Chapter 26 Implementation Program

26.1 General Conditions

26.1.1 Construction Component of Short Term Development Plan

The following construction components are proposed in the Short Term Development Plan;

Table 26.1.1 Construction Component of Short Term Development Plan

Construction Component	Description	Quantity
1. Dredging and Reclamation		
1) Dredging	Hard rock	85,000 m^3
	Soft rock	641,000 m^3
	General soil	430,000 m^3
2) Reclamation		1,953,000 m^3
2. Breakwater		
1) Type I (Average -15.0 m)	Rubble Mound	L = 1,350 m
2) Type II (Average -8.0 m)	Rubble Mound	L = 200 m
3. New Container Berth (-14.0 m)	R.C. Caisson	L = 600 m
4. Revetment	Rubble Mound	L = 650 m
5. Building/ Utilities Works	(Container Terminal)	
1) Administration Office/Gate	2 stories, approxi.	1 set
2) Maintenance shop	3,000m^2	1 set
3) Electrical / Mechanical works		1 set
6. Other Construction Items		
1) Container Yard paving	Concrete block paving	200,000 m^3
2) Drainage		1 set
3) Navigation Aid	Lighted buoys, Light Beacons	2 light beacons, 2 lighted buoys
4) Port Access Road	Asphalt concrete paving	L = Approxi. 2 km
5) Removal of Part of Exist. Breakwater Parapet/Wave walls etc.		1 set

26.1.2 Major Construction Materials

Major construction materials to be used in the development plan are as shown in Table 26.1.2.

Table 26.1.2 Main Construction Materials

Material	Quantity	Supply Source
1. Rock Materials	(1,434,000 m^3)	
1.1 Armor rock (5-15 t)	166,000 m^3	Local quarry(s)
1.2 Armor rock (1-5 t)	302,000 m^3	Ditto
1.3 Rubble (50-500 kg)	855,000 m^3	Ditto
1.4 Rubble for Foundation	28,000 m^3	Ditto
1.5 Quarry-run	53,000 m^3	Ditto
2. Reclamation Sand	1,953,000 m^3	Dredged sand / Sand borrow areas
3. Concrete	(94,500 m^3)	Concrete batching plant
3.1 Characteristic strength > 20 MPa	38,700 m^3	Imported / Local cement
3.2 Ditto < 20 MPa	19,800 m^3	Local cement
3.3 Paving concrete block	200,000 m2 (36,000 m^3)	Local cement/ products
4. Reinforcement Bars	5,000 t	Import
5. Other Materials		
5.1 Fabric sheet	18,000 m^2	Import
5.2 Marine fittings	Rubber Fender, Bollards	Import

Note; The above quantities are for Civil Works only, and exclude Drainage/ Port Access Road Works.

26.1.3 Supply of Construction Materials

(1) Rock Materials

Approximately 1.4 million m^3 of rock materials are required in the construction, of which more than 80% is to be used for Breakwater construction.

The rock materials are to be supplied from the existing quarries located at Shai Hills, about 20 - 40 km distant from Tema Port along Tema - Akosombo Road. At Shai Hills three (3) quarries exist, and are commercially operating. The supply capacity of the operating quarry is expected to be 40,000 ~ 50,000m^3/month or max. 2,000 ~ 2,500 m^3/day depending on rock type and size.

Since huge quantity of rock materials is used in the construction, it is necessary that rocks be constantly transported and stocked at appropriate locations for use with sufficiently large areas.

(2) Reclamation Sand

Approximately 2.0 million m^3 of sand is required for the reclamation to from the new container terminal (Total area about 28 ha.).

About a half of the required reclamation volume can be obtained from the dredged material (about 1.0 million m^3), however the remaining half should be obtained from other sources.
At Ayikuma and Akuse, 40 ~ 60 km distant from Tema, a few licensed sand borrow pits are available, therefore it may be possible to supply the remaining volume from this source by land transportation. It may however cause serious environmental issues such as noise and dust, traffic congestion etc. along the hauling route if all of the remaining volume is transported by dump

trucks as this requires numerous truck hauling with a quite long period.

It is therefore the following supply allocation is recommended;

Approxi.	1,000,000 m^3	Dredged material use
Approxi.	500,000 m^3	From Offshore sand borrow areas by sea transport
Approxi.	500,000 m^3	From On-shore sand pit by land transport

(3) Concrete

Total concrete volume estimated for the construction is of the order of 100,000 m^3. Though concrete plants are available in Tema, it is recommended to arrange temporary concrete batching plant for own use as a stable and of high quality concrete supply is necessary in the construction particularly for R.C caisson works.

(4) Other Materials

(a) Cement: Cement is locally produced, therefore maximum utilization of local cement be considered. It is however suggested to use imported cement for a concrete of high quality and strength such as R.C. Caissons.

(b) Reinforcement Bars: No deformed bar is produced in Ghana, thus all the deformed bar be imported

26.1.4 Other Notable Condition

1) The construction site proposed in the short Term Development Plan is located at west side and outside of the existing port area, it is therefore thought that no serious interference will occur throughout the construction period. It should however be noted that the site is always subjected to adverse wave conditions as the site is open to the predominant directions of wave attacks (South east to South)

2) Since major component of the construction is earth/rock works such as dredging & reclamation, breakwaters and revetment, these works will form the critical pass in the construction.

In planning the earth/rock work methods therefore, due considerations should be made as to the supply capacity of materials and work efficiency of the construction equipment/activity to be used in each work activity.

26.2 Construction Plan for Major Works

26.2.1 Dredging & Reclamation

(1) Dredging

1) The estimated dredging volume is approxi. 1.2 million m^3, of which more than 60% is thought to be rock materials. The rock materials to be dredged is, according to the soil investigation carried out in the Study, expected to be mostly weathered rock with its compressive strength less than 50 MPA (categorized as soft rock) which can be dredged without blasting (but use of rock breaking hammer).

2) For dredger type to be employed, a grab type dredger (18 ~ 20 m^3 grab capacity) is recommendable as the dredging work itself is not critical in the construction, thus this type is possible to dredge the estimated volume within the required time schedule at more economical cost than cutter suction type dredger.

3) The following methods are proposed in the dredging work depending on the material types to be dredged;

- Hard Rock (Estimated volume: 85,000 m^3) ; Blasting be employed to break hard rocks using Mini-SEP. as recommended in the Takoradi Port Development Study

- Soft Rock (Estimated volume: 641,000 m^3) ; Soft rock layers be broken by use of rock breaking hammer.

After completion of rock breaking by blasting or breaking hammer, all the broken rock material together with general soil be dredged by the grab dredger and disposed of by barge transportation.

4) The dredging work be started at first from hard rock blasting by use of Mini-SEP which is not so influenced by sea conditions and the dredging operation by grab dredger will be carried out in accordance with the progress of the breakwater construction in order to obtain more efficient work conditions.

(2) Reclamation

1) Reclamation work will be started from land side following the completion of certain portion of revetment.

2) From seaside reclamation, a barge unloader be considered due to shallow water area mostly.

26.2.2 Breakwater

1) Two (2) breakwaters are designed in the Short Term Development Plan (i.e. type I and Type II). Type I is the main breakwater extended from the reclaimed land at length 1,350 m and is to be constructed at deep water area (-7.5 ~ 15.5 m), whilst Type II is extended from the existing port main breakwater with its length 200 m.

2) It is planned that Type I be constructed as marine work whilst Type II can be done as on-shore work from the existing breakwater.

3) The construction of the main breakwater is the most critical one in the Short Term Development from the following points of view;

- As the construction site is open to predominant wave directions, it is importantly required to provide well-sheltered areas for other construction activities such as dredging, reclamation and berth construction, thus the progress of the breakwater construction will affect other works significantly.

- The estimated quantity of the required rock material for main breakwater is so large (approxi. 1.0 million m^3 as marine works quantity), the required duration of the construction will much depend on the supply capacity of the rock material from quarries.

4) The main breakwater construction can be done in the following manner;

- Rubble rocks below CD -5.0 m be placed by direct disposal of bottom open type barges towed by tug-boat.

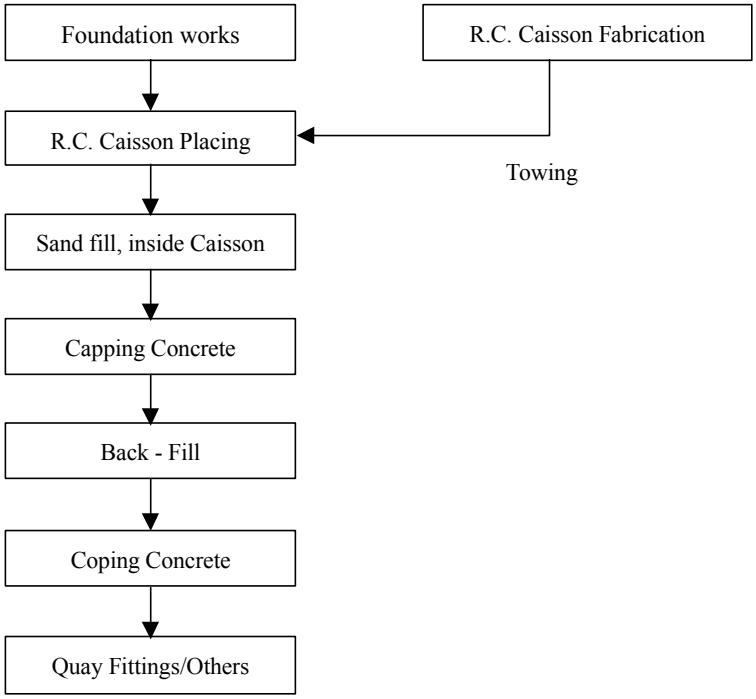
- Rubble rocks above CD -5.0 m be placed by use of gut-barge (clamshell equipped barge) or wheel loader on flat barge.

- Armor stone over 1.0 tonnes will be placed by crane barge and be followed after the rubble rocks placement with not more than 100 m distance when the area above CD -5.0m is being carried out.

5) The construction duration estimated for the main breakwater work is at least 34 months based on the constant rock material supply at 35,000 m^3/month (average) throughout.

26.2.3 New Container Berth

1) The construction of the R.C. Caisson berth is to be done under the following work flow:



2) Floating Dock method is recommended as no dry dock or slipway to fabricate the caisson units of the designed sizes are available in the vicinity of Tema Port.

3) The Floating Dock having its capacity 6000~8000 DWT class is recommended to produce 2~3 units of the designed caisson (1,800 t/Unit) at same time.

In this design, the production rate of 3 units/45 days (2.0 units/month) is applied. Thus the required time for the caisson fabrication for the container berth is as follows;

Total number of caisson unit = 31 units ÷ 2.0 = 16 months

26.2.4 Temporary Facilities

In the implementation of the Short Term Development Plan, the following temporary facilities/measures should be thoroughly studied and appropriately arranged:

(1) Materials Stock Yard

A sufficient space for materials stocking yards for rocks, fill sand, aggregates, cement, fabricated concrete products, etc. be considered. As for rock materials for offshore work use, it is recommended to arrange close to the rock loading Temporary Jetty, and rocks for land work use at the location (s) near the reclamation area.

(2) Temporary Jetty for Rock Loading

A temporary jetty is required to load the large quantity of rock materials for off-shore works use. The proposed location for the temporary jetty is the east side of Tema Fishing Harbour where is seemed to be relatively calm water area.

To make use of that area, the following consideration should be made:

- The proposed site is currently used as fish drying yard, it is therefore necessary to provide sufficient dust control measures along the temporary access road and jetty.

- A sufficient distance from the shore area to the temporary jetty be considered in order to obtain enough water depth (-3.5 to -5.0 m) and to mitigate the impact of the dust during loading.

- The proposed site is close to the entrance used by many fishing boats, thus the approach channel for rock transport be discussed and established providing appropriate navigation aids.

(3) R.C. Caisson Fabrication Yard

Floating dock method is recommended for the fabrication of concrete caisson unit. To dock the employed Floating Dock, the appropriate location where requires sufficient calmness and water depth can only be found within the existing port area, i.e. Side line of the existing Berth No. 12 or the area immediate behind of the existing main breakwater.

It will be preferable and advantageous, if compared within these two possible site, to use the area behind the main breakwater, as crossings during transporting the fabricated caissons with the ships approach routes is minimized and convenient to obtain necessary stocking area for the fabricated caissons.

(4) Other Items

The areas for construction office, construction equipment/materials, concrete batching plant etc is also preferably sought close to the new reclamation area within the Port Boundary.

26.3 Implementation Schedule

Short Term Development will require at least five (5) years for its implementation including 1.5 year for Engineering and Tendering before the commencement of the construction, and is to be completed by the end of year 2009.

The proposed implementation schedule of the Short Term Development of Tema Port is indicated in Figure 26.3.1.

