shall be carried out in the night-time as well. For such activities, light beacons and bouys are necessary.

Light Beacon	4
Light Buoy	12
Light Guide post	1

2-4 Alternative

2-4-1 Formulation of Alternatives

Required berths at the new site up to the year 1997 are one container berth, one feeder berth and one general/bulk cargo berth.

To avoid interference with the future plan, the locations of container berth and general/bulk cargo berth shall be planned at the same place as in the master plan. Thus, there are only two alternatives on the location for a feeder berths.

Construction of them should be begun from the place near Watering Point of Rumassala Hill considering natural conditions.

Alternative 1. Alternative for Cost Saving

A feeder berth will be constructed using the northern revetment of the container berth as shown in Fig. 2-4-1. There is little wave influence in front of the feeder berth, and it is now around eight metres in depth. And the required length of the Southwest Breakwater and the East Breakwater are 1200m and 250m respectively. Therefore, it would cost less comparing with Alternative 2. However, at the stage of the next expansion, the feeder berth will become useless. In this case, the length of the container berth will be 350m considering some space for handling feeder cargo at the side.

Alternative 2. Alternative for future plan connection.

The second container berth in the master plan will be constructed

continuously, north of the first berth as shown in Fig. 2-4-2. In this alternative, one section of the second berth will be constructed as a feeder berth. To secure the required tranquility in front of the feeder berth, it is necessary to invest more in construction of the East breakwater. The lengths to be prolonged is 100m. Further, since the depth of the bed rock becomes shallower in the northern part, the cost of dredging will increase. However, development in the following phase should prove less difficult.

Fig. 2-4-1 Short Term Development Plan (Alternative 1)

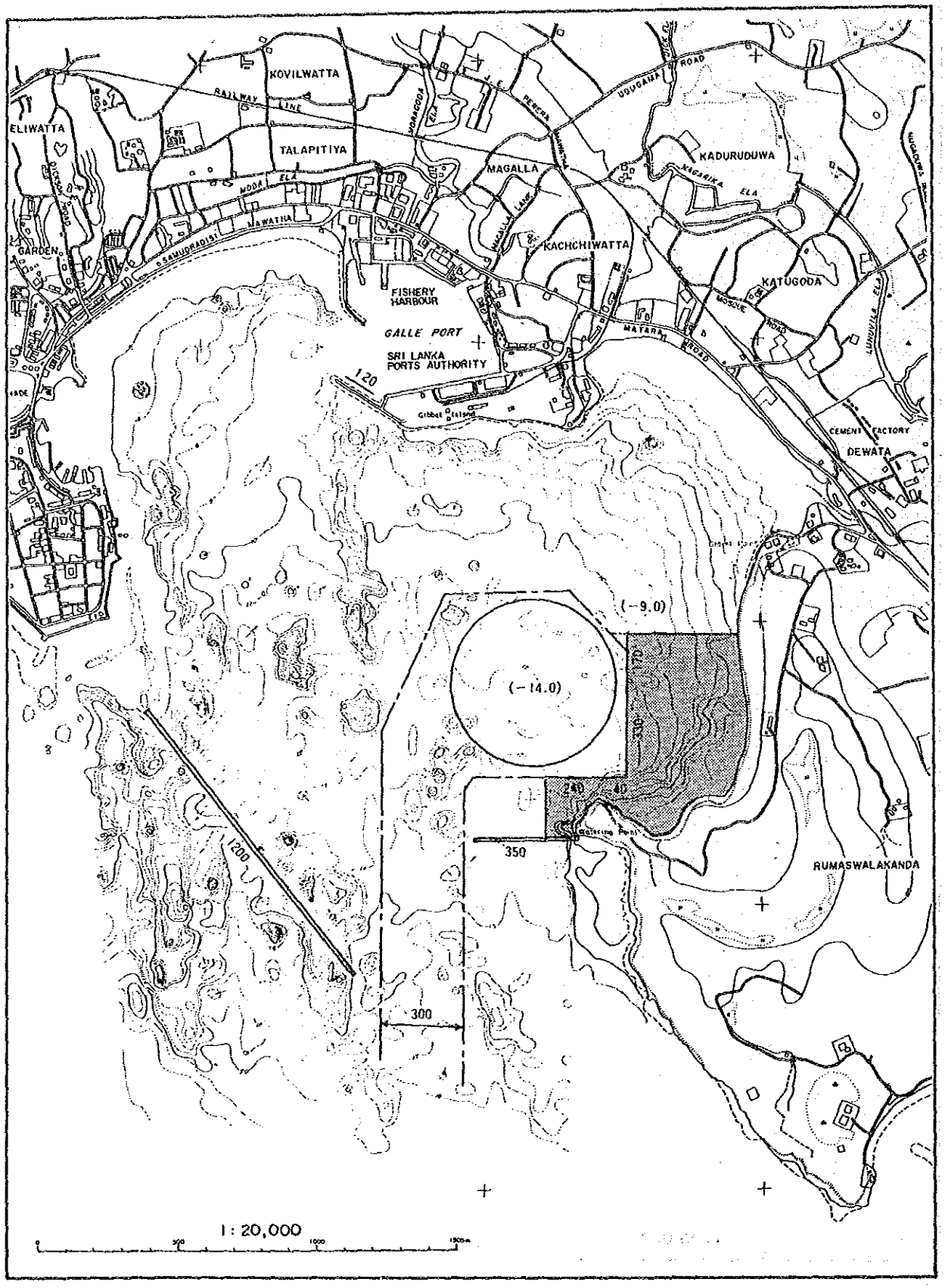


Fig. 2-4-2 Short Term Development Plan (Alternative 2)

2-4-2 Study of calmness

A computer-aided simulation analysis has been undertaken to determine the effect on the calmness of the inner harbor with respect to the two alternative plan layouts.

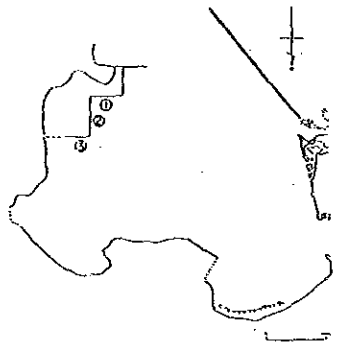
Appendix III-2-1(1) to Appendix III-2-2(8) show the wave height ratio of each alternative by wave direction. Using the diffraction coefficients given in Appendix III-2-3, the frequency of occurrence of the overall wave height below the critical wave height (0.5m) was calculated. The results are shown in table 2-4-1.

From these examination, it is judged that there are not so much differences between two alternatives in terms of calmness in front of quay walls.

Table 2-4-1 Degree of Calmness (Critical Wave Height Hc = 0.5 m)

Alternative 1 Unit: %

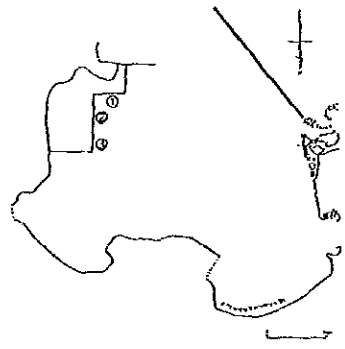
H ≷ Hc / Diretion / Point	H > Hc = 0.5 m								H < Hc
	SE	SSE	S	SSW	SW	WSW	W	Total	Total
1	0.00	0.00	0.00	0.23	2.00	1.79	0.04	4.06	95.94
2	0.00	0.00	0.00	0.30	2.32	1.79	0.04	4.45	95.55
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00



Points of Calmness Estimation

Alternative 2 Unit: %

H ≷ Hc / Diretion / Point	H > Hc = 0.5 m								H < Hc
	SE	SSE	S	SSW	SW	WSW	W	Total	Total
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
2	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	99.99
3	0.00	0.00	0.00	0.22	3.73	20.9	0.04	6.08	93.92



Points of Calmness Estimation

2-4-3 Evaluation

As mentioned in 2-4-1, each alternative has several merits and demerits. The main merit of Alternative 1 is cheaper cost for the time being and that of Alternative 2 is easy connection to future development. Appendix III-2-4 shows the construction cost of two Alternatives.

As the amount of initial cost of the short term plan is great, cost saving is the most important point to be considered for the time being. Therefore, Alternative 1 is recommended to be taken as the short term development plan.

2-4-4 Layout

Layouts of the each berth are shown in Fig 2-4-2 ~ 2-4-4 and layout plan of new terminal is shown in Fig 2-4-5.

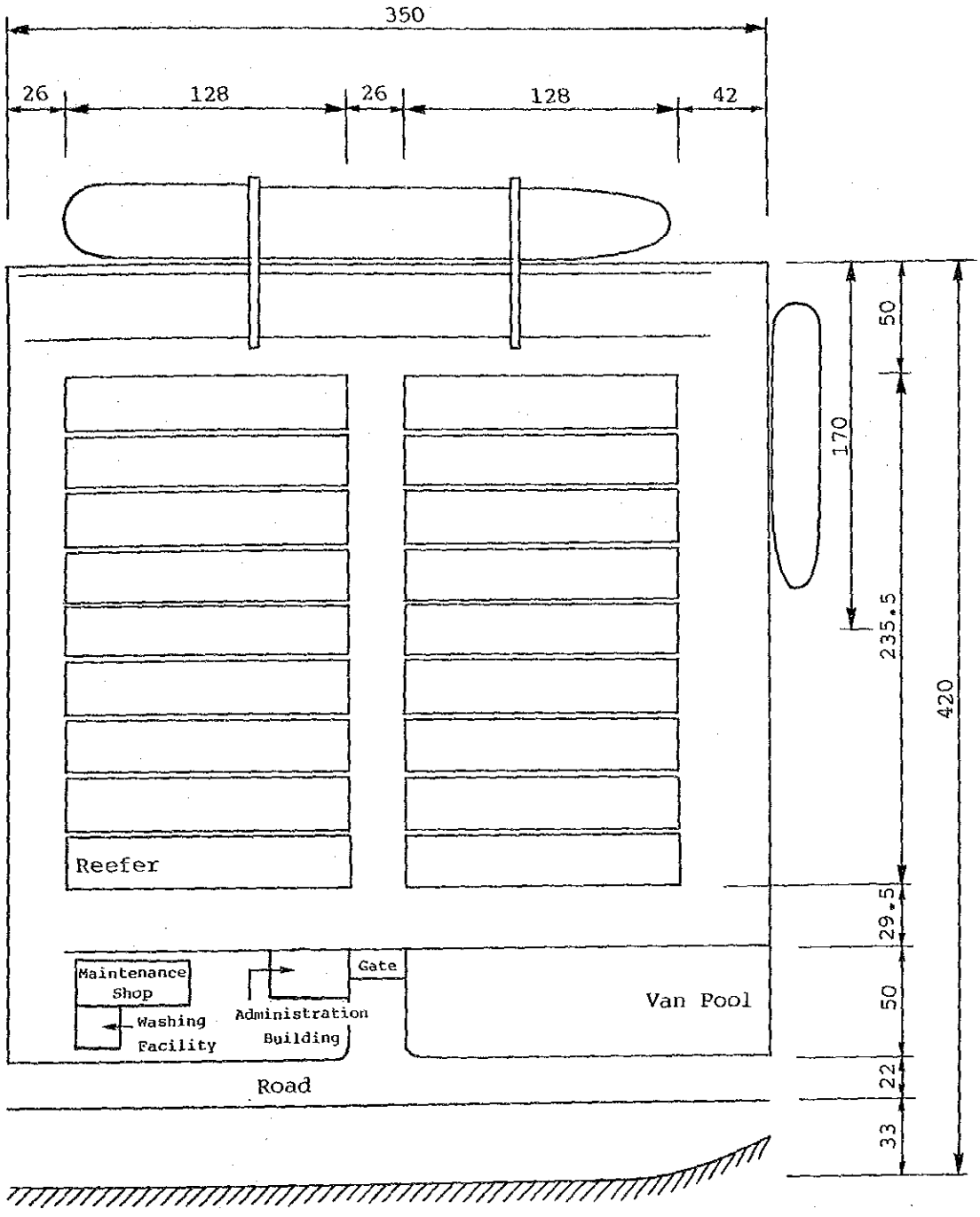


Fig. 2-4-3 Layout of Container Berth

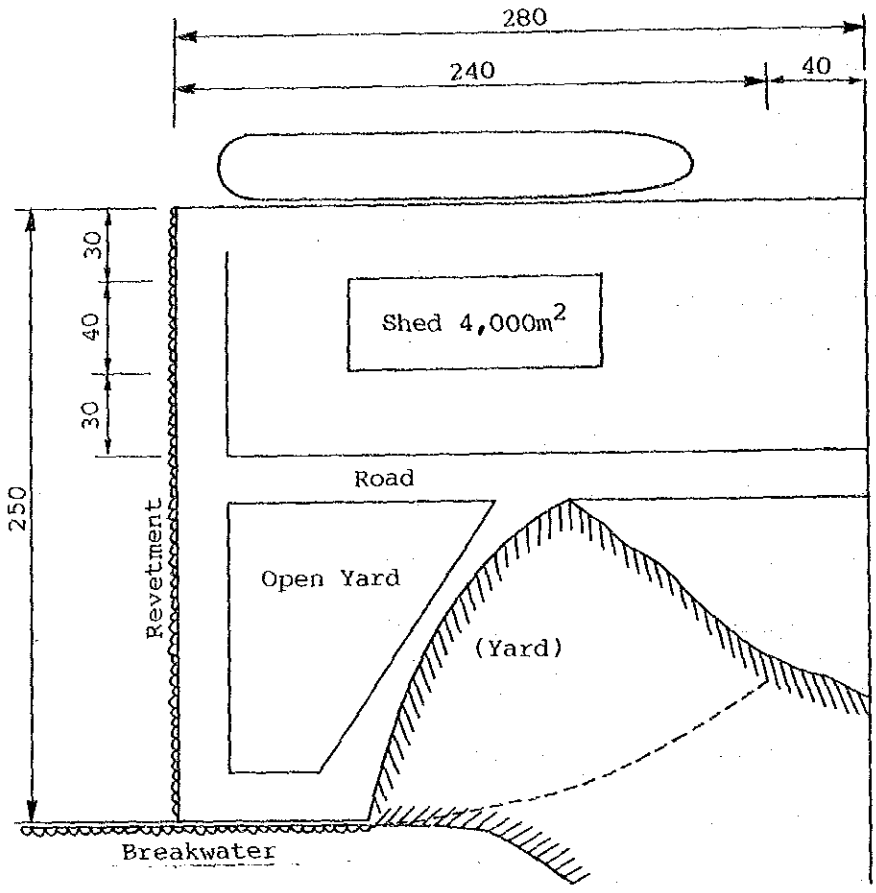


Fig. 2-4-4 Layout of General/Bulk Cargo Berth

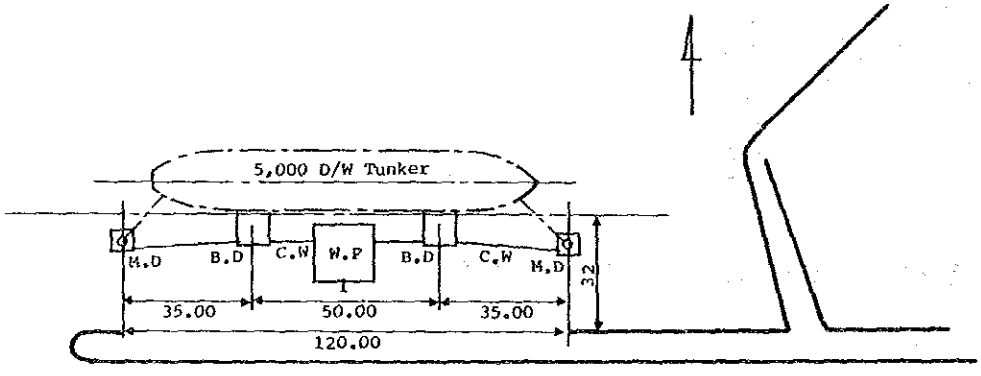


Fig. 2-4-5 Oil Berth

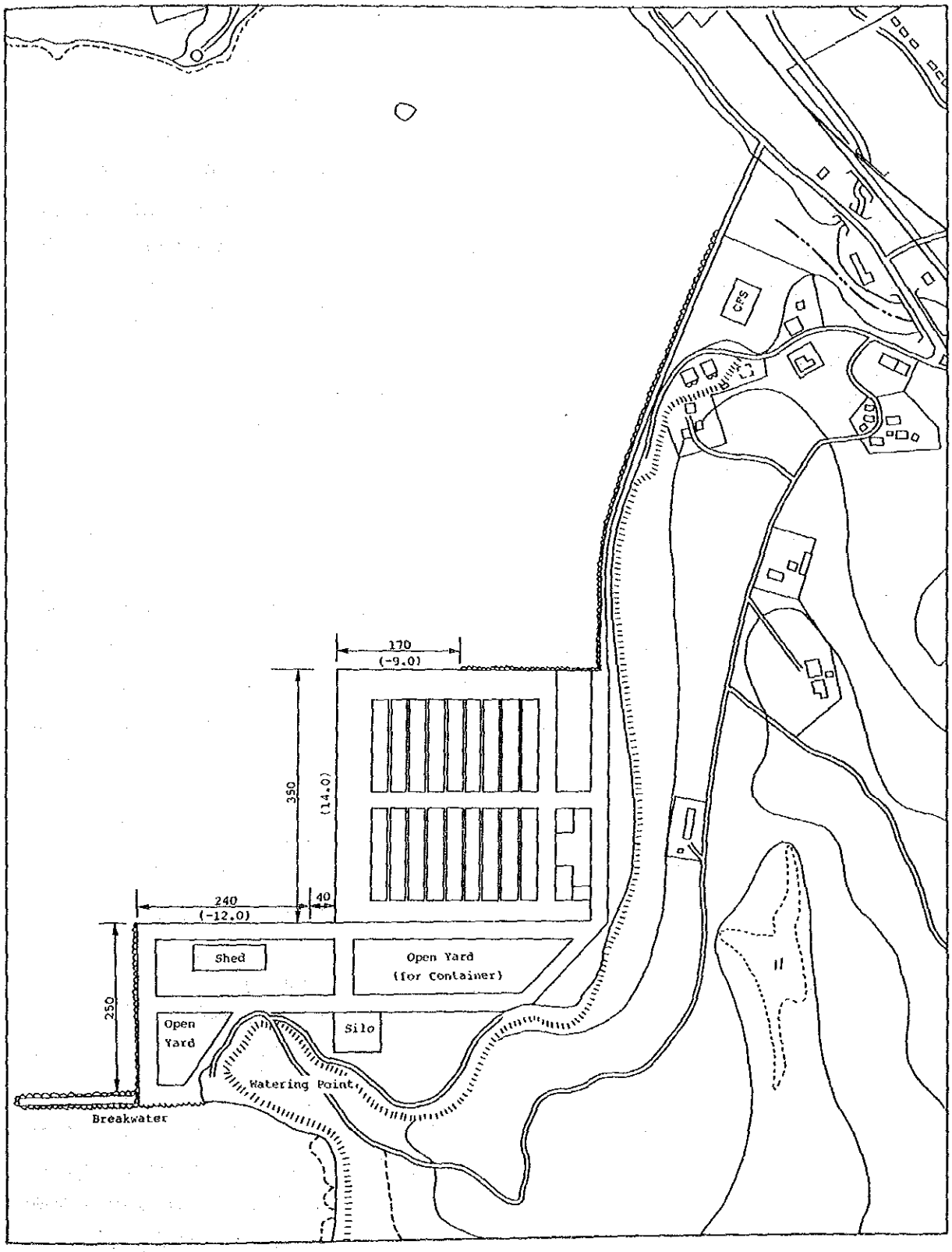


Fig. 2-4-6 Layout of New Terminal

3 PRELIMINARY DESIGN

3-1 Design Criteria

This subclause describes the design criteria established on the basis of the data contained in Part I, Chapter 4 Natural Conditions of Coastal Area Adjacent to Galle Port and additional information obtained through the site investigation conducted as part of the Study.

(1) Tide Levels

The tide levels in Galle Port are given below:

Mean High Water Level	+ 0.60 m
Mean Sea Level	+ 0.34 m
Mean Low Water Level	+ 0.10 m
Datum Level	± 0.00 m

(2) A sounding survey was executed in the Port of Galle in November 1990 according to the feasibility study program. The survey results are shown in Fig. 4-4-3 in Part I, Chapter 4. A sonic survey was also carried out in the same manner as the sounding survey, and the contour lines of hard strata prepared from these surveys are indicated in Fig. 4-4-4 in Part I, Chapter 4.

(3) Waves

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

Direction	Height (Ho')	Height (H 1/3)	Period
W ~ S	5.5 m	5.1 m	9.5 sec

(4) Geology

The geology of the Port and Bay of Galle and adjacent areas consists primarily of a gneiss formation as the bedrock which is partly overlain by laterite layers. Generally, the gneiss layer occurs at a limited depth in the North and Gibbet Island and its outcrops are seen at many places on both sides of the Central Channel. In the eastern part of the Bay, the gneiss layer is formed at greater depths with loose sand, silty sand, cohesive clay and laterite layers

overlying the layer.

At the location where the Southwest Breakwater is to be constructed, sediments are formed to a limited extent and the substratum consists primarily of relatively well graded sand and gravel. At the proposed construction sites of the General Cargo Wharf and East Breakwater, however, the substratum is composed primarily of silty sand and cohesive clay layers (N-value = 0 $\sim$ 1) of about 10 m thick. The proposed Container Wharf site is partly scattered with outcrops of gneiss.

(5) Earthquakes

Earthquakes are not considered in the design of the Project facilities.

(6) Wind

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

(7) Design Ship Characteristics

1) Container Berth

The maximum container ship sizes considered for design purposes are Post-Panamax type container ships of 50,000 DWT and feeder vessels of 12,000 DWT. The principal characteristics of the design ships are as noted below.

Container Ship		50,000 DWT	12,000 DWT
Length, overall	(m)	280.0	144.0
Breadth, molded	(m)	35.8	19.4
Depth, molded	(m)	22.6	11.2
Draught, full load	(m)	13.0	8.2

2) General/Bulk Cargo Berth

The General/Bulk Cargo Berth has been designed for a maximum ship size of 30,000 DWT. The major ship characteristics are as indicated below.

General/Bulk Cargo Vessel		30,000 DWT
Length, overall	(m)	186.0
Breadth, molded	(m)	27.1
Depth, molded	(m)	15.2
Draught, full load	(m)	10.9

3) Oil Bunkering Berth

The principal characteristics of the oil tankers considered for design purposes are as follows:

Oil Tanker		5,000 DWT
Length, overall	(m)	104.0
Breadth, molded	(m)	16.2
Depth, molded	(m)	7.8
Draught, full load	(m)	6.5

(8) Crown Height of Quays

Basically, the following crown heights, the same as for the existing quays in the Port, are taken for the proposed quays. For quays with a depth alongside of -7.5m or more: +8.25 ft (+2.5m).

(9) Surcharge on Quay Faceline

The surcharge load considered is in principle 1.5 tons/m^2 (uniformly distributed load).

Special cargo handling vehicles and crane wheel loads has been considered where appropriate.

3-2 Preliminary Design

(1) Basic Plans of Port Facilities

Preliminary designs have been undertaken with respect to the following port facilities proposed under the Plan.

Proposed Port Facilities

Facilities	Length (m)	Depth (m)
1) Breakwater		
- Southwest	1,200	Existing Water Depth
- East	250	Alongside
2) Container Berths*	350	-14.0
3) Feeder Berth	170	- 9.0
4) General/Bulk Cargo Berth	240	-12.0
		(-14.0)
5) Oil Berth	120	- 7.5
6) Transitional part	40	-14.0
7) Revetment on south side	250	Existing Water Depth
8) Revetment on north side	230	Existing Water Depth

Notes:

① Figure in brackets indicate the design depths alongside the quays.

② The berth marked with the Asterisk (*) is to be equipped with a crane.

(2) Structural Type of Breakwater

In selecting an optimum structural type for the proposed breakwater, due consideration was given to the following points:

1) Design wave of 50-year return period with the following characteristics:

H1/3 : 5.1

T : 9.5 sec

Direction : W - S

2) Bottom Characteristics;

3) Need to avoid monsoon seasons for the breakwater construction;

4) Necessity of providing a caisson fabrication yard;

5) Need for temporary storage of completed concrete caissons at sea;
6) Required time for the construction of caisson foundations;
7) Need to minimizing possible reexecution of any part of the foundation and armoring works;
8) Need to minimize permeability through voids between blocks;
9) Need for providing an armor stone storage yard and concrete block fabrication yard
10) Need for maximum utilization of local materials; and
11) Structural soundness from the economical point of view

In view of the critical time and cost factors, 10 structural types have been evaluated on their merits and demerits, and the rubble mound type with concrete block protection has been finally selected.

The main features of the final section of the proposed breakwater structure are as follows:

1) Armor stones will form the core of the structure.
2) The breakwater height of +5.0M is determined on the basis of the High Water Level plus 60% of H1/3 and an additional height is provided by 4 to 6-ton armor stones in place of armor concrete blocks on the harbour side.
3) That part of the breakwater lying between the level of -8.0 m and the crest will be covered with 16-ton concrete blocks on the seaward slope due to the non-availability of local stones of 6 tons or more which can be used for armoring.
4) The tip of the breakwater will be reinforced with 25-ton concrete blocks. A light beacon will be installed at the tip of the Southwest and East Breakwers.

Since approximately 80% of the total length of the Southwest Breakwater will be located on the existing rocky ground and the rest of the structure will be underlain by thin layers of sandy soils, it is not necessary to improve its subsoils foundation.

Unlike the Southwest Breakwater, the East Breakwater will require soil improvement by replacing the sandy soils with appropriate material as indicated in Figs. 3-2-1 and 3-2-2.

