PART IV SHORT-TERM DEVELOPMENT PLAN FOR TAKORADI PORT

Chapter 16 Short-term Development Plan for Takoradi Port

16.1 Planning Requirement for Short-term Development Plan

(1) Need of Strategy for Development

Takoradi Port has advantages for future development and the port must make the most of its advantages to play its expected role. However, it must be remember that there are some negative factors which could hinder development. Specially, some of main cargoes such as sawn timber and manganese are not expected to increase as rapidly as before, ocean freight to/from the port is higher than that of Tema Port due to imbalance of volume of containerized cargo between import and export and economic activities have been more concentrated in Great Accra Region.

Fortunately, as the port has basic cargoes, income from handling such cargoes will continue. Using this advantage, available resources should be concentrated on investment for facilities which are indispensable to future development of the port. As explained in Chapter 14.3.2, the most important project is the new container terminal planned at the inner port area. In the short-term development plan, the priority will be given to the new container terminal.

Dry bulk mining cargoes are also very important to the port. The mining companies are main users of the port and the port and mining companies have become prosperous side by side. Because of facility limitation at the port, mining companies have to endure higher transportation costs. It is beneficial to both the port and mining companies to develop deep bulk berths. Mining companies can save the transportation cost and the port can increase its revenue. And moreover, the appropriate combination of the new container terminal development project and the new deep bulk berth project will reduce the cost savings of both projects and expedite project implementation.

(2) Future Cargo Demand

Future cargo demand was forecasted and the results are summarized in Table 16.1.1 and Table 16.1.2. Main cargoes in which volumes will increase their volumes are clinker, bauxite and container cargo.

Table 16.1.1 Future Cargo Demand Forecast in Takoradi Port

IMPORT	1991	2000	2010
Dry Bulk	413,040	891,815	1,258,530
Clinker	323,538	694,374	991,760
Liquid Bulk	92,284	157,012	224,787
Bagged Cargo	2,514	5,770	51,839
General Cargo	20,868	26,619	222,250
Containerized Cargo	20,610	62,102	509,022
Total	**549,316**	**1,143,318**	**2,266,428**

Export	1991	2000	2010
Dry Bulk	644,310	1,461,732	2,000,000
Bauxite	324,313	503,823	1,000,000
Manganese	319,997	929,296	1,000,000
Liquid Bulk	0	6551	8386
Bagged Cargo	106,772	70,368	21,944
General Cargo	292,888	102,658	37,517
Containerized Cargo	46,182	271,889	789,981
Total	**1,090,152**	**1,913,198**	**2,857,828**
Grand Total	**1,639,468**	**3,056,516**	**5,124,256**

Table 16.1.2 Future Container Cargo Demand Forecast at Takoradi Port

	1991	2000	2010
Import	4,422	15,387	66,894
Export	4,690	24,418	68,098
Transit			1,204
Total	**9,112**	**39,805**	**136,196**

16.2 Facility Requirement for Short-term Development Plan

(1) Cargo Handling Productivity

As explained in chapter 13.4 and the development strategy mention above, new container berths and new bulk berths with deep depth have a higher priority among projects in the master plan. Therefore, the cargo handling productivity at 2010 for cargoes handled at multipurpose berths is set at the same level of that of the year 2000.

Table 16.2.1 Gross Cargo Handling Productivity at Takoradi Port in 2000and 2010

Type	Commodity	Unit	Productivity 2000	Productivity 2010	Equipment 2010
IMPORT					
DB	Clinker/Gypsum	t/hour/vessel	270	600	Grab, Belt conver
DB	Wheat	t/hour/vessel	90	100	Grab, hopper
LB	Petro products	t/hour/vessel	80	80	Pipeline
BC	Rice, Fertilizer	t/hour/vessel	40	50	Multi. Crane/ship gear
GC	Cars, Steel product	t/hour/vessel	70	70	Multi. Crane/ship gear
GC	Chemical	t/hour/vessel	58	60	Multi. Crane/ship gear
RO	RoRo cargo	t/hour/vessel	68	70	RoRo ramp
CO	Container	box/hour/vessel	9	24	Container crane
EXPORT					
DB	Bauxite	t/hour/vessel	190	600	Loader, belt conveyor
DB	Manganese	t/hour/vessel	210	600	Loader, belt conveyor
DB	Cocoa beans	t/hour/vessel	70	100	Belt conver
BC	Cocoa beans	t/hour/vessel	30	50	Multi. Crane/ship gear
GC	S/Timber, Wood product	t/hour/vessel	30	50	Multi. Crane/ship gear
RO	RoRo cargo	t/hour/vessel	68	70	RoRo ramp
CO	Container	box/hour/vessel	9	24	Container crane

Note: Productivity of the year 2000 is calculated from vessel berthing data

(2) Vessel Size at Target Year

Vessel sizes in the year 2010 are set as described in Table 16.2.2.

Table 16.2.2 Vessel Size at the Target Year 2010 at Takoradi Port

Vessel Type	2000		2010 (Standard Size)		
	Max.DWT (tons)	$DWT_{1/4}$ (tons)	DWT (tons)	Length (m)	Draft (m)
Bulk carrier	51,694	43,685	40,000	200	11.8
Cellular container	31,057	25,375	30,000	218	11.1
RO-RO	31,311	27,601	28,000	210	11.0

Note: $DWT_{1/4}$ means DWT of one fourths largest vessel

(3) Number of Berths Required

The result of required new berth number is shown in Table 16.2.3.

Table 16.2.3 Scale of New Berths for Short-term Development Plan of Takoradi Port

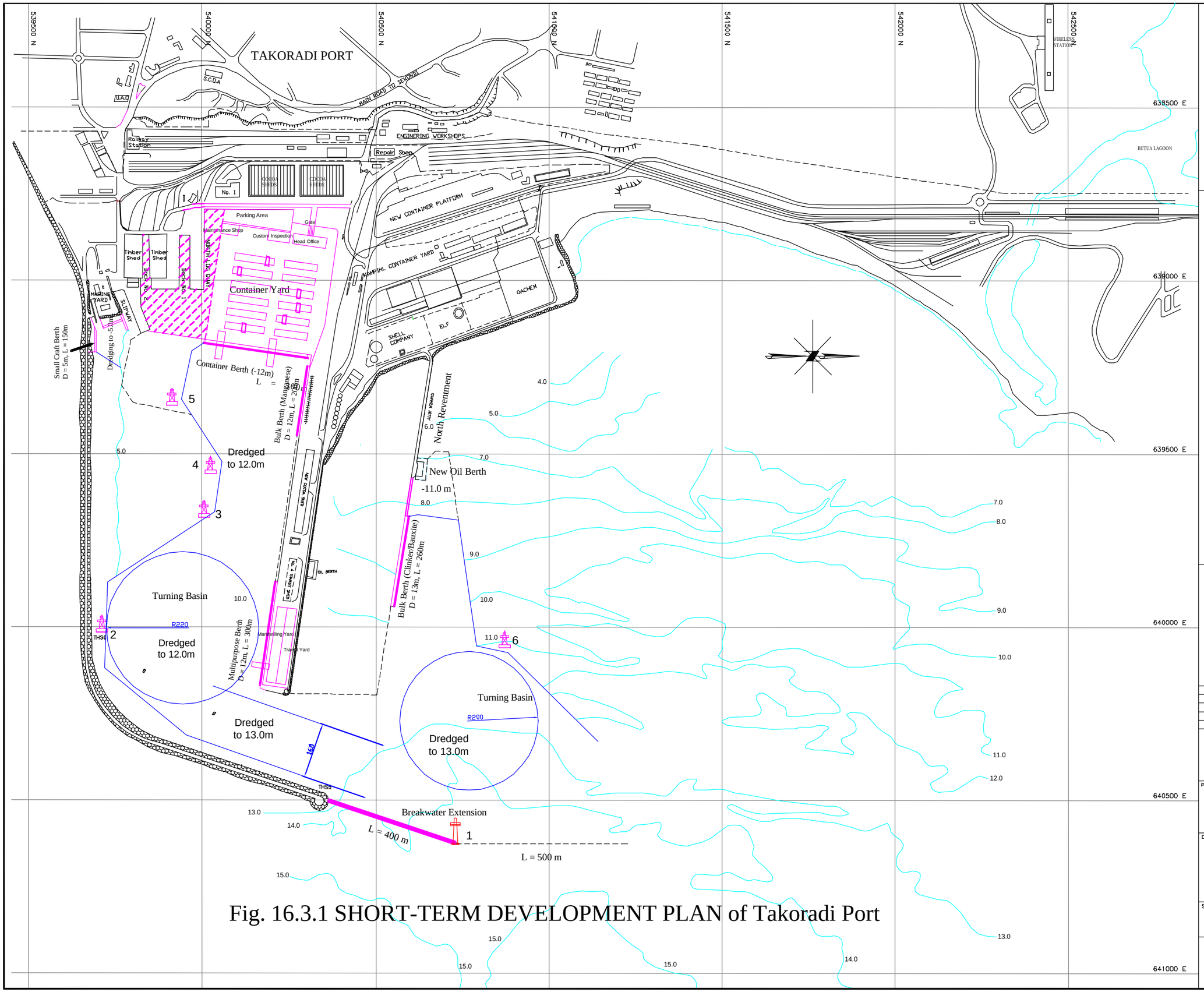
Berth	Commodity	Number	Depth	Length
Manganese Berth	Manganese	1	12m	200m
Bauxite Berth	Bauxite	1	13m	230m
Clinker Berth	Clinker			
Container Berth	Container	1	12m	300m
Multi-purpose Berth	Break bulk, wheat etc.	1	12m	300m
Total		4		

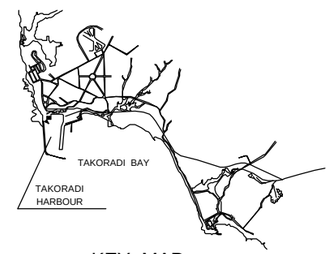
16.3 Port Facility Layout Plan for Short-term Development Plan

Fig. 16.3.1 shows the proposed layout. Table 16.3.1 shows the list of main facilities of the short-term development plan.