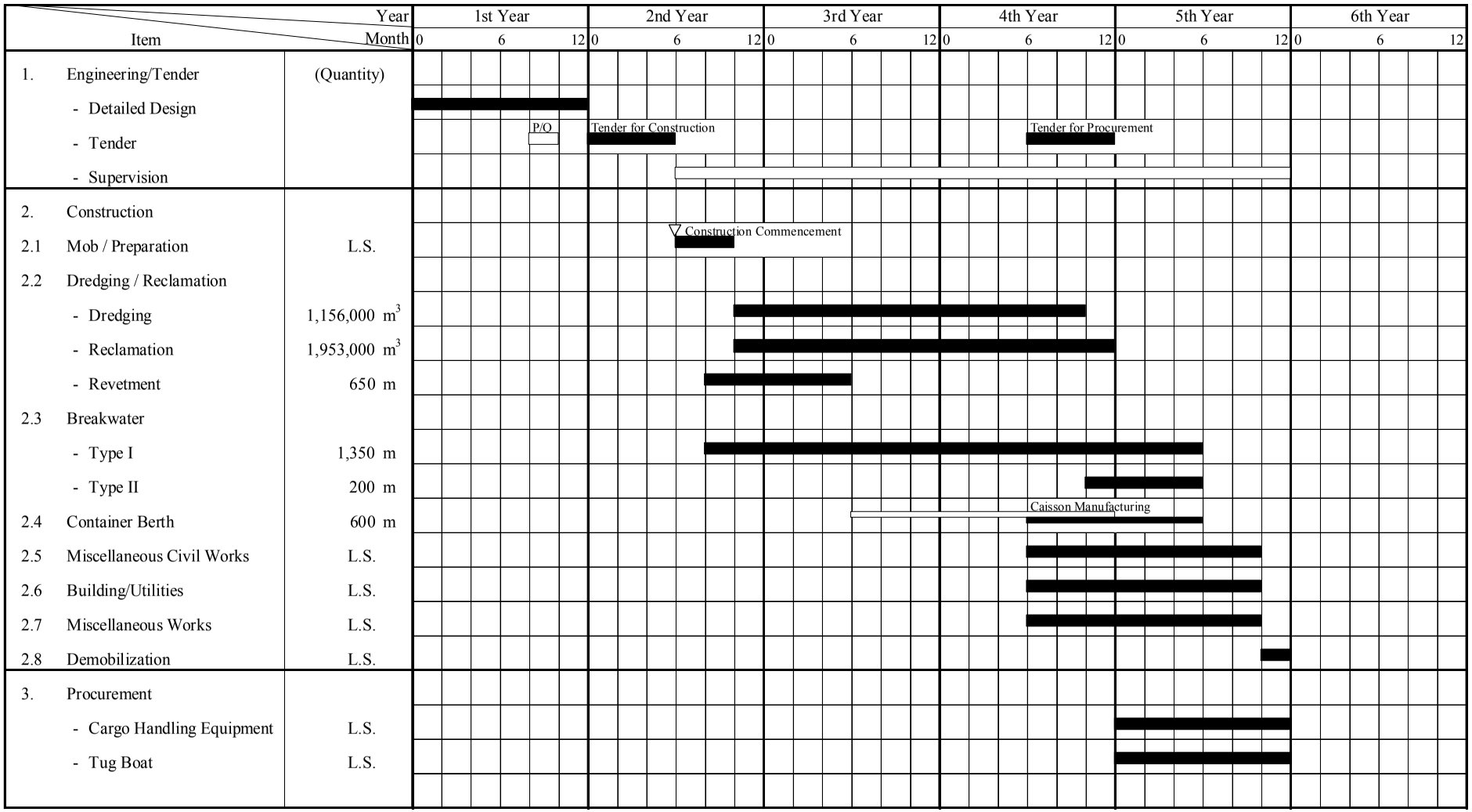


Figure 26.3.1 Implementation Schedule

Chapter 27 Cost Estimation.

27.1 Estimation Conditions

The following conditions are adopted for the cost estimation:

(1) Costs are estimated based on the recommended designs of the proposed facilities, works and equipments as necessary in the Short Term Development Plan, and the recommended or assumed construction methods described in Chapter 26.

(2) Implementation period is 5 years including 1.5 year for Engineering and Tendering for the construction.

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

1 U.S. dollars = 6,700 Cedis

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

(5) Tax/duties on the imported equipments/materials for the constructions/procurement are exempted.

(6) Foreign Currency Portion and Local Currency Portion

The following allocation of currency portions is applied ;

Foreign Currency Portion	Local Currency Portion
• Costs for all of imported construction materials and equipments. • Expatriates Staff or foreign workers costs. • Construction equipment costs originally imported.	• Costs of construction materials and goods produced or manufactured locally. • Domestic transportation costs. • Local staff and workers salary and associated costs.

27.2. Construction Costs for Major Work Components

Unit costs for major construction components are estimated as shown in Table 27.2.1.

Table 27.2.1 Unit Costs of Major Work Components

Work Component	Unit	(USD) Foreign	(USD) Local	(USD) Total
	(Per)			
1. Dredging Work				
· Hard Rock	m^3	64.6	3.4	68.0
· Soft Rock	m^3	23.75	1.25	25.0
· General Soil	m^3	5.7	0.3	6.0
2. Reclamation				
· Dredged Material Fill	m^3	1.8	0.2	2.0
· Borrow Material Fill	m^3	4.5	3.0	7.5
3. Breakwater				
· Type IA	m	27,200	4,800	32,000
· Type IB	m	16,575	2,925	19,500
· Type II	m	12,750	2,250	15,000
4. Container Berth	m	31,280	5,520	36,800
5. Revetment (-5.0 m)				
· Less -5.0m	m	4,565	3,735	8,300
· -5.0m ~ -10.0m	m	8,250	6,750	15,000
6. Concrete Block Paving	m^2	16.85	18.15	35.0

Note; The unit costs indicated above include indirect costs.

(3) Allocation of Foreign/Local Currency Portions for buildings, utilities and miscellaneous works costs and equipments costs are assumed as follows :

Table 27.2.2 Currency Portion Allocation of Other Work Component

Work Item	Foreign	Local
1.Building, Utilities and Miscellaneous Works		
- Building Works	40%	60%
- Electrical Works	90%	10%
- Drainage	40%	60%
- Navigation Aids	98%	2%
- Port Access Road	40%	60%
2.Equipment		
- Cargo Handling Equipment	100%	0
- Tug boat	100%	0

27.3 Implementation Cost

The total cost estimated for the implementation of Short Term Development of Tema Port is Approx. 171.8 Million U.S. dollars including Physical Contingency (10.9 Million U.S. dollars) and Engineering cost (5.9 Million U.S. dollars) as indicated in Table 27.3.1

The implementation cost disbursement estimated based on the implementation schedule is shown in Table 27.3.2.

Table 27.3.1 Implementation Cost

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	85,000	68.0	5,491	289	5,780
1.2 Soft Rock	m^3	641,000	25.0	15,224	801	16,025
1.3 General Soil	m^3	430,000	6.0	2,451	129	2,580
2. Reclamation						
2.1 Dredged Material Fill	m^3	1,000,000	2.0	1,800	200	2,000
2.2 Borrow Material Fill	m^3	953,000	7.5	4,289	2,859	7,148
3. Breakwater						
3.1 Type1A(-15.0mAverage)	m	950	32,000.0	25,840	4,560	30,400
3.2 Type1B(-10.0mAverage)	m	400	19,500.0	6,630	1,170	7,800
3.3 Type-2	m	200	15,000.0	2,550	450	3,000
4. Revetment						
4.1 Revetment (Less-5.0m)	m	500	8,300.0	2,283	1,868	4,150
4.2 Revetment(-5.0~-10.0m)	m	150	15,000.0	1,238	1,013	2,250
4. Container Wharf						
4.1 Wharf (-14.0m)	m	600	36,800.0	18,768	3,312	22,080
4.4 Yard Paving	m^2	200,000	35.0	3,360	3,640	7,000
5. Other Items						
5.1 Building Works	L.S.	1	3,700,000	1,480	2,220	3,700
5.2 Lighting/Electrical Works	L.S.	1	1,300,000	780	520	1,300
5.3 Access Road	L.S.	1	2,000,000	1,800	200	2,000
5.4 Drainage	L.S.	1	600,000	240	360	600
5.5 Navigation Aids	L.S.	1	100,000	98	2	100
5.6 Miscellaneous	L.S.	1	150,000	75	75	150
Total Construction Cost				**94,395**	**23,667**	**118,063**
6. Equipment						
6.1 Container Cranes	L.S.	1	32,000,000	32,000	0	32,000
6.2 Other Equipment	L.S.	1	1,906,000	1,906	0	1,906
6.3 Floating Equipment	L.S.	1	3,000,000	3,000	0	3,000
Total Equipment Cost				**36,906**	**0**	**36,906**
7. Physical Contingency	L.S.	1	10,921,000	9,028	1,893	10,921
8. Engineering Cost	L.S.	1	5,903,000	4,720	1,183	5,903
Grand Total				**145,049**	**26,744**	**171,793**

Table 27.3.2 Project Cost Disbursement

Item	1st Year		2nd Year		3rd Year		4th Year		5th Year	
	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local
(New Port Area)										
1. Dredging			1,931	102	11,583	609	9,652	508		
2. Reclamation			469	235	2,810	1,412	2,810	1,412		
3. Breakwater			3,184	562	12,735	2,247	12,735	2,247	6,366	1,124
4. Revetment			1,056	864	2,463	2,017				
5. Container Berth					4,692	828	9,384	1,656	4,692	828
6. Yard Paving									3,360	3,640
7. Building works							555	278	925	1,942
8. Lighting/ Electrical							293	195	487	325
9. Access road							675	75	1,125	125
10. Drainage							120	180	120	180
11. Navigation									98	2
12. Miscellaneous									75	75
Total	0	0	6,640	1,763	34,283	7,113	36,224	6,551	17,248	8,241
Contingency			531	141	2,743	569	2,898	524	1,380	659
13. Equipment										
-Container cranes									32,000	0
-Other equipment									1,906	0
-Tug boat									3,000	0
Total									36,906	0
Contingency									1,476	
Total Construction	0	0	6,640	1,763	34,283	7,113	36,224	6,551	17,248	8,241
Total Equipment	0	0	0	0	0	0	0	0	36,906	0
Total Contingency	0	0	531	141	2,743	569	2,898	524	2,856	659
Engineering	**1,416**	**355**	**826**	**207**	**826**	**207**	**826**	**207**	**826**	**207**
Grand Total	**1,416**	**355**	**7,997**	**2,111**	**37,852**	**7,889**	**39,948**	**7,282**	**57,836**	**9,107**

Chapter 28 Economic Analysis

28.1 Methodology

The method of analysis in this case is the same as that of Takoradi Port mentioned in Chapter 20.1.

28.2 Prerequisites of Analysis

In order to estimate the costs and benefits, the following requisites are assumed for the analysis.

(1) Base Year

2001 is set as the "Base Year" for this study.

(2) Project Life

Taking into consideration the depreciation period of the main facilities of 30 years and the construction period of 5 years including detail design, the period of calculation (project life) in the economic analysis is assumed to be 35 years from the beginning of construction.

(3) Foreign Exchange Rate

The exchange rate adopted for this analysis is US$ 1.00 = 6,700 Cedi, the same rate as used in the cost estimation.

(4) "With" Case

The "With" case scenario includes all improvements in productivity and all expansions of port facilities for the short-term plan.

(5) "Without" Case

A cost-benefit analysis is conducted on the difference between the "With" and "Without" investment cases. In this study, the following considerations are taken into accounts to the "Without" case.

1) No investment is made for the port.

2) In the "Without" case, the distribution of ships and the working efficiency of cargo handling are the same as that in the year 2000. On the other hand, in "With" case, the distribution of ships is almost same as the year 2000, but the working efficiency of cargo handling is assumed to be higher than the year 2000. (Table 28.2.1)

3) Berth assignment and cargo allocation by ship type are planned for W/O. case and W/. case categorizing the present conditions of Takoradi Port. (Table 28.2.2(1), (2), (3))

4) Berthing facility use models are made based on the above analysis. (Table 28.2.3) Model-0 is the prototype model assuming that all the berthing facilities are available to any calling vessels. Model-1 could be applicable to the short-term plan.

Table 28.2.1 Ave. Cargo Volume and Turnaround Time at Berth by Ship Type in Both Cases
Tema Port

Berth	Ship Type	W/O.			
		Ave.Ship Size (GRT)	Ave.Ship Size (DWT)	Ave. Cargo Vol/Ship (MT/Ship)	Time at Berth (Hrs/Ship)
GPHA	BU(C)	25,315	43,143	23,201	77
	BU(W)	17,711	24,675	24,615	352
	BU(A)	6,300	10,000	4,969	59
	CM	14,289	18,877	2,128	31
	CO	18,145	23,579	2,658	17
	GC	12,802	19,203	2,165	72
	OT	9,012	13,518	1,524	9
	RO	28,307	24,562	2,995	44
	TK	500	850	207	26
Oil Berth	TK(O)	22,614	38,444	21,178	55
VALCO	BU(A)	18,857	31,137	30,176	144
	CM(A)	14,289	18,877	3,864	72
	GC(A)	12,802	19,203	3,930	47

Berth	Ship Type	W/.			
		Ave.Ship Size (GRT)	Ave.Ship Size (DWT)	Ave. Cargo Vol/Ship (MT/Ship)	Time at Berth (Hrs/Ship)
GPHA	BU(C)	25,000	40,000	19,000	54
	BU(W)	18,750	30,000	25,000	167
	BU(A)	6,300	10,000	5,000	59
	CM	13,000	20,000	2,767	40
	CO	17,000	25,000	5,900	25
	GC	10,000	15,000	2,815	47
	OT	9,000	13,000	1,981	9
	RO	30,000	24,000	3,894	56
	TK	500	850	269	34
Oil Berth	TK(O)	18,750	30,000	27,531	46
VALCO	BU(A)	18,750	30,000	28,500	136
	CM(A)	13,000	20,000	5,023	59
	GC(A)	10,000	15,000	5,110	60

BU: DWT/GRT=1.6
TK: DWT/GRT=1.7
RO: DWT/GRT=0.8
Others: DWT/GRT=1.5

5) In the model-1, berthing facilities are divided into the 5 groups. Berthing time and waiting time are estimated by the group.

6) In the “Without” case, it is assumed that the container cargoes, general cargoes and bagged cargoes are handled at the same berth group. However, in “With” case increment container cargoes are assumed to be handled at the additional new container berth. The upper limit of berth occupancy ratio is assumed to be 0.82. The overflowed cargoes are to be handled in a foreign port and carried by land between Takoradi Port and a foreign port.

