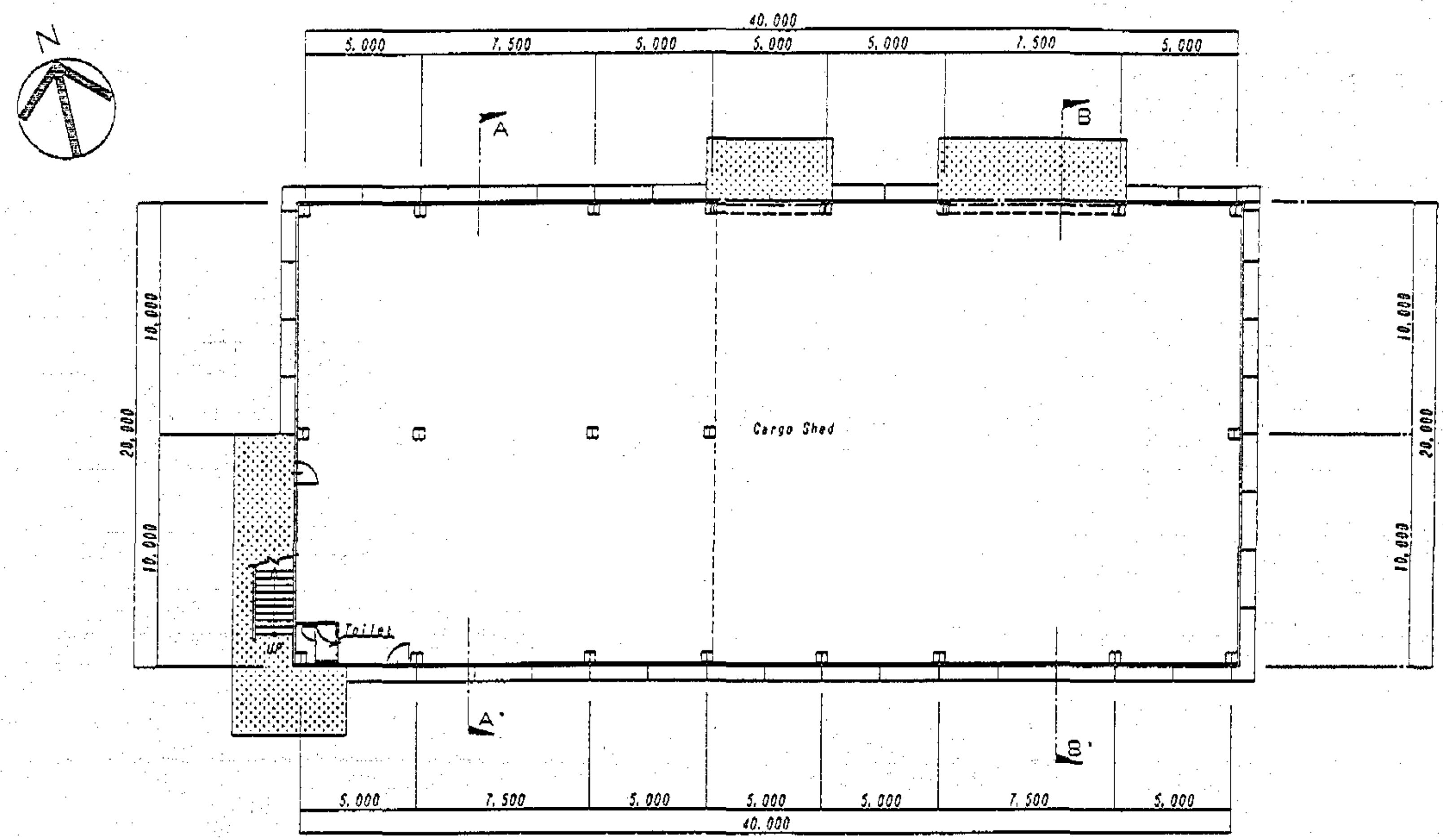



Figure 2-5-9 Ground Floor Plan of Cargo Shed and Administration Office

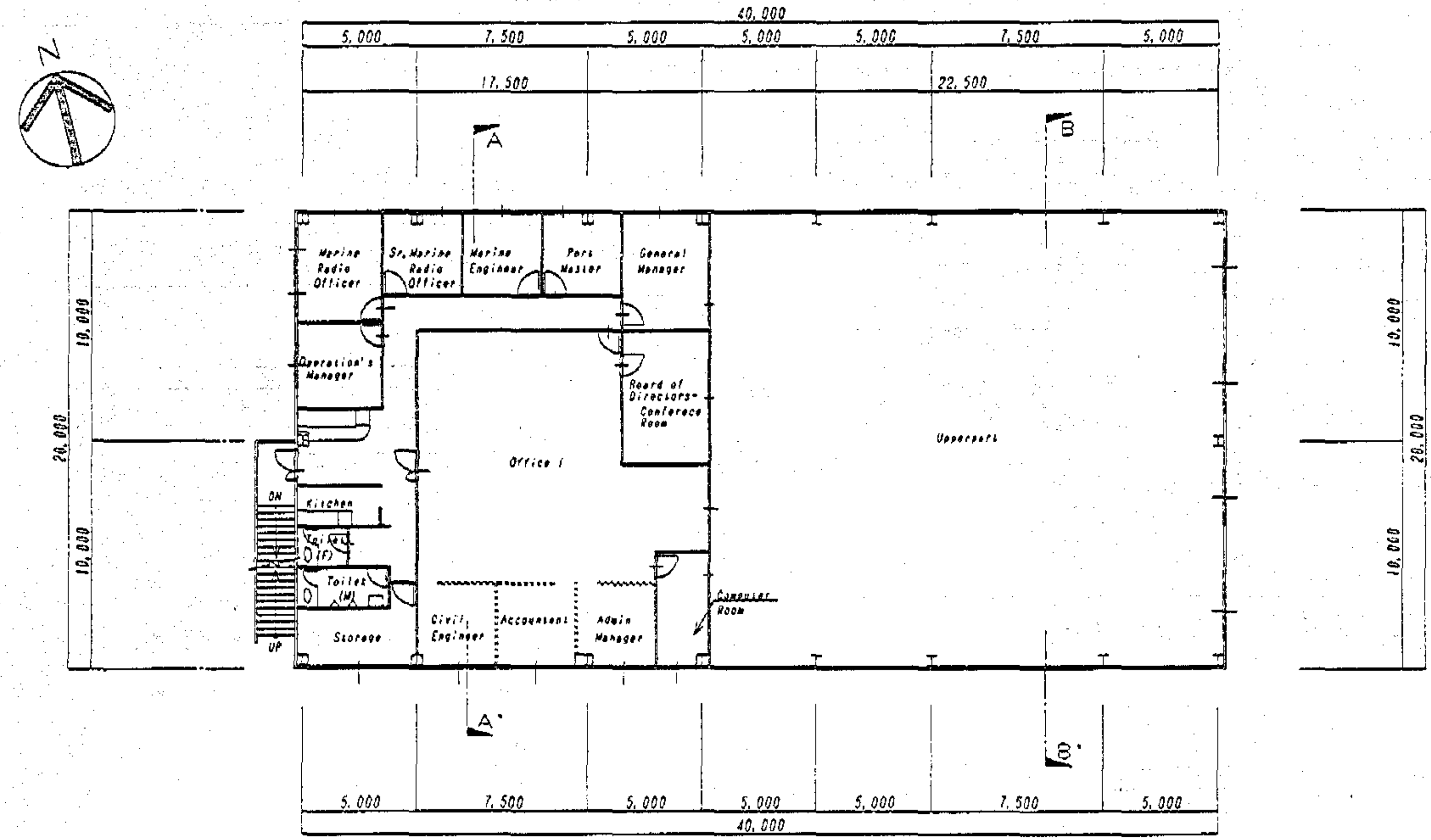



Figure 2-5-10 1st Floor Plan of Cargo Shed and Administration Office

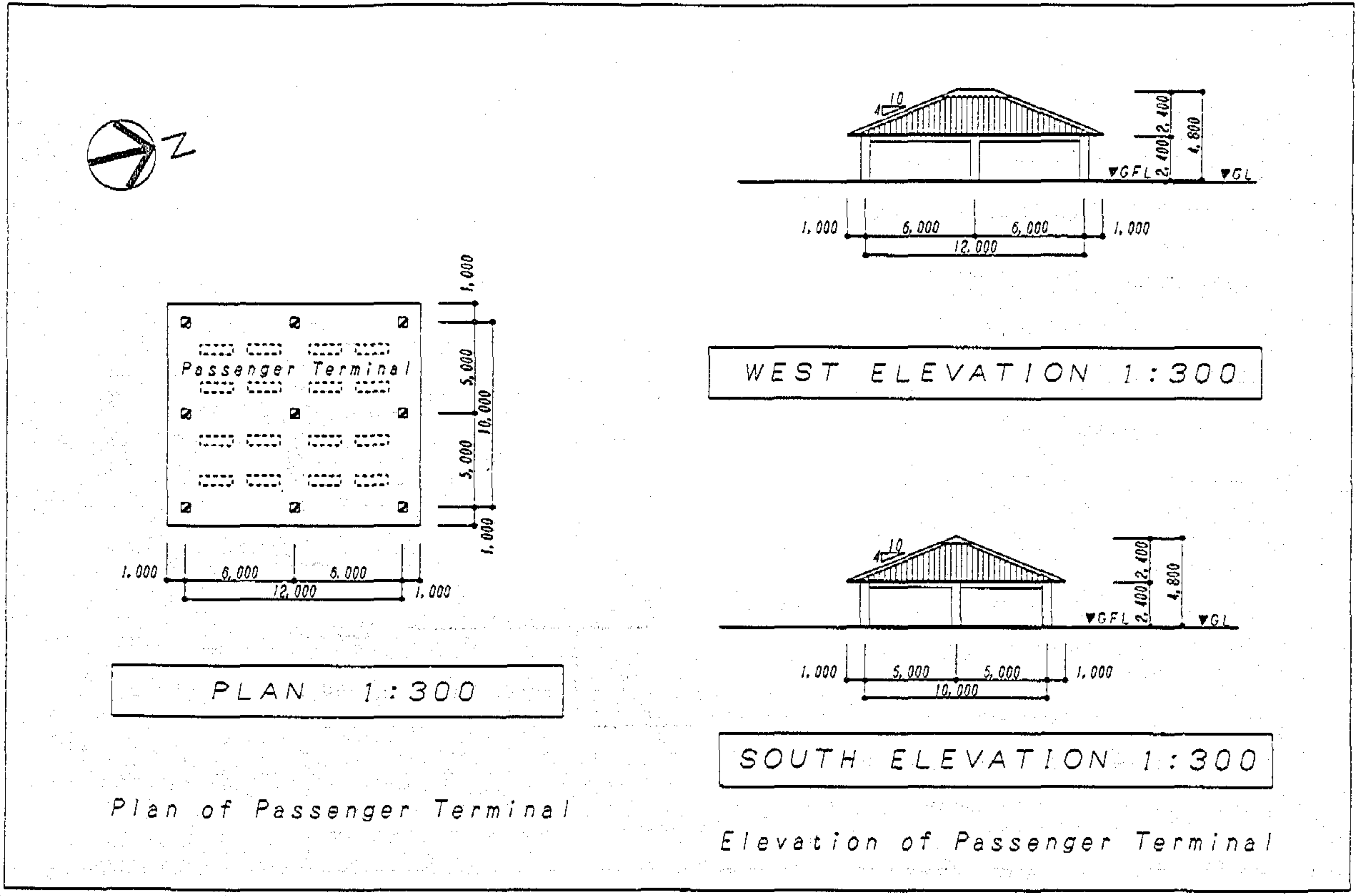



Figure 2-5-11 Elevation of Passenger Terminal

## 2-6 Environmental Consideration

### 2-6-1 Biological Research

There are few sea-grass beds, high coral coverage areas and mangrove forests contributing highly to reproduction and species diversity of the tropical marine organisms surrounding area of the project site. Only a small scale sea-grass bed exists 500m westward from the project site.