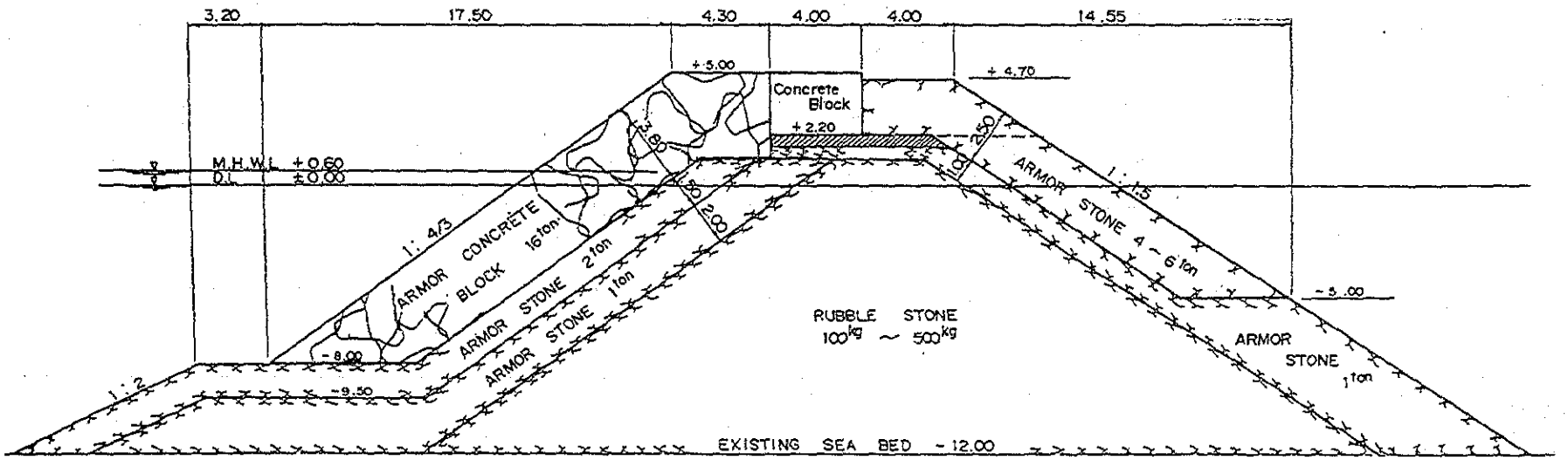


Fig. 3-2-1 Typical Cross Section of Southwest Breakwater

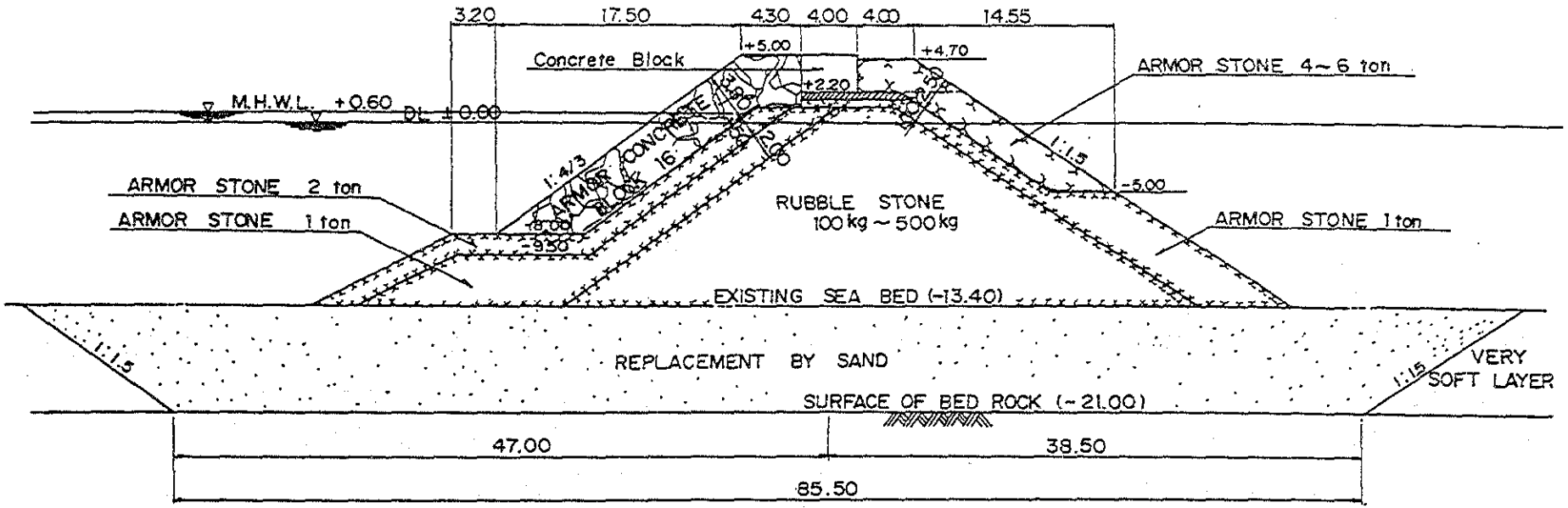


Fig. 3-2-2 Typical Cross Section of East Breakwater

(3) Selection of Structural Type for Quays

The quay structures have been selected by considering such factors as stability, influence on the environment, construction cost and time, ease of maintenance and repairs based on the design conditions.

The following factors were taken into consideration in choosing between the Gravity Type of Quay and Open Type Quay supported on Vertical Piles for the proposed quay structures.

① Availability of a solid foundation in relatively shallow areas -10 m to -20 m deep where the quay line is proposed.

② Where the gneiss formation is deeper than the design level, soft marine clays must be dredged and replaced.

③ No more material of medium stiffness is found between the soft marine clays and the gneiss layer.

④ Earthquakes need not be considered.

With due regard for the site conditions, a gravity type of quay structure has been selected.

Among such gravity type quay structures as the caisson type, cellular concrete block type, and cast-in place concrete type, the caisson type quay is considered most suitable in terms of the site conditions, construction cost, and construction time.

1) Container Berth

Figs. 3-2-3 and 3-2-4 illustrate the typical cross sections of the container berth. The quay will be of a caisson type structure of 10.0 m in width and will have seaward container rails on its apron. The landward crane rails will be laid on the part of the apron supported on vertical steel piles as its foundation.

2) Feeder Berth

The feeder berth will be built at right angles to the face line of the container berth. The feeder berth will be a caisson-supported structure of 5.8 m in width and will have no container crane installation. The caisson foundation will be constructed on the same concept as the container berth. The typical cross section of the feeder berth is shown in Fig. 3-2-5.

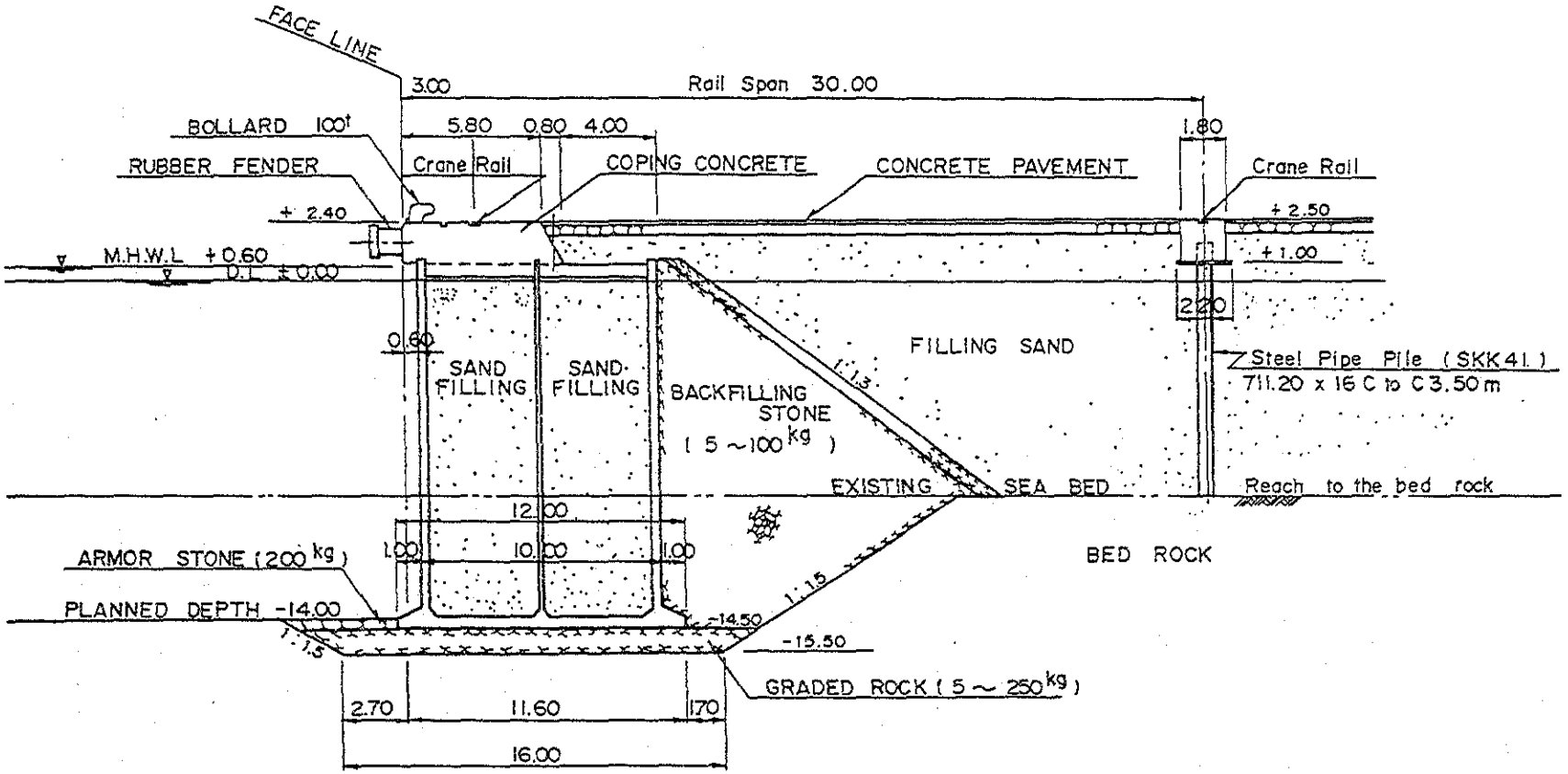


Fig. 3-2-3 Typical Cross Section of Container Berth
(Excavation of Bed Rock)

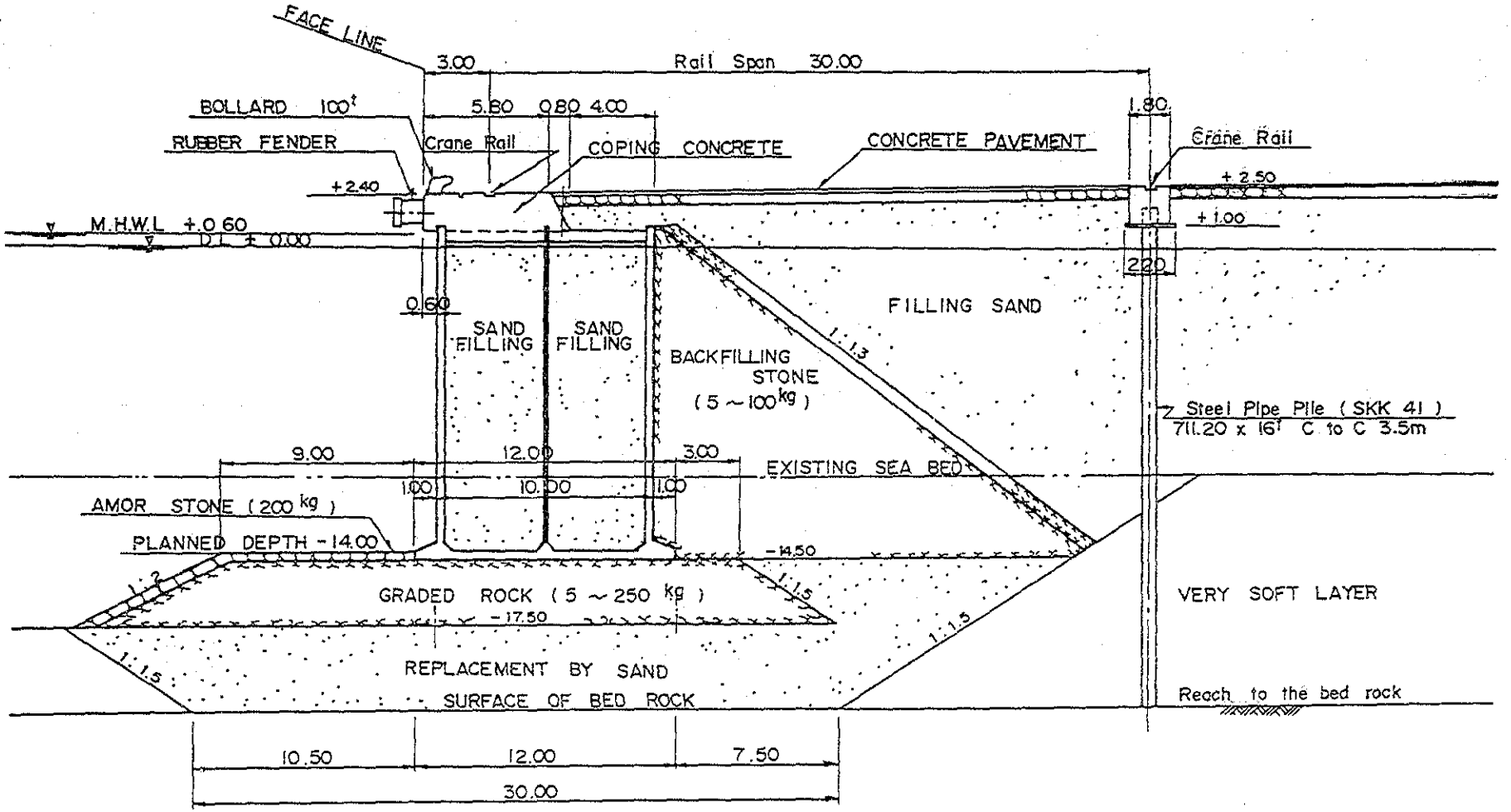


Fig. 3-2-4 Typical Cross Section of Container Berth
(Replacement by Sand)

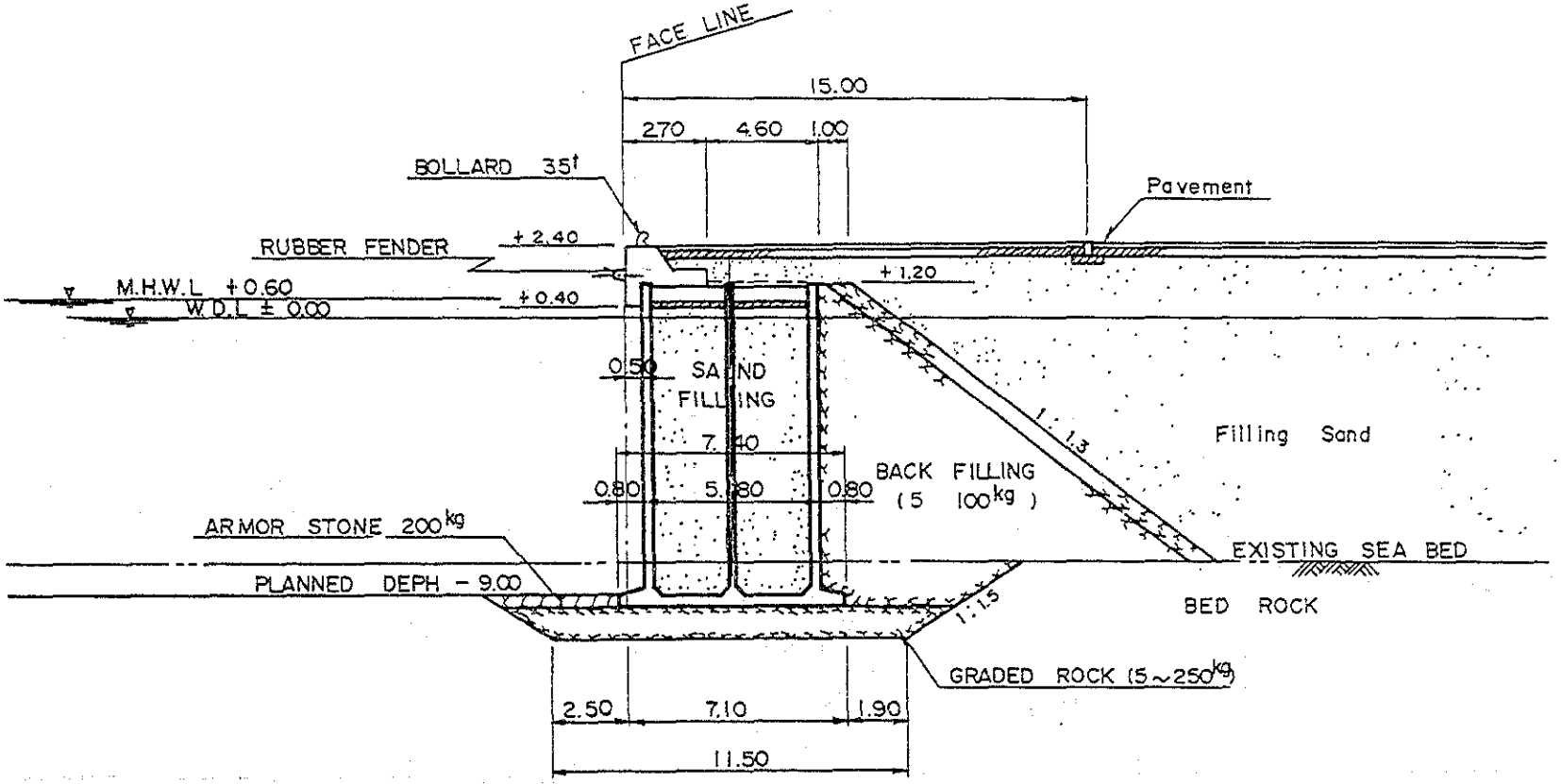


Fig. 3-2-5 Typical Cross Section of Feeder Berth

3) General/Bulk Cargo Berth

The general/bulk cargo berth shall be a caisson-supported structure of 10.0 m in width. A quay crane is not intended to be constructed under the Short Term Plan, but the design of the berth provides for sufficient strength to enable the crane to be installed in future according to the Master Plan. Fig. 3-2-6 shows the typical cross section of the general/bulk cargo berth.

4) Oil Bunkering Berth

The oil bunkering berth is planned at the north of the existing South Breakwater (inside the old harbour area). It will be of a gravity type dolphin structure consisting of a working platform, breasting dolphin, two mooring dolphins, catwalk and pipe supporting bridges. Fig. 3-2-7 shows the typical cross section of the oil bunkering berth.

5) Transitional Part

The 40-m transitional portion linking the container berth and the general/bulk cargo berth will have the same structure as the general cargo berth.

6) Revetment for Reclaimed Area

A rubble mound structure has been chosen for the revetment for the reclaimed area to meet the following requirements;

a) Reliability in protecting the reclaimed area against waves and surging storm;
b) Ensuring greater stability of the structure against other external forces; and
c) prevention of possible outflow of filling materials from the reclamied area.

Fig. 3-2-8 shows the typical cross section of the revetment.

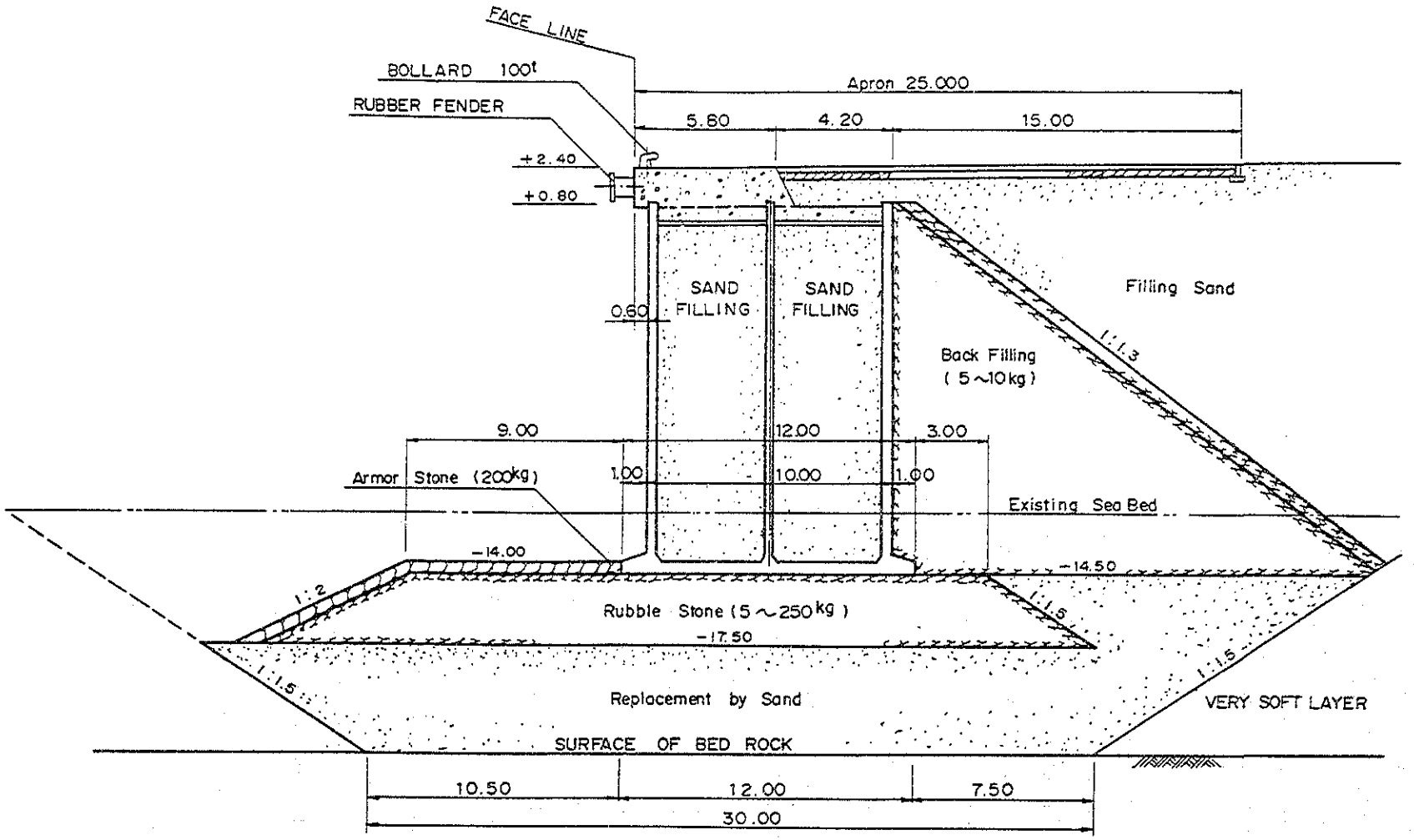


Fig. 3-2-6 Typical Cross Section of General/Bulk Cargo Berth

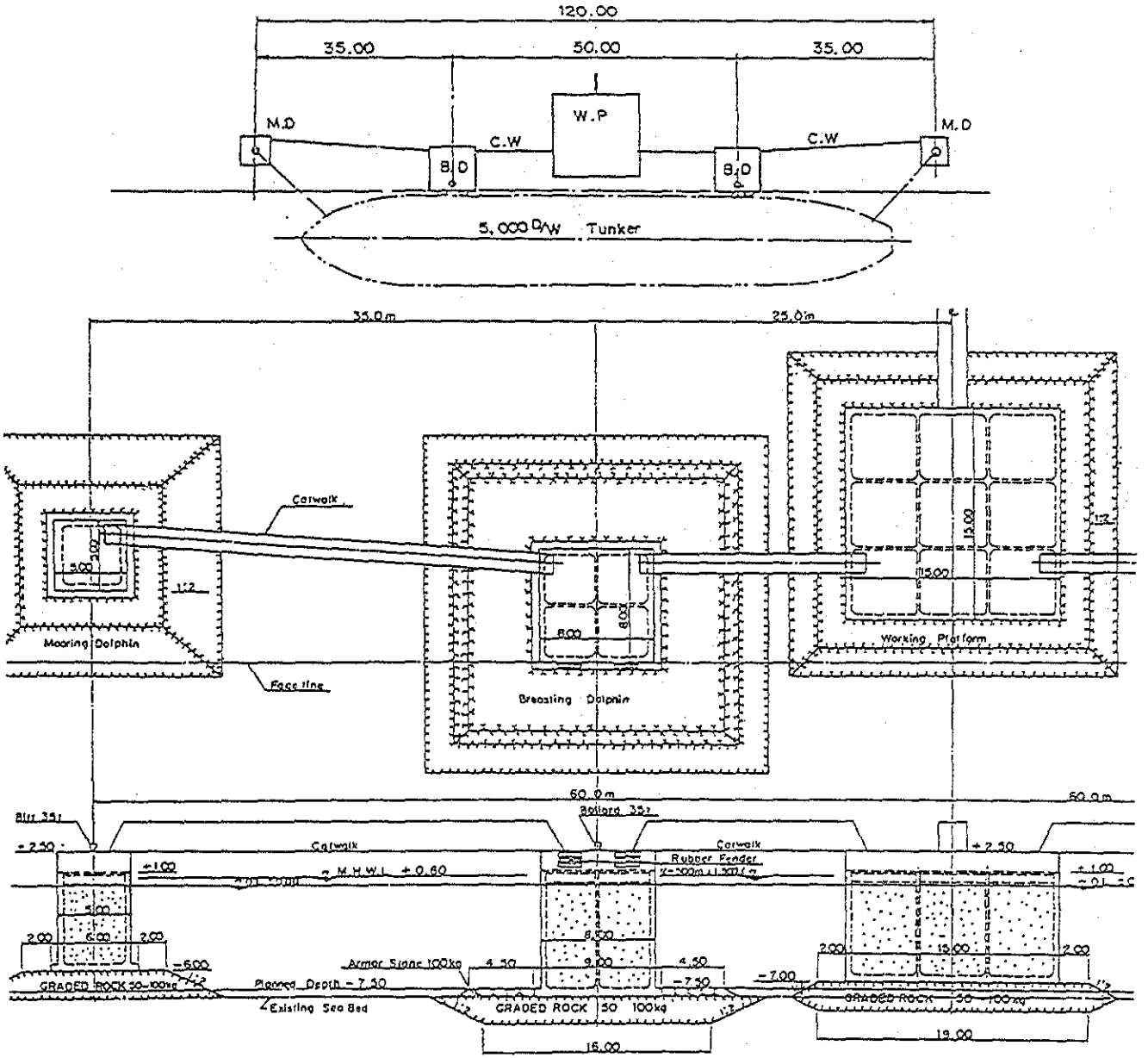
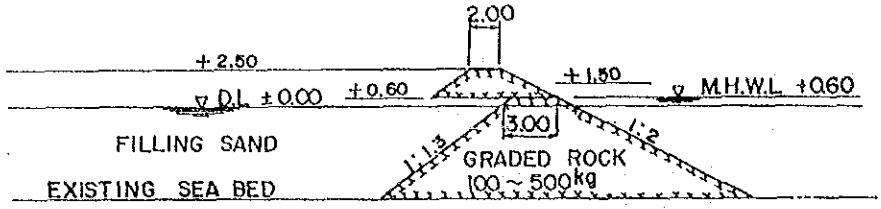


Fig. 3-2-7 Plan and Cross Section of Oil Berth

North Side



South Side

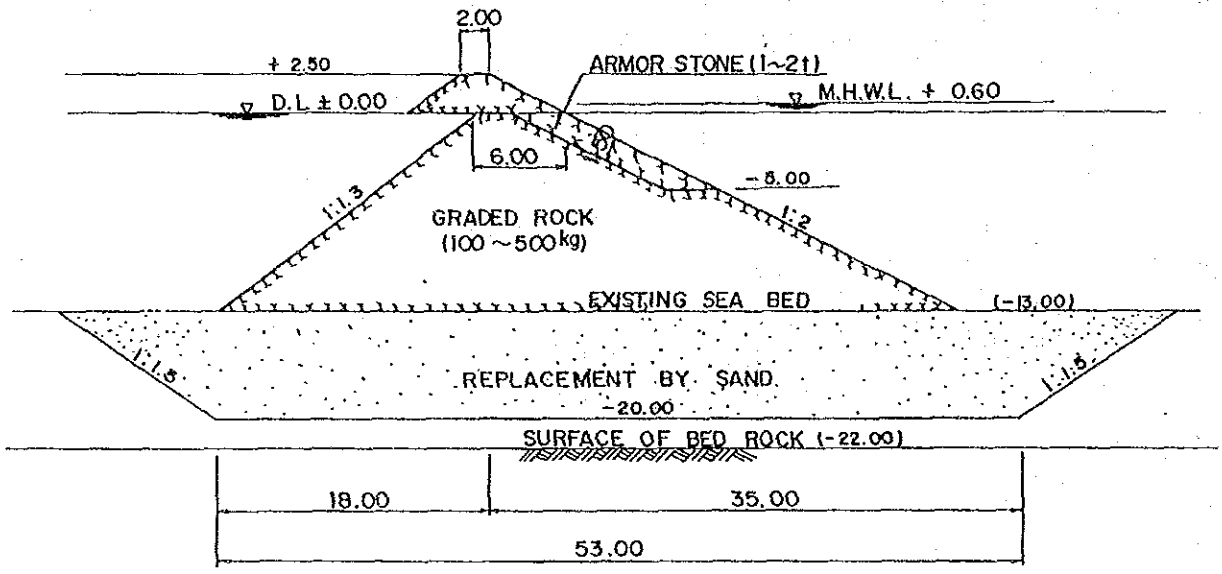


Fig. 3-2-8 Typical Cross Section of Revetment

4 IMPLEMENTATION PROGRAM AND COST ESTIMATION

4-1 Implementation Program

4-1-1 Construction Schedule

The construction schedule for the Short Term Construction Plan is described below in brief. Fig. 4-1-1 provides a detailed explanation of the time schedule of construction.