Table 28.2.2(1) Planned Berth Assignment and Cargo Allocation by Ship Type (2000) - W/O. Case

Tema

Berth**	Ship Type	Ship Size(DWT)	Ship Nos.	Cargo (MT)	Ave. Cargo Vol. /Ship	BC, GC, CT						Dry Bulk		Vehicles		Crude Oil & Petro-products	
						Share*	Cargo (MT)	Share*	Cont.(MT)	Share*	Others(MT)	Ship Nos.	Cargo (MT)	Ship Nos.	Cargo (MT)	Ship Nos.	Cargo (MT)
W.12	BU(C)	43,143	48	1,113,669	23,201							48	1,113,669				
A	BU(W)	24,675	6	147,688	24,615							6	147,688				
W.12	BU(A)	10,000	18	89,445	4,969							18	89,445				
A	CM	18,877	181	385,216	2,128	0.172	385,216	0.277	116,850	0.277	268,366						
A	CO	23,579	276	733,714	2,658	0.327	733,714	-	733,714	-	-						
B	GC	19,203	245	530,430	2,165	0.237	530,430	0.381	160,898	0.381	369,531						
A	OT	13,518	76	115,829	1,524	0.052	115,829	-	115,829	-	-						
A	RO	24,562	172	515,201	2,995	0.212	476,305	0.342	144,480	0.342	331,824			172	38,896		
B	TK	850	16	3,315	207										-	16	3,315
Sub-total		21,478	1,038	3,634,507	3,501	1.000	2,241,494	1.000	1,271,772	1.000	969,722	72	1,350,802	172	38,896	16	3,315
Oil Berth	TK(O)	38,444	99	2,096,584	21,178											99	2,096,584
Sub-total		38,444	99	2,096,584	21,178											99	2,096,584
VALCO	BU(A)	31,137	10	301,755	30,176							10	301,755				
VALCO	CM(A)	18,877	10	38,637	3,864	0.291	38,637	-	-	0.291	38,637						
VALCO	GC(A)	19,203	24	94,331	3,930	0.709	94,331	-	-	0.709	94,331						
Sub-total		21,841	44	434,723	9,880	1.000	132,968	-	-	1.000	132,968	10	301,755	-	-	-	-
Total		22,913	1,181	6,165,814	5,221		2,374,462		1,271,772		1,102,690	82	1,652,557	172	38,896	115	2,099,899

***Berth group A includes W.1, 2, 4, 5, 10 and 11.*

***Berth group B includes W.6, 7, 8 and 9.*

** Shares are estimated by ship type assuming that cargoes are burdened proportionally to the transportation capacity of ship, i.e. Ship Size x Ship Nos.*

: *Input Data*

Planned Transshipment Cargo

Tema

Item	2000	2010	2020
Transit(MT):	145,763	213,689	287,180
GC(MT)	108,299	74,791	71,795
CO(MT)	37,464	138,898	215,385
(TEU)	2,751	10,519	16,312
Transsip(MT):	18,408	582,050	782,210
GC(MT)	-	-	-
CO(MT)	18,408	582,050	782,210
(TEU)	1,858	58,749	78,952
Total(MT):	164,171	795,739	1,069,390
GC(MT)	108,299	74,791	71,795
CO(MT)	55,872	720,948	997,595
(TEU)	4,609	69,268	95,264

Note: Transshipment cargoes are added to the original cargoes.

2,210,291	1,215,900	994,391
164,171	55,872	108,299
2,374,462	1,271,772	1,102,690

Table 28.2.2(2) Planned Berth Assignment and Cargo Allocation by Ship Type (2010) - W/O. Case

Tema

Berth**	Ship Type	Ship Size(DWT)	Ship Nos.	Cargo (MT)	Ave. Cargo Vol. /Ship	BC, GC, CT						Dry Bulk		Vehicles		Crude Oil & Petro-products	
						Share*	Cargo (MT)	Share*	Cont.(MT)	Share*	Others(MT)	Ship Nos.	Cargo (MT)	Ship Nos.	Cargo (MT)	Ship Nos.	Cargo (MT)
W.12	BU(C)	43,143	60	1,394,696	23,201							60	1,394,696				
A	BU(W)	24,675	11	264,003	24,615							11	264,003				
W.12	BU(A)	10,000	23	114,098	4,969							23	114,098				
A	CM	18,877	388	825,053	2,128	0.172	825,053	0.277	494,066	0.277	330,987						
A	CO	23,579	591	1,571,466	2,658	0.327	1,571,466	-	1,571,466	-	-						
B	GC	19,203	525	1,136,072	2,165	0.237	1,136,072	0.381	680,313	0.381	455,759						
A	OT	13,518	163	248,083	1,524	0.052	248,083	-	248,083	-	-						
A	RO	24,562	372	1,115,431	2,995	0.212	1,020,147	0.342	610,894	0.342	409,253			172	95,284		
B	TK	850	24	5,000	207										-	24	5,000
Sub-total		21,229	2,157	6,673,902	3,095	1.000	4,800,821	1.000	3,604,822	1.000	1,195,999	94	1,772,797	172	95,284	24	5,000
Oil Berth	TK(O)	38,444	60	1,260,159	21,178											60	1,260,159
Sub-total		38,444	60	1,260,159	21,178							-	-	-	-	60	1,260,159
VALCO	BU(A)	31,137	13	384,950	30,176							13	384,950				
VALCO	CM(A)	18,877	2	8,904	3,864	0.318	8,904	-	-	0.318	8,904						
VALCO	GC(A)	19,203	5	19,096	3,930	0.682	19,096	-	-	0.682	19,096						
Sub-total		26,928	20	412,950	20,730	1.000	28,000	-	-	1.000	28,000	13	384,950	-	-	-	-
Total		21,742	2,236	8,347,011	3,733		4,828,821		3,604,822		1,223,999	107	2,157,747	172	95,284	84	1,265,159

***Berth group A includes W.1, 2, 4, 5, 10 and 11.*

***Berth group B includes W.6, 7, 8 and 9.*

** Shares are estimated by ship type assuming that cargoes are burdened proportionally to the transportation capacity of ship, i.e. Ship Size x Ship Nos.*

: *Input Data*

Planned Transshipment Cargo

Tema

Item	2000	2010	2020
Transit(MT):	145,763	213,689	287,180
GC(MT)	108,299	74,791	71,795
CO(MT)	37,464	138,898	215,385
(TEU)	2,751	10,519	16,312
Transsip(MT):	18,408	582,050	782,210
GC(MT)	-	-	-
CO(MT)	18,408	582,050	782,210
(TEU)	1,858	58,749	78,952
Total(MT):	164,171	795,739	1,069,390
GC(MT)	108,299	74,791	71,795
CO(MT)	55,872	720,948	997,595
(TEU)	4,609	69,268	95,264

4,033,082	2,883,874	1,149,208
795,739	720,948	74,791
4,828,821	3,604,822	1,223,999

Note: Transshipment cargoes are added to the original cargoes.

Table 28.2.2(3) Planned Berth Assignment and Cargo Allocation by Ship Type (2010) - W/. Case

Tema

Berth**	Ship Type	Ship Size(DWT)	Ship Nos.	Cargo (MT)	Ave. Cargo Vol. /Ship	BC, GC, CT						Dry Bulk		Vehicles		Crude Oil & Petro-products	
						Share*	Cargo (MT)	Share*	Cont.(MT)	Share*	Others(MT)	Ship Nos.	Cargo (MT)	Ship Nos.	Cargo (MT)	Ship Nos.	Cargo (MT)
W.12	BU(C)	40,000	73	1,394,696	19,000							73	1,394,696				
A	BU(W)	30,000	11	264,003	25,000							11	264,003				
W.12	BU(A)	10,000	23	114,098	5,000							23	114,098				
A	CM	20,000	175	484,321	2,767	0.172	484,321	0.277	191,145	0.277	330,987						
A	CO	25,000	156	922,479	5,900	0.327	922,479	-	804,481	-	-						
B	GC	15,000	237	666,895	2,815	0.237	666,895	0.381	263,200	0.381	455,759						
A	OT	13,000	74	145,629	1,981	0.052	145,629	-	127,001	-	-						
A	RO	24,000	178	694,129	3,894	0.212	598,845	0.342	236,343	0.342	409,253			172	95,284		
B	TK	850	19	5,000	269										-	19	5,000
Sub-total		22,250	945	4,691,250	5,379	1.000	2,818,169	1.000	1,622,170	1.000	1,195,999	107	1,772,797	172	95,284	19	5,000
C	CO	25,000	336	1,982,652	5,900		1,982,652		1,982,652		-						
Sub-total		25,000	397	1,982,652	5,900		1,982,652		1,982,652		-	107	1,772,797	172	95,284	19	5,000
Oil Berth	TK(O)	30,000	46	1,260,159	27,531											46	1,260,159
Sub-total		30,000	46	1,260,159	27,531												
VALCO	BU(A)	30,000	14	384,950	28,500							14	384,950				
VALCO	CM(A)	20,000	2	8,904	5,023	0.318	8,904	-	-	0.318	8,904						
VALCO	GC(A)	15,000	4	19,096	5,109	0.682	19,096	-	-	0.682	19,096						
Sub-total		26,000	19	412,950	21,714	1.000	28,000	-	-	1.000	28,000	14	384,950		-	46	1,260,159
Total		22,580	462	8,347,011	18,075		4,828,821		3,604,822		1,223,999	120	2,157,747	172	95,284	64	1,265,159

***Berth group A includes W.1, 2, 4, 5, 10 and 11.*

***Berth group B includes W.6, 7, 8 and 9.*

***Berth group C includes new container berths assuming it handles 55% of the total contaner cago.*

** Shares are estimated by ship type assuming that cargoes are burdened proportionally to the transportation capacity of ship, i.e. Ship Size x Ship Nos.*

: *Input Data*

Planned Transshipment Cargo

Tema

Item	2000	2010	2020
Transit(MT):	145,763	213,689	287,180
GC(MT)	108,299	74,791	71,795
CO(MT)	37,464	138,898	215,385
(TEU)	2,751	10,519	16,312
Transsip(MT):	18,408	582,050	782,210
GC(MT)	-	-	-
CO(MT)	18,408	582,050	782,210
(TEU)	1,858	58,749	78,952
Total(MT):	164,171	795,739	1,069,390
GC(MT)	108,299	74,791	71,795
CO(MT)	55,872	720,948	997,595
(TEU)	4,609	69,268	95,264

Note: Transshipment cargoes are added to the original cargoes.

4,033,082	2,883,874	1,149,208
795,739	720,948	74,791
4,828,821	3,604,822	1,223,999

Table 28.2.3(1) Facility Use Model (2010) - W/O. (1)

Items	Unit	***Model-0***	***Model-1***				
		All Facilities	Oil Berth**	VALCO Berth	Dry Bulk Berth W12	Container Berth W1,2,4,5,10,11	Other Facilities W6,7,8,9
Nos. of Berth	Berth	13	1	1	1	6	4
Nos. of Calling Ships	Ship	2,236	60	20	83	1,523	549
Ave. Ship Size	DWT	21,742	38,444	26,928	33,959	21,555	18,401
Cargo Handling Volume	MT	8,347,011	1,260,159	412,950	1,508,794	4,024,036	1,141,072
Ave. Cargo Volume per Ship	MT/ship	3,733	21,178	20,730	18,149	2,643	2,079
Berthing Time per Ship	Hrs/ship	41.9	55.0	113.0	72.0	29.0	70.0
Berthing Time per Year	Days	3,904	136	94	249	1,840	1,600
		3,904	3,919				
Berth Occupancy Ratio	-	0.86	0.39	0.27	0.71	0.88	1.14
Waiting Time Factor ($M/E_2/n$)*	-	-	0.46	0.00	1.80	-	-
Waiting Time per Year	Days	-	63	0	-	-	-
		-	-				

** Random arrivals, Erlang 2-distributed service time*
***Oil berth handles petrol products.*

Table 28.2.3(2) Facility Use Model (2010) - W/O. (2)

Items	Unit	***Model-0***	***Model-1***				
		All Facilities	Oil Berth**	VALCO Berth	Dry Bulk Berth W12	Container Berth W1,2,4,5,10,11	Other Facilities W6,7,8,9
Nos. of Berth	Berth	13	1	1	1	6	4
Nos. of Calling Ships	Ship	2,137	60	20	83	1,425	394
Ave. Ship Size	DWT	21,742	38,444	26,928	33,959	21,555	18,401
Cargo Handling Volume	MT	7,977,751	1,260,158	412,950	1,508,794	3,766,548	818,879
Ave. Cargo Volume per Ship	MT/ship	3,733	21,178	20,730	18,149	2,643	2,079
Berthing Time per Ship	Hrs/ship	41.9	55.0	113.0	72.0	29.0	70.0
Berthing Time per Year	Days	3,731	136	94	249	1,722	1,148
		3,731	3,350				
Berth Occupancy Ratio	-	0.82	0.39	0.27	0.71	0.82	0.82
Waiting Time Factor ($M/E_2/n$)*	-	0.14	0.46	0.00	1.80	0.42	0.68
Waiting Time per Year	Days	522	63	0	449	723	781
		522	2,016				
Navigation Time per Year	Days	149	4	1	6	99	27
		149	138				
Staying Time at Port per Year	Days	4,402	203	95	704	2,544	1,956
		4,402	5,503				

** Random arrivals, Erlang 2-distributed service time*
***Oil berth handles petrol products.*

Table 28.2.3(3) Facility Use Model (2010) - W/.

