6.2 Port Improvement Plan of the Existing Facilities

It has been proposed to extend the existing west breakwater by 300 m to reduce sea wave (swell) agitation in front of Pier No.1. By the extension, calmness level in the basin will be improved by an increase in 50 cm non-excess provability of wave height to 95.8% from the current level of 89.7% at the tip of the pier.

6.3 Port Expansion Plan

(1) Necessity of Port Expansion

To meet the forecast demand for the Port in the stage of the Long-Term Plan with the target year 2022, it is necessary to expand port capacity. The new off-shore port area needs to be placed to the east of the existing off-shore port area so as to facilitate an access from the reserved land port area to be used in the future extending to the east from the existing land port area, whereas to the west of the existing port area and if expanded in that direction, there would be a fear of interference between off-shore port operations at the existing and newly expanded areas.

In addition to meet the demand for a quantitative increase in cargo-handling capacity, it is required to increase the competitiveness of the Port among the neighbouring ports in the northeast region by preparing highly efficient marine terminals with deepwater berths catering for Post-Panamax container ship, Cape-Size bulkers and Aframax tankers connected with well-designed railway access lines as well as road access.

(2) Marine Terminals

The required number, scale and type of marine terminals at the expanded port area have been verified by computer simulation. In the first step, some number, scale and type of terminals have been assumed, and then has been verified whether the required service level has been satisfied. If not satisfied, different figures have been given for the further simulation trial. After trial and error procedure, eventually, the optimum number, scale and type of required marine terminals have been determined composed of Container Terminal, Grain/Fertilizer Terminal, Multi-purpose Terminal and Fruit Terminal..

(3) Required Dimensions of a New Sea Channel and Basins

To have access to a new off-shore port area to be expanded in the direction of the east, it is necessary to create an access channel. A one-way channel has been verified to be sufficient by the results of the simulation. The bottom width of the planned one-way sea channel has been designed through the verification by applying the prevailing guidelines including PIANC for the representative principal dimensions of the design vessels. In this study, 210 m has been applied as the planned bottom breadth of the sea channel

The water depths of the planned one-way sea channel and basins within the expanded port area protected breakwaters have been designed by applying the prevailing guidelines including PIANC for the representative principal dimensions of the design vessels. According to the PIANC Guideline, water depth of 16 m is required by applying multiplier of 1.1 for design draft of 14.5 m in inside basins. On the other hand, water depths of 16.5 m in the open sea are required according to the method considering ship movements that was recently developed in Japan.

(4) Turning Basin

The turning basin within the expanded port area protected breakwaters has been designed so as to provide a turning circle with a diameter of twice the LOA of the design vessel. The maximum length among design vessel is 381 m. Thus a diameter of 760 m for turning circle has been considered in the design of the turning basin.

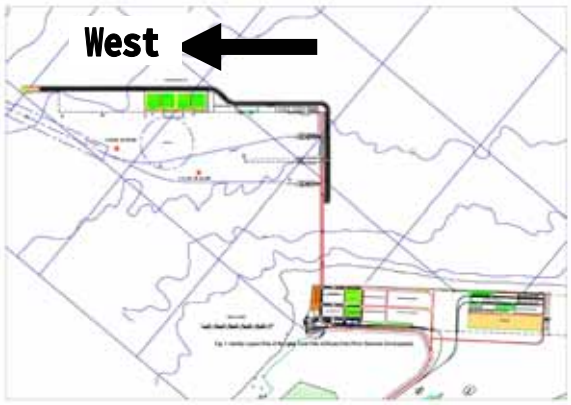
(5) Required Breakwaters

Breakwaters are required for the new off-shore port area to protect the inner channel, turning basins and berths. The new breakwaters need to be placed so as to halt the waves in the outer sea penetrating to the port waters from ENE as wind waves and NE as swell.

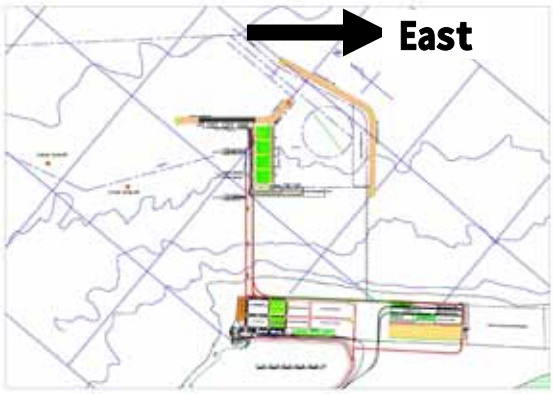
(6) Facility Layout Plan

1) Potential Directions of Port Expansion

When considering the direction of port expansion, the two directions, viz. east and west of the existing port facilities have been envisaged. The two options, viz. the west expansion option (Option 1) and the east expansion option (Option 2) have been compared in detail with possible layout plans as shown below.



Option 1



Option 2

As a result of the comparison, it has been concluded that the west expansion plan, “Option 1” has the following fatal disadvantages over the east expansion plan, “Option 2”:

- Insufficient protection of basins from the penetrating waves from ESE direction due to the limitation of extending the existing south breakwater.
- Excessively far haul distance from port land area for port cargo storage
- High construction cost

Thus, in this study, “Option 1” has been ruled out and “Option 2” has been further divided into four Alternatives which have been compared with each other to select the optimum plan.

2) Alternative Plans

Four alternative layout plans satisfying facility requirements for the new port in the stage of the Long-Term Plan have been made (see Figures 6.2 to 6.5).

