3.1.3 Improvement of Port Operation

(1) Container Operations

1) General

The world-wide trend in the use of containers for almost all commodities (except dry and liquid bulk) is a phenomenon being witnessed in many ports both in developed and developing countries. While it is accepted that cargo in containers are more speedily and safely handled, the technological change in cargo-handling in ports puts a great strain on the financial and human resources in developing countries, which are "forced" to invest heavily in infrastructure and equipment (which they can hardly afford), but the workers have to also learn new skills rather quickly to meet the technological change.

Container ships are costly and ship owners expect the port to provide efficient services and a good turnaround – otherwise freight rates are going to be very high (partly contributed by the imbalance of import and export laden containers) as costs are incurred by the need to reposition the empty containers.

Thus in a dedicated container terminal, special equipment and trained staff are required to meet this challenge, but at a substantial cost. To achieve the ship owners' expectations, there should be close coordination and more discipline among the consignees/consignors, forwarding agents, shipping agents and the port operator. Rules, procedures, and deadlines should be strictly observed for the efficient discharge/loading of the containers. A high productivity rate per ship (or crane-hour) is imperative to achieve a lower unit cost for the port and also a faster turnaround of the ship.
These objectives assume the followings:

i) Adequate equipment (including cranes, heavy forklift trucks, small forklifts for stuffing/unstuffing etc.).

ii) A spacious container storage yard for loaded and empty containers.

iii) A skilled and knowledgeable work-force to plan, handle, and store the TEUs in a proper and disciplined manner.

iv) A system for the tracking, and slotting the containers with good selectivity to enable cargo-owners to get their cargo as quickly as possible.

v) The active co-operation of cargo-owners and shipping agents.

All port users should realize and recognize that container operations require more precise moves than the old system of handling general cargo, and should adopt to the changes in a co-operative manner, and not "demand" exceptions to the rules. For instance, there is a "closing time" for the receipt in the yard of export FCLs for ship-planning purposes, which is always done before discharging/loading of containers commence.

2) Future Operations

It is hoped that an experienced and knowledgeable Operations Manager can be recruited to strengthen the weak incumbents in the operations section. There appears to be very little planning for daily operations. This situation must be given a strong booster of one or two barges, until the new alongside berthing facilities are ready.

There will be a fairly large container yard of about 120m x 170m for loaded FCLs and LCLs to be stacked to maximum 3 high in double rows by Heavy F/Lifts. This stacking pattern should provide good selectivity and should provide a more efficient service to port users who will take delivery of their cargo from the transit shed, which had previously been unstuffed by port labour. Empty containers will be block-stacked in another area.

The inventory of TEUs in the stacks, both laden and empty TEUs, must be monitored daily and internal movements made for direct FCL delivery and unstuffing of cargo. Liaison with the shipping agent is essential.

These new facilities and operations should satisfy ship owner's expectations from a small developing country like Kiribati, and perhaps make more frequent calls.

(2) Copra Handling

In some countries in the Pacific, copra is handled in bulk not in bag. Copra is collected in bags from farmers and the bags are opened in a shed to store copra in bulk.

Large steel box of about 3 m^3 is filled with copra by a payloader and carried to ship. The box is lifted by ship's gear and emptied in hatch and returned to apron. This operation can be adopted in Betio Port without any expensive investment to the existing facilities.

Copra from outer-islands are stored in three copra sheds waiting for a ship. Due to shortage of shed area, copra is stacked high up to the ceiling of the sheds. This stacking operation lowers efficiency and safety of handling. The general cargo sheds are underutilized and their transfer copra shed should be considered.

(3) Passenger Transport

Passengers are transported to a ship anchoring offshore by barge. Boarding on barge can be dangerous especially for children when sea is rough. In some cases, passengers have to wait on barge in a strong sunshine for a long time until the ship become ready for boarding. Further, an adequate facility for waiting is not available.

3.2 Demand Forecast

3.2.1 Future Economic Framework

The Seventh National Development Plan contains detailed description on past and future projected performance of the country's economy and has been thoroughly reviewed together with the comprehensive study on transport sector "Inter-island Transport Study Kiribati" April 1991. Also the related past economic and port cargo statistics have been scrutinized and compared with the development targets and the past forecasts. Projection of economic activities is given in the plan up to 1995 while the port cargo forecast is presented in the above study up to the year 2005, the target year of conceptual plan of the present study. The inter-island transport study basically follows the national development plan and the economic framework and cargo forecast established are realistic and reasonable when compared with the past economic performance. In the present study, the future economic framework has been set up following the projected economic growth rates given in the national development plan and extrapolating the growth trends up to the year 2005.

The results of study on population forecast of "Inter-island Transport Study Kiribati" is reviewed to be reasonable to follow, and the natural rate of population growth is assumed to be 2.5% by 2005. The population in Line and Phoenix Islands is, reflecting the resettlement plan from Gilbert Island and, forecast to increase at an annual growth rate of 7% until 2000 and 2.5% thereafter. Thus the population of Kiribati is forecast to increase from 71,756 in 1990 to 91,961 in 2000 and 104,050 in 2005 as shown in Table 3-2-1.

The Seventh National Development Plan has set out the target real GDP growth rate of 5.0% for the plan period of 1992-95. The target rate is rather high, due to a very low base in 1991. The projected sectoral GDP is summarized in Tables 3-2-2 and 3-2-3. Table 3-2-2 shows projected change of economic structure, and any drastic change is not expected with minor moves among the sectors of increase in fisheries and decrease in public services of government offices. As shown in Table 3-2-3, the primary sectors of agriculture and fisheries are projected to grow at a higher rate than the average growth rate of 5.0%. While the largest sector of public services of government offices is given a low rate of 4.0%.

Table 3-2-1 Population Forecast, Kiribati

Year	S. Tarawa	O. Gilbert	L/P Groups	Total
1985	21,439	39,936	2,669	64,044
1986	22,039	40,455	2,968	65,462
1987	22,656	40,981	3,300	66,938
1988	23,291	41,514	3,670	68,475
1989	23,943	42,054	4,081	70,077
1990	24,626	42,600	4,530	71,756
1991	25,463	43,154	4,847	73,464
1992	26,329	43,715	5,186	75,230
1993	27,224	44,283	5,549	77,057
1994	28,150	44,859	5,938	78,947
1995	29,107	45,442	6,354	80,902
1996	30,097	46,033	6,798	82,928
1997	31,120	46,631	7,274	85,025
1998	32,178	47,237	7,783	87,199
1999	33,272	47,851	8,328	89,451
2000	34,566	48,473	8,922	91,961
2001	36,260	48,764	9,145	94,169
2002	38,036	49,056	9,374	96,467
2003	39,900	49,351	9,608	98,859
2004	41,855	49,647	9,848	101,350
2005	43,956	50,000	10,094	104,050

Source: Consultant Estimate at mid-year.

Table 3-2-2 Sectoral Distribution of GDP at Factor Cost

		(%)	
	1980	1991	1995
Agriculture	9.0	7.6	7.8
Fisheries	11.8	11.4	12.3
Manufacturing	2.1	2.1	2.2
Electricity and Water	1.2	1.9	1.9
Construction	5.7	5.8	5.9
Wholesale and Retail Trade	15.7	17.0	17.2
Transport & Communications	16.7	16.6	16.5
Finance & Insurance	0.6	5.5	5.4
Public Administration	33.9	31.2	29.9
Others incl. Ownership of Dwellings	3.8	5.5	5.4
Less: Imputed Bank Charges	(-)0.5	(-)4.6	(-)4.5
TOTAL:	100.0	100.0	100.0

Table 3-2-3 Projection of Gross Domestic Product at Factor Cost
1991, 1995 ('000 A$)

(A$'000)

	1991	1995	Rate of Growth (%)
1. Agriculture	3,110	3,920	6.0
2. Fisheries	4,685	6,130	6.8
3. Manufacturing and Mining	875	1,120	6.4
4. Energy and Water	795	965	5.0
5. Construction and Buildings	2,400	2,950	5.3
6. Wholesale and Retail Trade and Hotels	6,960	8,590	5.4
7. Transport and Communications	6,790	8,250	5.0
8. Finance and Insurance	2,250	2,730	5.0
9. Real estate and Ownership of Dwellings	1,035	1,190	3.5
10. Public Administration	12,740	14,900	4.0
11. Community Services	1,250	1,530	5.2
12. Less: Imputed Bank Charges	- 2,080	- 2,535	- 5.1
13. Total G.D.P. at factor cost	40,810	49,740	5.0

Source: Statistics Office and NPO, MFEP

Table 3-2-4 shows projection of export and import of major commodities. Of the agriculture sector, copra export is expected to increase from A$ 2.3 million in 1992 to A$ 2.4 million in 1995 at an annual growth rate of 1.1%. Commercial fish export is projected to rise from A$ 0.8 million in 1992 to A$ 0.9 million in 1995. Seaweed production is also expected to grow at annual rate of 9% faster than fisheries. While imports of goods and services are expected to increase at 5.7% per annum. In 1992, imports were shared by food 30%, machinery and transport equipment 25%, manufactured goods 12% and mineral fuels 11%. In the plan period, food imports are projected to rise at 5.0% per annum, chemicals 8%, manufactured goods 5% and machinery and transport equipment 7%.

Based on the past performance, the export earnings by seaweed and fisheries products are expected to significantly increase. In the Seventh National Development Plan, development of fisheries in processing, marketing and management for exports and domestic consumption with adequate improvement to port and ship repair facilities is emphasized.

3.2.2 Port Cargo Forecast

Export and import cargo forecast is shown in Figure 3-2-1 (1) and Table 3-2-9 (1).

(1) Export Cargo

1) Copra

Agriculture is a major sector of economic activities in Kiribati and coconut production is a mainstays of the economy for both people's diet and cash income. As shown in Table 3-2-5, copra production fluctuates significantly due to erratic rainfall with the maximum production of 14,406 ton in 1988 down to 5,603 ton in 1990. 87% of total production was exported earning an average of 83% of total exports of the country during the last plan period of 1987 - 1991. Commercial development of sizable copra production is constrained by such factors as smallness of land area, poor quality of soil and erratic rainfall. To protect copra farmers from fluctuating production and market prices, the government of Kiribati has introduced a scheme for a minimum guaranteed price of at least 22 cent/kg.

Table 3-2-4 Projections of Export/Import Values by Major Commodity (A$ '000)

EXPORT	1992	1993	1994	1995	Growth Rate
Copra	2,300	2,325	2,350	2,375	1.1
Fish	810	831	852	874	2.6
Seaweed	755	822	895	975	9.0
Petfish	370	381	392	403	3.0
Others	50	52	54	56	4.0
Re-exports	630	730	846	981	16.0
TOTAL EXPORT	4,915	5,141	5,389	5,664	
TOTAL IMPORT	35,134	37,149	39,286	41,553	
TRADE BALANCE	-30,219	-32,008	-33,897	-35,889	

IMPORTS	1992	1993	1994	1995	Growth Rate
0 Food	10,450	10,973	11,521	12,097	5.0
1 Beverage & Tobacco	2,342	2,400	2,460	2,522	2.5
2 Crude Materials	525	549	574	599	4.5
3 Minerals & Fuels	3,885	4,157	4,448	4,759	7.0
4 Oils & Fats	92	101	111	123	10.5
5 Chemicals	1,985	2,143	2,315	2,500	8.0
6 Manufactured Goods	4,318	4,534	4,761	4,999	5.0
7 Machinery, Transport & Equipment	8,817	9,435	10,095	10,802	7.0
8 Misc. Manufactured Goods	2,501	2,626	2,757	2,895	5.0
9 Misc. Commodities	219	231	244	257	5.5
Total Import	35,134	37,149	39,286	41,553	

Source: NPO Staff Estimates

Table 3-2-6 shows export destination of copra, and as shown the previous major importer Netherlands has been replaced with Bangladesh which imported 5,308 ton in 1991 under three year contract.

Apart from coconut production, other crops like breadfruit, swamp taro, etc. are planted only on subsistence base.

The past trend of copra export has been analyzed with regression method for the period of 1983-93 and though sharply fluctuating, a modest annual growth rate of 1.2% has been calculated which almost coincides with the target growth rate of 1.1% of the national development plan. The annual growth rate of 1.2% is adopted for copra export in the present study.

The volume of export copra is forecast to increase from 7,050 ton in 1995 to 7,950 t in 2005 as shown in Table 3-2-9 (2) and Figure 3-2-1 (2).

2) Fish

Kiribati has a large sea area of 3 million km^2 Exclusive Economic Zone rich in fisheries resources. The production of fisheries products fluctuates due to managerial problem of the national fishing company, Te Mautari Limited, as shown in Table 3-2-7. Kiribati is favoured with fishery resources as illustrated in Table 3-2-8. The share of fisheries industry in GDP is about 11 % in 1991 accounting for about half the total exports. The fisheries sector expands products to include seaweed, sea cucumber, pet fish and shell for export commodities. The annual growth rate of fisheries export is set at 2.6% following the national development plan.

Fish export is forecast to recover past level of 1986 in 1993 and then rise at an annual rate of 2.6% to about 1,000 t in 2000 and 1,180 t in 2005 as shown in Table 3-2-9 (2) and Figure 3-2-1 (2).

3) Seaweed

Export of seaweed commenced in 1986 mostly destined to Denmark and has been steadily increasing in recent years. Growth rate for the first five years from 1986 is as high as 99% but for the mature period of DP6 from 1992, the growth rate is set at more modest value of 9% which coincides with a production plan of Atoll

Seaweed Company. Seaweed is exported in container dried and compressed for higher stowage factor.

The export of seaweed is expected to increase to 2,000 t in 2000 according to the production plan of the company and 3,000 t in 2005 as shown in Table 3-2-9 (2) and Figure 3-2-1 (2).

Processing of raw seaweed becomes beneficial for higher price and lower freight when the volume exceeds order of 5,000 t. The cargo volume reduces to one fifth after processing but this will not happen in the project period.

4) General Cargo

The other export general cargoes include nominal volume of handicrafts, re-exports, etc. but detailed statistics showing volume of exports by commodity are not available. In 1993, the volume of export cargo other than copra totaled at about 3,500 t which exceeds the average of the previous years of about 1,000 t. This can be explained by the fact that KSSL ship "Matangare" commenced a feeder service of transship cargoes to Tuvalu which totaled at about 2,400 t in six months. The remainder of about 1,100 t includes about 350 t of fish, seaweed and about 750 t of re-export, handicrafts, etc.

In the present study, the general cargoes including re-export, handicrafts etc., are forecast to rise from 750 t in 1993 to 980 t in 2000 and 1,200 t in 2005 as shown in Table 3-2-9 (2) and Figure 3-2-1 (2).

5) Transship Cargoes

The volume of transship cargoes destined to Tuvalu was in order of about 3500 t for one year from mid 1993. Cargo demand in Tuvalu has been forecast to grow at an annual rate of 4.5% by UNDP Report "SEA/AIR TRANSPORT STUDY" 1991. Sea transport capacity of Tuvalu is not enough to meet country's traffic demand which results in dependence on ships of foreign flag. KSSL intends to continue to provide transshipment service to Tuvalu and the present study assumes that the transship cargoes to Tuvalu via Kiribati will grow from 3,770 t in 1995 to 4,702 t in 2000 and 5,860 t in 2005 at 4.5% per annum. All the transship cargoes are carried in container.

Table 3-2-5 Total Copra Production and Exports

Year	Total Prod. (m.t.)	Exports (F.O.B) Quantity (m.t.)	Exports (F.O.B) (Value (A$'000)
1987	6,026	4,437	1,172
1988	14,406	11,790	4,203
1989	9,924	10,175	3,127
1990	5,603	4,682	1,023
1991	8,661	7,817	2,090
TOTAL DP6	44,620	38,901	11,615

Source: International Trade 1991, Statistics Office, MFEP

Notes: a) Export quantities are based on weights recorded at export destination.
b) All figures relate to Calendar Year and DP 6 means Development Plan period 1987-1991.

Table 3-2-6 Copra Exports by Destination

COUNTRY	1987	1988	1989	1990	1991
Bangladesh	-	-	-	-	5,308
Netherlands	3,785	11,032	8,607	3,572	-
Marshall Is.	-	-	1,568	1,110	1,384
Fiji	622	738	-	-	-
Western Samoa	-	-	-	-	1,125
U.S.A.	30	20	-	-	-
TOTAL	4,437	11,790	10,175	4,682	7,817

Source: Statistics Office, MFEP

Table 3-2-7 Export of Major Marine Resources

MAJOR DOMESTIC EXPORTS VOLUME: 1982-92 (metric tons)											
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fish	579	1,858	2,289	1,038	1,524	685	1,456	2,567	861	146	397
Seaweed	-	-	-	-	22	65	32	115	789	693	388
Shark Fins	1.6	0.9	3.0	1.8	1.1	1.0	1.2	2.0	1.1	1.0	5.7

INDICATOR	1987	1988	1989	1990	1991
Total Export (FOB) (A$'000)	901	1,639	2,727	1,719	977
Shark Fins	16	18	42	32	24
Fish	823	1,606	2,600	964	277
Seaweed	62	15	85	723	676

Source: Statistics Office and NPO staff estimate

Notes : Total Exports exclude Fish Pets Reported at $336,000 in 1991.

Table 3-2-8 Fish Catch by Foreign Fishing Vessels in Kiribati EEZ
(in metric tons)

COUNTRY	1987	1988	1989	1990	1991
JAPAN	8,254	8,499	21,234	1,005	3,549
KOREA	4,464	4,068	6,072	6,253	3,954
USA	9,215	2,596	2,739	73,695	34,486
OTHERS	-	-	-	142	-
TOTAL	21,933	15,113	30,045	81,095	41,989

Source: MENRD and Statistics Office, MFEP

Table 3-2-9(1) Export/Import Cargo Forecast
1995-2005

Freight Ton

Year	Export Total	Import Total	Grand Total
1995	13,854	54,491	68,345
1996	14,282	57,269	71,551
1997	14,732	60,188	74,920
1998	15,203	63,256	78,459
1999	15,700	66,482	82,182
2000	16,220	69,871	86,091
2001	16,770	73,434	90,204
2002	17,349	77,179	94,528
2003	17,957	81,115	99,072
2004	18,600	85,252	103,852
2005	19,278	89,599	108,877

Table 3-2-9(2) Export Cargo Forecast, 1995-2005

Freight Ton

Year	Copra	Fish	Seaweed	G.Cargo	Transship	Export Total
1995	7,054	910	1,308	809	3,773	13,854
1996	7,139	933	1,426	841	3,943	14,282
1997	7,225	957	1,554	875	4,121	14,732
1998	7,311	982	1,694	910	4,306	15,203
1999	7,399	1,008	1,846	947	4,500	15,700
2000	7,488	1,034	2,012	984	4,702	16,220
2001	7,578	1,061	2,193	1,024	4,914	16,770
2002	7,669	1,089	2,391	1,065	5,135	17,349
2003	7,761	1,117	2,606	1,107	5,366	17,957
2004	7,854	1,146	2,840	1,152	5,608	18,600
2005	7,948	1,176	3,096	1,198	5,860	19,278

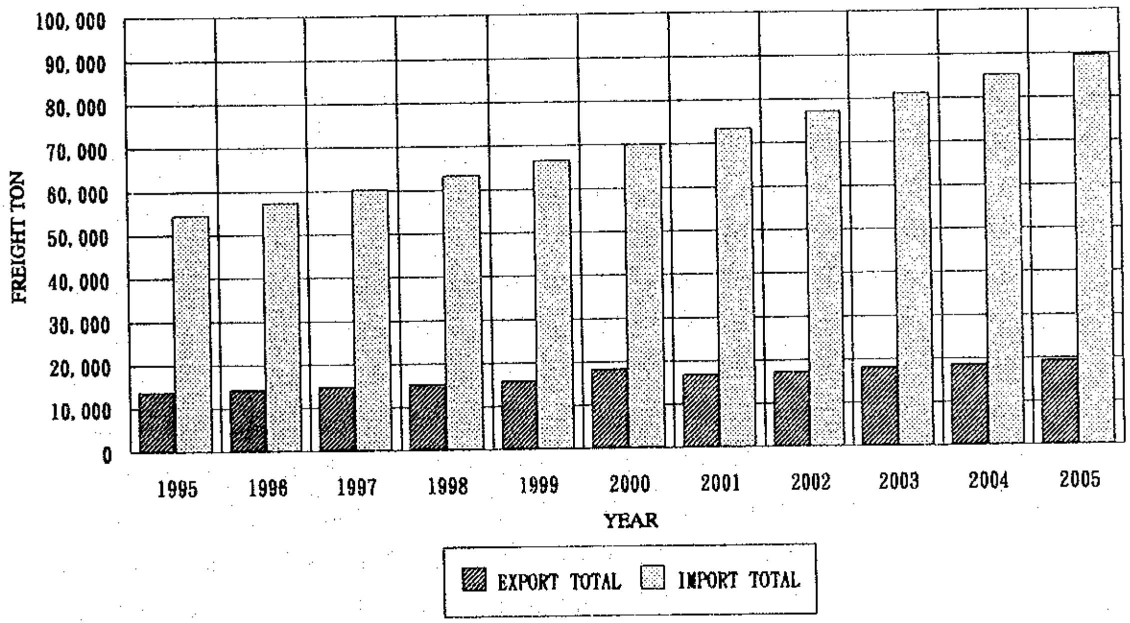


Figure 3-2-1(1) Cargo Forecast, 1995-2005, Betio Port

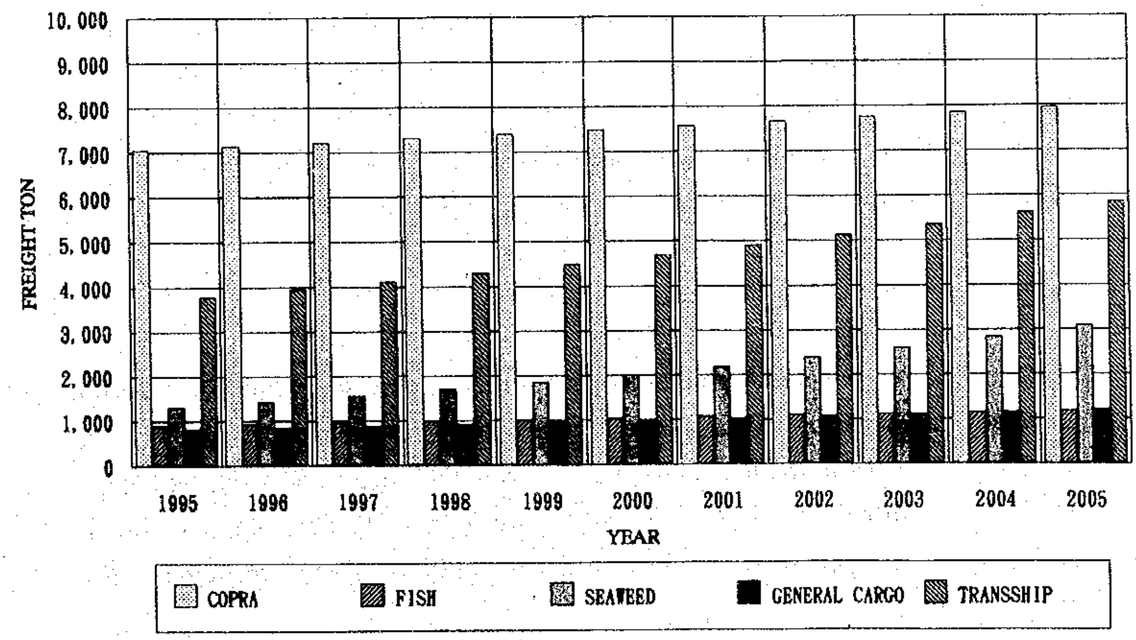


Figure 3-2-1(2) Export Cargo Forecast, 1990-2005, Betio Port

(2) Import Cargo

1) Container Cargo

Major item of import cargoes is food accounting for about 30% of all the imports and as shown in Table 3-2-4, the growth rate of food import is set at 5% in monetary term in the national development plan. Machinery, transport and equipment occupying share of 25% are projected to rise at annual rate of 7%. The third largest share is occupied by manufactured goods and its growth rate is set at 5%. "The Inter-island Transport Study Kiribati" set the growth rate of 5% for total dry cargo imports in terms of cargo volume. The past trend of dry cargo imports handled through Betio Port has been analyzed with a regression method to give the rate of 5.2%. In the present study, the growth rate of dry import cargoes is set at 5.2% through consideration of all the above. To derive the volume of container cargoes, containerization rate has to be multiplied to the volume of total dry import cargoes. "The Inter-island Transport Study Kiribati" assumed to be 80% in 1995 and saturated at 90% in 2000. In the present study, through consideration of recent trend of containerization shown in Figure 2-4-1 (4) and the above study, the containerization rate is set at 85% in 1995 increasing to a saturation rate of 90% in 2000.

As shown in Table 3-2-9 (3) and Figure 3-2-1 (3), the container cargoes are forecast to increase from the present level of about 35,000 t to about 47,000 t in 2000 and about 61,000 t in 2005. In terms of TEU, containers are expected to increase from 1,600 in 1993 to 2,500 in 2000 and 3,200 in 2005. In other words, in the year 2005, the container cargoes are forecast to increase by about 50% in 2000 from the present level and double the present level in 2005.

2) Break Bulk Cargo

Break bulk cargoes include vehicles, construction equipment, lengthy construction materials and other non-containerized cargoes. Non-containerized cargoes out of dry import cargoes in the above calculation gives the volume of break bulk cargoes. As shown in Table 3-2-9 (3) and Figure 3-2-1 (3), the volume of break bulk cargoes is forecast to remain in order of 5,000 to 6,000 t throughout the project period.

3) Bulk Fuel

Fuel oil is imported in bulk from Fiji by tanker and unloaded at the Fisheries Jetty to Mobil Tank Yard by pipeline. Past trend of imported fuel shows a steady increase without any significant fluctuation at an annual growth rate of 4.9% in terms of volume. The volume of bulk fuel is, as shown in Table 3-2-9 (3) and Figure 3-2-1 (3), forecast to increase from the present level of about 10,000 t to 13,000 t in 2000 and 16,000 t in 2005.

4) Transship Cargoes

The same volume of transship cargoes is imported for transship service to Tuvalu as forecast in the previous section.