Items	Unit	***Model-0***	***Model-1***					
		All Facilities	Oil Berth**	VALCO Berth	Dry Bulk Berth W12	General Berth W1,2,4,5,10,11	Other Facilities W6,7,8,9	New Berth
Nos. of Berth	Berth	15	1	1	1	6	4	2
Nos. of Calling Ships	Ship	1,306	46	19	96	585	258	336
Ave. Ship Size	DWT	22,580	30,000	26,000	32,813	21,870	13,810	25,000
Cargo Handling Volume	MT	8,347,011	1,260,159	412,950	1,508,794	2,510,561	671,895	1,982,652
Ave. Cargo Volume per Ship	MT/ship	6,393	27,531	21,714	15,646	4,295	2,601	5,900
Berthing Time per Ship	Hrs/ship	38.9	46.0	113.0	55.2	39.8	45.9	25.0
Berthing Time per Year	Days	2,114	88	90	222	970	494	350
		2,114	2,214					
Berth Occupancy Ratio	-	0.40	0.25	0.26	0.63	0.46	0.35	0.50
Waiting Time Factor ($M/E_2/n$)*	-	0.00	0.00	0.00	1.23	0.02	0.02	0.24
Waiting Time per Year	Days	0	0	0	273	19	10	84
		0	386					
Navigation Time per Year	Days	91	3	1	7	41	18	23
		91	93					
Staying Time at Port per Year	Days	2,204	91	91	501	1,030	522	457
		2,204	2,693					

** Random arrivals, Erlang 2-distributed service time*
***Oil berth handles petrol products.*

28.3 Economic Prices

The method for converting to economic prices from market prices is the same as that of Takoradi Port mentioned in Chapter 20.3.

28.4 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 are divided into such categories as foreign currency portion and local currency portion that is broken down into non-traded goods, skilled labor and unskilled labor. The cost of non-traded goods at market prices are converted to economic prices by multiplying by the standard conversion factor (SCF). The costs of skilled labor and unskilled labor at market prices are converted to economic prices by multiplying by the conversion factor for skilled labor and the conversion factor for unskilled labor respectively. Construction costs and investment schedule at economic prices are summarized in Table 28.4.1 and 28.4.2.

(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. Assuming that the maintenance costs by item consist of same
categories as construction costs, maintenance costs at economic prices could be calculated as shown in Table 28.4.3.

Table 28.4.3 Maintenance Costs at Economic Price – Tema Port

(Unit:thousand US$)

Item	Construction Costs at Market Price	Maintenance Costs at Market Price	Overall Conversion Factors	Maintenance Costs at Economic Price
Dredging	24,385	0	0.996	0
Reclamation	9,148	0	0.973	0
Breakwater	41,200	412	0.992	409
Quaywall	22,080	221	0.980	217
Revetment	6,400	64	0.963	62
Pavement	9,000	90	0.994	89
Building	3,700	37	0.927	34
Ancilary	2,150	22	0.971	21
Machine & Equip.	36,906	1,476	1.000	1,476
Total	154,969	2,322	-	2,308

(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 28.4.4 Economic Durable Periods and Costs of Equipment

Equipment	Durable Periods	Costs('000US$)
Gantry Crane, Transfer Crane, Tug Boat	20 Years	35,000
Tractor, Trailer	10 Years	1,906

Table 28.4.1(1) Breakdown of Local Portion for Construction Works

(Unit: % of total)

Construction Works	Local Portion		
	Non-Traded Goods	Skilled Labor	Unskilled Labor
Dredging	50	40	10
Reclamation	50	40	10
Breakwater	75	20	5
Quaywall	70	20	10
Revetment	70	20	10
Other Civil Works	50	45	5
Building	50	30	20
Machine & Equip.	50	45	5
Engineering Cost	0	100	0

* Above figures are refered from rough cost estimate.

Table 28.4.1(2) Construction Costs at Economic Prices

Facilities	Construction Works	Construction Cost at Market Prices	Foreign Portion	Local Portion			Overall Conversion Factor	Construction Cost at Economic Prices
				Non-traded Goods	Skilled Labor	Unskilled Labor		
		('000 US$)	1.000	0.970	0.970	0.451	0.988	('000 US$)
Extension	Dredging	24,385	23,166	591	473	55	0.996	24,285
	Reclamation	9,148	6,089	1,484	1,187	138	0.973	8,897
	Breakwater	41,200	35,020	4,496	1,199	139	0.992	40,854
	Revetment	6,400	3,521	1,955	559	130	0.963	6,164
	Container Whalf	29,080	22,128	4,720	1,349	314	0.980	28,511
	Access Road	2,000	1,800	97	87	5	0.994	1,989
	Building/Utility	5,000	2,260	1,329	797	247	0.927	4,633
	Other Works	850	413	212	191	10	0.971	826
Equipment	Cranes	20,000	20,000	-	-	-	1.000	20,000
	Tractor, Trailers	13,906	13,906	-	-	-	1.000	13,906
	Floating Equip.	3,000	3,000	-	-	-	1.000	3,000
Others	Engineering Survey	6,493	5,254	-	1,202	-	0.994	6,456
Total		161,462	136,557	14,884	7,043	1,037	0.988	159,521

Table 28.4.2 Annual Investment Schedule at Economic Prices

(Unit: '000 US$)

Item	2005	2006	2007	2008	2009	Total
Total(Market Price)	1,948	9,537	42,533	43,912	63,532	161,462
Total(Economic Price)	1,925	9,422	42,022	43,384	62,768	159,521

28.5 Benefits of the Project

In this section, benefits that are adopted for a cost-benefit analysis are defined and converted from market prices to economic prices.

(1) Benefit Items

As benefits brought about by the short-term plan of the study port, the following items are identified.

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

5) Savings of costs in cargo handling

6) Savings in interest of cargo costs

7) Reduction of cargo damage and accidents at the port

8) Promotion of regional economic development

9) Increase in employment opportunities and incomes

Of the above, items from 1) to 4) are considered as measurable benefits in terms of the cost-benefit analysis in this study.

(2) Calculation of Benefits

1) Savings in staying costs of ships

In accordance with the implementation of the projects, the total ship staying time, namely ship waiting time for berthing and ship mooring time for unloading/loading in the port, will greatly decrease. The reduction of the ship staying time under the "With" case is one of the major benefits of the projects. The benefits that will accrue to Ghana from the projects can be calculated by the following formula.

Savings in ships' staying costs = Difference in staying time between "With" and "Without" cases x Ships' staying cost (unit cost) x Share of benefits accruing to Ghana (= 0.5)

Whereby,

Savings in ships' staying costs = *(5,503-2,693)days x 7,608$/day x 0.5 = 10,689,240 US$*

Although it is conceivable to estimate ship cost based on charter rate, this rate has been fluctuating so much according to the market conditions that it is not appropriate for economic price of ship cost.

Table 20.5.1 and 2 show the ship cost estimated by the Study Team based on the estimation made by some Japanese shipping companies. These data are used as unit cost of ship staying.

Table 28.5.1 Ship Cost by Ship Size (General Cargo)

(Unit: US$ per day)

DWT	Tons	Navigation	Anchorage	Knot
5,000	4,500	7,442	6,067	13.0
8,000	7,200	7,883	6,533	13.0
10,000	9,000	8,100	6,775	13.0
20,000	18,000	8,925	7,608	13.0
30,000	27,000	9,550	8,183	13.0

Table 28.5.2 Ship Cost by Ship Size (Container Cargo)

(Unit: US$ per day)

DWT	TEUs	Navigation	Anchorage	Knot
4,500	200	9,042	7,917	12.0
5,900	300	10,800	9,475	13.0
8,800	500	15,008	12,975	15.0
22,000	1,200	29,250	23,433	20.0
35,000	2,000	40,258	32,450	22.0

The savings in staying costs of vessels are primarily realized by shipping companies. Since Ghana has no national shipping company at present, these benefits accrue to other countries. However, some portion of these benefits should be returned to Ghana after some time lag. It is possible for Ghana to acquire some of the benefits by, for instance, decreasing freight rates reflecting the reduced incidence of delays at the port. In this Study, it is assumed that 50% of the benefits attributed to foreign ship operators will be transferred to the Ghana economy.

The above savings are estimated to be foreign portion. So, these benefits are economic prices themselves.

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

At present, calling ships at Takoradi Port cannot transport the cargoes fully loaded due to the shallow berths. When the deep-water berths are materialized in the short-term plan, they can call at Takoradi with full load. Therefore, average cargo volume per ship will increase resulting the lower water transportation cost. As of February 2001, water transportation cost between Tema and Rotterdam is 67.41 US$ per MT, which could be reduced to 51.85US$ (67.41/1.3). 20% of the differences excluding working expenses, fuels and so forth could be saved. These savings are applicable to all the cargoes at Takoradi Port as well. In this Study, it is assumed that 50% of the benefits attributed to foreign ship operators will be transferred to the Ghana economy by the cheaper freightage.

Table 28.5.3 Sea Transportation Cost by Cargo Type, Tema-Rotterdam

Cost	General Cargo (per MT)	Container Cargo (per TEU)
Transportation Cost (EUR)	77.50	1,060.00
Transportation Cost (US$)	67.41	781.00

Source: Ghana Shippers' Council

Savings in water transportation costs = Difference in water transportation costs between "With" and "Without" cases (unit cost) x Total cargo volume x Share of benefits accruing to Ghana (= 0.5)

Whereby,

Savings in water transportation costs = $(67.41 - \frac{67.41}{1.3})$\$/MT x 0.2 x 7,767,329MT x 0.5

= 12,082,976

The calculation of above savings is based on the charter rates quoted at world prices. So, these benefits are economic prices themselves.

3) Savings in land transportation costs

In the following case, it is assumed that the cargoes will be handled in other foreign ports and then be transported to Ghana by land.

- Cargo handling volume reaches the maximum volume with handling capacity of the port. (max. berth occupancy ratio = 0.82)

In accordance with the implementation of the projects, it will become unnecessary to transport the cargoes by land. The benefit that will accrue to Ghana from the projects can be calculated by the following formula.

Savings in land transportation costs = Difference in handling cargo volume between "With" and "Without" cases x Land transportation cost (unit cost)

Whereby,

Savings in land transportation costs = *(8,347,011-7,767,329)MT x 9.14US$/MT = 5,298,293 US$*

The unit cost of land transportation between Takoradi and Abidjan is estimated to be around 9.14 US$ per MT in the market price, which can be broken down into component costs such as depreciation, working expenses and fuel. These components could be roughly allocated to be 60%, 20% and 20% (10%:skilled Labor, 10%unskilled labor) of the total. Then, the economic pricing is applied to each component in estimating the economic price of land transportation costs. (See, Table 28.5.5)

Table 28.5.4 Land Transportation Cost by Distance

Cost	200 Km	800 Km
Transportation Cost (US$/MT)	4.00	9.14
Transportation Cost (US$/TEU)	60.00	137.10

Source: Ghana Shippers' Council

Table 28.5.5 Land Transportation Cost at Economic Price

Item	Cost at Market Price ('000US$)	Foreign Portion	Local Portion			Overall Conversion Factor	Cost at Economic Price ('000US$)
			Non-traded Goods	Skilled Labor	Unskilled Labor		
		1.000	0.970	0.970	0.397	0.937	
Land Trans-portation Cost	-	80%	-	10%	10%	100%	-
	5,298	4,238	-	514	210	-	4,962

4) Earnings of foreign currency in cargo handling

In "Without" case, overflowed cargoes will be handled in the competitive foreign ports due to the lack of sufficient facilities and the increase of waiting time. The benefit that will accrue to Ghana from the projects can be calculated by the following formula.

Earnings of foreign currency = Difference in handling cargo volume between "With" and "Without" cases x Cargo handling fee per MT(unit price)

Whereby,

Earnings of foreign currency = *(8,347,011-7,767,329)MT x 10.32$/MT = 5,982,318 US$*

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

Table 28.5.6 Benefits of the Projects for Short-term Plan – Tema Port
(Unit: thousand US$)

Items	Benefits
Ships' Staying Time	10,689
Water Transportation Cost	12,083
Land Transportation Cost	4,962
Earnings of Foreign Currency	5,982
Total	33,716

28.6 Evaluation of the Project

(1) Calculation of the EIRR

The economic internal rate of return (EIRR) based on a cost-benefit analysis is used to appraise the economic feasibility of the project.

The EIRR of the project at Tema Port is calculated as 16.3%. The results of calculation are shown in Table 28.6.1.

(2) Evaluation

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 10.4% in the worst case. Therefore, this short-term development project is feasible from the viewpoint of the national economy.

Table 28.6.1 Cost/Benefit Analysis of Short-Term Plan for Tema Port

Name of Port: :Tema
Table ____ (1/1)
Economic Evaluation
(In constant 2000 prices, 1000US$)

Year	Costs			Benefits	Net Benefits
	Investment	O&M	Total	Total	
2005	1,925	-	1,925	-	(1,925)
2006	9,422	-	9,422	-	(9,422)
2007	42,022	-	42,022	-	(42,022)
2008	43,384	-	43,384	-	(43,384)
2009	62,768	-	62,768	-	(62,768)
2010		2,308	2,308	33,716	31,408
2011		2,308	2,308	33,716	31,408
2012		2,308	2,308	33,716	31,408
2013		2,308	2,308	33,716	31,408
2014		2,308	2,308	33,716	31,408
2015		2,308	2,308	33,716	31,408
2016		2,308	2,308	33,716	31,408
2017		2,308	2,308	33,716	31,408
2018		2,308	2,308	33,716	31,408
2019	1,906	2,308	4,214	33,716	29,502
2020		2,308	2,308	33,716	31,408
2021		2,308	2,308	33,716	31,408
2022		2,308	2,308	33,716	31,408
2023		2,308	2,308	33,716	31,408
2024		2,308	2,308	33,716	31,408
2025		2,308	2,308	33,716	31,408
2026		2,308	2,308	33,716	31,408
2027		2,308	2,308	33,716	31,408
2028		2,308	2,308	33,716	31,408
2029	36,906	2,308	39,214	33,716	(5,498)
2030		2,308	2,308	33,716	31,408
2031		2,308	2,308	33,716	31,408
2032		2,308	2,308	33,716	31,408
2033		2,308	2,308	33,716	31,408
2034		2,308	2,308	33,716	31,408
2035		2,308	2,308	33,716	31,408
2036		2,308	2,308	33,716	31,408
2037		2,308	2,308	33,716	31,408
2038		2,308	2,308	33,716	31,408
2039		2,308	2,308	33,716	31,408
Total	**198,333**	**69,240**	**267,573**	**1,011,480**	**743,907**
Economic Internal Rate of Return (EIRR):					**16.3%**

Sensitivity Analysis

	EIRR	Increase in Investment Cost		
	16.3%	0%	10%	20%
Decrease Benefits	0%	16.3%	14.8%	13.5%
	10%	14.7%	13.2%	12.3%
	20%	12.9%	11.6%	10.4%

Chapter 29 Financial Analysis

29.1 Purpose and Methodology

29.1.1 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.