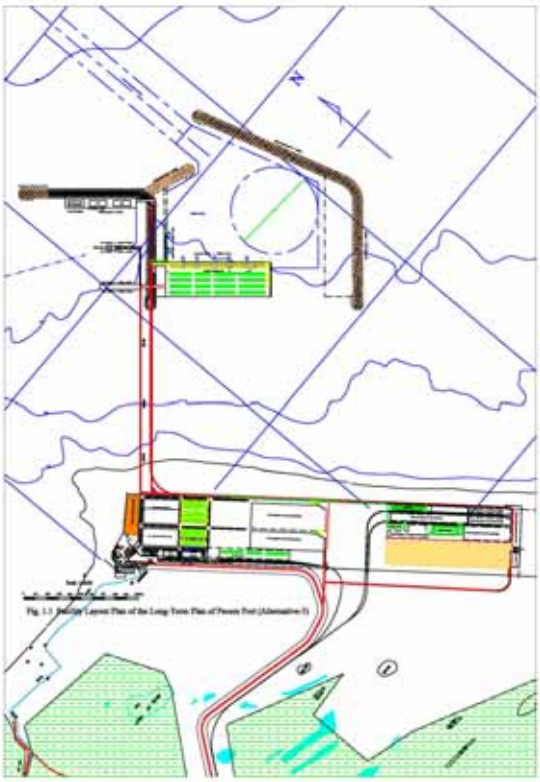


Figure 6.2 Alternative - 1

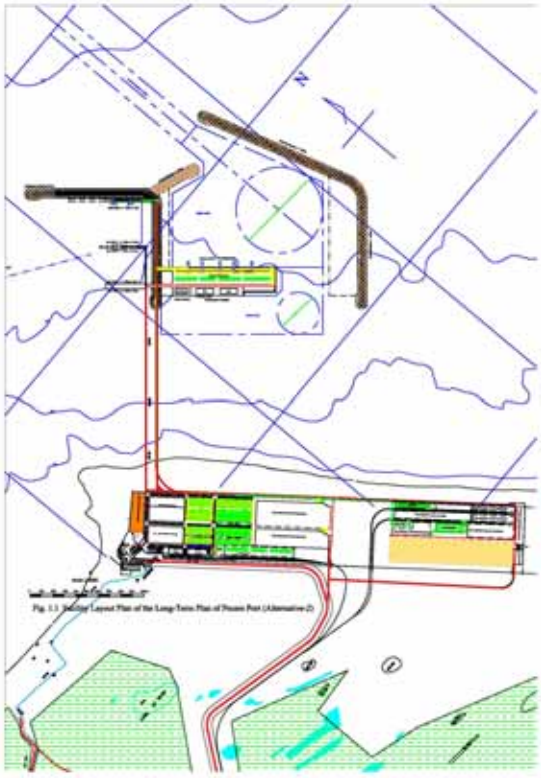


Figure 6.3 Alternative - 2

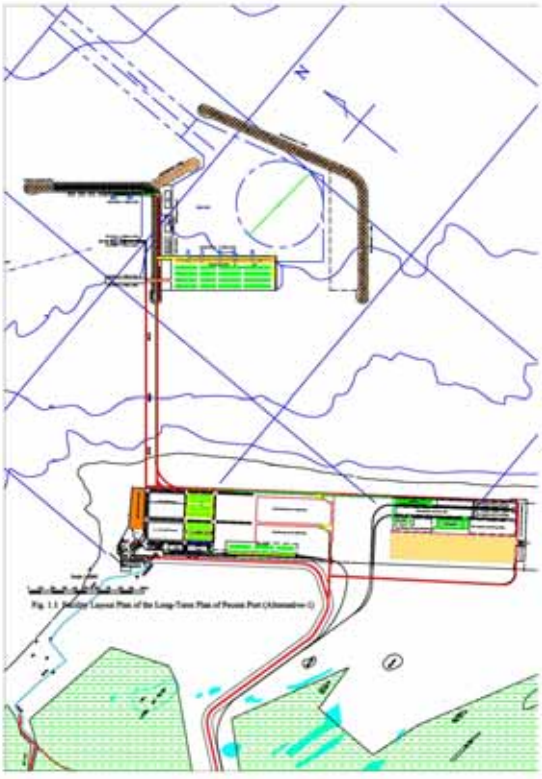


Figure 6.4 Alternative - 3

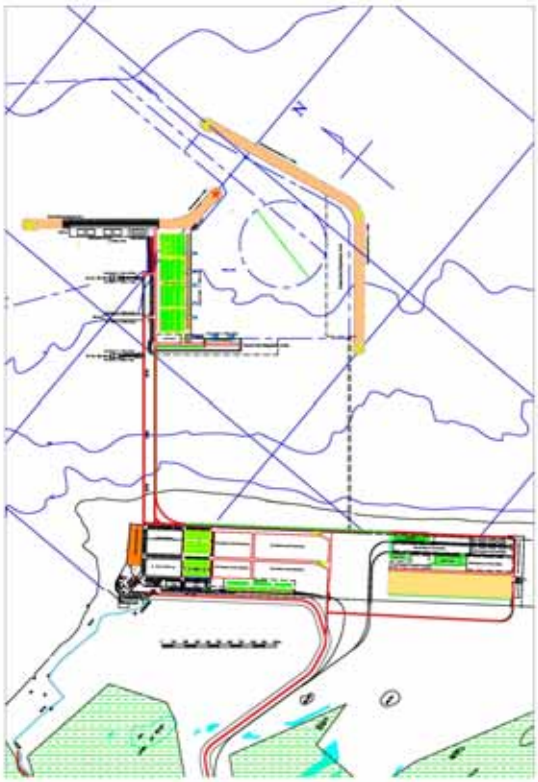


Figure 6.5 Alternative - 4

3) Comparison of Alternative Facility Layout Plans

The above four alternatives have been compared with each other from the following points.

a) Calmness in the basin
b) Accessibility to the port terminals for railcars.
c) Accessibility to the terminals for vehicles from the outside of the port
d) Required area for the port expansion
e) Conservation of the natural sand beach
f) Construction cost
g) Ease of further expansion
h) Accessibility to the marine terminals for calling vessels
i) Competitiveness to other seaports in terms of water depth
j) Storage capacity
k) Efficiency of container-handling operations on dock

From the above comparison, Alternative-4 has been selected and proposed as the optimum plan.