(1) Construction of the Southwest Breakwater and the East Breakwater with a length of 1,200 m and 250 m, respectively, is a key element of the development of the Port of Galle. The port open to the south will be exposed to swells. High rough waves invade the port particularly during the southwest Monsoon Season lasting from May to September.

The breakwaters are intended to secure a sufficiently large calm port area so as to allow the construction of the project facilities within the area.

The Southwest Breakwater will take a longer construction time. The construction will start in early 1993 and will be completed in late 1997, approximately one year after the completion of the other port facilities.

The East Breakwater needs early completion since several port facilities are planned to be constructed at its back. The construction of this breakwater is, therefore, required to start in early 1993 to ensure the scheduled completion in early 1995.

(2) In the dredging of the approach channel and the port basin, soils must first be excavated and then rock excavation will follow. The dredging works is to commence at the end of 1993 and to be completed at the end of 1996.

(3) Construction of the South Revetment behind the East Breakwater will start in late 1993 and is scheduled for completion in late 1994.

The construction of the North Revetment is scheduled for commencement in mid-1994 and for completion in mid-1995.

(4) The time available for dredging in a year is estimated at seven (7) months, that is, from January to April and October to December. Therefore, the reclamation work will be executed in three different periods, that is, from october 1993 through April 1994, from October 1994 through April 1995 and finally from October 1995 to January 1996.

(5) Construction of the general/bulk cargo berth including the transitional part is to start at the beginning of May 1994 and to be completed at the end of 1995.

(6) Construction of the container berth will commence two months after the work on the general/bulk cargo berth is started. The container berth is planned for completion at the end of October 1996.

The feeder berth construction, scheduled to start in March 1996, must be completed by the end of 1996 so as to come into service at the beginning of 1997.

(7) Construction of the oil berth can take place independently of the other project facilities, because its construction site is located at the back of the existing Breakwater. The construction will start in March 1996 and will be completed by the end of the same year so as to be in time for the commissioning of the entire project facilities in early 1997.

(8) The paving works for the container yard and the roads will start in 1995 with completion scheduled for late 1996. The bridge construction is scheduled to commence in early 1996 with its completion expected at the end of October of the same year.

(9) Navigation aids are to be installed by the end of 1996.

(10) The building works, including the Administration Building, Transit Shed, Maintenance Shop, CFS and container cleaning facility, will be started in late 1995 and completed in 1996.

(11) The utility works comprising water and electric supply facilities and the computer system for cargo handling operations will be constructed

Description	Quantity	
1. Temporary Works	1	Sum
2. Dredging	1,585,000	m^3
3. Breakwater	1,450	m
4. Container Berth (-14.0M)	350	〃
5. Feeder Berth (-9.0M)	170	〃
6. General/Bulk Cargo Berth (-12.0M)	280	〃
7. Oil Berth (-7.5M)	120	〃
8. Revetment	480	〃
9. Reclamation	2,530,000	m^3
10. Pavement	283,000	m^2
11. Navigation Aids	1	Sum
12. Administration Building	800	m^2
13. Transit Shed	4,000	〃
14. Maintenance Shop	1,000	〃
15. C.F.S.	2,025	〃
16. Cleaning Facilities	400	〃
17. Utilities	1	Sum
18. Procurement of Equipment	1	〃
19. Procurement of Port Service Vessels	1	〃
21. Engineering Services	1	Sum

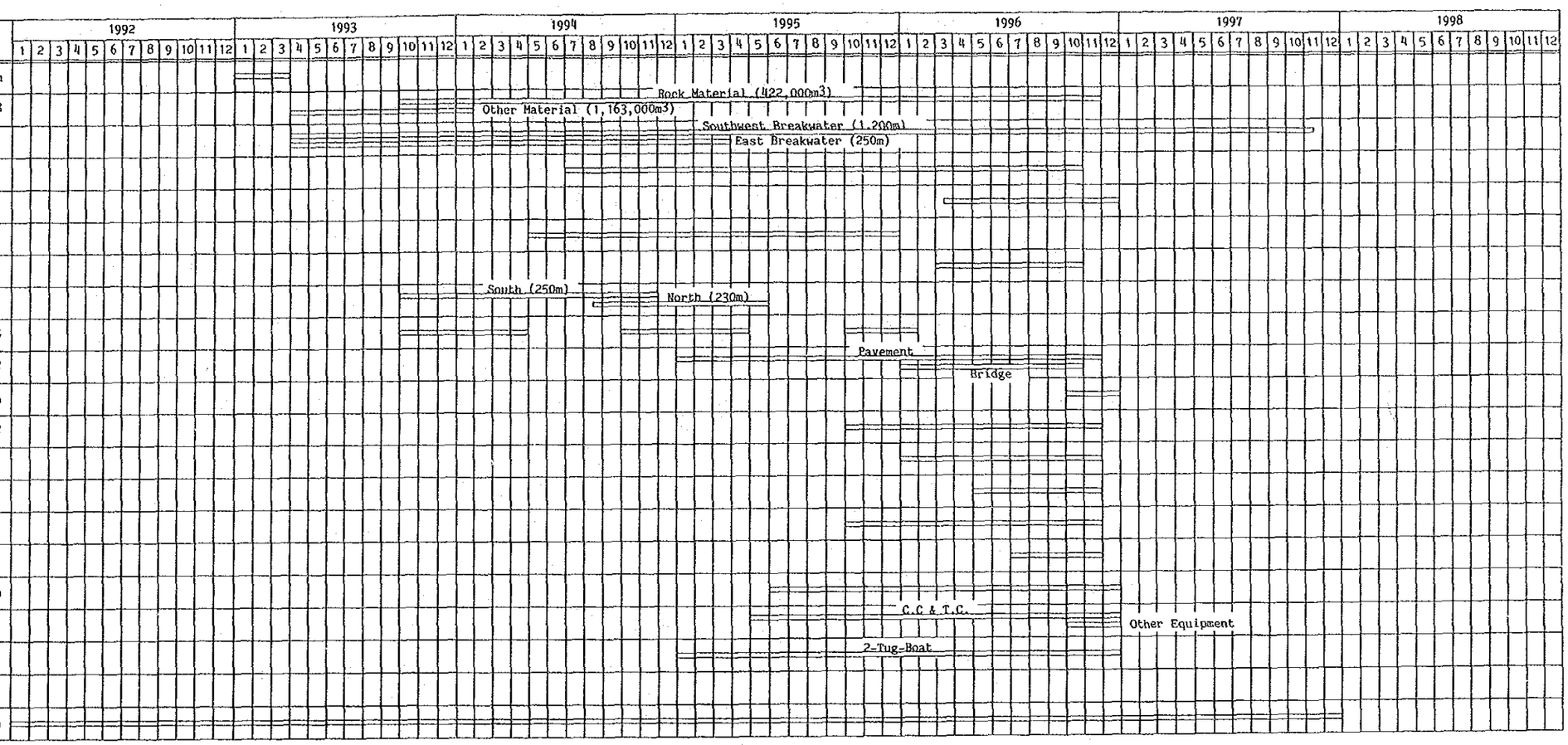


Fig. 4-1-1 Construction Schedule of Short Term Plan

between mid-1995 and the end of 1996.

(12) The cargo handling equipment and port service vessels will be procured by the end of 1996.

4-1-2 Project Site

The Short Term Plan calls for the construction of a variety of port facilities and involves a very tight construction schedule.

At present, the Port of Galle has a certain amount of unused land space other than land lots for office buildings. The existing quay has a design depth of -8.85 m and a design length of 426.7 m with an apron 15.2 m wide. Viewed in the light of the fact that only a total of 78 ships with an average deadweight tonnage of 2,130 called at the port during 1989, the existing quay may be said to be under utilized, although its tip has been partially damaged.

For the construction of the project facilities, land spaces will have to be secured for such construction facilities as a field office, concrete plants, material storage area, and fabrication yards for concrete blocks and armour blocks. Some of the land space requirements can be met by the reclamation works. Adequate land spaces will have to be secured for such works as the breakwater and revetment construction which must be started in the early stage of the project construction.

A temporary storage area for stones can be obtained by temporary reclamation of approximately 17,000 m^2 of area at the mouth of the Waggal Modera Ela River. This storage area requires a temporary jetty of 100 m in length and an access road of 420 m in length and 15 m in width.

The volume of stones required for offshore works is as follows:

Net Volume of Stones Required

Offshore Works	Volume of Stones
Breakwater	860,500 m^3
Revetment	117,100 m^3
Quays	45,000 m^3
Total	1,022,600 m^3

The actual volumes of stones required will be increased to approximately 1,200,000 m^3 when losses due to slippage to subsoils and washing by waves are taken into accounts.

A space of 2,500 m^2 for a concrete batching plant will have to be secured by utilizing the unused land at the back of the quay. Part of the unused land and the damaged tip of the quay after repairs will be used for the fabrication and storage of conerete blocks. The storage area for concrete blocks will need approximately 10,000 m^2. tabulated below are the quantities of armour concrete blocks and concrete blocks required.

Quantity of Blocks Required for
Breakwater Construction

Item	Quantity
Armour concrete blocks 16 tons	10,700 pcs.
Armour concrete blocks 25 tons	500 pcs.
Coping concrete blocks 25 tons	1,460 pcs.

Unused land inside the port area will be used for the contractor's site office and for the installation of construction plants.

A floating dock in the 5,000-ton class will be utilized for fabricating concrete caissons to be incorporated into the quay structure. The floating dock will be moored within the calm port area in such manner as to avoid interference with the movements of other vessels.

4-1-3 Construction of Breakwater

The construction methods to be employed for the project construction will not vary very widely from the those adopted in the Jaye Container Terminal Project insofar as the works are performed within calm water areas.

The construction works on the breakwater in Port of Galle. however, will have to be carried out in the open sea under an extraordinarily severe marine weather conditions and the influence of waves on the works will not be negligible.

The following description has relevance to the breakwater

construction.

Looking toward the Indian Ocean, Galle Bay is exposed to southerly swells more than 0.5 meter high all the year round. Moreover, wind waves of 1.5 m or more in height reach the bay from S to SW directions during the five southwest monsoon months of May to September.

Wind speeds of 10 m/sec or more and significant wave heights of 0.3 to 0.5 m or more are generally considered critical physical conditions which render harbour works and other marine construction activities impractical. By this standard, the proposed breakwater works in Galle Port will be affected to a greater or lesser degree throughout the year.

The numbers of days available for construction operations as determined on the basis of wave heights in and around the port are as indicated in Table 4-1-1. In this table, the wave heights of less than 1.5 m are considered to permit construction activities to be carried out, though with reduced efficiency, without interruptions.

The available days in the tabulation are for offshore or coastal construction operations. For shore works the number of available days is assumed to be increased by nearly 80 days, which may vary depending on the type of work.

Table 4-1-1 Available Working Days

Season		Wave Height				Available Working Days
		~ 0.49 m	0.5 m ~ 0.99 m	1.0 m ~ 1.49 m	1.5 m ~	
Month	Total Days	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Total Ⓐ~Ⓒ
March - April	61	-	15 days (24.6%)	34 days (55.7%)	12 days (18.5%)	49 days (810.3%)
May - September	153	-	-	4 days (2.6%)	149 days (97.4%)	4 days (2.6%)
October - November	61	-	9 days (14.8%)	27 days (44.3%)	25 days (40.9%)	36 days (59.0%)
December - February	90	-	43 days (47.8%)	45 days (50.0%)	2 days (2.2%)	88 days (97.8%)
Total	365	-	67 days (18.4%)	110 days (30.1%)	188 days (51.5%)	177 days (48.5%)

The structural type of the breakwaters and construction method adopted Table 4-1-1, are typical and prevalent in the world. As can be seen from the weather at the sea is quite inclement. The depth at the sites of the breakwater construction is substantial and the construction works are expected to be massive.

The major construction materials for the breakwater construction include stones and concrete blocks, all of which will have to be transported from the stock yard onshore for incorporation into the construction works.

Instead of joint operation of plural working crafts, operation of a singles barge is planned to minimize idle time due to high waves. One unit each of floating crane and rock barge will be used for placing concrete blocks and stones.

The Southwest Breakwater construction will experience five monsoon seasons throughout the construction period, while the works on the East Breakwater will undergo two monsoons during the construction. Protection and reinforcement works on the tips of the structures are to be executed before the monsoon seasons come in order to avoid damage. Offshore works during the monsoon seasons are impossible at the sections where high waves strike the structures directly. On the other hand, works are likely to make good headway within the relatively calm inner harbour.

4-2 Cost Estimation

4-2-1 The unit prices and rates for calculation of construction cost in respect of labor, equipment, plant and materials are obtained through Feasibility Studies Which were conducted during the first filed survey in October 1990 and the third field survey in May 1991.

(1) The construction cost is broken-down into foreign and local currency portions at the exchange rate of US$ 1.00 = Rs 41.00 = ¥ 138.85 quoted during the Third Filed Survey.

(2) The import duties assessable on materials, equipment and plant to be imported into Sri Lanka are not included in the cost estimates.

(3) The transaction tax (BTT) to be levied on materials and fuels obtainable from local sources is not included in the cost estimates.

(4) The contract tax considered in the cost estimates is as follows:

Construction and procurement cost	3%
Engineering Services	5%

(5) Physical Contingency of 6% is included in the construction cost except for the costs of container handling equipment and engineering services. No price escalation is considered in the cost estimate.

4-2-2 Estimation of Cost

(1) Basic prices and Capacity for material and Labor Supply

In addition to a survey on prices and rates for locally available labor, fuels and materials, an investigation was undertaken with particular reference to the recent development projects in Sri Lanka to determine the supply capacities of these items.

Reserves and production capacities of the major construction materials are outlined below.

1) Stone

Rubble stone of 100 to 500 kg apiece and armor stone of 1 to 6 tons are obtainable from a private-owned quarry in the vicinity of Galle Port. The deposits of the quarry are sufficient, but the production capacity at the moment is still limited. Consequently, the contractor for this project may have to invest a substantial sum of money and mobilize appropriate equipment to exploit the quarry by paying a royalty to the quarry owner to obtain the stones necessary for the execution of the works.

2) Aggregate for concrete

Quarry-run will be used for coarse aggregates, since gravel from the rivers is not sufficiently obtainable to satisfy the huge demand in the construction industry.

River sand can be used for fine aggregates, but authorized firms

only are allowed access to the sources to excavate sand. Such restraints are intended to preserve the river bed.

3) Cement

Clinker, a major raw material used at a cement factory located immediately behind the Port of Galle, is imported from Middle East countries. The clinker constitutes the greater part of the cargo volume handled at the Port.

The volume of cement necessary for the construction of the project facilities can be procured within the country even when the volume of cement consumed by other projects is taken into account.

4) Steel

Despite the fact that Ceylon Steel Corporation produces such steel products as bars, flat bars, binding wires, barbed wires and nails, the major steel materials to be incorporated in the project will have to be imported.

5) Material for Reclamation

For reclamation works of the Project, fill materials will be obtained from seabed or river. The excavation of such fill material must be approved well in advance by the Coast Conservation Department.

6) Concrete Products

Standardized concrete products, such as hume pipes for drainage and concrete intended for kerbs, gutters and lamp posts are to be provided by the State Development and Construction Corporation.

Listed in Table 4-2-1 and 4-2-2 are the current market rates for labour, fuels and materials.

Table 4-2-1 Unit Cost of Local Worker and Fuels

(Unit: Rs.)

Item	Unit Cost	
Worker (per day) :	Basic Wage	Working Wage
Unskilled	90	175
Skilled	120	230
Foreman	225	440
Carpenter	160	310
Bar Bender	140	270
Welder	140	270
Surveyor	300	600
Mechanics	140	270
Driver	120	230
Crew (High class)	300	600
Crew (Normal class)	150	300
Fuel (per liter) :	Unit Cost	
Gasoline	25	
Light Oil	11	
Heavy Oil	10.6	

Table 4-2-2 Unit Cost of Local Materials

(Unit = Rs.)

Item	Unit	Net unit cost
Sand for Reclamation	m^3	190
Stone (100 - 500 kg/pc)	m^3	370
Stone (1 - 6 tons/pc)	m^3	410
Gravel	m^3	360
Cement	Ton	4,000
Aggregate (Crusher-run)	m^3	600
Fine Aggregate (Sand)	m^3	200
Admixture	kg	76
Asphalt	kg	15.3

(2) Foreign and Local Currency Components

The direct construction cost is divided into the foreign and local currency components. The percentage distributions of the major items of equipment, materials and labour between the foreign and local currency components are indicated below.

Item	Foreign (%)	Local (%)
1. Rubble and other stones	0	100
2. Fill materials	0	100
3. Cement and admixture	0	100
4. Aggregates for concrete	0	100
5. Concrete products from local sources	0	100
6. Labour	0	100
7. Fuel and asphalt	100	0
8. Steel and reinforcing bar	100	0
9. Floating equipment	100	0
10. Construction plant and equipment	90	10
11. Formwork for concreting	70	30
12. Materials for temporary works and scaffolding	70	30

4-2-3 Project Cost

The construction cost for the Short Term Plan is given in Table 4-2-3 and 4-2-4.

The total construction cost for the Short Term Plan amounts to US$ 334,612,000 broken down into US$ 245,291,000 for the foreign currency component and US$ 89,321,000 for the local currency component.

Table 4-2-5 gives the annual investment plan extending from 1992 to 1997.

Table 4-2-3 Construction Cost of Short Term Plan

Unit : Thousand US$

	Description	Quantity	Unit	Construction Cost			Remarks
				Foreign	Local	Total	
Construction of Civil and Building	Dredging of Rocks	210,000	m^3	10,992	3,699	14,691	Basin
		212,000	〃	11,096	3,734	14,830	Channel
	〃 Other Material	887,000	〃	4,616	416	5,032	Basin
		276,000	〃	1,436	130	1,566	Channel
	Southwest Breakwater	1,200	m	57,710	19,808	77,518	
	East Breakwater	165	〃	11,797	3,379	15,176	
	East Seawall	85	〃	4,683	1,542	6,225	
	Container Berth (-14.0M)	350	〃	17,463	8,428	25,891	
	Feeder Berth (- 9.0M)	170	〃	4,172	2,108	6,280	
	General/Bulk Cargo Berth (-12.0M)	280	〃	12,694	6,917	19,611	Including Transitionnal Part
	Oil Berth (-7.5M)	120	〃	3,135	1,290	4,425	
	Revetment	480	〃	8,800	3,788	12,588	North and South Side
	Reclamation (Yard and Road)	2,530,000	m^3	19,371	2,747	22,118	
	Pavement (Yard and Road)	283,000	m^2	11,794	7,378	19,172	
	Bridge	60	m	1,684	718	2,402	
	Navigation Aids	1	Sum	494	198	692	
	Administration Building	800	m^2	182	738	920	
	Transit Shed	4,000	〃	310	1,734	2,044	
	Maintenance Shop	1,000	〃	112	635	747	
	C.F.S.	2,025	〃	205	819	1,024	
	Cleaning Facilities	400	〃	37	212	249	
	Utilities (Water Supply)	1	Sum	2,350	265	2,615	
	〃 (Electric Supply Computer System)	1	〃	5,485	619	6,104	
	Sub-Total (1)			190,618	71,302	261,920	
Procurement	Container Cargo Handling Equipment	1	Sum	22,514	-	22,514	
	Cargo Handling Equipment for General/Bulk Cargo Berth	1	〃	886	86	972	
	For Oil Berth	1	〃	117	13	130	
	Port Service Vessels (Tugboat)	1	〃	6,482	-	6,482	
	Sub-Total (2)			29,999	99	30,098	
	Total (1) + (2)			220,617	71,401	292,018	
	Engineering Service	1	Sum	13,237	3,570	16,807	Foreign 6% Local 5%
	Physical Contingency	Sub-Total (1) × 6%		11,437	4,278	15,715	
	Tax				10,072	10,072	Construciton & Procurement 3% E/S 5%
	Grand Total			245,291	89,321	334,612	

Table 4-2-4 Breakdown of Procurement Cost of Equipment and Vessels

Unit : Thousand US$

Description	Quantity	Unit	Procurement Cost			Remarks
			Foreign	Local	Total	
1. Navigation Aids			494	198	692	
Light Beacon	4	Nos.	200	81	281	
Light Guide	2	〃	14	4	18	
Light Buoy	12	〃	280	113	393	
2. Container Cargo Equipment			22,514		22,514	
Container Crane	2	Nos.	12,963		12,963	
Transfer Crane	5	〃	6,122		6,122	
Top Lifter (40ton)	2	〃	1,005		1,005	
Tractor-Trailer	14	〃	2,017		2,017	
Tractor	1	No.	119		119	
Trailer	10	Nos.	252		252	
Forklift (2ton)	2	〃	36		36	
3. General/Bulk Cargo Berth			886	86	972	
Fork Lift (3ton)			237		237	
Packer and Hopper			347	86	433	
Trucks (10ton)			302		302	
4. For Oil Berth			117	13	130	

Table 4-2-5 Annual Investiment Plan (Short Term)

(Unit : 1000 US$)

Description	1992			1993			1994			1995			1996			1997			Total		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
I. Civil and Building																					
1. Dredging for Basin				5,022	666	5,688	3,933	1,210	5,143	3,471	1,168	4,639	3,182	1,071	4,253				15,608	4,115	19,723
2. Dredging for Channel				2,169	412	2,581	3,647	1,192	4,839	3,504	1,179	4,683	3,212	1,081	4,293				12,532	3,864	16,396
3. Southwest Breakwater				9,358	3,212	12,570	12,478	4,283	16,761	12,478	4,283	16,761	12,478	4,283	16,761	10,918	3,747	14,665	57,710	19,808	77,518
4. East Breakwater				737	211	948	8,848	2,534	11,382	2,212	634	2,846							11,797	3,379	15,176
5. East Seawall				4,683	1,542	6,225													4,683	1,542	6,225
6. Container Berth (-14.0M)							3,742	1,806	5,548	7,484	3,612	11,096	6,237	3,010	9,247				17,463	8,428	25,891
7. Feeder Berth(-9.0M)													4,172	2,108	6,280				4,172	2,108	6,280
8. General/Bulk Cargo Berth (-12.0M)							5,078	2,767	7,845	7,616	4,150	11,766							12,694	6,917	19,611
9. Oil Berth (-7.5M)													3,135	1,290	4,425				3,135	1,290	4,425
10. Revetment				1,727	673	2,400	6,682	2,775	9,457	391	340	731							8,800	3,788	12,588
11. Reclamation (Yard and Road)				3,229	458	3,687	7,533	1,068	8,601	7,533	1,068	8,601	1,076	153	1,229				19,371	2,747	22,188
12. Pavement (Yard and Road)										6,153	3,849	10,002	5,641	3,529	9,170				11,794	7,378	19,172
13. Bridge													1,684	718	2,402				1,684	718	2,402
14. Navigation Aids													494	198	692				494	198	692
15. Administration Building										39	158	197	143	580	723				182	738	920
16. Transit Shed													310	1,734	2,044				310	1,734	2,044
17. Maintenance Shop													112	635	747				112	635	747
18. C.F.S.										44	176	220	161	643	804				205	819	1,024
19. Cleaning Facilities													37	212	249				37	212	249
20. Utilities (Water Supply)										866	98	964	1,484	167	1,651				2,350	265	2,615
21. Utilities (Electric & Computer)										2,021	228	2,249	3,464	391	3,855				5,485	619	6,104
Sub-Total (1)				26,925	7,174	34,099	51,941	17,635	69,576	53,812	20,943	74,755	47,022	21,803	68,825	10,918	3,747	14,665	190,618	71,302	261,920
II. Procurement of Equipment and Vessels																					
22. Container Cargo Equipment																					
Container Crane & Transfer Crane										7,634		7,634	11,451		11,451				19,085	-	19,085
Other Equipment													3,429		3,429				3,429	-	3,429
23. General/Bulk Cargo Berth													886	86	972				886	86	972
24. For Oil Berth													117	13	130				117	13	130
25. Port Service Vessel										3,241		3,241	3,241		3,241				6,482	-	6,482
Sub-Total (2)										10,875		10,875	19,124	99	19,223				29,999	99	30,098
Sub-Total (1) + (2)				26,925	7,174	34,099	51,941	17,635	69,576	64,687	20,943	85,630	66,146	21,902	88,048	10,918	3,747	14,665	220,619	71,401	292,018
26. Engineering Service	3,310	893	4,203	2,206	595	2,801	2,206	595	2,801	2,206	595	2,801	2,206	595	2,801	1,103	297	1,400	13,237	3,570	16,807
27. Physical Contingency				1,616	430	2,046	3,116	1,058	4,174	3,229	1,257	4,486	2,821	1,308	4,129	655	225	880	11,437	4,278	15,715
28. Tax		210	210		1,224	1,224		2,353	2,353		2,844	2,844		2,905	2,905		536	536		10,072	10,072
Grand Total	3,310	1,103	4,413	30,747	9,423	40,170	57,263	21,641	78,904	70,122	25,639	95,761	71,173	26,710	97,883	12,676	4,805	17,481	245,291	89,321	334,612

5 MANAGEMENT AND OPERATION PROGRAM

5-1 Funds for Constructing the Port

In general, fundamental facilities or infrastructures such as port facilities, transport facilities and so on are often constructed with subsidies from the government, as these facilities are generally used by the public at large. And as the development of an infrastructure generally requires substantial investment and often takes a long time to recover these investments, the government and public organizations have responsibilities regarding the development of an infrastructure.

On the other hand, some functional facilities such as cargo handling equipment are sometimes provided by the actual operators.

Often, in the initial stages of an infrastructure project except for port development project, the adoption of the B.O.T. (Build, Operate and Transfer) model is sometimes considered and executed. But in the case of the port development project, though the B.O.T. model is opted for in some countries, the construction has not yet commenced because there are many unresolved questions to be solved. The team will examine the feasibility of applying the B.O.T. model to the Galle Port project for the short-term plan.

5-2 Outline of the B.O.T. Model

The principles of the B.O.T. model are summarized as follows:

In the broadest terms, the build-operate-transfer model states that an international consortium bidding on a project shall design the project, raise and secure funding for the construction, construct, own, manage and maintain the project with the host government's guarantees to take the products of the plan during a given period of say 10-15 years. At this point, the prices of product and/or services throughout the said period will be decided at a level sufficient to cover debt service, operation and

maintenance costs and to provide a return on equity to attract investors. At the end of the term, when all the project's loans have been paid and equity capital has been repatriated, ownership of the project will transfer to the host government without charge. An appropriate representative of the host country will be permitted to invest a fixed percentage of the equity of the joint venture in order to acquire and operate the project. The project must be completed under a turnkey fixed price contract. Force majeure risks during the construction and operation of the project are borne by the host government. Payment for the products and/or services will be made in foreign currency, using the same basket currencies with which the project is financed.