29.1.2 Methodology

(Refer to 21.1.2)

29.2 Prerequisites of the Financial Analysis

29.2.1 General

(1) Scope of the Financial Analysis

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

・New Container Terminal 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”.

29.2.2 Base Year

(Refer to 21.2.2)

29.2.3 Project Life

(Refer to 21.2.3)

29.2.4 Fund Raising

(Refer to 21.2.4)

29.2.5 Revenue and Expenditure

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.

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 the number of calling vessels by present tariffs.

A breakdown of revenues generated at the new container terminal berth is shown from Table 29.2.1 to 29.2.3.

Table 29.2.1 Revenue from Cargo Services at the New Container Terminal

Cargo Volume(TEU)			Unit Price(US$)		Revenue(US$)
Stuffed	Empty	Total	Stuffed	Empty	
178,753	88,169	266,922	100.30	66.2	23,765,712

Table 29.2.2 Revenue from Vessel Services at the New Container Terminal

No. of Vessels	Unit Price(US$)	Revenue(US$)
336	6,433.4	2,161,622

Table 29.2.3 Total Revenue Generated at the New Container Terminal

Unit : US$

Cargo Services	Vessel Services	Total
23,765,712	2,161,622	25,927,334

Expenditures

1) Project Costs

Project Costs are estimated in Chapter 27. According to the construction schedule, investment will be made. Table 29.2.4 and Table 29.2.5 show a summary of the construction and equipment cost of the New Container Terminal Project.

Table 29.2.4 Summary of the Construction Cost of the New Container Terminal Project

Unit : US$'000

Currency	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
Foreign	1,416	7,997	37,852	39,948	19,454	106,667
Local	355	2,111	7,889	7,282	9,107	26,744
Total	1,771	10,108	45,741	47,230	28,561	133,411

Table 29.2.5 Summary of the Equipment cost of the New Container Terminal Project

Unit : US$'000

Currency	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
Foreign	0	0	0	0	38,382	38,382
Local	0	0	0	0	0	0
Total	0	0	0	0	38,382	38,382

The equipment will be replaced after service life. Service lives are as follows

Gantry Carne : 20 years
Transfer Carne : 20 years
Tugboat : 20 years
Yard Tractor : 10 years
Yard Trailer : 10 years

2) Personnel Costs

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.

a) Personnel cost for cargo handling

Administration Section (in Terminal)
6 persons / berth × 1 shift × 2 berth = 12 persons (Snr.-8, Jnr.-4)

Operation Section
Gantry Carne 2 Unit / berth × 1.5 persons / Unit × 3 shift × 2 berth
= 18 persons (Jnr.-18)
Transfer Carne 6 Unit / berth × 1.5 persons / Unit × 3 shift × 2 berth
= 54 persons (Jnr.-54)
Tractor & Trailer 8 Unit / berth × 1 person / Unit × 3 shift × 2 berth
= 48 persons (Jnr.-48)

Yard Control Section
3 persons / berth × 3 shift × 2 berth = 18 persons (Snr.-12, Jnr.-6)

Gate Operation Section

2 gates (in and out) / berth × 2 lane × 1 person / lane × 3 shift × 2 berth
= 24 persons (Jnr.-24)

Documentation Section

2 persons / berth × 2 (Import / Export) × 2 berth = 8 (Snr.-8)

Maintenance Section

Electricity 3 persons / berth × 3 shift × 2 berth = 18 persons (Snr.-6, Jnr.-12)
Refrigeration 3 persons / berth × 3 shift × 2 berth = 18 persons (Snr.-6, Jnr.-12)
Vehicle 3 persons / berth × 3 shift × 2 berth = 18 persons (Snr.-6, Jnr.-12)

Total

Snr. Staff 46
Jnr. Staff 190

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

Snr. Staff = 46 persons × US$6,970 / person・year = US$320,620 / year
Jnr. Staff = 190 persons × US$2,750 / person・year = US$522,500 / year

Total US$843,120 / year

b) Personnel cost for administration, security and marine services

GPHA is assuming the number of required personnel for present Tema Port following passage of the Landlord Port Bill as follows.

Snr. Staff – 134 , Jnr. Staff – 801

Assuming that the staff is provided to each present berth (Quay1-Berth6～12; Quay2-Berth1, 2, 4, 5; Valco Berth; Oil Berth : Total 13 Berths) equally, the required number for each berth is as follows.

Snr. Staff – 10 / berth , Jnr. Staff – 62 / berth

Required annual personnel costs per berth are calculated by multiplying number of staff by average unit wages estimated according to present levels.

Snr. Staff = 10 persons / berth × US$6,970 / person・year = US$69,700 / year・berth
Jnr. Staff = 62 persons / berth × US$2,750 / person・year = US$170,500 / year・berth

Total US$240,200 / year・berth

c) Total personnel cost for the New Container Terminal

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

US$843,120 / year + US$240,200 / year・berth × 2berth = US$1,323,520 / year

29.3 Evaluation of the Project

29.3.1 Viability of the Project

(1) Calculation of FIRR

The result of the FIRR calculation is shown in Table 29.3.1. FIRR exceeds the weighted average interest rate of the funds (2.73%).

Table 29.3.1 Result of FIRR Calculation

	New Container Terminal Project
FIRR	10.3% (Table 29.3.2)

(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 29.3.3. FIRR exceeds the weighted average interest rate of the funds (2.73%).

Table 29.3.3 Sensitivity Analysis of FIRR

	Base Case	Case 1	Case 2	Case 3
FIRR	10.3%	9.3%	8.9%	7.9%

(3) Evaluation

Judging from the above, this project is regarded as financially feasible under the assumptions in Chapter 29.2.

Table 29.3.2 FIRR of New Container Terminal Project

Unit : 1000$

Year		Revenue		Cost					Revenue − Cost	Net Present Value		
		Cargo Service and Vessel Service	Total	Investment	Personnel Cost	Maintenance Cost	Administration Cost	Total		Revenue	Cost	Difference
1	2005			1,771				1,771	-1,771	0	1,771	-1,771
2	2006			10,108				10,108	-10,108	0	9,163	-9,163
3	2007			45,741				45,741	-45,741	0	37,585	-37,585
4	2008			47,230				47,230	-47,230	0	35,179	-35,179
5	2009			66,943				66,943	-66,943	0	45,198	-45,198
6	2010	25,927	25,927	0	1,324	2,869	265	4,458	21,469	15,868	2,728	13,140
7	2011	25,927	25,927	0	1,324	2,869	265	4,458	21,469	14,384	2,473	11,911
8	2012	25,927	25,927	0	1,324	2,869	265	4,458	21,469	13,038	2,242	10,797
9	2013	25,927	25,927	0	1,324	2,869	265	4,458	21,469	11,819	2,032	9,787
10	2014	25,927	25,927	0	1,324	2,869	265	4,458	21,469	10,714	1,842	8,871
11	2015	25,927	25,927	0	1,324	2,869	265	4,458	21,469	9,711	1,670	8,042
12	2016	25,927	25,927	0	1,324	2,869	265	4,458	21,469	8,803	1,514	7,290
13	2017	25,927	25,927	0	1,324	2,869	265	4,458	21,469	7,980	1,372	6,608
14	2018	25,927	25,927	0	1,324	2,869	265	4,458	21,469	7,233	1,244	5,990
15	2019	25,927	25,927	1,982	1,324	2,869	265	6,440	19,487	6,557	1,629	4,928
16	2020	25,927	25,927	0	1,324	2,869	265	4,458	21,469	5,944	1,022	4,922
17	2021	25,927	25,927	0	1,324	2,869	265	4,458	21,469	5,388	926	4,461
18	2022	25,927	25,927	0	1,324	2,869	265	4,458	21,469	4,884	840	4,044
19	2023	25,927	25,927	0	1,324	2,869	265	4,458	21,469	4,427	761	3,666
20	2024	25,927	25,927	0	1,324	2,869	265	4,458	21,469	4,013	690	3,323
21	2025	25,927	25,927	0	1,324	2,869	265	4,458	21,469	3,638	625	3,012
22	2026	25,927	25,927	0	1,324	2,869	265	4,458	21,469	3,297	567	2,730
23	2027	25,927	25,927	0	1,324	2,869	265	4,458	21,469	2,989	514	2,475
24	2028	25,927	25,927	0	1,324	2,869	265	4,458	21,469	2,709	466	2,244
25	2029	25,927	25,927	38,382	1,324	2,869	265	42,840	-16,913	2,456	4,058	-1,602
26	2030	25,927	25,927	0	1,324	2,869	265	4,458	21,469	2,226	383	1,844
27	2031	25,927	25,927	0	1,324	2,869	265	4,458	21,469	2,018	347	1,671
28	2032	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,829	315	1,515
29	2033	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,658	285	1,373
30	2034	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,503	258	1,245
31	2035	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,363	234	1,128
32	2036	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,235	212	1,023
33	2037	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,120	192	927
34	2038	25,927	25,927	0	1,324	2,869	265	4,458	21,469	1,015	174	840
35	2039	25,927	25,927	1,982	1,324	2,869	265	6,440	19,487	920	229	691
Total		777,810	777,810	214,139	39,720	86,070	7,944	347,873	429,937	160,739	160,739	0

FIRR= 10.3%

29.3.2 Financial Soundness of the Port Management Body

The projected financial statements and financial indicators (the rate of return on net fixed assets, debt service coverage ratio, operating ratio and working ratio of the port management body) with regard to the Short-Term Development Plan are summarized in Table 29.3.4.

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

Throughout 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.

29.3.3 Possibility of Private Company Participation in the New Container Terminal

As mentioned above, this project executed and operated by GPHA are regarded as financially feasible.
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

There are several ways for private companies to participate in container terminal operations. Here, as mentioned in Chapter 30, roles of GPHA and private company are assumed below. These roles are based on the following objectives ; 1) Ensuring GPHA has the authority to make master plans and control development; 2) Reducing initial costs and project risks of private company; 3) Keeping up with any changes in the future.

(a) GPHA
- Construction, ownership and management of Infrastructure (Berth, Reclamation, Dredging and Pavement etc.)
- Marine services (Pilotage and Towage)

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

(2) Revenues and expenditures of GPHA and private company

Table 29.3.4 Financial Stetements and Financial Indicators (1/2)

Profit and Loss Statement

Unit: US $

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Operating Revenue	45,000,000	45,000,000	45,000,000	45,000,000	45,000,000	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453
Operating Expense	7,600,000	7,600,000	7,963,000	9,751,000	11,599,000	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600
Personnel Cost	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000
Maintenance Materials	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000
Admin. Expenses	600,000	600,000	600,000	600,000	600,000	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600
Depreciation	0	0	363,000	2,151,000	3,999,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000
Net Operating Income	37,400,000	37,400,000	37,037,000	35,249,000	33,401,000	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853
Non-Operating Expense	673,996	576,973	515,758	610,111	1,101,136	1,486,573	1,945,154	1,675,789	1,405,196	1,135,217	865,238	609,304	422,406	363,656	871,341	1,439,058
Interest of Long-Term Loans	673,996	576,973	515,758	610,111	1,101,136	1,486,573	1,945,154	1,675,789	1,405,196	1,135,217	865,238	609,304	422,406	363,656	871,341	1,439,058
Net Income Before Tax	36,726,004	36,823,027	36,521,242	34,638,889	32,299,864	35,804,280	35,345,699	35,615,064	35,885,657	36,155,636	36,425,615	36,681,549	36,868,447	36,927,197	36,419,512	35,851,795
Income Tax	12,854,101	12,888,059	12,782,435	12,123,611	11,304,952	12,531,498	12,370,995	12,465,272	12,559,980	12,654,473	12,748,965	12,838,542	12,903,956	12,924,519	12,746,829	12,548,128
Net Income After Tax	23,871,903	23,934,968	23,738,807	22,515,278	20,994,912	23,272,782	22,974,704	23,149,792	23,325,677	23,501,163	23,676,650	23,843,007	23,964,491	24,002,678	23,672,683	23,303,667