Marine flowering plants such as Thalassia sp. or Zostera sp., composing of sea-grass bed in a most or a shallow area of the lagoon, are relatively tolerative species against the turbid water. In addition to this biological characteristics, countermeasure of silt-protecting curtain against the high turbid water originating from the dredging area of the project site will be adopted. Therefore, a negative effect on the sea-grass bed 500m westward from the project site will not be caused by the dredging and after construction. In view of the relatively high Suspended Solids (SS) and low transparency of the water quality test done at the project site and its surrounding area (refer to Table 2-6-1), this marine flowering plant's characteristics of tolerance against the turbid water are easily understood.

There is a sandy bottom at the project site and its surrounding area. Almost all of the project site include an intertidal zone (sea bottom dries up only at low tide). Halimeda sp., green algae and Calappa sp., marine crab are commonly observed at the sandy bottom in the tropical shallow water and at the project site (refer to Photo of appendices B). They will lose a limited part of their habitat because of constructions of new container yard and access road. It is considered that this scale of constructions will not force these common species' local population to disappear.

After construction, the sewage from the new administration office and other facilities will flow in the surrounding water. The water quality of this sewage will satisfy the criteria of waste water by means of installation of septic tank that decreases BOD (Biological Oxygen Demand). No organic pollution is expected to originate from the new facilities.

### 2-6-2 Water Quality Analysis

Water quality surveys were done at five (5) stations set up at the existing Betio Port and the project site (refer to Figure 2-6-1) during the high tide of 19th and the low tide of 20th August 1996. Water quality tests were regularly taken at the depths of 0.5 m (Upper Layer) and 1 m above the bottom (Lower Layer) at each station. These water quality test results are shown in the Table 2-6-1.

Comparing with Japanese Environmental (sea water) Quality Standard of Environmental Conservation for livelihood, pH and COD (Chemical Oxygen Demand) meets the Criteria A, high quality of water (pH: 7.8-8.3; COD: less than 2mg/l), DO (Dissolved Oxygen) is included in the Criteria B (DO: 5-7.4mg/l). In a tropical area such as Betio Port, DO will tend to indicate a lower value than temperate area because of high temperature. As similar to Betio Port, DO in the Criteria B are shown in Japanese Southern Prefecture Okinawa located subtropical zone and famous marine resort providing high quality of sea water. The relatively lower value of transparency and higher value of Suspended Solid (SS) listed on the Table do not indicate a clear water caused by the up-coming fine sand from the bottom. Therefore, relatively low transparency and high SS in this water do not indicate organic pollution.

**Table 2-6-1(1) Water Quality Test Result**

Date: 19 AUG 1996
Time: High Tide

| Station / Item | Unit | W1 | | W2 | | W3 | W4 | | W5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Upper | Lower | Upper | Lower | Upper | Upper | Lower | Upper | Lower |
| Sampling time | | 14:40 | 14:50 | 15:06 | 15:12 | 15:25 | 14:26 | 14:30 | 14:00 | 14:10 |
| Water depth | m | 12.2 | | 6.4 | | 1.0 | 2.5 | | 3.4 | |
| Transparency | m | 3.5 | | 3.0 | | Landing | 1.0 | | 1.3 | |
| Water Temp. | ℃ | 29.6 | 29.3 | 29.5 | 29.6 | 29.9 | 30.4 | 30.0 | 30.4 | 30.2 |
| Salinity | | 35.6 | 35.7 | 35.6 | 35.6 | 35.7 | 35.9 | 35.8 | 35.7 | 35.7 |
| PH | | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| SS | mg/l | 2.3 | 8.6 | 2.8 | 3.5 | 6.5 | 8.4 | 7.7 | 5.6 | 5.6 |
| COD | mg/l | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| DO | mg/l | 6.9 | 5.7 | 6.7 | 5.8 | 7.3 | 7.0 | 6.6 | 5.2 | 5.2 |

Upper: 0.5m depth, Lower: 1.0m above the bottom

**Table 2-6-1(2) Water Quality Test Result**

Date: 20 AUG 1996
Time: Low Tide

| Station / Item | Unit | W1 | | W2 | | W3 | W4 | | W5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Upper | Lower | Upper | Lower | Upper | Upper | Lower | Upper | Lower |
| Sampling time | | 09:10 | 09:18 | 09:30 | 09:38 | 09:51 | 08:47 | 08:56 | 08:20 | 08:31 |
| Water depth | m | 11.9 | | 6.3 | | 1.0 | 3.4 | | 4.3 | |
| Transparency | m | 3.9 | | 3.3 | | Landing | 2.9 | | 2.1 | |
| Water Temp. | ℃ | 29.3 | 29.3 | 29.2 | 29.1 | 28.1 | 29.1 | 29.0 | 29.5 | 29.3 |
| Salinity | | 35.6 | 35.6 | 35.7 | 35.7 | 35.9 | 35.6 | 35.7 | 35.8 | 35.8 |
| PH | | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| SS | mg/l | 1.7 | 2.7 | 2.5 | 3.1 | 1.2 | 3.1 | 2.5 | 2.8 | 3.8 |
| COD | mg/l | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| DO | mg/l | 6.4 | 5.5 | 6.4 | 5.2 | 5.8 | 5.3 | 5.3 | 5.7 | 5.5 |