We will examine the possibility of applying the B.O.T. model to this project in the next section, as well as taking other models into account.

5-3 Classifications of the Port Management and Operation Model

The following three models offer different solutions to the problems of port construction, management and operation:

- Public Autonomy Model

In this model, the SLPA constructs, manages and operates the port facilities and activities, much as in the present system.

- Lease Model

The SLPA constructs the port facilities. The SLPA leases the port facilities to the private company or the joint venture of the government organization and private companies. The lessee manages and operates the port facilities and activities.

There are three basic types of leases: flat rate, mini-max rate and shared revenue.

- B.O.T. Model

The private company or the joint venture is responsible for

all facets of the project, the construction, management and operation necessary for port activities.

As the mode of model moves from the public autonomy model to the B.O.T. model, a higher ratio of private investment is encountered. Generally speaking, as private investment increases, the economic resources are used more efficiently, thereby improving the viability of project and the productivity of operations. In the case of the B.O.T. model, the construction costs are also added in the scope of the above judgment.

However, it is difficult to analyze quantitatively the benefits of the improved viability and productivity because the changes in the productivity of cargo handling operations and the changes of the demand forecast of cargo volume are intertwined with the private companies' economic agenda: they are designed to recover their investments, and so the precise measurements cannot be calculated.

We will describe the merits and demerits of each model for this project.

(1) Public Autonomy Model

If the productivity of operations or the cargo forecast are not changed by privatization, this model provides the maximum profit for the SLPA, as the surplus after taxes does not need to be divided among foreign companies.

Furthermore, the SLPA already has its own laborers with the technology to operate and manage the new terminal. So, if the SLPA can obtain foreign loans at a low rate of interest through the government, this model might be suited for managing and operating the new terminal.

(2) Lease Model

The advantages of the lease model are as follows:

1) Securing handling cargo volume and clients for a extended period of time.
2) Gaining the new technology of port operations and the know-how to

utilize human resources from foreign companies.

3) Improving the profitability of the project and the productivity of the operation and management through the effects of privatization.

Here, we will give a brief account of the three basic types of the lease model.

- Flat rate type

The owner(lessor) gives the user(lessee) the right to use fixed assets for a specific period of time in exchange for a fixed amount of money. The main advantage of the flat rate lease is that costs and benefits are known to both parties in advance. The flat rate lease provides the greatest incentive to the lessee to generate as much business as possible for the terminal.

- Mini-max rate type

The owner(lessor) gives the user(lessee) the right to use fixed assets for a specific period of time in exchange for a variable amount of money. There is a minimum and a maximum amount of money for the lease depending upon the amount of activity performed on the fixed asset. There is a pre-established bottom and a ceiling amount of money in the mini-max. For example, a user that leases a container terminal will pay more or less for the lease depending on the amount of cargo throughput annually.

-Shared revenue type

The owner(lessor) gives the user(lessee) the right to use fixed assets for a specific period of time in exchange for a variable amount of money. In this type of lease, there is no limit to the amount of money that the lessee can pay, even though there is a minimum amount of money that the lessee will always pay regardless of the amount of activity.

It is critical for the success of the lease model to show how the benefits gained by improving the profitability and the cargo handling efficiency are divided between the lessee and the lessor. The methods of the distribution of profits are considered three

types as above. At any rate, each method must take into account the fact that a private company is designed to make profits, therefore, it is the necessary that lease model be constructed in such a way that the potential for profit exists.

However, in the case of the Galle Project, FIRR including the construction of breakwater and channel dredging is about 2%. Therefore, the lessee cannot gain a sufficient profit without subsidies. At the very least, it is necessary to aid the construction and/or operations with incentives from the government.

At present, the SLPA already has sufficient technology to operate a container terminal, and is making efforts to operate port activities efficiently. Therefore, the lease model is of little value besides its capacity for securing clients and handling cargo volume for a extended period of time.

(3) B.O.T. Model

The merit of the B.O.T. model is that it promotes the advantages 1)-3) mentioned in the lease model. Furthermore, when it is difficult to attract investment at a national level, this model is the best choice because the SLPA does not have to raise the funds for construction. Namely, the investment risk does not have to be borne by the SLPA and the government. The construction costs also might decrease through the effects of privatization.

At any rate, the profit margin of the project must be at a level high enough to merit the investment risk that companies joining the project take.

When the viability of the project is low and it is difficult to guarantee sufficient profits, this model has many problems. In adopting the B.O.T. model, the government must offer incentives to the companies: for example, reducing initial construction costs in such a way that will satisfy the private companies, reducing taxes, and so on. These problems must be solved at the government level.

In the case of the Galle Project, because FIRR is very low, it is likely that private companies would experience difficulties in

raising funds. Therefore, incentives from the government are necessary, more so than in the case of the public autonomy model.

However, because the B.O.T. model also has an advantage in that the government does not have to raise funds for the construction of a new terminal and can instead direct its funds to other projects, the B.O.T. model is worth inviting proposals from private companies.

5-4 Choice of Port Management and Operation Model

The financial situation of the SLPA is good at present. The SLPA operates and manages all of port activities including those for the container terminal at the Port of Colombo by its own laborers. It also has a training institute which keeps the workers up-to-date with the latest technology.

Therefore, the SLPA is considered to have sufficient human resources and operating technology to manage the port activities of the Port of Galle.

Though the SLPA has a few too many laborers at present, this is not a cause for concern because the SLPA is reducing the number of laborers each year and wages are comparatively low.

Therefore, the SLPA can be regarded as the organization best equipped to handle management and operation of the new terminal. We will examine and formulate a port management and operation plan for the SLPA in the next sections.

5-5 Management and Operation Plan

5-5-1 Increment of Tariff

Because the natural conditions in the case of the Galle Project are very severe, the construction costs are extremely high. Therefore, the SLPA needs to receive government subsidies for the construction of the breakwater and for the execution of the channel dredging, and it needs to increase the charges of transshipment container cargoes handled in the

Port of Galle by 20% to secure the viability of the project. This increase can be justified as compared with tariffs of other ports. We will elaborate on this increment of charges in the chapter on financial analysis.

5-5-2 Organization

The SLPA should manage and operate new terminals in order to establish an integrated organization with the existing sections of the Port of Galle.

In creating the operating section of container cargo in the operating division of the Port of Galle, additional divisions are not necessary.

5-5-3 Required Number of the Staff

The number of staff at the Port of Galle is 755 as of 30th Sept. 1990. It is important to make the utmost use of the existing labour force.

But, when the new terminals of the Port of Galle are opened, a new staff is required.

(1) Container Berth

The required number of new staff at the main container berth and the feeder berth respectively is shown in Table 5-5-1.

It is recommended that the control room and the gate in the container berth be used both for the main and the feeder berth and operated under an integrated administration.

Table 5-5-1 The Required Number of Staff at the Container Berth

Offices	Divisions/Sections	Main Terminal	Feeder Terminal	Shifts
Head Office	General affairs, Accounting	7	-	day
	Planning of handling	10	5	day(partly night)
	Yard control center	8	4	day & night
	Container inventory	3	2	day
	Documentation of cargo delivery/receiving	12	6	day & night
Gate	Gate check	12	-	day & night
CFS	Documentation of cargo delivery/receiving	12	-	day & night
Cargo handling	Stuffing/unstuffing of containers (including operators of forklifts)	80	20	day & night
	Loading/unloading and transporting of containers (including operators of gantry cranes straddle carriers, tractors and forklifts)	52	48	day & night
Maintenance	Maintenance of equipment and containers	25	-	day(partly night)
Security	Security	38	-	day & night
Others	Others	5	-	day
Total		264	85	

(2) General/Bulk Cargo Berth

The wheat, fertilizer and clinker are mainly loaded and discharged at the general/bulk cargo berth.

The standard number of workers required for the handling of bulk cargo per gang will be shown in Table 5-5-2.

Eight gangs are required in all.

When the break bulk cargoes are loaded and discharged, workers need to be assisted by others in the existing section.

(3) Others

At the navigation section, because a couple of tug boats are added when new berths are opened, 20 workers are required in addition to the existing workers at that section.

Table 5-5-2 Formation of Gang for Handling the Bulk Cargo

			NO.OF EQUIPMENT	NO.OF OPERATORS/ LABOURERS
SHIP GEAR CRANE	OPERATOR	1/CRANE	1	1
PACKER	LABOURER	4/PACKER	3	12
TRUCK	OPERATOR	1/LOADER	3	3
FORK LIFT	OPERATOR	1/FORK LIFT	3	3
	FOREMAN	1/GANG		1
TOTAL				20/GANG

5-5-4 Operation System

(1) Working Hours and Shifts

The cargo-handling operations of the Port of Galle are performed exclusively during the day at present. As the handling cargoes increase, two twelve hour shifts should be implemented.

In particular, in the case of container cargoes, two 12-hour shifts should be performed as in the operation system at the Port of Colombo. Finally, dividing the operation system into three shifts should be considered to maintain and improve services to port users in the future.

(2) Stevedoring Method at the Feeder Berth

The stevedoring at the feeder berth should be performed by the ship gear crane. The latest technological advances in the ship gear crane allows it to execute the stevedoring in an efficient fashion.

5-5-5 Computer System

Generally speaking, a computer-based container handling system should be introduced when cargo volume of a container terminal exceeds

60,000 TEUs per year. According to the demand forecast, the cargo volume will exceed 60,000 TEUs soon after the completion of the container berth. Therefore, the installation of a computer handling system is needed not only to efficiently utilize the terminal facilities but also to meet the port user demand.

There are excellent computers in the Port of Colombo at present. In addition, the SLPA has an improvement plan to upgrade the computer system. Moreover, the present computer system has free capacity of 30% in its memory bank. Therefore, in order to make use of the computer system in the Port of Colombo and to manage the container inventory under integrated system, the terminal units should be installed in the Port of Galle and be connected with the main computer in the Port of Colombo. However, because telephone lines are very poor, the terminal units should be connected with the main computer by a radio line. Facilities necessary for radio communication should be built.

5-6 Recommendation of Port Management System

(1) Berth assignment

In the case of the Port of Colombo, berth assignments are determined by taking the priorities of ships into account. The de tailed explanation is found in Chapter 5-7 of Part I.

It is important to maintain a fixed schedule for a container ship between ports. It is necessary to give the priority to a container ship running along main routes.

In the case of Galle Project, because the profitability of the project has improved, the SLPA should consider whether or not to give the priority of berth assignments to partial shipping lines or only to a major shipping line.

(2) Simplicity of Document Procedures

Port users currently submit too many documents to various offices of the SLPA at the Port of Colombo.

The SLPA should simplify the procedures for ship entry/departure and cargo operations by promoting computerization at the SLPA for the Galle Project.

(3) Port Marketing Activities

The SLPA should carry out intensive port marketing activities to ensure the success of the new port. Without a positive approach, clients may not be attracted to the port.

However, it should be noted that a reputation for prompt, reliable, economical and efficient service as well as publicity is essential for attracting clients. To this end, a quick passage through customs, efficient immigration and quarantine procedures are also vital in attracting potential clients.

(4) Coordination

To operate port activities smoothly, the SLPA should coordinate the various organizations related to port activities such as customs, quarantine and immigration. Furthermore, the SLPA should consider integrating the organizations with the aid of the computer system. This would be helpful in attracting users to the Port of Galle.

(5) Recruitment and Training

The Galle Project requires about 600 new workers, and the staff of the Colombo Port will need to assist in training the new workers. The staff of the existing training institute in Colombo Port should also be called upon for assistance.

Besides, port workers will need continuous training to catch up with advanced port operation technologies.

A training center for port workers and personnel will be needed at the Port of Galle.

(6) Telecommunication and Computer System

The poor telecommunication system between Colombo city and Galle city has a detrimental effect on all aspects of business. Although the telecommunication system is expected to improve in the near future, the SLPA should examine the possibility to permit the companies related port operations to use the radio lines of the SLPA.

6 ECONOMIC ANALYSIS

The purpose of the economic analysis is to appraise the economic feasibility of the Short-term Development Plan for the Port of Galle in the target year (1997) from the viewpoint of the national economy.

Therefore, the purpose of this chapter is to investigate the economic benefits as well as the economic costs that will arise from this project and to evaluate whether the net benefits of the project exceed those that could be obtained from other investment opportunities ("The Opportunity Cost of Capital") in Sri Lanka.

6-1 Methodology of Economic Analysis

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

The flow chart of the economic analysis procedure is shown on Figure 6-1-1.

In estimating costs and benefits of the project, they should be fixed quantitatively as much as possible. Then, "Economic Pricing" is applied after the removal of "Transfer Items" such as tax, interest charges and subsidies. "Economic Pricing" here means the appraisal of costs and benefits in terms of international prices ("Border Prices").

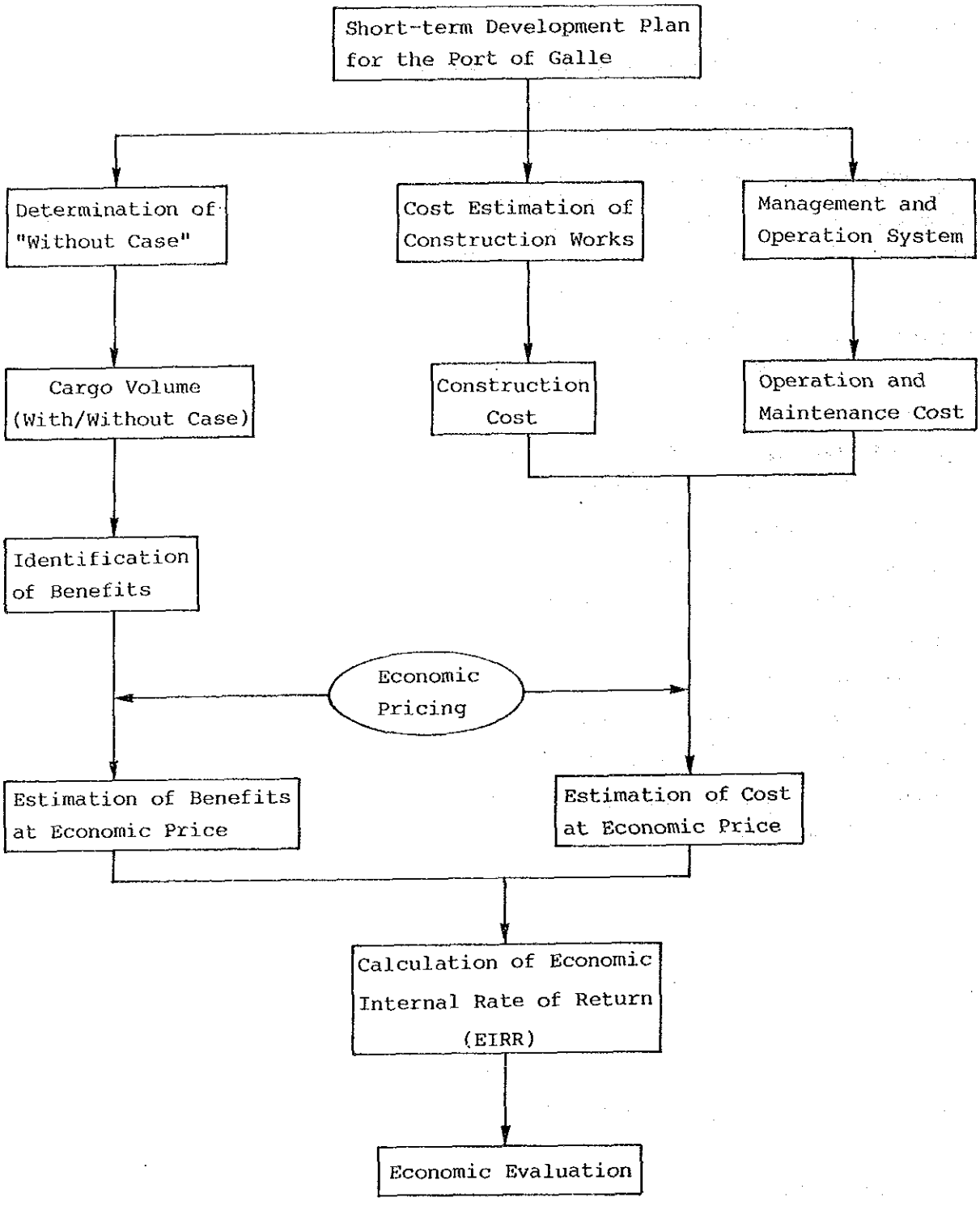


Figure 6-1-1 Flow Chart of Economic Analysis Procedure

6-2 Prerequisites of the Economic Analysis

6-2-1 Base Year

The "Base Year" here means the starting year of the economic analysis. Taking into consideration the construction schedule in Chapter 4 of this part, 1992 is set as the "Base Year" for this Study.

6-2-2 Project Life

Taking into consideration the depreciation period of the main facilities mentioned in the next chapter and the construction period of five years, the period of calculation ("Project Life") in the economic analysis is assumed to be thirty-five years from the beginning of construction (i.e., from 1992 to 2026).

6-2-3 Foreign Exchange Rate

The exchange rate adopted for this analysis is US$ 1.00 = Rs. 41.00, that is, the same rate as used in the cost estimation.

6-2-4 "Without" Case

A cost-benefit analysis is conducted on the difference between the "With" case where investment is made and the "Without" case where no investment is made. In other words, incremental benefits and costs arising from the proposed investment are compared, and it is examined whether the net benefits generated by the project exceed "the Opportunity Cost of Capital" in Sri Lanka.

Therefore, considering the "Without" case is one of the key elements of the economic analysis. In arguing the merit of the "Without" case, one must consider the true purpose of the project. Expressed in broad terms the true purpose is the "Regional development of the Southern Province". Secondary aims include "Providing supplementary cargo handling facilities to the Port of Colombo" and "Generation of foreign currency". Then, in this Study, the following conditions are adopted as the "Without" case after various possibilities are discussed:

-No investment is made for the Port of Galle;
-The construction plan for Jaye Container Terminal No.3 & No.4 and rehabilitation of the QEQ Container Terminal of the Port of Colombo is implemented on schedule;
-National development plans, such as Koggala EPZ, etc., are implemented.

6-2-5 Cargo Volume Handled at the Port of Galle

(1) "With" Case

The cargo volume handled at the Port of Galle in the target year under the "With" case was forecast in Chapter 3 of Part II. The maximum handling capacity of the Port of Galle after completion of this project was also estimated in Chapter 2 of this part. The cargo volume will increase after 1997 and exceed the handling capacity in 1998. Therefore, the cargo volume used for the economic analysis are assumed as follows:

-The volume forecast in Chapter 3 of Part II (1997)

Break bulk cargo:	219,000 M.T.
Bulk cargo:	378,000 M.T.
Local containers:	36,000 TEUs
Transshipment containers:	190,000 TEUs

-The maximum handling capacity estimated in Chapter 2 of this part (after 1997)

Break bulk cargo:	230,000 M.T.
Bulk cargo:	391,000 M.T.
Local containers:	43,000 TEUs
Transshipment containers:	225,000 TEUs

The volume exceeding the maximum handling capacity is to be accommodated by the following stage of the development plan mentioned in Chapter 4 of Part II.

(2) "Without" Case

1) Container Cargo

In the "With" case, container cargoes of 1,380,000 TEUs are to be handled at the Port of Colombo in 1997 (of which 326,000 TEUs are local cargoes, that is, import/export cargo, and 1,054,000 TEUs are transshipment cargoes); at these volumes, the port is at its maximum handling capacity for containers. However, an additional 36,000 TEUs in local cargo forecast for 1997 could be handled at the Port of Galle in the "With" case. In the "Without" case, all local cargo forecast for 1997 must be handled at the Port of Colombo, with local cargo taking priority over transshipment container cargo. Therefore, the breakdown of local and transshipment containers handled at the Port of Colombo in 1997 will be 362,000 and 1,018,000 TEUs, respectively.

In other words, because total container volume handled at the Port of Colombo is to be the same in both the "With" and "Without" case, the opportunity for handling transshipment container cargoes of 226,000 TEUs--the balance of the forecast cargo volume in Sri Lanka in 1997--would be lost for Sri Lanka. These transshipment cargoes are assumed to be transferred to other foreign ports such as Singapore, Fujairah, etc. This "lost" cargo volume in containers will increase to 268,000 TEUs in 1998 and will remain stable at this level thereafter.

2) Other Cargo

With the exception of bulk clinker of 194,000 tons, bulk wheat of 100,000 tons, containerized flour of 65,000 tons and imported break bulk cargo of 100,000 tons that will be handled at the Port of Galle, all other cargo will have to be handled at the Port of Colombo.

The above bulk clinker and imported break bulk cargo will have been handled at the existing port in Galle as at present. As for the bulk wheat and the containerized flour, it would be lost for Sri Lanka. In the "Without" case, a new flour mill will not be constructed and operated in the Galle port area, and there is no room in Colombo.

Table 6-2-1 shows the cargo volume handled at the Port of Galle

in 1997 and in 1998 in both the "With" and "Without" case.

Table 6-2-1 Forecast Cargo Volume in both the "With" and "Without" Case at the Port of Galle

(Unit: '000)

		With		Without
		1997	1998	
Bulk Wheat	(Tons)	100	100	Handled in another country
Bulk Fertilizer	(Tons)	84	97	Handled in Colombo
Bulk Clinker	(Tons)	194	194	194
General Cargo	(Tons)	219	230	100; Remainder in Colombo
Containers				
Flour	(TEUs)	7	7	Handled in anther country
Other Local	(TEUs)	29	36	Handled in Colombo
Transshipment	(TEUs)	190	225	Handled in another country

Year: Cargo volume handled at the Port of Galle under the "With" case will remain constant at the level expected in 1998.

6-3 Economic Prices

6-3-1 Methodology

The purpose of the economic analysis is to examine the value of a project, that is to see if it represents an efficient allocation of resources in the national economy. The value of goods quoted at a market price do not always represent the true value of national resources actually consumed from the viewpoint of the national economy. The local currency portion of goods and materials at a market price often includes sales tax, subsidies, customs duties, etc. The labour cost at market prices is often influenced by a minimum wage system. Therefore, "Economic Pricing" should be conducted for the economic analysis.

There are several ways of conversion from market price to "Economic Price". In this Study, the benefits and costs are divided into five items: traded goods, non-traded goods, skilled labour, unskilled labour and transfer items. Then, they are revised to "Border Prices" in an

effort to determine a more rational valuation (L-M Method or OECD Method). In general, these "Border Prices" are intended to represent the international market value or the world prices. The market prices are changed to "Border Prices" by various conversion factors such as "Standard Conversion Factor", "Conversion Factor for Consumption" and so forth.

6-3-2 Exclusion of Transfer Items

Import duties, other taxes and subsidies are merely transfer items, which do not actually reflect consumption of national resources. Therefore, these transfer items should be excluded in the calculation of the costs and benefits of the project for the economic analysis.

6-3-3 Method of Applying Conversion Factors

As mentioned above, all costs and benefits are generally divided into traded goods, non-traded goods, skilled labour, unskilled labour and transfer items.

Traded goods are expressed at CIF (cost, insurance & freight) for imports and FOB (free on board) for exports. As for non-traded goods, theoretically speaking, they should be classified and sorted by category and respective sub-categories into traded goods, non-traded goods, skilled labour, unskilled labour and transfer items, which are the items required for the production of the non-traded goods. However, because of the absence of an I/O (input-output) table of inter-industrial relations in Sri Lanka, it is impossible to take these steps in this Study. Hence, the local currency portion after deducting labour costs and transfer items is considered as non-traded goods, the economic price of which is calculated by multiplying the "Standard Conversion Factor" (SCF).

The economic price of skilled labour is obtained by multiplying its market price by the "Conversion Factor for Skilled Labour" and that of unskilled labour is calculated by multiplying the market price by the "Conversion Factor for Unskilled Labour".

(1) Shadow Exchange Rate (SER)

1) Standard Conversion Factor (SCF)

Economic policy items such as import duties and export subsidies cause a price differential between the domestic market and the international market. The SCF is applied to determine the economic prices of certain non-traded goods and services that cannot be directly valued at border prices, and the SCF is obtained by the following equation:

$$SCF = \frac{I + E}{(I + D_I) + (E - D_E)}$$

where, I: Total value of imports
E: Total value of exports
D_I: Total value of import duties
D_E: Total value of export duties and subsidies

Each value in the above equation is calculated based upon 1988 data from Sri Lanka Customs.

In this Study, the SCF is stated as 0.918.

2) Conversion Factor for Consumption (CFC)

The "Conversion Factor for Consumption" (CFC) is used for converting the prices of consumer goods from domestic market prices to border prices. This is particularly required in converting domestic labour costs to corresponding border prices. The CFC is usually calculated in the same manner as the SCF, replacing total imports and total exports by imports and exports of consumer goods only.

In this Study, the CFC is stated as 0.947.

(2) Shadow Wage Rate

For economic analysis, labour costs should be measured in terms of the opportunity cost of labour; that is, the value of the marginal

product of labour foregone elsewhere because of its use in a given project.

1) Conversion Factor for Skilled Labour

The opportunity cost of skilled labour is assumed to be equal to the actual wage rate, since the number of skilled labourer is limited and the market mechanism is functioning properly.

However, since these are domestic prices, they should be converted to border prices. Wages can be measured in terms of their purchasing power of consumer goods.

Therefore, the cost of skilled labour is calculated by multiplying their actual wage rate by the CFC; that is, the "Conversion Factor for Skilled Labour" is stated as 0.947 in this Study.

$$\boxed{\text{Conversion Factor for Skilled Labour}} = \frac{\text{Opportunity Cost of Skilled Labour}}{\text{Nominal Wage Rate of Skilled Labour}} \times \text{CFC} = 1 \times 0.947 = 0.947$$

2) Conversion Factor for Unskilled Labour

The opportunity cost of unskilled labour is generally far below the actual wage rate, since the rate is controlled by a minimum wage system and other regulations. Nevertheless, there are many unskilled labourer. However, it is virtually impossible to calculate an accurate opportunity cost for unskilled labour.

When a project is conducted, the inflow of unskilled labourer to the project is mainly from the agricultural sector which is relatively elastic in its use of labour. Therefore, in a simplified manner it is often assumed that the opportunity cost of unskilled labour is equal to the per capita income of the agricultural sector.

Because Sri Lanka does not have a labour force census by sector, per capita income of the agricultural sector is another item for which no firm figures are available. However, "Price and Wage Statistics 1986" issued by the Central Bank of Sri Lanka presents an average daily salary in this sector that can be

considered as a proper indicator of its marginal productivity.

Therefore, in this Study, the opportunity cost of unskilled labour of Rs. 45 per day is adopted with reference to the above issue.