Table 3-2-9(3) Import Cargo Forecast, 1995-2005

Freight Ton

Year	Dry Cargo	Cont. Rate	Container	TEU	Gen. Cargo	Bulk Fuel	Transship	TEU	Import Total
1995	40,866	0.85	34,736	1,828	6,130	9,853	3,772	199	54,491
1996	42,991	0.86	36,972	1,946	6,019	10,336	3,942	207	57,269
1997	45,266	0.87	39,347	2,071	5,879	10,842	4,120	217	60,188
1998	47,578	0.88	41,868	2,204	5,709	11,374	4,305	227	63,256
1999	50,052	0.89	44,546	2,345	5,506	11,931	4,499	237	66,482
2000	52,655	0.90	47,389	2,494	5,265	12,516	4,701	247	69,871
2001	55,393	0.90	49,853	2,624	5,539	13,129	4,913	259	73,434
2002	58,273	0.90	52,446	2,760	5,827	13,772	5,134	270	77,179
2003	61,303	0.90	55,173	2,904	6,130	14,447	5,365	282	81,115
2004	64,491	0.90	58,042	3,055	6,449	15,155	5,606	295	85,252
2005	67,844	0.90	61,060	3,214	6,784	15,897	5,858	308	89,599

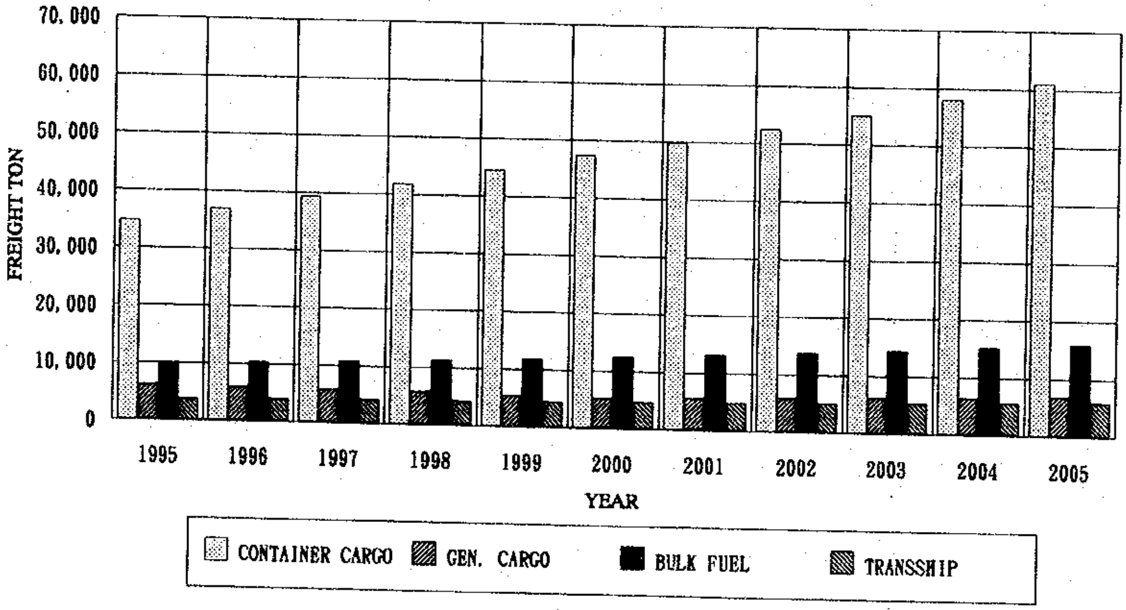


Figure 3-2-1(3) Import Cargo Forecast 1995-2005, Betio Port

- Domestic Distribution of Imported Cargoes

Imported cargoes are distributed in the country either by road in South Tarawa or by sea to outer islands. Sea transport of cargoes to outer islands are done by three shipping networks, namely KSSL ships, private ship operators and informal sector. Since the cargo and passenger statistics of private ship operators and informal sector are not available, overall picture of domestic cargo movement are not clarified. According to the past study, it is estimated that about 58% of total import cargoes are consumed in South Tarawa and the remainder in the outer islands. The share of private sector in domestic sea transport is estimated at 40% for North and Central Gilbert, 10% for South Gilbert and none for Line and Phoenix Island giving overall share of about 32%.

3.3 Required Port Facilities and Equipment

3.3.1 Design Ship

(1) Outline of Characteristics of Vessels Calling at Betio Port

The dimensions of ships carrying foreign cargos called Betio Port in 1993 are summarized in Tables 2-4-5 (1) and (2).

As shown, the largest cargo ship is a copra carrier "Moraybank" which is 161.65 m in LOA with an arrival draft of 8.4 m. Copra carriers call Betio Port infrequently only 4-5 times a year and load about 2,500 t of copra/call.

Container cargo transports are rendered by three shipping lines, monthly by Chief Container Service from Australia, bi-monthly by Bali Hai Line from Japan and monthly by Kiribati Shipping Services Limited from New Zealand and shares of three lines are about 60%, 10% and 30% respectively. The container ship of CCS, Papuan Chief is 130 m in LOA drawing arrival draft of 7.5 m, Pacific Islander of BHL is 144.93 m with arrival draft of about 7.5 m, while KSSL's largest ship Matangare is 68.00 m with arrival draft of 4.5 m.

Recently, Chief Container Services places Baltimar Boreas on the line from Australia replacing Papuan Chief and the former vessel visited Tarawa four times in 1994. KSSL has taken over from PFL shipping services from Fiji and New Zealand in September 1994 with putting a chartered vessel of Arktis Trader.

Aiming at promotion of shipping business, KSSL is scheduled to charter a vessel named Micro Kiss in 1995 replacing Arktis Trader.

Characteristics of these vessels are as follows:

	LOA (m)	Breadth (m)	Draft (m)	GRT	NRT	DWT
A. Trader	76.6	12.1	5.0	1,559	1,088	2,470
B. Boreas	91.0	15.1	4.9	2,854	1,107	-
M. Kiss	79.4	13.8	5.3	1,599	1,036	2,864

(2) Examination of Design Ship

Port planning normally requires that a design ship be determined as the maximum size among vessel sizes forecast in target year. Each port planning follows the above method when a project is found feasible. Alternative plan will be considered if a project is not feasible for a plan fully accommodating all the requirements. In such a case curtailment of a project is requested with some compromise for economic justification of a project.

As stated above, the largest ship of a copra carrier "Moraybank" with an arrival draft of 8.4 m visited Betio Port irregularly, and Pacific Islander and Papuan Chief rendering regular services are ranked as the second and third respectively.

In the case of a project accommodating the above larger ships, a project cost is estimated at about A$70 million. As a result of economic analysis, the project scale is found not to be economically feasible. It shows that the size of the larger vessels like Moraybank, Papuan Chief and Pacific Islander can not be a design ship for the present project due to high project cost when compared with small volume of port cargoes.

100% of cargoes are transported into/from Kiribati by three liners of CCS, BHL and PFL. Papuan Chief shares 60% of the total cargoes handled in Betio Port. The vessel was replaced by smaller Baltimar Boreas for regular services in August 1994 and the draft of the replacement is 4.9 m, which needs water depth of 6.0 m in Betio Port with allowance mentioned in sub-section 3.3.2. About 90% of imported cargoes will be handled at a berth in new Betio Port, if the berth is designed deep enough to accommodate Baltimar Boreas in the development plan. This plan will generate lots of benefits and is found economically feasible as will be described in a subsequent chapter.

Table 2-4-6 shows accumulated distribution of arrival drafts in 1993 and as shown, 59% of ships called Betio Port in 1993 fall in range of arrival draft less than 4.5 m, which is "Matangare" class and 62% of all the ships is in range of the draft less than 5.0 m.

The Government of Kiribati and Japanese Preparatory Study Team have agreed in the Minutes of Meeting signed on December 3, 1993 to improve Betio Port so as to accommodate vessels plying between Betio and outer islands, which is represented by

"Matangare".

With consideration of all the conditions stated above and feedback examination between port planning and economic analysis, "Mantangare" is selected as a design ship, however, ship's draft of 5.0 m for Baltimar Boreas is applied instead of Matangare's draft.

All the ships of national flag are in the range under the above design ship and part of small foreign vessels such as copra carrier from Bangladesh can come alongside a future wharf. Inconvenience presently experienced by passengers transported by domestic vessels will be completely removed with provision of a passenger terminal in addition to a new wharf. Selection of "Matangare" as a design ship is appropriate and practical through consideration of various aspects of construction and operation costs, port management and operation, establishment of a new port authority, etc.

The vessels with characteristics listed below are owned by KSSL and are involved in inter-island sea transport. Ships owned by private shipping firms are smaller than these.

*Matangare

- LOA :	68 m
- Breadth :	11.8 m
- Draft(full loaded) :	4.2 m

*Momi

- LOA :	42.5 m
- Breadth :	9.6 m
- Draft(full loaded) :	3.0 m

*Mataburo

- LOA :	42.5 m
- Breadth :	9.6 m
- Draft(full loaded) :	3.2 m

*Moanaraoi

- LOA :	59.92 m
- Breadth :	9.61 m
- Draft(full loaded) :	4.01 m

3.3.2 Dimension of Wharf

(1) Berth Length

To accommodate Matangare, a berth requires length of LOA plus allowance for mooring of about 20% of LOA as indicated on the "Technical Standard for Port and Harbour Facilities in Japan". The required berth length is thus given as:
68 m x 1.20 = 81.6 rounded to 80 m

(2) Depth

Design wharf depth is given as summation of full draft and allowance of 10% of full draft for a medium-size vessel. Furthermore, lower tide level below Port Datum Line frequently occurs in Betio Port and difference is about 0.4 metres.

Design depth is to include all the above allowance and is calculated as:
$5.0 \times (1 + 0.1) + 0.4 = 5.9$ (m)

The wharf depth is determined to be 6.0 metres.

3.3.3 Container Yard, Shed and Equipment

(1) Container Yard

A new container yard will be planned to efficiently handle the future container cargoes.

Table 3-3-1 shows a record on a number of containers imported by such principal carriers as Papuan Chief(CCS), Pacific Islander(BHL) and Forum Micronesia(PFL) from 1990 to 1993.

Table 3-3-1 Imported Containers/Call by Carrier, 1990-1993

	TEU/call
CCS	81.8
BHL	27.4
PFL	34.3
Total	143.5

The above states that absolute minimum number of TEUs to be stacked in a container yard is 143.5. To determine a number of TEUs of allowance for practical and efficient container movement, the study team counted number of TEUs in the yard and checked in/out TEUs recorded in April 1994. Following numbers were obtained.

Number of working TEUs :	145 (absolute minimum)
Total TEUs stacked :	230
Total	85 (allowance)

TEUs for allowance are counted to be 58.6% of number of working TEUs and the number counted by the team is almost same as the number in Table 3-3-1. This means that average number of total containers in the yard is estimated to be 1.58 times of average number of working TEUs.

Number of containers handled in year 2005 will be 3522 TEUs and they will be transported by the same liners. Assuming that the current vessels calling the port will continue to come at the same interval in the year 2005, the number of TEUs in 2005 is estimated as shown in the following Table 3-3-2.

Table 3-3-2 Imported Containers by Carrier, 2005

	TEU/yr	Nos. of call	TEU/call
CCS	2,063.9 (1,839.9)*	10.3	200.4 (178.6)
BHL	405.0	6.0	67.5
PFL(KSSL)	1,053.1	12.5	84.2
Total	3,522.0		352.1

*( ) shows TEUs excluding containers for transship.

Table 3-3-3 Imported Containers by Carrier
(Average Nos. excluding transshipment in 1990 and 1993)

	TEU/year	Share (%)	Nos. of call	TEU/call
CCS	808	57.6	10.3	78.8
BHL	165	11.7	6.0	27.4
PFL	429	30.6	12.5	34.3
Total	1,401			140.5

As stated above, number of TEUs for allowance in the container yard is counted to be 58.6% of working containers. Following the rate, average number of containers stacked in the yard are calculated as 140.5 x (1 + 0.586) = 223 (TEUs)

The above number of TEUs are defined as the total TEUs in average annually-imported containers of 1,401 TEUs. Table 3-3-4 shows number of TEUs including transshipped containers in 2000 and 2005 as follows:

Table 3-3-4 Number of Import TEUs Forecast (including transshipment) in 2000 and 2005

Year	TEU
2005	3,522
2000	2,741

Total TEUs in the container yard in the target years are calculated below with applying the defined figure.

* in 2005 : 3522 x (223/ 1401) = 561
* in 2000 : 2741 x (223/ 1401) = 436

Average tiers of containers in the yard for year 2005 is planned to be 2.5 for laden and 3 for empty container and necessary ground slots is calculated at 207. Required area of container yard is calculated as about 20,400 m^2 including areas for other purposes like open storage, car park, etc.

(2) Shed

Local importers of incoming cargoes are categorized as follows:

Consignees	Share*
1) Kiribati Supplies Co., Ltd.	10 %
2) Kiribati Cooperative Wholesale Society	15 %
3) Abamakoro Trading Ltd.	21 %
4) Private Enterprises	54 %

* Wet cargoes are excluded.

Cargoes imported by the large consignees from 1) to 3) share about 50% of all imported cargoes and about 50% of the cargoes for large consignees, 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 shed.

* 25% of imported TEUs are delivered as FCL container.

* Remaining 75% of all imported TEUs are handled as LCL container and all the containers are unstuffed in the first 7 days and stored in a shed . 70% of container cargoes are carried out of the shed by the 7th day; 90% out by the 14th day; and all by the 30th day.

A number of TEUs excluding TEUs for transship to be discharged from CCS (Baltimar Boreas) in year 2005 is applied for calculation of required shed area. It is forecast to be and 75% of 178.6 TEUs, 134.0 TEUs are unstuffed to the shed. Container cargoes dwelling in the shed are 30% of unstuffed 134.0 TEUs at the peak time on 7th day, i.e. 40.2 TEUs.

Peak factor to allow fluctuation of import containers is found to be 1.4 times of the average.
Possible container cargoes to be stored in a shed in terms of TEU are 40.2 x 1.4 TEUs plus containers dwelling from previous ship assumed to be 10% on the 14th day, giving 69.7 TEUs.

19 freight ton per TEU and 2.5 t/m^2, average cargo weight per sq. metres in a shed are assumed and necessary floor area of the shed including passages of 50% of floor area will be:
(40.2 x 1.4 + 13.4) x 19/2.5 x 2 = 1,059 m^2

The Required floor area is rounded as 1,100 m^2.

To store export copra, a shed with floor area of 1,200 m^2 is required. The floor area of the new shed is about 20 % larger than total area at present allowing smooth hand–

ling operation of copra.

(3) Cargo Handling Equipment

The conceptual plan aims to improve efficiency of cargo handling in the container yard with not only construction of wharf and land facilities but provision of cargo handling equipment.

On consideration that all the cargo handling equipment presently owned by KSSL will become old and out of service by the time of target year of the conceptual plan , all the cargo handling equipment are proposed to be newly purchased.

Cargo handling equipment are required for each step of operation as listed in Table 3-3-5.

Table 3-3-5 Required Cargo Handling Equipment

Container Cargo Movement	Required Equipment	Nos.
1) Barge <-> Wharf	80 t Mobile Crane	1
2) On wharf	25 t Forklift	1
3) Wharf <-> Yard	Tractor/Trailer	2
4) In yard	25 t Forklift	1
5) In shed	5 t Forklift	4
6) Consigner/consignee <-> Shed/Yard	Tractor/Trailer	1

In the case that ship berth alongside the wharf, 80 t mobile crane can assist 25 t fork-lift either on wharf or in yard, or at the time of maintenance/repair.

3.3.4 Other Facilities

(1) Passenger Terminal

A waiting room for outgoing passengers will be provided. Future number of passengers in 2005 is estimated with their records from 1983 to 1993.

For designing a waiting room, passenger traffic record for the period of 1983-1993 is shown in Table 3-3-6.

Table 3-3-6 Numbers of Outgoing Passengers

Year	Nos. of Passengers	Average Increase Rate
1983	2,362	
1984	2,603	
1985	3,184	
1986	3,505	
1987	4,375	3.6 %
1988	4,486	
1989	4,356	
1990	8,093	
1991	7,787	
1992	6,514	
1993	4,696	

The average increase rate is obtained with regression analysis omitting the numbers in 1990, 1991 and 1992, because the data in these years seem to be singular.

Numbers of passengers are estimated with the above increases rate and the forecast is shown in Figure 3-3-1.

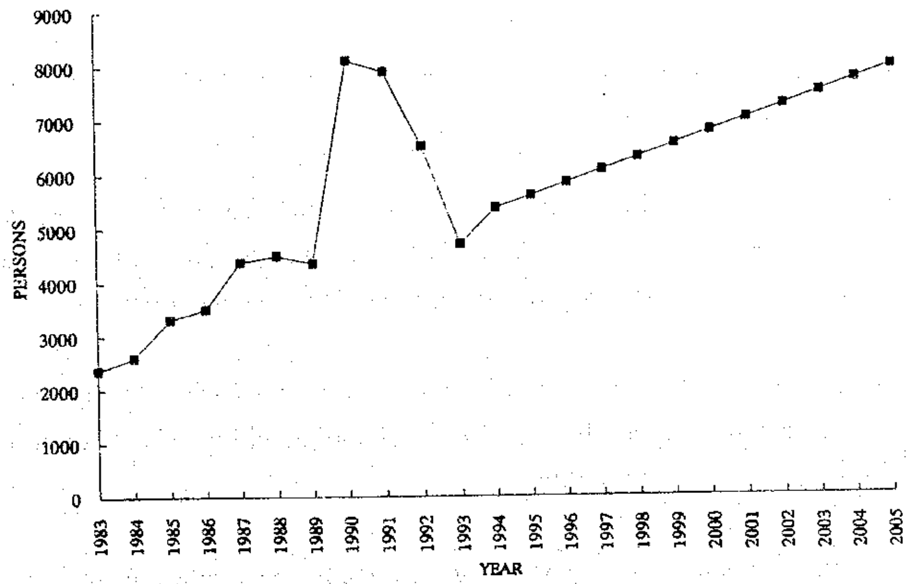


Figure 3-3-1 Forecast of Passenger Traffic

Passenger statistics during 1989 and 1993 shows that 515 passengers were recorded in 1991 as the largest number of passengers and the third one is 508 in 1990. These figures were recorded at the time of resettlement to outer islands. They were not suitable for estimation of future number of passengers to determine a necessary floor area for a waiting room, because of their singular records.

The number of 331 passengers in 1989 being as the fourth largest seems to be one of the largest number of passengers in an ordinary cruise and will be applied to design of the facility.

Passengers in 2005 is forecast to be 506 persons with the increase rate of 3.6%.

A unit area per person in the waiting room is 1.2 m^2 and a total area to meet the number is:
506 x 1.2 = 607 (m^2)

An office for ticket sale and a toilet will be planned with an area of 46 m^2.

A total area for the facility will be 653 m^2 and 650 m^2 will be applied to the total floor area of the terminal.

(2) Office for Kiribati Port Authority

A number of staffs of Kiribati Port Authority is proposed and an office building will be required for the new staffs.

An required area for the organization is estimated to meet the number of staffs as shown in Table 5-3-2 of Chapter 5. Each unit area per person is applied from the standards in Japan, considering a number of staffs in a single room .

As stated in the Table 5-3-2, an office area will be about 283 m^2 and about 60 m^2 for the other function. A total floor area of the building will be 350 m^2 to accommodate the new staffs of the Port Authority.

To minimize a construction cost and to efficiently function the facility, a two-story building will be planned to be located in a new shed.

3.3.5 Utilization of Existing Facilities

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 the newly developed facilities proposed in the present study. The major rehabilitation works include repair to the corroded steel sheet piles of the wharf and dredging in the silted channel and basin.

(1) Ships to be accommodated

After completion of the project, the existing Betio Port shall serve such ships as those owned by private ship operators and informal sector, fishing boats, tugs and barges, landing craft, ships to be repaired in the ship yard and leisure boats. The new facilities shall be utilized mainly by foreign ships and KSSL ships, while the existing Betio Port shall serve small local ships. This separation will increase productivity of cargo handling operation in the proposed port. Share of local ships other than KSSL in domestic sea transportation is about 40%.

(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 cargoes of KCWS and Supply Division of MWE, long term staying cargoes and a waiting room of passengers with manor repair and remodeling to be done by the government.

3.4 Conceptual Development Plan

As described in the previous chapter, due to serious obsolescence and insufficiency of the existing port facilities, Betio Port has already reached to saturation in handling capacity and safety of port operation is not secured. Inefficient port operation gives rise to increase of trana-portation cost and eventually hampers sound growth of the country's economy. The existing port facilities could not meet an increasing traffic demand of container cargos without drastic im-provement and rehabilitation. The existing port facilities can be improved by such measures as i) reinforcement of cargo handling equipment ii) reinforcement of tugs and barges iii) expansion of the existing wharf iv) expansion of the existing container yard v) construction of a new wharf and vi) construction of a new container yard. Thorough consideration to the local conditions of Betio Port has led the conclusion that expansion of the existing facilities is difficult and construc-tion of a new wharf and a new container yard is necessary. A construction site near coast in a reef flat area involves large and expensive dredging work and an offshore site near reef edge is advantageous allowing efficient utilization of the existing Moles.

3.4.1 Possible Sites for Development

Expansion of a container yard is a crucial factor in planning future development of Betio Port. However, land area necessary for future port development is not available on land near the existing Betio Port.

According to the land use plan authorized by the Ministry of Home Affair, reef flat area east side to the Betio Port is defined as "Investigation Long Term Reef Reclamation Area" as shown in Figure 3-4-1.

The authorized land use plan is considered to indicate a future development direction of the Betio Town, which is to the east from the port where an ample land area is available toward the governmental and commercial center "Bairiki". In the land use plan, the vicinity of the Betio Port is all defined as "Government, Commercial and Industrial Area" except for the area west to the port gate where a cemetery of World War II is, which is defined as "Civic Uses, Open Spaces and Cultural Sites".

Since a land area wide enough for developing future port is not available near the existin port, a reclamation work is necessary to create the land area required in the port development project.

Sites for future port development could be either east or west of the Moles or in between.

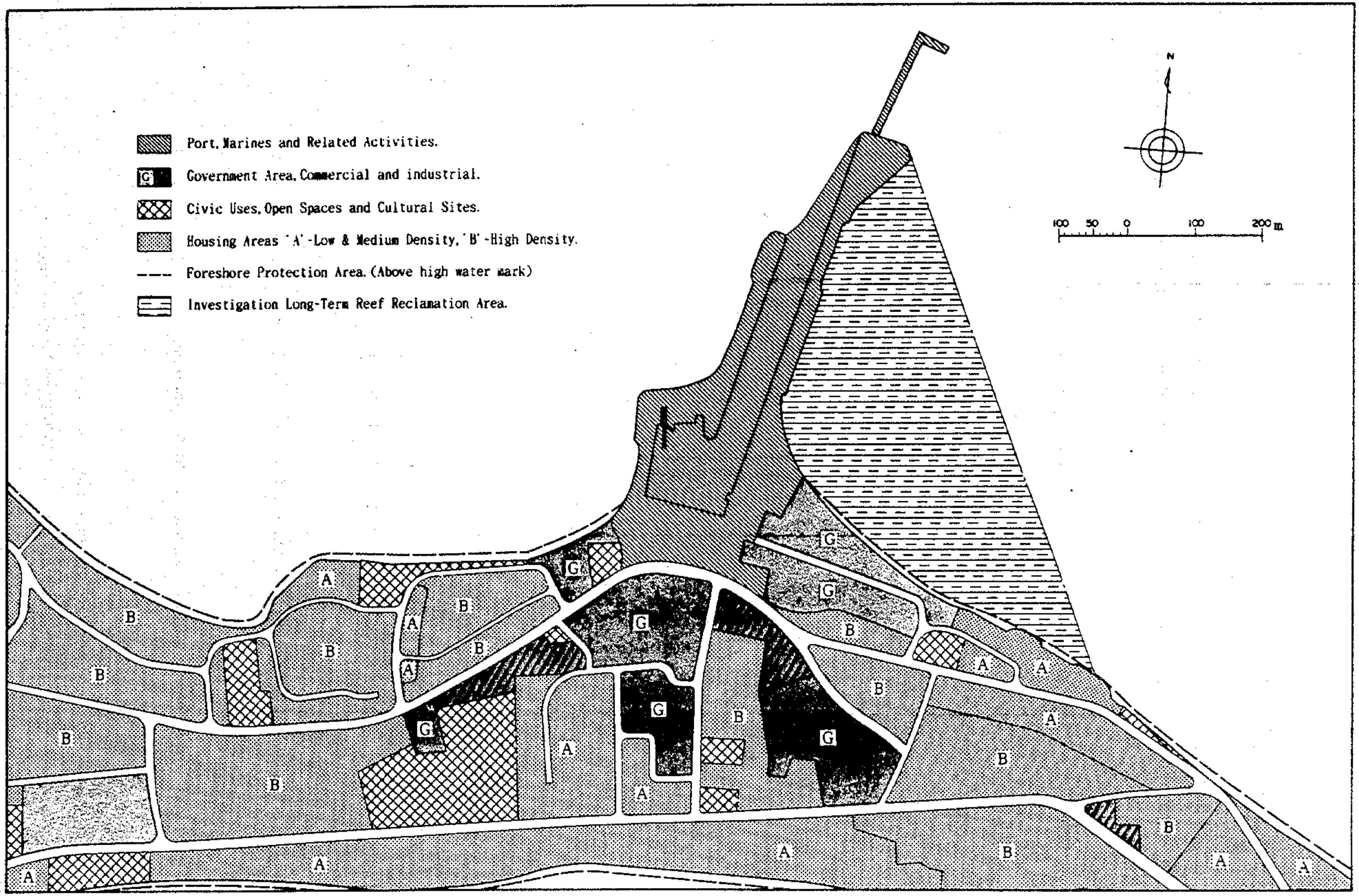


Figure 3-4-1 Land Use Plan, Betio Town

3.4.2 Proposed Port Layout

Following the result of consideration on site selection, three alternative plans can be proposed as shown in Figures 3–4–2 to 3–4–5. They are compared in various aspects as detailed in Table 3–4–1.

Factors considered in comparison of alternative plans are as follows:

(1) Construction Cost
- construction, equipment, engineering fee, etc.