Table 16.3.1 List of Main Facilities for Short-term Development Plan of Takoradi Port

Facility	No.	Dimension / Capacity
Container Berth	1	Length 300m, depth 12m
Multipurpose Berth	1	Length 300m, depth 12m
Manganese Berth	1	Length 200m, depth 12m
Bauxite/Clinker Berth	1	Length 260m, depth 13m
Berth for small craft	1	Length 150m, depth 5m
Navigational aids	1	1 Light beacons, 5 Buoys
Tug boat	1	2,420 Hp
New approach channel	1	One way, width 160m, depth 13m
Turning basin 1	1	Radius 220m, depth 12m
Turning basin 2	1	Radius 200m, depth 13m
Container yard	1	10.5 ha
Breakwater extension	1	400m
Revetment	1	480m, 270m, 160m
Access road improvement	1	1 set
Inner harbour road	1	1 set
Container crane	2	35 tons
Multipurpose crane	1	35 tons
Transfer crane	6	35 tons, 1 over 4
Top lifter	3	35 tons, 15 tons
Tractor head	16	For container cargo
Trailor	16	For container cargo





KEY MAP

NOTES:

1. Geodetic information:
   Ellipsoid: WGS84
   DATUM: WGS84
   Projection: UTM Zone 31
2. Coastline digitized from British Admiralty Chart 3102
3. Levels referenced to Chart Datum

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GHANA PORTS AND HARBOURS AUTHORITY (GPHA)

PROJECT

THE DEVELOPMENT STUDY OF GHANA SEA PORTS IN THE REPUBLIC OF GHANA

Drawing Title

TAKORADI PORT
MASTER PLAN

SCALE	DATE	Drawing No.	Rev. No.
1:			

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN (OCDI)

NIPPON KOEI CO.,LTD.

Fig. 16.3.1 SHORT-TERM DEVELOPMENT PLAN of Takoradi Port

16.4 Proposal for Efficient Port Operation

16.4.1 Container Cargo

- New container terminal (length 300m, 1 berth, depth 12m) will be constructed at the inner port area. This is the first dedicated container terminal at Takoradi Port with sufficient container yards and sophisticated cargo handling equipment.
- Berths 5-6 will be redeveloped as a multipurpose berth (length 300m) for container and Ro-Ro vessels with a depth of 12m.
- Until container yard behind the new multipurpose berth is constructed, users of the new multipurpose berth have priority to utilize New Container Platform (NCP) and GPHA's new container yard (KAMPIHL Container Yard).
- Seventy percent of container cargo will be handled at the new container terminal, and the rest (30%) will be handled at the new multipurpose berth.

Table 16.4.1 Estimated Storage Area for Container Cargo

Port of Takoradi		2000	2010	unit
Volume of Container Cargo		39,966	136,196	TEU
Volume of Container Cargo		31,469	107,241	Box
Productivity		9	24	box/hour/vessel
Working day		365	365	day
Cargo throughput in a day		109	373	TEU/day
Average Dwell Time(Target)		12	6	day
Peak Ratio		1.3	1.3	
		2000	2010	
Required Capacity Volume for Container storage		1,700	2,909	TEU
Required Area for Container Storage	2 tiers	21,255	36,368	m2
	3 tiers	14,170	24,245	m2
	4 tiers	**10,628**	**18,184**	**m2**

Size of 20ft Container	
Length(l)	6.058 m
Widgh(w)	2.438 m
Height(h)	2.438 m
Bottom Area(=l x w)	15 m2
Area for 1slot	
(+ 50cm space on each side)	
lengh + 50cm x 2(ls)	7.058 m
widgh + 50cm x 2(ws)	3.438 m
Bottom Area(=ls x ws)	25 m2

(1) New Container Terminal

In the short-term plan, new container terminal (length 300m, 1 berth, depth 12m) is proposed to be constructed at the inner port area. For the most efficient use of this area, transfer crane method is recommended to handle the maximum volume of container cargoes.

- Two gantry cranes are proposed to be installed in the new container berth.
- The required number of transfer cranes for the new container terminal is 6 units.
- Between quay side and marshalling yard, container cargo will be carried by yard tractor-trailers. The required number of yard tractor-trailers is 8 units for 2 gantry cranes.

Total required equipment for the new container berth:

Quay side gantry crane:	2 units
Transfer crane:	6 units
Yard tractor trailer:	8 units
Storage capacity:	3,120 TEUs

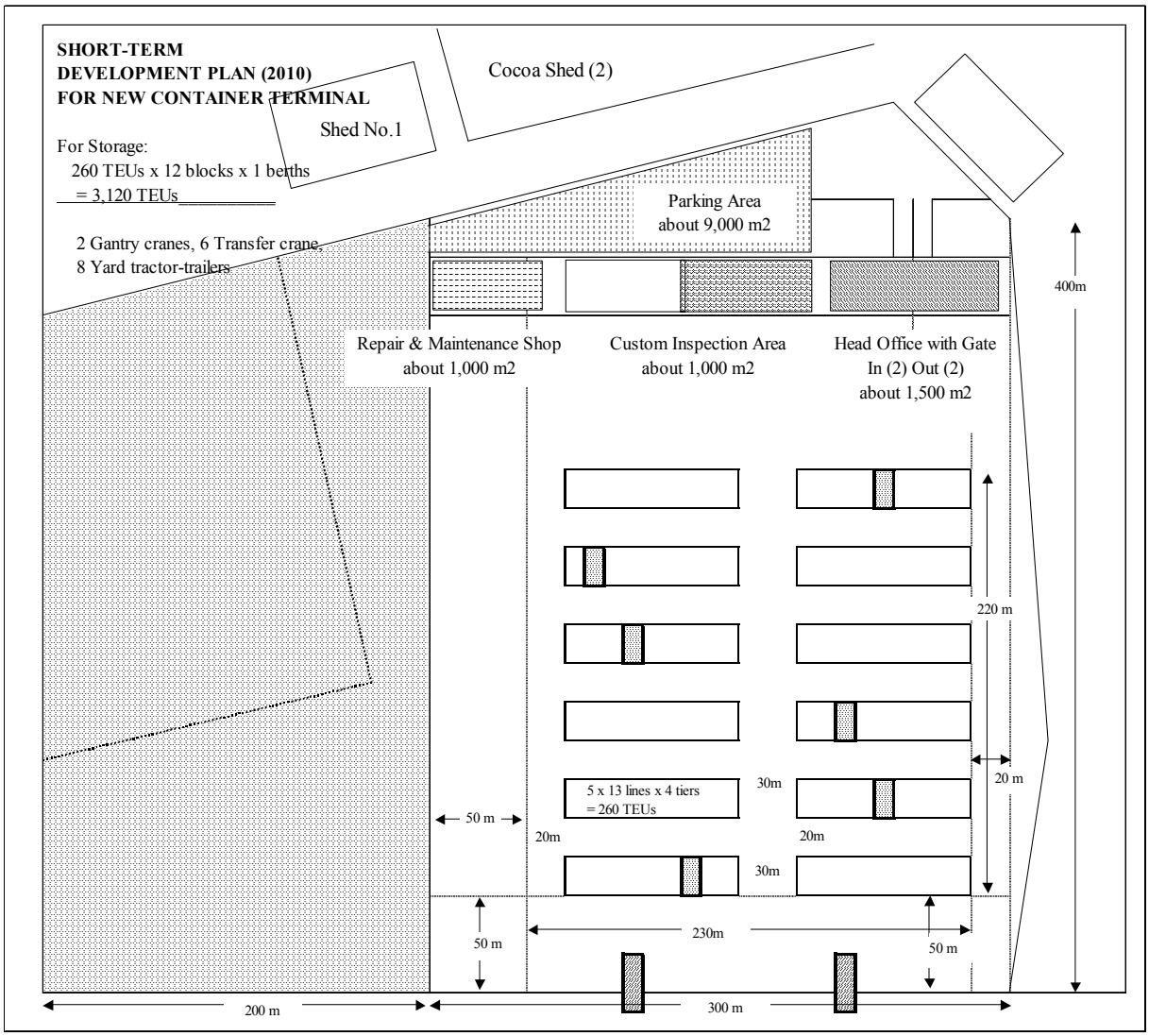


Figure 16.4.3 Layout of New Container Terminal at 2010

- New computer system for container operation will be installed in the new container terminal. For efficient operation with gantry cranes and transfer cranes, rapid control of their operation is required and this work is difficult to do without computers. Following operation works will be done by computer system:

  - Vessel Operation（Loading/Discharging Operation Control）
  - Gantry Crane Allocation
  - Transfer Crane Allocation
  - Yard Planning
  - Container Inventory Control
  - Container Delivery/Receiving Control（Gate Operation）

(2) New Multipurpose Berth

- Top-lifter method is the most convenient for container handling in the new multipurpose berth because it is easier to change the cargo handling layout.
- In the short-term plan, one gantry crane with multi-use-attachment is proposed to be installed for container handling and other heavy cargoes.
- Most ports in West Africa do not have quay-side cranes. Therefore, most container ships have their own ship gear for container handling. When ship gears are utilized together with the quay side cranes at the new multipurpose berth, the productivity of container handling will be enhanced.
- The layout of the new container yard behind the new multipurpose berth is envisioned in Figure 16.4.5. As the storage capacity under this layout is about 200 TEUs, container cargo has to be removed to other container yards such as NCP and KAMPIHL Container Yard. These two container yards can be utilized for the new multipurpose berth and GPHA should give priority to utilize these yards to users of the new multipurpose berth.