The "Conversion Factor for Unskilled Labour" is calculated as follows:

$$\boxed{\text{Conversion Factor for Unskilled Labour}} = \frac{\text{Opportunity Cost of Unskilled Labour}}{\text{Nominal Wage Rate of Unskilled Labour}} \times \text{CFC}$$

$$= \frac{\text{Rs. } 45}{\text{Rs. } 90} \times 0.947 = 0.474$$

6-4 Benefits

6-4-1 Benefit Items

Considering the "With" and "Without" situations mentioned earlier, the following items are identified as the benefits of the Short-term Development Plan for the Port of Galle:

1) Savings in land transportation costs;
2) Generation of foreign currency earnings from handling container cargoes;
3) Promotion of regional development in the Southern Province as well as national development in Sri Lanka;
4) Increase in employment opportunities/incomes;
5) Increase in value added for port service and the related industries;

Of the above, items 1) and 2) are considered as benefits suitable for the cost-benefit analysis of this project. Other benefits are also considered qualitatively in this Study.

6-4-2 Savings in Land Transportation Costs

As mentioned in 6-2-5, under the "Without" case, some cargo from/to the Southern Province, the hinterland of the Port of Galle, are assumed to be handled at the Port of Colombo. As a result, additional traffic will occur between Galle and Colombo to transport this cargo.

Therefore, the savings in land transportation costs in the "Without" case can be considered as one of the benefits of the project.

(1) Premise

a) Road transportation is only considered because the capacity of railway transportation is not sufficient to transport the extra cargo mentioned above.
b) For calculation purposes, the trucks adopted for our cost estimation are to be "Medium Truck A" (7 tons capacity), of which 30% are to be empty trucks in consideration of the proportion of imports and exports. The loading weight of the loaded trucks is assumed to be 75% of capacity. Consequently, the average loaded weight per truck is 3.675 tons.
c) The road distance between Colombo and Galle is 120 km.
d) Local container cargoes transferred to the Port of Colombo under the "Without" case are vanned/devanned in Colombo because there is no CFS in Galle. Therefore, no transportation of containers occurs between Colombo and Galle.

(2) Cargo Volume for Transportation under the "Without" Case

Cargo volumes transported between the Port of Colombo and Galle under the "Without" case are shown in Table 6-4-1.

Table 6-4-1 Cargo Volumes Transferred to Colombo Port

Items	Quantity ('000 M.T.)	
	1997	1998
Fertilizer	84	97
General Cargo	119	130
Other Local Cargo	282	347
Total	485	574

(3) Calculation of "Economic Prices" of Land Transportation

The unit cost of land transportation is calculated based on the actual operation performance in Sri Lanka; the Study Team was able to obtain some data and information by interviewing the Transport Studies & Planning Center.

The unit costs are first estimated in the market prices, which can be broken down into component costs such as fuel, depreciation, maintenance, workers' wages, insurance, spare parts and so forth. Then, "Economic Pricing" is applied to each of these factors in estimating the "Economic Price" of the land transportation costs (see, Appendix III-6-1).

Taking into consideration that the distance between Colombo and Galle is 120 km, the unit cost of land transportation is estimated at US$ 5.676 per ton.

The benefit from savings in land transportation costs can be obtained by multiplying the above unit cost by cargo volume. The results are shown in Table 6-4-2.

Table 6-4-2 Savings in Land Transportation Costs

Year	Cargo Volume (tons)	Benefit ('000 US$)
1997	485,000	2,753
1998	574,000	3,258
↓	↓	↓
2026	574,000	3,258

6-4-3 Foreign Currency Earnings in Handling Container Cargoes Etc.

While 1,606,000 TEUs of containers will be handled at both the Port of Colombo and Galle in 1997 under the "With" case, it is assumed that only 1,380,000 TEUs would be handled at the Port of Colombo under the "Without" case.

This means that the foreign currency earnings in handling the balance of the cargo volumes between both cases (226,000 TEUs, of which 219,000 TEUs are transshipment containers) would be lost for Sri Lanka in 1997. Therefore, realizing these earnings would be another major benefit of the project. This volume will increase to 268,000 TEUs, of which 261,000 TEUs are transshipment containers, from 1998.

Furthermore, the earnings in handling 100,000 tons of bulk wheat (imports) would be also lost for Sri Lanka.

Foreign currency revenue related to cargo handling in the Port of Galle can be estimated as appropriate international prices, based upon the figures given in the next chapter and Appendix III-7-4. Since this revenue can be considered as border prices, there is no need for conversion to economic prices.

Table 6-4-3 shows the benefits of foreign currency earnings from 1997.

Table 6-4-3 Earnings of Foreign Currency in Handling Cargoes

('000)

Year	Transshipment		Exported Flour		Imported Wheat		Total
	Volume (TEUs)	Benefit (US $)	Volume (TEUs)	Benefit (US$)	Volume (Tons)	Benefit (US $)	Benefit (US $)
1997	219	15,330	7	1,085	100	730	17,145
1998	261	18,270	7	1,085	100	730	20,085
↓	↓	↓	↓	↓	↓	↓	↓
2026	261	18,270	7	1,085	100	730	20,085

6-4-4 Other Benefits

As mentioned in 6-4-1, there are other important benefits generating from this project even though they are not calculated as benefits in the cost-benefit analysis in this chapter.

(1) Promotion of Regional Development in the Southern Province

As detailed in Chapter 2 of Part II, there are many projects proposed such as an Export Processing Zone (EPZ), a flour mill, a fertilizer mixing plant, agro-based industries and so forth, which are crucially dependent upon the development of the Port of Galle.

With the development of the port, it will be impossible to carry out the above projects, which will promote regional development in the Southern Province and achieve diversification of Sri Lankan industry.

The development of the port also contributes to the rationalization of the distribution mechanism and to the activation of industries in the hinterland. As a result, an improvement in people's livelihood in the province is expected.

(2) Increase in Employment Opportunities/Incomes

The construction of new facilities at the Port of Galle will increase employment opportunities for both construction and port workers.

According to our cost estimates, total compensation paid to local employees during construction at market prices will be US$ 25,021,000.

According to Chapter 5 of this part, the port management body of this project will employ 625 peoples and annual personnel costs at economic prices will be US$825,000.

This boost to the region's employment level can be considered as one of the benefits of the project.

(3) Increase in Value Added for Port Service and the Related Industries

If this project is not be implemented, the port service industries and port related industries will be very restricted in their production activities. However, this project would contribute to their production output, an increase in value added that can be considered as one of the benefits of the project.

6-5 Costs

The cost items of the project are: construction costs, personnel costs, maintenance costs, operation/management costs and replacement investment costs. "Residual Value" is also considered as a cost in the final year of the project.

6-5-1 Construction Costs

Construction costs are estimated in Chapter 4 of this part. However, these costs include construction of the breakwaters, dredging of the navigation channel and so forth, which are provided not only for the Short-term Development Plan but also are included as permanent structures in the long-term development plan. Therefore, it would be excessive to consider all of these costs as elements of the short-term project only. In the economic analysis, the cost of these common facilities is allocated between the Short-term Development Plan for 1997 and the subsequent long-term development plan. The allocation is based on the number of berths and the total length of berths in each plan. The costs for the Short-term Development Plan are assumed to be one-fifth of the total cost of the above facilities.

The costs estimated in Chapter 4 of this part are shown at market prices. In the economic analysis, these costs have to be divided into foreign materials, other foreign currency portions (labour and equipment), non-traded goods, skilled labour and unskilled labour.

Since the foreign currency portions, excluding foreign materials, are shown in CIF prices, they do not need to be converted into economic prices. As for foreign materials, 1% of duty has to be deducted; the costs do not include import taxes.

Table 6-5-1 Construction Costs at Economic Prices

(Unit: '000 US$)

Description	Market Prices	Economic Prices
Dredging	1,320	1,308
Rock Dredging	5,904	5,764
Breakwaters	19,783	19,263
Container Wharf	32,171	30,837
General Cargo Wharf	19,610	18,752
Oil Berth	4,424	4,256
Revetment	12,587	11,664
Reclamation	22,118	21,688
Pavement	19,171	18,430
Access Bridge	2,402	2,325
Buildings	4,984	4,453
Water/Power Supply	8,719	8,562
Navigation Aids	692	653
Handling Equipment	23,616	23,378
Port Service Vessels	6,482	6,418
Engineering Services	10,587	10,467
Physical Contingency	9,233	8,877
Total	203,805	197,095

Economic prices of non-traded goods are calculated by multiplying the SCF after deducting 1% of duty, and the local labour costs are converted into economic prices by using the respective conversion factors mentioned in 6-3-3.

Table 6-5-1 shows the construction costs at both market prices and economic prices (refer to Appendix III-6-2). Appendix III-6-3 shows its disbursement schedule.

6-5-2 Personnel Costs

The personnel costs for the new facilities at the Port of Galle are shown in the next chapter. The costs are converted into economic prices

by multiplying the corresponding conversion factor.

Total personnel costs at economic prices are calculated as US$ 825,000 per annum.

6-5-3 Maintenance Costs

Maintenance costs are also shown in the next chapter. The costs are assumed to be 1% of the total construction cost excluding the cost of dredging/rock dredging and reclamation at economic prices.

Annual maintenance costs at economic prices are US$ 1,650,000.

6-5-4 Operation Costs

In the next chapter, the operation costs are estimated to be 20% of total personnel costs.

Annual operation costs at economic prices are US$ 165,000.

6-5-5 Replacement Investment Costs

The next chapter presents the replacement investment schedule. Economic prices of these costs are calculated by multiplying the respective overall conversion factors shown in Appendix III-6-2. The results are shown in Appendix III-6-4.

6-5-6 Residual Values

The next chapter also presents residual values (they are minus costs) in the final year of this project. However, in the economic analysis, only materials of water/electric supply, navigation aids and handling equipment are considered as residual values. Economic prices of these costs are calculated by multiplying the respective overall conversion factors shown in Appendix III-6-2. The results are shown in Appendix III-6-4.

6-6 Evaluation

Table 6-6-1 shows the calculated results of the cost-benefit analysis of this project.

6-6-1 Calculation of EIRR

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

The EIRR is a discount ratio that makes the costs and benefits of a project during the project life equal. It is calculated by using the following formula:

$$\sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^{i-1}} = 0$$

where, n: Period of cost-benefit analysis
B_i: Benefit in i-th year
C_i: Cost in i-th year
r: Discount Rate (EIRR)

The EIRR of the Short-term Development Plan of the Port of Galle is calculated as 8.15%.

6-6-2 Conclusion

There are various views concerning the appropriate EIRR level used to determine whether a project is feasible. The leading view is that the project is feasible if the EIRR exceeds the "Opportunity Cost of Capital" (OCC).

The OCC in Sri Lanka is not known. The value of the OCC adopted by International Bank for Reconstruction and Development (IBRD) is 12%, for the United States Agency for International Development (USAID), 8%, and for the Asian Development Bank (ADB), 10%. Meanwhile, the rate varies from 8% to 12%, according to the degree of development in each country. It is generally considered that an EIRR of more than 10% is economically feasible for infrastructure or social service projects.

Table 6-6-1 Cost/Benefit Analysis

Year	Cost ('000 US$)							Benefit ('000 US$)			Benefit - Cost	Net Present Value (NPV)		
	Construction	Management & Operation			Replacement Investment	Residual Value	Total	Land Transportation	Handling Charge	Total		Benefit	Cost	Benefit - Cost
		Personnel	Maintenance	Operation										
1992	2,619						2,619			0	-2,619	0	2,619	-2,619
1993	14,201						14,201			0	-14,201	0	13,131	-13,131
1994	41,558						41,558			0	-41,558	0	35,533	-35,533
1995	64,833						64,833			0	-64,833	0	51,258	-51,258
1996	69,660						69,660			0	-69,660	0	50,925	-50,925
1997	4,224	825	1,650	165			6,864	2,753	17,145	19,898	13,034	13,451	4,640	8,811
1998							2,640	3,258	20,085	23,343	20,703	14,591	1,650	12,941
1999												13,492	1,526	11,966
2000												12,476	1,411	11,065
2001					2,186		4,826				18,517	11,536	2,385	9,151
2002							2,640				20,703	10,667	1,206	9,460
2003												9,863	1,116	8,748
2004												9,120	1,031	8,089
2005												8,433	954	7,480
2006					2,819		5,459				17,884	7,798	1,824	5,974
2007							2,640				20,703	7,211	815	6,395
2008												6,668	754	5,913
2009					8,044		10,684				12,659	6,165	2,822	3,343
2010							2,640				20,703	5,701	645	5,056
2011					2,601		5,241				18,102	5,271	1,184	4,088
2012							2,640				20,703	4,874	551	4,323
2013												4,507	510	3,997
2014												4,168	471	3,696
2015												3,854	436	3,418
2016					33,084		35,724				-12,381	3,563	5,453	-1,890
2017							2,640				20,703	3,295	373	2,922
2018												3,047	345	2,702
2019												2,817	319	2,499
2020												2,605	295	2,310
2021					2,186		4,826				18,517	2,409	498	1,911
2022					8,044		10,684				12,659	2,227	1,019	1,208
2023							2,640				20,703	2,060	233	1,827
2024												1,904	215	1,689
2025												1,761	119	1,562
2026						-19,600	-16,960				40,303	1,628	-1,183	2,811
Total	197,095	24,750	49,500	4,950	58,964	-19,600	315,659	97,235	599,610	696,845	381,186	187,163	187,163	0

EIRR = 8.15%

From this premise, alone, the calculated EIRR of 8.15% falls slightly short of the benchmark. However, this analysis takes into consideration only two items of benefits as mentioned in 6-4-1, and calculated EIRR should not necessarily take priority over the incalculable social benefits, including a possible end to poverty in the Southern Province. At the very minimum, the development of the Port of Galle will expand the economy of the province by creating permanent employment for both skilled and unskilled labour. Income per capita will rise in the province as the port and new industry are developed. As a result, the wealth differential between the province and Colombo will narrow, averting potential social and economic friction. Sri Lanka is a small country but with vast potential, and we strongly believe that the development of the Port of Galle will help distribute more evenly the country's potential.

Consequently, we judge that this project should be implemented as a project leading the regional development in the province, in close cooperation with the development of port-related industries and the progress of other development projects in the province.

7 FINANCIAL ANALYSIS

7-1 Purpose of the Financial Analysis

The purpose of the financial analysis is to examine the viability of the project and the financial soundness of the port management body during the project life. (The project means the short-term development plan for the Port of Galle in this chapter.)

7-2 Methodology of the Financial Analysis

7-2-1 Viability of the Project

The viability of the project is analyzed using the Financial Internal Rate of Return (FIRR) by means of the discount cash flow method. The FIRR is a discount rate that makes the costs and the revenues during the project life equal, and it is calculated using the following formula:

$$\sum_{i=1}^{n} \frac{Bi - Ci}{(1+r)^{i-1}} = 0$$

n : Project life
Bi: Revenue in the i-th year
Ci: Cost in the i-th year
r : Discount rate

Here, the revenues and the costs in this analysis cover the following items:

Revenues: operating revenues
Costs: investments (initial investments and re-investments)
maintenance, repair and fuel costs
personnel and administration costs

When the calculated FIRR exceeds the weighted average interest rate of the total funds for the investments of the project, the project is regarded as financially feasible.

7-2-2 Financial Soundness of the Port Management Body

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

(1) Profitability

Rate of Return on Net Fixed Assets:

$$\frac{\text{Net Operating Income}}{\text{Total Fixed Assets}} \times 100\ (\%)$$

This indicator shows the profitability of the investments, which are presented as net total fixed assets. It is necessary to keep the rate above the average interest rate of the funds for investments.

(2) Loan Repayment Capacity

Debt Service Coverage Ratio:

$$\frac{\text{Net Operating Income before Depreciation}}{\text{Repayment of and interest on long-term loans}}$$

This indicator shows whether the operating income can cover the repayment and the interest on long-term loans. The ratio must be higher than 1.0.

(3) Operational Efficiency

Operating Ratio:

$$\frac{\text{Operating Expenses}}{\text{Operating Revenues}} \times 100\ (\%)$$

Working Ratio:

$$\frac{\text{Operating Expenses - Depreciation Expenses}}{\text{Operating Revenues}} \times 100\ (\%)$$

The operating ratio shows the operational efficiency of the organization as an enterprise, and the working ratio shows the efficiency of the routine operations of the port.

When the calculated operating ratios are less than 70-75%, and the working ratios are less than 50-60%, the operations of port are efficient.

7-3 General Presuppositions of the Financial Analysis

7-3-1 Scope of the Financial Analysis

The viability of the project can be analyzed, using the revenues and costs related to the project (namely, the short-term plan for the Galle Port).

On the other hand, the finances of the entire SLPA as the port management body must be analyzed to estimate of financial soundness. Plans for the Colombo Port are generally based on the Report for the Development Study on the Port of Colombo in 1989 issued by JICA (hereinafter referred to as the Colombo Report).

Matters related to the Galle project are dealt with in the following sections, 7-3-2 to 7-3-7. Matters used to analyze the SLPA financial stability are discussed in section 7-3-8.

7-3-2 Project Life

Taking account of the conditions of the long-term loans and the service lives of the port facilities, the project life for the financial analysis is determined as 35 years from the beginning of the project including six years of detailed design and construction of the port facilities and 30 years of operation.

7-3-3 Base Year

For the estimate, all costs, expenditures and revenues analyzed quantitatively here are indicated in prices as of 1991, when the price survey was conducted. Neither price inflation nor increases in nominal wages are considered during the project life.

7-3-4 Cargo Handling Volume

Based on the cargo volume forecast and estimated cargo handling capacity of facilities, the annual cargo handling volume is determined as shown in Appendix III-7-1.

For liquid cargo, which is bunkering oil, the volume is calculated based on the projected vessels and the data for the Colombo Port.

7-3-5 Port Charges and Revenues

Port charges will remain almost at existing tariffs, which are shown in Appendix III-7-2 and III-7-3. However all charges for the transshipment container operations have to be increased by 20% when the container terminal opens.

Compared with the charges levied by the ports of Singapore, Fujairah and Madras, the charges for transshipment container operations in Colombo Port are very inexpensive (See Appendix III-7-4). The new charges for transshipment container operations at Galle can be justified because of the port's advantageous location to the main shipping route.

We also determined the level rates of new charges by taking account of the feasibility of the project.

Revenues from port activities are calculated based on the above new tariff, the cargo handling volume and the projected calling vessels.

7-3-6 Fund Raising

(1) Government Funds

Funds necessary for construction of certain port facilities -- particularly breakwaters and channel dredging for public-use port facilities-- are assumed to be covered entirely by government

investment in the project.

The government funds are assumed to be free of repayment and interest.

These funds are essential to the feasibility of the project. (If all construction costs are borne by the SLPA, FIRR is 2.06%.)

The rest of the necessary funds are assumed to be raised by soft loans from foreign governments and domestic funds in Sri Lanka.

(2) Soft Loans

We assumed that 85% of all construction costs after subsidies will be raised by soft loans in this financial analysis.

A soft loan for this project is assumed to be as follows:

Loan period: 30 years, including a grace period of 10 years
Interest rate: 3.5% per annum
Repayment: fixed amount repayment of principal

(3) Domestic Funds

The other portion of the construction costs financing for this project is assumed to be raised in Sri Lanka as follows:

Loan period: 10 years, including a grace period of three years
Interest rate: 7.0% per annum
Repayment: fixed amount repayment of principal

Any cash shortage should be covered by short-term loans with an annual interest rate of 15% in local currency.

Interest rates on domestic loans currently amount to 18% annually on long-term loans, on short-term loans, the rate is 26% annually. Because these rates reflect domestic price inflation we deflated those rates by 11% to take into account the implicit GNP deflator and the exchange rate.

This method is used for local currency, because the tariffs for port operations are charged in U.S. dollars and the repayments of soft loans by the SLPA also are executed in foreign currency.

7-3-7 Expenditure

(1) Investments

The initial construction costs of the project are estimated in Chapter 4 of Part III.

The initial investment calculation must include all taxes payable, the Business Turnover Tax, Import Tax and so on. Those initial investments are shown in Table 7-3-1 and Appendix III-7-5. The initial investments will require US$343 million, including US$126 million in the government subsidies.

The depreciable facilities and equipments will be renewed based on their service lives. The service lives of the facilities and equipments are shown in Appendix III-7-6.

It is assumed that the funds for re-investment will be raised from the reserves of the project accounts.

(2) Maintenance and Repair Costs

Maintenance and repair costs are calculated as 1% of depreciable assets. This ratio is based on the actual accounts of the SLPA, and 1% is also the standard in ports around the world.

(3) Personnel and Administration Costs

The annual personnel costs are estimated based on the required number of workers proposed in Chapter 5 and the existing scale of pay.

The annual administration costs are calculated as 20% of the total annual personnel costs.

(4) Depreciation Expenses

The annual depreciation expenses of the port facilities and equipments are calculated by the straight line method, based on their service lives. Residual values after all depreciations are estimated as zero. At the end of the project life, fixed assets are assumed to be sold at their residual values.

Table 7-3-1 Galle Port Revised Investment Plan

(Unit: 1,000 US$)

	1992			1993			1994			1995			1996			1997			Grand Total
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	
Dredging for Basin				5,223	935	6,259	4,186	1,490	5,859	3,879	1,425	5,105	3,873	1,307	4,880				21,702
Dredging for Channel				2,299	541	2,840	3,866	1,459	5,325	3,714	1,439	5,153	3,495	1,319	4,724				18,941
Southwest Breakwater				9,819	3,841	13,760	13,227	5,122	18,348	13,227	5,122	18,348	13,227	5,122	18,348	11,573	4,481	16,054	94,858
East Breakwater				781	257	1,038	9,379	3,081	12,460	2,345	771	3,116			0				16,613
East seawall				4,984	1,851	6,815									0				6,815
Container Berth							3,987	2,436	6,402	7,933	4,872	12,805	6,611	4,060	10,671				29,879
Feeder Berth													4,422	2,825	7,247				7,247
General Cargo Berth							5,383	3,671	9,053	8,073	5,505	13,578			0				22,631
Oil Berth													3,323	1,783	5,107				5,107
Revetment				1,831	803	2,634	7,033	3,296	10,329	414	388	802			0				13,515
Reclamation				3,423	615	4,038	7,985	1,435	9,420	7,985	1,435	9,420	1,141	205	1,346				24,223
Pavement										8,522	4,609	11,131	5,979	4,226	10,205				21,337
Bridge													1,785	1,051	2,836				2,836
Navigation Aids													524	296	819				819
Administration Bld.										41	177	219	152	650	802				1,020
Transit Shed													329	1,939	2,267				2,267
Maintenance Shop													119	710	829				829
C.F.S										47	197	244	171	721	892				1,136
Cleaning Facilities													39	237	276				276
Utilities(Water Supply)										918	236	1,154	1,573	433	1,976				3,129
Utilities(Electric)										2,142	549	2,691	3,872	941	4,813				7,504
SUB-TOTAL				22,541	8,843	37,383	55,057	21,989	77,046	57,041	26,724	83,765	49,843	27,795	77,638	11,573	4,481	16,054	291,887
Container & Transfer Crane										7,634	815	8,449	11,451	1,222	12,673				21,121
Tractor & Truck													2,087	458	2,545				2,545
Chassis													603	132	735				735
Fork Lift & Top Lifter													1,278	136	1,414				1,414
Equipment for Others													464	151	615				615
Tug Boat										3,241	172	3,413	3,241	172	3,413				6,826
SUB-TOTAL										10,875	986	11,861	18,124	2,272	21,398	0	0	0	33,257
Engineering Service	3,310	1,103	4,413	2,206	735	2,941	2,206	735	2,941	2,206	735	2,941	2,206	735	2,941	1,103	367	1,470	17,647
TOTAL	3,310	1,103	4,413	30,747	9,578	40,324	57,263	22,724	79,987	70,122	28,445	98,568	71,173	30,801	101,975	12,676	4,848	17,524	342,791

Breakwater & Channel	0	0	0	13,000	4,638	17,638	26,471	9,661	36,133	19,286	7,331	26,617	16,631	6,441	23,072	11,573	4,481	16,054	119,514
Engineering Service	764	260	1,024	764	260	1,024	764	260	1,024	764	260	1,024	764	259	1,023	1,103	367	1,470	6,589
TOTAL	764	260	1,024	13,764	4,898	18,662	27,235	9,921	37,157	20,050	7,591	27,641	17,395	6,700	24,095	12,676	4,848	17,524	126,103
Investment by SLPA	2,546	843	3,389	16,983	4,680	21,662	30,028	12,803	42,831	50,072	20,855	70,927	53,778	24,102	77,880	0	0	0	216,689

(5) Taxes

Payable taxes are turnover tax, income tax and deemed dividend tax.

Taxes in addition to construction costs are already mentioned in part of investments.

7-3-8 Presuppositions for Colombo Port

The presuppositions mentioned in this paragraph are used to analyze the financial statements only of the Colombo Port, the Trincomalle Port and the existing Galle Port.

The short-term plan mentioned in the Colombo Report is assumed to be delayed by one year.

The presuppositions of the short-term plan for the Colombo Port are similar to those in the Colombo Report of 1989. However, some presuppositions have to be adjusted to the Galle Project. The key differences from the Colombo Report are as follows:

(1) Cargo Handling Volume

Based on the cargo volume demand forecast in Chapter 3 of Part III and that in the Colombo Report, the annual cargo handling volume of all ports is determined as shown in Appendix III-7-7.

(2) Port Charges

Port charges, except for activities related to the project will be based on the existing tariff. In other words, the charges for the transshipment container operations will not match the rates of the project.

(3) Fund Raising

The funds necessary for the implementation of the short-term plan in the Colombo Port are assumed to be raised as follows:

1) Soft Loans

We assume that 85% of all construction costs will be financed by soft loans from overseas. The other conditions are the same as those in the Colombo Report, as follows:

Loan period: 25 years, including a grace period of four years

Interest rate: 10% per annum

Repayment: fixed amount repayment of principal

2) Domestic Funds

The other portion of the construction costs is assumed to be raised from reserves of the SLPA.

Cash shortages should be covered by short-term, local currency loans with an interest rate of 15% per annum.

3) Investments

The initial construction costs are shown in Appendix III-7-8, where costs reflect inflation from the Consumer's Price Index and import and miscellaneous taxes.

Depreciable facilities and equipments will be renewed based on their service lives as shown in Appendix III-7-6.

The reinvestment of channel dredging will be made each 10 years, as mentioned in the Colombo Report.

7-4 Evaluation

7-4-1 Viability of the Project

The FIRR of this project is 4.99%, as shown in Table 7-4-1.

At 4.99% the rate exceeds the weighted average interest rate of funds of 4.03% during the project life; for our purposes, the weighted average is also the floor limit.