(2) Construction Work
- ease of work, interference with port operation, environmental impact

(3) Traffic Interference in Channel
- interference and safety of channel traffic in existing and new ports

(4) Maneuverability to Wharf
- ease and safety of maneuver to/from a new wharf

(5) Yard Traffic
- efficiency and safety of yard traffic

(6) Access Road
- ease of access to yard by road

(7) Calmness in Water Area
- shelter from waves affecting cargo handling of ship

(8) Siltation
- siltation and required maintenance dredging in channel and basin

(9) Land Use
- ease and policy of future expansion and development

(10) Environment
- environmental impact to lagoon ecology on a west reef flat
- provision of rubbish dumping area for environment preservation

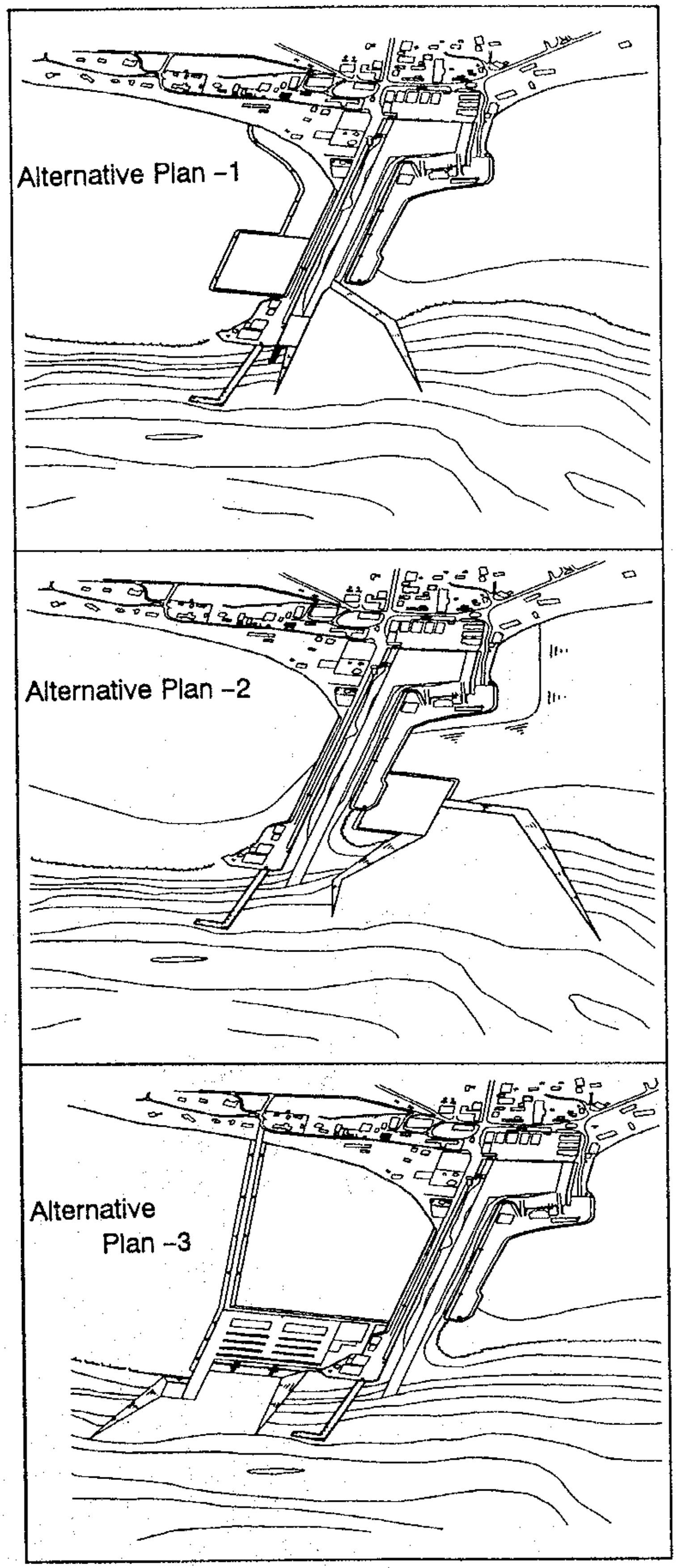


Figure 3-4-2 Alternative Conceptual Port Development Plans

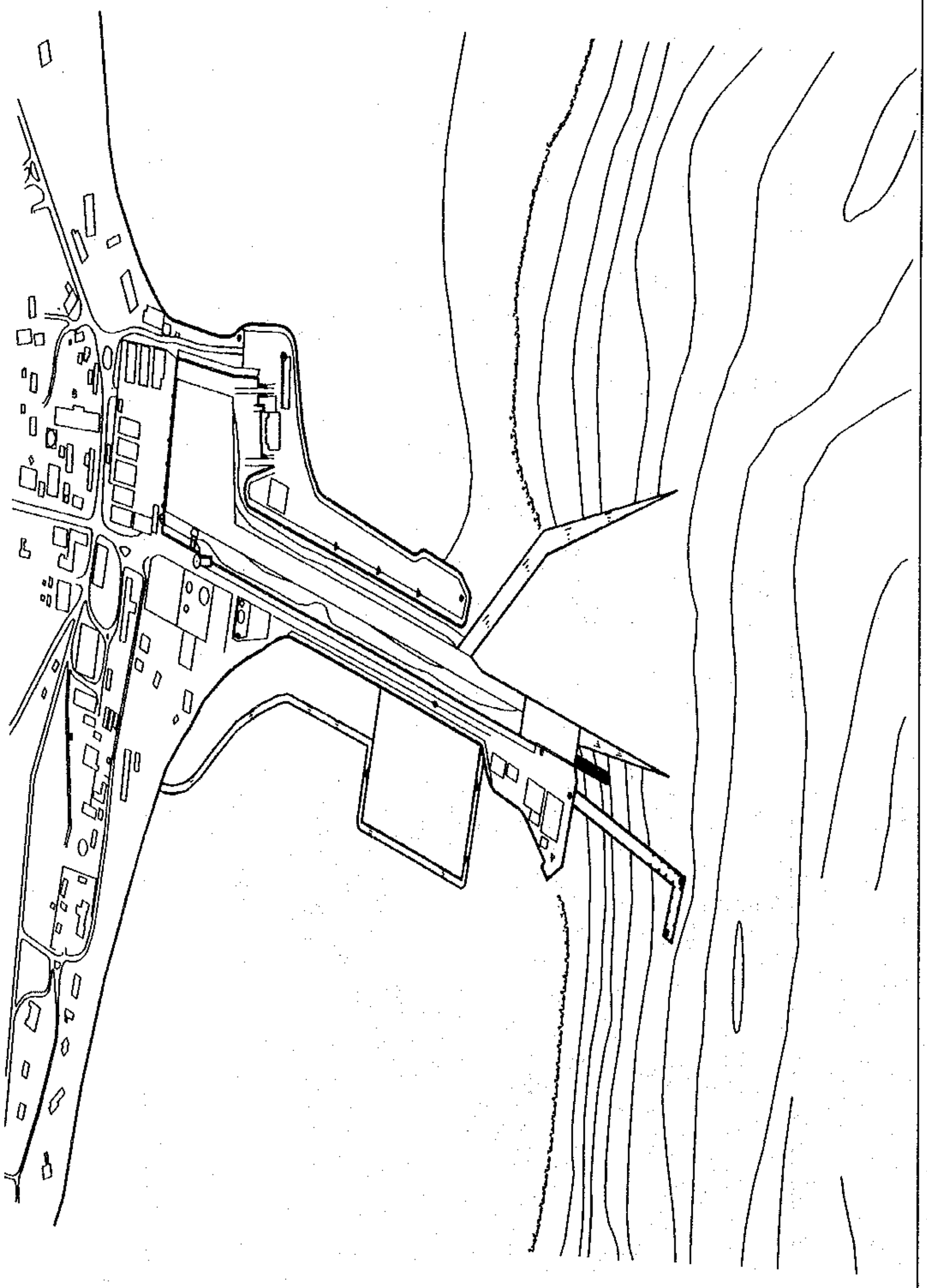


Figure 3-4-3 Alternative Plan 1

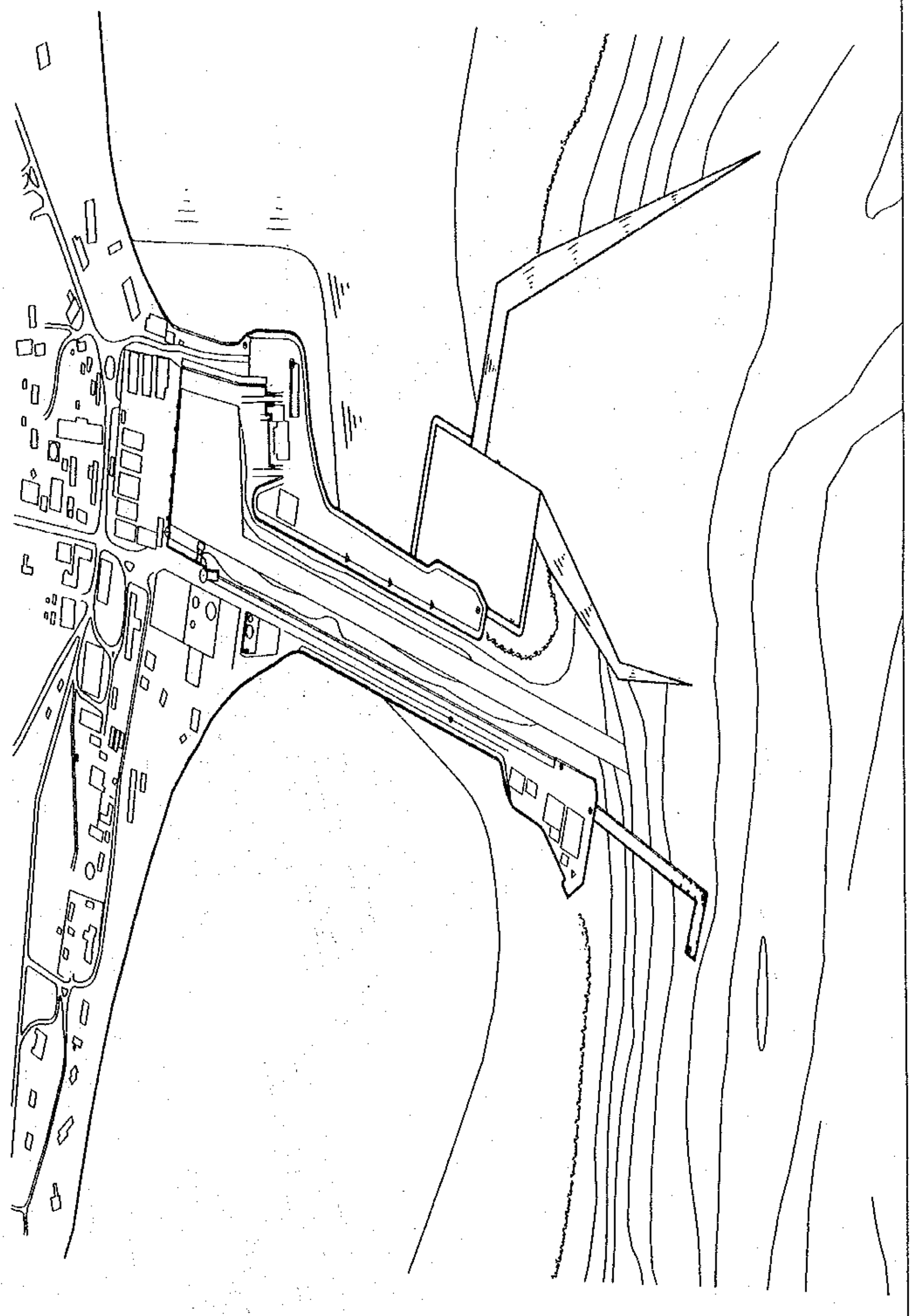


Figure 3-4-4 Alternative Plan 2

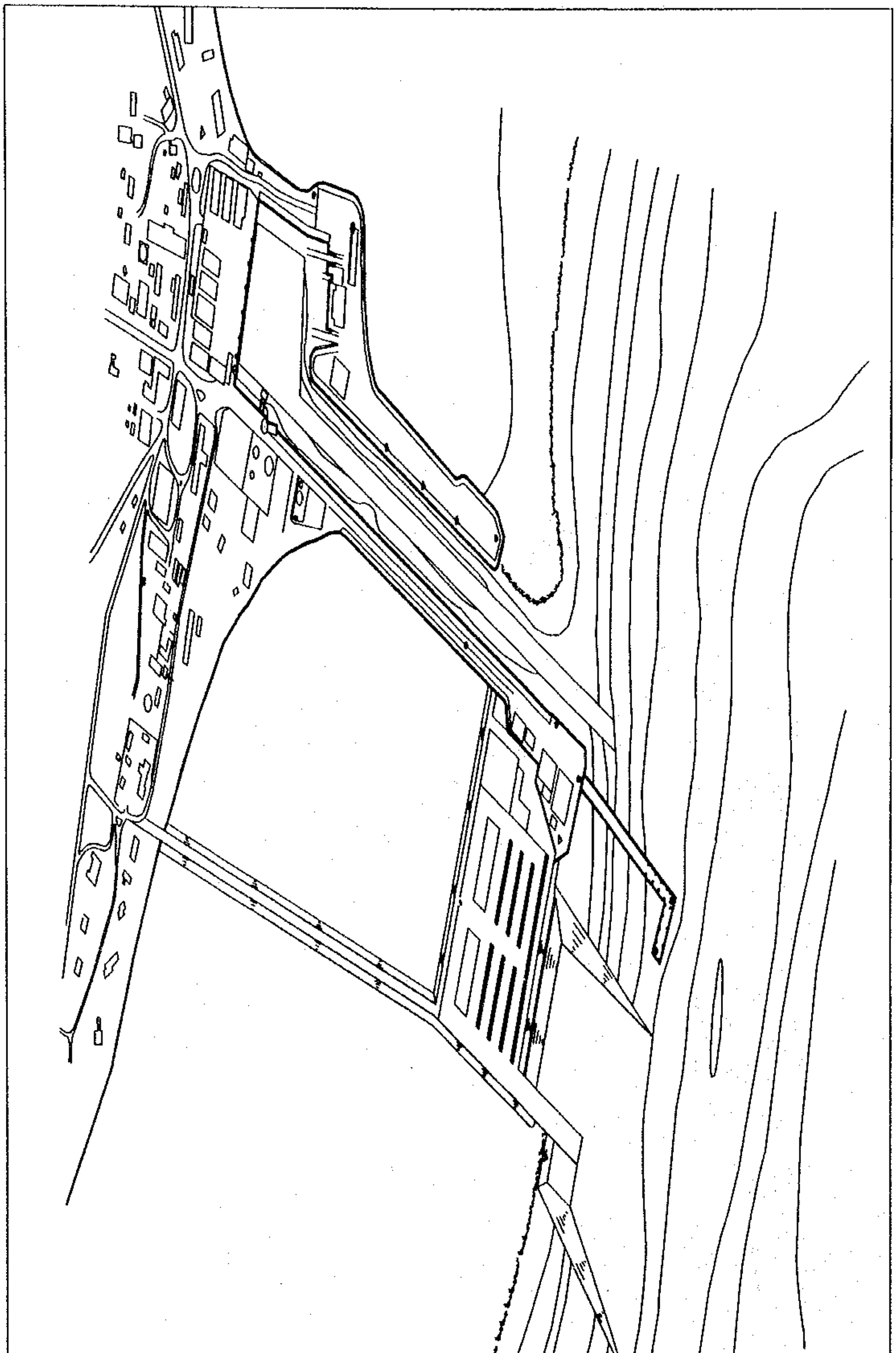


Figure 3-4-5 Alternative Plan 3

Table 3-4-1 Comparison of Alternative Conceptual Port Development Plans

	Plan 1	Plan 2	Plan 3
Construction Cost	○	△	△
Existing Channel	△	○	○
Wharf/Yard Traffic	×	○	△
Land Use	○	△	○
Environment	△	×	○

Comparison of three plans is outlined below.

– Alternative Plan 1 –

The future port is developed along the east mole with a wharf on west side and a yard on east side between Te Mautari and Mobil tank yard. Existing facilities of the east mole is best incorporated in the plan and the construction cost is the lowest at about A$ 42 million. Disadvantage of this plan is separation of the wharf and the yard and a resulting interference with the traffic on the east mole road. This separation also causes lower efficiency and safety of yard operation and difficulty of security. The channel to the existing port has to be bent around the southern corner of the new wharf. Land access to the wharf is aligned on a narrow strip of reclaimed land along the east side of the East Mole. In a construction stage, this plan most interferes with the operation of the existing port. Further, dredged soil has to be transported around the east mole. The yard is located on the east side allowing easier future expansion.

– Alternative Plan 2 –

The future port is developed at the tip of the west mole best sheltered from easterly waves. Expansion is easy in near future but further detailed consideration should be given for the distant future. Traffic through the existing channel is very close to the turning basin of a new port. In the construction stage, dredging work will interfere with a traffic through the existing channel to some extent. Access road to the port accommodates port traffic and ship yard traffic which is not heavy. Narrow section in front of the custom office can be easily expanded. Yard traffic from the wharf is best arranged among three plans. Future extension of the wharf toward the sea is to involve more expensive dredging cost due to shallower water depth than the east side. The construction cost is the highest at about A$ 44 million among three.

– Alternative Plan 3 –

The future port is located on the east side of the east mole and an impact to ecology on the west reef flat is minimum. This plan follows the authorized land use plan having greater flexibility of future development. The plan has the least interference with the channel traffic to the existing port during and after the construction. The wharf projects from the east end of the yard and prevent sand movement into the channel and basin. Distance between the wharf and the yard is a little longer than Alternative Plan 2. Land access is aligned from the southeastern corner of container yard to the district court and enclosed shallow reef flat area is to provide a space for dumping rubbish and sand from maintenance dredging. The construction cost is estimated at about A$ 43 million.

Overall evaluation of all the aspects and their importance on the Alternative Plans leads to selection of Alternative Plan 3, and the proposed layout plan is shown in Figures 3–4–6 (1) and (2).

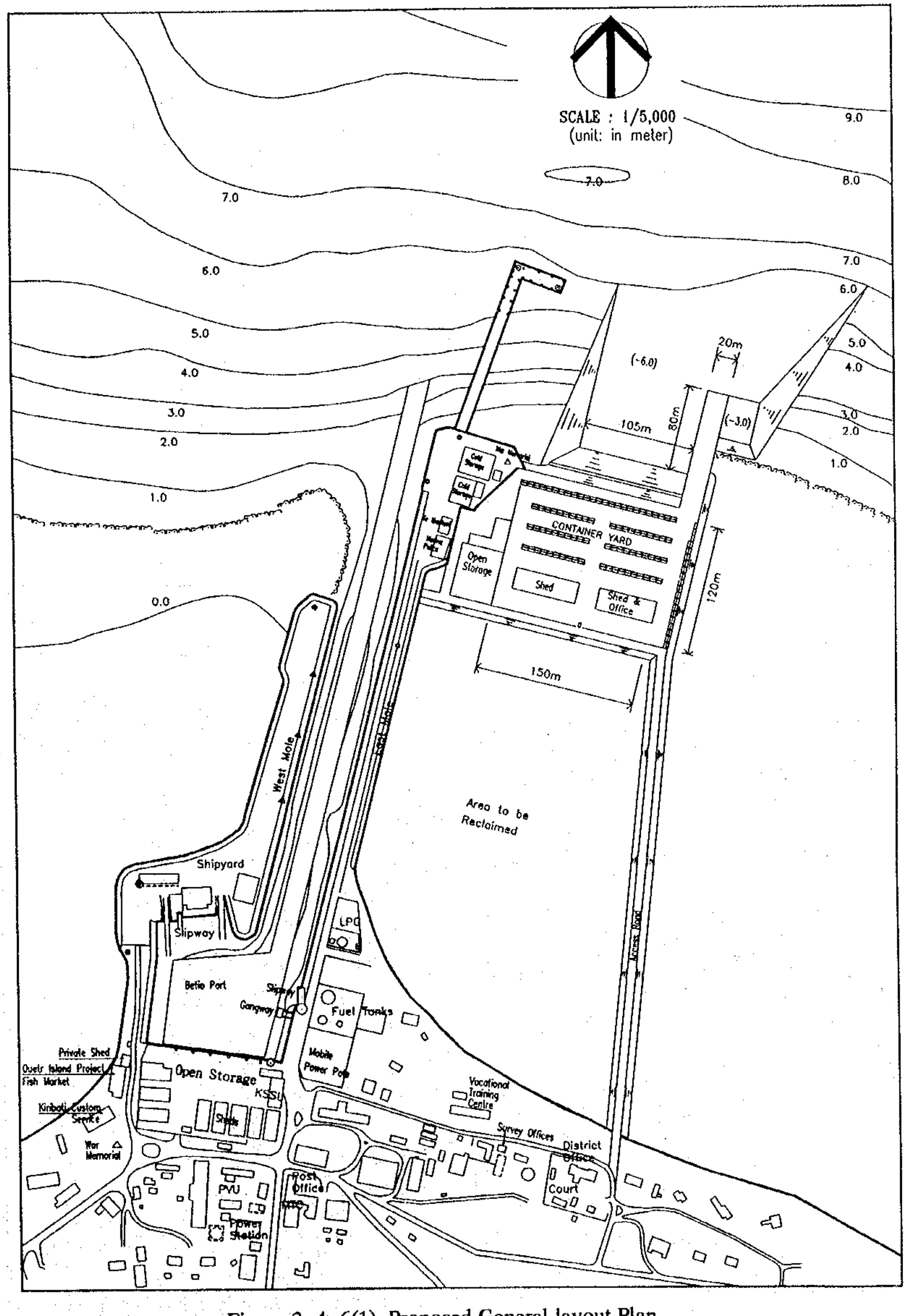


Figure 3-4-6(1) Proposed General layout Plan
(Conceptual development Plan)

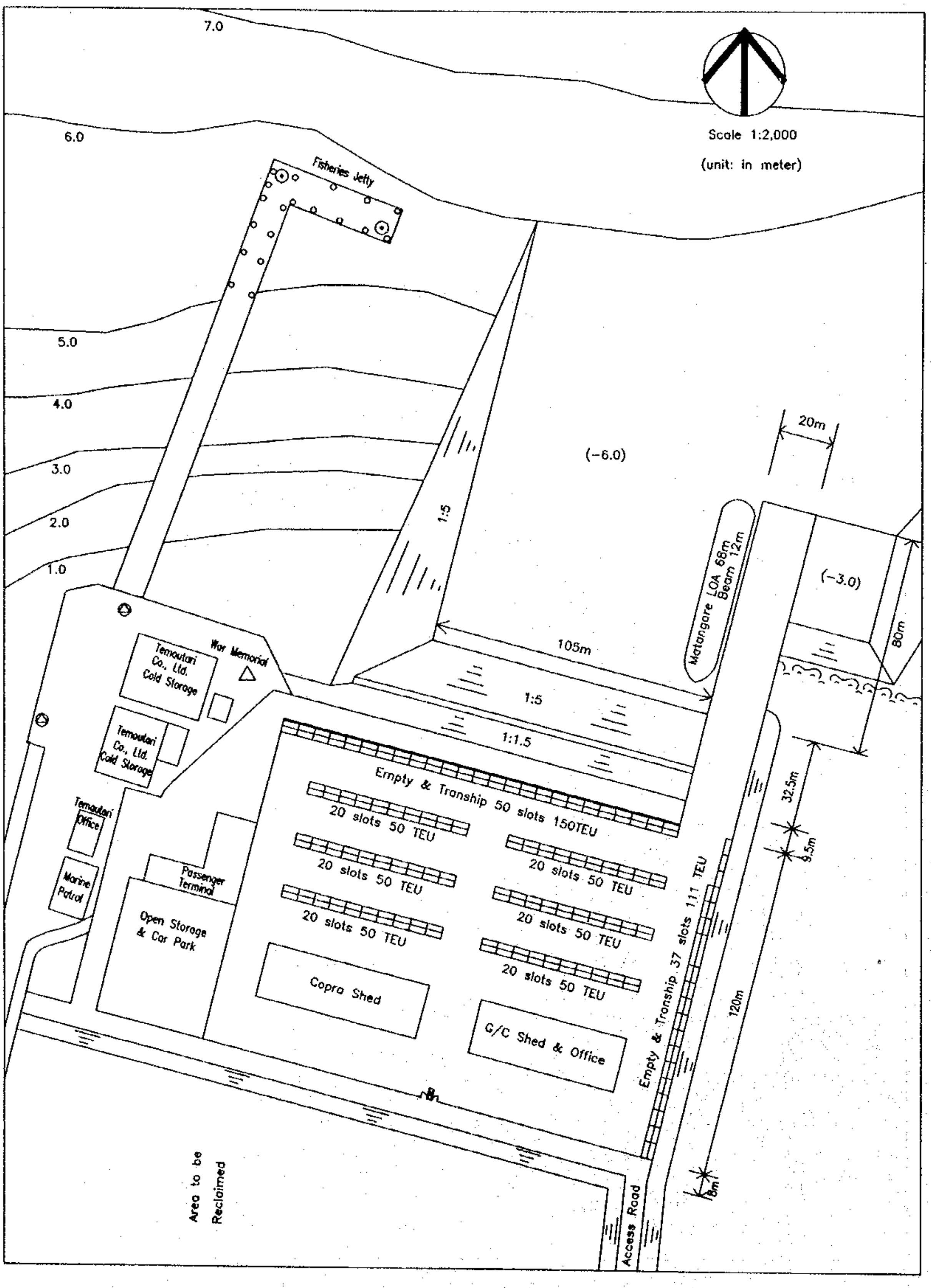


Figure 3-4-6(2) Proposed Container Yard Layout Plan

3.4.3 Examination on Littoral Drift

(1) General

As stated in the sub-section 2.2.1 on natural conditions at Betio Port, volume of littoral drift is estimated to be small. But determination of layout of new port facilities will require examination on how to minimize volume of sand deposition in a basin.

For evaluation of the layout plans proposed in the previous sub-section, numerical simulation with computer was conducted for estimating volume of littoral drift.

Computer simulation for littoral drift requires wave data, current data and topographic data for several years to accurately predict future topographic change. There are very limited data available relating natural conditions in Kiribati and the Study Team conducted supplementary survey to obtain such data as much as possible in the limited period. The survey results obtained by the Team were used as input data for simulation. The results of simulation show tendency of topographic change to be brought by implementaion of the project.

Outline of simulation is as follows:

1) Input data collection and evaluation

Available information on bathmetric change is difference between the present and dredged depths about 40 years ago in the channel and basin. Data on current and waves around the port were collected in this study in March 1994 for the computor simulation.

2) Determination of coefficients for numerical simulation model

Various coefficients are determined by simulating the present topography for numerical simulation of future topography by different alternative plan. A calculation area is set as 2 km x 2 km with a new port be positioned at the center.

3) Examination of future topography for the alternative plans

All the data and coefficients for a numerical model determined as above will be used for simulation of future topography.

The numerical simulation is composed of two components as below:

a) Calculation of nearshore current in the area
b) Calculation of topographic changes in the area

(2) Numerical Simulation of Field Current

1) Calculation of Current

a) Tidal Current

Calculation of current around the port was conducted for reproduction of current obtained in the field measurement in May, 1994. Results of current calculation are shown in Appendices 3-4-1 and 3-4-2 which show good similarity between simulation and field currents.

b) Current Induced by Long-period Oscillation

Current induced by long-period oscillation is computed around the existing port. As shown in Appendix 3-4-3, remarkable peak of amplification factors is at 500 seconds and current distribution in the existing port is calculated, based on gradient of sea water level corresponding to the long period of 500 seconds.

c) Nearshore Current

Nearshore current around the port was computed for comparison and reproduction with current data obtained in the field survey 1994. Calculated current velocity are obtained with significant similarity with field data. The result is shown in Appendix 3-4-4.

(3) Topographic Change

1) Calculation Method

Different numerical calculation methods for littoral drift are applied to different topographies of outside and inside the existing port.

a) Outside the Port

Applied method for the topography outside the port horizontally predicts topographic change of seabed by calculating littoral drift of bed load of sand caused by waves and currents.

b) Inside the Port

In this field, tidal current is predominant to induce sediment transportation toward the inner port and volume of sand deposition is estimated as follows:

i) Concentration of SS at the port mouth is estimated with Bijker formula and is compared with field data obtained in the site survey in 1994.

ii) Tidal current induces sedimentation in the port with the maximum velocity of 3 cm/s.

iii) SS flux is entrained toward the inner port by tidal current and deposits there.