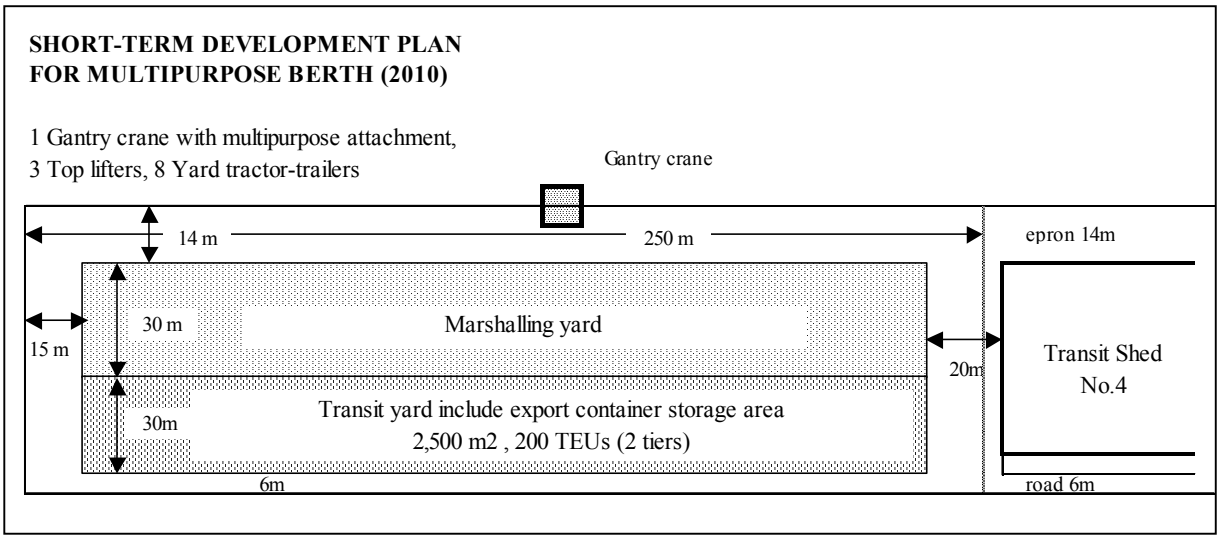


Figure 16.4.5 Layout for New Multipurpose Berth at 2010

- Three top lifters are required for 1 crane (1 for import, 1 for export, 1 for container relocation and backup).
- Container cargoes are required to be shifted to the new proposed container terminal and NCP and KAMPIHL Container Yard near the main gate. Between the new multipurpose berth and NCP or GPHA's yard, container cargo would be carried by yard tractor-trailers. The required number of yard tractor-trailers for one quay-side crane is 8 units

Total required equipment for the new multipurpose berth in the short-term plan:

Quay side gantry crane:	1 unit
Top lifter:	3 units
Yard tractor trailer:	8 units

16.4.2 Manganese

In the short-term plan, manganese berth (Berth No.1) will be reinforced and deepened. With these improvements, manganese will be loaded to vessels directly at the manganese berth. After the improvement of the manganese berth, about 25,000-40,000t of manganese will be loaded directly to one vessel. Manganese handling works will then be able to be completed in 4-7 days.

16.4.3 Bauxite and Clinker

(1) New Bulk Berth

Bauxite and clinker will be handled at new bulk berths with the depth of 13m. Bauxite will be loaded to vessels and clinker will be discharged from vessels directly at the new bulk berth. In this plan, conveyor belt system for bauxite and clinker will be extended from present position to the new bulk berths. These extension works will be done by mining companies.

(2) Bauxite

For direct loading to vessels, conveyor belt for bauxite is expected to extended to the new bulk berths, and raised to a level that will allow loading onto large vessels. With these improvements, double-handling problem will be solved and bauxite handling for one vessel will be finished in 3 days. These improvement works will be done by Ghana Bauxite Company.

(3) Clinker

For discharge clinker from vessels directly, conveyor belt is expected to be extended to the new bulk berths and unloader or grab bucket for clinker is supposed to be introduced with the productivity of 600-700 t/hour. With these improvements, clinker handling by lighter will be replaced to direct handling with vessels at the new bulk berths. These implementation works will be done by Ghana Cement Company Limited (GHACEM).

16.4.4 Ro-Ro Cargo

Ro-Ro cargo (sawn timber, paper reel, vehicle etc.) is mainly handled at berth 6 because it is the deepest berth with marshalling yard. As in the short-term plan, the construction of additional cargo handling yard behind berths 2-6 is not planned. At the new multipurpose berth, Ro-Ro cargo is mainly handled, and 15% of container cargo in Ro-Ro vessels and general cargo vessels will be also handled.

Before introduction of sufficient storage and vanning area behind berths 2-6 at 2020, Ro-Ro cargo should be loaded or discharged as soon as possible, and then transferred to the container yard or shed immediately to avoid congestion in the marshalling yard.

One gantry crane with multi-use-attachment is proposed to be installed at the new multipurpose berth for container and heavy cargo handling. Cargo handling productivity of Ro-Ro vessels which don't have ship gears will be increased by using the quay side crane. As for Ro-Ro vessels with

ship gears, even if ship gears are broken down, cargo handling activity can be continued using the quay side crane.

16.4.5 Other Cargo

Dry bulk cargo, General cargo and bagged cargo such as wheat, sugar, rice, steels, and machinery are handled at berths 2-6. Before sufficient storage and vanning area is provided behind berth 2-6 at the master plan stage, these cargoes are required to be transferred to the shed immediately to make yards free.

Wheat is imported as a grain bulk and handled at berth 2-6. Wheat is discharged using ship gears and hoppers (loading to trucks). In the short-term stage, wheat handling should concentrate to berths 2-4 to avoid congestion with other cargo. Discharged wheat is desired to carry out to the Silo or shed as soon as possible.

For efficient handling of general cargo and bagged cargo, cargo handling works should be separated. For example steels is usually discharged from vessels directly on the bed of trucks. It is difficult to perform such precise work with ship gears. If these works were divided into "discharging to the berth by ship gear" and "loading to the trucks by forklift", the efficiency would be increased.

Chapter 17 Structural Design of Main Port Facilities

17.1 Design Requirements and Conditions

(1) Required Facilities of Short Term Development Plan

The following facilities are planned in the Short Term Development:

Table 17.1.1 Facilities Required in Short Term Development Plan

Facilities	Requirement
1. Breakwater Extension	Extension of the Existing Main Breakwater to obtain necessary calmness for New Bulk Berth, L = 400m.
2. Wharf/ Berths	
- New Bulk Berth	- 13.0m, L = 260m; Extended from the existing Clinker Jetty.
- New container wharf	- 12.0m, L = 300m; Along with the reclaimed land area for new container yard
- Small Craft Wharf	- 5.0m, L = 150m; Replacing the exist. mooring facilities for port services crafts.
3. Exist wharf Improvement	- 12.0m, L = 200m (Exist. Berth No 1)
- Manganese Berth	- 12.0m, L = 300m (Exist. Berth No 5 & 6)
- Multi-purpose Berth	
4. Basin and Navigation	Dredge to - 12.0m for inside Exist. Port Basin Dredge to - 13.0m for New Bulk Berth Basin and Channel Navigation Aids
5. Building & Utilities	Admi. Office & Gate for New Container Terminal, Lighting etc.
6. Others	Port Access Road improvement, Drainage, Container Yard paving etc.

(2) Basic Design Conditions

The following conditions on the objective vessels and design wave are applied in the design;

Table 17.1.2 Design Vessels Specification

Vessel Type	Max. DWT (GT)	Length Overall (m)	Breadth (m)	Max. Draft (m)	Remarks
Bulk carrier	40, 000	200	29.9	11.8	Bulk berth
General cargo ship	30, 000	185	27.5	11.0	Multipurpose
Container ship	30, 000	220	30.2	11.1	Container wharf
Ro/Ro ship	28, 000	210	-	11.0	Multipurpose
Port service craft	(250)	30.5	10.3	4.1	Small craft wharf

Table 17.1.3 Design Wave (50 years return period)

Wave Direction	SW	S	SE	E
Wave Height ($H_{1/3}$)	3.70m	4.40m	4.40m	3.80m
Wave Period ($T_{1/3}$)	9-11 sec.		5-9 sec.	