Table 7-4-1 FIRR Calculation

FIRR CALCULATION

BASE CASE FIRR= 4.99%

(UNIT:1,000US$)

YEAR	REVENUE	COST			REVENUE-COST	PRESENT VALUE IN 1992		
		INVESTMENT	EXPENSE	TOTAL		REVENUE	COST	DIFFERENCE
1992		3,389		3,389	-3,389	0	3,389	-3,389
1993		21,662		21,662	-21,662	0	20,632	-20,632
1994		42,831		42,831	-42,831	0	38,853	-38,853
1995		70,927		70,927	-70,927	0	61,281	-61,281
1996		77,880		77,880	-77,880	0	64,088	-64,088
1997	16,167	0	3,665	3,665	12,503	12,672	2,872	9,799
1998	18,843	0	3,840	3,840	15,003	14,066	2,867	11,199
1999	18,843	0	3,840	3,840	15,003	13,397	2,730	10,667
2000	18,843	0	3,840	3,840	15,003	12,760	2,600	10,159
2001	18,843	2,677	3,840	6,517	12,326	12,153	4,203	7,950
2002	18,843	0	3,840	3,840	15,003	11,575	2,359	9,216
2003	18,843	0	3,840	3,840	15,003	11,024	2,247	8,778
2004	18,843	0	3,840	3,840	15,003	10,500	2,140	8,360
2005	18,843	0	3,840	3,840	15,003	10,001	2,038	7,963
2006	18,843	3,450	3,840	7,290	11,553	9,525	3,685	5,840
2007	18,843	0	3,840	3,840	15,003	9,072	1,849	7,223
2008	18,843	0	3,840	3,840	15,003	8,641	1,761	6,880
2009	18,843	9,177	3,840	13,017	5,825	8,230	5,685	2,544
2010	18,843	0	3,840	3,840	15,003	7,838	1,597	6,241
2011	18,843	3,165	3,840	7,006	11,837	7,465	2,776	4,690
2012	18,843	0	3,840	3,840	15,003	7,110	1,449	5,661
2013	18,843	0	3,840	3,840	15,003	6,772	1,380	5,392
2014	18,843	0	3,840	3,840	15,003	6,450	1,315	5,136
2015	18,843	0	3,840	3,840	15,003	6,143	1,252	4,891
2016	18,843	37,611	3,840	41,451	-22,608	5,851	12,872	-7,021
2017	18,843	489	3,840	4,329	14,514	5,573	1,280	4,293
2018	18,843	0	3,840	3,840	15,003	5,308	1,082	4,226
2019	18,843	0	3,840	3,840	15,003	5,055	1,030	4,025
2020	18,843	0	3,840	3,840	15,003	4,815	981	3,834
2021	18,843	2,677	3,840	6,517	12,326	4,586	1,586	3,000
2022	18,843	9,177	3,840	13,017	5,825	4,368	3,018	1,350
2023	18,843	0	3,840	3,840	15,003	4,160	848	3,312
2024	18,843	489	3,840	4,329	14,514	3,962	910	3,052
2025	18,843	0	3,840	3,840	15,003	3,774	769	3,005
2026	18,843	-124,336	3,840	-120,496	139,339	3,594	-22,985	26,579
TOTAL	562,606	161,264	115,030	276,295	286,312	236,440	236,440	0

7-4-2 Financial Soundness of the Port Management Body

The projected financial statements and financial indicators, -- the working ratio, operating ratio, rate of return on net fixed assets and debt service coverage ratio -- are shown in Table 7-4-2.

(1) Profitability

The rate of return on net fixed assets is less than the average interest rate of funds (6.64%) under the construction of port facilities, but after 1999 the rate of return on net fixed assets exceeds the average interest rate during the project life (See Figure 7-4-1).

(2) Loan Repayment Capacity

Throughout the project life, the debt service coverage ratios exceed 1.0. There will be no problem with the repayments of the long-term loans using the annual operating revenues (See Figure 7-4-2).

(3) Operational Efficiency

Both the operating ratios and the working ratios maintain positive levels (See Figure 7-4-3, 7-4-4).

Table 7-4-2 Projected Financial Statements of the SLPA

PROFIT AND LOSS STATEMENT (UNIT:1000US$)

BASE CASE ITEM	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
OPERATING REVENUE																																				
TOTAL OPERATING REVENUE	75,468	81,779	82,293	91,421	98,329	102,833	127,484	130,948	135,215	135,543	139,849	138,648	143,408	143,408	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188	147,188
OPERATING EXPENSES																																				
PERSONNEL EXPENSES	27,884	28,561	29,193	30,219	31,217	31,895	33,956	34,011	34,019	34,139	34,200	34,261	34,322	34,383	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394	34,394
ADMINISTRATION	5,593	5,713	5,839	6,043	6,243	6,378	6,791	6,802	6,810	6,820	6,840	6,852	6,864	6,877	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879	6,879
MAINTENANCE, REPAIR AND FUEL	5,550	5,674	5,674	9,031	9,031	13,516	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691	13,691
DEPRECIATION OF FIXED ASSETS	7,760	7,915	7,915	9,479	12,233	12,233	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640
AMORTIZATION OF DEFERRED ASSETS	0	0	0	1,358	1,525	1,525	3,815	3,815	3,815	3,815	3,815	3,815	3,815	3,342	3,176	3,176	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886
TOTAL OPERATING EXPENSES	46,748	47,869	48,621	55,130	61,050	61,847	77,719	77,967	78,040	78,113	78,186	78,260	78,333	77,933	77,781	77,781	75,486	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490	75,490
NET OPERATING INCOME	28,719	33,910	33,852	36,291	35,279	40,987	49,765	52,981	57,175	57,430	61,663	61,388	65,075	65,475	69,387	69,387	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677
NON-OPERATING REVENUES																																				
INTEREST ON DEPOSIT	174	348	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	587	1,135	1,975	95	0	366	0	106	1,473	2,851	4,056	5,522	8,712	8,054	9,335	11,798
OTHER NON-OPERATING REVENUES	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502
TOTAL NON-OPERATING REVENUES	1,676	1,850	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	2,089	2,637	3,477	1,597	1,502	1,868	1,502	1,608	2,975	4,353	5,558	7,024	8,214	9,556	11,337	13,298
NON-OPERATING EXPENSES																																				
INTEREST ON LONG-TERM LOANS	11,361	12,939	19,135	29,315	33,959	37,338	40,319	38,491	36,341	34,082	31,688	28,213	26,819	24,424	22,476	20,612	18,252	17,202	16,142	14,582	13,037	11,483	9,928	8,373	6,818	5,263	3,708	2,686	2,098	1,641	1,262	940	622	337	116	0
INTEREST ON SHORT-TERM LOANS	0	0	612	3,245	4,299	5,585	7,228	7,581	7,884	8,071	8,250	8,327	7,849	8,558	7,716	5,798	5,393	3,869	1,561	596	0	0	0	1,791	0	3,562	0	0	0	0	0	0	0	0	0	0
TOTAL NON-OPERATING EXPENSES	11,361	12,939	19,748	33,059	38,258	42,944	47,865	46,072	44,225	42,073	39,958	37,540	34,668	32,980	30,192	26,409	24,650	21,591	17,703	15,186	13,037	11,483	9,928	8,373	6,802	5,253	3,371	2,898	2,098	1,641	1,262	940	622	337	116	0
NET INCOME BEFORE TAX	18,474	22,821	15,487	4,744	-1,487	-455	3,843	8,405	14,472	16,858	23,106	25,350	31,909	33,897	40,886	44,280	48,529	51,589	55,471	57,992	60,729	62,832	65,227	64,402	66,670	68,312	69,809	70,589	72,566	74,206	75,973	77,761	79,270	80,895	82,396	84,975
BUSINESS FORENVER TAX	4,068	4,889	4,114	4,572	4,816	5,142	6,373	6,547	6,761	8,777	5,992	5,932	7,170	7,170	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358	7,358
INCOME TAX	5,371	6,581	3,952	80	0	0	0	850	2,099	3,528	5,843	6,429	8,859	9,354	11,089	12,923	14,410	15,481	16,840	17,722	18,680	19,416	20,254	20,140	20,824	21,334	20,458	22,131	22,823	23,387	24,015	24,641	25,169	25,738	26,439	27,186
NET INCOME AFTER TAX	9,035	11,351	7,361	112	-6,304	-5,597	-2,731	1,207	5,612	4,553	10,480	11,988	16,080	17,372	21,871	23,999	26,761	28,750	31,273	32,912	34,691	36,058	37,615	37,403	37,168	39,620	41,993	41,100	42,385	43,451	44,600	45,762	46,742	47,800	49,101	50,451
DEEMED DIVIDENT TAX	2,484	3,060	1,985	28	0	0	0	302	1,253	1,638	2,820	2,885	4,020	4,343	5,418	6,000	6,690	7,187	7,818	8,228	8,673	9,014	9,404	9,351	9,297	9,905	9,498	10,275	10,596	10,865	11,150	11,441	11,686	11,950	12,275	12,613
NET INCOME AFTER PAYMENT	7,481	9,151	5,505	84	-6,304	-5,597	-2,731	904	4,359	3,915	7,660	8,954	12,060	13,029	16,253	17,998	20,071	21,562	23,455	24,684	26,018	27,043	28,211	28,052	27,891	29,715	32,495	30,825	31,789	32,586	33,450	34,322	35,057	35,850	36,826	37,838

CASH FLOW STATEMENT (UNIT:1000 US$)

ITEM	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CASH BEGINNING	4,349	3,707	-4,082	-21,631	-28,860	-32,101	-48,173	-50,581	-52,428	-53,805	-54,997	-55,513	-52,329	-51,705	-51,440	-38,650	-35,954	-25,928	-10,406	-3,971	14,671	28,380	49,381	2,380	-11,940	9,908	-23,750	2,839	38,915	88,677	101,393	138,040	167,811	201,356	245,885	294,893
CASH INFLOW																																				
NET OPERATING INCOME	28,719	33,910	33,852	36,291	35,279	40,987	49,765	52,981	57,175	57,430	61,663	61,388	65,075	65,475	69,387	69,387	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677	71,677
DEPRECIATION	7,760	7,915	7,915	9,479	12,233	12,233	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	19,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640	18,640
AMORTIZATION OF DEFERRED ASSETS	0	0	0	1,358	1,525	1,525	3,815	3,815	3,815	3,815	3,815	3,815	3,815	3,342	3,176	3,176	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886	886
SUBSIDY	0	1,024	18,982	37,157	27,641	24,095	17,524	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LONG-TERM LOANS	20,952	35,356	129,196	75,506	85,888	69,706	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER CURRENT LIABILITIES	0		0																																	
OTHER FIXED LIABILITIES	0		0																																	
INTEREST ON DEPOSIT ETC.	174	348	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	587	1,135	1,975	95	0	366	0	106	1,473	2,851	4,056	5,522	8,712	8,054	9,335	11,798
OTHER NON-OPERATING REVENUES	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502
TOTAL CASH INFLOW	59,508	79,855	189,837	161,308	164,068	170,048	92,227	77,938	82,132	82,387	88,419	88,368	90,033	89,959	93,705	93,705	93,705	93,705	93,705	93,705	94,292	94,841	95,681	93,801	93,705	94,102	93,705	93,811	95,132	98,373	97,761	99,227	100,418	101,769	103,541	105,501
CASH OUTFLOW																																				
INVESTMENT	29,683	94,114	170,588	123,485	121,293	120,822	22,558	5,034	5,034	5,443	7,711	5,034	16,242	1,313	5,034	15,565	9,035	5,034	16,011	5,034	11,300	5,034	24,204	41,364	5,034	69,362	5,525	5,034	12,068	8,528	8,119	16,011	13,693	5,523	5,034	5,034
LONG-TERM LOAN REPAYMENT	3,151	3,151	3,151	3,151	8,221	12,113	18,099	21,175	23,556	24,119	24,120	24,192	24,843	22,373	21,246	21,534	21,534	21,534	21,534	21,534	21,534	21,534	21,534	21,534	21,534	20,537	17,110	12,041	10,485	9,772	9,269	9,065	6,145	6,324	3,310	0
INTEREST ON LONG-TERM LOANS	11,361	12,939	19,135	29,315	33,959	37,338	40,319	38,491	36,341	34,082	31,688	28,213	26,819	24,424	22,476	20,612	19,252	17,202	16,142	14,582	13,037	11,483	9,928	8,373	6,818	5,263	3,708	2,686	2,098	1,641	1,262	940	622	337	116	0
OTHER CURRENT ASSETS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BALANCE SHEET(UNIT:1000 US$)

ITEM	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ASSETS																																				
CASH & DEPOSITS	3,707	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,671	28,380	49,381	2,380	0	9,908	0	2,839	38,915	88,677	101,393	138,040	167,811	201,356	245,885	294,893	344,224
OTHER CURRENT ASSETS	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767
TOTAL CURRENT ASSETS	59,474	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	55,767	70,438	84,147	105,148	58,147	55,767	65,675	55,767	58,606	92,682	122,444	157,160	193,807	223,578	257,123	301,652	350,660	400,991
FIXED ASSETS																																				
DEPRECIABLE ASSETS	323,476	417,590	581,984	674,907	798,110	885,718	888,276	892,210	888,344	903,788	911,491	916,531	923,914	931,267	936,321	952,907	961,941	966,975	982,488	988,020	998,321	1,004,355	1,069,700	1,111,084	1,118,098	1,179,460	1,184,983	1,190,017	1,202,085	1,210,711	1,218,830	1,234,861	1,239,975	1,245,398	1,256,432	1,255,466
ACCUMULATION OF DEPRECIATION	3,760	15,675	23,590	33,069	45,302	57,535	77,176	96,816	116,456	136,096	155,737	175,377	195,017	214,657	234,297	252,938	272,578	292,218	312,858	332,499	352,139	371,779	391,419	411,060	430,700	450,340	469,980	489,620	508,261	528,901	548,541	568,181	587,822	607,462	627,102	646,742
NET DEPRECIABLE ASSETS	319,716	401,914	558,393	641,838	752,807	828,182	811,100	795,394	771,888	767,692	755,750	741,154	728,897	716,610	702,024	699,969	689,363	674,757	670,128	655,522	645,182	632,576	678,281	700,024	687,398	729,120	715,003	700,397	693,824	681,810	670,289	666,680	652,054	637,936	623,332	608,724
NON-DEPRECIABLE ASSETS	0	0	12,586	21,485	21,485	49,668	48,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898	49,898
TOTAL FIXED ASSETS	319,716	401,914	550,980	663,323	772,292	858,080	860,998	845,292	821,786	817,588	805,648	791,052	778,795	766,508	751,922	748,867	739,261	724,655	720,026	705,420	695,080	682,474	728,179	749,922	737,296	779,018	764,901	750,295	742,722	731,708	720,187	716,578	701,952	687,834	673,230	658,622
DEFERRED CHARGES	0	0	13,528	13,200	12,366	33,742	28,927	26,112	23,298	19,481	14,666	10,851	15,885	12,553	8,377	6,261	5,215	4,329	3,543	2,857	1,772	886	8,859	7,973	7,087	6,201	5,315	4,429	3,543	2,658	1,772	886	8,859	7,973	7,087	6,201
TOTAL ASSETS	379,190	457,681	620,352	732,990	840,425	947,589	945,691	926,270	900,849	891,837	876,082	857,071	850,457	834,848	817,886	810,835	799,343	783,951	779,538	778,515	782,989	788,508	795,384	813,662	809,059	840,987	829,522	843,406	866,710	891,525	915,768	941,022	957,934	997,460	1,030,978	1,066,814
LIABILITIES & NET WORTH																																				
LIABILITIES																																				
CURRENT LIABILITIES																																				
SHORT-TERM LOANS	0	4,982	21,631	24,688	37,101	48,173	50,581	52,429	53,805	54,997	55,513	52,329	57,705	51,440	38,650	35,954	25,928	10,406	3,971	0	0	0	0	11,940	0	23,750	0	0	0	0	0	0	0	0	0	0
OTHER CURRENT LIABILITIES	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915	21,915
FIXED LIABILITIES																																				
LONG-TERM LOANS	112,894	180,299	301,254	388,611	447,278	524,877	588,772	485,592	482,041	437,922	413,801	389,809	384,940	342,538	321,342	281,807	278,219	256,739	235,204	213,670	192,136	170,601	149,067	127,533	105,999	85,466	68,352	56,311	45,826	36,054	26,846	17,778	9,634	3,310	0	0
OTHER FIXED LIABILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL LIABILITIES	134,809	207,196	344,798	420,186	508,294	594,959	579,268	559,942	537,761	514,834	491,229	463,854	464,560	415,842	381,907	357,677	326,114	289,060	281,090	235,585	214,051	192,516	170,982	161,388	127,913	131,128	90,267	78,226	67,741	57,969	48,759	39,694	31,549	25,225	21,915	21,915
EQUITY																																				
CAPITAL	195,300	196,324	214,988	252,143	279,784	303,939	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493	321,493
RESERVES	49,081	55,002	60,567	60,651	54,347	48,751	46,020	46,028	50,885	55,800	62,460	72,414	64,474	97,503	112,756	131,755	151,824	173,388	196,843	221,527	247,545	274,560	302,798	330,432	358,743	388,459	418,952	447,771	479,556	512,154	545,484	579,925	614,592	650,332	685,264	725,496
TOTAL EQUITY	244,381	251,326	275,553	312,794	334,131	352,690	367,513	367,521	372,378	377,293	383,953	393,907	405,971	419,996	434,250	453,248	473,316	494,881	518,336	543,020	568,948	595,982	624,292	651,925	680,236	709,951	740,445	769,264	801,049	833,647	867,007	901,328	936,085	972,235	1,008,881	1,046,909
TOTAL LIABILITIES & EQUITY	379,190	457,682	620,352	732,980	840,425	947,569	946,692	926,270	900,849	891,837	876,082	857,071	850,457	834,848	817,886	810,835	799,343	783,951	779,538	778,515	783,988	788,508	795,184	813,642	808,059	840,887	829,822	843,408	868,710	891,526	915,768	941,022	957,934	997,468	1,030,978	1,068,814
RATE OF RETURN ON NET FIXED ASSETS	9.32%	8.44%	6.15%	5.47%	4.57%	4.78%	5.78%	6.28%	6.67%	7.02%	7.83%	7.78%	8.38%	8.54%	9.28%	9.27%	9.71%	9.88%	9.95%	10.16%	10.28%	10.58%	9.84%	9.58%	9.75%	9.28%	9.37%	9.55%	9.65%	9.80%	9.95%	10.08%	10.21%	10.42%	10.85%	10.88%

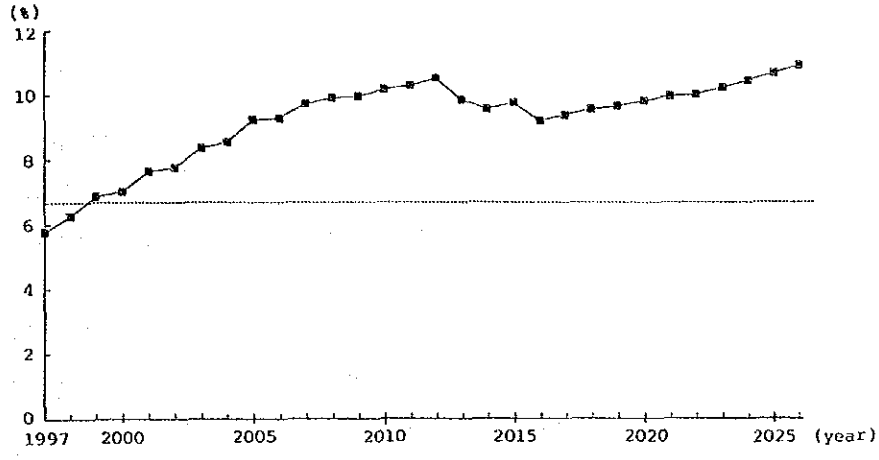


Fig. 7-4-1 Rate of Return on Net Fixed Assets

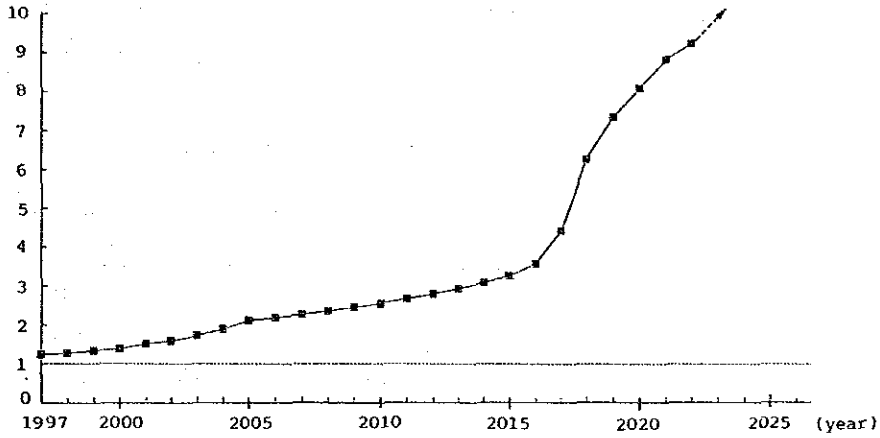


Fig. 7-4-2 Debt Service Coverage Ratio

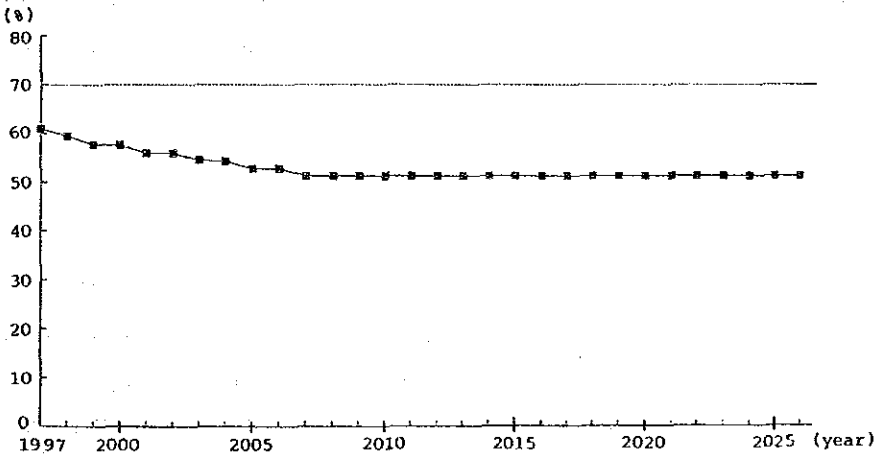


Fig. 7-4-3 Operating Ratio

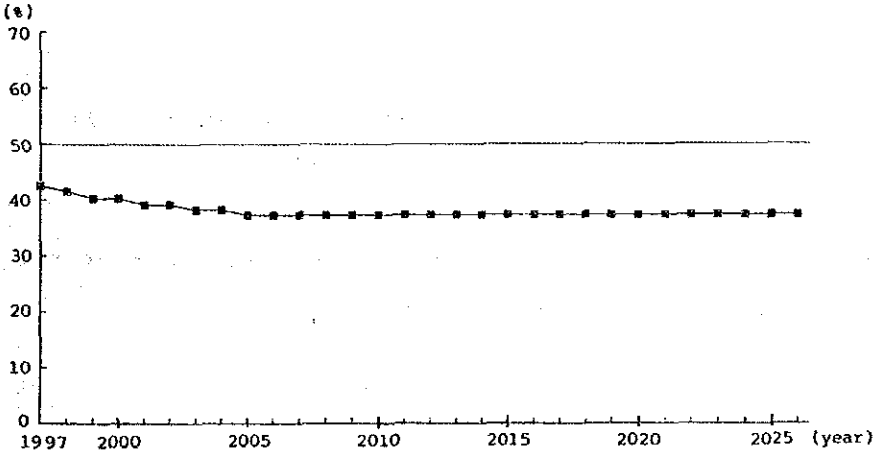


Fig. 7-4-4 Working Ratio

7-5 Sensitivity Analysis

A sensitivity analysis is made for the following three cases:

Case I: The revenues decrease by 10%.
Case II: The construction costs increase by 10%.
Case III: The operating expenses increase by 10%.

The FIRR of each case is as shown in Table 7-5-1

Table 7-5-1 FIRR in Sensitivity Analysis

	Base Case	Case I	Case II	Case III
FIRR	4.99%	4.09%	4.22%	4.81%
Floor Limit	4.03%			

In each case, the ratio exceeds the weighted average interest rate of funds, which is also the floor limit during the project life.

7-6 Conclusions

Judging from the above analysis, this project can be regarded as financially feasible if the funds necessary for construction of breakwaters and channel dredging is financed through interest-free government funds that require no repayment and if the charges for transshipment container operations in the Port of Galle are increased 20% from the existing tariff.

Because the initial construction costs are huge, it will be impossible for the SLPA to invest in the project for itself.

At last, it is recommended that the following measures be taken to improve the financing during the project life.

(1) The re-lending rate on the long-term loans from the government to the SLPA should be kept as low as possible including the development plans of Colombo Port.

(2) The SLPA should maintain its efforts to secure sufficient cargo volume and to improve cargo handling efficiency.

(3) Because the short-term loans with high interest rates are to continue until 2009, the SLPA should attempt to refinance with lower-cost funds, taking account of actual cash flow.

APPENDIX

LIST OF APPENDIXES

Appendix I-2-1 Rainfall and Temperature (1951-80)

	Annual Rainfall	Temperature	
		Maximum	Minimum
Colombo	2,527mm	30.4℃	24.0℃
Jaffna	1,184		
Trincomalee	1,615	31.1	25.2
Hambantota	1,073	30.2	24.1
Ratnapura	3,740	31.9	22.7
Anuradhapura	1,358	31.9	23.1
Kandy	1,947	28.7	20.2
Diyatalawa	1,662	24.7	15.6
Nuwara Eliya	2,044	20.2	11.4
Kankesanthurai	1,252	31.2	25.0

Source: Statistical Pocket Book of Sri Lanka, Department of Census and Statistics, Ministry of Policy Planning and Implementation

Appendix I-2-2 Population of Sri Lanka (1980-89)

(In thousands)

Year	Male	Female	Total	Growth Rate (%)
1980	7,582	7,165	14,747	1.91
1981	7,706	7,282	14,988	1.63
1982	7,742	7,447	15,189	1.34
1983	7,858	7,558	15,416	1.49
1984	7,951	7,648	15,599	1.19
1985	8,072	7,765	15,837	1.53
1986	8,215	7,902	16,117	1.77
1987	8,339	8,022	16,361	1.51
1988	8,454	8,132	16,586	1.38
1989			16,806	1.33
Ave.				1.46

Source: Central Bank of Sri Lanka

Appendix I-2-3 Sectoral Composition of GDP at Constant (1982) Factor Cost Prices

(Unit: Million Rs)

	Agriculture, Forestry and Fishing					Mining and Quarrying		Manufacturing		Construction		Electricity, Gas, Water and Sanitary		Transport, Storage and Communications	
	Plantations		Others		Total										
	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)
1982	6,451		18,513			2,238		13,601		7,959		1,089		10,666	
1983	6,166	-4.4	20,046	8.3	5.0	2,413	7.8	13,710	0.8	8,039	1.0	N.A.		N.A.	
1984	6,072	-1.5	20,041	0.0	-0.4	2,449	1.5	15,390	12.3	8,030	-0.1	1,239		12,437	
1985	7,438	22.5	20,928	4.4	8.6	2,486	1.5	16,193	5.2	8,070	0.5	1,313	6.0	12,959	4.2
1986	7,514	1.0	21,592	3.2	2.6	2,615	5.2	17,558	8.4	8,191	1.5	1,406	7.1	13,377	3.2
1987	6,482	-13.7	20,927	-3.1	-5.8	3,112	19.0	18,748	6.8	8,338	1.8	1,448	3.0	13,538	1.2
1988	6,197	-4.4	21,787	4.1	2.1	3,392	9.0	19,622	4.7	8,463	1.5	1,499	3.5	13,619	0.6
1989	6,575	6.1	21,091	-3.2	-1.1	3,576	5.4	20,488	4.4	8,514	0.6	1,526	1.8	13,883	1.9
Ave.		0.3		1.9	1.5		6.9		6.0		1.0		4.9		3.8

Source: 1) Review of the Economy and Annual Reports, Central Bank of Sri Lanka
2) Public Investment 1989 - 1993, Dept of National Planning, Ministry of Policy Planning & Implementation

Wholesale and Retail Trade		Banking, Insurance and Real Estate		Ownership of Dwellings		Public Administration and Defence		Services		Gross Domestic Product	
Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)	Amount	Growth Rate (%)
19,694		3,715		3,250		2,899		4,604		94,679	
20,738	5.3	4,130	11.2	N.A.		3,786	30.6	4,590	-0.3	99,375	5.0
22,029	6.2	4,526	9.6	3,381		4,165	10.0	4,636	1.0	104,395	5.1
22,925	4.1	4,975	9.9	3,432	1.5	4,432	6.4	4,419	-4.7	109,570	5.0
23,821	3.9	5,174	4.0	3,497	1.9	5,274	19.0	4,242	-4.0	114,261	4.3
24,496	2.8	5,490	6.1	3,550	1.5	5,435	3.1	4,358	2.7	115,922	1.5
25,164	2.7	5,819	6.0	3,603	1.5	5,462	0.5	4,423	1.5	119,050	2.7
25,588	1.7	6,168	6.0	3,650	1.3	6,140	12.4	4,530	2.4	121,729	2.3
	3.8		7.5		1.7		11.3		-0.2		3.7

Appendix I-2-4 Exports, Imports and Balance of Trade (1980-89)

(Unit: SDR Million)

	Exports	Imports	Balance of Trade
1980	818	1,577	-759
1981	928	1,614	-686
1982	934	1,826	-892
1983	998	1,811	-813
1984	1,432	1,823	-391
1985	1,311	1,956	-645
1986	1,036	1,658	-622
1987	1,080	1,589	-509
1988	1,098	1,661	-563
1989	1,216	1,737	-521

Source: 1) Customs, Sri Lanka
2) Central Bank of Sri Lanka

Note: Data were adjusted for lags and other factors.