Upper: 0.5m depth, Lower: 1.0m above the bottom

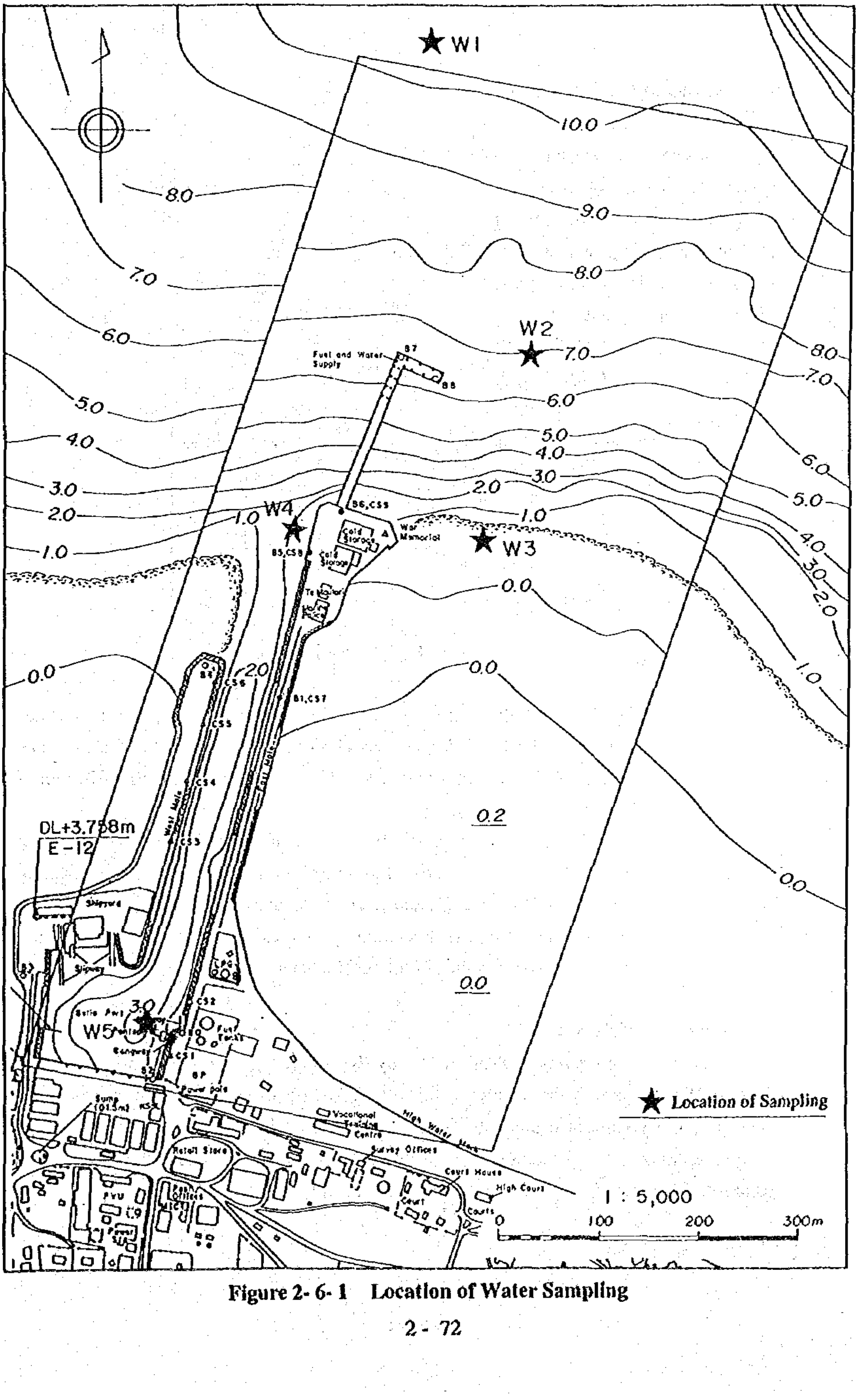



Figure 2- 6- 1 Location of Water Sampling

### 2-6-3 Sediment Quality Survey

#### (1) Front area of Container Yard

Sediment quality surveys were done at five (5) stations set up at the project site (refer to Figure 2-6-2). Sediments of sea bottom were sampled by a small bucket dredger. And samples of sediment were sent to Japan in a tightly closed bottle and their quality analyzed at the laboratory as soon as possible. These sediment quality test results are indicated in the Table 2-6-2.

Table 2-6-2 Sediment Quality Test Result

| Item/Stations | No.1 | No.2 | No.3 | No.4 | No.5 |
|---|---|---|---|---|---|
| Water depth (m) | 0.0 | -1.0 | -3.5 | -3.5 | -3.5 |
| Specific gravity | 2.78 | 2.70 | 2.79 | 2.81 | 2.81 |
| Moisture content (%) | 22 | 24 | 24 | 25 | 24 |
| Medium grain size (D50: mm) | 4 | 5 | 8 | 7 | 7 |
| Uniformity coefficient (D60/D10) | 41 | 35 | 80 | 85 | 90 |
| Silt fraction (%) | 3 | 4 | 4 | 3 | 4 |

The specific gravity is relatively high at around 2.8, but moisture content indicates proper value in the ordinary sand. The 50% diameter of particle ranges 4 to 8 mm. The uniformity coefficient (D60/D10) ranges from 35 to 100. The silt (less than 0.074 mm of particle size) fraction indicates less than 4%.

In view of these test results, the characteristics of sediments distributed in this area can be expected to have high specific gravity and good uniformity from silt to gravel (more than 10 of uniformity coefficient mean generally good characteristics of sediment).

The silt fraction is low and it means that countermeasures like a silt-protecting curtain will work effectively against dispersion of high turbid water originating from dredging.

#### (2) Inner Bay of Betio Port

According to the previous Feasibility Study Report (JICA), the sediment of inner bay of Betio Port contains the heavy metal of lead (Pb) from ship paint of material. Therefore, the countermeasures of setting a silt-protecting curtain and cementing of dredged sediment must be required to protect the dispersion and leak of contaminated sediment. Cemented materials can be used for landfill.