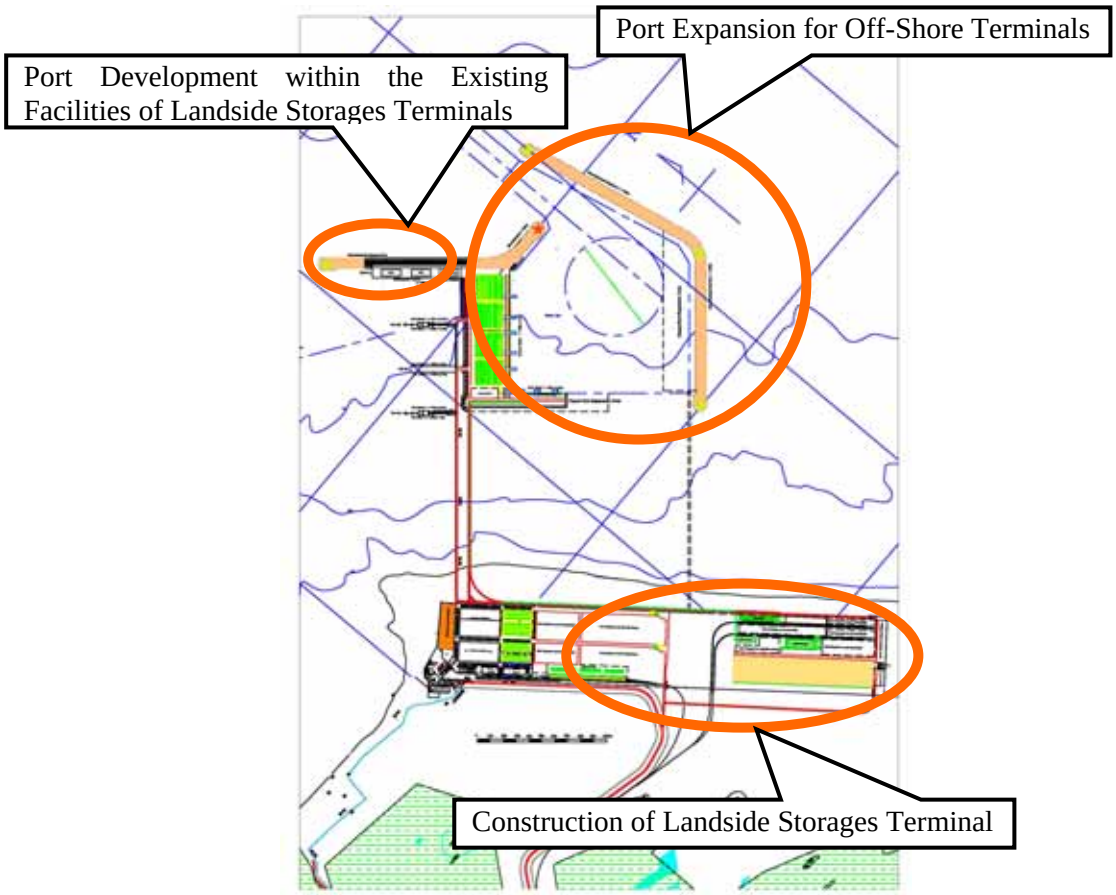


Figure 6.6 Concept of Facility Layout Plan

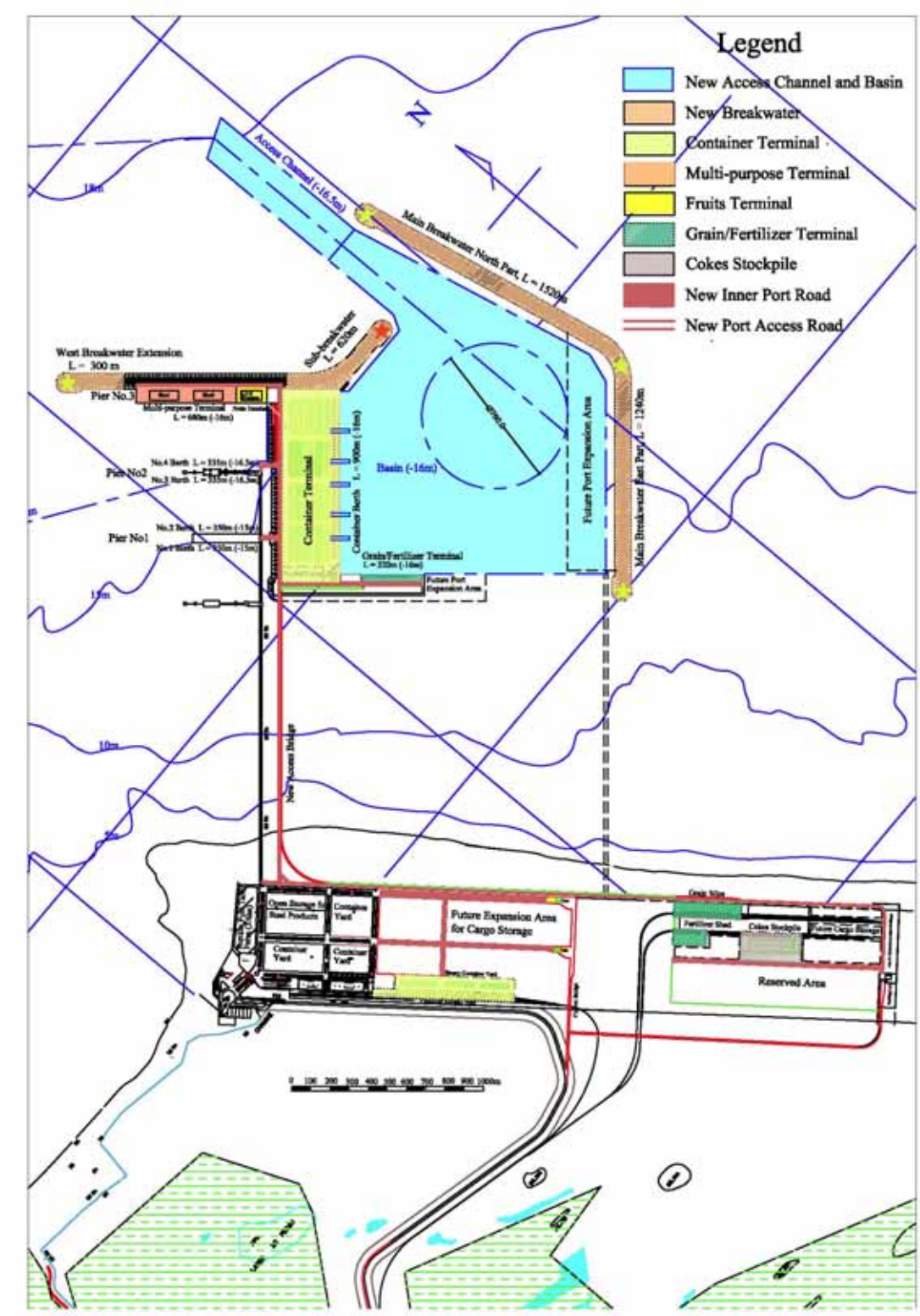


Fig. 6.7 Facility Layout Plan of Pecem Port (Long-Term Development Plan)

(7) Cargo Handling System

1) Container Handling Operation System

Important of container handling operation depends largely on the skill or technique of a quay side gantry crane operator, signal man's role to support a quay side gantry crane operator.

2) Container Handling Information System

Necessary information on containers should be obtained from container carriers or it agents as early as possible.

3) Container Inventory Control System

Inventory control of C.Y(container yard) is the most important task of container terminal management and operation.

4) Container Handling Equipment

Vessel and C.Y (container yard) operation efficiency variety significantly depending on the equipment introduced,

Quay side gantry crane (outreach 50m applied for 18 rows stow on deck)

Yard equipment = rubber tier mounted gantry crane (capacity 1 over 4 high type)

Tractor and trailers (applied for 20’ 40’ and 45’ box)

5) Required Number of Container Handling Equipment (Long-term Project)

- Quay side gantry crane 6 units
- Rubber tier mounted gantry crane 22 units
- Tractor head 25 units
- Trailer (chassis) 28 units

6) Conventional Bulk Cargo Operation System

Conventional vessel operation efficiency varies significantly depending on the skilled labour and proper cargo handling tools introduced, for improvement of conventional vessels cargo and warehouse cargo operation.

7) Dry Bulk Cargo Handling Operation System

Bulk cargo operation system which is applied for these cargoes are equipment, which is installed on the quay side as well as a system that is connected to the storage site via belt conveyers.

8) Liquid Bulk Cargo Handling Operation System

It is windy and there are large swell and wave in around Pecem port, in order to protect marine pollution, it is necessary to expand the oil fence and to change the system of spreading the oil fence to an automated spreading system.

6.4 Connection to the Inland Transport Network

To receive the above-mentioned new cargoes from the expanded hinterland of the Port expected to be brought in mainly by railways, Pecem Port is required to prepare railway car receiving facilities with well-designed layout and sufficient capacity of tracks. From this viewpoint, track layout plan has been made.

6.5 Hydrological and Coastal Study

(1) Incidents Involving Moored Vessels in Present Port

There have been incidents at pier No.1 involving moored vessels concerning ship motion since the port opened. According to interviews with individuals involved, incidents of breaking mooring lines and of damage to mooring posts have taken place. The main reason for these incidents is swell waves. Though the frequency of incidents during the rainy season is much higher than that during the dry season, these incidents occurred throughout the year.

It was observed that rolling and pitching were predominant as the ship motions in these incidents. The oscillation period of rolling for the vessels of 10,000 to 30,000 DWT was estimated to be of about 14 to 16s. The peak frequency of wave spectrums for swell waves was about 0.07 Hz (T_p=14.3s). From this, the incidents involving moored vessels are presumably due to the fact that the peak frequency of wave spectrum was harmonized with the natural period of rolling for the vessel.

(2) Estimation of Calmness

The layout of offshore breakwaters for the long-term port development plan should be determined in such a way as to maintain the required calmness inside the basin. To estimate the wave height inside the basin, the numerical computation model for waves, which can consider the wave diffraction, refraction and reflection under the expected conditions of the wave field with directional wave spectrums, has been applied.

The calmness for the proposed container berth and for the existing pier No.1 has been estimated by using threshold wave heights of both 0.5m and 0.3m. The calmness for other berths has been estimated by using the threshold wave height of 0.5m. The appearance frequency of wave height not exceeding the threshold wave height shall be achieved for 97.5% or more of the days of the year.

The location map for calmness estimation points is shown in Fig. 6.8.

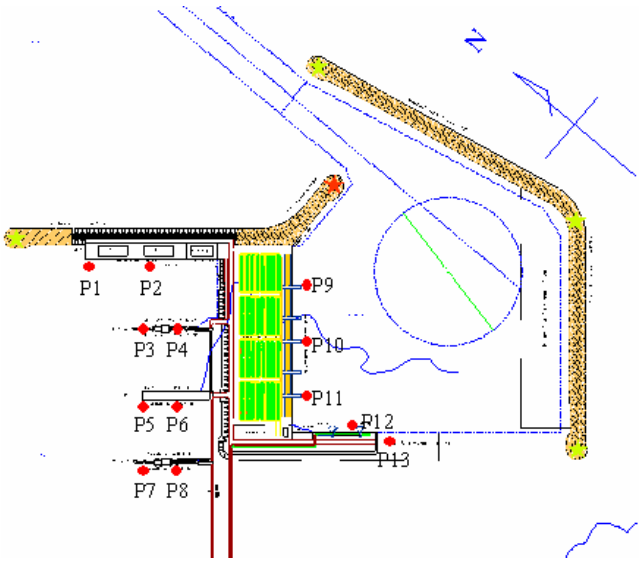


Figure 6.8 Calmness Estimation Points

Table 6.2 shows the obtained calmness at each berth point.

- The proposed new container and grain berth can be protected from both swell and sea waves due to construction of Main and Sub Breakwaters, and 100% calmness can be secured even for the case of the threshold wave height of 0.3m.
- The extension of the West Breakwater is necessary to secure the required calmness at existing pier No.1. The calmness at the head position of pier No.1 can be improved from 89.3% to 95.7% at the head position (Point No.4) by a 300m extension in the length of West Breakwater. The Pier No.1 (multi-purpose and fruits berth) also can secure 100% calmness.

Table 6.2 Estimated Calmness at Each Berth

Berth	Position	Point No.	Long-Term Plan		Present	
			Hcr<50cm	Hcr<30cm	Hcr<50cm	Hcr<30cm
Pier No.3	Head	1	-	100	-	100
	Center	2	-	100	-	100
Pier No.2	Head	3	100	-	93.0	-
	Center	4	100	-	100	-
Pier No.1	Head	5	95.7	70.3	89.3	29.1
	Center	6	99.2	91.9	93.0	64.0
Pier No.0 (for Reference)	Head	7	89.2	-	-	-
	Center	8	91.3	-	-	-
Container Berth	Head	9	100	100	-	-
	Center	10	100	100	-	-
	Bottom	11	100	100	-	-
Grain Berth	Head	12	100	-	-	-

(3) Coastal Impact Study

1) Characteristics of Littoral Drift

In the Pecém area, the westward littoral drift is predominant. From the previous studies, the net annual littoral transport at Mucuripe port was estimated at about 600,000 m3/year to 876,000 m3/year. On the other hand, the net annual littoral transport at Pecém area was estimated to be in the order of 350,000 m3/year.

2) Process of Shoreline Change Before Construction of the Port

From the comparison of shoreline in 1958, 1968 and 1987, the coast line from Ponta do Pecém to Pecém village has obviously retreated since 1958 by about 60m during the subsequent 30 years (about 2m/year). Especially, remarkable retreat has occured between 1968 and 1987.