2) Calibration of Reproduction by Simulation

a) Outside the port

i) Calculation conditions

* Area: 2km x 2km, centering the port.
* Seabed material: 0.15 mm
* Waves: as below

Direction	Occurrency (%)	Equivalent Wave With Average Energy (Height)	(Period)	(Direction)
1) NNE, NE, ENE, E	84.3	0.9 m	3.0 s	N40°E
2) NNW, N	15.7	0.7 m	3.0 s	N

ii) Calculation result

The calculation results show that the annual siltation rates vary between + 5 cm and – 3 cm at grid points in calculation area and the total volume of sand deposition per year is estimated to be in order of not more than 1,000 cubic metres. According to the limitation and accuracy of numerical simulation on littoral drift, it is commonly said that the volume of topographic change smaller than 1,000 cubic metres is not accurate enough, that is, the volume of littoral drift estimated with numerical simulation will be reliable when the volume is in order of a few thousand cubic metres. Therefore, the present result shows that the significant topographic change will not occur in the vicinity of the Betio Port.

b) Inside the port

i) Calculation conditions

* Wave

Height	Period	Current
0.5 m	3 second	0.03 m/s

* Average concentration of SS : 40 mg/ltr under the above wave conditions (calculated with Bijker formula)

ii) Calculation result

Transported and deposited volume of SS through the port mouth into the inner port is 1175 m^3/yr, which is approximately as the same as volume of 1,400 m^3/yr estimated with actual deposited volume in the port.

3) Prediction of Topographic Change for Alternative Plans

Topographic changes are computed under the same wave conditions as above for the equivalent time of one year for the three proposed alternative plans. The calculation results do not show that any significant topographic changes for the three alternative plans since the annual siltation rates are estimated to be between + 5 cm and – 5 cm for all the plans. It is concluded that there is not significant difference among the three proposed options and that the absolute volume of littoral drift is very small, however, it is proposed that the Port shall be prepared for maintenance dredging of sand deposition of 1,000 cubic metres as minimum siltation volume with considering the limitation of numerical simulation on littoral drift.

3.5 Structural Design

3.5.1 Design Premises

The material, equipment and topographical conditions restrict construction works in the Tarawa atoll.

As construction materials, only sand and crushed coral aggregate are available and water quantity is insufficient. Marine crafts for works are not available. Dredged spoil is not allowed to be dumped in the lagoon and it is very far to get the appropriate position in deep sea, considering sea environment.

To make a plan appropriate and to minimize its cost, imported material and equipment will be minimized and dredged spoil be placed near the site with thorough consideration given to environment aspects.

The facilities will be designed following the premises from local conditions.

3.5.2 Design Conditions

(1) Dimensions of Facilities

* Wharf
  - Overall length : 80 m
  - Depth : 6.0 m below D.L.
  - Top elevation of : + 4.00 m
    Coping

* Return wall
  - Overall length : 20 m

* Seawall for Apron
  - Overall length : 80 m

* Seawall facing a turning basin : 155 m

* Seawall for Container Yard
  - Overall length : 150 m

* Seawall for Access Road
  - Overall length : 470 m

(2) Design Vessel

* LOA : 68 m
* Breadth : 11.8 m
* Draft, full loaded : 4.2 m

(3) External Force

* Surcharge : 3.0 t/m^2
* Berthing velocity of a ship : 20 cm/sec
* Design seismic coefficient (k_h) : 0.05

(4) Natural Conditions

1) Sea conditions

* Tidal Level

M.H.W.S + 1.80 m
M.L.W.S + 0.10 m
C.D.L. - 0.40 m

2) Wind Speed : 30 m/sec

(5) Soil Conditions

No boring survey was conducted in the present study stage and accurate data on the soil at the site is not obtained. All the facilities will be designed, based on the boring logs from the survey for the construction of Fisheries Jetty.

The soil profile around the site is assumed to be mostly coral sand with following characteristics and for surface coral rocks to be dredged with excavators.

* Bulk density :	1.7 t/m^3 (in air)
* Angle of internal friction :	30°
* N value :	15 (average)

3.5.3 Proposed Port Facilities

(1) Mooring Facility

1) Wharf

To minimize construction cost and to select appropriate structure, comparison of structure design of the facilities is be required. Following is normally proposed for wharf structure:-

* Steel Sheet Pile Type
* Open-type Pier with Steel Pipe Pile
* Gravity Type: Caisson, Concrete Blocks, Cellular Concrete, Blocks, etc.

The layout of the conceptual plan for year 2005 is proposed with consideration of environmental aspects including sedimentation also.

The wharf will be located beyond the reef edge for functioning a impermeable jetty preventing sand drift toward the existing port. If an open type structure is applied, a groyne for preventing littoral drift will be needed and total cost will be apparently higher than a solid type.

Gravity–type structure requires a foundation mound of rocks to disperse loads. As mentioned in the sub–section 3.6.1, large rocks are not locally available. The structure needs large quantity of rocks (100 – 500 kg/pc) and it is not suitable for the wharf in Betio.

Examining the structure with consideration of the site conditions and the layout plan proposed as above, a steel sheet piled doublewall is recommended for the new wharf in Betio Port.

A 20 metre wide apron is to be paved with concrete on the wharf.

The general plan and a typical cross section of wharf are shown in Figures 3–5–1 (1) and (2).

2) Return Wall

A return seawall connecting with the wharf to the container yard will be constructed as shown in Figure 3–5–1 (1). The return wall structure will be of a steel sheet pile type with anchor sheet piles. Figure 3–5–1 (2) show a typical cross section of the structure.

(2) Seawall

1) Seawall for apron

The same structure as above is applied to the seawall for apron as shown in Figure 3–5–1 (2).

2) Seawall for Container Yard and Access Road

The site is shallow on the reef flat and wave action is small. The seawall will be low–cost structure of concrete board with fabric–sheet forms. This structure is applied to the slope protection of the Causeway between Betio and Bairiki.

Before injecting concrete grout into the fabric forms, toe parts of the slopes will be constructed with sand bags stacked up to M.H.W.S +1.80 m to prevent deformation of injected concrete.

Figures 3–5–2 (1) and (2) shows the typical cross section.

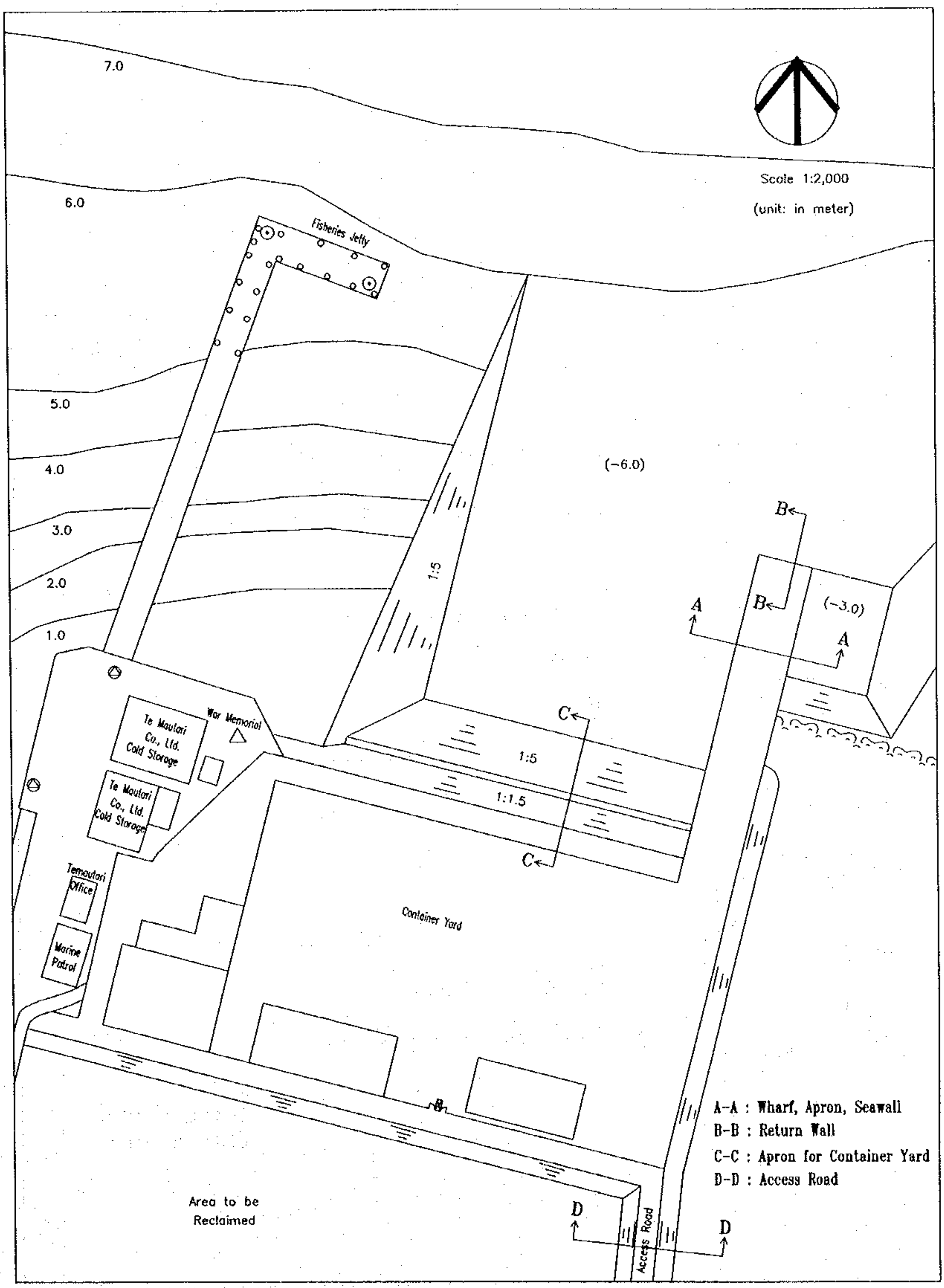
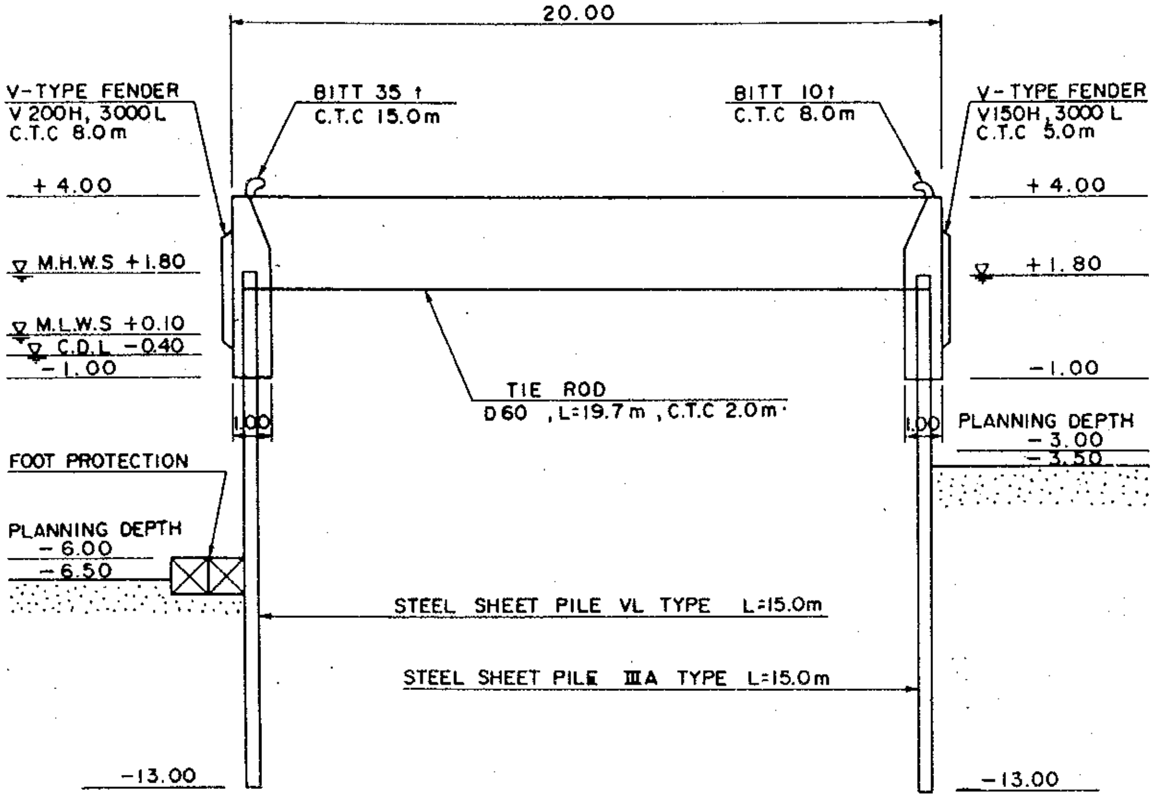


Figure 3-5-1(1) General Plan of Wharf

Cross Section A – A (Wharf)



Cross Section B – B (Return Wall)

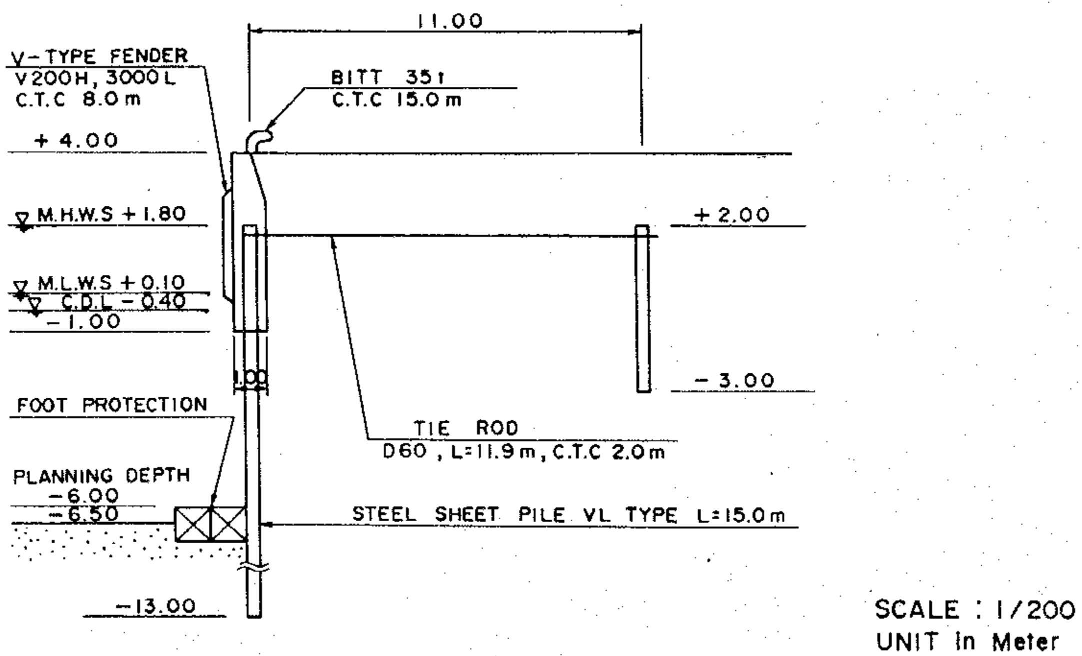
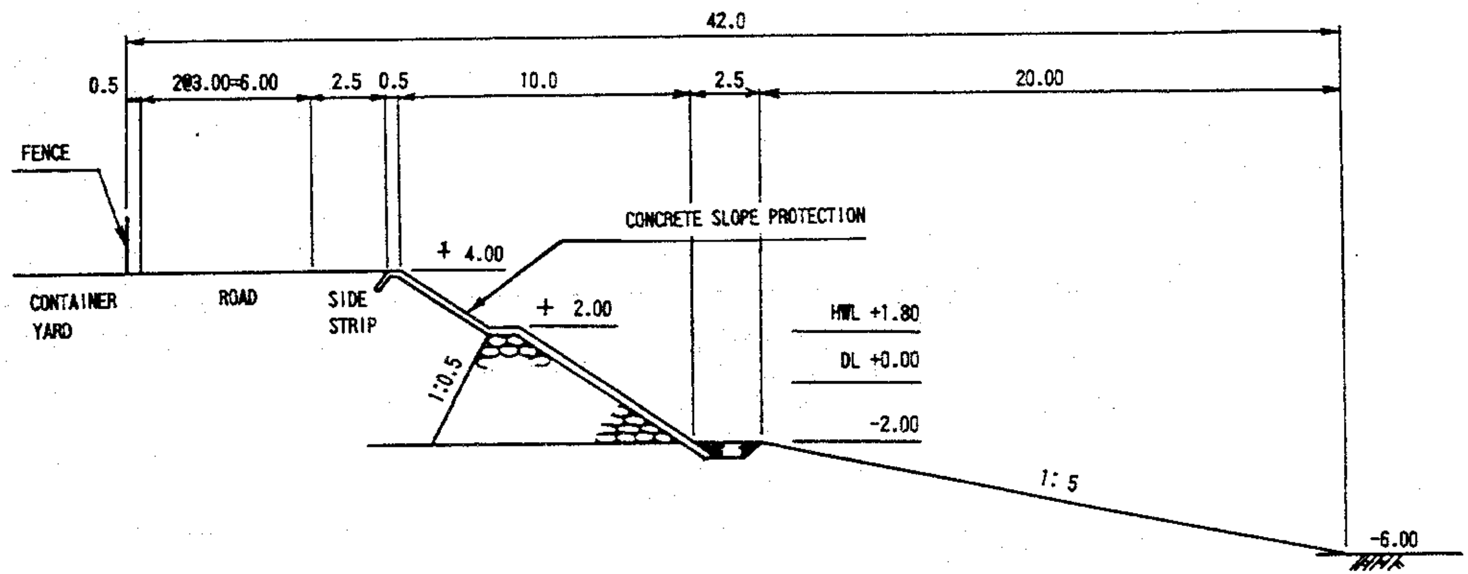


Figure 3–5–1(2) Typical Cross Section of Wharf and Return Wall

SECTION C - C



SEAWALL (FACING A TURNING BASIN)

Figure 3-5-2(1) Typical Cross Section of Seawall

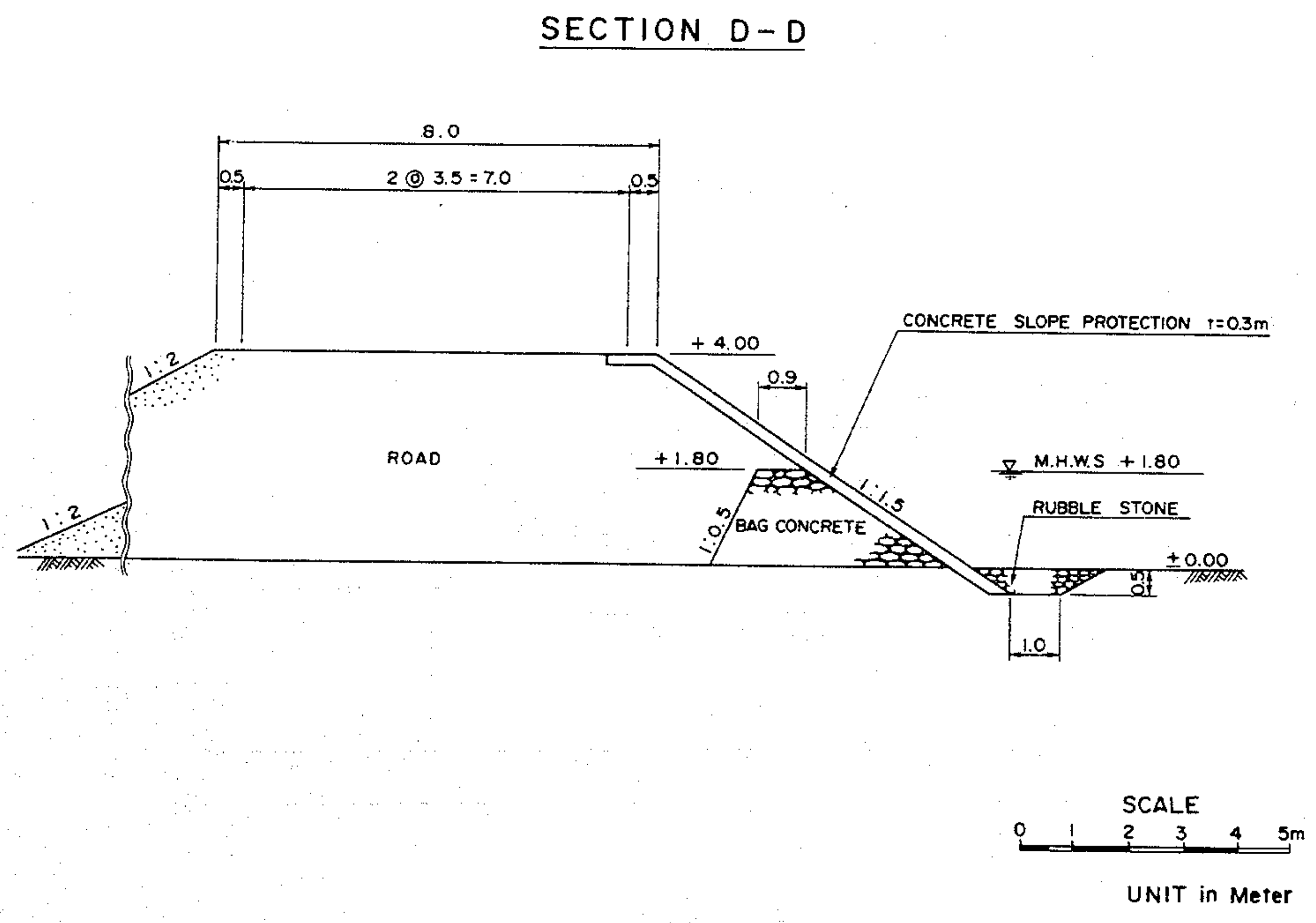


Figure 3-5-2(2) Typical Cross Section of Seawall at Access Road

(3) Buildings

1) Shed and Administration Office

The storage shed will be built in the container yard. The structure of the building will be of steel frames with anti-corrosion paint. Vinyl-coated and galvanized steel sheets will be applied to exterior walls and a roof.

The administration office for KPA will be located inside of the shed building.

2) Passenger Terminal

The terminal will be built as " Maneaba" type to create open space with fresh air.

It will be constructed with steel frames and steel plates with anti-corrosion paint will be applied to roofing.

(4) Apron and Container Yard Pavement

Due to shortage of hard rocks like basalt rocks, only friable coral rocks are used for manufacturing concrete. Reliable compressive strength of concrete is 200-230 kg/cm^2 and it will not be applicable to normal concrete pavement.

In the plan reinforced concrete pavement will be required for the apron and container yard.

(5) Lighting

For night work in the container yard lighting system will be installed.

(6) Navigational Aids

According to the proposed Conceptual Plan, the new wharf will be shifted to the eastern side of the existing harbour. It will require new arrangement of navigational aids from the entrance to the new wharf.

Figure 3-5-3 shows a new arrangement of navigational aids. Considering present conditions of all the facilities, new buoys with light and radar-reflector will be set along the fairway and a light beacon indicating the harbour will be installed in the vicinity of the wharf.

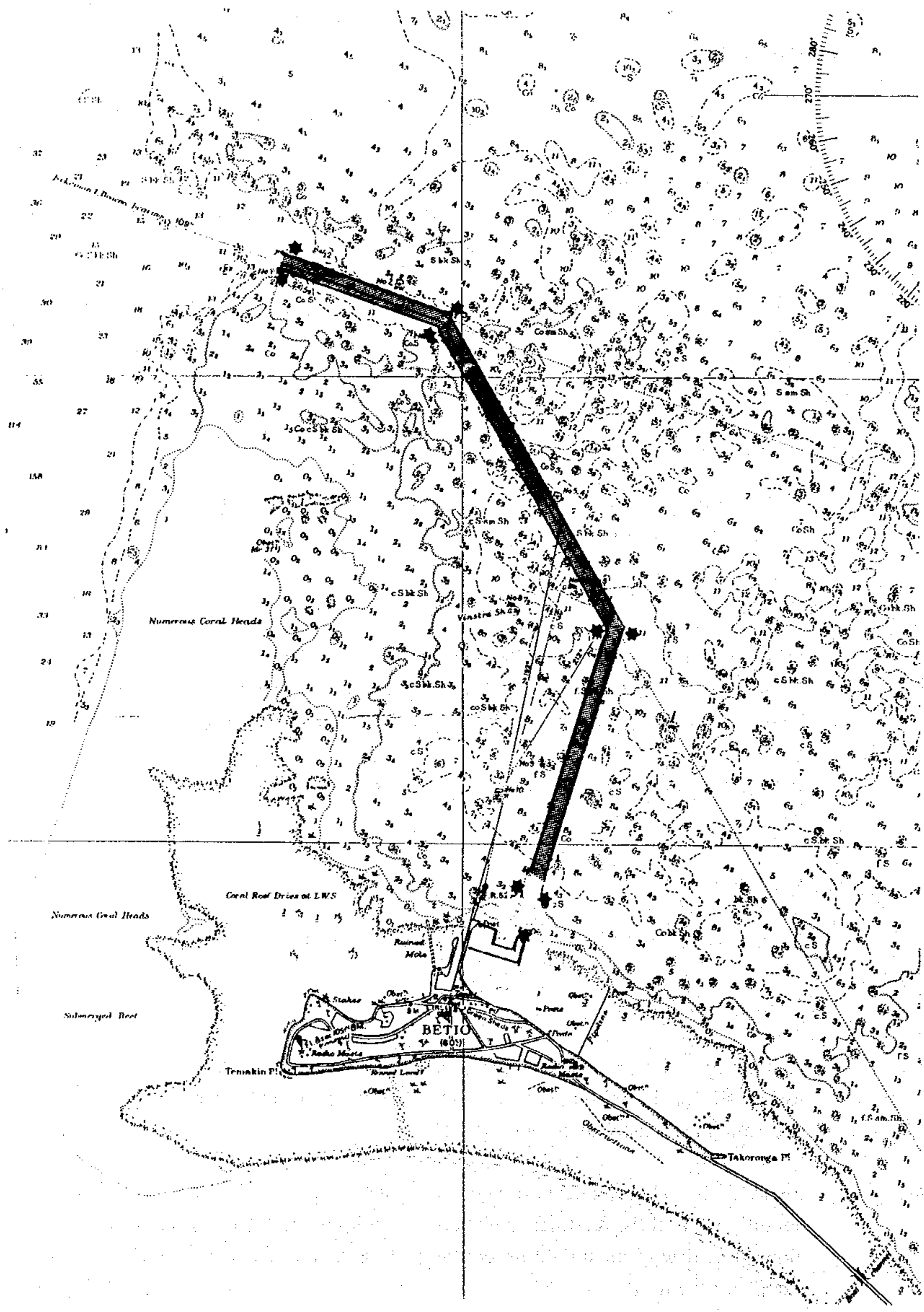


Figure 3-5-3 New Arrangement of Approach Channel and Navigation Aids

3.6 Construction Plan and Preliminary Cost Estimation

This chapter presents the construction plan and the cost estimation for Betio Port in the conceptual port development plan.