Cash Flow Statement

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cash Beginning	0	21,861,165	43,749,895	66,004,330	88,034,336	109,663,776	135,779,386	161,596,918	187,589,538	213,758,043	240,102,034	266,621,512	294,872,819	323,056,860	350,175,388	375,694,721
Cash Inflow	39,171,000	47,508,000	83,141,000	84,630,000	104,343,000	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	46,390,853	44,408,853
Net Operating Income	37,400,000	37,400,000	37,037,000	35,249,000	33,401,000	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853
Depreciation	0	0	363,000	2,151,000	3,999,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000
Long-Term Loans	1,771,000	10,108,000	45,741,000	47,230,000	66,943,000	0	0	0	0	0	0	0	0	0	1,982,000	0
Cash Outflow	17,309,835	25,619,270	60,886,565	62,599,994	82,713,560	18,293,243	18,591,321	18,416,233	18,240,348	18,064,862	17,889,375	16,157,546	16,224,812	17,290,325	20,871,520	21,437,836
Investment	1,771,000	10,108,000	45,741,000	47,230,000	66,943,000	0	0	0	0	0	0	0	0	0	1,982,000	0
Repayment of Principal	2,010,738	2,046,238	1,847,372	2,636,272	3,364,472	4,275,172	4,275,172	4,275,172	4,275,172	4,275,172	4,275,172	2,709,700	2,898,450	4,002,150	5,271,350	7,450,650
Interest on Long-Term Loans	673,996	576,973	515,758	610,111	1,101,136	1,486,573	1,945,154	1,675,789	1,405,196	1,135,217	865,238	609,304	422,406	363,656	871,341	1,439,058
Income Tax	12,854,101	12,888,059	12,782,435	12,123,611	11,304,952	12,531,498	12,370,995	12,465,272	12,559,980	12,654,473	12,748,965	12,838,542	12,903,956	12,924,519	12,746,829	12,548,128
Cash Inflow - Cash Outflow	21,861,165	21,888,730	22,254,435	22,030,006	21,629,440	26,115,610	25,817,532	25,992,620	26,168,505	26,343,991	26,519,478	28,251,307	28,184,041	27,118,528	25,519,333	22,971,017
Cash Ending	21,861,165	43,749,895	66,004,330	88,034,336	109,663,776	135,779,386	161,596,918	187,589,538	213,758,043	240,102,034	266,621,512	294,872,819	323,056,860	350,175,388	375,694,721	398,665,738

Balance Sheet

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
(Assets)																
Current Assets	38,278,853	60,167,583	82,422,018	104,452,024	126,081,464	152,197,074	178,014,606	204,007,226	230,175,731	256,519,722	283,039,200	311,290,507	339,474,548	366,593,076	392,112,409	415,083,426
Cash & Deposit	21,861,165	43,749,895	66,004,330	88,034,336	109,663,776	135,779,386	161,596,918	187,589,538	213,758,043	240,102,034	266,621,512	294,872,819	323,056,860	350,175,388	375,694,721	398,665,738
Other Current Assets	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688
Fixed Assets	1,771,000	11,879,000	57,257,000	102,336,000	165,280,000	158,162,000	151,044,000	143,926,000	136,808,000	129,690,000	122,572,000	115,454,000	108,336,000	101,218,000	96,082,000	88,964,000
Existing Fixed Assets	1,771,000	11,879,000	57,620,000	104,850,000	171,793,000	171,793,000	171,793,000	171,793,000	171,793,000	171,793,000	171,793,000	171,793,000	171,793,000	171,793,000	173,775,000	173,775,000
Accumulated Depreciation	0	0	363,000	2,514,000	6,513,000	13,631,000	20,749,000	27,867,000	34,985,000	42,103,000	49,221,000	56,339,000	63,457,000	70,575,000	77,693,000	84,811,000
Net Fixed Assets	1,771,000	11,879,000	57,257,000	102,336,000	165,280,000	158,162,000	151,044,000	143,926,000	136,808,000	129,690,000	122,572,000	115,454,000	108,336,000	101,218,000	96,082,000	88,964,000
Total Assets	40,049,853	72,046,583	139,679,018	206,788,024	291,361,464	310,359,074	329,058,606	347,933,226	366,983,731	386,209,722	405,611,200	426,744,507	447,810,548	467,811,076	488,194,409	504,047,426
(Liabilities and Capital)																
Liabilities	16,177,950	24,239,712	68,133,340	112,727,068	176,305,596	172,030,424	167,755,252	163,480,080	159,204,908	154,929,736	150,654,564	147,944,864	145,046,414	141,044,264	137,754,914	130,304,264
Long-Term Loans	16,177,950	24,239,712	68,133,340	112,727,068	176,305,596	172,030,424	167,755,252	163,480,080	159,204,908	154,929,736	150,654,564	147,944,864	145,046,414	141,044,264	137,754,914	130,304,264
Capital	23,871,903	47,806,871	71,545,678	94,060,956	115,055,868	138,328,650	161,303,354	184,453,146	207,778,823	231,279,986	254,956,636	278,799,643	302,764,134	326,766,812	350,439,495	373,743,162
Retained Earnings	23,871,903	47,806,871	71,545,678	94,060,956	115,055,868	138,328,650	161,303,354	184,453,146	207,778,823	231,279,986	254,956,636	278,799,643	302,764,134	326,766,812	350,439,495	373,743,162
Total Loabilities and Capital	40,049,853	72,046,583	139,679,018	206,788,024	291,361,464	310,359,074	329,058,606	347,933,226	366,983,731	386,209,722	405,611,200	426,744,507	447,810,548	467,811,076	488,194,409	504,047,426

Financial Indicators

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Rate of Return on Net Fixed Asset	2111.8%	314.8%	64.7%	34.4%	20.2%	23.6%	24.7%	25.9%	27.3%	28.8%	30.4%	32.3%	34.4%	36.8%	38.8%	41.9%
Debt Service Coverage Ratio	13.93	14.26	15.83	11.52	8.38	7.71	7.14	7.46	7.82	8.21	8.64	13.38	13.37	10.17	7.23	5.00
Operating Ratio	16.9%	16.9%	17.7%	21.7%	25.8%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%
Working Ratio	16.9%	16.9%	16.9%	16.9%	16.9%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%

Table 29.3.4 Financial Stetements and Financial Indicators (2/2)

Profit and Loss Statement

Unit: US $

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Operating Revenue	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453	55,181,453
Operating Expense	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,890,600	17,527,600	15,739,600	13,891,600	12,790,600
Personnel Cost	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000	3,253,000
Maintenance Materials	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000	6,869,000
Admin. Expenses	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600	650,600
Depreciation	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	6,755,000	4,967,000	3,119,000	2,018,000
Net Operating Income	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,653,853	39,441,853	41,289,853	42,390,853
Non-Operating Expense	2,492,266	2,345,866	2,199,465	2,053,065	1,906,665	1,760,265	1,613,865	1,467,465	1,321,065	1,174,665	3,807,625	3,370,025	2,932,424	2,494,824	2,057,224
Interest of Long-Term Loans	2,492,266	2,345,866	2,199,465	2,053,065	1,906,665	1,760,265	1,613,865	1,467,465	1,321,065	1,174,665	3,807,625	3,370,025	2,932,424	2,494,824	2,057,224
Net Income Before Tax	34,798,587	34,944,987	35,091,388	35,237,788	35,384,188	35,530,588	35,676,988	35,823,388	35,969,788	36,116,188	33,483,228	34,283,828	36,509,429	38,795,029	40,333,629
Income Tax	12,179,505	12,230,745	12,281,986	12,333,226	12,384,466	12,435,706	12,486,946	12,538,186	12,589,426	12,640,666	11,719,130	11,999,340	12,778,300	13,578,260	14,116,770
Net Income After Tax	22,619,082	22,714,242	22,809,402	22,904,562	22,999,722	23,094,882	23,190,042	23,285,202	23,380,362	23,475,522	21,764,098	22,284,488	23,731,129	25,216,769	26,216,859

Cash Flow Statement

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Cash Beginning	398,665,738	420,952,170	443,333,762	465,810,514	488,382,426	511,049,498	533,811,730	556,669,122	579,621,674	602,669,386	622,172,258	639,963,706	657,912,544	675,520,023	692,765,142
Cash Inflow	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	82,790,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853	44,408,853
Net Operating Income	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,290,853	37,653,853	39,441,853	41,289,853	42,390,853
Depreciation	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	7,118,000	6,755,000	4,967,000	3,119,000	2,018,000
Long-Term Loans	0	0	0	0	0	0	0	0	38,382,000	0	0	0	0	0	0
Cash Outflow	22,122,421	22,027,261	21,932,101	21,836,941	21,741,781	21,646,621	21,551,461	21,456,301	59,743,141	24,905,981	26,617,405	26,460,015	26,801,374	27,163,734	27,264,644
Investment	0	0	0	0	0	0	0	0	38,382,000	0	0	0	0	0	0
Repayment of Principal	7,450,650	7,450,650	7,450,650	7,450,650	7,450,650	7,450,650	7,450,650	7,450,650	7,450,650	11,090,650	11,090,650	11,090,650	11,090,650	11,090,650	11,090,650
Interest on Long-Term Loans	2,492,266	2,345,866	2,199,465	2,053,065	1,906,665	1,760,265	1,613,865	1,467,465	1,321,065	1,174,665	3,807,625	3,370,025	2,932,424	2,494,824	2,057,224
Income Tax	12,179,505	12,230,745	12,281,986	12,333,226	12,384,466	12,435,706	12,486,946	12,538,186	12,589,426	12,640,666	11,719,130	11,999,340	12,778,300	13,578,260	14,116,770
Cash Inflow - Cash Outflow	22,286,432	22,381,592	22,476,752	22,571,912	22,667,072	22,762,232	22,857,392	22,952,552	23,047,712	19,502,872	17,791,448	17,948,838	17,607,479	17,245,119	17,144,209
Cash Ending	420,952,170	443,333,762	465,810,514	488,382,426	511,049,498	533,811,730	556,669,122	579,621,674	602,669,386	622,172,258	639,963,706	657,912,544	675,520,023	692,765,142	709,909,351

Balance Sheet

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
(Assets)															
Current Assets	437,369,858	459,751,450	482,228,202	504,800,114	527,467,186	550,229,418	573,086,810	596,039,362	619,087,074	638,589,946	656,381,394	674,330,232	691,937,711	709,182,830	726,327,039
Cash & Deposit	420,952,170	443,333,762	465,810,514	488,382,426	511,049,498	533,811,730	556,669,122	579,621,674	602,669,386	622,172,258	639,963,706	657,912,544	675,520,023	692,765,142	709,909,351
Other Current Assets	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688	16,417,688
Fixed Assets	81,846,000	74,728,000	67,610,000	60,492,000	53,374,000	46,256,000	39,138,000	32,020,000	63,284,000	56,166,000	49,048,000	42,293,000	37,326,000	34,207,000	32,189,000
Existing Fixed Assets	173,775,000	173,775,000	173,775,000	173,775,000	173,775,000	173,775,000	173,775,000	173,775,000	212,157,000	212,157,000	212,157,000	212,157,000	212,157,000	212,157,000	212,157,000
Accumulated Depreciation	91,929,000	99,047,000	106,165,000	113,283,000	120,401,000	127,519,000	134,637,000	141,755,000	148,873,000	155,991,000	163,109,000	169,864,000	174,831,000	177,950,000	179,968,000
Net Fixed Assets	81,846,000	74,728,000	67,610,000	60,492,000	53,374,000	46,256,000	39,138,000	32,020,000	63,284,000	56,166,000	49,048,000	42,293,000	37,326,000	34,207,000	32,189,000
Total Assets	519,215,858	534,479,450	549,838,202	565,292,114	580,841,186	596,485,418	612,224,810	628,059,362	682,371,074	694,755,946	705,429,394	716,623,232	729,263,711	743,389,830	758,516,039
(Liabilities and Capital)															
Liabilities	122,853,614	115,402,964	107,952,314	100,501,664	93,051,014	85,600,364	78,149,714	70,699,064	101,630,414	90,539,764	79,449,114	68,358,464	57,267,814	46,177,164	35,086,514
Long-Term Loans	122,853,614	115,402,964	107,952,314	100,501,664	93,051,014	85,600,364	78,149,714	70,699,064	101,630,414	90,539,764	79,449,114	68,358,464	57,267,814	46,177,164	35,086,514
Capital	396,362,244	419,076,486	441,885,888	464,790,450	487,790,172	510,885,054	534,075,096	557,360,298	580,740,660	604,216,182	625,980,280	648,264,768	671,995,897	697,212,666	723,429,525
Retained Earnings	396,362,244	419,076,486	441,885,888	464,790,450	487,790,172	510,885,054	534,075,096	557,360,298	580,740,660	604,216,182	625,980,280	648,264,768	671,995,897	697,212,666	723,429,525
Total Loabilities and Capital	519,215,858	534,479,450	549,838,202	565,292,114	580,841,186	596,485,418	612,224,810	628,059,362	682,371,074	694,755,946	705,429,394	716,623,232	729,263,711	743,389,830	758,516,039

Financial Indicators

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Rate of Return on Net Fixed Asset	45.6%	49.9%	55.2%	61.6%	69.9%	80.6%	95.3%	116.5%	58.9%	66.4%	76.0%	89.0%	105.7%	120.7%	131.7%
Debt Service Coverage Ratio	4.47	4.53	4.60	4.67	4.75	4.82	4.90	4.98	5.06	3.62	2.98	3.07	3.17	3.27	3.38
Operating Ratio	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	32.4%	31.8%	28.5%	25.2%	23.2%
Working Ratio	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%

(a) GPHA

Revenues

・Revenue from Port Dues
・Revenue from vessel services
・Rent for Container Terminal

Expenditures

・Project Costs
Cost for construction of Berth, Dredging, Reclamation, Revetment, Pavement, Gate, Lighting facilities and Drainage.

・Personnel Costs
Cost of personnel in charge of Administration, Security and Marine services.

・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

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

Administration Costs = Total Personnel Costs × 0.2

(b) Private company

Revenues ）

・Revenue from Cargo handling (Present tariff is used in this study)

Expenditures)

・Project Costs (including renewal investment)
Costs for procurement of Office, Gantry Crane, Transfer Crane, Yard Tractor and Yard Trailer.