3) Process of Shoreline Change During and After the Construction Period

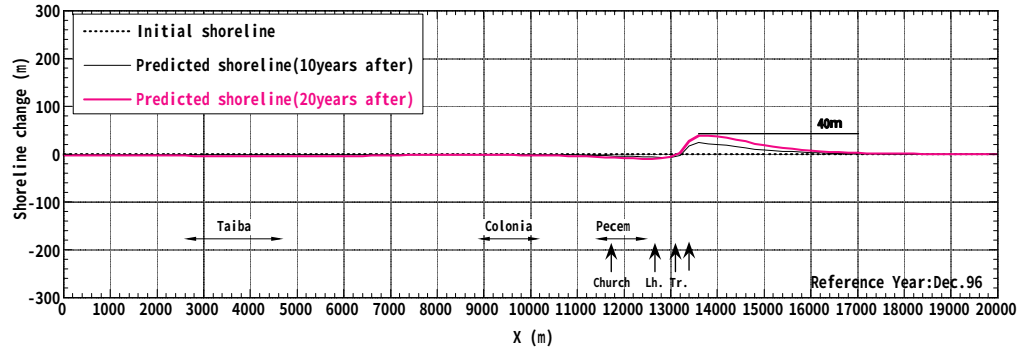
After construction of temporary jetty (TEP) during the construction period, the westward littoral drift was completely blocked and this caused shoreline accumulation east of Ponta do Pecém and caused retreat on the west side. At the east side (down-drift side) of TEP, the maximum of about 200 m of shoreline retreat occurred on the lee side of TEP, and about 30 to 40 m in front of Pecém village. The annual littoral transport, which can be roughly estimated by the monitoring survey result is about

280,000 to 360,000 m^3/year. From the comparison of shoreline change between 2004 and 2005 using the image processing of satellite photographs, it is expected that the drastic changes caused by the construction and removal of TEP, have almost finished. The coastal impact due to the existing port will be tracked from now on by conducting shoreline monitoring.

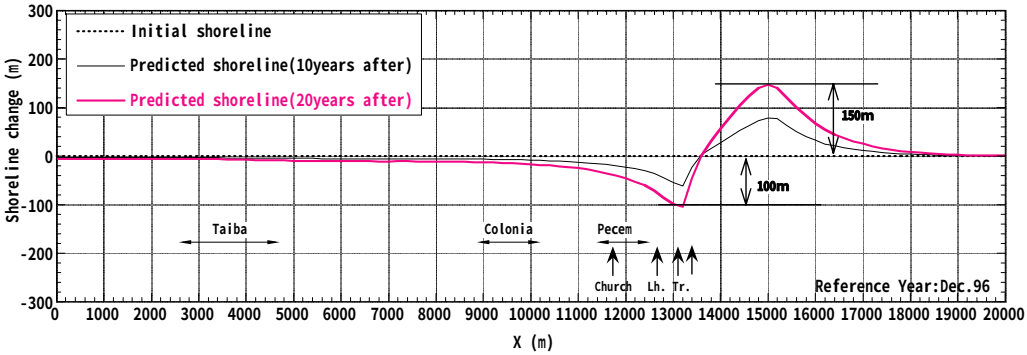
4) Coastal Impacts from the Future Plan

The coastal impacts caused by the layout of the long-term development plan have been examined using the numerical computation model called “multi contour line model”. Fig. 6.9 shows the comparison of shoreline change between existing and future port layout. With the future plan, a large accumulation area is formed behind the offshore breakwater compared to the present layout. The shoreline change at the maximum accumulation point increases by about four times compared to the case of the existing port.

Fig. 6.10 shows the comparison between the future plan and that of a semi-infinite jetty type breakwater the same as at Mucuripe Port. The shoreline change for the semi-infinite jetty type breakwater is significant with a maximum of 800m expected in 20 years because the westward littoral transport is completely intercepted by the jetty type breakwater. Therefore, even though the shoreline change for the proposed future plan is expected to be larger than that of the existing port due to expansion of the breakwater, this change of shoreline is much smaller than that for the semi-infinite jetty type breakwater.



(1) Existing Port Layout



(2) Long Term Development Plan

Fig. 6.9 Comparison of Predicted shoreline Change

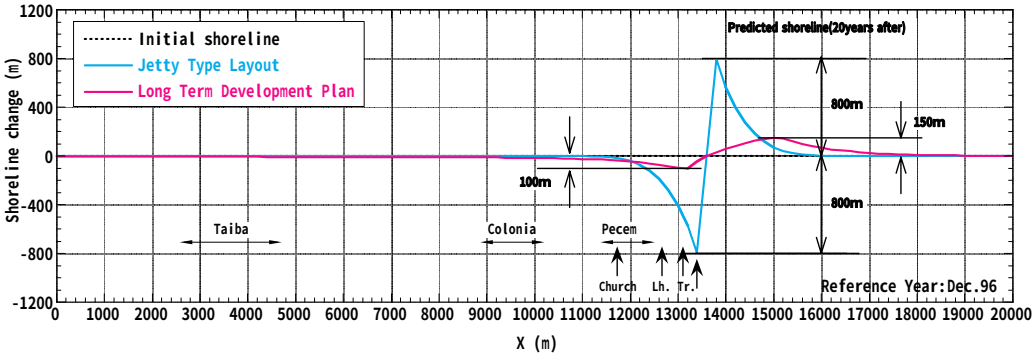


Fig. 6.10 Comparison of Shoreline Change for Two Type of Breakwater (Proposed Future Layout and Jetty Type Breakwater)

Table 6.3 shows the sediment balance, which was estimated by both the numerical and data analysis. Before construction of the port facility, the coastline around Pecém was in dynamic equilibrium with net annual transport of about 280,000 to 360,000 m3/year at the east side of Ponta do Pecém and 240,000 to 320,000 m3/year at the west side, and no net accumulation existed. For the long-term development plan, the net accumulation increases by about 120,000 to 160,000 m3/year, and further decrease of littoral transport at the west side occurs by about 63% (net littoral transport at the down drift side is 120,000 to 160,000 m3/year).

Table 6.3 Sediment Balance for Each Port Layout

Layout	Net annual littoral transport (m3/year)		Sediment Loss due to Natural Conditions (m3/year)	Net Accumulation due to Existence of Port (m3/year)
	Up-Drift Side (East Side)	Down Drift Side (West Side)		
Without Port	280,000 - 360,000	240,000 - 320,000	40,000	0
Existing Port	280,000 - 360,000	210,000 - 280,000	40,000	30,000 - 40,000
Long-Term Development Plan	280,000 - 360,000	120,000 - 160,000	40,000	120,000 - 160,000
(ref.) Semi- infinite Breakwater (Same as Mucuripe Port)	280,000 - 360,000	0	-	280,000 - 360,000

(4) Possibility of Sedimentation in Port Basin

From the monitoring survey results in the basin, no significant sedimentation was observed after construction of the Port. In addition, the average depths at pier No. 1 and No. 2 are about 15.5m and 16.5m, respectively, and this is far deeper than the estimated critical water depth for sediment movement. From this, the probability of remarkable sedimentation in the basin is quite low as long as the depth of the basin remains at the same level as the present basin. However, there is a possibility of sedimentation if the basin depth changes to become near the critical water depth for sediment movement, or, the shadow region for waves becomes wider due to the construction of a long breakwater due to the settlement of the suspended load in the shadow region for waves.

6.6 Design

(1) Design Manual, Standards and Codes

The Japanese Design Manual (Technical Standards and commentaries on Port and Harbour Facilities in Japan, 1999) has been basically adopted for the design of port facilities. In addition, the Shore Protection Manual (1977, 1984) has also been referred to for some specific parts.

(2) Design Criteria

The representative design criteria are shown as below.

Tide Condition

HHWL +3.20 m, LLWL (=DHN) 0.00 m

HWL +2.70 m, LWL +0.30 m

Design Waves

Table 6.4 Design Wave Heights (offshore and 18m depth)

Return Period (Year)	N	NNE	NE	ENE	E	ESE
H_0 (m)	2.1	2.4	2.8	2.3	3.2	2.9
$H_{1/3}$ (=H_s) (m) (at -18m depth)	2.1	2.4	2.9	2.1	2.9	2.7
T_p (s)	13.7	14.2	15.9	7.7	7.7	7.7
$T_{1/3}$(=T_p/1.05) (s)	13.0	13.5	15.1	7.3	7.3	7.3

Seismic Load

0.05 (kh).