17.2 Breakwater Extension

In other to obtain the required calmness level for the planned new bulk berth, the existing main breakwater is extended at length 400m along the main breakwater alignment. The recommended structural type is a rubble mound type with its crown height at C.D + 5.00m. Based on the design wave height of 4.4m, the required armor rock size is estimated as 10.0~15.0 tf/pcs. The mound slopes recommended are 1:2 for seaside slope (1:1.5 for below C.D – 6.0m) and 1:1.5 for lee side.

The calmness ratio estimated from the analysis based on the 400m breakwater extension is around 96 %.

17.3 New Wharf/Berth

A preliminary design has been carried out for the planned new wharf/ berth and the following structural types and dimensions are proposed;

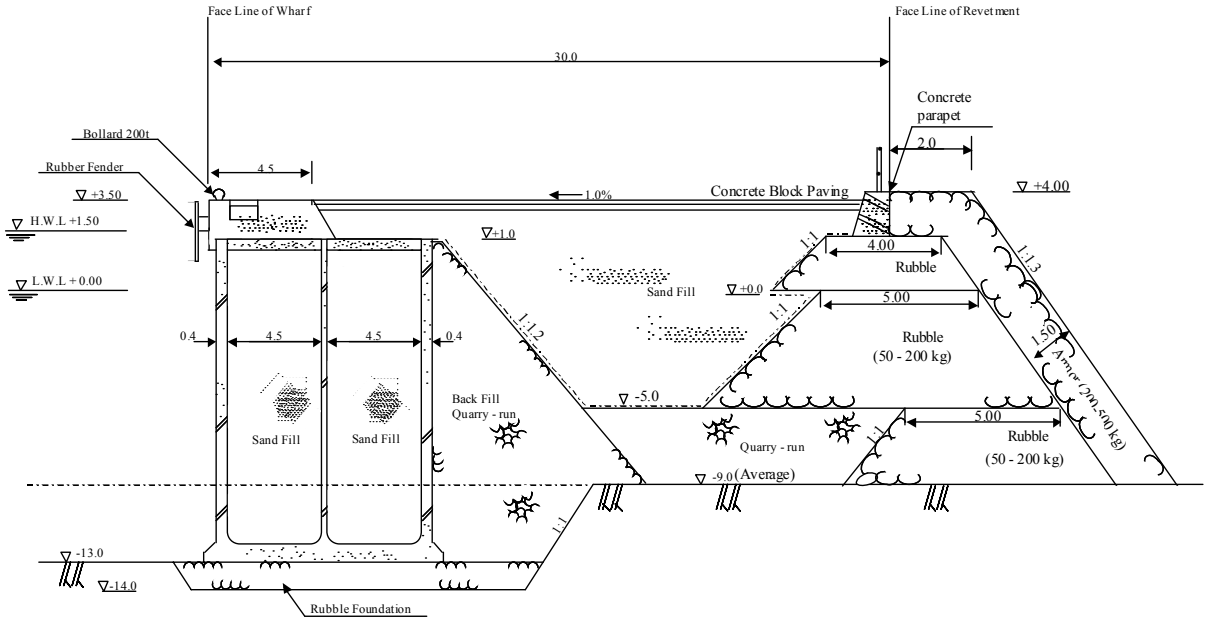
Location	Objective Vessel	Crown Height	Water Depth	Structural Type
Bulk Berth	Bulk carrir;40,000 DWT	+3.50m	-13.0m	Concrete caisson
Container Wharf	Container ship 30,000 DWT	+3.00m	-12.0m	Concrete caisson
Small Craft Wharf	Port service boat; 250 GRT	+2.50m	-5.0m	Concrete block wall type

No reclamation work is proposed at the area behind New Bulk Berth in the Short Term Development Plan. Therefore an access road connecting the existing Clinker Jetty and New Bulk Berth will be constructed at width 15m. The structural type of the access road is rubble mound type considering the future function as revetment.

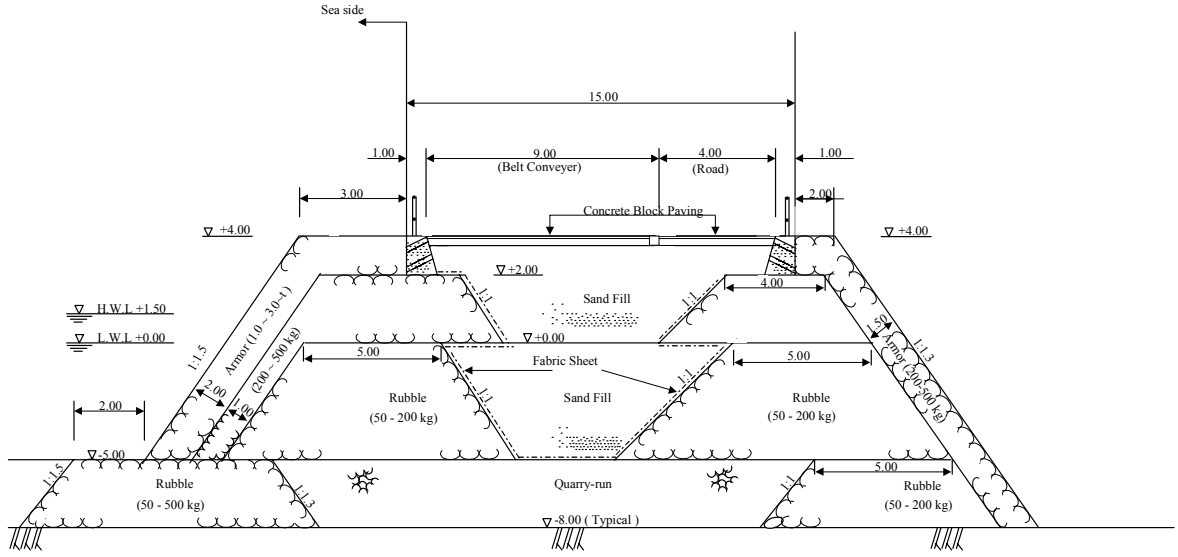
The typical sections of the New Bulk Berth, Container Wharf and Small Craft Wharf are shown in Figure 17.3.1, 17.3.2 and 17.3.3 respectively.

17.4 Existing Wharf Improvement

In the Short Term Development Plan, the existing wharf improvement is limited to the areas for Manganese Berth (200m) and Multi-purpose Berth (300m). Although some inefficiency in the wharf operation may result in from the partial improvement, it is recommended to adopt the same structural type proposed in the Master Plan design (concrete block type) as most reliable.