・Personnel Costs
Refer to 29.2.5.

・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

・Administration Costs

Administration Costs are assumed based on the current statistics of GPHA.

Administration Costs = Total Personnel Costs × 0.2

・Rent for Container Terminal

(3) Calculation of FIRR

The result of FIRR calculation under variable rental conditions is shown in Table 29.3.5.

Table 29.3.5 Result of FIRR Calculation

Rent（US$'000 / year・berth）	FIRR of GPHA	FIRR of Private Company
2,000	6.6%	27.2%
2,500	7.4%	24.3%
3,000	8.1%	21.4%
3,500	8.8%	18.4%
4,000	9.4%	15.2%
4,500	10.1%	11.8%
5,000	10.7%	8.1%

Judging from the above calculation and fund raising conditions of both parties, assuming that rent is set at US$3,500,000 / 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$3,500,000 / 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 29.3.6. 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 29.3.6 Sensitivity Analysis for FIRR

	FIRR of GPHA	FIRR of Private Company
Base Case	8.8%	18.4%
Case 1	8.0%	16.4%
Case 2	7.6%	13.1%
Case 3	6.9%	11.4%

(5) Evaluation

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

There are several methods to set the rent. One method is to fix the annual rent, as stated above. Another method is to divide the rent into a fixed part and variable part which increases progressively by cargo volume. The latter method has the following merits. 1) In case cargo volume is less than estimated cargo volume, risk of lessee (private company) will be reduced. 2) In case cargo volume increases beyond the estimated level, the lessor (GPHA) can obtain a part of the additional benefit.

Furthermore, given that the lessee can set tariffs independently, it might be possible to strengthen the position of the terminal among competing terminals.

29.3.4 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 30 Port Management and Operation

30.1 Proposal for Efficient and Reliable Port Management

30.1.1 General Problem for Privatization of Tema Port

Under the Landlord Port Bill, GPHA is going to change from a service port to a landlord port. Final amendments to the Landlord Port Bill are now being made and it is expected to pass the Parliament soon.

GPHA has already introduced privatization to same extent, namely;
- Cargo handling operation (stevedoring and shorehandling) with private companies
- Offdock terminal operation by private company
  (at Tema port, TCT: Tema Container Terminal LTD operated by ANTRAK)

The biggest change by this privatization is cargo handling operations. At present, cargo handling operations are implemented by GPHA and 3 private companies. But there is no actual competition because GPHA decided to allocate the amount of works (See Chapter 5.3.1). 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. Following systems will be required to increase workers' skill, knowledge and early retirement:

- Introduction of training center for workers
- Introduction of three-shift working system
- Assistance for replaced workers of looking for new job
- Introduction of early retirement benefit or retirement pension

The introduction of early retirement benefit or retirement pension, outplacement to urge early retirement is also necessary steps.

30.1.2 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.) Different approaches should be taken in some instances. Details for Takoradi port are as follows.

(1) New Container Terminal

Two berths of the new container terminal on the western side of Tema port is desired to be leased one by one to a single operator as a public berth or commercial berth because many companies will utilize this container terminal. The competition between these container terminals will be occurred and cargo handling productivity will be increased at each container berths such as the container

berths of Ouay1, Quay2, and the new container terminal on the western side of existing port area.

GPHA constructs the basic facilities while the operating company is responsible for equipment procurement and operation. However, 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

Under the Landlord Port Bill, GPHA will mainly have the function of port administration and management such as to prepare and update a port master plan, to regulate and control the development within ports, to regulate navigation, dredging, and operations on ship, cargo handling and passengers, to promote the use, improvement and development of the port and participate in the activities and meeting on ports, etc.

Terminal operator and port authority (landlord GPHA) are required to cooperate for efficient port operation. While risk and benefit will be properly shared, it is also important to cooperate for efficient vessel operation.

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.

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

Several types of container terminal lease system at foreign ports are shown in Table 22.1.1.

(2) New Container Terminal at Quay2

GPHA plans to establish Quay2 into new container terminal (945 slots, about 24,000m^2). The container terminal which 2 gantry cranes and transfer crane method (3 transfer cranes) will be installed is under construction. Now, dredging is under going near Quay2 wharf and this wharf will be extended for the new container berth as GPHA's project. As shown in former section, this new container berth and two new container berths on the west side of existing port area are desired to be leased one by one to private sector and the competition between them will be generated.

(3) Berth 11 (Bulk Berth for Clinker)

Management and operation of berth 11 (for bulk cargo handling berths) is desired to be managed as a public berth by GPHA and to be operated by private companies. Maintenance of facilities will be done by GPHA or private companies by contract with GPHA. Private companies can be expected to adopt the most efficient way of providing services and handling cargoes in these berths.

(4) Others

Berths 6-9 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.

30.1.3 Monitoring the Performance of Operation

As mentioned in the Landlord Port Bill, private companies are allowed to perform cargo-handling activities. 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.

If GPHA participates in the joint venture with private companies in future, GPHA is required to keep its monitoring section independent from the operating section. Operation activities within landlord GPHA and private companies need to be closely monitored.

30.1.4 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. Breakdown time of equipment has to be minimized. Storage facilities should be properly designed to prevent cargo damages. Security measures for cargoes or countermeasures against pilferage must be taken effectively. Cargo handling operation must be precise, careful and safe.

To generate the maximum income from port service, cargo handling must be done continuously, and this requires well-maintained cargo handling equipment. Reservation of back up equipment and sufficient amount of parts are required, and periodic maintenance of cargo handling equipment is also required.

Especially for containers, it is essential to minimize the breakdown time of container handling equipment to achieve the targeted productivity. 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.

30.1.5 Three-Shift Working System

Two-shift working schedule for dock workers is now adapted, that is from 7:30 to 19:30 for the 1st shift and from 19:30 to 7:30 for the 2nd shift (with overtime period 17:00 to 19:30 for 1st shift, 3:30 to 7:30 for 2nd shift). It is difficult to realize continuous works under this system. The introduction of a third-shift (for 8 hours) is required to achieve more effective cargo handling by workers. Continuous 24 hours cargo handling needs to be maintained.

To effectively utilize new equipment such as cargo handling machines (gantry crane, transfer crane, etc.) and the computer system for container handling, periodic training for workers is desirable. This will help to prevent accidents as well as enhance the skill level of workers.

30.1.6 Port EDI System

Refer to Chapter 15.1.4.

30.1.7 Port Promotional Activities for Tema Port

To increase cargo volume and number of vessels calling in Ghana Sea Ports, port promotional activities are important. In West Africa, Ghana Sea Ports enjoy a reputation for reliability thanks to the stability of the Ghanaian government. Recently, some seaports in neighbouring countries have problems concerning reliability, and some shipping companies plan to shift their cargo handling to Ghana Sea ports. Important points for promoting Ghana Sea Ports in future are below:

- To emphasize the high stability and reliability of Ghana Sea Ports.
- To emphasize the greater convenience and performance of Ghana Sea Ports that can be effected once the Landlord Port Bill is passed.

In addition, holding periodic meetings with port users such as shipping companies and agents is also useful for identifying and solving problems. Such activities will increase the competitiveness of Takoradi Port.

30.1.8 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.

The following points should be considered in terms of the tariff structure.

- The revenue from the tariff can cover costs for construction, management, maintenance and repair.
- The tariff should be rational in correspondence with the service provided.
- The tariff structure should include a system which leads to more effective management and operation of the port. This implies that an incentive should be provided for vessels and cargo to move efficiently through the port.
- Tariff structure and the way of imposition should be as simple as possible.

The tariff for the new container terminal and the new multipurpose berth will be set in view of the above points. Tariff for the new multipurpose berth is appropriate to be lower than the new container terminal because of its limitations (container yard is far from berth side, container cargo should be moved outside the multipurpose yard in a day etc.).

Chapter 31 Environmental Impact Assessment

The Study Team carried out the environmental analysis for formulate the draft EIS for the short-term development plan of Takoradi Port. Formal EIS should be made by a project proponent following the EIA guidelines of Ghana. This draft EIA provides the project proponent with technical support to compile the EIS. This chapter summarizes the results of environmental analysis. Full description is included in Appendix B.

31.1 Introduction

31.1.1 Project Background and Objectives

(1) Background

Tema Port construction began in 1954 and opened in 1962 as an outer port for Accra. The original layout of the Tema Port was composed of two breakwaters. A water basin, Quay No. 1 and Quay No. 2 were added between 1970 and 1975, completing the present port. Tema Port was one of the three integral components of the Volta River Project. The other two were the dam at Akosombo and the aluminum smelter at Tema.

Tema Port is located about 30km east of Accra. About 80 % of imported goods to Ghana is handled in Tema Port. The main commodities handled here are crude oil, clinker, oil products, rice, sugar, wheat, alumina, and aluminum. Recently the volume of container cargo has been increasing.

Main port facilities of Tema Port include 14 berths, i.e. seven (7) berths in Quay No. 1 and five (5) berths in Quay No. 2, an Oil Berth and a Valco Berth. There are 11 sheds, one (1) CFS, one (1) container yard, one (1) container devanning areas and one (1) open storage yard. Out of these, four (4) sheds in Quay No. 2 will be demolished during the on-going Quay No. 2 Extension Project. The existing port layout plan of Tema Port is shown in Figure 7.2.1.

Increasing cargo-handling volume requires a considerable scale of expansion of capacity of the Port. The cargo handling volume will reach to 10 million tons and 18 million tons in 2010 and 2020, respectively, while it remains around 6 million tons at present. In particular, container cargo is estimated to increase 3 times and 6 times in 2010 and 2020(see Table 14.1.1).

In order to respond to the increasing demand of cargo volume, the provision of deep berths is indispensable and urgent. At the same time, the space for the cargo-handling operation should be provided considering the requirement from the local residents.

(2) Objectives

JICA Study Team proposed a development plan of Takoradi Port, in response to the request from the Government of Ghana to Government of Japan, to accelerate and support the economic development of Ghana. Based on the Scope of Works signed by JICA and Government of Ghana on July 20th, 2000, the study team carried out an EIA study for a short-term development plan of Tema Port with a target year of 2010.

The short-term development plan of Tema Port comprised of the following components:

- Creation of new berths and a container yard through reclamation of the sea area southwest of the main breakwater
- Construction of new breakwaters sheltering the new berths
- Construction of new access road from the container yard to West Gate Road and Meridian Road
- Container and other cargo-handling operation on the reclaimed land
- Increase in the cargo transportation

In compliance with the Environmental Protection Agency (EPA) Act, Act 490 of 1994, the plan must be registered with the EPA by GPHA, the project proponent. Under the Ghana Environmental Assessment Regulations, 1999 (LI 1652), port expansion projects with the increase of cargo handling volume of 25 % or more fall within the category of Environmental Critical Undertakings for which EIA is mandatory.

The objective of the environmental study in this report is to prepare the technical parts of the EIS for the short-term development plan of Tema Port, which in due course, GPHA will complete for the implementation of the plan.

31.1.2 Legal, Administrative and Policy Consideration

The relevant policies and the regulatory conditions that must be considered for the successful implementation of the project have been reviewed and are discussed below.

The laws considered include:

- Environmental Protection Agency Act, 1994 (Act 490)
- Environmental Assessment Regulation, 1999 (LI 1652)
- Ghana Ports and Harbours Authority Law, 1986 (PNDC Law 160)
- Merchant Shipping Act, 1963 (Act 183)
- Port Regulations, 1964 (LI 352)
- Ghana Free Zones Act, 1995 (Act 504)

In addition, the followings were considered, though under consideration of the Government of Ghana:

- Draft National Maritime Authority Act, 2000
- Draft Landlord Ports Act, 2000
- Draft Port Regulations, 2000

The Environmental Assessment Regulations, 1999 (LI 1652) enacted under the provisions of the EPA Act, set out the procedures governing EIA in Ghana. Under Schedule 2 Regulation 3 (10) of these regulations, the proposed port development project falls under the undertakings for which EIA is mandatory as it is expected to result in an appreciable increase in port handling capacity.

Section 5 of the Ghana Ports and Harbours Authority Law, empowers the GPHA to build, develop, manage, maintain, operate and control all ports in Ghana. The law also charges the Authority to maintain and deepen as necessary the approaches to the port and also to provide cargo

storage/handling facilities such as warehouses etc.

The Ministry of Road and Transport is responsible for Government policy issues related to the Maritime sector. Currently the Merchant Shipping Act, 1963 (Act 183) and the Port Regulations, 1964 (LI 352) have been revised as part of an overall restructuring of the Maritime Administration in Ghana. These revised laws are yet to be approved by Parliament.

Apart from the administrative and policy issues, various legislation and guidelines concerning safety, pollution etc. have also been considered. Among these are:
- EPA Quality Guidelines (Effluents, Air Quality and Noise)
- Radiation Protection Instrument, 1993 (LI 1559)
- National Oil Spill Contingency Plan
- Various international maritime conventions (MARPOL, SOLAS, OPRC, IMDG codes etc.)

These are discussed in relevant details in the sections later where they are applicable.

31.1.3 Scope of Study

In prior to the preparation of the short-term plan, the study team made a master plan for Tema Port development (see Interim Report (1)). In accordance with the EIA procedure in Ghana, Scoping work was also done to identify the environmental elements with possible impact, and in due course of the said procedure, TOR for EIA on the master plan prepared (Appendix B).

Here, the Study Team applies the TOR for EIA on the master plan to the EIA on the short-term plan, since the master plan's components of construction work and operational activity entirely contain those of the short-term 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 Tema Port.