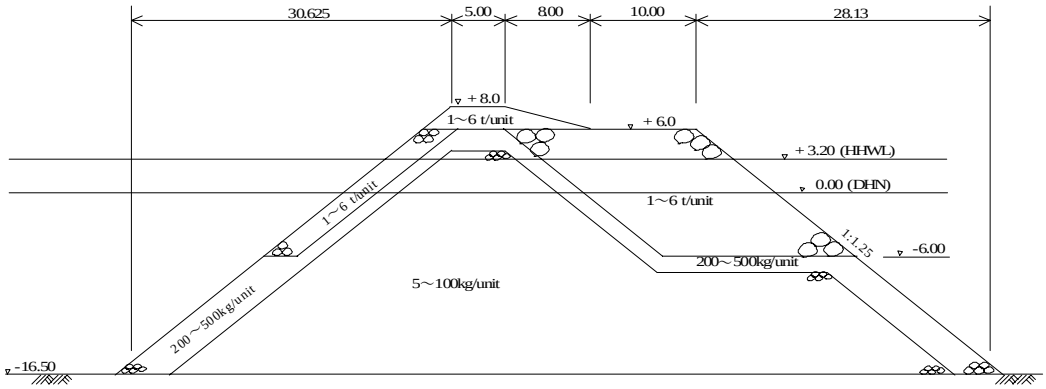
Subsoil Condition

Table 6.5 Preliminary Design Soil Parameters

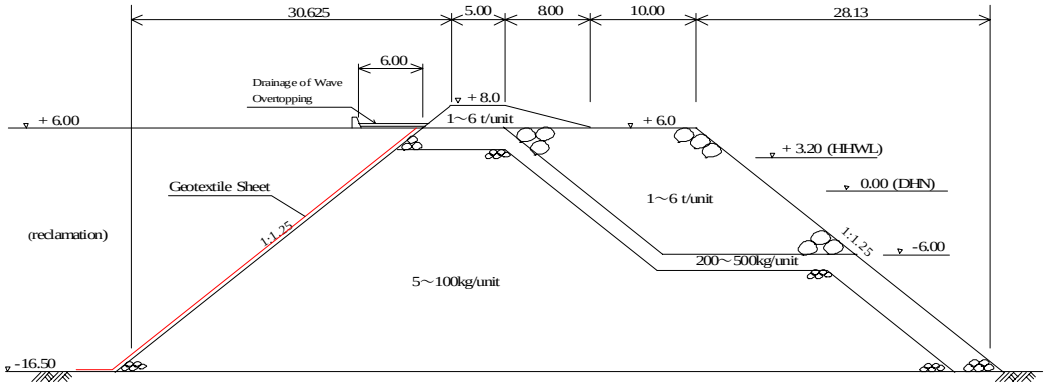
Stratum	Composition	N-Value	Unit Weight γ_t(kN/m^3)	Int. Friction Angle	Comp. Strength (N/mm^2)
Upper Stratum	Sand	10 to 50	18	30 °	-
Lower Stratum	Gneiss	Over 50	18	35 °	>100

(3) Design of Breakwaters

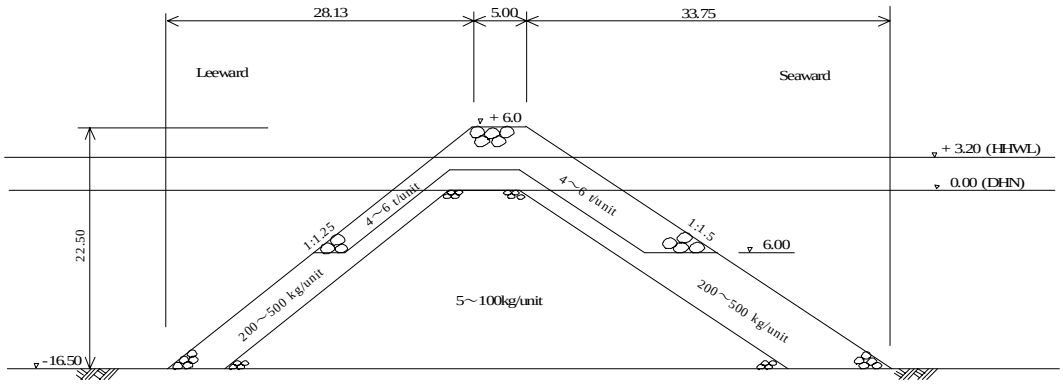
For the West and sub breakwaters, which are connected continuously to the existing breakwater, the berm type breakwaters with the same dimensions as the exiting breakwaters have been proposed to minimize the wave overtopping to the newly constructed berth. For the main breakwaters, the conventional type of breakwaters has been proposed to reduce the volume of rocks. The typical cross sections of each breakwater at the trunk portion are shown in Fig. 6.11.



(1) West and South Breakwaters (Berm Type)



(2) Seawall Portion (Berm Type)

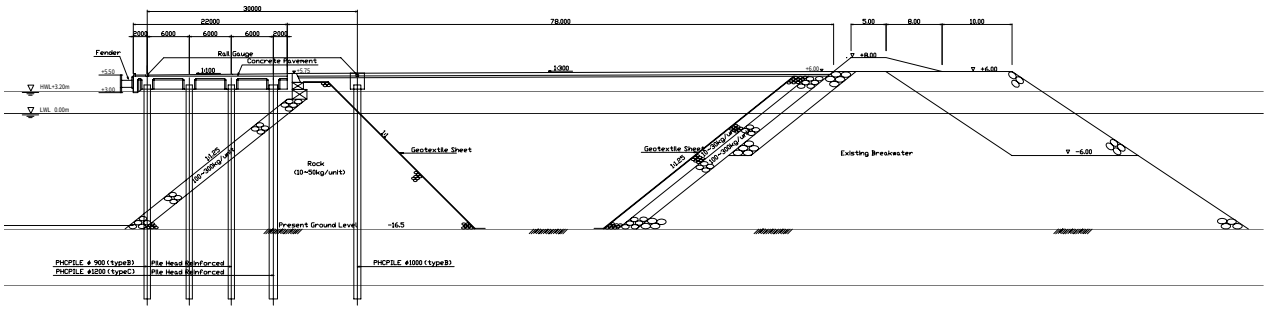


(3) Main Breakwater (Conventional Type)

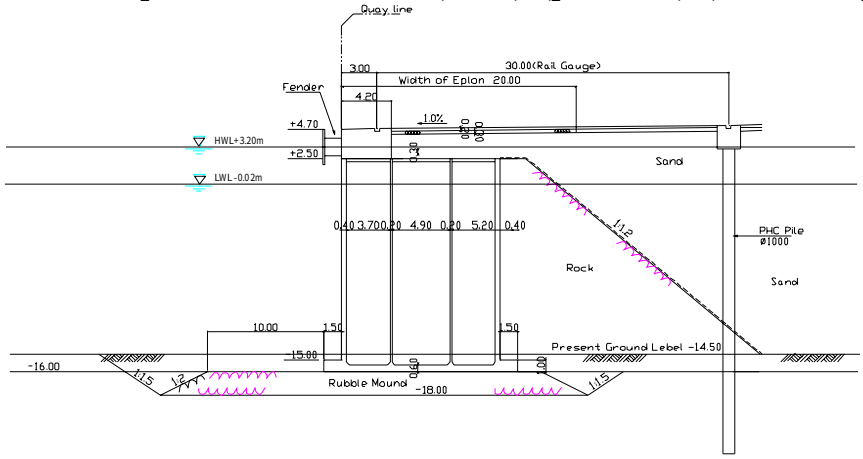
Fig. 6.11 Typical Cross Section of Breakwaters

(4) Design of Quaywall

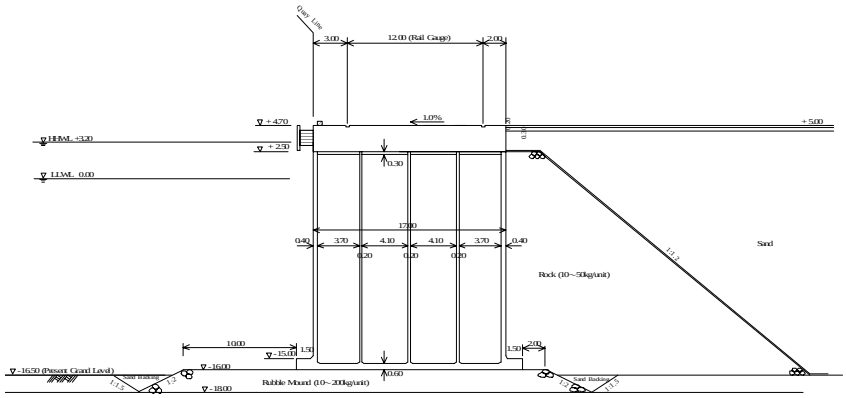
A pill pier type with vertical piles was selected for existing pier No.1 considering the shipping, geological, operational and construction conditions. The same structural type has been proposed for the Multi-Purpose and Fruit Berth (Pier No.3) in consideration of the urgent implementation schedule. On the other hand, according to the subsoil condition around the existing offshore port facilities, there is a possibility to select concrete caisson type structures. From cost estimate, the quaywall for the concrete caisson type has a lower price than that for pile pier type. Therefore, the concrete caisson type structures have been proposed for the Container and Grain Berths. The proposed structure types for the Multi-Purpose and Fruit Berth (Pier No.3), Container Berth and Grain berth are shown in Figure 6.12.



(1) Multi-Purpose and Fruit Berth (-16m) (pier No.3) (Pile Pier Type)



(2) Container Berth (-16m) (Concrete Caisson Type)



(3) Grain Berth (-16m) (Concrete Caisson Type)

Fig. 6.12 Typical Cross Section of Quaywall

(5) Design of Revetment

As the face line of the container berth at the onshore side is not be used as a quaywall for a container berth, this section is designed as a rubble-type revetment. Fig. 6.13 shows the proposed typical cross section of the revetment.