Typical Section of Bulk Berth



Typical Section of Access Way to Bulk Wharf

Figure 17.3.1 Typical Sections of New Bulk Berth and Access

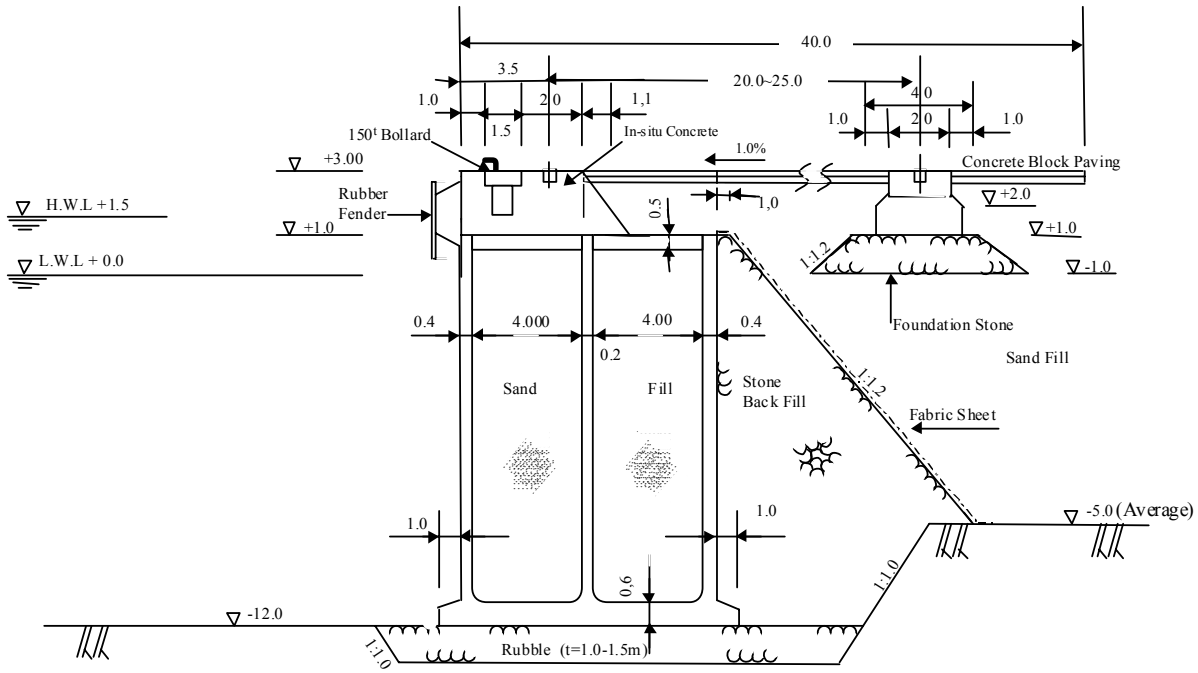


Figure 17.3.2 Typical Section of Container Wharf

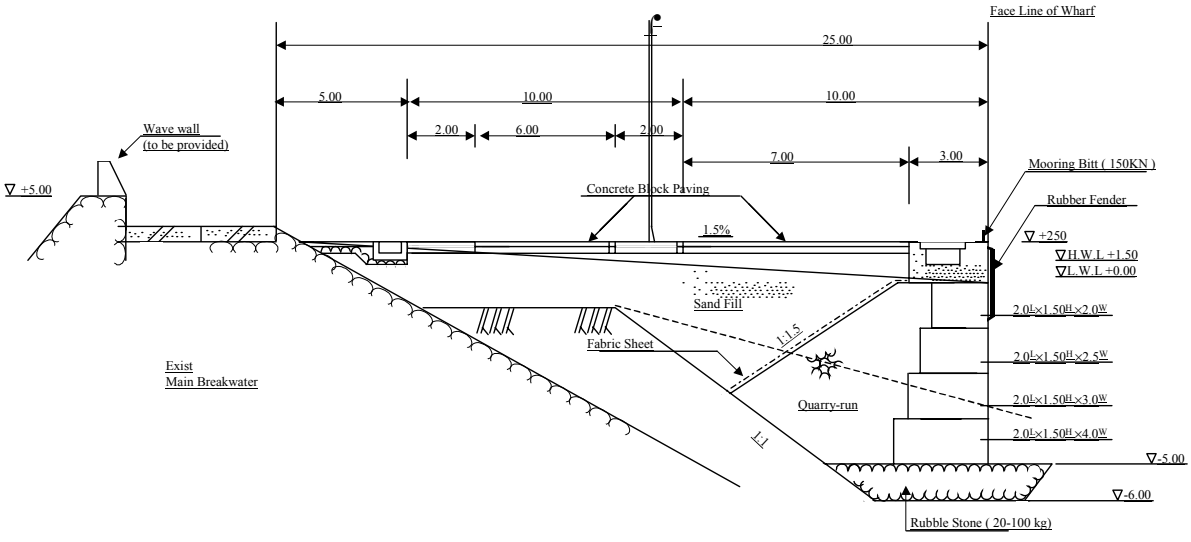


Figure 17.3.3 Typical Section of Small Craft Wharf

Chapter 18 Implementation Program

18.1 Construction Plan for Major Works

(1) Dredging and Reclamation

The estimated dredging volume is approximately 1.7 million m^3 of which about 70 % is thought to be soft rock dredging. It is recommended to employ a grab type dredger of 18.0~20.0 m^3 grab capacity and equipped with rock breaking devices as this type of dredger is typically used in the hard soil dredging works. After breaking the rock layers, the dredging work will be carried out by the dredger.

Hard rock materials which is found at certain part of the existing port basin will be first blasted using drilled holes with Mini-SEP and disposed of together with general soil by use of barges.

The reclamation work , which requires about 1.2 million m^3 of reclamation material, can be done fully utilizing the dredged materials.

(2) Concrete Caisson Wharf/ Berth

A floating dock of 4,000~6,000 DWT is proposed since no appropriate facilities such as dry dock or slip-way for the fabrication of concrete caissons is available in the vicinity of Takoradi Port. For docking the floating dock the tip of the existing Clinker Jetty is recommended as the area is relatively calm and deep. The duration for the caisson fabrication will require approximately 12 months for each berth under the estimated caisson unit numbers, 15 units for the Bulk Berth and 16 units for the Container Berth (used production rate is 2~3 units/ 45 days).

(3) Existing Wharf Improvement

In the Short Term Development Plan, the existing wharf will be improved limiting for the manganese berth (200m) and the multi-purpose berth (300m) with concrete block wall. In order to avoid any adverse effect to the existing structure, a careful execution in the excavation close to the structure by use of a dipper type dredger is recommended.

18.2 Implementation Schedule

The implementation of the Short Term development is required about 5 years including 1.5 years engineering and tendering period and is to be completed by the end of year 2009. In order to minimize interruption of the port operation, the following work sequence of the berths construction is recommended;

Small Craft Berth ➔ Container Wharf ➔ Manganese Berth ➔ Multi-purpose Berth

The estimated implementation schedule based on the above considerations is shown in Figure 18.2.1.

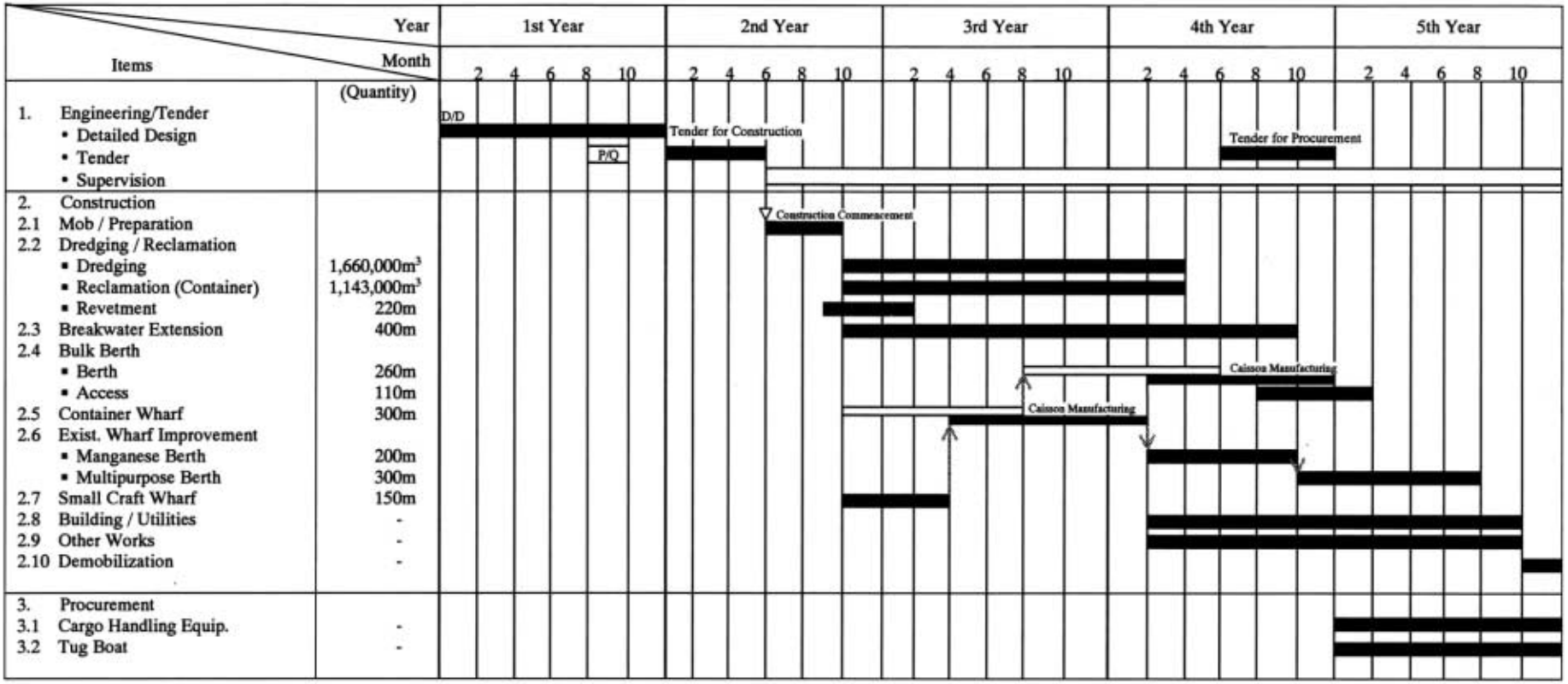


Figure 18.2.1 Implementation Schedule

Chapter 19 Cost Estimation.

19.1 Estimation Conditions

The following conditions are adopted for the cost estimation:

1) Costs are expressed in US dollars under the following exchange rate;

1 U.S. dollars = 6,700 Cedis

2) Costs for land acquisitions or any compensations are not considered.

3) The implementation period is 5 years and includes 1.5 years for engineering and tendering.

19.2 Implementation Cost

The total cost estimated for the implementation of Short Term Development is indicated in Table 19.2.1, and the yearly cost disbursement is shown in Table 19.2.2.