3.6.1 Construction Quantities

(1) Facilities

The construction quantities of facilities of Betio Port are shown in Table 3-6-1.

Table 3-6-1 Port Facilities and Construction Quantities

Facility	Unit	Quantity	Remarks
1. Dredging	m^3	138,648	-6.0m depth (channel and basin)
2. Aids to Navigation	LS	1	A entrance buoy, Beacons
3. -6.0m Wharf	m	80	Including berths for barges
4. Rehabilitation of -3.0m Wharf	m	130	Existing wharf
5. Slope Protection	m	775	Armoured concrete slope structure
6. Land/Road Area and Yard Pavement	m^2	33,600	Filling and concrete pavement
7. Road Pavement	m	955	Concrete pavement
8. Shed	m^2	2,300	1,100 m^2 for cargo, 1,200 m^2 for copra
9. Passenger Terminal	m^2	650	Shelter
10. Cargo Handling Equipment	LS	1	A 80t track crane, two 25t F/L, four 5t F/L, three trucktractor and trailor
11. Maintenance Dredging Equipment	LS	1	0.6 cubic meters dredger

(2) Construction Materials

The main materials needed for the construction are shown in Table 3-6-2. Water, fuel and electricity are not included in this table. As shown in the table, a great amount of materials are needed for the construction. Construction materials which are procurable in Kiribati are only sand and aggregates for concrete. Evaluating the prices and qualities of materials in adjacent countries, Japan, Fiji and New Zealand, the following procurement is preferable:

- Steel materials be procured from Japan.
- Cements for concretes be procured from New Zealand.
- Sand and aggregates for concretes be procured in Kiribati.

- Stones for slope protections, 10 kg to 100 kg weight, be procured in Kiribati, collecting coral rocks dredged in reef flat within the proposed dredged area.
- Fillings for a container yard be procured in Kiribati, using coral sand dredged in the proposed dredged area.

Table 3-6-2 Main Construction Materials

Facility	Materials				Others
	Steel (ton)	Concrete (m^3)	Stone (m^3)	Filling (m^3)	
1. Dredging	---	---	---	---	
2. Aids to Navigation	---	---	---	---	5 Buoys , 9 Beacons
3. -6.0m Wharf	780	1,790	---	7,460	Rubber Fenders (19 sets), Bitts and Bollards (12 sets)
4. Rehabilitation of -3.0m Wharf	10	195	---	---	Rubber Fenders (20 sets)
5. Slope Protection	---	1,722	4,030	---	
6. Land/Road Area and Yard Pavement	231	7,000	---	131,188	Lighting, Reefer
7. Road Pavement	74	2,300	---		
8. Shed	700	2,000	---	---	
9. Passenger Terminal	120	150	---	---	
Total	1,915	15,157	4,030	138,648	

3.6.2 Construction Procedure

(1) Basic Concept

In Kiribati construction works such as dredging, piers and other port facilities have been executed with the introduction of a foreign engineering. The proposed facilities will be able to be constructed using the same methods as before. Large scale construction equipment such as a dredger, a floating pile driver, a floating crane and so on will be procured from Japan, considering the prices and availability of those in the adjacent countries, Fiji and New Zealand. Small scale construction equipment for a road construction, road rollers and motor graders, will be locally available. Common labours for the construction works will be locally procurable.

(2) Construction Procedures of Main Facilities

Construction procedures of the main facilities are as follows:

1) Dredging of the approach channel and boat basin

A large sized grab dredger, 4.0 cubic meters capacity, will be used. The dredged coral sand will be used for the filling of a container yard. Unsuitable dredged spoils will be dumped at the lower layer of a container yard with suitable treatment, cement caking.

2) -6.0 m Wharf

A steel sheet pile structure is adopted. Flow of the construction works is shown in Figure 3-6-1.

(a) The area for driving steel sheet piles is dredged up to the designed depth in advance at the same time of dredging of the approach channel and the boat basin.

(b) After dredging, steel sheet piles of the front wall are installed at the designed position with assistance of piles of guide waling and then is driven by a floating pile driver. The top of driven steel sheet piles are arranged straight by waling channel steels using a floating crane.

(c) Anchor wall of steel sheet piles are driven and arranged in the same method as mentioned above.

(d) The area sandwiched between the two walls are backfilled up to the water surface using a clam shell. Caution shall be paid not to cause the deformation of the pile top.

(e) The front wall and the anchor wall are connected by tie ropes using a small crane and manpower.

(f) The coping concrete of the front wall is cast using a concrete pump.

(g) Backfilling is finalized adjusting the tension of tie ropes in order to arrange the face line of the front wall.

(h) Apron concrete is cast, and accessories such as fenders, bitts, lightings and so on are installed.

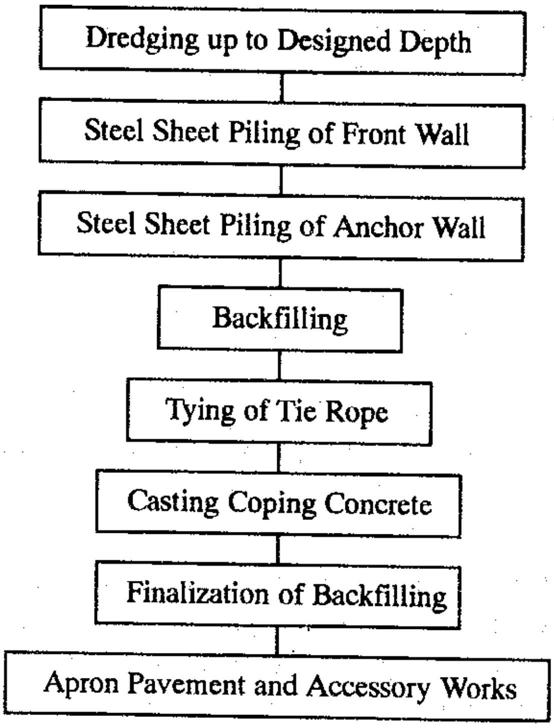


Figure 3-6-1 Flow of Construction Procedure of Steel Sheet Pile Wharf

3.6.3 Construction Schedule

Construction schedule of the conceptual plan of Betio Port is presented in Table 3-6-3.

Table 3-6-3 Construction Schedule

Facility	Unit	Quantity	Construction Year									
			1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1. Dredging	m^3	138, 648										
2. Aids to Navigation	LS	1										
3. -6.0m Wharf	m	80										
4. Rehabilitation of -3.0m Wharf	m	130										
5. Slope Protection	m	775										
6. Land/Road Area and Yard Pavement	m^2	33, 600										
7. Road Pavement	m	955										
8. Shed	m^2	2, 300										
9. Passenger Terminal	m^2	650										
10. Cargo Handling Equipment	LS	1										
11. Maintenance Dredging Equipment	LS	1										

3.6.4 Cost Estimation

The construction costs of the conceptual plan of Betio Port are estimated as follows:

(1) Estimate Conditions

1) Estimation Limit

Some limits for the estimation are as follows:

(a) The construction costs of Alternative 3 are estimated.

(b) Taxes locally imposed on materials and labours are included in the estimation.

(c) Customs duties imposed on import goods are excluded from the estimation.

(d) Land rents, compensations and insurance costs are excluded from the estimation.

2) Domestic and Foreign Portion

In general, the cost of the foreign portion includes:

(a) Articles and goods which have never been produced domestically,

(b) Articles and goods which are seldom produced domestically,

(c) And articles and goods which cannot be procured locally because of low domestic production or high domestic consumption

Based on the above criteria, the foreign portion comprises:

(a) Labour cost of the foreigners who work for foreign contractors, and the rental fee of construction equipment which belong to foreign contractors,

(b) Imported materials and goods such as steel materials, cements, bitts, fenders, aids to navigation, building materials, electric facilities and so on and

(c) Imported equipment such as cargo handling equipment and maintenance dredging equipment.

3) Exchange Rate

The following exchange rate among A$, US$ and Japanese Yen issued at the end of July ,1994 are applied:

1 Australian $ = 0.757 US$ = 75.33 Yen

4) Physical Contingency

Cost estimates include physical contingencies. Contingency rates are as follows:

(a) 0 % : Imported cargo handling equipment and other machineries and construction costs of sheds and concrete pavement

(b) 5 %: Construction cost of slope protection

(c) 10 % : Construction costs of steel sheet pile wharf and electric facilities

(d) 20 % : Dredging cost

Since the construction costs for piling and dredging works depend on the soil conditions, the physical contingency rates are high as mentioned above.

(2) Estimation Procedure

The estimation procedures are as follows:

1) The prices of main materials used for the cost estimation are shown below.

Aggregate	Cement	Steel
106 A$/m3	250 A$/ton	1,250 A$/ton

2) As for the prices of imported materials and goods, lower prices among Japan and New Zealand are adopted.

3) As for the rental fees of construction equipment, those in Japan are lower than the other adjacent countries, Fiji and New Zealand, and are adopted.

4) Overhead for construction works is fixed as 10% of the sum of the direct construction costs and expenses for expatriates, and engineering services fee as 9.5% of the total construction cost.

5) Overhead for the cargo handling equipment and the maintenance dredging equipment is fixed as 3% of the total prices.

6) Taxes such as a sales tax or an additional tax have not been applied in Kiribati.

(3) Estimation Result

The summary of the construction cost of the conceptual plan of Betio Port is presented in Table 3-6-4.

Table 3-6-4 Summary of Construction Cost

Facility	Unit	Quantity	Construction Cost ('000 AUS$)		
			Total	Foreign Portion	Local Portion
1. Dredging	m^3	138,648	4,503	3,680	823
2. Aids to Navigation	LS	1	351	309	42
3. -6.0m Wharf	m	80	5,230	3,490	1,740
4. Rehabilitation of -3.0m Wharf	m	130	407	287	120
5. Slope Protection	m	775	2,921	1,450	1,471
6. Land/Road Area and Yard Pavement	m^2	33,600	8,708	3,504	5,204
7. Road Pavement	m	955	2,013	667	1,346
8. Shed	m^2	2,300	8,223	5,756	2,467
9. Passenger Terminal	m^2	650	687	480	207
Sub-total (1 to 9)			33,043	19,623	13,420
10. Cargo Handling Equipment	LS	1	3,776	3,776	0
11. Maintenance Dredging Equipment	LS	1	1,411	1,411	0
Sub-total (10 to 11)			5,187	5,187	0
12. Engineering Services	LS	1	3,088	2,007	1,081
13. Physical Contingency	LS	1	1,641	1,207	434
Grand Total			42,959	28,024	14,935

3.7 Port Development in Christmas Islands

3.7.1 Development Plan

In Seventh National Development Plan, great emphasis has been laid on development of outer islands. The rural development will contribute to restriction of population growth in Tarawa as well as growth of country's economy. The resettlement plan will remove differences of living standard and quality of life between urban and rural areas in the country by providing improved social infrastructures and services to the immigrants

(1) Resettlement Plan

The Northern Line Islands, Washington, Fanning and Christmas officially became a part of Kiribati in 1983 and permanent settlement in Washington and Fanning started in 1988 under the on-going Settlement Scheme. All the other islands in Line and Phoenix Groups, except Canton in Phoenix Islands are uninhabited.

Funning is a large fertile lagoon island favoured with tourism potential of fishing, water sports and bird watching. A sheltered water area for anchorage exists in the island and an air strip is readily available.

Washington Island, lying about 500 km north west of Christmas Island, is of the most fertile soil for agriculture in the country with heavy rainfall.

Settlement Programme of shifting more than 6,000 persons from highly populated Gilbert Islands to Northern Line Islands for the period from 1989 to 1993 has been initiated. It is aimed to settle an optimum number of applicants to Fanning and Washington Islands. The programme has not been fully implemented due to delay of providing adequate infrastructure and support.

(2) Port Development Plan in Christmas

1) Possible Sites for Development

Two options have been proposed on the port development of London Wharf. First one is to construct a new jetty facing the western ocean near the oil depot, and second option is to rehabilitate and improve the present facility.

There is no restriction on land use for both sites. Other sites are considered in the island, however, several constraints listed below make difficult in selecting development site of the port.

* Poor road system
* Rough sea conditions outside and littoral drift inside
* Valued environment resources

With consideration of the above, the said options are proposed to be possible for the development.

2) Proposed Port Layout

Three alternatives are proposed as shown Figures 3-7-1 to 3-7-3, following the above two options. Comparison is made in various aspects and shown in Table 3-7-1.

In addition to the site options, possibility to accommodate "Matangare" will be another option to establish a plan. There is no berthing place for Matangare in the island and an ocean berth has been historically desired for the development of the Island.

Table 3-7-1 Comparison of Alternative Conceptual Development Plans

	Plan 1	Plan 2	Plan 3
Construction Cost	×	×	○
Construction Work	×	△	○
Rate of Workable Days	×	○	○
Siltation	○	×	△
Environment	△	○	○

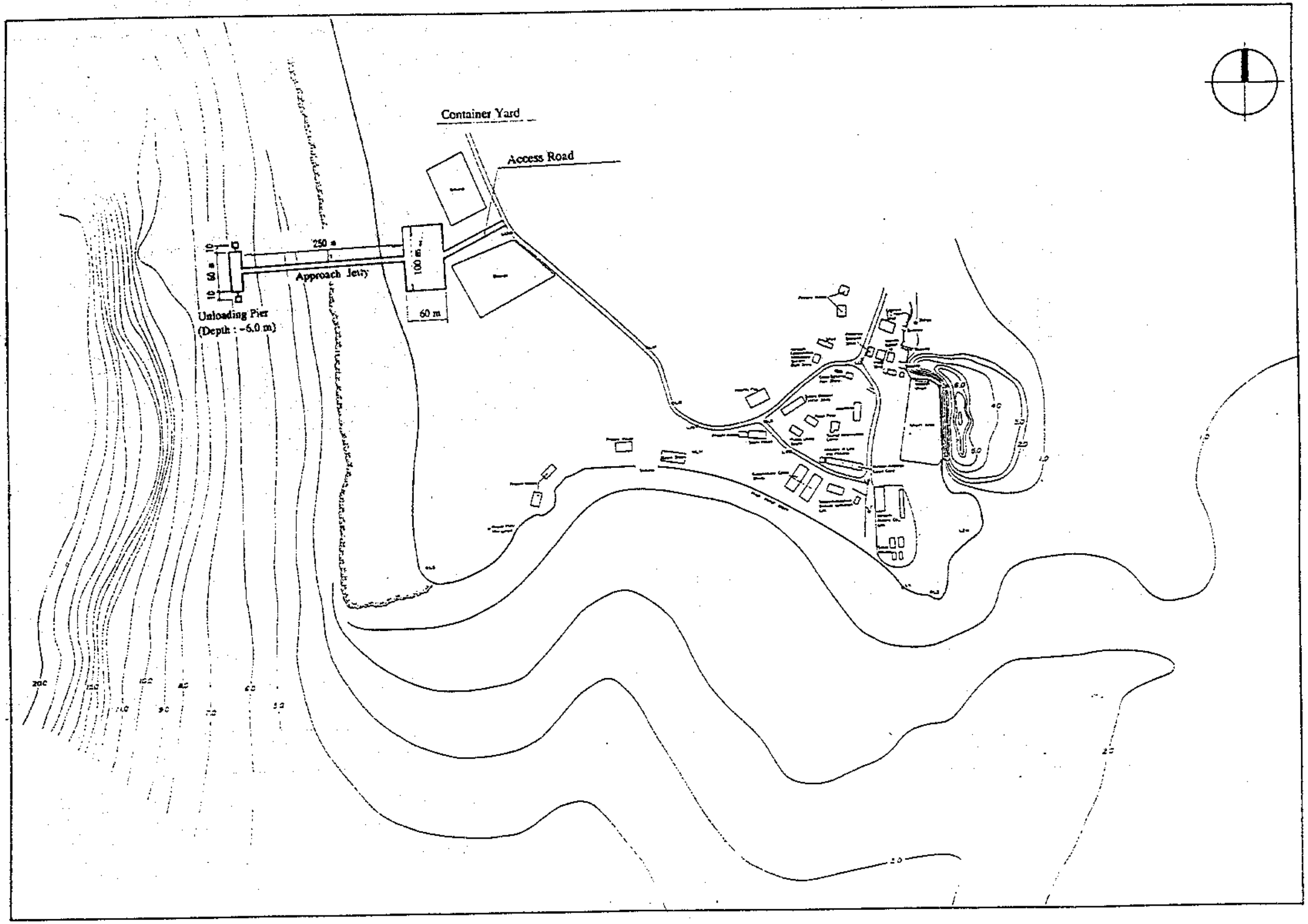


Figure 3-7-1(1) Conceptual Development Plan of London Wharf, Alternative Plan 1

OPEN-TYPE WHARF FOR CARGO SHIP AT OCEAN SIDE

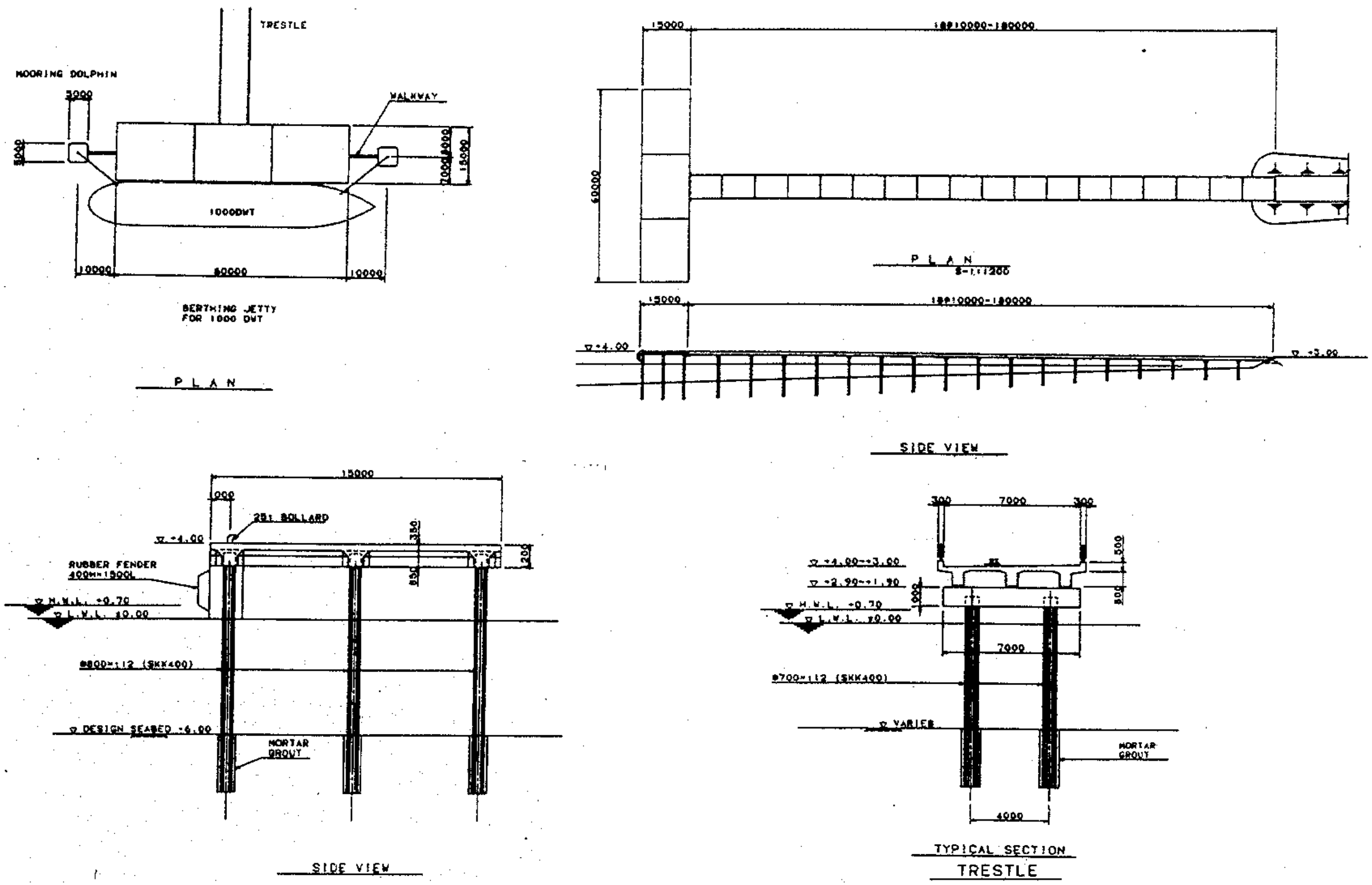


Figure 3-7- 1(2) Typical Cross Section of Main Wharf (Alternative Plan 1)

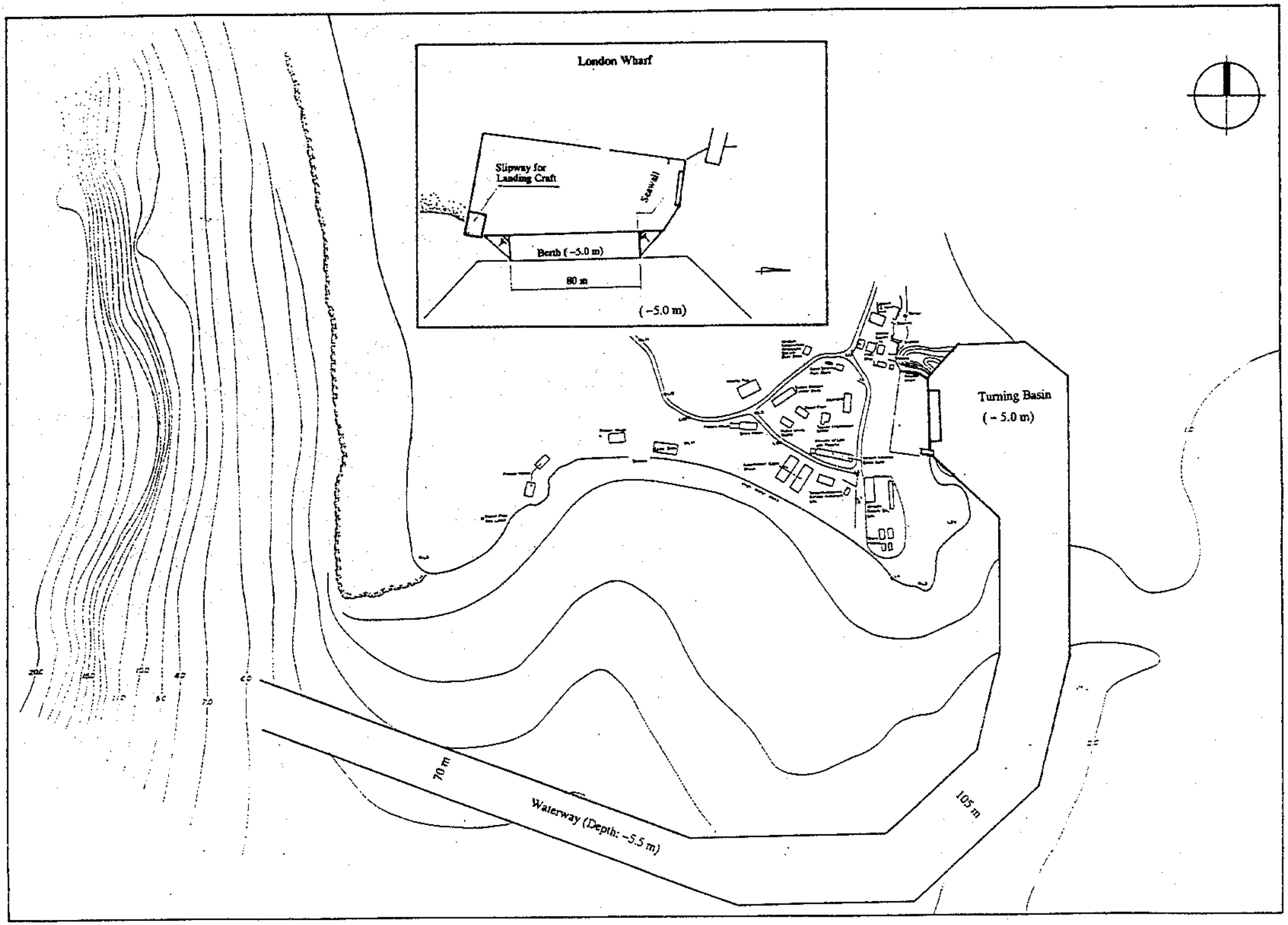


Figure 3−7−2(1) Conceptual Development Plan of London Wharf, Alternative Plan 2

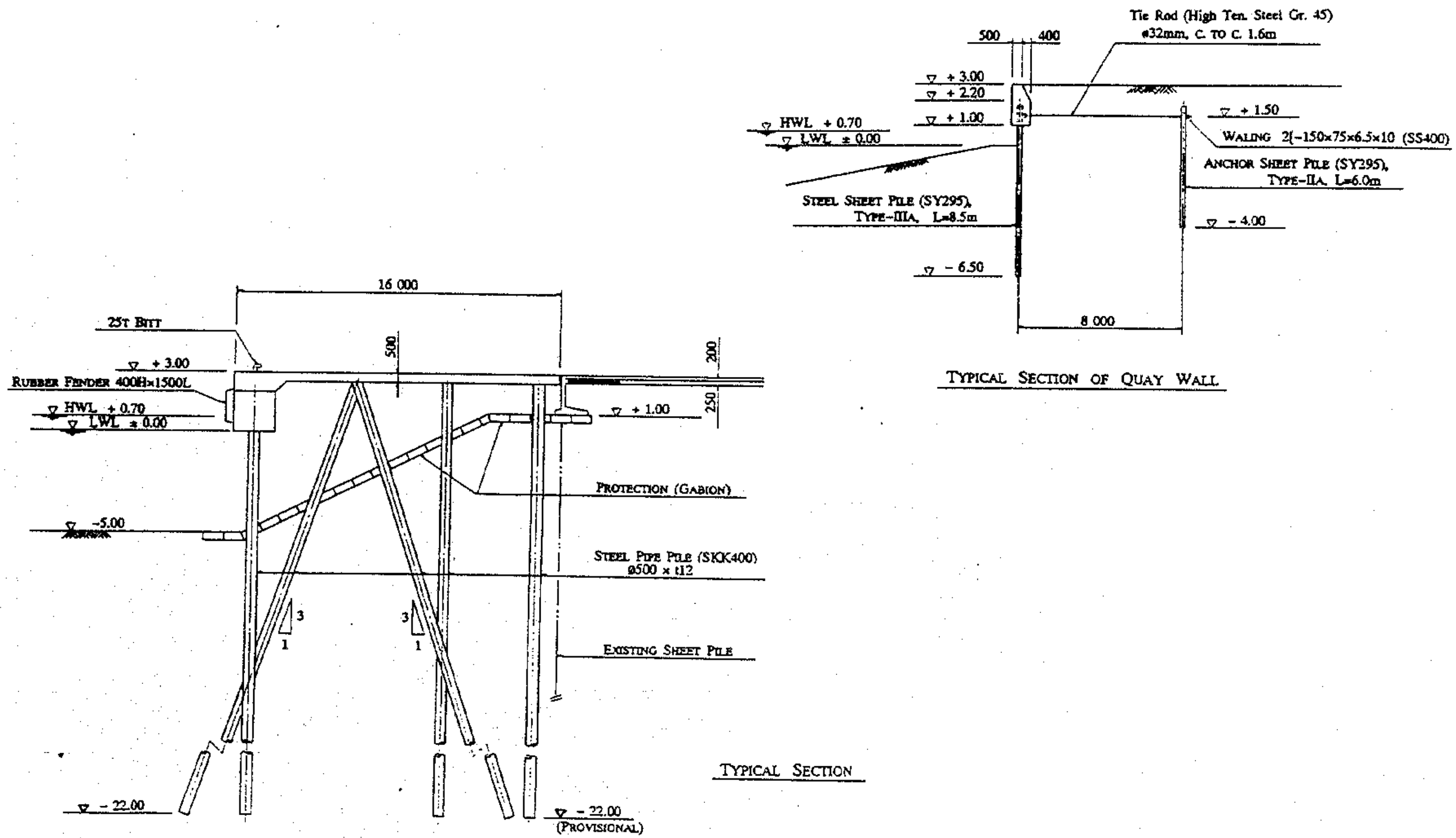


Figure 3-7-2(2) Typical Cross Section of Main Wharf (Alternative Plan 2)