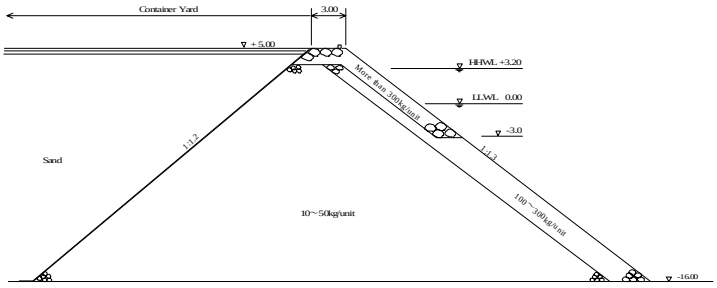


Fig. 6.13 Typical Cross Section of Revetment

(6) Design of New Access Bridge

For the proposed new access bridge, both the vertical and ranking pile segments have been set every 10m according to the structural calculation.

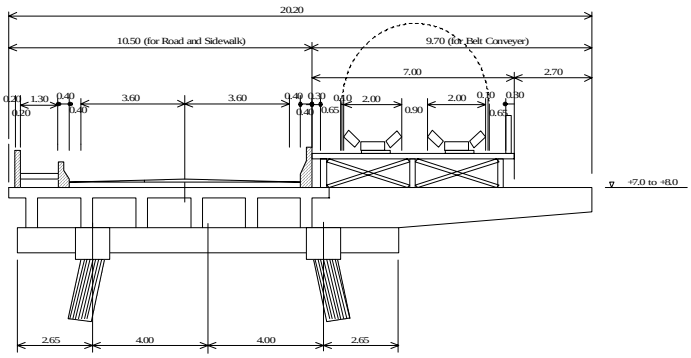


Fig. 6.14 Cross Section of Access Bridge

(7) Design of Port Road on Existing Breakwater

The existing North-South Breakwater can be used as the port road for the container terminal and for Pier No.3, and as the revetment for the new container yard. The port road will consist of four lanes with the width of 3.6m each, one parking lane and a sidewalk.

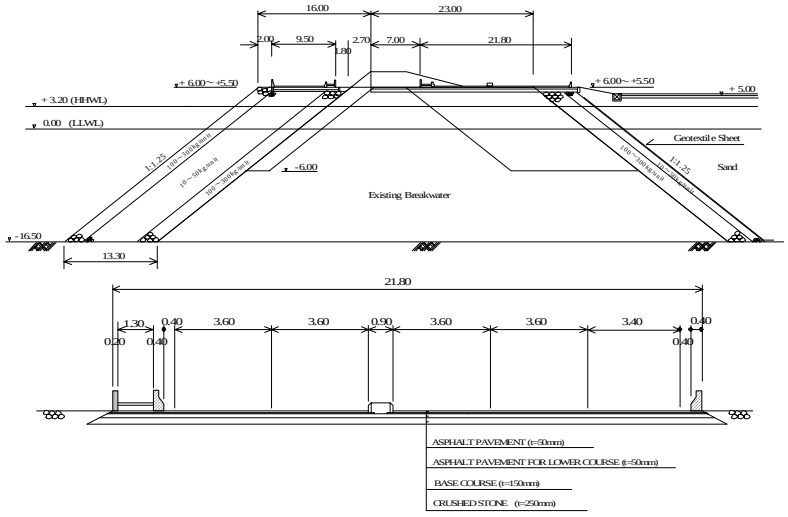


Fig. 6.15 Cross Section of Port Road on Existing Breakwater

(8) Design of Container Yard

A reinforced concrete slab with a thickness of 300mm is to be installed under the RTG traffic lane in consideration of the heavy weight. A pre-cast concrete plate with a thickness of 250mm is to be installed at the foundation for stacked containers. The width of the RTG traffic lane, chassis lane and the space for stacking shall be determined appropriately to ensure smooth storing, marshalling receipt and dispatch of containers and chassis.

(9) Design of Railway

According to CFN, a rail gauge of 1,600mm has been applied for the design of the railway. Since the railway alignment is located in the coastal dunes, it is necessary to take some measures to avoid of the line being buried by sand due to the wind.

6.7 Cost Estimates

(1) Cost Estimates

Exchange Rate

1 US$ = R$ 2.30
1 R$ = Yen 50 (Yen 1 = 0.020 R$)
As of 10, Aug on Central Bank of Brazil

Unit Price

The proposed offshore facility components are similar to the existing facilities. General index of prices from the base of 1996 commenced construction is 265 at the present.

Portion of Local and Foreign Currency

All materials such as steel & iron products, mechanical & electrical goods, secondary concrete products and elemental raw materials shall be provided in Brazil. Regarding execution, construction machinery, equipment and floating equipment shall also be procured in Brazil. However, when concrete caisson structures are adopted at container and fruits & multipurpose quays, a floating dock for fabricating the caissons may be procured from abroad. The depreciation charge represents only a very small portion of the concerned facility construction cost. Therefore, the estimate neglects the foreign portion and transfers the cost to the local currency balance. All of the Items for Procurement of Equipment shall be made using Foreign Currency. All of the nominated equipment shall be transported as a module directly to the site. Therefore, no local currency such as erection cost will be incurred.

Cost estimates

1) Composition of cost item

Cost item is composed as following:

A Offshore Civil Works

Access bridges	m	2,500
Port road and temporary port road	m	1,375
Breakwater	m	3,680
Container Terminal offshore (d=300m)	m	900

		Reclamation	m3	6,750,000
		Fruits & Multipurpose Terminal	m	680
		Grain Berth	m	320
		Revetment and -4m port service boats	m	920
B	Civil Works on land			
		Site preparation, Fence, Gate, Buildings	Ha	100
		Container Terminal landside	m2	250,000
		Grain Silo Terminal	cell	120
		Belt Conveyor	m	4,800
		Cokes stockpile yard	m2	18,200
		Railway	m	18,350
C	Procurement of Equipment	gantry crane, etc	units	76
D	Total of Construction Cost		A + B + C	
E	Engineering Service		(A+B) x 3%+C x 1%	
F	Contingency		D x 10%	
G	Project Cost (Excluding VAT)		D + E + F	

2) Cost comparison by alternatives

Alternatives were made only for the civil works offshore. An open type wharf with vertical piles was designed to compare the cost of each Alternative.

Table 6.6 Cost Comparison by Alternatives

Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Index	100.00	100.66	101.72	99.84

In the aspect of construction cost, Alternative 4 is the most economical.

3) Cost comparison by structural types

Wharves of the container and fruits/multipurpose berth must be equipped bulk heads. Wharves of the gravity type such as the caisson type do not need bulkhead, but those of the open type have bulkheads constructed. A caisson structure is more economical than pier structure by approximate 39 points.

4) Premises for estimating Project Cost

a) Alternative 4 of facility layout plan is applied.

b) Structural type of concrete caisson is applied for container and fruits/multipurpose berth

c) Construction cost of equipment was quoted in Japanese Yen in Japan. The exchange rate of 1 Yen = 0.02 R$ was applied.

5) Project cost

Preliminary project cost is 1,435 million R$ as shown in Table 6.7. Engineering cost of 3 % on the total cost of civil works is estimated and Training of equipment operators is estimated at 1% of cost for procurement of equipment.