Table 19.2.1 Implementation Cost of Short Term Development Plan

Item	unit	Quantity	Unit Price (USD)	Foreign Cost (x1,000 USD)	Local Cost (x1,000 USD)	Total Cost (x1,000 USD)
1. Dredging						
1.1 Hard Rock	m^3	100,000	68.0	6,460	340	6,800
1.2 Soft Rock	m^3	1,199,200	25.0	28,481	1,499	29,980
1.3 General Soil	m^3	360,300	6.0	2,054	108	2,162
2. Reclamation (Dredged Material)	m^3	1,143,000	2.0	2,057	229	2,286
3. Breakwater Extension (-14.0 m Average)	m	400	29,500.0	6,490	5,310	11,800
4. Bulk Berth						
4.1 Berth (-13.0 m)	m	260	34,200.0	7,558	1,334	8,892
4.2 Access Way	m	110	10,000.0	660	440	1,100
5. Container Wharf						
5.1 Wharf (-12.0m)	m	300	31,600.0	8,058	1,422	9,480
5.2 Revetment (-5.0m)	m	220	6,000.0	726	594	1,320
5.3 Yard Paving	m^2	120,000	35.0	2,022	2,178	4,200
6. Existing Wharf Improvement						
6.1 Manganese Berth	m	200	26,400.0	4,224	1,056	5,280
6.2 Multi-purpose Berth	m	300	25,667.0	6,160	1,540	7,700
7. Small Craft Wharf	m	150	10,000.0	1,200	300	1,500
8. Other Items						
8.1 Administration Office	L.S.	1	500,000	200	300	500
8.2 Gate	L.S.	1	100,000	60	40	100
8.3 Lighting/ Electrical work	L.S.	1	1,000,000	900	100	1,000
8.4 Drainage	L.S.	1	250,000	100	150	250
8.5 Navigation Aids	L.S.	1	200,000	196	4	200
8.6 Port Access Road Improvement	L.S.	1	1,500,000	600	900	1,500
Total Construction Cost				**78,206**	**17,844**	**96,050**
9. Equipment						
9.1 Manganese Berth	L.S.	1	6,970,000	6,970	0	6,970
9.2 Container Wharf	L.S.	1	16,952,000	16,952	0	16,952
9.3 Tug Boat	L.S.	1	3,000,000	3,000	0	3,000
Total Equipment Cost				**26,922**	**0**	**26,922**
10. Physical Contingency	L.S.	1	8,760,872	7,334	1,427	8,761
11. Engineering Cost	L.S.	1	4,802,495	3,910	892	4,802
Grand Total				**116,372**	**20,163**	**136,535**

Table 19.2.2 Implementation Cost Disbursement

Item	1st Year		2nd Year		3rd Year		4th Year		5th Year	
	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local
A. Bulk Berths										
1. Dredging/Reclamation					9,897	520	3,300	174		
2. Breakwater extension			539	441	3,245	2,655	2,706	2,214		
3. Berths/Others					1,890	334	10,334	2,351	414	149
Sub-total	**0**	**0**	**539**	**441**	**15,032**	**3,509**	**16,340**	**4,739**	**414**	**149**
Contingency			43	35	1,203	281	1,307	281	33	12
Total	**0**	**0**	**582**	**476**	**16,235**	**3,790**	**17,647**	**5,020**	**447**	**161**
B. Container Terminal										
4. Dredging/ Reclamation			226	25	3,128	246	8,427	470		
5. Berths/Revetment			1,839	633	7,138	1,505	1,007	178		
6. Other Civil Works							1,061	1,164	1,661	2,064
7. Building/ Utility Works							580	220	580	220
Sub-total	**0**	**0**	**2,065**	**658**	**10,266**	**1,751**	**11,075**	**2,032**	**2,241**	**2,284**
Contingency			165	53	821	140	886	162	180	183
Equipment									19,952	0
Contingency									798	0
Total	**0**	**0**	**2,230**	**711**	**11,087**	**1,891**	**11,961**	**2,194**	**23,171**	**2,467**
C. Multipurpose Berth										
8. Dredging			6,052	319	8,022	422				
9. Berth							1,232	308	4,928	1,232
Sub-total	**0**	**0**	**6,052**	**319**	**8,022**	**422**	**1,232**	**308**	**4,928**	**1,232**
Contingency			484	25	642	34	99	25	394	98
Equipment									6,970	0
Contingency									279	0
Total	**0**	**0**	**6,536**	**344**	**8,664**	**456**	**1,331**	**333**	**12,571**	**1,330**
Total Construction	0	0	8,656	1,418	33,320	5,682	28,647	7,079	7,583	3,665
Total Equipment	0	0	0	0	0	0	0	0	26,922	0
Total Contingency	0	0	692	113	2,666	455	2,292	468	1,684	293
Engineering	1,174	268	684	156	684	156	684	156	684	156
Grand Total	**1,174**	**268**	**10,032**	**1,687**	**36,670**	**6,293**	**31,623**	**7,703**	**36,873**	**4,114**

Chapter 20 Economic Analysis

20.1 Methodology

An economic analysis was carried out applying the following method. Short-term plan for Takoradi Port was defined and it was compared to the “Without” case. All the benefits and costs accruing from the difference between “With” and “Without” cases were calculated in market prices and it was converted to economic prices. Here, the economic internal return (EIRR) based on a cost-benefit analysis was used to appraise the feasibility of the project. The procedure used for this economic analysis is shown in Figure 20.1.1.

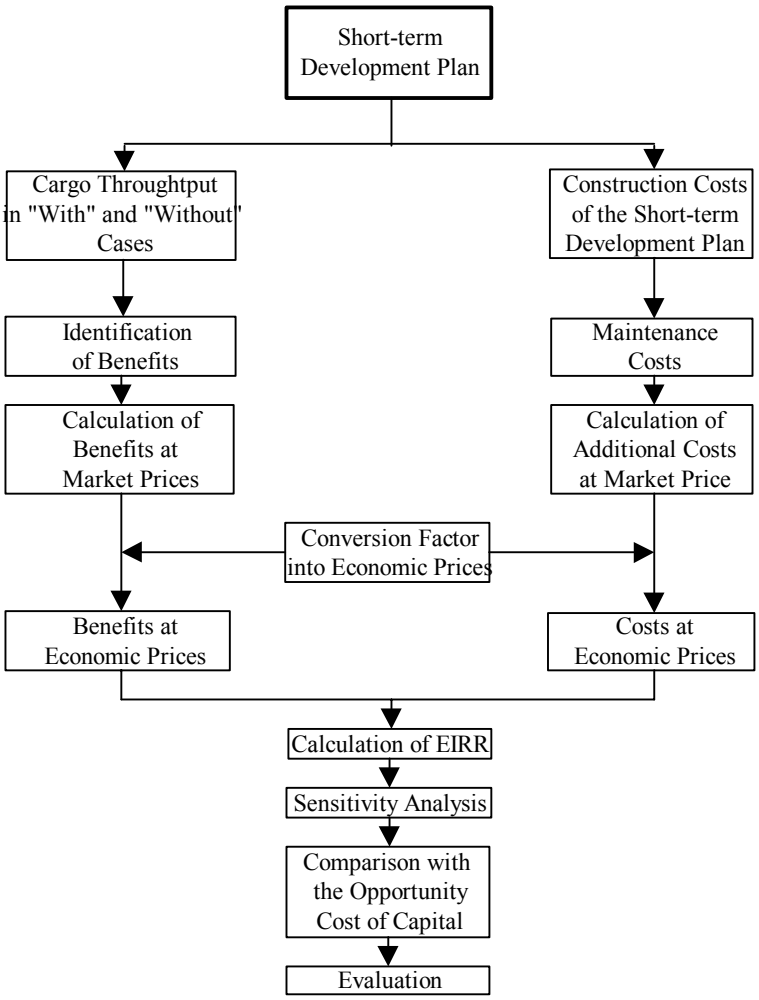


Figure 20.1.1 Procedure of the Economic Analysis

20.2 Costs of the Project

The items that should be considered as costs of the projects are construction costs, maintenance costs and renewal investment costs. These project costs must be converted from market prices into economic prices for the economic analysis.

(1) Construction Costs

Construction costs and investment schedule at economic prices are summarized in the following table.

Table 20.2.1 Annual Investment Schedule at Economic Prices

(Unit: '000US$)

Item	2005	2006	2007	2008	2009	Total
Economic Price	1,428	10,807	39,451	36,207	38,627	126,519

(2) Maintenance Costs

The costs of maintaining of port facilities and equipment per year are estimated as a fixed proportion (1 % for structures, 4 % for handling equipment) of the original construction costs excluding the costs of dredging and reclamation costs.

Table 20.2.2 Maintenance Costs at Economic Price – Takoradi Port

(Unit:thousand US$)

Item	Construction Costs at Market Price	Maintenance Costs at Market Price	Overall Conversion Factors	Maintenance Costs at Economic Price
Dredging/Reclamation	41,278	0	0.996	0
Breakwater	11,800	118	0.975	115
Quaywall/Revetment	35,472	355	0.985	350
Other Civil Works	5,950	60	0.970	58
Building/Utility	1,600	16	0.985	16
Machine & Equip.	26,922	1,077	1.000	1,077
Total	122,972	1,626	-	1,616

(3) Renewal Investment Costs

The renewal costs for cargo handling equipment after their economic durable periods should be considered. The economic durable periods of equipment are planned as follows. This investment will be done by foreign portion.

Table 20.2.3 Economic Durable Periods and Costs of Equipment

Equipment	Durable Periods	Costs('000US$)
Gantry Crane, Transfer Crane, Tug Boat	20 Years	24,000
Tractor, Trailer	10 Years	2,922

20.3 Benefits of the Project

The following items are considered as tangible benefits in terms of the cost-benefit analysis in this study.

1) Savings in staying costs of ships

2) Savings in water transportation cost by increase of cargo volume per ship

3) Savings in land transportation costs

4) Earnings of foreign currency in cargo handling

Benefits of the projects at economic price are summarized in the following table.

Table 20.3.1 Benefits of the Projects for Short-term Plan – Takoradi Port

(Unit: thousand US$)

Items	Benefits
Ships' Staying Time	10,077
Water Transportation Cost	6,072
Land Transportation Cost	10,585
Earnings of Foreign Currency	12,759
Total	39,493

20.4 Evaluation of the Project

The EIRR of the project at Takoradi Port is calculated as 22.7%. The results of calculation are shown in Table 20.4.1.