Appendix I-2-5 Major Exports and Share (1984, 1989)

	1984		1989	
	SDR Million	Share (%)	SDR Million	Share (%)
Tea	604.5	42.2	295.8	24.3
Rubber	126.6	8.8	67.4	5.5
Coconut Products	81.2	5.7	62.0	5.1
Textile & Garments	290.1	20.3	381.8	31.4
Petroleum Products	126.1	8.8	48.5	4.0
Gems	23.6	1.6	47.7	3.9

Source: 1) Customs, Sri Lanka
2) Ceylon Petroleum Corporation
3) Air Lanka Ltd.
4) Central Bank of Sri Lanka

Appendix I-2-6 Major Imports and Share (1984, 1989)

	1984		1989	
	SDR Million	Share (%)	SDR Million	Share (%)
Rice	7.5	0.4	73.5	4.2
Flour	1.1	0.1	3.8	0.2
Sugar	51.6	2.8	93.7	5.4
Petroleum	409.6	22.5	181.3	10.4
Fertilizer	42.3	2.3	138.0	2.2
Chemicals	39.4	2.2	45.8	2.6
Wheat	94.8	5.2	107.5	6.2
Textile & Clothing	114.0	6.2	216.1	12.4
Machinery	204.6	11.2	135.9	7.8

Source: 1) Customs, Sri Lanka
2) Food Commissioner's Department
3) Ceylon Fertilizer Corporation & other major importors of fertilizer
4) Ceylon Petroleum Corporation
5) Co-operative Wholesale Establishment
6) Central Bank of Sri Lanka

Appendix I-2-7 Passenger and Cargo Transport by Rail

(in Millions)

Item	Unit	1978	1985	1986	1987	1988	1989
Passenger	man-Km	3,709	2,101	1,972	2,059	1,859	1,677
Cargo	ton-Km	281	232	204	195	198	178

Source: Sri Lanka Socioeconomic Data, Central Bank of Sri Lanka

Appendix I-2-8 The Number of Registration of Motor Vehicles

	Passenger Transport				Goods Transport		Land Vehicles			Other
	SLTB Buses	Private Coaches	Private Cars	Motor Cycles	Lorries	Others	Tractors	Trailers	Other	
1975	11,907	1,174	92,358	23,269	35,623	4,243	16,070	8,762	4,282	435
1980	15,416	5,834	122,428	80,477	57,702	4,793	24,882	17,236	13,279	647
1985	16,936	21,924	152,548	162,570	95,137	5,487	28,035	20,652	27,465	763
1986	17,190	23,705	163,737	189,163	98,384	5,590	28,577	21,234	30,131	780
1987	17,275	24,856	174,666	218,204	101,230	5,645	29,187	21,901	31,531	830
1988	17,520	25,719	185,699	246,041	103,675	5,704	29,696	22,272	32,993	831
1989		26,163								

Source: Department of Motor Traffic

Appendix I-2-9 Passenger Transport by Road

(in Millions)

Item	Unit	1978	1985	1986	1987	1988	1989
Passenger	man-Km	20,374	14,249	15,149	15,974	15,413	12,980

Source: Sri Lanka Socioeconomic Data, Central Bank of Sri Lanka

Appendix I-2-10 Passenger and Cargo Transport by Air

(in Millions)

Item	Unit	1978	1985	1986	1987	1988	1989
Passenger	man-Km	129	2,509	2,108	1,946	2,832	2,625
Cargo	ton-Km	12	296	246	226	278	313

Source: Sri Lanka Socioeconomic Data, Central Bank of Sri Lanka

Appendix I-3-1 Employment and Unemployment (1990)

(Unit: No. of Persons)

District	Employment		
	Male	Female	Total
Galle	142,063	45,468	187,531
Matara	109,051	36,938	145,989
Hambantota	90,752	13,742	104,494
Southern Province	341,866	96,148	438,014
District	Unemployment		
	Male	Female	Total
Galle	37,495	33,279	70,774
Matara	29,145	27,593	56,738
Hambantota	14,667	11,825	26,492
Southern Province	81,307	72,697	154,004
Unemployment Ratio	19.2	43.1	26.0

Source: Galle Municipal Council

Appendix I-3-2 Sectoral GDP at 1982 Factor Prices in Southern Province

	GDP Southern Province	Share of Sector	GDP Sri Lanka	Share of Sector	Share of Southern Province
	(Rs.Mil.)	(%)	(Rs.Mil.)	(%)	(%)
Agriculture, Forestry and Fishing	2,829	30.32	24,964	26.37	11.33
Mining and Quarrying	50	0.54	2,238	2.36	2.23
Manufacturing	872	9.35	13,601	14.37	6.41
Construction	971	10.41	7,959	8.41	12.20
Electricity, Gas, Water and Sanitary	75	0.80	1,089	1.15	6.89
Transport, Storage and Communications	996	10.68	10,666	11.27	9.34
Wholesale and Retail Trade	1,979	21.21	19,694	20.80	10.05
Banking, Insurance and Real Estate	302	3.24	3,715	3.92	8.13
Ownership of Dwellings	448	4.80	3,250	3.43	13.78
Public Administration and Defence	290	3.11	2,899	3.06	10.00
Service	518	5.55	4,604	4.86	11.25
Gross Domestic Product	9,330	100	94,679	100	9.85

Source: Strategy for the Accelerated Development of the Southern Province of Sri Lanka, Marga Institute

Appendix I-3-3 Extent of Agricultural Crops in Southern Province

Crops	Unit	Southern Province	Share (%)	Sri Lanka	Year
Paddy	(Hectare)	97,671	12.5	781,896	1986
Tea	(")	33,300	15.0	221,683	1988
Rubber	(")	27,858	13.7	202,771	1986
Coconuts	(")	50,200	12.0	419,201	1984
Cinnamon	(")	16,240	78.4	20,715	1985

Source: 1) Ministry of Agriculture
2) Central Bank of Sri Lanka

Appendix I-3-4 Fish Production in Sri Lanka

(Unit: Tonnes)

Year	Coastal	Offshore and Deep Sea	Inland	Total
1980	165,264	2,148	20,266	187,678
1981	175,075	2,178	29,590	206,843
1982	182,532	1,078	33,323	216,933
1983	184,049	689	36,068	220,806
1984	136,642	823	31,882	169,347
1985	140,266	2,400	32,743	175,409
1986	144,266	3,400	35,390	183,056
1987	149,278	4,259	36,465	190,002
1988	155,099	4,425	38,012	197,536
1989	157,411	8,155	39,720	205,286

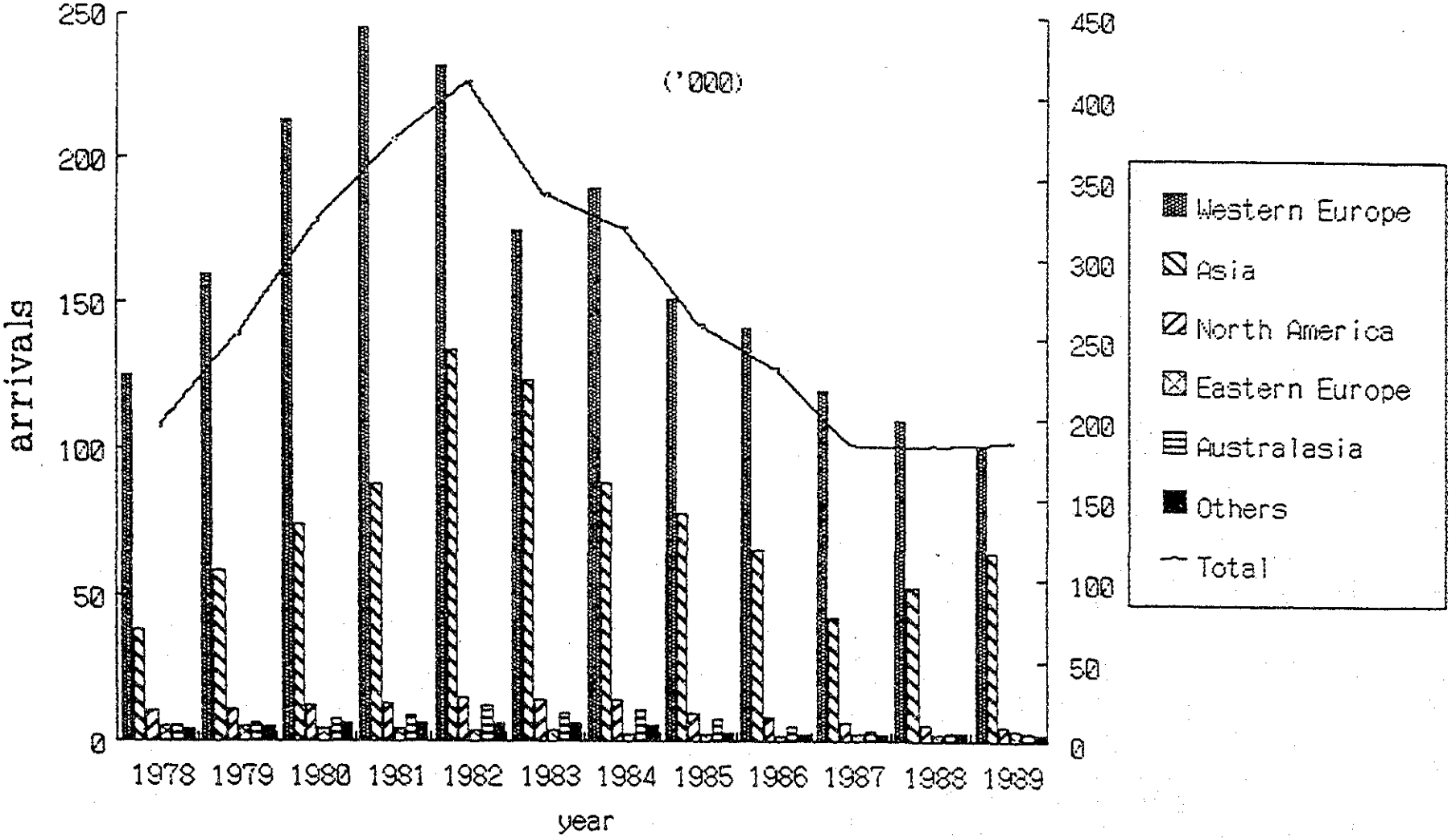
Source: Ministry of Fishery

Appendix I-3-5 Fish Production in Southern Province

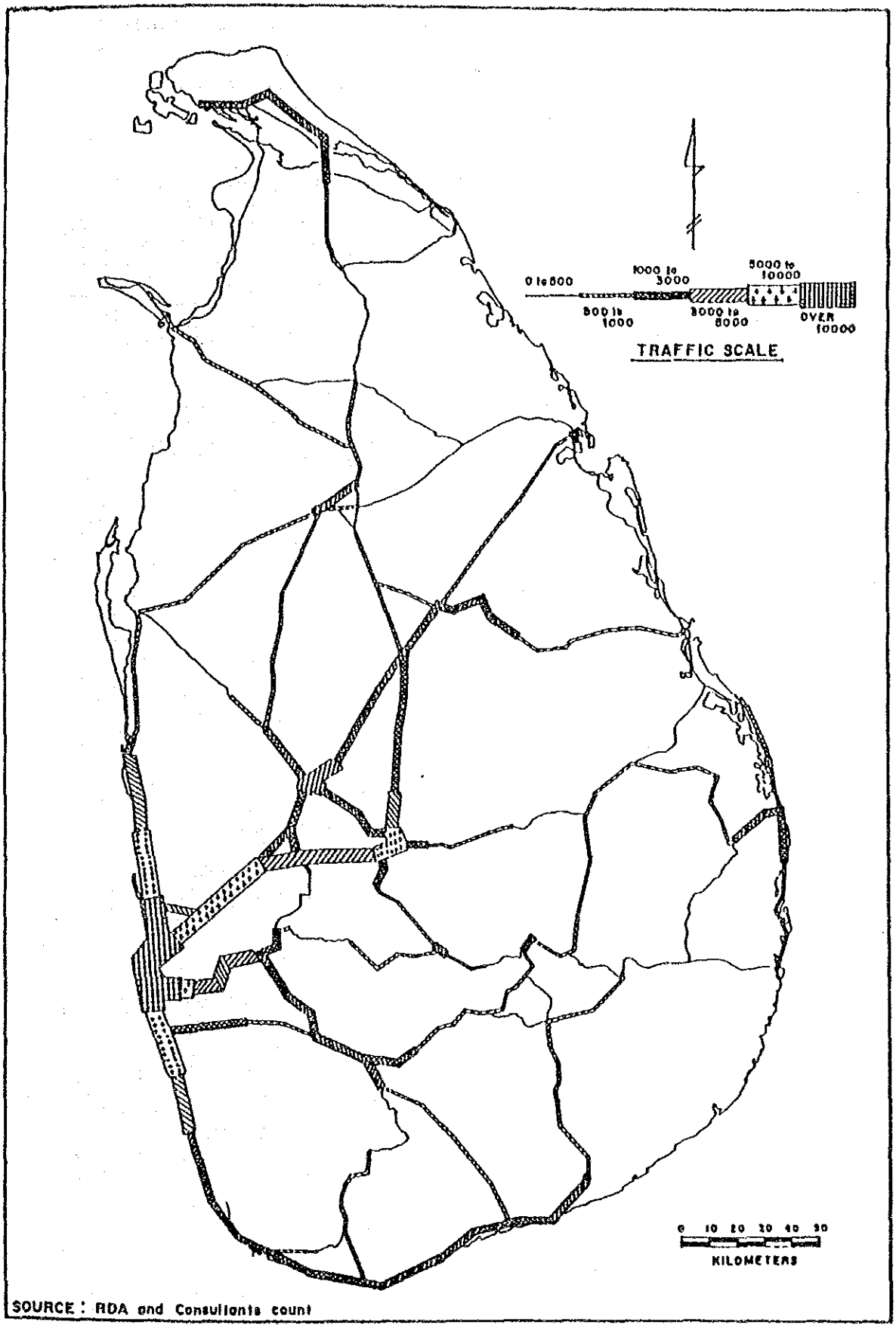
(Unit: Tonnes)

Year	① Galle	② Southern Province	③ Sri Lanka	④ ①/② (%)	⑤ ①/③ (%)	⑥ ②/③ (%)
1980	8,101	23,518	187,678	34.4	4.3	12.5
1981	8,680	23,575	206,843	36.8	4.2	11.4
1982	10,309	26,741	216,933	38.6	4.8	12.3
1983	10,264	28,815	220,806	35.6	4.6	13.0
1984	12,902	31,394	169,347	41.1	7.6	18.5
1985	11,622	31,943	175,409	36.4	6.6	18.2
1986	11,550	31,502	183,056	36.7	6.3	17.2
1987	12,220	33,330	190,002	36.7	6.4	17.5
1988	12,696	34,628	197,536	36.7	6.4	17.5
1989	12,885	35,142	205,286	36.7	6.3	17.1

Source: Ministry of Fishery



Appendix I-3-6 Average Arrivals of Tourists



Appendix I-3-7 Average Daily Traffic 1986

Appendix I-3-8 Summary Statistics of Electricity (1989)

No. of Power Stations:			18	
Hydro:	13			
Thermal:	5			
Installed Capacity:			1,240	MW
Hydro:	968	MW		
Thermal:	272	MW		
Gross Generation:			2,858	GWh
Hydro:	2,802	GWh		
Thermal:	56	GWh		

Source: Ceylon Electricity Board

Appendix I-4-1 Frequency of Wind Occurrence (%)

March April

U (Knot) \ Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
0.0- 4.9	1.8	0.0	9.5	0.0	2.7	0.0	5.4	0.0	1.7	0.0	27.0	0.1	3.4	0.0	3.2	0.1	9.2	64.3
5.0- 9.9	0.1	0.0	3.8	0.0	1.5	0.0	3.6	0.2	0.4	0.2	18.9	0.0	1.7	0.0	2.4	0.0	0.0	32.7
10.0-14.9	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.1	0.0	0.3	0.0	0.0	2.8
15.0-19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
20.0-24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.0-29.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0-34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.0-39.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0-44.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45.0-49.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.0-54.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55.0-59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.0-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65.0-69.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.9	0.0	13.6	0.0	4.3	0.0	9.0	0.2	2.1	0.2	48.2	0.1	5.2	0.0	5.9	0.1	9.2	100.0

May ~ Sep.

U (Knot) \ Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
0.0- 4.9	0.3	0.0	0.8	0.0	0.2	0.0	0.6	0.0	0.1	0.0	17.3	0.0	1.5	0.0	3.8	0.0	1.0	25.7
5.0- 9.9	0.1	0.0	0.3	0.0	0.1	0.0	0.1	0.0	0.3	0.0	39.8	0.0	3.6	0.0	10.3	0.0	0.0	54.5
10.0-14.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	0.0	1.0	0.0	5.3	0.0	0.0	15.3
15.0-19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.2	0.0	1.2	0.0	0.0	4.3
20.0-24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
25.0-29.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0-34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.0-39.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0-44.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45.0-49.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.0-54.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55.0-59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.0-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65.0-69.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.4	0.0	1.2	0.0	0.3	0.0	0.7	0.0	0.4	0.0	69.2	0.0	6.2	0.0	20.6	0.0	1.0	100.0

Oct. Nov.

U (Knot) \ Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
0.0- 4.9	0.7	0.0	3.5	0.0	0.7	0.0	3.2	0.0	0.7	0.0	26.3	0.0	3.1	0.0	4.0	0.0	8.2	50.4
5.0- 9.9	0.4	0.0	0.8	0.0	0.8	0.0	0.9	0.0	0.0	0.0	29.5	0.0	4.1	0.0	5.6	0.0	0.0	42.1
10.0-14.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	5.1	0.0	1.2	0.0	0.8	0.0	0.0	7.3
15.0-19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
20.0-24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.0-29.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0-34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.0-39.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0-44.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45.0-49.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.0-54.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55.0-59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.0-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65.0-69.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.2	0.0	4.4	0.0	1.5	0.0	4.3	0.0	0.7	0.0	61.0	0.0	8.4	0.0	10.4	0.0	8.2	100.0

Dec. ~ Feb.

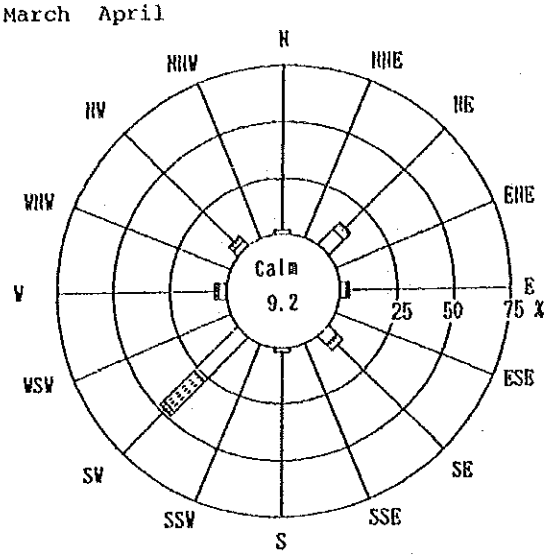
U (Knot) \ Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
0.0- 4.9	0.8	0.0	16.1	0.0	4.4	0.0	3.8	0.0	3.0	0.0	20.7	0.0	2.6	0.0	7.6	0.0	10.7	69.6
5.0- 9.9	0.2	0.0	2.6	0.0	1.3	0.0	1.2	0.0	0.9	0.0	16.5	0.0	1.3	0.0	4.6	0.0	0.0	28.6
10.0-14.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.7	0.0	0.0	1.7
15.0-19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
20.0-24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25.0-29.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0-34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.0-39.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0-44.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45.0-49.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.0-54.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55.0-59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.0-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65.0-69.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.9	0.0	18.8	0.0	5.7	0.0	4.9	0.0	3.8	0.0	38.3	0.0	3.9	0.0	12.9	0.0	10.7	100.0

Annual

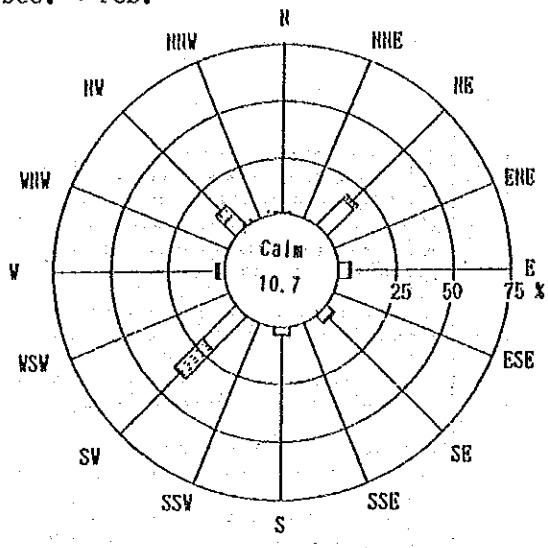
U (Knot) \ Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTAL
0.0- 4.9	0.7	0.0	6.5	0.0	1.8	0.0	2.6	0.0	1.2	0.0	21.3	0.0	2.3	0.0	4.7	0.0	6.0	47.2
5.0- 9.9	0.2	0.0	1.5	0.0	0.7	0.0	1.1	0.0	0.4	0.0	28.8	0.0	2.8	0.0	6.8	0.0	0.0	42.4
10.0-14.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.6	0.0	2.5	0.0	0.0	8.5
15.0-19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.1	0.0	0.5	0.0	0.0	1.9
20.0-24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
25.0-29.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0-34.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.0-39.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0-44.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45.0-49.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.0-54.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55.0-59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.0-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65.0-69.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.9	0.0	8.2	0.0	2.5	0.0	3.7	0.0	1.6	0.0	56.6	0.0	5.8	0.0	14.5	0.0	6.0	100.0

Appendix I-4-2 Wind Rose

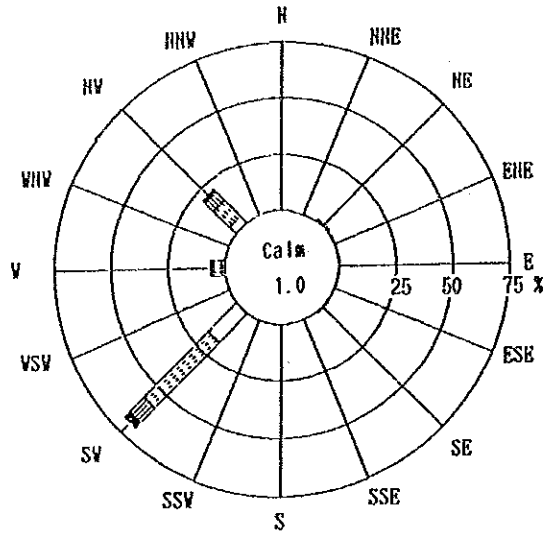
March April



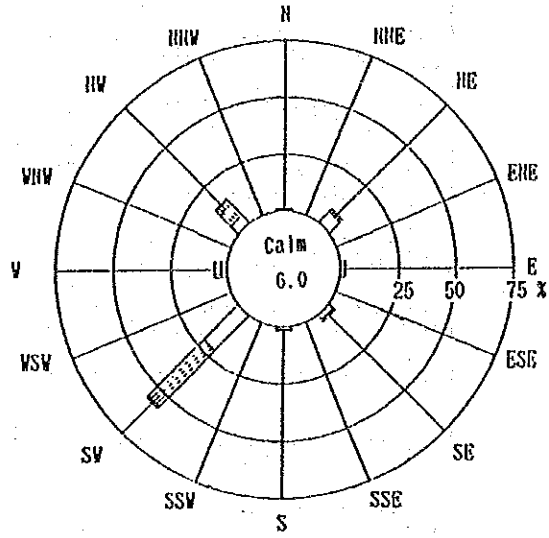
Dec. ~ Feb.



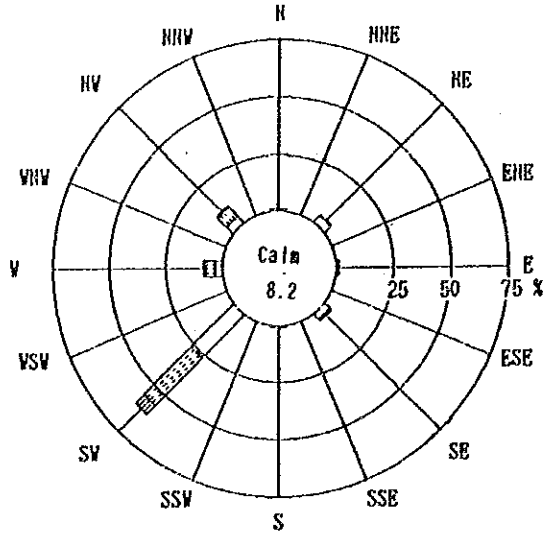
May ~ Sep.

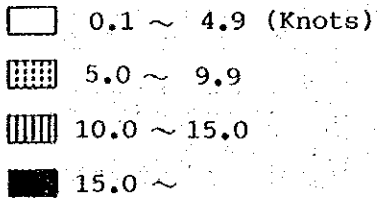


Annual



Oct. Nov.