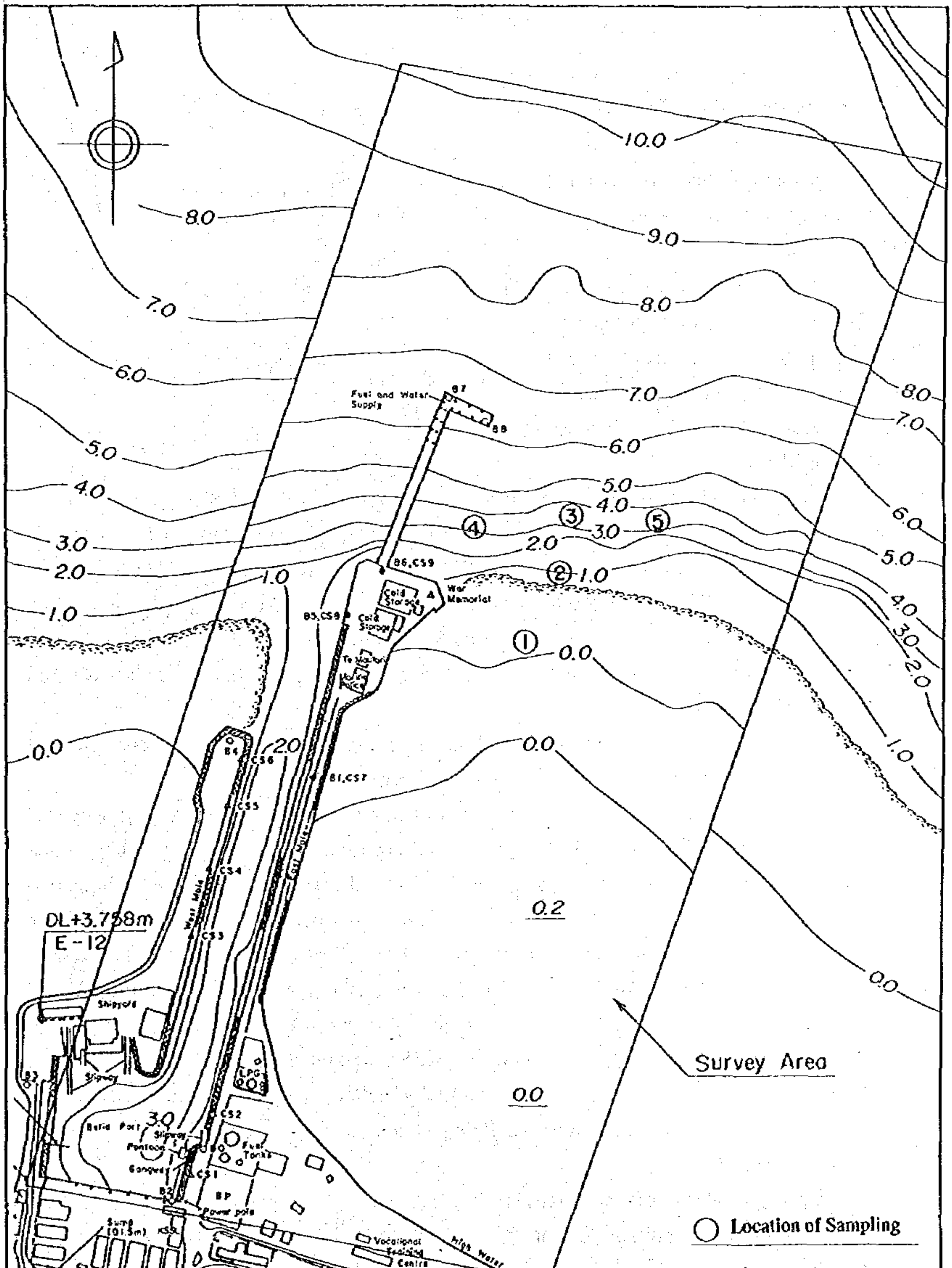



Figure 2-6-2 Location of Bottom Sampling

## 2-7 Implementation of Project

Organization responsible for implementation of the project and operation of the facilities after completion of the project is MICT. Organization chart of MICT is shown in Figure 2-7-1.

In implementing the project, the ministry can be technically supported by engineering staffs of the ministry of works and energy (MWE). The Public Works Department of MWE has experiences of supporting such similar projects as Japan's Grant Aid Project, "Causeway Construction Project for Fishing Boats" and "Fisheries Jetty Construction Project" financed by United Kingdom and is judged to have sufficient knowledge to supervise the construction works for MICT.

Management and operation of the port facilities after completion of the project will be done by KPA to be newly established under control of the Marine Department of MICT. The port facilities can be adequately maintained with engineering support of MWE and any substantial problems are not expected. While careful preparatory examination, planning, and launching actions toward establishment of KPA are necessary and KPA is a key factor for smooth and efficient management and operation of the new port. Detailed discussion on KPA is given in the following.

Betio Port is presently operated by KSSL under control of the Marine Department of MICT. Organization chart of KSSL is shown in Figure 2-7-2.

The government of the Republic of Kiribati has enacted Kiribati Ports Authority Act 1990 (KPAA) on 29 December, 1990 to separate both functions of shipping company and port authority possessed by Shipping Corporation of Kiribati (SCK) by establishing two organizations of KPA and KSSL. However, KSSL has been only established and the company has taken almost SCK's business. The Marine Department of MICT is in charge of excavation of channel, installation and maintenance of navigation aids and operation of marine radio communication but does not serve any of important duties of port authority related to port management and operation. KSSL, though being a shipping company, collects part of port charges which are normally collected by a port authority while, cooperate to the government to abolish living standard differentials of outer islands by lowering cargo freight.

The problem of the present system is that port management/operation and improvement/maintenance of port facilities are not appropriately planned and executed. For instance, KSSL has not allocated fund required for adequate maintenance and improvement resulting in accelerated deterioration of the port facilities.

To improve the above situation, the government of the Republic of Kiribati has enacted KPAA but it has not yet been implemented. Establishment of KPA involves a large scale reposition of more than 100 staffs from MICT and KSSL, and transfer of major fixed assets and is dispensable for smooth and efficient management and operation of the port facilities planned in the project.

"The Study on Ports Development in Kiribati" done by JICA made detailed study on organization of KPA, transfer of the assets, a new port tariff structure, financial viability, etc. The KPA organization proposed by JICA is shown in Figure 2- 7- 3. Based on this study, MICT requested Economic and Social Commission for Asia and the Pacific (ESCAP) a further detailed study. The study commenced in March 1996 and completed in December 1996. A draft report was submitted in May and proposed an organization of KPA as shown in Figure 2- 7- 4 following the results of JICA study with minor changes on number of staffs.