Table 6.7 Preliminary Project Cost for Long Term Development Plan

Unit: R$

Item		Description	Detail	Unit	Quantity	Unit Price	Amount
A		Off shore Works					
	1	Mobilization and Demobilization		LS	1		7,000,000
	2	Temporary works		LS	1		240,000
	3-1	Temporary port road		m	425	27,500	11,687,500
	3-2	New Access Bridge No.0 to Container Terminal		m	1,510	43,000	64,930,000
	4-1	Pier No.3		m	680	270,000	183,600,000
	4-2	Transit shed		m2	7,500	1,210	9,075,000
	4-3	Transfer gantry cranes	2 units	sum	1		400,000
	5-1	Sub-breakwater		m	620	57,100	35,402,000
	5-2	Main breakwater		m	2,760	40,200	110,952,000
	5-3	West breakwater		m	300	57,400	17,220,000
	6-1	Container Berth	crane girder	m	900	153,000	137,700,000
	6-2	Container Terminal (pavement)		m2	243,000	140	34,020,000
	6-3	Port road		m	900	3,110	2,799,000
	6-4	Reclamation		m3	4,989,000	10	49,890,000
	6-5	Port service boats (Construct & Demolish)	-4m quay	m	276	56,000	15,456,000
	6-6	Junktion of Container berth	Caisson type	m	40	120,000	4,800,000
	7-1	Grain Berth		m	320	148,000	47,360,000
	7-2	Crane rail and Accessories		m	320	800	256,000
	7-3	Reclamation 70mx716mx21		m3	1,053,000	10	10,530,000
	7-4	-4m revetment at corner of grain berth	Caisson type	m	40	120,000	4,800,000
	7-5	New Port Service Boat Basin	Caisson type	m	110	120,000	13,200,000
	7-6	Revetment		m	807	27,500	22,192,500
	8	Channel & Basin		LS	1		8,240,000
		Sub Total					791,750,000
B		On land works					
	1	Site preparation		Ha	100	11,550	1,155,000
	2	Fence with seaside retaining wall		m	2,000	270	540,000
	3	Gate/Watch house, Truck scale		LS	1	600,000	600,000
	4	Administration office	30x20x3F	m2	1,800	1,000	1,800,000
	5	Chemi-coke stockpile yard	Pavement	m2	18,200	91	1,656,200
	6	Grain silo for 230,000 tons storage	1200tons/cell	cell	120	1,600,000	192,000,000
	7	Belt Conveyer	2500 ton/hr	m	4,800	16,000	76,800,000
	8	Railway		m	18,350	1,800	33,030,000
	9	Parking lot		m2	10,000	90	900,000
		Sub Total					308,481,200
		TOTAL OF CIVIL WORKS					1,100,231,200
C		Procurement of equipment					
	1	Quay Side Gantry Crane		units	6	17,000,000	102,000,000
	2	Rubber Tire Mounted Gantry Crane		units	15	2,800,000	42,000,000
	3	Tractor head / Trailer		units	53	150,000	7,950,000
	4	Loadeer / Unloader		units	2	9,000,000	18,000,000
		Sub Total					169,950,000
D		TOTAL OF CONSTRUCTION COST					1,270,181,200
E		Engineering services					
	1	Consultation of the Project	Civil x 0.03	%	1,100,231,200	0.03	33,006,936
	2	Training of equipment	Equipment 1%	%	169,950,000	0.01	1,699,500
		Sub Total					34,706,436
F		Indirect Cost + Contingency		%	1,304,887,636	0.10	130,488,764
G		GRAND TOTAL	Exclude VAT			R$	1,435,376,400
		Equivalent Japanese Yen				¥	71,768,819,980

(2) Construction Schedule

Table 6.8 Construction Schedule for Master Plan

Item		Description	Unit	Quantity	Urgent	Short Term: Remain						Long term								
					2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
A		Off shore Works																		
	1	Mobilization & Demobilization	LS	1																
	2	Temporary works	LS	1																
	3	Access Road & Bridge														Completion				
	3-1	Temporary port road	m	440																
	3-2	New access bridge	m	1,510																
	4	Pier No.3	m	680				Start Operation												
	5	Breakwater	m	3,680																
	6	Container Terminal										Partiary operation start					Start operation			
	6-1	Container Berths	m	900																
	6-2	Container Terminal	m	900																
	6-3	Reclamation	m3	4,989,000																
	6-4	Revetment (-4m quay)	m	276																
	7	Grain Berth	m	320																
	8	Channel & Basin	LS	1																
B		On land works																		
	1	Site preparation	Ha	100																
	2	Fence with seaside retaining wall	m	2,000																
	3	Gate/Watch house, Truck scale	LS	1																Start operation
	4	Administration office	m2	1,800															Grain terminal	
	5	Chemi-coke stockpile yard	m2	18,200																
	6	Grain silo for 230,000 tons storage	Cell	120																
	7	Belt Conveyer	m	4,800																
	8	Railway	m	18,350																
	9	Parking lot	m2	10,000																
C		Procurement of equipment																		
	1	Quayside Gantry Crane	unit	6																
	2	Rubber Tire Mounted Gantry Cran	unit	15																
	3	Tractor head & Trailer	unit	53																
	4	Loading/Unloading Machine	unit	2																

Local currency
Foreign currency
2006.July→

Year is shown as the Fiscal Year that start in April of thye year and end in March of the next year

6.8 Phased Implementation Plan

(1) Phasing of the Entire Plan

The Short-Term Development Plan with the target year 2012 that will be proposed after this is considered as the first-phase plan. The remaining portion (i.e. the entire plan, viz. Long-Term Development Plan minus the first phase plan) could be divided into several phased plans following the first phase plan. Taking account of the entire scale of plan, however, the interval between the years 2012 and 2022 viz. 10 years, is considered to be too short to divide the remaining portion into more than two phases. Thus, the entire plan will be divided into the two phased plans, viz. the first phase and the second phase plans.

(2) Implementation Schedule of Phased Plans

First Phase Plan

The schedule of the First Phase Plant in terms of implementation has been roughly drafted as follows.

1) Beginning of 2006: Start of construction works
2) 2012: Completion of construction works
3) 2012: Start of terminal operations

Main project components of the first phase plan are:

- Construction of breakwater,
- Reclamation
- Construction of container, multi-purpose and fruits terminals
- Purchase of container-handling equipment

Second Phase Plan

The schedule of the Second Phase Plan has also been roughly drafted as follows.

1) Beginning of 2014: Start of construction works
2) 2021: Completion of construction works
3) 2022: Start of terminal operations

The following construction works have been planned to be implemented extending from the first and the second phase plans..

- Extension of breakwater,
- Extension of container terminal

Main project components of the second phase plan to be newly added in the second phase plan are:

- Construction of grain, fertilizer and cokes terminals
- New access bridge

6.9. Economic Appraisal

A Comparison between "Without-the-project" case and "With-the-project" case has been carried out to evaluate the economic feasibility of the port development project composed of the construction of breakwaters, the terminals of containers, multipurpose, fruits and grain/fertilizer and the new access bridge proposed in the Master Plan from the viewpoint of the national economy of Brazil. The main economic benefits of the project are (1) saving in container land transportation costs, (2) saving in container transhipment costs, (3) saving in sea transportation costs and (4) value added from soybean for export. Resulting economic internal rate of return (EIRR) for the above mentioned project is 17.33% which exceeds the general criterion to assess the economic feasibility.

6.10 Financial Appraisal

The financial revenues are generated from port dues and charges based on the tariff to cover capital investment and operational costs by referring to the current tariff level and those of the neighbouring ports.. The resulting financial internal rate of return (FIRR) for the Master Plan is 11.60% which exceeds the weighted averaged interest rate (8 %) of assumed fund raising and hence the project has been considered to financially viable.

7 PORT MANAGEMENT AND OPERATION

7.1 Management and Operation of Pecem port

The trend today is for container vessels to become larger in size with deeper draft vessels.

It is recommended that even in the case of large vessels such as Panamax sized vessels, the system should be established where the berthing and the container operation can be commenced within 1 hour.

To that end, the improvement in technique of pilots and immediate introduction of high power tug boats are essential.

7.2 Port Authority Main Administration and Management Jobs

- Generally, the affairs/business of a port are as follow;
- Port and harbour construction program under the master plan
- Management of maintenance of port and harbour facilities
- Construction management of port and harbour facilities
- Management within a port and harbour area
- General management of port and harbour facilities
- Establishment and public announcement of suitable tariff classification and rates
- Management of vessel movement
- Port statistics management (cargo and vessel etc)
- Port and harbour utilization advancement

7.3 Problems of Management and Operation of Pecem port

- Deficit of revenue and expense account
- Lack of function for port plan
- Insufficient capacity of port promotion
- Strengthening of management and operation department
- Lack of collaboration with CIPP

7.4 Type of Container Terminal Operation Method

There are three type of container terminal utilization, as follow:

- Open use (Public use)

  Open use is a utilization type that makes every container carriers to be served on the basis of “First come first served”

- Prioritized use

  Prioritized use is a utilization type where specific container carriers are given over priorities tariff and available time on certain conditions such as cargo volumes under “Open use”

- Exclusive use

Exclusive use is a utilization type where a specific container carriers exclusively leases a terminal only for its own fleets and alliance.

7.5 Patterns of Development, Management and Operation

Patterns of Development, Management Terminal Operation

PATTERN		A	B	C	D	E	F
Master Plan		○	○	○	○	○	○
Construc-tion	Channels	○	○	○	○	●	●
	Breakwater	○	○	○	○	●	●
	Infrastructure	○	○	○	○	●	●
	Superstructure	○	○	○	●	●	●
Owner ship	Land	○	○	○	○	○	●
	Terminal Facilities	○	○	*●	*●	*●	●
Terminal operations		○	●	●	●	●	●
Berth Allocations		Open	Open (Prioritized Exclusive)	Open (Prioritized Exclusive)	Open (Prioritized Exclusive)	Open (Prioritized Exclusive)	Open (Prioritized Exclusive)

Note-1 : ○:Public sector ●:Private sector
Note-2 *: Land area leasing system

7.6 Proposal of Improvement of Management and Operation of Pecem port

- Sharing the role of government and CEARAPORTOS
- Improvement of the duties of CEARAPORTOS

  CEARAPORTOS should conduct the port development plan by itself in the future. The port development plan includes long-term master planning, short-term planning, individual project planning and so on.