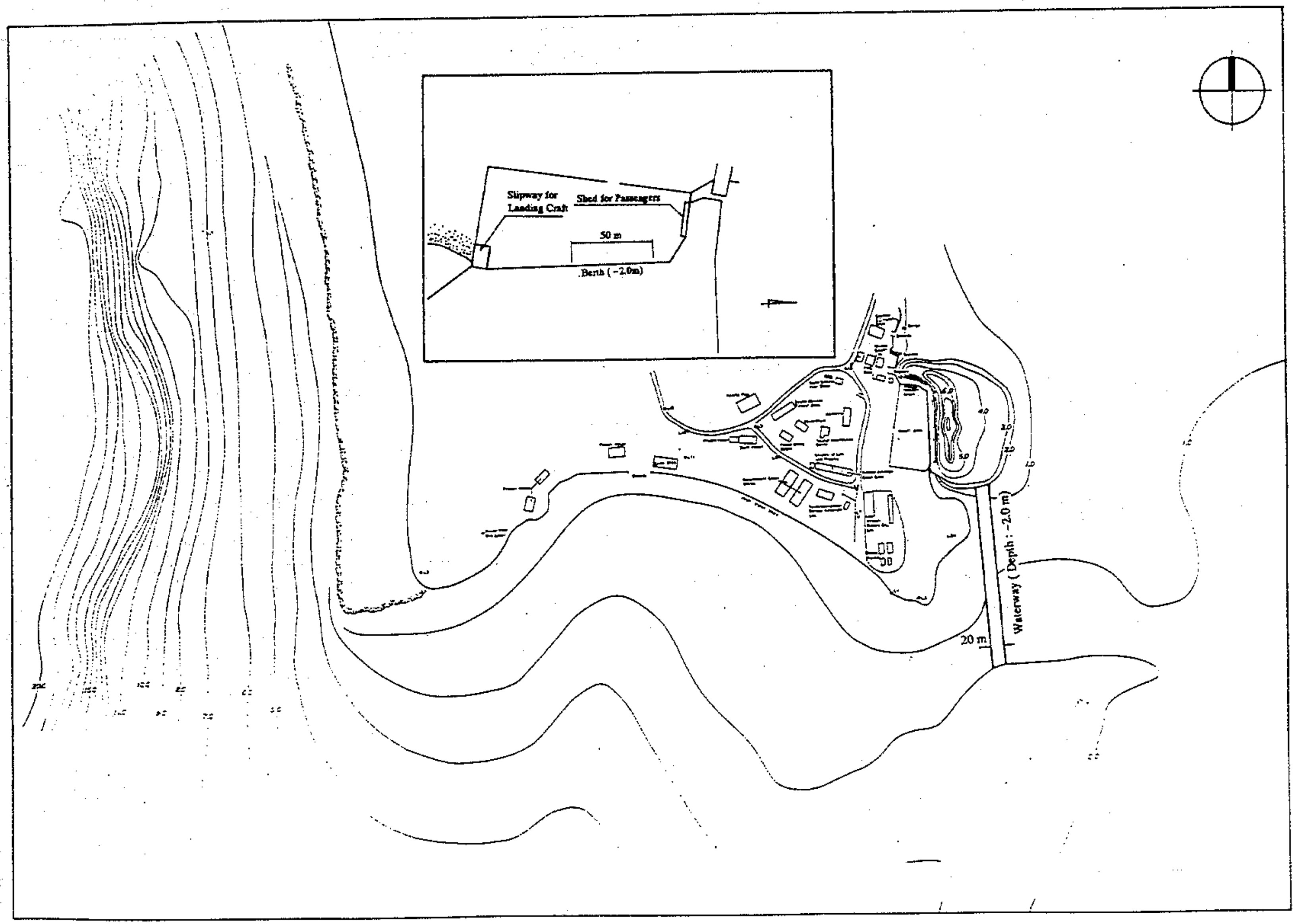


Figure 3-7-3(1) Conceptual Development Plan of London Wharf, Alternative Plan 3

QUAY WALL FOR BARGE

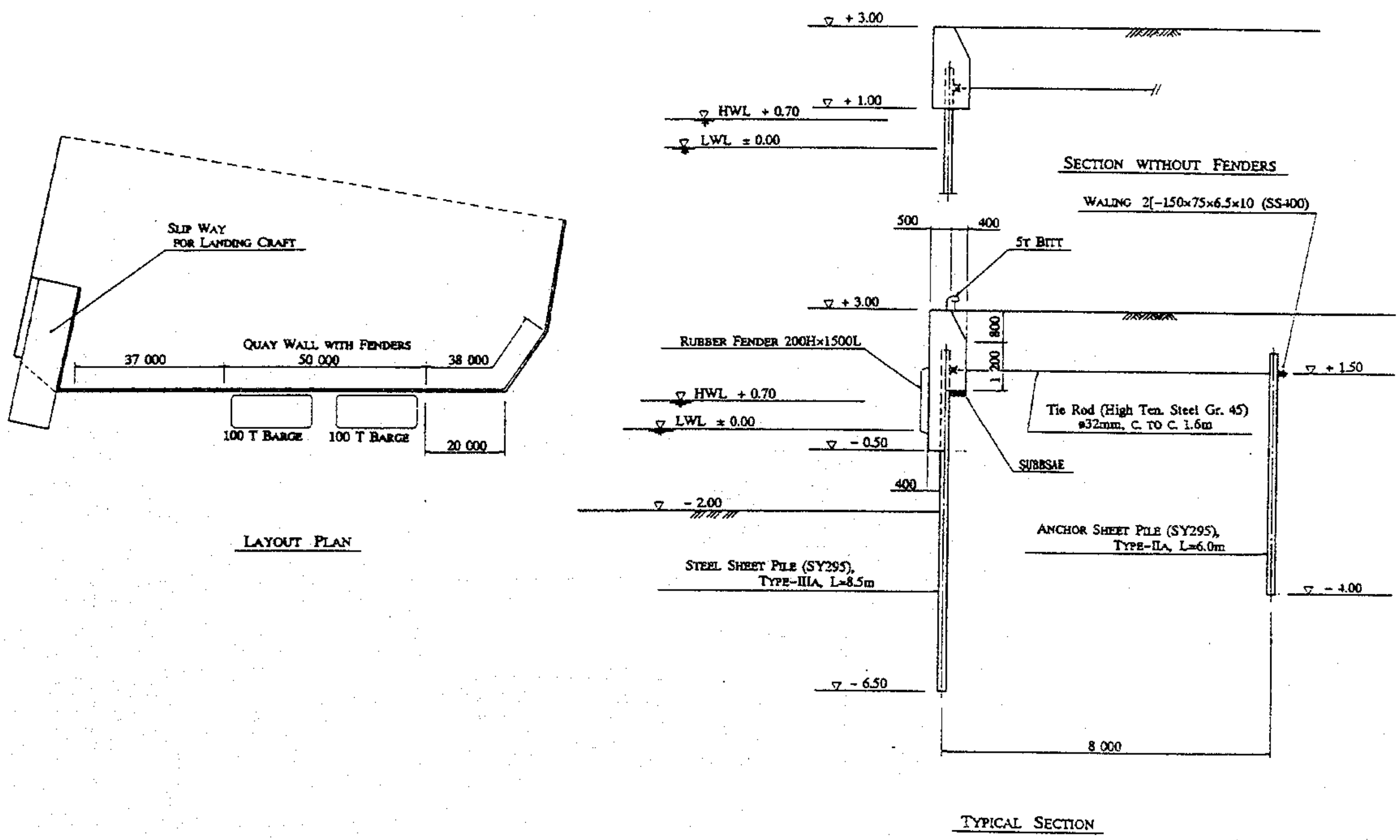


Figure 3-7-3(2) Typical Cross Section of Main Wharf (Alternative Plan 3)

Outline of the alternatives are as follows:

* Alternative Plan 1

A jetty for a berth to accommodate a Matangare-size ship is planned and container yard will be prepared on the land. Both facilities will be connected with a trestle. An access road will be from the main road to the yard and no obstruction will be there. The proposed plan is based on assumption that coral reef flat has enough compression strength to support steel piles, because of no soil information at the site. Construction cost indicated in the comparison table is estimated on the above soil assumption. Swells of long period of about 14 seconds rush to the shores and they will affect cargo handling while berthing.

* Alternative Plan 2

The plan aims Matangare's direct access to the Wharf with maintaining an access channel there. The wharf is of open-type piers to ease wave reflection. This plan will require usual maintenance dredging of the channel. Its volume will be large but not quantified at the present stage.

* Alternative Plan 3

The plan seems to be practical in every aspect. The present facility will be rehabilitated to prepare a new wharf for accommodating barges for transport of cargoes from a cargo carrier. A ramp for a landing craft will be planned. For improving efficiency of cargo handling, a small tugboat will be required. Even this plan will need maintenance dredging to -2 metres. Its volume is not clear now but will not be so huge, considering the present sea depth.

As stated in the Table 3-7-1, the alternatives are evaluated from several aspects to approach choice of Alternative Plan 3 as an appropriate one.

The summaries of the above alternative plans are shown in Tables 3-7-2 to 3-7-4.

Table 3-7-2 Summary of Construction Cost (Alternative 1)

(Unit: '000 AUS$)

Facility	Unit	Quantity	Cost	Remarks
1. -6.0m Wharf	m	60	4,000	Steel pipe pile structure, crown height +4.0m
2. Mooring Dolphin	unit	2	800	Steel pipe pile structure
3. Approach Jetty	m	250	8,800	Steel pipe pile structure
4. Land Filling	m2	6,000	500	Crown height +4.0m
5. Container Yard Pavement	m2	3,000	800	Concrete pavement
6. Access Road	m	100	300	Concrete pavement
7. Shed	m2	800	2,500	Including office(150m2)
Sub-total (1 to 7)			17,700	
8. Cargo Handling Equipment	LS	1	2,500	Two 25t F/L, two 3t F/L, four Truck-tractor and trailor, a 10t truck and a 5t truck with crane
9. Engineering Services	LS	1	1,700	
Sub-total (1 to 9)			21,900	
10. Physical Contingency	LS	1	2,600	
Grand Total			24,500	

Table 3-7-3 Summary of Construction Cost (Alternative 2)

(Unit: '000 AUS$)

Facility	Unit	Quantity	Cost	Remarks
1. Dredging	m3	560,000	11,000	-5.0m
2. Aids to Navigation	LS	1	800	A entrance buoy and 13 light beacons
3. -5.0m Wharf	m	80	5,500	Steel pipe pile structure crown height +4.0m
4. Sea Wall	m	125	2,000	L-shaped concrete block structure
5. Container Yard Pavement	m2	3,000	800	Concrete pavement, crown height +4.0m
6. Slipway	m	10	400	10m × 36m, slope 1 : 8
Sub-total (1 to 6)			20,500	
7. Cargo Handling Equipment	LS	1	900	A 25t F/L, two 3t F/L, a 10t truck and a 5t truck with crane
8. Engineering Services	LS	1	1,900	
Sub-total (1 to 8)			23,300	
9. Physical Contingency	LS	1	2,300	
Grand Total			25,600	

Table 3-7-4 Summary of Construction Cost (Alternative 3)

(Unit: '000 AUS$)

Facility	Unit	Quantity	Cost	Remarks
1. Dredging	m3	16,100	700	-2.0m
2. Aids to Navigation	LS	1	300	4 light beacons
3. -2.0m Wharf	m	50	3,000	Steel sheet pile structure crown height +3.0m
4. Sea Wall	m	75	1,500	L-shaped concrete block structure
5. Container Yard Pavement	m2	3,000	1,000	Concrete pavement, crown height +3.0m
6. Slipway	m	10	500	10m × 36m, slope 1 : 8
Sub-total (1 to 6)			7,000	
7. Cargo Handling Equipment	LS	1	4,600	A 80t Truck crane, a 200Hp tug boat, two 60 t barge, two 3t F/L, a 10t truck and a 5t truck with crane
8. Engineering Services	LS	1	700	
Sub-total (1 to 8)			12,300	
9. Physical Contingency	LS	1	2,000	
Grand Total			14,300	

3.8 Maintenance Dredging Operation

There are constraints on littoral drift at all the ports in Kiribati, however, any measures to maintain channels and basins have not been taken for long years. It is understood that no maintenance was made due to unavailability of dredgers and shortage of maintenance budget.

In the occasion of establishing the development plan, maintenance dredging shall be discussed for all the ports in this country. It is obvious that maintenance dredging is required even at the present stage and that it will activate the ports to improve cargo flows like foodstuff in the outer islands.

3.8.1 Maintenance Dredging in Betio Port

(1) Volume of deposited sand in the port

As discussed in sub-section 3.4.3, total volume of sand deposited in the port is summarized below:

	Siltation Volume	Area of Port *	Siltation Rate
Existing port :	1,000 m^3/year	38,000 m^3	0.03 m/year
New port :	1,000 m^3/year	27,000 m^3	0.04 m/year

* Area of Port Water includes a channel and a basin.

As mentioned in sub-section 3.4.3, application of simulation models to an actual site leaves some difficulties to accurately predict future topography due to littoral drift. The siltation rate shown above includes allowance and shows average change of seabed depth.

Actual topography will change with other irregular causes to induce partial sand deposition and erosion. For maintenance of the port, dredging will be required to keep necessary water depth in a basin and a channel of the port.

(2) Proposed Dredging Method in Betio Harbour

Maintenance dredging is proposed in the conceptual plan for Betio Port. Dredging operation required in Betio Port will not be so frequent in Betio Port because sand deposition in a new basin is expected to be small. However no maintenance against suspended sediment will cause sand deposition like the present harbour basin. Periodical maintenance to keep an existing channel and a new basin will be required. According to results of computer simulation on littoral drift, significant sand deposition will not occur but about 1,000 m^3 of sand deposition in the both basin will be expected, considering allowance of simulation.

In spite of a small sand deposition, it is not allowed for safety maneuvering not to maintain the channel basin. Therefore, an economical and minimum-size dredging system below is proposed for the port.

* A crawler crane (25 t) mounted on a flat barge

The outline of the dredger is shown in Figure 3-8-1.

Thickness of accumulated sand on the seabed is estimated to be about 0.1 m in average and maintenance dredging will not be required every year. Dredging will be conducted when any obstacles or shallow places are found on the seabed but it is recommended that dredging be carried out every 10 years normally with irregular dredging. The recommendation is based on calculation allowance for sand deposition and soft sandy-seabed material.

3.8.2 Dredging Method in Outer Islands

The above system will be carried by Matangare to the outer islands for maintenance dredging when required. This dredging equipment will be operated for shifting with own winches and it will not need any helps by tugboats.

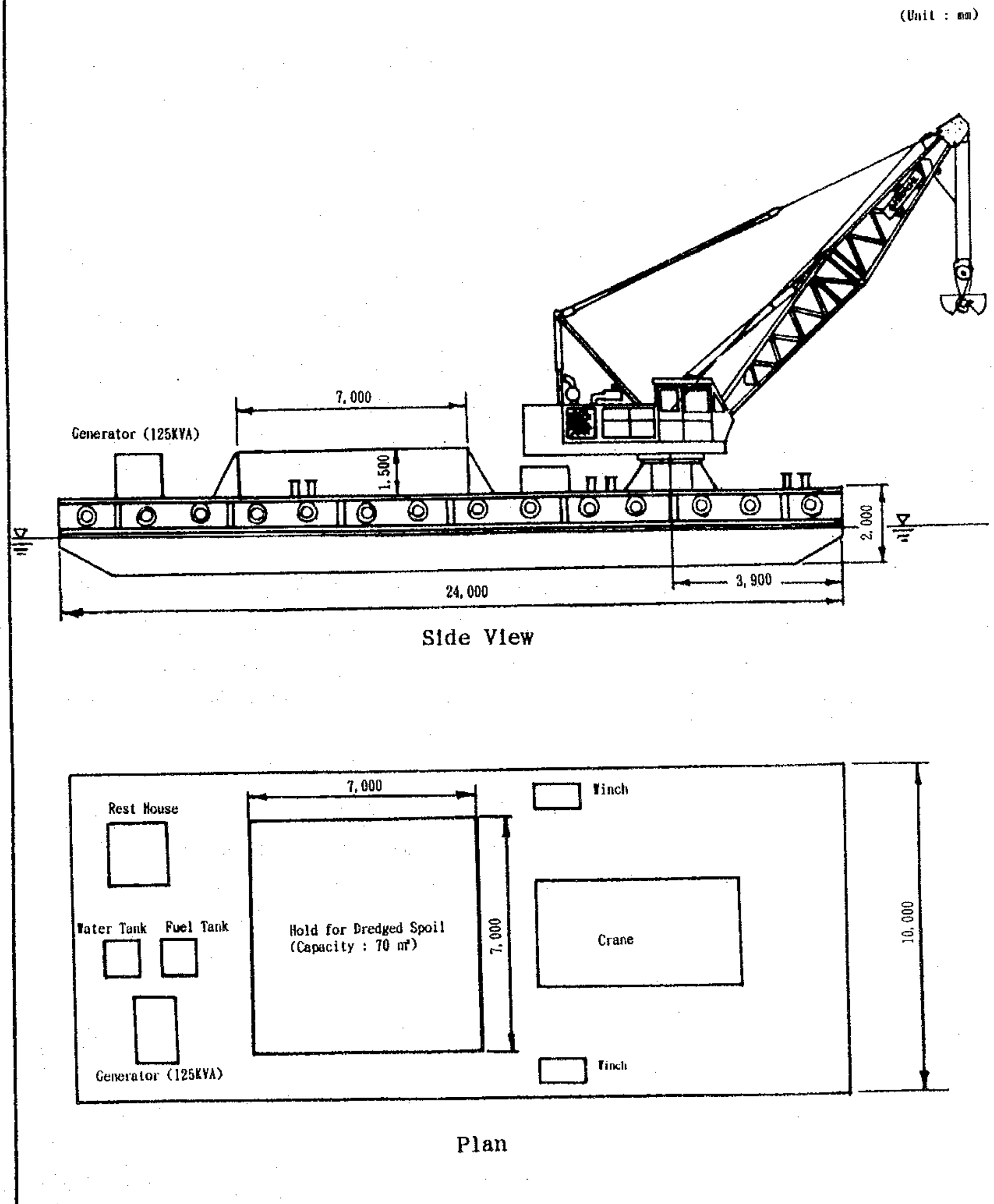


Figure 3-8-1 Outline of Proposed Dredger

Accumulated material in the channels or basins in the ports of outer islands consists of silty sand, sand or small stones. Dumping dredged spoil will be prohibited to reserve sea environment. So the dredged material will be unloaded on land and it will be used for fine sand for concreting or reclamation.

As discussed in sub-section 2.5, all port facilities the study team visited were not well maintained with problems of sedimentation in the channels and basins.

Considering the scales of these facilities and port operation system, additional investment will not be feasible for construction of breakwaters to prevent littoral drift. To determine these scales of facilities, surveys on marine conditions will be required. Since littoral drift around the outer islands is very dynamic according to the study team's view, it is apparent that it will cost so much to protect the ports from sedimentation. So dredging will be most helpful for efficient operation in these ports in the course of provision of a dredger.

Dredging equipment will be operated by KPA and it is recommended that MLPD will finance KPA for dredging in outer islands when required. The superintendents in the outer islands shall keep monitoring the channels and basins to find appropriate timing to start dredging. It is easily conducted through communication with ships' captains who will inform them of the timing.

The present study team's findings on the sedimentation problems are that these problems will occur so frequently because of locations of the facilities as stated in sub-section 2.5. So it is impressed that monitoring of sedimentation in the channels or basins will be indispensable to determine timing to conduct dredging.

CHAPTER 4

IMPROVEMENT PLAN OF BETIO PORT

4. IMPROVEMENT PLAN OF BETIO PORT

4.1 Basic Planning Policies of Improvement Plan

The target year of the improvement plan is set as the year 2000, five years before the target year of the conceptual plan. Volume of cargoes handled in the port is forecast about 20 % less than that in the conceptual plan. This small difference is to necessitate almost the same scale reinforcement of port capacity as that in the conceptual plan. The improvement plan to Betio Port is to make up for a long period of no investment and in the following five year period till the conceptual plan, an entire system of port management shall be renovated for a further investment for full development of the port.

The improvement plan with the target year of 2000 shall be worked out in line with the basic planning policies of the conceptual development plan with the target year of 2005 to keep overall continuity of long term port development.

Following are the main premises of planning the improvement plan;

1) Project scope of the improvement plan shall be determined in line with the conceptual development plan.

2) Scale of the port facilities shall be planned to meet a traffic demand forecast in the target year of 2000.

3) The existing port facilities to be, in transition to the conceptual development plan, efficiently used for copra export by barges, small vessels of private ship operators, informal sector and small fishing boats.

4) Betio Port requires urgent improvement to both port facilities and management, and the urgency of the project is reflected in planning.

4.2 Port Layout and Facilities

4.2.1 Port Layout

The improvement work to Betio Port is planned according to the above policies and the proposed layout of the container terminal is shown in Figure 4–2–1. As shown, the layout of civil structure is almost the same as those proposed in the conceptual development plan. All the yard and road layouts are the same except for the landward boundary of container yard which is shifted 20 m seaward. This 20 m by 230 m land area is assumed to be first reclaimed with sand dredged from maintenance operation to form the eventual container yard planned in the conceptual development plan. Major differences in the plans are a smaller area of container yard, a cargo shed and an open storage and a smaller number of cargo handling equipment.

4.2.2 Required Port Facilities and Equipment

(1) New Wharf

The dimensions of a new wharf is the same as the conceptual plan shown in Chapter 3.

Width of apron is designed 20 m wide to permit temporary stacking of large number of containers on an apron for a possible down time of yard equipment and barge operation along the rear of the wharf.

The new wharf is designed to be dredged –3 m at the back and can accommodate tug and barge and the other small ships.

(2) Container Yard

As mentioned in sub–section 3.3.3, total TEUs handled in Betio Port in 2000 is fore–cast to be 436 and the same stacking tiers in the yard will be followed as 2.5 for laden and 3 for empty containers. Principal stacking layout is the same as the conceptual plan, since difference between estimated TEUs in 2005 and those in 2000 is not so large and additional TEUs in 2005 from those in 2000 will be stacked outside of slots in the improvement plan as shown in proposed container yard layout plan of Figures 4–2–1(2).

(3) Shed

1) Shed for General Cargo

The conditions and assumption stated in sub-section 3.3.3 are applied for calculating shed area to meet forecast cargo in 2000.

A number of TEUs excluding transship containers to be discharged from CCS (Baltimar Boreas) in year 2000 is a base figure for calculation of required shed area. It is assumed that 75% of 141.9 TEUs (number of containers per call given in Table 4-2-1), 106.4 TEUs, are unstuffed to the shed. Container cargoes dwelling in the shed are 30 % of unstuffed 106.4 TEUs at the peak time on 7th day, i.e. 31.9 TEUs.

Table 4-2-1 Imported Containers by Carrier, 2000

	TEU/year	Nos. of call	TEU/call
CCS	1,606.2 (1,461.5)*	10.3	155.9 (141.9)
BHL	315.2	6.0	52.5
KSSL	819.6	12.5	65.6
Total	2,741.0		273.9

*( ) shows TEUs excluding transship containers.

Peak factor to allow fluctuation of import containers is found to be 1.4 times of the average.

Possible container cargoes to be stored in a shed in terms of TEU are 31.9 x 1.4 TEUs plus containers dwelling from previous ship assumed to be 10% on the 14th day, giving 55.3 TEUs.

19 freight ton per TEU and 2.5 t/m^2, average cargo weight per sq. metres in a shed are assumed and necessary floor area of the shed including passages of 50% of floor area is calculated as:
$(31.9 \times 1.4 + 10.6) \times 19/2.5 \times 2 = 839\ m^2$

The planned floor area of a shed for the target year 2000 is rounded to 800 m^2.