Organizations of KPA proposed by JICA and ESCAP are basically the same as compared in Table 2-7-1 below.

**Table 2-7-1 Number of KPA Staffs proposed by JICA and ESCAP**

| Section | JICA | ESCAP | Remarks |
|---|---|---|---|
| Administration | 30 | 20 | less security |
| Accounting | 9 | 9 | |
| Tug and Barge | 22 | 21 | |
| Yard Operation | 31 | 23 | less tallymen |
| Shed Control | 12 | 7 | less tallymen |
| Channel Blast/Maint | 4 | 6 | |
| Marine Radio/Eng | 21 | 13 | no marine radio sec |
| Total | 129 | 99 | |

### 2- 7- 1 Establishment of KPA

The government of the Republic of Kiribati plans to establish and put KPA in full operation at the time of completion of the project starting preparatory actions from early 1997. KPA is crucial factor for efficient utilization of the project facilities and it should be carefully planned for early establishment.

### 2- 7- 2 KPA and the Existing Organizations

KPA can not commence operation from zero position and some of the existing staff in the Marine Department of MICT and the port section of KSSL should be taken over. A section handling national policies of sea transport sector should remain in MICT while, a pilot service and offshore/wharf/yard/shed cargo handling services should be transferred from KSSL to KPA. According to this basic direction, a concrete establishment plan shall be worked out incorporating institutional strategy of the government of the Republic of Kiribati.

### 2-7-3 Preliminary Arrangements Required

It is important for the following preliminary arrangements to be made when KPAA is to be implemented.

a) Legislative amendments to KPAA
b) Provision of a temporary office of KPA
c) Transfer and recruitment of staffs
d) Review and amendment of port tariff
e) Transfer of assets and liabilities of KSSL to KPA
f) Arrangement of operation taking over procedure during transition period
g) Public announcement of KPA

### 2-7-4 Transfer of Major Assets

The following major fixed assets shall be transferred from MICT and KSSL to KPA.

| | |
|---|---|
| a) Breakwaters, Wharf, Jetty | from MICT |
| b) Sheds | from KSSL |
| c) Tugs, Barges | from KSSL |
| d) Forklifts, Tractors | from KSSL |
| e) Marine Radio Equipment | from MICT |
| f) Navigation Aids | from MICT |