Appendix I-4-3 Temperature and Humidity

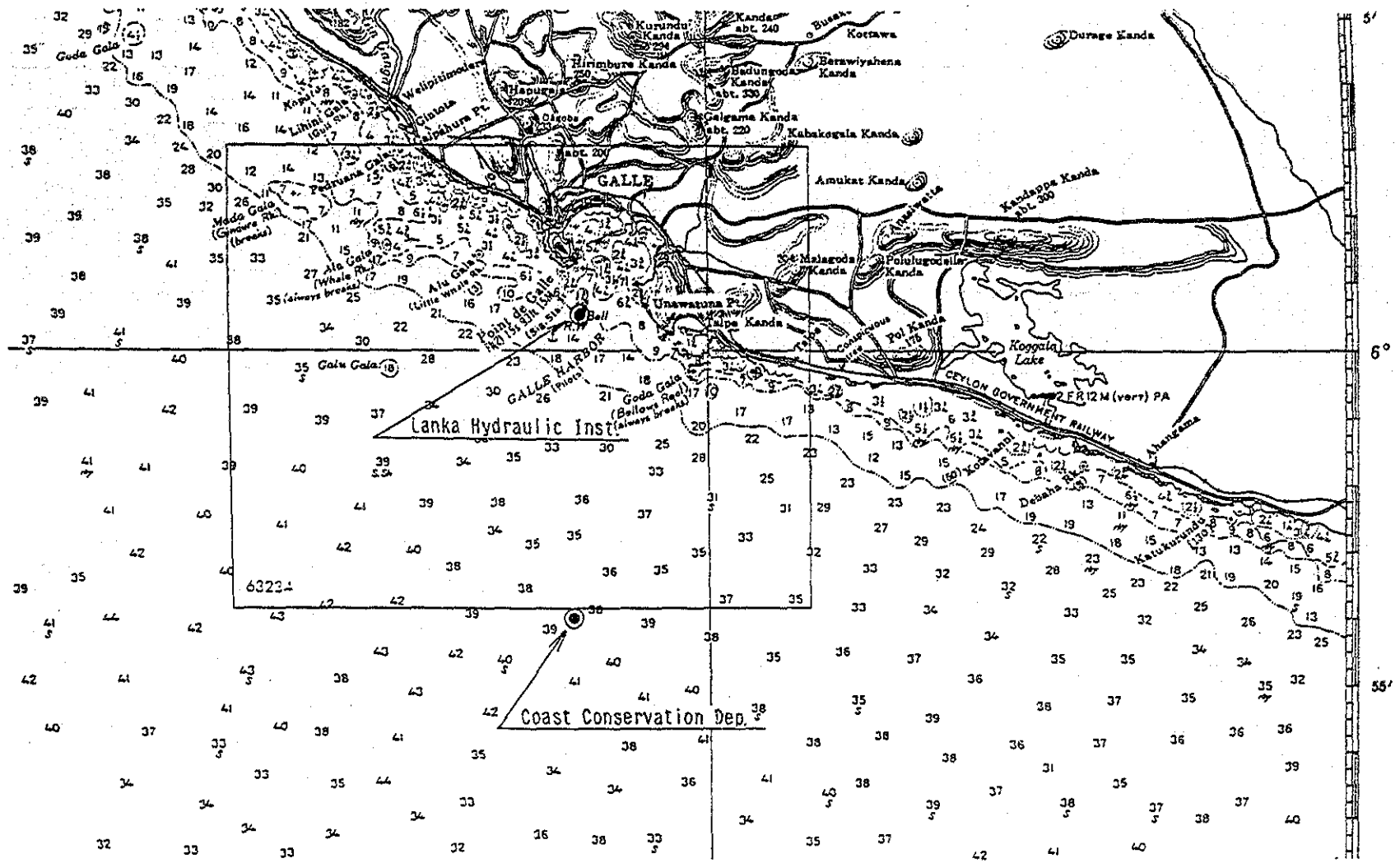
(Jan. 1980 ~ Dec. 1989)

MONTH	TEMPERATURE (°C)				HUMIDITY(%)	
	MAXIMUM		MINIMUM		MEAN	
	MEAN	HIGHEST	MEAN	LOWEST	DAY	NIGHT
Jan.	29.1	31.8	23.2	20.5	78.2	88.6
Feb.	30.1	34.1	23.2	21.5	72.8	86.0
Mar.	30.9	35.4	24.3	20.9	73.6	87.0
Apr.	30.9	34.6	25.3	21.7	78.2	88.2
May.	30.1	32.6	25.7	22.3	81.6	88.8
Jun.	29.0	30.6	25.4	21.2	88.3	87.4
Jul.	28.6	30.4	25.1	21.7	84.2	90.2
Aug.	28.4	30.4	25.0	22.3	85.8	89.4
Sep.	28.7	30.6	24.9	21.9	82.8	88.0
Oct.	29.0	32.5	24.4	22.0	81.7	89.2
Nov.	29.4	32.8	23.5	21.3	79.2	89.4
Dec.	29.4	32.2	23.4	21.2	79.0	91.3
Total	353.6		293.4		960.4	1063.5
Mean	29.5		24.5		80.0	88.6
Max.		35.4		20.5		

Appendix I-4-4 Rainfall

YEAR		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	ANNUAL
1980	1	125.8	4.6	63.4	175.3	102.3	126.5	61.3	148.8	416.4	244.5	286.0	253.3	2008.2
	2	7	3	7	21	14	33	19	19	18	19	19	10	179
	3	43.2	3.6	26.3	30.7	51.1	22.9	10.1	44.8	192.1	44.8	76.5	100.9	192.1
1981	1	102.0	83.2	88.7	273.0	394.0	52.8	44.5	147.9	148.0	239.9	305.9	205.8	2085.7
	2	7	8	10	15	22	11	15	17	22	16	10	10	163
	3	45.8	23.0	35.2	97.1	106.9	10.7	10.6	37.4	50.2	58.2	90.8	65.4	106.9
1982	1	17.3	1.8	151.3	421.3	322.0	235.4	191.9	158.6	174.3	218.6	577.1	87.3	2556.9
	2	3	1	14	7	17	21	20	12	23	18	25	14	175
	3	13.4	1.8	47.6	139.6	105.6	38.4	34.4	118.1	69.4	38.3	158.3	30.2	158.3
1983	1	76.4	0.6	54.5	18.7	110.1	122.6	113.5	150.7	338.0	180.2	144.6	240.0	1549.9
	2	7	1	3	3	14	17	17	22	25	16	10	14	149
	3	49.8	0.6	44.2	14.6	31.6	28.4	21.8	19.1	33.0	41.7	39.8	56.7	49.8
1984	1	212.0	102.1	60.5	304.2	466.4	208.0	149.6	18.8	208.1	98.8	310.3	106.6	2245.4
	2	16	8	7	19	20	23	19	5	11	14	20	7	169
	3	59.6	46.7	19.1	62.8	93.3	48.7	24.5	8.7	60.8	20.4	89.8	74.1	93.3
1985	1	139.4	114.0	91.7	82.1	212.5	402.2	71.6	229.3	159.2	252.9	224.1	240.7	2219.7
	2	11	9	15	13	23	24	17	23	15	16	18	15	199
	3	35.3	26.8	22.2	44.0	45.0	53.8	22.9	115.1	35.9	87.8	58.5	46.2	115.1
1986	1	63.2	60.1	151.8	148.8	224.1	79.1	31.9	90.3	122.0	223.3	313.0	186.4	1694.0
	2	9	6	17	13	13	15	13	15	20	19	21	15	176
	3	29.8	34.0	29.5	27.3	51.7	17.8	11.1	20.0	30.0	42.0	65.3	47.7	65.3
1987	1	87.7	3.7	5.1	242.6	140.6	237.2	8.1	476.9	334.1	523.5	335.3	71.7	2466.5
	2	13	3	4	15	13	18	8	26	19	24	19	8	172
	3	19.0	2.4	2.1	55.8	48.8	84.1	3.0	59.1	107.1	50.8	103.7	23.4	107.1
1988	1	92.0	114.1	225.4	222.7	228.1	328.4	224.7	301.9	249.3	60.1	260.7	83.6	2391.0
	2	8	13	13	17	21	22	23	23	17	7	0	9	173
	3	66.9	69.7	106.7	73.6	72.0	109.8	41.6	46.4	44.4	16.5	139.8	40.2	139.8
1989	1	86.7	23.0	68.6	322.1	386.1	228.7	141.1	118.9	179.2	428.9	284.0	58.0	2325.3
	2	13	4	5	17	21	14	15	14	23	16	19	7	168
	3	18.4	16.3	29.3	104.7	110.0	49.1	36.3	38.9	41.6	82.2	96.1	19.8	110.0
MEAN	1	100.2	50.7	96.1	221.1	258.6	202.1	103.8	184.2	232.9	247.1	304.1	153.3	2154.3
MEAN	2	9.4	5.6	9.5	14.0	17.8	18.8	16.6	17.8	19.3	16.5	17.9	10.9	174.1
MAX	3	66.9	69.7	106.7	139.6	106.9	109.8	41.6	118.1	192.1	87.8	158.3	100.9	192.1

Note : 1.Monthly Rainfall (mm)
2.Number of Rainy Days
3.Heaviest Rainfall (mm/day)



Appendix I-4-5 Location of Wave Meters

Appendix I-4-6 Distribution of Significant Wave Height and Period (%)

March April

$H_{1/3}$ (m) \ $T_{1/3}$ (sec)	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
0.50-0.99	0.0	0.0	0.0	0.1	5.1	15.0	15.8	7.1	2.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	45.8
1.00-1.49	0.1	0.0	0.0	0.0	0.6	12.2	16.4	11.9	7.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	50.0
1.50-1.99	0.0	0.0	0.0	0.0	0.0	0.2	1.3	0.9	1.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	4.1
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1	0.0	0.0	0.1	5.8	27.3	33.5	19.9	11.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0

May ~ Sep.

$H_{1/3}$ (m) \ $T_{1/3}$ (sec)	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.50-0.99	0.0	0.0	0.0	0.0	0.3	1.8	1.3	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8
1.00-1.49	0.0	0.0	0.0	0.0	0.9	8.7	8.9	3.9	1.5	0.6	0.2	0.2	0.1	0.2	0.1	0.1	25.3
1.50-1.99	0.0	0.0	0.0	0.1	0.6	13.4	26.8	9.2	1.5	0.5	0.1	0.1	0.0	0.1	0.1	0.1	52.5
2.00-2.49	0.0	0.0	0.0	0.1	0.3	2.2	5.9	5.5	1.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	15.8
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.3
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.1	2.0	26.2	43.5	19.8	5.5	1.4	0.6	0.2	0.2	0.3	0.1	0.2	100.0

Oct. Nov.

$H_{1/3}$(m) \ $T_{1/3}$(sec)	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
0.50-0.99	0.0	0.0	0.0	0.1	1.7	8.3	11.4	5.0	1.0	0.6	0.7	0.2	0.4	0.6	0.0	0.0	30.1
1.00-1.49	0.0	0.0	0.0	0.2	1.8	11.8	13.7	7.7	3.2	1.0	1.4	0.2	0.3	0.7	0.2	0.2	42.5
1.50-1.99	0.0	0.0	0.0	0.4	0.3	7.6	5.8	1.3	1.4	1.4	0.7	0.1	0.2	0.2	0.0	0.2	19.5
2.00-2.49	0.1	0.0	0.0	0.2	0.4	1.2	2.6	0.7	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.1	5.6
2.50-2.99	0.0	0.0	0.0	0.0	0.1	0.1	1.0	0.7	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	2.1
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.1	0.0	0.0	0.9	4.3	29.2	34.5	15.4	6.1	3.0	3.0	0.6	0.9	1.5	0.2	0.4	100.0

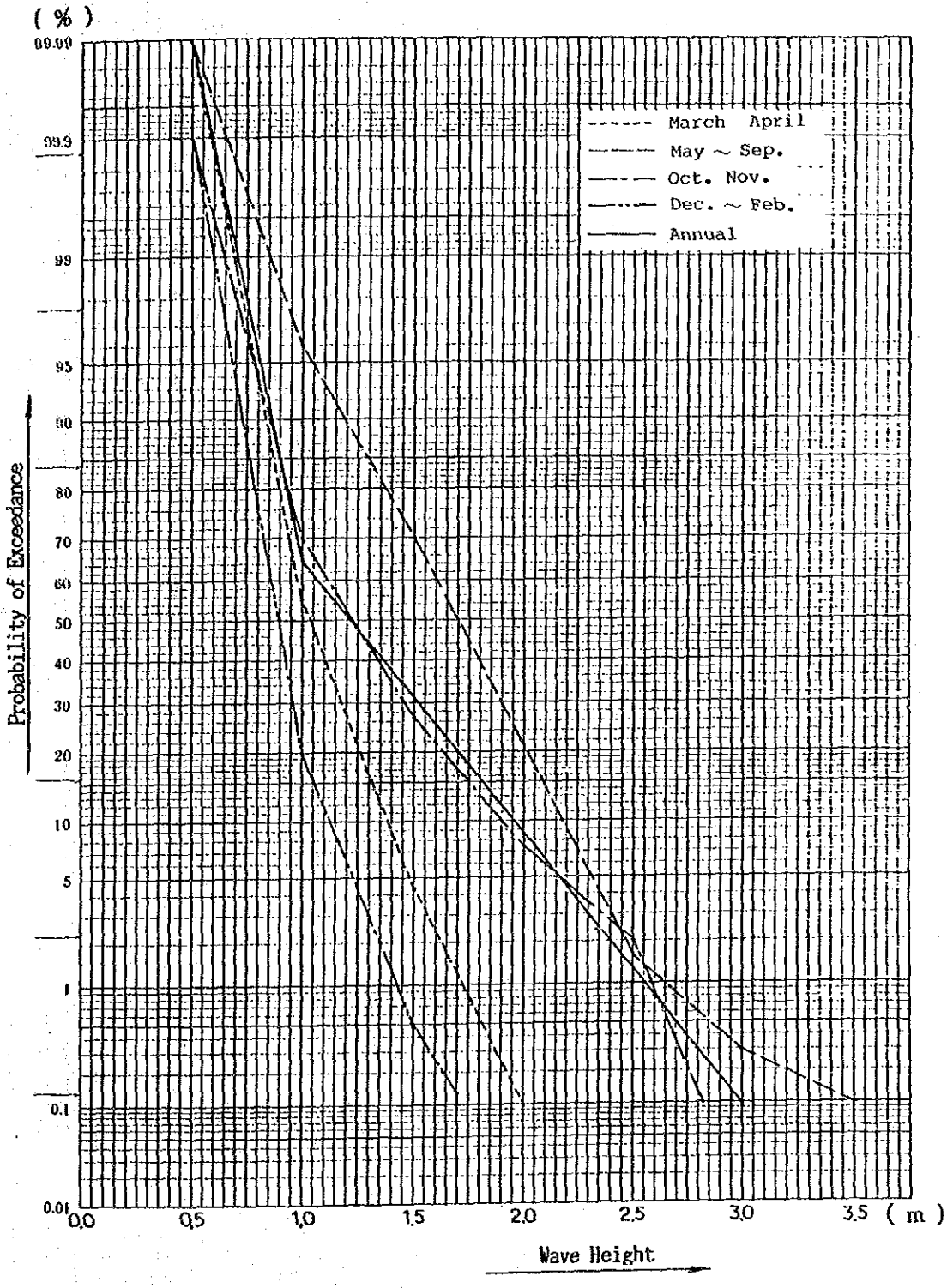
Dec. ～ Feb.

$H_{1/3}$(m) \ $T_{1/3}$(sec)	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
0.50-0.99	0.0	0.0	0.0	0.8	13.7	30.2	17.9	7.3	3.7	2.2	2.0	0.5	0.8	0.5	0.1	0.1	79.9
1.00-1.49	0.0	0.1	0.0	0.9	2.9	5.7	4.7	2.4	1.6	1.1	0.2	0.1	0.0	0.0	0.0	0.0	19.4
1.50-1.99	0.0	0.0	0.0	0.0	0.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.1	0.0	1.7	16.7	36.3	22.7	9.7	5.2	3.3	2.1	0.6	0.8	0.5	0.1	0.1	100.0

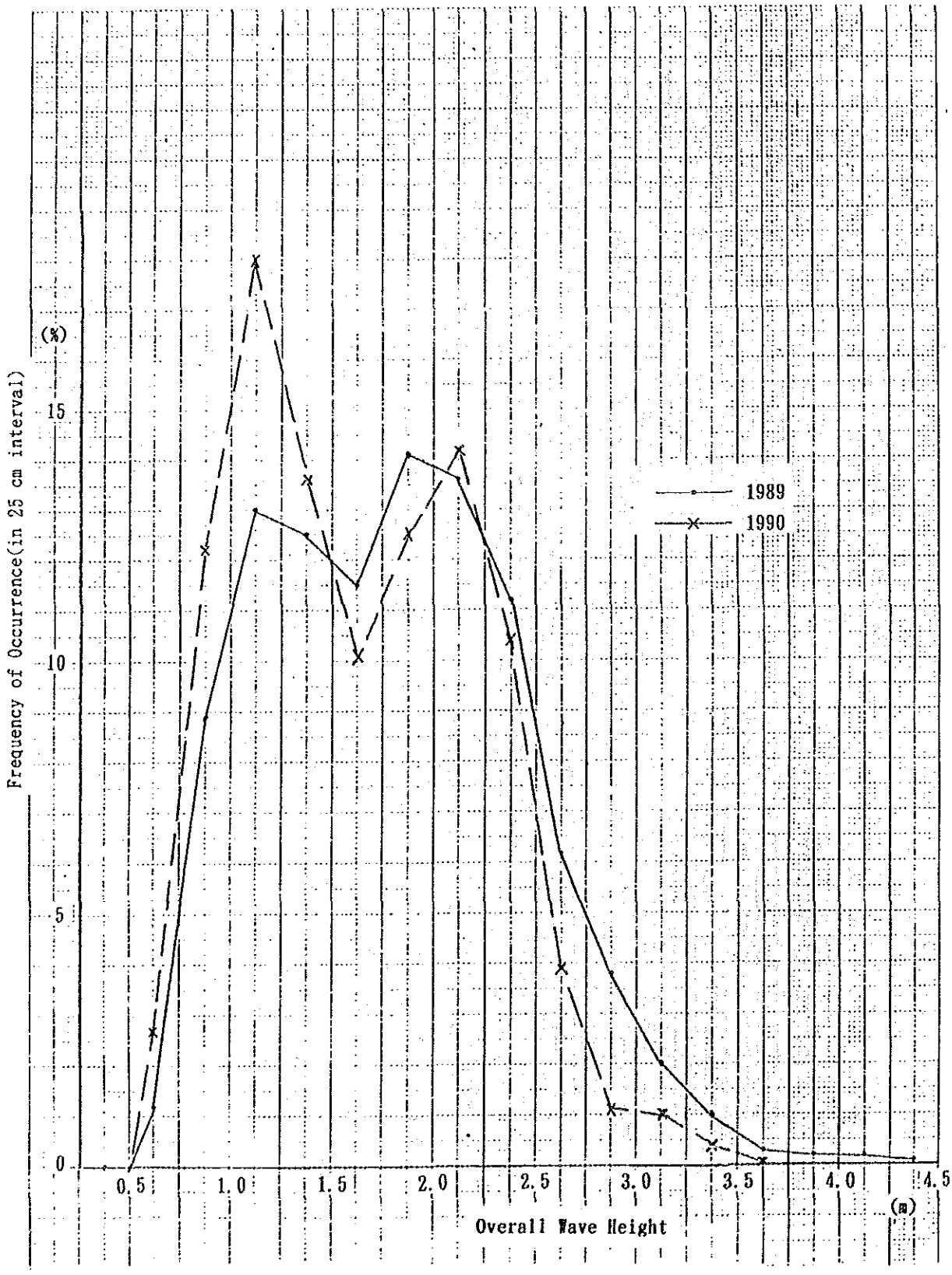
Annual

$H_{1/3}$ (m) \ $T_{1/3}$ (sec)	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
0.50-0.99	0.0	0.0	0.0	0.2	4.6	12.1	9.5	4.3	1.6	0.7	0.6	0.2	0.3	0.2	0.0	0.0	34.4
1.00-1.49	0.0	0.0	0.0	0.3	1.5	9.1	9.9	5.5	2.8	0.9	0.4	0.1	0.1	0.2	0.1	0.1	30.9
1.50-1.99	0.0	0.0	0.0	0.1	0.3	7.0	12.5	4.2	1.0	0.5	0.2	0.0	0.0	0.1	0.0	0.1	26.1
2.00-2.49	0.0	0.0	0.0	0.1	0.2	1.1	2.9	2.4	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	7.6
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.9
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.6	6.7	29.4	35.2	16.6	6.4	2.3	1.3	0.3	0.4	0.5	0.1	0.2	100.0

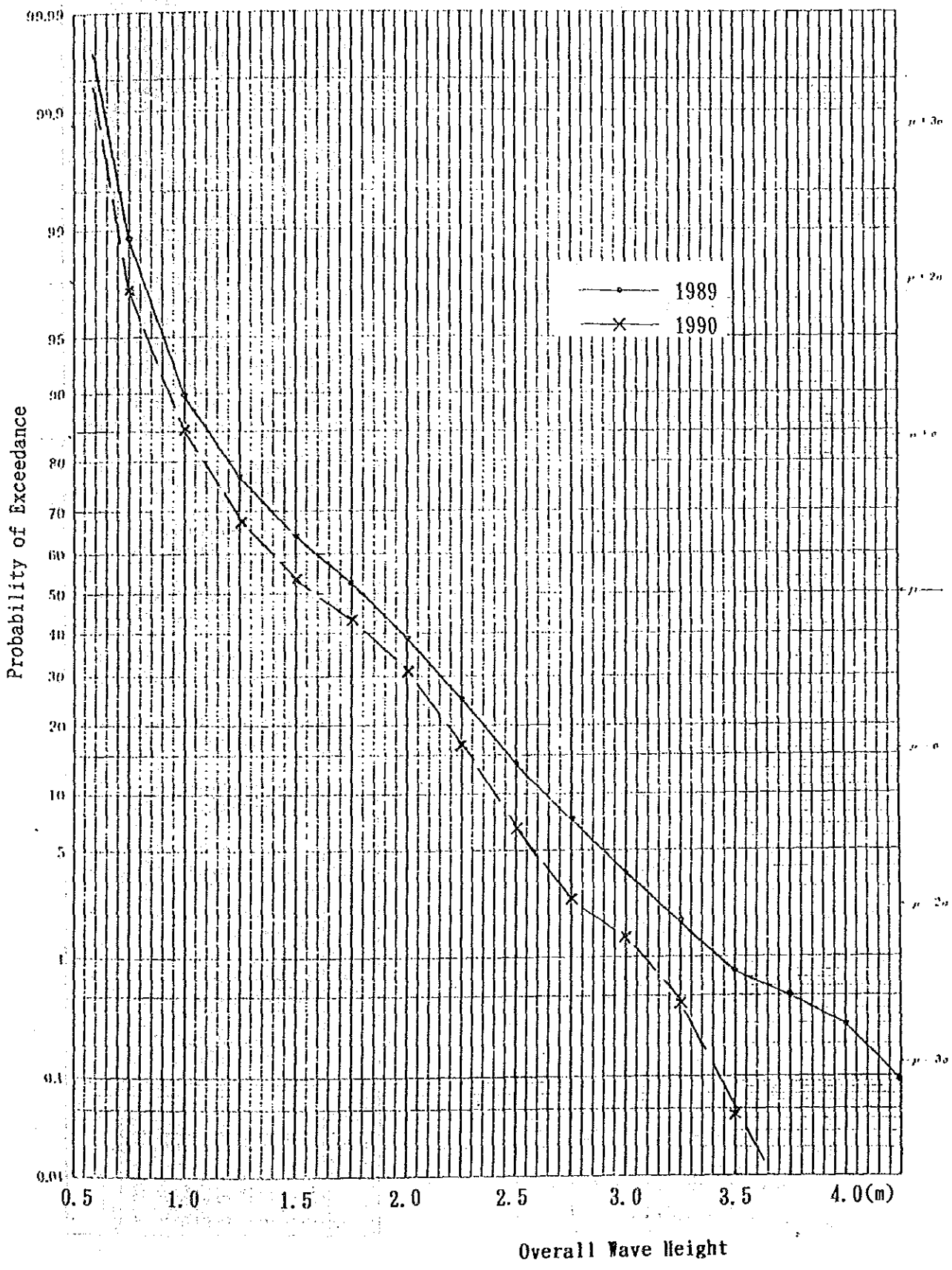
Appendix I-4-7 Exceedance Probability of Wave Height



Appendix I-4-8 Frequency Distribution of Overall Wave Height



Appendix I-4-9 Exceedance Probability of Overall Wave Height



Appendix I-4-10 Distribution of Significant Wave Height and Direction (%)

(Swell)

March April

Direction / $H_{1/3}$ (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.9
0.50-0.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	34.4	9.7	0.0	0.0	0.0	0.0	0.0	0.0	51.3
1.00-1.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	33.4	5.5	0.0	0.0	0.0	0.0	0.0	0.0	40.3
1.50-1.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	6.2
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	71.8	19.8	0.0	0.0	0.0	0.0	0.0	0.0	100.0

May ～ Sep.

Direction / $H_{1/3}$ (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.6
0.50-0.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	5.3	4.9	1.0	0.0	0.1	0.0	0.0	0.0	11.4
1.00-1.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	21.5	16.3	0.8	0.6	0.1	0.0	0.0	0.0	41.2
1.50-1.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	22.9	10.4	0.9	0.8	0.0	0.0	0.0	0.0	38.2
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	3.5	3.5	0.1	0.0	0.0	0.0	0.0	0.0	7.4
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	1.1
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	53.4	36.3	3.1	1.5	0.2	0.0	0.0	0.0	100.0

Oct. Nov.

Direction / $H_{1/3}$ (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	1.3
0.50-0.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	21.4	15.2	0.0	0.0	0.0	0.0	0.0	0.0	37.0
1.00-1.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	42.5	11.2	0.0	0.0	0.0	0.0	0.0	0.0	55.3
1.50-1.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	6.4
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	70.5	27.5	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Dec. ~ Feb.

Direction / $H_{1/3}$ (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	3.0
0.50-0.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	66.1	20.3	0.0	0.0	0.0	0.0	0.0	0.0	94.4
1.00-1.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	2.6
1.50-1.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	69.1	22.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Annual

Direction / $H_{1/3}$(m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.9	0.1	0.0	0.0	0.0	0.0	0.0	1.6
0.50-0.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	27.9	11.2	0.4	0.0	0.0	0.0	0.0	0.0	42.8
1.00-1.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	22.0	9.8	0.3	0.3	0.0	0.0	0.0	0.0	33.9
1.50-1.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	11.2	4.8	0.4	0.3	0.0	0.0	0.0	0.0	18.1
2.00-2.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	3.2
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	63.2	28.5	1.3	0.6	0.1	0.0	0.0	0.0	100.0

Appendix I-4-11 Distribution of Significant Wave Height and Period (%)

(Swell)

Annual

$T_{1/3}$(sec) / $H_{1/3}$(m)	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	20.0-20.9	21.0-21.9	22.0-22.9	TOTAL
0.00-0.49	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.1	0.2	0.5	0.0	0.2	0.0	0.1	0.0	0.0	1.6
0.50-0.99	0.0	0.2	1.6	5.8	13.0	5.7	5.1	4.1	4.3	2.2	0.0	0.6	0.0	0.2	0.0	0.1	42.8
1.00-1.49	0.0	0.3	0.8	4.6	7.7	4.9	5.3	4.4	4.1	1.4	0.0	0.4	0.0	0.0	0.0	0.1	33.9
1.50-1.99	0.0	0.0	0.3	1.5	4.0	2.5	2.9	2.5	2.9	1.0	0.0	0.2	0.0	0.2	0.0	0.0	18.1
2.00-2.49	0.0	0.0	0.0	0.3	0.5	0.4	0.5	0.3	0.7	0.5	0.0	0.2	0.0	0.1	0.0	0.0	3.2
2.50-2.99	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5
3.00-3.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.50-3.99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.00-4.49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.5	2.7	12.1	25.2	13.7	13.9	11.4	12.2	5.7	0.0	1.6	0.0	0.7	0.0	0.2	100.0