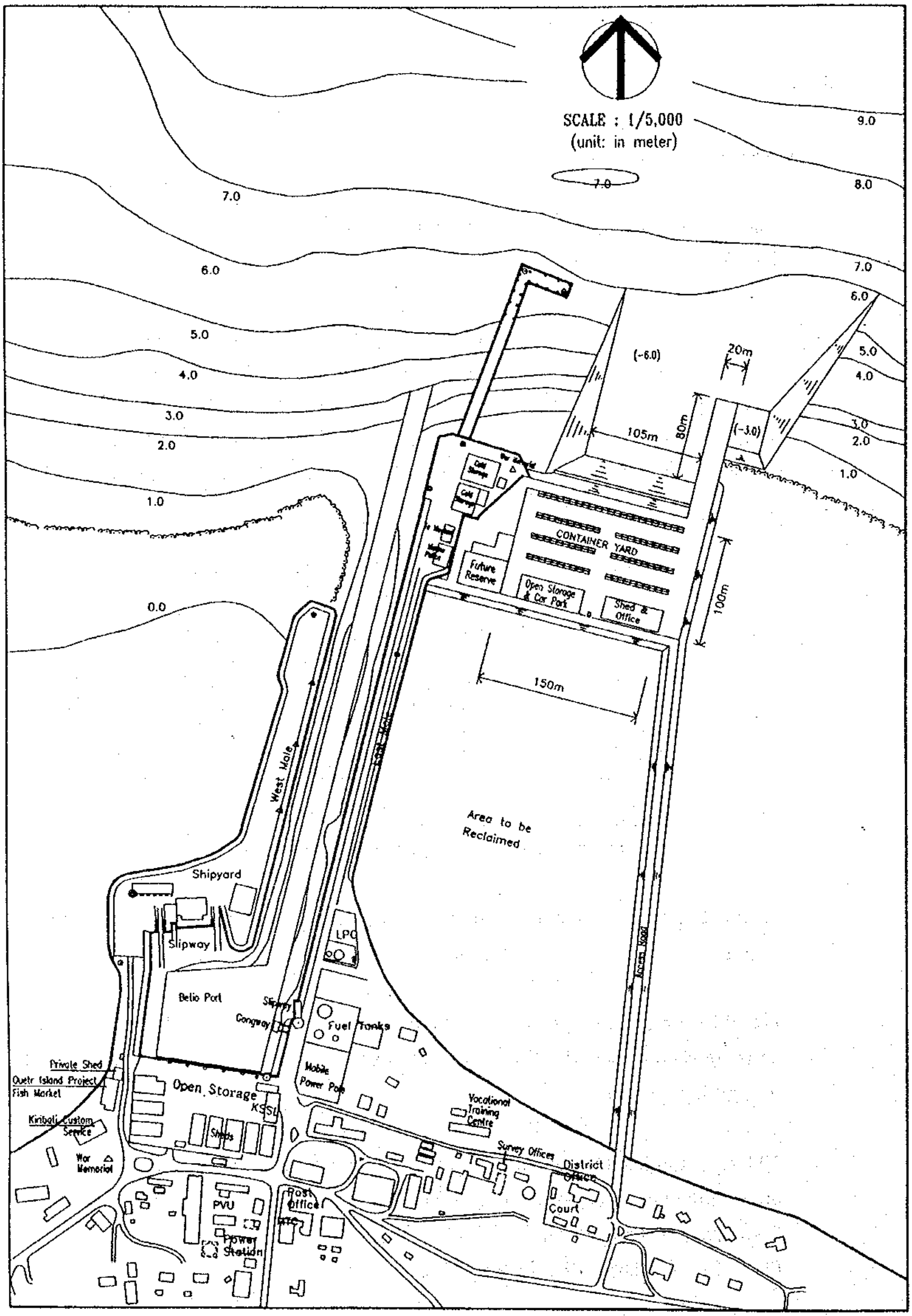


Figure 4-2-1 (1) Proposed General Layout Plan
(Improvement Plan)

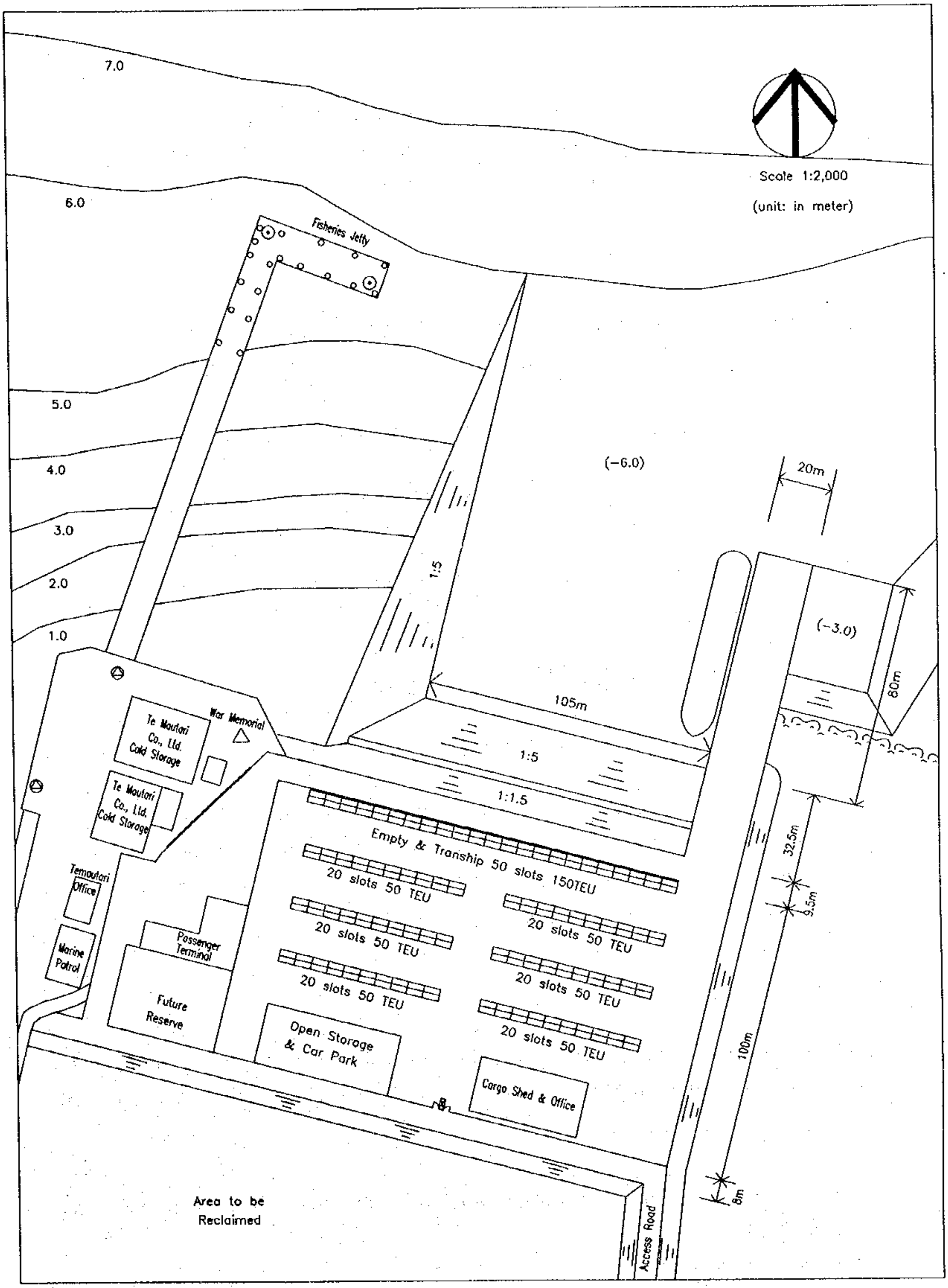


Figure 4-2-1 (2) Proposed Container Yard Layout Plan

2) Existing sheds

Floor area of three copra sheds is not enough and the shed No. 7 is planned to be converted to a copra shed to release overstoring and resulting inefficient handling. Export copra is planned to be stored in the existing sheds until the conceptual plan when the shed wide enough to store one export lot of copra is provided.

(4) Cargo Handling Equipment

Cargo handling equipment are required in addition to those available at present for each step of operation as listed in Table 4-2-2.

Table 4-2-2 Required Cargo Handling Equipment

Container Cargo Movement	Required Equipment	Nos.
1) Barge <-> Wharf	80 t Mobile Crane	1
2) Wharf <-> Yard	Tractor/Trailer	(2)*
3) In yard	25 t Forklift	1
4) In shed	5 t Forklift	2
5) Consigner/consignee <-> Shed/Yard	Tractor/Trailer	(1)*

* Tractor/Trailers presently owned by KSSL

In the case that a ship berth alongside the wharf, 80 t mobile crane will be used for handling containers on wharf. Introduction of new tractor/trailers will not be made on this stage and the same equipment owned by KSSL will be used for handling until purchase of the equipment at the conceptual plan stage.

(5) Passenger Terminal

A base number of passengers for calculating terminal area is 331 and its increase rate is 3.6% as mentioned in sub-section 3.3.4 for the conceptual plan. Passengers in 2000 is forecast to be 425 persons.

A unit area per person in the waiting room is 1.2 m^2 and a total area to meet the number is:

$425 \times 1.2 = 510$ (m^2)

An office for ticket sale and a toilet will be planned with an area of 46 m^2.

A total floor area of the passenger terminal is 556 m^2 and rounded to 560 m^2.

Passenger terminal is constructed adjacent west of the container yard and access to the wharf is aligned along the front of container yard. Separation of passenger from cargo operation is essential for efficient and safe port operation and a fence shall be erected for segregation. Passenger will not suffer inconvenience presently experienced after opening of the terminal.

(6) Office for Kiribati Ports Authority

Staff organization at the stage of the improvement plan will be the same as that at the conceptual plan stage. Therefore, required floor area for the KPA office will be 350 m^2 as stated in subsection 3.3.4.

(7) Access Road

Road connection between landward end to the existing port and Bairiki is very narrow for future port traffic and shall be improved by the Kiribati Government.

The new access road to the container terminal is planned to run from the southeast corner of the container yard to the district court. Area of the shallow reef flat area in west to the access road is measured at 150m x 500m = 75,000 m^2. This area will provide an area for dumping rubbish collected in Tarawa and the surface will be covered with sand taken from maintenance dredging operation in approach channels and turning basins in the existing and new ports. This future spacious land area will release overpopulated Betio City from a serious shortage of land. The reclaimed area is advantageously located between the port and center of Betio City and could be utilized for such port related functions as cargo storage, stevedore, bank, shipping agent, etc. as well as the other general purpose of light industry, office, shop, residence, etc.

In the process of reclamation, the area will be used for dumping rubbish and dredged sand which will contribute to preservation of environment in the island. Illegal dumping of rubbish in Betio area mar city environment and provision of dumping space has been a long recognized social need. While, sand material dredged in channel and basin maintenance will be used for creating land instead of dumping it offshore.

(8) Open Storage

The existing container yard is to provide an open storage to some extent and an area west of the cargo shed supplements it with the open yard to be created in the existing container yard after provision of a new port facility.

(9) Rehabilitation Works

1) Existing Wharf in the Basin

As mentioned in the sub-section 2.3, the existing wharf backing up the container yard is seriously deteriorated. In the conceptual plan targeting year 2005, the new container yard will be provided and the existing yard will be obliged to change its role. The existing facility, as mentioned in the Plan, will function as mooring wharf for KSSL floating equipment, ships to be repaired in BSL, private ships, informal ships, small fishing boats, leisure boats, etc.

To extend a life of the facility for its efficient utilization, the wharf is required to be rehabilitated.

Rehabilitation works of the facility will be only to protect the existing wharf from further corrosion instead of construction of a new wharf.

2) East and West Mole

The section 3 of Chapter 2 mentions that concrete-bagged slope protection of the two moles are partially damaged and cave-ins are found due to filling sand washed away. Serious damage like breakage of a shoulder of the bank is caused, however, only primitive repair will be required for most damages.

Special material like steel will not be necessary; only concrete and sand will be used for rehabilitation. The urgent repair works to the damaged portions are necessary.

Considering path conditions and traffic on the moles, especially East Mole, a cargo traffic flow outside a new container yard in future will be planned to be separated from the existing traffic on the mole.

4.2.3 Examination on Littoral Drift

Significant topographic changes in the wide area as stated in sub-section 3.4.3 will not occur in the proposed layout plan for the Improvement Plan, since the size and layout of the port facilities for the Improvement Plan is almost the same as the Conceptual Plan.

Numerical simulation on shoreling in the turning basin is conducted for three options of the layout plans mentioned below, to examine stability of the dredged turning basin with consideration of necessity of a breakwater annexed to the west side of the turning basin.

1) No west breakwater
2) A west breakwater of 70 m to be extended to -3 m deep
3) A west breakwater of 120 m to be extended to -5 m deep

The same methods are applied to numerical simulation as mentioned in sub-section 3.4.3.

The calculation results show that total volume of sand deposition is estimated to be in the order of not more than 1,000 m^3 and that significant difference of topographic changes will not occur among the three options. It is concluded that maintenance dredging of 1,000 m^3 as minimum siltation will be also required for the implementation plan , as stated in sub-section 3.4.3, without provision of a west breakwater.

4.3 Structural Design

4.3.1 Proposed Port Facilities

(1) Mooring Facility

1) Wharf

The layout of the improvement plan for year 2000 is proposed with consideration of environmental aspects including sedimentation also.

The steel-sheet-piled quaywall is recommended as the wharf structure in the improvement plan with consideration of the site conditions as stated sub-section 3.5.3 for the conceptual plan.

The general plan and a typical cross section are shown in Figures 4-3-1 (1) and (2).

2) Return Wall

In extended part of the wharf stated above, the return wall will be constructed with steel sheet piles and anchor sheet piles are required for the structure as shown in Figure 4-3-1 (2).

(2) Seawall

1) Seawall for apron

The same structure is applied to the seawall as shown in Figure 4-3-1 (2).

2) Seawall for Container Yard and Access Road

The seawall will be low-cost structure of concrete board with fabri-sheet forms as the structure for the conceptual plan. Figure 4-3-2 (1) shows the typical cross section of an access road and Figure 4-3-2 (2) shows the section of a seawall facing a turning basin.

(3) Buildings

1) Shed and Administration Office

The storage shed will be built in the container yard. The structure of the building will be of the same specifications as stated in sub-section 3.5.3.

The administration office for KPA will be located inside of the shed building. General layout plans and elevations of the building are shown in Figures 4-3-3 (1) and (2).

2) Passenger Terminal

The terminal will be built as " Mancaba" type with same specifications as mentioned in sub-section 3.5.3. Figures 4-3-4 (1) and (2) show general layout plan and elevations of the facilities, respectively.

(4) Apron and Container Yard Pavement

A reinforced concrete pavement will be applied for the apron and container yard as the same as that in the conceptual plan.

(5) Lighting

For night work in the container yard lighting system will be installed. According to "Technical standards for port and harbour facilities in Japan", intensity of illumination is required as follows:

Facilities	Standard Intensity of Illumination (lx)
* Apron	50
* Container Yard	20

Lighting facilities will be provided to satisfy the above requirements.

(6) Navigational Aids

Following the proposed improvement of plan in line with the conceptual plan, arrangement of navigational aids from the entrance to the new wharf will be newly proposed as same as the conceptual plan.

4.3.2 Rehabilitation of the Existing Wharf

The existing wharf will be rehabilitated with minimum cost both on account of cost considerations and future utilization. Typical cross section is shown in Figure 4-3-5.

To improve stability of the wharf and protect further damage, the corroded steel sheet piles of the wharf will be covered with concrete. Concrete mass will be supported with reinforcing bars welded on the surfaces of steel sheet piles.

Rubber fender system will be installed to protect the facility from collision of barges and small crafts.

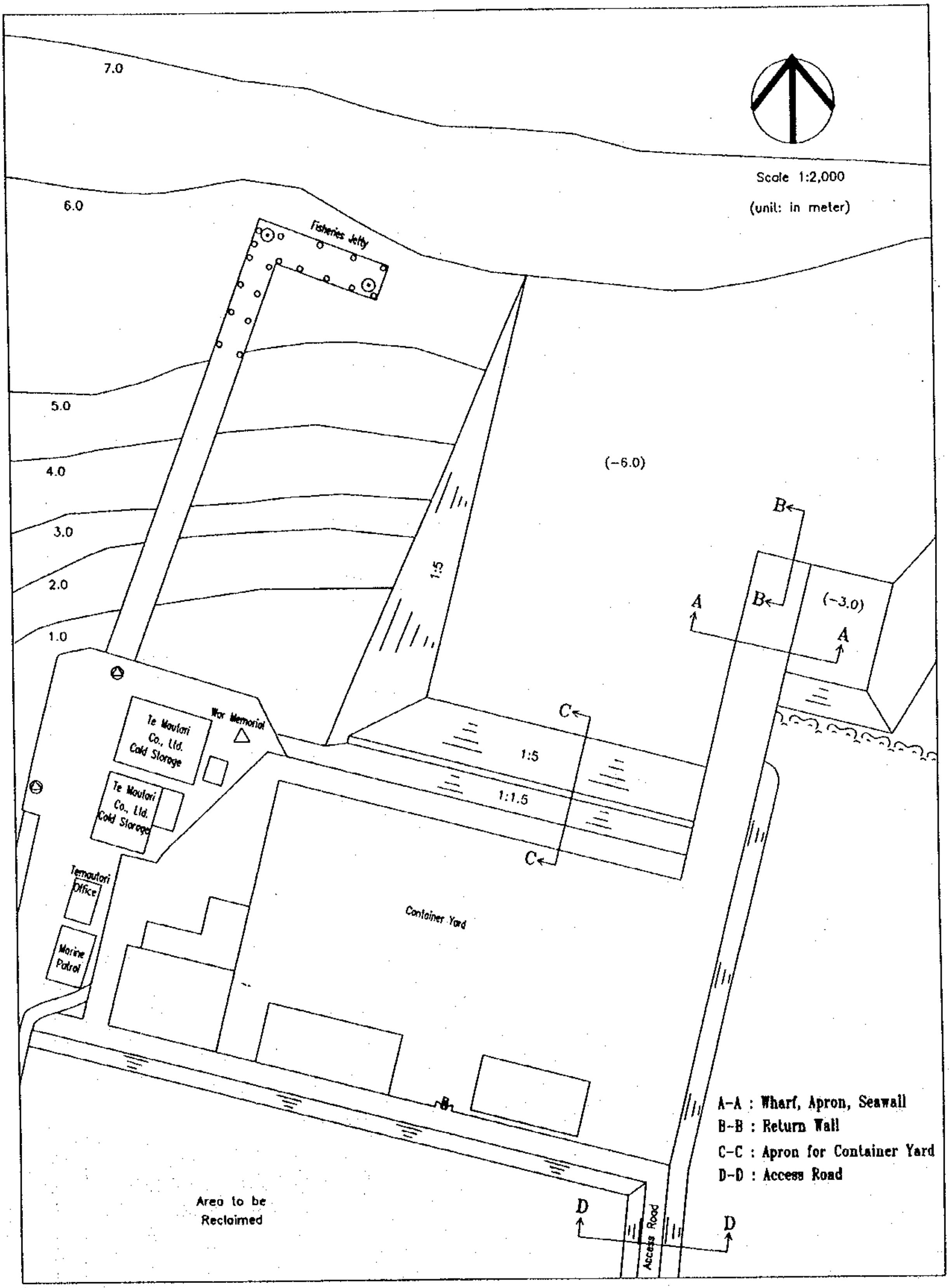


Figure 4-3-1(1) General Layout Plan of Wharf

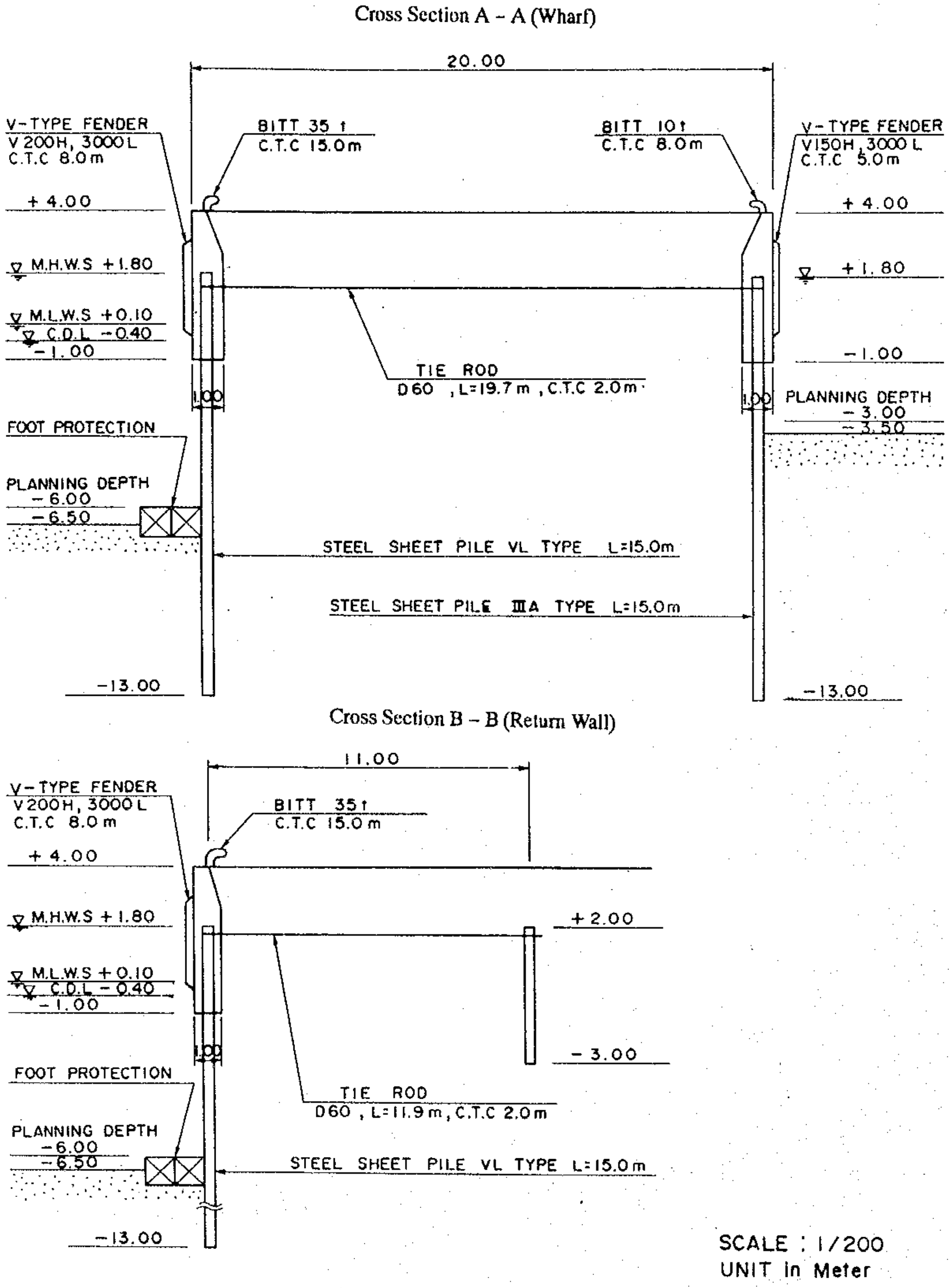
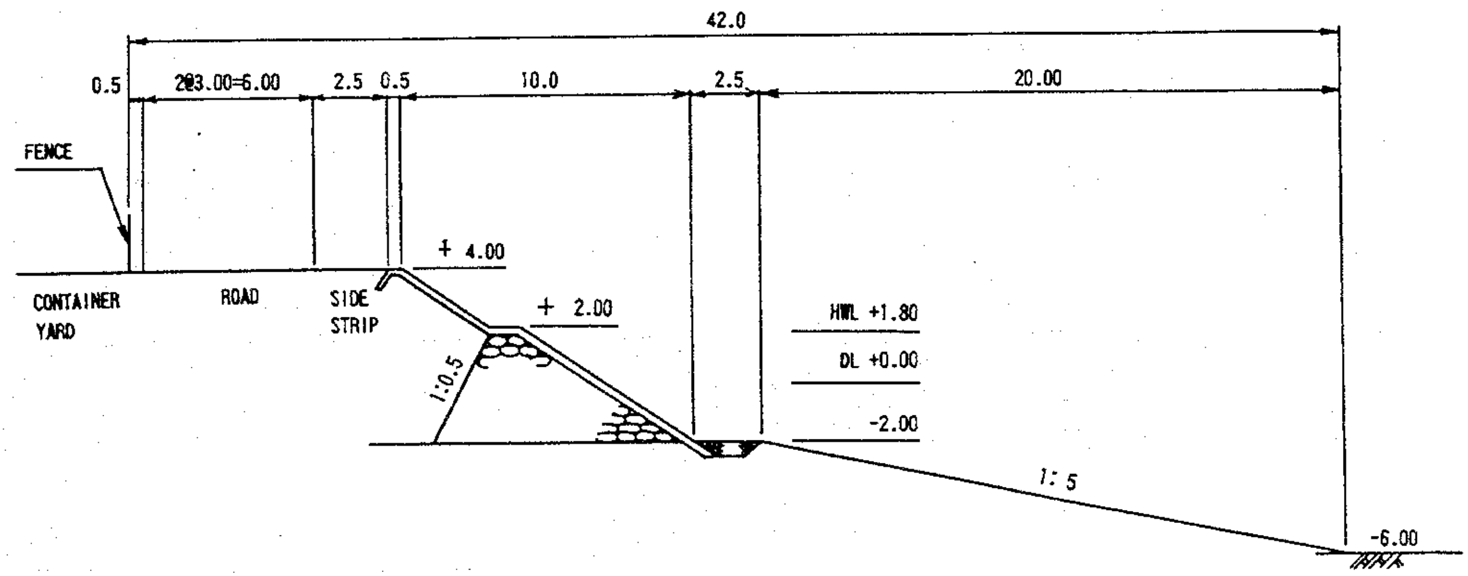


Figure 4-3-1(2) Typical Cross Section of Wharf and Return Wall

SECTION C - C



SEAWALL (FACING A TURNING BASIN)