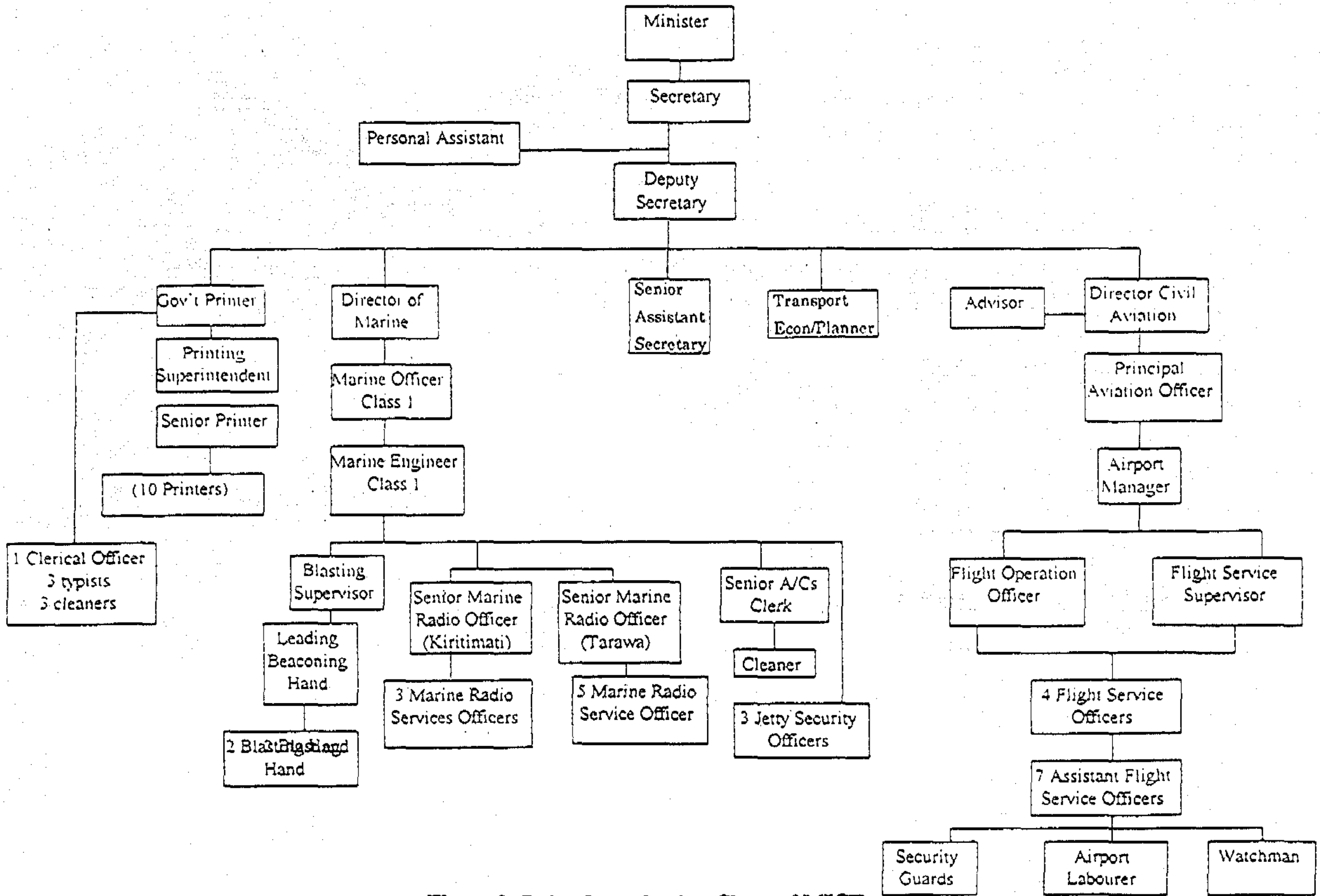



**Figure 2-7-1 Organization Chart of MICT**

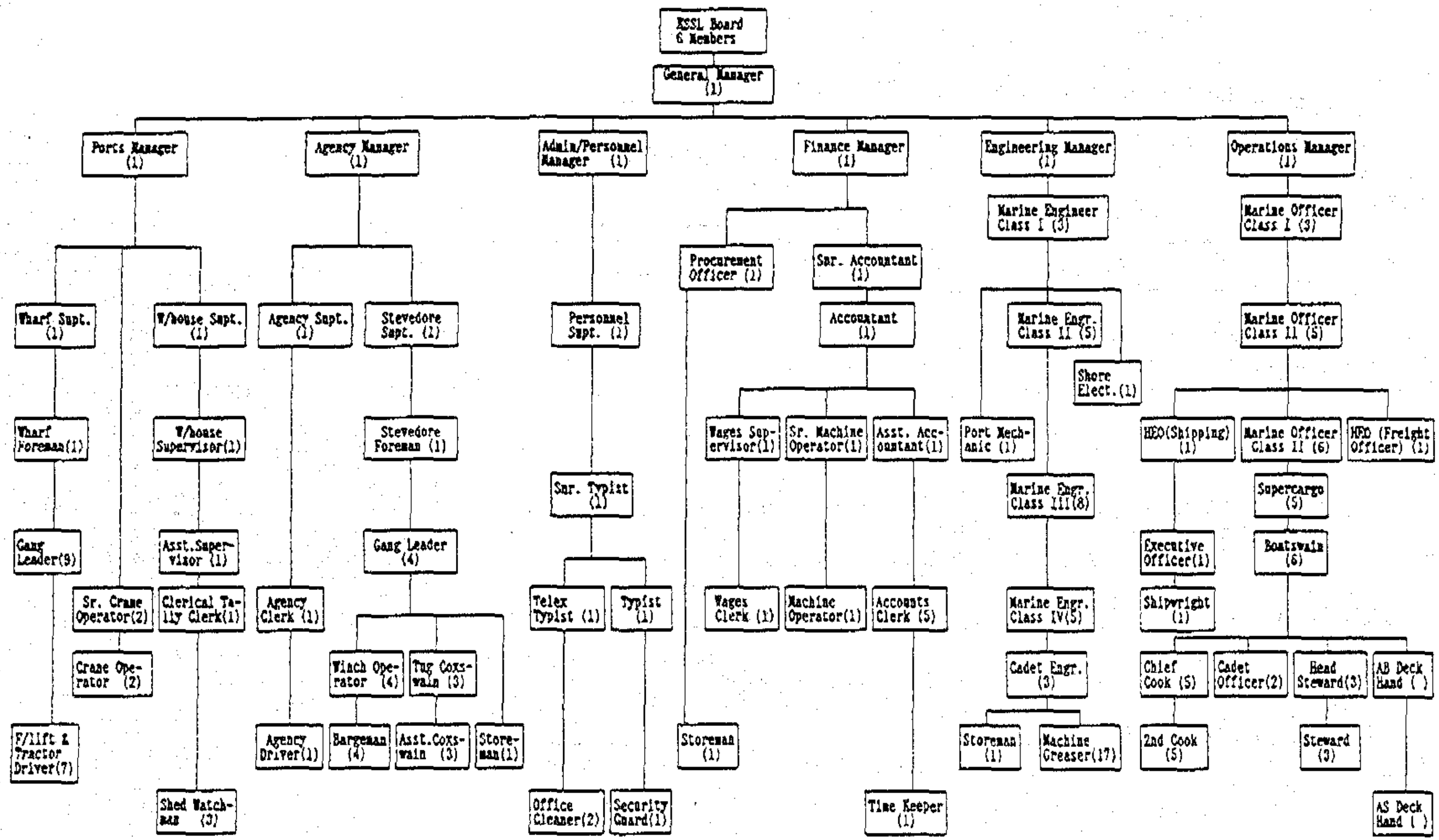



Figure 2-7-2 Organization Chart of KSSL