In accordance with the Environmental Assessment Regulations, 1999, the EIA of the Tema Port short-term development plan includes:
- A description of the proposed undertaking and an analysis of the need/reason for the undertaking;
- Objectives of the undertaking;
- Other options for carrying out the undertaking;
- Alternatives to the undertaking;
- A description of the present environment that would be affected, directly, or indirectly;
- A description of the future environment, predicting its condition if the undertaking did not take place;
- Impacts that may be caused to the environment by the undertaking;
- Proposed measures to prevent or mitigate all adverse impacts;
- Evaluation of opportunities and constraints to the environment of the undertaking;
- Proposal for an environmental management program to cover constructional, operational and decommissioning stages of the undertaking;
- Proposal for a program of public information

31.2 Description of Proposed Development Plan

The short-term development plan of Tema Port comprises the following components:

- Creation of new berths and a container yard through reclamation of the sea area southwest of the main breakwater
- Construction of new breakwaters sheltering the new berths
- Construction of new access road from the container yard to West Gate Road and Meridian Road
- Container and other cargo-handling operation on the reclaimed land
- Increase in the cargo transportation

31.2.1 Preparation Phase

Since GPHA has already owned the necessary areas for the port expansion, it will not need further land acquisition and relocation of facilities.

31.2.2 Construction Phase

The short-term development plan of Tema Port is drawn as in Figure 24.3.1. The schedule of the construction works is planned as in Figure 26.3.1.

(1) Reclamation for New Container Yard

A coastal sea area neighboring west to the existing port will be reclaimed with materials both dredged to deepen the new port basin and transported from a quarry site. The reclamation of the area of ca. 290,000 m^3 requires 2.3 million $m^3$of filling materials. The reclaimed area will be used for berths and a yard for container handling.

(2) Dredging

The new port basin will be deepened to 13.0 meter to provide deep container berths and a turning basin. The dredging will be carried out by a dredge cutter boat, a pump-dredge boat and a grab-dredge boat.

The dredged materials will be used for the reclamation in the proposed plan. The materials to be dredged is estimated to be about 1.3 million m^3, which accounts for about 50 % of the required filling material volume of 2.3 million m^3.

(3) Construction of Breakwater

New breakwaters will be constructed to provide the new container berths and a turning basin with a calm condition and consequent safe navigation at the port entrance. The structure will be same as the existing breakwater, using rocks that are available from the quarry site.

(4) Demolishing Existing Facility

A small-scale demolition will occur to the existing facilities located on the hinterland of the planned new container yard. This may include the existing two cocoa sheds and parapet and wavewall of the existing breakwater.

(5) Construction of New Access Road

A new access road will be constructed connecting the new container yard to West Gate Road and Meridian Road. The new access road is expected to share the cargo transportation with the existing access roads.

31.2.3 Operation Phase

(1) Container-Handling at Berth/Yard

The new container berths and yard, which would be constructed through reclamation, will handle around 250,000 TEU of containers. Cranes and other container-handling equipment will be installed. Light facility will also be set up to ensure the safe work and the security. Port workers will also be posted for an efficient container handling.

(2) Cargo Transportation

Increased trucks and trailers will be employed to transported the increased cargoes through port access roads including the planned road. Future cargo volume is estimated to be 10 million tons in 2010, while it remains 6 million tons at present.

(3) Ship Berthing/Navigation

Pilots and tugboats will work properly for navigation in the port area and berthing, as same as at present.

31.2.4 Demolition Phase

The port structures should be long-life assets and will form the basement for future expansion of the port. Therefore, demolishing port is not reality, though the future port development work may demolish partly some port structure.

31.3 Existing Environmental Condition

The existing environmental conditions of Tema Port and its surrounding area were described based on results of field surveys, literature survey and interviews(see Appendix B).

The following environmental problems were identified.
- Water quality (Concentration of oil and organic matter)
- Bottom sediment quality (Lead and mercury concentration)

- Noise due to road traffic
- Fauna of the Ramsar Site (Bird species)
- Waste treatment

31.4 Assessment of Impact

Fourteen (14) environmental elements needed to be assessed on the impacts, as shown in the TOR for EIA. The impacts on these elements were identified for every phase of the project, i.e. preparation phase, construction phase and operation phase. Every activity likely to have impacts on the environment was listed up and its environmental impacts were evaluated. The result is summarized in Table 31.4.1

It is not realistic for the port development to assume demolishing port structure. When demolition becomes necessary, it will be to implement the further development of the port. In the present study, therefore, the demolition phase was not considered. Instead, impacts of the demolition of existing facilities during the construction phase were taken into account.

In Table 31.4.1, the significance of the environmental impact was evaluated from the viewpoint of "Importance" and "Magnitude". "Importance" was classified into five (5) ranks positively or negatively (second row of Table 31.4.1). The classification was based on the following points of view:
- How local people and/or port workers value the environmental element to be affected.
- Whether or not the environmental element has a value of national/regional/global level which the local people are not aware of.
- Whether or not improving the situation of the environmental element leads the poverty reduction in the local community.

Thus, "Importance" is the property of the environmental elements for local people, port workers and other relevant persons/parties/organizations, regardless of the contents and scale of the development activity involved.

"Magnitude" was also classified into five (5) ranks (top of each cell of Table 31.4.1). Criteria for the classification include the followings:
- Degree and/or scale of the impact on the environmental element
- Whether the impact is temporal, residual or permanent.
- Whether the impact is reversible or irreversible.

Thus, "Magnitude" is determined through the extent of the environmental alteration by the proposed development activity.

Finally, the evaluation of the significance of the environmental impact was made multiplying "Importance" by "Magnitude". The obtained values were put on the bottom of each cell of Table 31.4.1.

Justification on the ratings for each element is shown below.
- Progress of air pollution (AP): Although, Ghana has an Environmental Quality Standard for air

quality, air pollution is still causing various health hazards and nuisance and is a major concern for the local people.

- Progress of water pollution (WP): Despite the poor water quality in the Tema port basin and the surrounding coastal waters, no Environmental Quality Standards for recipient water has yet been established in Ghana. Local people do not show the concern on the seawater quality.
- Bottom sediment pollution (SP): Though the local people might be unaware of sediment pollution, high concentration of heavy metal substances have been recorded in the port area, which could potentially have an adverse affect on the health of local residents through biological accumulation.
- Noise generation (Noi): Noise is not a major concern for the local people as yet, with GPHA receiving no noise complaints so far. However, noise level in the port area occasionally exceeded the Ghana Environmental Quality Standards.
- Odor generation (Odr): Odor-related complaints from local residents and port workers are uncommon, though odor is obviously detectable when a lot of wastewater flows into the existing port basin..
- Progress of Erosion (Ero): Tema Port is located in the active littoral drift zone facing the open ocean.
- Deterioration of Fauna/Flora (F/F): A Ramsar site (Sakumo Ramsar Site) has been set up neighboring west to Tema Port. This lagoon should be of regional value.
- Promotion of Economic Activities (EA): The livelihood of the local people is intimately linked to the presence of the port. The local people are engaged in various forms of port related activities, which could either be directly or indirectly related. Indirect port related activities include manufacturing, repairing, transportation and fishing. Increased port activity will lead to the poverty reduction in Tema.
- Resettlement (RES): Resettlement of port facilities could disturb the efficiency of port workers.
- Development of Infrastructure (INF): With many unpaved roads and inadequate sewage systems, improvement of infrastructure is a key issue among the local people. Improvement in the infrastructure will lead to the poverty reduction.
- Promotion of Fisheries (Fsh): Fisheries is an important industry for Tema and has contributed to the poverty reduction. A strong interest in fisheries exists among the local people.
- Rational Land Use (LU): Tema is a planned city and has a perspective of the future land use. Change in Land use should be under the control of local government.
- Waste generation (Wst): The importance of waste management is strongly emphasized in the Ghana EIA guideline, since many disposal sites are approaching its full capacity.
- Promotion of Public Health and Safety (HS): There is a strong interest in Public Health and Safety among the local people, but poverty reduction is their first priority.

Table 31.4.1 Environmental Impact Matrix

Element	AP	WP	SP	Noi	Odr	Ero	F/F	EA	Res	Inf	Fsh	LU	Wst	HS
Importance	-3	-1	-3	-1	-1	-2	-3	+5	-3	+5	+2	+1	-3	+2
Activity														
Preparation Phase (no activity)														
Construction Phase														
Dredging & other marine works		2 -2	-2 +6	1 -1							0 0		1 -3	
Construction machines, and vehicles/vessels	1 -3	0 0		1 -1				1 +5			0 0		1 -3	-1 -2
Reclamation	1 -3	1 -1					0 0				0 0		-1 +3	
Demolition of existing facilities	1 -3			1 -1					0 0				1 -3	
Employing construction workers		1 -1						2 +10					2 -6	
Operation Phase														
Altered port configuration		0 0	2 -6			1 -2					0 0			
Increased ship-call		0 0						2 +10			0 0		2 -6	
Increased cargo-handling	0 0	0 0		2 -2	0 0			2 +10					2 -6	0 0
Increased port workers		0 0						3 +15					2 -6	
Port-associated development										2 +10				
Rearrangement of facilities							0 0					0 0		
Increased land transportation	1 -3			3 -3			2 -6	2 +10						-1 -2
Demolition Phase (not applicable)														

AP: Progress of air pollution
WP: Progress of water pollution
SP: Bottom sediment pollution
Noi: Noise generation
Odr: Odor generation
Ero: Progress of Erosion
F/F: Deterioration of Founa/Flora
EA: Promotion of Economic Activities
Res: Resettlement
Inf: Development of Infrastructure
Fsh: Promotion of Fisheries
LU: Rational Land Use
Wst: Waste generation
HS: Promotion of Public Health and Safety

top: Magnitude of impact
bottom: Significance of impact
(importance × magnitude)

Detailed analysis on the magnitude of the impact is described in Appendix B.

31.5 Mitigation of Impact

31.5.1 Air Quality

The increased air pollution should be mitigated by planting in the port area and along the road in the vicinity of the residential area.

31.5.2 Water Quality

In the construction phase, a silt protection curtain should be employed to surround the dredging site and the water way from the reclamation to reduce the SS dispersion. Coagulant may be introduced to the reclamation area to facilitate the sedimentation of the mud contaminated with heavy metals.

31.5.3 Bottom Sediment Quality

Severely contaminated mud to be dredged should be contained in the reclamation area, because of the reason of the hard structure there, and should be sealed securely.

31.5.4 Noise

A roadside fence or plantation to alleviate the noise should be installed in Sakumo Ramsar Site. It is also desirable on the Meridian Road. Setting a buffer zone along the road would be most effective, where possible.

31.5.5 Erosion

Careful monitoring on the shoreline change should be done. Beach nourishment will be implemented when necessary.

31.5.6 Fauna and Flora

A roadside fence or plantation should be installed in Sakumo Ramsar Site. This will also reduce the impact of light of vehicles during night.

31.5.7 Economic Activity

In order to enhance the positive impact to local community, it is expected that, apart from the foreign workers, most of the labor that would work on the port projects would be recruited from the residents of the local communities. This should help to control the influx of non-resident job seekers and reduce the slums.

31.5.8 Infrastructure

To maximize the benefit to the local community, it is desirable to facilitate the development of infrastructure in accordance with port expansion. The improvement of the road would be the first priority to meet the purpose of the promotion of the public safety.

31.5.9 Waste Management

Wastes from operational activities will be transported to the approved municipal landfill sites in Tema. The waste collection bins in the ports are of the covered type. In addition, all other trucks carrying wastes will be adequately covered to prevent spillage on the way to the landfill sites.

It is recommended that the development plans should allow for existing waste management facilities to be expanded to cater for the increased levels of activity in the port.

It is also recommended that reception facilities for oily/liquid waste should be provided within Tema Port as part of the Port State Control regime to be implemented under the auspices of the Shipping and Navigation Division of the Ministry of Roads and Transport.

31.5.10 Public Health and Safety

During the construction phase, inspection should be made to ensure that truck drivers would comply with the safety guidelines which should be established by GPHA.

During the operation phase, traffic signal lights will be located at the junctions of access roads to the Port and the existing trunk roads. Speed limit signs and directional signs will be located at vantage points along these roads to guide road users.

31.6 Evaluation

The evaluation was made for the short-term development plan of Tema Port from the environmental point of view. Table 31.6.1 summarizes the results of impact assessment shown in Table 31.4.1. The principal environmental problems in future would involve:

- Waste generation
- Noise generation

The magnitude of impacts will be generally small (1 or 2 in the five-rank rating) and it is not likely that severely adverse effects would occur as a consequence of the port development.

It was also estimated that the plan would give positive impacts mainly on the socio-economic environment of Tema. The magnitude of positive impact was not large either (1 to 3 in the five –rank rating), because the public involvement in the planned project was not so extensive. These impacts should be amplified to contribute to the poverty reduction of the area.

After all, the short-term development plan of Tema Port was evaluated to be proceeded. Provided with the coordination with other infrastructure planning, such as waste management system,

sewage treatment system and road network, the development of Tema Port will largely improve the situation of local community.

Since the alternative plans were prepared and evaluated in the phase of Master Plan study (Section 14.8), the short-term plan did not have the alternatives. Therefore, comparative evaluation with alternatives was not done.

Table 31.6.1 Summary of Evaluation of Environmental Impact

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	-6
	Construction machines, vehicles, and vessels	Setting signals Announcement to local residents	Local economy	Waste Air quality Safety Noise	+1
	Reclamation	Carefully designed containment	Waste	Air quality Water quality	-1
	Demolition of existing facility	Enhanced waste handling capacity	-	Waste Air quality Noise	-7
	Employing construction workers	Local employment and vocational training	Local economy	Waste Water quality	+8
Operation	Altered port configuration	Announcement to fishermen	-	Sediment quality Erosion	-8
	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 Noise	+2
	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	Fauna and Flora Air quality Noise Safety	-4
Demolition	Not applicable	-	-	-	-
Total					+8