It is generally recognized that the project is feasible if the EIRR exceeds the opportunity cost of capital. Usually, the opportunity cost of capital is considered to range from 8% to 10% according to the degree of development in each country. It is acceptable that a project with an EIRR of more than 8% is economically feasible for infrastructure or social service projects.
As for this project, even though the economic calculation only takes into account the items that are easily quantified, the EIRR is still 15.8% in the worst case. Therefore, this short-term development project is feasible from the viewpoint of the national economy.

Table 20.4.1 Results of Sensitivity Analysis on Short-Term Plan for Takoradi Port

	EIRR 22.7%	Increase in Investment Cost		
		0%	10%	20%
Decrease Benefits	0%	22.7%	20.3%	19.0%
	10%	20.2%	18.7%	17.5%
	20%	18.4%	17.0%	15.8%

Chapter 21 Financial Analysis

21.1 Purpose and Methodology

21.1.1 Purpose

The purpose of the financial analysis is to appraise the financial feasibility of the Short-term Development Plan. The analysis focuses on the viability of the project itself and the financial soundness of the port management body during the project life.

21.1.2 Methodology

(1) Viability of the project

The viability of the project is evaluated using the Financial Internal Rate of Return (FIRR). The FIRR is a discount rate which makes the cost and the revenue during the project life equal.

(2) Financial soundness of the port management body

The financial soundness of the port management body is appraised with its projected financial statements (Profit and Loss Statement, Cash Flow Statement and Balance Sheet). The appraisal is made from the viewpoints of profitability, loan repayment capacity and operational efficiency.

21.2 Prerequisites of the Financial Analysis

21.2.1 General

(1) Scope of the Financial Analysis

Scope of this financial analysis is the projects in the Short-term Development Plan. The specific projects are as follows.

1) Bulk Berth Project (Construction of New Bulk Berth for bauxite and clinker and improvement of present berth for manganese)
2) New Container Terminal and Multipurpose Berth Project

(2) ”With Case” and ”Without Case”

The viability of the project, namely FIRR, is analyzed based on the difference of revenues and costs between the “With Case” and the “Without Case”. Here, the “With Case” is the case in which the Short-term Development Plan is executed while the “Without Case” is the case which represents the existing situation. The financial soundness of the port management body is analyzed using the “With Case”.

21.2.2 Base Year

All costs and revenues are indicated in prices as of March 2001, when the price survey was conducted (US$1.00 = 6,700Cedis). We call this year the “Base Year”.

21.2.3 Project Life

Considering the long-term loans and the service lives of the port facilities, the project life in the financial analysis is assumed to be 35 years including the period of 5 years for detailed design and construction work. Neither inflation nor an increase in nominal wages is considered during the project life.

21.2.4 Fund Raising

Fund raising is divided into foreign and domestic funds. In this study, referring to funding conditions of soft loan by international financial institute including JBIC, the upper limit of finance for foreign funds is assumed to be the total amount of foreign portion or 85% of initial investment costs, whichever is higher. In the proposed projects, eighty-five percent of initial investment costs is assumed to be raised by foreign fund. The remaining initial investment costs (15%) and all renewal investment are assumed to be raised by domestic fund. Conditions of loans are assumed as follows.

(1) Foreign funds

Loan Period	：	30 years, including a grace period of 10 years
Interest rate	：	1.8%
Repayment	：	Fixed amount repayment of principal

(2) Domestic funds

Loan Period	：	10 years
Interest rate	：	8.0%
Repayment	：	Fixed amount repayment of principal

(3) Weighted average interest rate

2.73%（=1.8%×0.85+8.0%×0.15）

21.2.5 Revenue and Expenditure

(1) Bulk Berth Project

Operating revenues are estimated from the difference of revenues between the “With Case” and the “Without Case”. All revenues are calculated by multiplying cargo volume and the number of calling vessels by present tariffs.

The companies handling manganese, bauxite and clinker are specific ones. They will be able to decrease ship berthing, navigation and land transportation cost after the Bulk Berth Project is executed. Therefore, as a beneficiary of the project, these companies will be requested to share a

certain percentage of the project cost as a special charge during the project life.

Revenues)

1) Operating Revenues

a) Revenues from cargo and vessel services
b) Special Charge

The parties that have interest in the project are the port authority (GPHA), shipping companies, producers and consumers. Therefore, it is assumed that the benefit obtained by executing the project will be distributed equally to these four parties. As a result, GPHA will get one-fourth of the benefit as a special charge.

Expenditures)

1) Project Costs

Project Costs are estimated in Chapter 19. According to the construction schedule, investment will be made.

2) Personnel Costs

Stevedoring is being done by Private Companies and GPHA is getting a royalty fee from these companies now. Therefore there is no difference in personnel cost between the "With Case" and the "Without Case".

3) Maintenance Costs

The annual maintenance costs for the port facilities are calculated as follows.

Infrastructure	:	1.0% of the original construction cost
Equipment	:	4.0% of the original procurement cost

4) Administration Costs

Since there is no difference in personnel cost between the "With Case" and the "Without Case", there is also no difference in administration cost.

(2) New Container Terminal and Multipurpose Berth Project

Revenues)

1) Operating Revenues

Operating Revenues are estimated from the difference of revenues between the "With Case" and

the “Without Case”. All revenues are calculated by multiplying cargo volume and number of calling vessels by present tariffs.

As for the New Container Terminal, it is assumed that cargo volume in the “With Case” will increase to the level of Berth Occupancy level = 0.6 (150,000TEU) after the year 2010 because the New Container Terminal has sufficient capacity.

As for the Multipurpose Berth, it is assumed that container cargo volume handled here in the “Without Case” and the “With Case” will remain at the level of the year 2000 for the following reasons.

- Container Cargo handled at Berth 2～6 is transported to a remote yard because of the narrow apron and limited space behind the berths.
- Cargoes except container cargoes are also forecasted to increase slightly.
- Consequently it might be unrealistic to expect to handle more container cargo than the present level.

Expenditures)

1) Project Costs

Project Costs are estimated in Chapter 19. According to the construction schedule, investment will be made. The equipment will be replaced after service life. Service lives are as follows

2) Personnel Costs

a) New Container Terminal

While it is assumed that the New Container Terminal will be leased to a private company, we estimate newly required personnel cost including for cargo handling here.
The required staff is as follows.

Snr. Staff 23
Jnr. Staff 95

Required annual personnel costs for the New Container Terminal are calculated by multiplying number of staff by average unit wages estimated according to present level.

Snr. Staff = 23 persons × US$6,970 / person・year = US$160,310 / year
Jnr. Staff = 95 persons × US$2,750 / person・year = US$261,250 / year
Total US$421,560 / year

Required personnel cost for administration, security and marine services of GPHA with construction of New Container Terminal are estimated as follows.

US$295,390 / year・berth

Therefore required total personnel cost for the New Container Terminal are calculated as follows.

US$421,560 / year + US$295,390 / year = US$716,950 / year

b) Multipurpose Terminal

Since GPHA does not engage in stevedoring, there is no difference in personnel cost between the "Without Case" and the "With Case".

3) Maintenance Costs

The annual maintenance costs for the port facilities are calculated as follows.

Infrastructure : 1.0% of the original construction cost
Equipment : 4.0% of the original procurement cost

4) Administration Costs

Administration Costs are assumed as follows according to the actual present level of GPHA.

Administration Costs = Total Personnel Costs × 0.2

21.3 Evaluation of the Project

21.3.1 Viability of the Project

(1) Calculation of FIRR

The result of the FIRR calculation is shown in Table 21.3.1. In all the projects, FIRR exceeds the weighted average interest rate of the funds (2.73%).

Table 21.3.1 Result of FIRR Calculation

	Bulk Berth Project	New Container Terminal and Multipurpose Berth Project	Whole
FIRR	9.1%	11.1%	10.4%

(2) Sensitivity Analysis

Sensitivity analysis is conducted to examine the impact of unexpected future changes such as cargo volume, construction cost, inflation or exchange rate. The following cases are envisioned.

- Case 1 : The investment costs increase by 10%
- Case 2 : The revenues decrease by 10%
- Case 3 : The investment costs increase by 10% and the revenues decrease by 10%

The results of the sensitivity analysis are shown in Table 21.3.2. In all the cases, FIRR exceeds the weighted average interest rate of the funds (2.73%).

Table 21.3.2 Sensitivity analysis of FIRR

	Bulk Berth Project	New Container Terminal and Multipurpose Berth Project	Whole
Base Case	9.1%	11.1%	10.4%
Case 1	8.2%	10.1%	9.4%
Case 2	8.0%	9.6%	9.1%
Case 3	7.2%	8.7%	8.1%

(3) Evaluation

Judging from the above, this project is regarded as financially feasible under the assumptions in Chapter 21.2.

21.3.2 Financial Soundness of the Port Management Body

1) Profitability

Throughout the project life, the rate of return on net fixed assets exceeds the weighted average interest rate of funds.

2) Loan Repayment Capacity

Through the project life, the debt service coverage ratio exceeds 1.0. This means that there will be no difficulty in repaying long-term loans from the annual operating revenues.

3) Operational Efficiency

Both the operating and working ratios maintain favorable levels. This shows that the operation will be efficient.

21.3.3 Possibility of Private Company Participation in the New Container Terminal

After the passage of the Landlord Port Bill, private company participation in the operation of the New Container Terminal will become a real possibility.