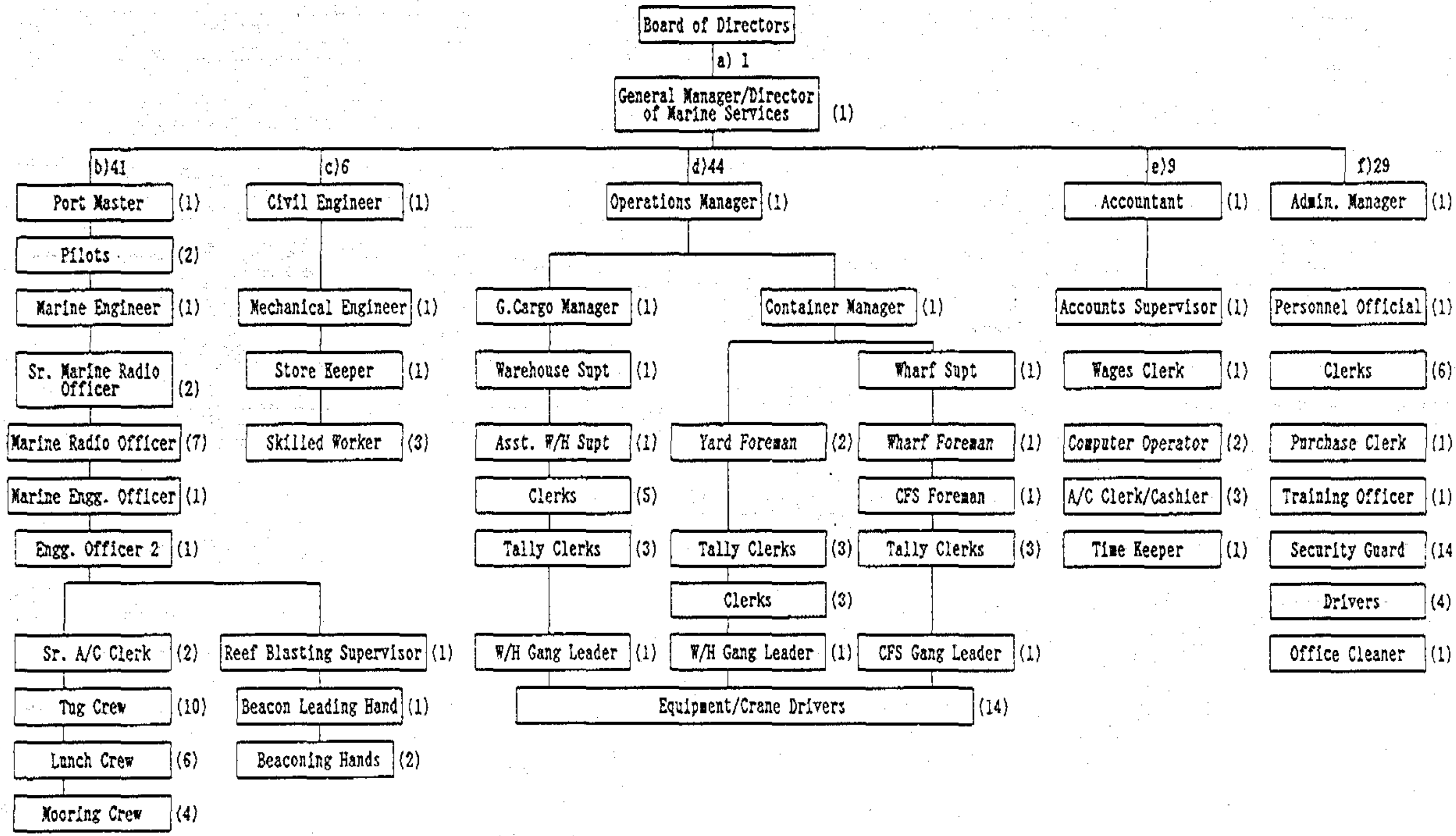



**Figure 2-7-3 Organization Chart of KPA ( proposed by JICA )**

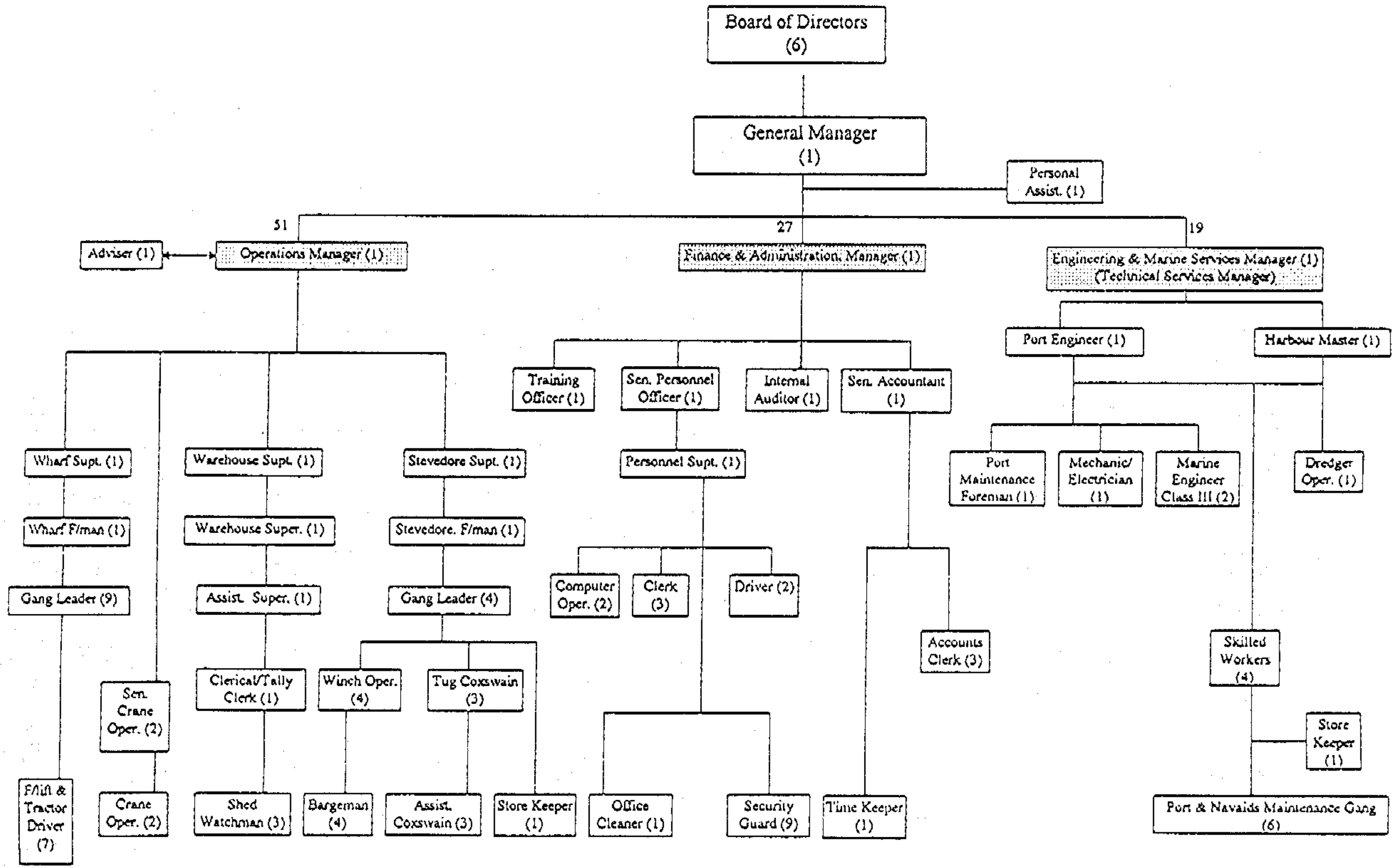



**Figure 2-7-4 Organization Chart of KPA ( proposed by ESCAP )**