Figure 4-3-2(1) Typical Cross Section of Seawall

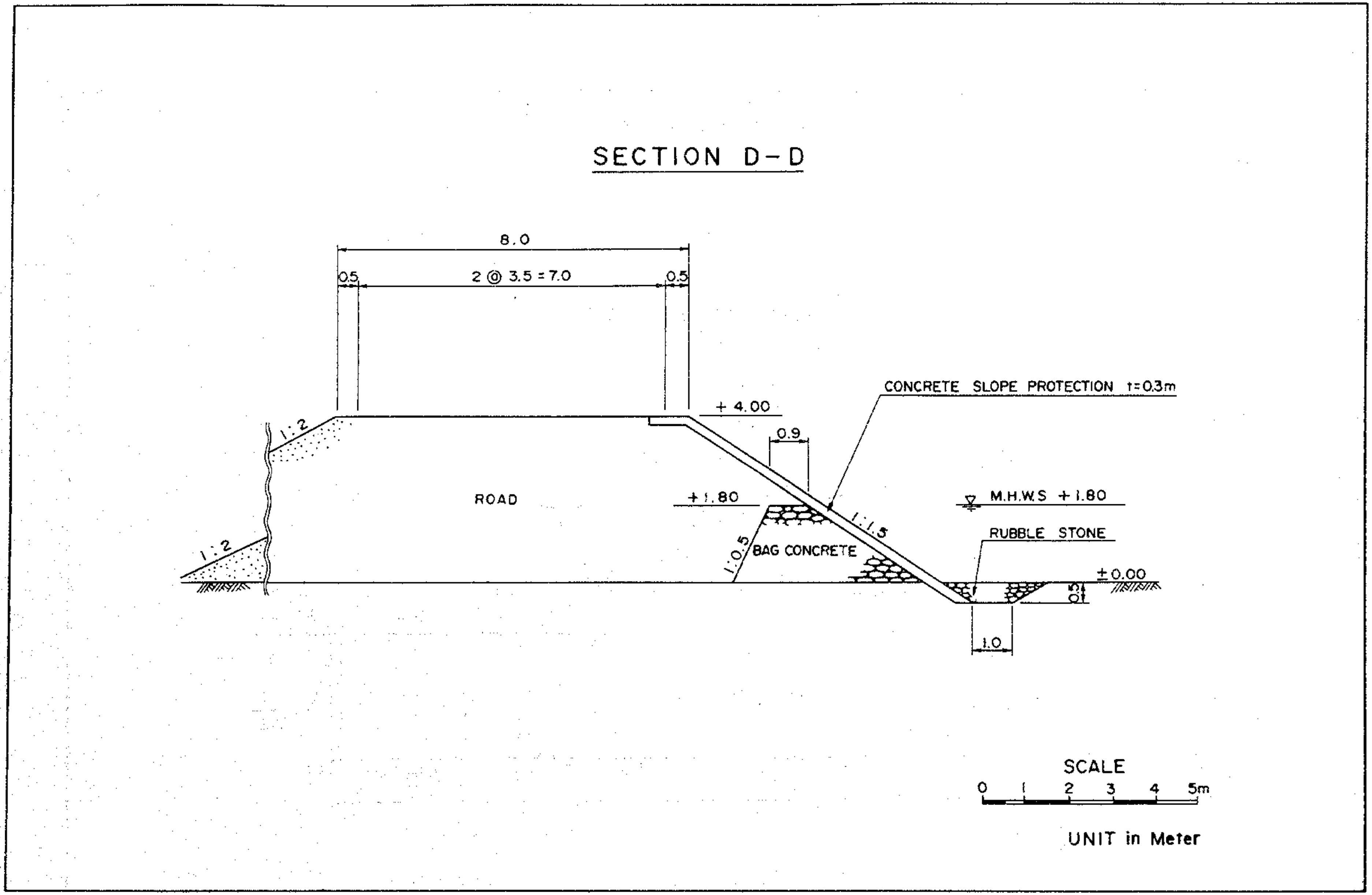
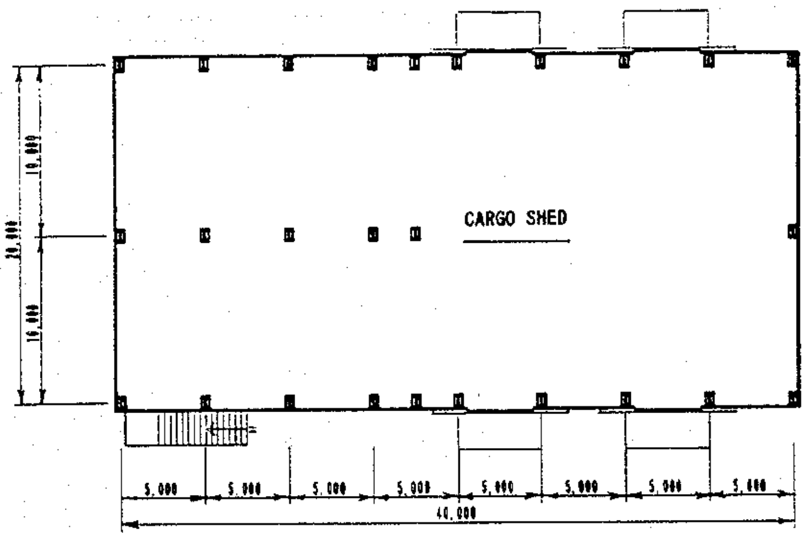
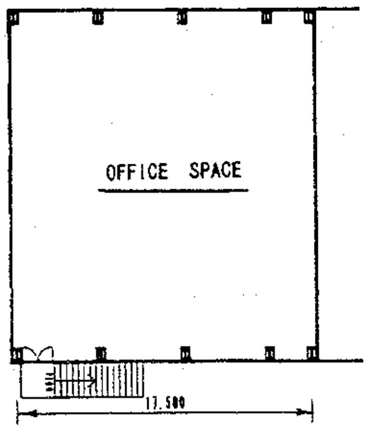


Figure 4-3-2(2) Typical Cross Section of Seawall at Access Road



1 F PLAN



2 F PLAN

Figure 4–3–3(1) General Layout Plan of Shed and Office

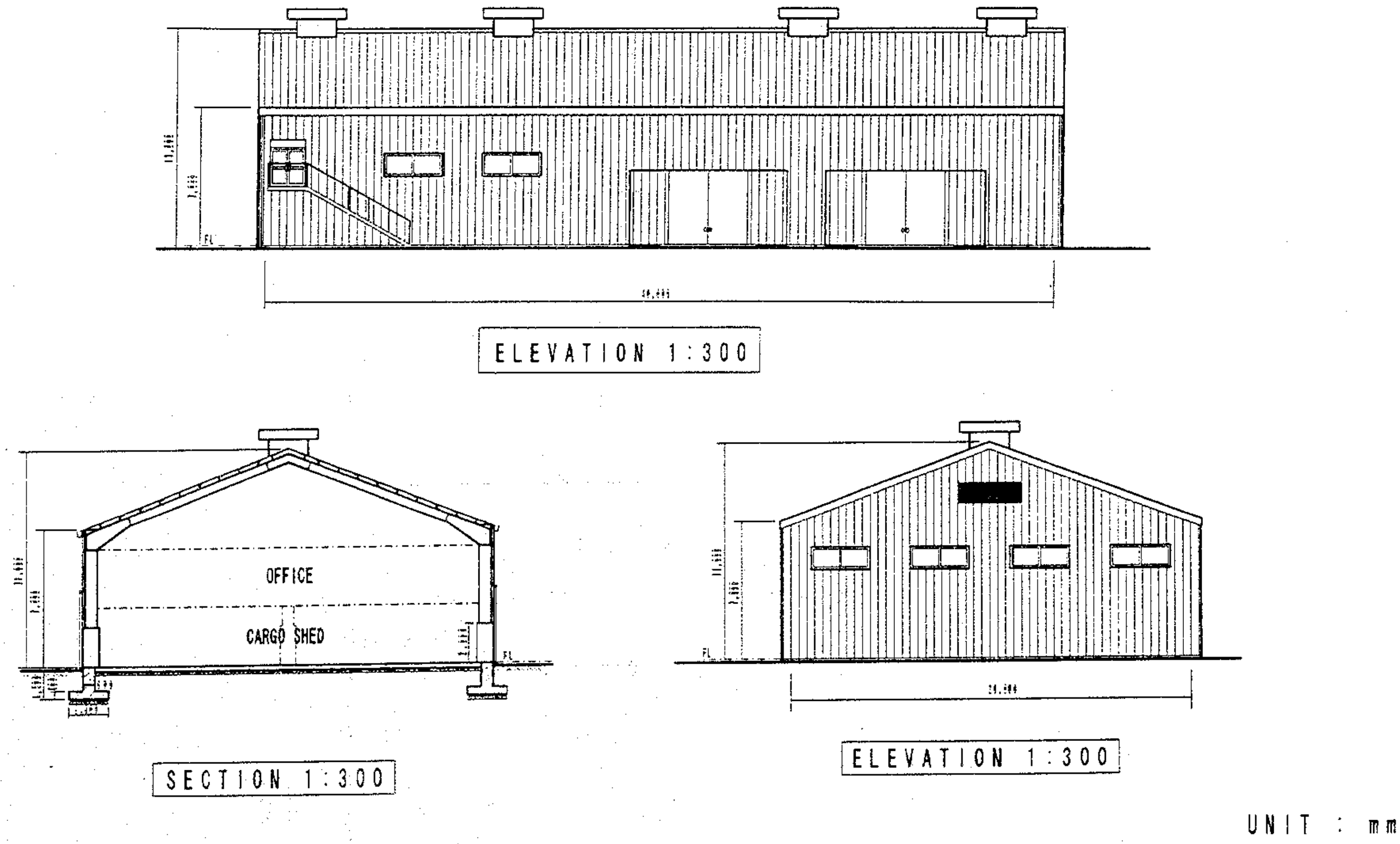


Figure 4-3-3(2) Elevations and Cross Section of Shed and Office

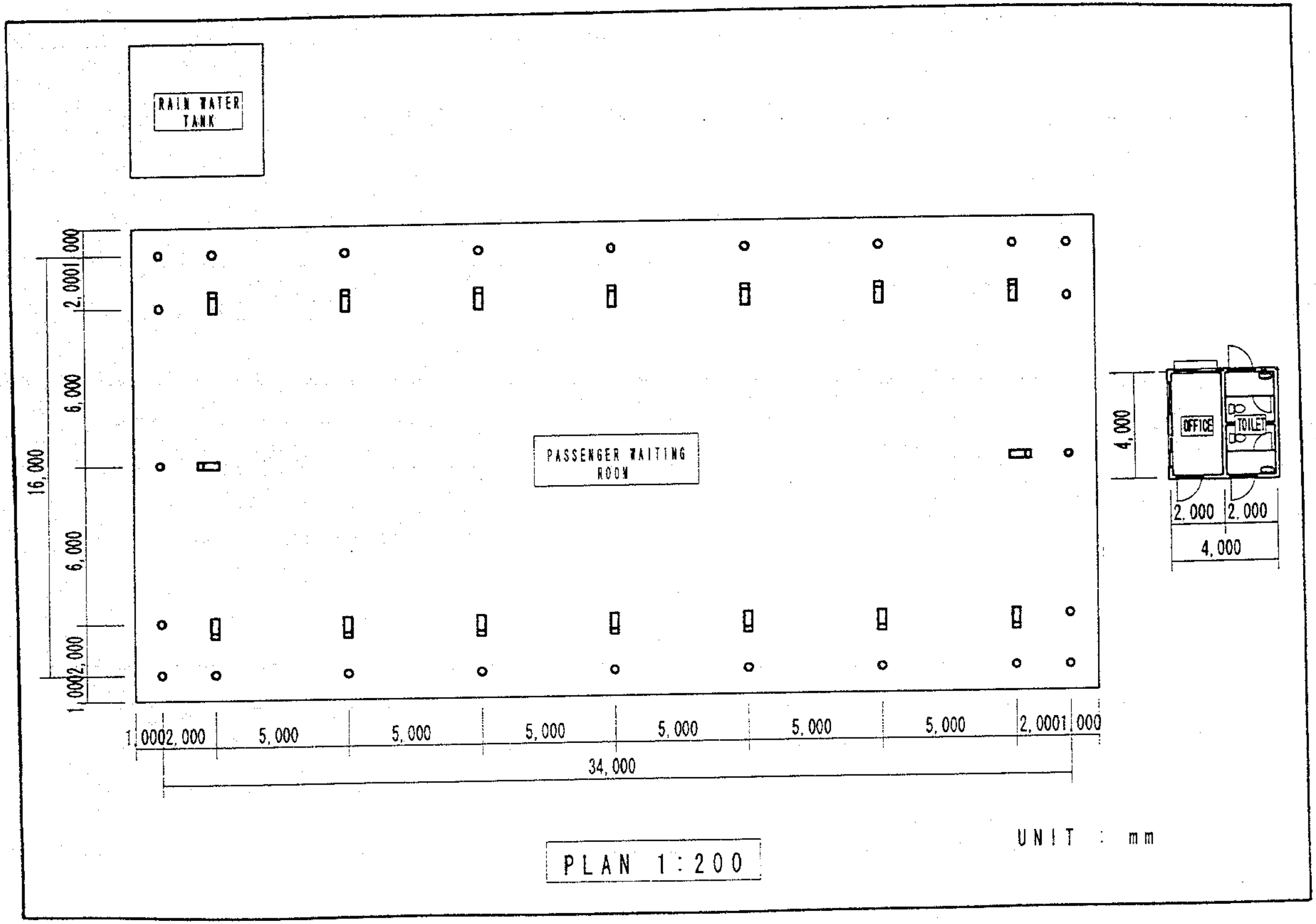


Figure 4-3-4(1) General Layout Plan of Passenger Terminal

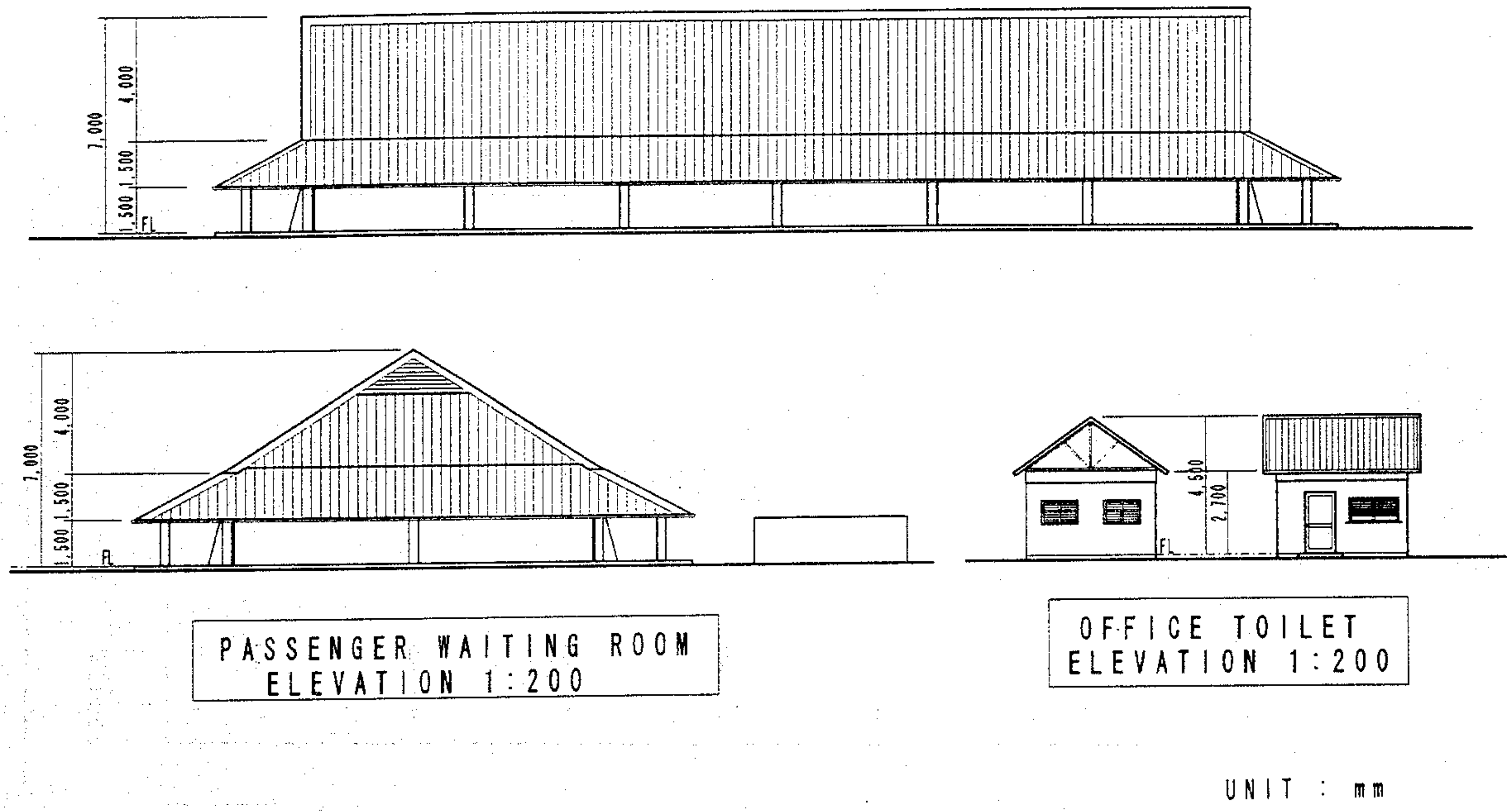


Figure 4–3–4(2) Elevations of Passenger Terminal

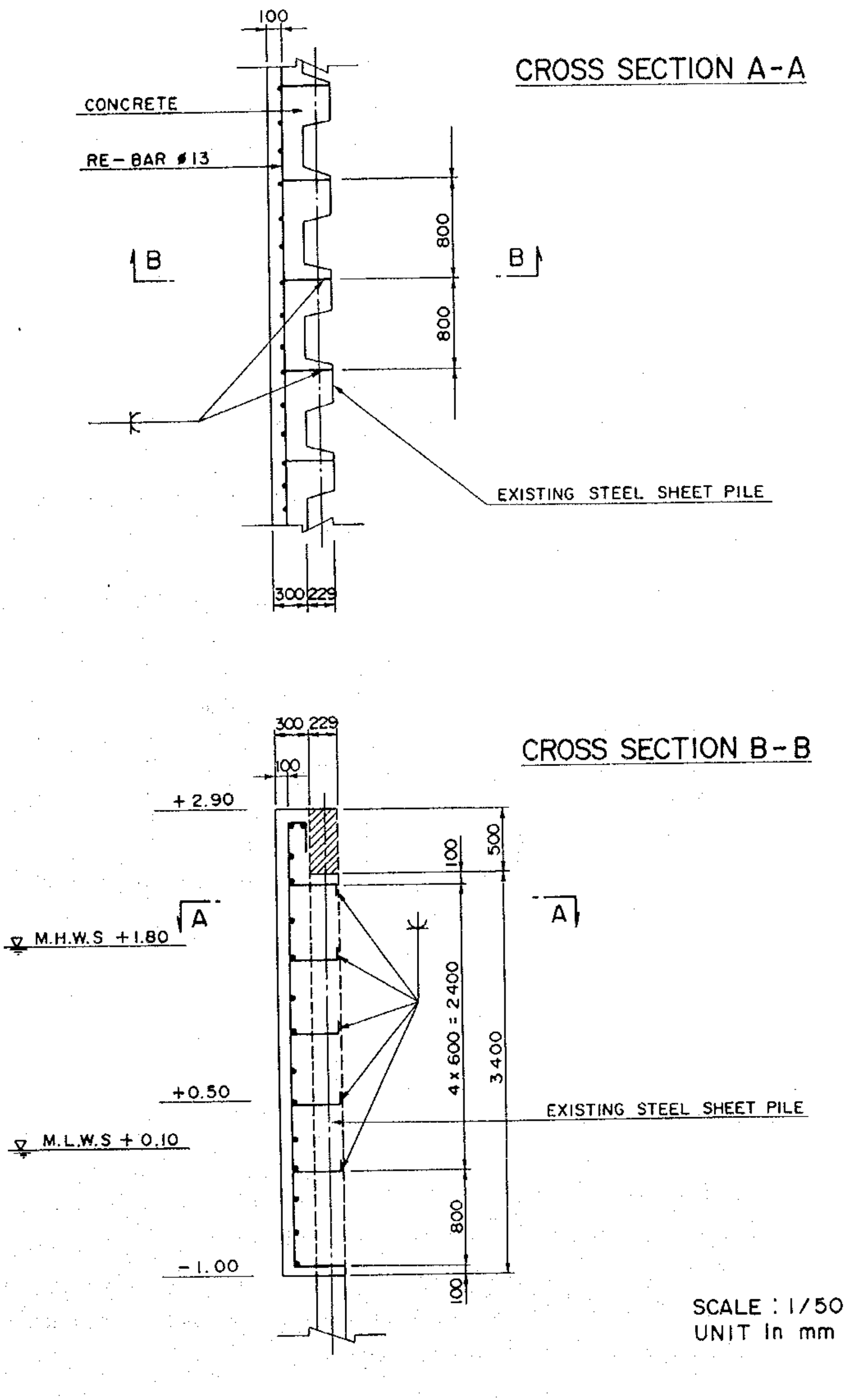


Figure 4-3-5 Repair Work of Existing Wharf in Betio Port

4.4 Construction Plan and Cost Estimation

This chapter presents the construction plan and the cost estimation of the improvement plan of Betio Port.

4.4.1 Construction Quantities

(1) Facilities

The construction quantities of facilities of Betio Port are shown in Table 4–4–1.

Table 4–4–1 Port Facilities and Construction Quantities

Facility	Unit	Quantity	Remarks
1. Dredging	m^3	138,648	-6.0m depth (channel and basin)
2. Aids to Navigation	LS	1	A entrance buoy, Beacons
3. -6.0m Wharf	m	80	Including berths for barges
4. Rehabilitation of -3.0m Wharf	m	130	Existing wharf
5. Slope Protection	m	775	Armoured concrete slope structure
6. Land/Road Area	m^2	29,000	Filling
7. Shed	m^2	800	1,100 m^2 for cargo, 1,200 m^2 for copra
8. Passenger Terminal	m^2	560	Shelter
9. Cargo Handling Equipment	LS	1	A 80t track crane, a 25t F/L, two 5t F/L
10. Maintenance Dredging Equipment	LS	1	0.6 cubic meters dredger

(2) Construction Materials

The main materials needed for the construction are shown in Table 4–4–2. Construction materials which are procurable in Kiribati are only sand and aggregates for concrete, and the other materials such as steel materials, cement and so on will be procured from the adjacent countries in the same way that is mentioned in the chapter 3, the conceptual port development plan.

Table 4-4-2 Main Construction Materials

Facility	Materials				Others
	Steel (ton)	Concrete (m^3)	Stone (m^3)	Filling (m^3)	
1. Dredging	---	---	---	---	
2. Aids to Navigation	---	---	---	---	5 Buoys , 9 Beacons
3. -6.0m Wharf	780	1,790	---	7,460	Rubber Fenders (19 sets), Bitts and Bollards (12 sets)
4. Rehabilitation of -3.0m Wharf	10	195	---	---	Rubber Fenders (20 sets)
5. Slope Protection	---	1,722	4,030	---	
6. Land/Road Area	0	0	---	131,188	Lighting, Reefer
7. Shed	240	700	---	---	
8. Passenger Terminal	103	130	---	---	
Total	1,133	4,600	4,030	138,648	

4.4.2 Construction Procedure

(1) Basic Concept

In Kiribati construction works such as dredging, piers and other port facilities have been executed with the introduction of a foreign engineering. The proposed facilities will be able to be constructed using the same methods as before. The procurement of the construction equipment is the same as mentioned in the chapter 3, the conceptual port development plan.

(2) Construction Procedures of Main Facilities

Since the main components of the improvement plan are the same as the conceptual port development plan, the construction procedures of the conceptual port development plan are applied.

4.4.3 Construction Schedule

Construction schedule of the improvement plan of Betio Port is presented in Table 4-4-3.

Table 4-4-3 Construction Schedule

Facility	Unit	Quantity	Construction Year 1996	1997	1998	1999	2000
1. Dredging	m3	138,648	■				
2. Aids to Navigation	LS	1		■			
3. -6.0m Wharf	m	80	■	■			
4. Rehabilitation of -3.0m Wharf	m	130	■				
5. Slope Protection	m	775	■	■			
6. Land/Road Area	m2	29,000	■				
7. Shed	m2	800		■			
8. Passenger Terminal	m2	560		■			
9. Cargo Handling Equipment	LS	1		■			
10. Maintenance Dredging Equipment	LS	1		■			

4.4.4 Cost Estimation

Applying the same estimation conditions and procedures as those of the conceptual port development plan, the estimation results are as shown in the Tables 4-4-4 and 4-4-5.

Table 4-4-4 Summary of Construction Cost

Facility	Unit	Quantity	Construction Cost ('000 AUS$)		
			Total	Foreign Portion	Local Portion
1. Dredging	m3	138,648	4,503	3,680	823
2. Aids to Navigation	LS	1	351	309	42
3. -6.0m Wharf	m	80	5,230	3,490	1,740
4. Rehabilitation of -3.0m Wharf	m	130	407	287	120
5. Slope Protection	m	775	2,921	1,450	1,471
6. Land/Road Area	m2	29,000	1,718	1,204	514
7. Shed	m2	800	2,341	1,639	702
8. Passenger Terminal	m2	560	670	468	202
Sub-total (1 to 8)			18,141	12,527	5,614
9. Cargo Handling Equipment	LS	1	2,348	2,348	0
10. Maintenance Dredging Equipment	LS	1	1,411	1,411	0
Sub-total (9 to 10)			3,759	3,759	0
11. Engineering Services	LS	1	1,654	1,075	579
Sub-total (1 to 11)	LS	1	23,554	17,361	6,193
12. Physical Contingency	LS	1	1,641	1,207	434
Grand Total			25,195	18,568	6,627
13. Tax	LS	1	8	0	8
Grand Total excluding Tax			25,187	18,568	6,619

Table 4-4-5 Annual Investment

Facility	Unit	Quantity	Construction Cost ('000 AUS$)			Annual Investment														
						1996			1997			1998			1999			2000		
			Total	Foreign Portion	Local Portion	F/P	L/P	Total	F/P	L/P	Total	F/P	L/P	Total	F/P	L/P	Total	F/P	L/P	Total
1. Dredging	m3	138,648	4,503	3,680	823	3,680	823	4,503	0	0	0	0	0	0	0	0	0	0	0	0
2. Aids to Navigation	LS	1	351	309	42	0	0	0	309	42	351	0	0	0	0	0	0	0	0	0
3. -6.0m Wharf	m	80	5,230	3,490	1,740	1,745	870	2,615	1,745	870	2,615	0	0	0	0	0	0	0	0	0
4. Rehabilitation of -3.0m Wharf	m	130	407	287	120	287	120	407	0	0	0	0	0	0	0	0	0	0	0	0
5. Slope Protection	m	775	2,921	1,450	1,471	725	736	1,461	725	735	1,460	0	0	0	0	0	0	0	0	0
6. Land/Road Area	m2	29,000	1,718	1,204	514	1,204	514	1,718	0	0	0	0	0	0	0	0	0	0	0	0
7. Shed	m2	800	2,341	1,639	702	0	0	0	1,639	702	2,341	0	0	0	0	0	0	0	0	0
8. Passenger Terminal	m2	560	670	468	202	0	0	0	468	202	670	0	0	0	0	0	0	0	0	0
Sub-total (1 to 8)			18,141	12,527	5,614	7,641	3,063	10,704	4,886	2,551	7,437	0	0	0	0	0	0	0	0	0
9. Cargo Handling Equipment	LS	1	2,348	2,348	0	0	0	0	2,348	0	2,348	0	0	0	0	0	0	0	0	0
10. Maintenance Dredging Equipment	LS	1	1,411	1,411	0	0	0	0	1,411	0	1,411	0	0	0	0	0	0	0	0	0
Sub-total (9 to 10)			3,759	3,759	0	0	0	0	3,759	0	3,759	0	0	0	0	0	0	0	0	0
11. Engineering Services	LS	1	1,654	1,075	579	525	283	808	550	296	846	0	0	0	0	0	0	0	0	0
Sub-total (1 to 11)	LS	1	23,554	17,361	6,193	8,166	3,346	11,512	9,195	2,846	12,041	0	0	0	0	0	0	0	0	0
12. Physical Contingency	LS	1	1,641	1,207	434	590	212	802	617	222	839	0	0	0	0	0	0	0	0	0
Grand Total			25,195	18,568	6,627	8,756	3,558	12,314	9,812	3,068	12,880	0	0	0	0	0	0	0	0	0
13. Tax	LS	1	8	0	8	0	4	4	0	4	4	0	0	0	0	0	0	0	0	0
Grand Total excluding Tax			25,187	18,568	6,619	8,756	3,554	12,310	9,812	3,064	12,876	0	0	0	0	0	0	0	0	0

(4) Maintenance Dredging Cost

Maintenance dredging will have to be carried out by port authority to keep the required water depth in the turning basin and approach channel of the proposed Betio port. Since the estimated annual dredging volume to be maintained is approximately 1,000 cubic meters, the annual maintenance dredging cost is as follows:

Dredging	5.28 A$/cubic meters
Transport, dumping and grading	1.06 A$/cubic meters
Total	6.34 A$/cubic meters
Annual maintenance dredging cost	6,340 A$