(1) Roles of GPHA and Private Company

(a) GPHA
・Construction, ownership and management of Infrastructure

・Marine services

(b) Private company
・Procurement, ownership and management of cargo handling facilities
・Terminal operation

(2) Revenues and expenditures of GPHA and private company

(a) GPHA

Revenues）
・Revenue from Port Dues
・Revenue from vessel services
・Rent for Container Terminal
Expenditures)
・Project Costs
・Personnel Costs
・Maintenance Costs
・Administration Costs

(b) Private company

Revenues）
・Revenue from Cargo handling (Present tariff is used in this study)
Expenditures)
・Project Costs (including renewal investment)
・Personnel Costs
・Maintenance Costs
・Administration Costs
・Rent for Container Terminal

(3) Calculation of FIRR

The result of FIRR calculation under variable rental conditions is shown in Table 21.3.3.

Table 21.3.3 Result of FIRR calculation

Rent（US$'000 / year）	FIRR of GPHA	FIRR of Private Company
2,000	13.7%	28.7%
2,500	14.6%	26.2%
3,000	15.5%	23.7%
3,500	16.4%	21.2%
4,000	17.2%	18.6%
4,500	18.0%	16.0%
5,000	18.9%	13.4%

Judging from the above calculation and fund raising conditions of both parties, assuming that rent is set at US$3,000,000 / year, FIRR of GPHA and the private company are well-balanced.

(4) Sensitivity Analysis

Sensitivity analysis is conducted to examine the impact of unexpected future changes in cargo volume, construction cost, inflation or exchange rate. FIRR is checked on condition that rent is set at US$3,000,000 / year. The following cases are envisioned

- Case 1 : The investment costs increase by 10%
- Case 2 : The revenues decrease by 10%
- Case 3 : The investment costs increase by 10% and the revenues decrease by 10%

The results of the sensitivity analysis are shown in Table 21.3.4. In all cases, FIRR of GPHA exceeds the weighted average interest rate of the funds (2.73%) and FIRR of private company exceeds the general interest rate of domestic funds (8.0%).

Table 21.3.4 Sensitivity Analysis for FIRR

	FIRR of GPHA	FIRR of Private Company
Base Case	15.5%	23.7%
Case 1	14.4%	21.7%
Case 2	14.0%	19.3%
Case 3	13.0%	17.5%

(5) Evaluation

Judging from above analysis, it is financially feasible for a private company to participate in the operation of the New Container Terminal.

21.3.4 Conclusion

Judging from the above analysis, all the projects are regarded as financially feasible. However, the port management body should make continuous efforts to secure forecast cargo volume, to improve cargo handling efficiency and to reduce operating expenses.

Chapter 22 Port Management and Operation

22.1 Proposal for Efficient and Reliable Port Management

22.1.1 General Problem for Privatization of Takoradi Port

GPHA has already introduced privatization to same extent, namely:
- Cargo handling operation (stevedoring and shorehandling) with private companies
- Offdock terminal operation by private company

After the privatization, principle of competition will be introduced and more efficient cargo handling operation will be expected. And as the landlord, GPHA is required to take the initiative to further increase operational efficiency at Ghana Sea Ports.

However, it is desirable that workers currently employed by GPHA for stevedoring activities be hired by the private companies or retained by GPHA. Several systems will be required to increase workers' skill, knowledge and early retirement.

22.1.2 Privatization of Port Management and Operation

For Ghana Sea Ports, it is recommended to select the D-type form of privatization.
(See Chapter 15.1.2. and Table 15.1.1.)

(1) New Container Terminal

New container terminal at the inner port area is desired to be leased to a single operator as a public berth. GPHA constructs the basic facilities while the operation company is responsible for equipment procurement and operation.
There are plural possibilities concerning the make-up of that single operator.
- One private company such as shipping company, stevedoring company
- One joint venture company of private companies.
- One joint venture company of these private companies and GPHA

It will be important work for GPHA to ensure that all terminal users are fairly treated. It is also required to monitor the tariff structure, performance of operations such as effective use of facilities and productivity of cargo handling. (GPHA should make some criteria for the monitoring such as minimum amount of cargo handling per annual.)

Container cargo will be handled at both the new container terminal and the new multipurpose berth. New multipurpose berth is appropriate to be managed by GPHA and operated by private companies. But to promote efficient port management, these two container operators should compete with each other.

(2) New Multipurpose Berths (Berths 5-6)

Since berths 5-6 will function as the multipurpose berths, it is appropriate for them to be managed

by GPHA, including facilities and equipment such as quay side gantry cranes. Maintenance of facilities and equipment will be done by GPHA or contracted to private company. Private companies can also provide other cargo handling equipment and do handling operations.

Prior to the opening of the container yard behind the new multipurpose berth, it is recommended that GPHA should give users of those berths priority to use NCP and KAMPIHL Container Yard.

(3) New Bulk Berth, Improved Manganese Berth

Management and operation of the new bulk berths for manganese, bauxite, clinker would be the responsibility of private companies. Private companies can be expected to adopt the most efficient way of providing services and handling cargoes in these berths.

(4) Others

Berths 2-4 for other cargoes (Ro-Ro cargo, general cargo, bagged cargo) are desired to be managed by GPHA and operated by private companies. Maintenance of facilities will be done by GPHA or private companies by contract with GPHA. Cargo handling equipment will be provided by private companies.

Management and operation of oil handling berth would be the responsibility of private companies. Private companies can be expected to adopt the most efficient way of providing services and handling cargoes in this berth.

22.1.3 Monitoring the Performance of Operation

GPHA should monitor the performance of operators and recommend the improvement of productivity if the performance is poor and reject the renewal of lease contract if improvement is not expected. GPHA needs to put pressure on port operators to improve the productivity of operation.

22.1.4 Maintenance of Cargo Handling Equipment

Port facilities and cargo handling equipment must be well maintained so that port users can make full use of facilities and equipment. To generate the maximum income from port service, cargo handling must be done continuously, and this requires well-maintained cargo handling equipment. Maintenance of equipment will be done efficiently by private terminal operators. Maintenance of equipment owned by GPHA will be done by GPHA or contracted to private company.

22.1.5 Three-Shift Working System

Refer to Chapter 13.5.2(4)

22.1.6 Port EDI System

Refer to Chapter 15.1.4.

22.1.7 Port Promotional Activities for Takoradi Port

It is vital to increase trade visits to potential customers for Takoradi Port to attract more cargoes, especially import cargoes at the hinterland of Takoradi Port such as Western Region, Ashanti Region (Kumasi), Brong-Ahafo Region (Sunyani) , Northern Region (Tamale).

To become competitive with other ports, rectifying the imbalance between import and export containers (including container size) is also an important task for Takoradi Port. Container freight for Takoradi Port is higher than at neighbouring ports. In addition, holding periodic meetings with port users such as shipping companies and agents is useful for identifying and solving problems.

22.1.8 Port Tariff

Port charges should be competitive but must cover the cost of construction, management and maintenance of port facilities. Furthermore, tariff structure should encourage port users to use port facilities efficiently.

Chapter 23 Environmental Impact Assessment

An EIA was conducted based on the Short-term Development Plan of Takoradi Port. The TOR for EIA for Master Plan of Takoradi Port development was applied to the EIA for the Short-term Development Plan, because the master plan's components of the construction works and operation activities entirely contained those of the short-term development plan. Hence it can be said that the TOR for EIA on the master plan cares all of the possible environmental impacts of the short-term development plan of Takoradi Port.

Environmental problems such as disposal of dredged material contaminated with heavy metals, dust dispersal in certain areas of the port and needs of waste management were predicted to occur. The following mitigation measures were suggested to minimize the above environmental problems:

- Usage of the dock area as a containment facility for contaminated bottom sediment,
- Construction of fences or planting of trees,
- Cooperation with the local government,
- Others.

Summary of the EIA is shown in Table 23.1. The proposed short-term development plan of Takoradi Port is feasible from the environmental point of view.

The environmental management plan was proposed including environmental monitoring plan, waste management plan and contingency plan. The contents of these plans were proposed.

Table 23.1 Summary of Evaluation of Environmental Impact (Takoradi Port)

Phase	Impact	Mitigation	Positive effect	Negative effect	Total
Preparation	No activity	-	-	-	-
Construction	Dredging & other marine works	Silt protection curtain	Sediment quality	Waste Water quality Noise	0
	Construction machines, vehicles, and vessels	Setting signals Announcement to local residents	Local economy	Waste Dust Safety Noise	-4
	Reclamation	Carefully designed containment	Waste	Dust Water quality	-1
	Demolition of existing facility	Enhanced waste handling capacity	-	Waste Dust Noise	-7
	Employing construction workers	Local employment and vocational training	Local economy	Waste	+4
Operation	Altered port configuration	Announcement to fishermen	Erosion	Sediment quality	+3
	Increased ship-call	Waste reception facility	Local economy	Waste	+4
	Increased cargo-handling	Dust protection fence or plantation Proper waste management program	Local economy	Waste Dust Noise Safety	-7
	Increased port workers	Proper waste management program	Local economy	Waste	+9
	Port-associated development	Improvement of road Coordination with city planning	Infrastructure	-	+10
	Rearrangement of facilities	-	-	-	0
	Increased land transportation	Setting signals Soundproof fence	Local economy	Safety Dust Noise	0
Demolition	Not applicable	-	-	-	-
Total					+8