  To complete the plan development plan CEARAPORTOS needs to examine various items as follows;

  - Recognition of current situation
  - Analysis of economic trend of the hinterland
  - Forecast of cargo volume
  - Land-use planning
  - Facilities layout planning
  - Feasibility study
  - Assessment of environment impact
  - Annual plan of projects, etc.
- Strengthening of organization of CERARAPORTOS
- Proposal for CERARAPORTOS
- Scheme of port development

7.7 Strengthening of Organization

(1) Establishment of Port Council

Generally the port authorities are managed independently from government under the control of the “Board”, which is the highest decision council of the port authority. The

first priority of board is to benefit the region, because ports are considered as public assets which should contribute to regional development.

The port council should include the following members.

- State government
- State assembly
- CEARAPORTOS
- Port users
- Persons of knowledge and experience.

Maine function should be as following

- Approval of port development
- Approval of port tariff
- Approval of annual budget of CEARAPORTOS
- Supervision and council over port activities
- Coordination between CEARAPORTOS, CIPP and port users

(2) Improvement of Organization of CEARÁPORTOS

a) Establishment of Planning Department

CEARÁPORTOS needs to set up a Planning Department which takes charge of the port planning.

b) Establishment of Port Promotion Section

To perform the port promotion activity in a professional manner, CEARÁPORTOS needs to set up a Port Promotion Section.

7.8 Proposal for CEARÁPORTOS's Revenue

(1) Port Tariff

Tariff structure should not only cover expenses for management and operation of the Port but also encourage port users to use port facilities efficiently. Therefore, the followings points should be considered in terms of tariff structure.

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

(2) Revenue from Terminal

There are several variations of concept of revenue from terminal, depending on the construction and operation type of terminal.

For example, if the port management body develops terminal facilities and lends it to a private operator, the management body should impose a lease fee, which corresponds with costs for construction and maintenance of facilities, to the terminal operator.

When the port management body determines the lease fee, it should consider bringing out the efficiency of the terminal in the private operator as well as maintaining competitiveness of the said port.

7.9 Scheme of Port Development

(1) Water Area Facilities

Water area facilities, such as breakwaters, channels and navigation aids, should be developed with national or state funds under the responsibility of the government. In this case, it is necessary that government and port management body define a financial scheme of port development before starting the project, because the whole time span of the project would be long.

(2) Container Terminal

Unlike water area facilities such as breakwater, channel and so on, container terminals are profitable facilities. There are several variations of construction and operation schemes. With either scheme, the construction costs of terminal facilities are basically covered with the revenue from the terminal operation.

7.10 Port Promotion and Marketing

- Marketing strategy for port promotion
- Marketing promotion method and material
- Promotion compact disk or video
- Marketing research
- Coordination of relation to CIPP
- Port marketing mission
- Home page of port (Web-site of CERARAPORTOS
- Advertisement
- User friendly management

7.11 Improvement of a Port Management Body's Monitoring System

- Monitoring the performance of port operation

  Port management and administrator should be monitoring the performance of operators and recommended the improvement of real time productivity and operating condition.

- Monitoring of development port logistics and industry

  As the development of port advances, the related industries such as port and harbour transportation will as a consequence also develop.

7.12 Training System

At CEARAPORTOS, employees in each section should control port activities appropriately to materialize efficient management and operation. In order words, it is important through training to give staff full knowledge, skills and understanding both on technological and functional requirements of the port and to make them cost conscious and efficient in conducting their duty and assignment.

8 ENVIRONMENT AND SOCIAL CONSIDERATIONS

8.1 Introduction

It is considered that positive and negative influences take place environmentally and socially wise with the implementation of the Plan of Industrial and Port Development of Pecém. It is necessary to elaborate measures so that negative influences won't take place through the appropriate estimate of the influence of the implementation of the project. The present report presents the data of the existent studies on the environmental situation and the planning of execution of the initial environmental study.

This chapter is constituted of i) preservation of the environment; ii) new guide of environmental and social considerations of JICA; iii) situation of the industrial port of Pecém and adjacent environment; iv) activities done until the present moment related with the environmental and social considerations of the industrial and port plan of Pecém; and v) Planning of execution of the initial environmental study.

8.2 Preservation of the environment

(1) legislation

The preservation of the environment is regulated by the Brazilian constitution. With base in her, National Council of the Environment (CONAMA), State Council of the Environment (COEMA) and the municipal districts have been organizing his/her environmental legislation.

(2) procedures for evaluation of the environmental impact

The resolution 237/97 of CONAMA defines the need of environmental licenses sent previously by the responsible organism for the environment, about the influence the project can have on the environment with the activity or use of natural resources. There are 3 environmental licenses: the Previous License, the License of Installation, and the License of Operation.

The expedition of the license is made by IBAMA when the activity is made in an area under the federal government's jurisdiction; when it concerns an area of more than a state; when it causes international repercussions; and when it happens in a federal public property or a protection area. For the other cases SEMACE sends the licenses.

For the obtaining of the license, the entrepreneur must present the necessary documents for appreciation from the responsible organism. The documents to be presented are defined by discussion with the entrepreneur during the process of expedition of the license.

8.3 New Guide of Environmental and Social Considerations of JICA

We presented the basic guideline, beginnings, items requested from the countries that receive cooperation, and study procedures for development of the new guide of environmental and social considerations of JICA.

8.4 Environmental situation of the industrial and port area of Pecém and their surroundings

(1) Social situation

The rising of the social situation was made through the collection of information close to the related organisms and interviews. The area objective was the city of São Gonçalo of Amarante , especially the town of Pecém in the same municipal district.

The town of Pecém has 8.688 inhabitants, distributed equally between the urban part and the rural part. The religion is predominantly Catholic. Economically, GDP of São Gonçalo of Amarante, that includes the town of Pecém, was of R$ 75,2 million of Real, representing 0,3% of the state of Ceará.

The town of Pecém possesses police station and bank, besides association of fishermen, where 296 fishermen are registered.

80% of the residences of the town of Pecém healthy own house. The covering of water supply is of 80% and of sewer system of 30%. The electric power almost supplies all of the families.

A system of registration of poor families exists, that includes a monthly financial support. The GTP(Group of Participative Work) provides and organizes teaching activities and professional trainings.

(2) Environmental conditions

The rising of the environmental situation was made through the collection of information close to related organisms. The area objective was the area of CIPP and surroundings mainly.

The topography of the study area is formed mainly of moving dunes, permanent dunes, lake areas, marshes and rivers. The water is supplied by the dam of Sitios Novos Dam. The bottom of the sea of the coastal area is sandy, but the continental platform is covered by reefs close to the coast.

The quality of the water presents inferior numbers to the minimum pattern for all the main items, just as oil and fecal coliformes, if not verifying differences among the monitoramento points.

The fauna of the area has been registered. It is composed of 5 species of mammals, 317 species of birds, and 19 types of registered reptiles.

The flora is poor due to forest depredation. 13 species are registered in the flora monitoring.

The areas of environmental protection within CIPP are 2 areas of priority (956ha) protection and 2 protection areas with maintainable use in 2 places (2.009 ha).

(3) Activities of environmental protection

The details about the activities of environmental protection are being verified. In the city of São Gonçalo of Amarante there are several projects of social improvement.

8.5 Evolution of the social and environmental conditions with the industrial and port development plan of Pecém

EIA / it RHYMES of the Industrial and Port Development of Pecém was presented in 1995, being approved by COEMA in 1996. The preliminary license was sent in 1995 by SEMACE. The implementation license was sent or reverse-sent up to 2000 for the construction of the port of Pecém, highways, quarry, etc. Regarding the construction of the port of Pecém, as the coast and the marine area are under the federal government's jurisdiction, the environmental license was sent by IBAMA. The operation license was sent in 2001.

Despite the initial plans, it was resolved that SEMACE would send environmental licenses for each installation, with the diffusion of the evaluation of strategic environmental impact. IBAMA pointed out the need of presentation of AAE and of environmental license. In answer, SEINFRA is at the moment elaborating AAE.

Regarding the social and environmental conditions necessary to the industrial and port development of Pecém, the environmental monitoring part was accomplished (Weather conditions, waves, marine topography, quality of the water, flora and fauna, etc) . Besides, the program for protection of the forest was established in accordance with the plan of environmental protection required to obtain the environmental license.

8.6 Initial Environmental Examination

(1) Predicted Impacts on Environmental and Social Condition due to the Long-term Development Plan

The environmental and social impacts on Pecém port and the surrounding area by the long-term plan are summarized in Table 8.1.

Negative impacts are prospected as shown in the table. Relatively large negative impact on shoreline is prospected during operation period. Other impacts are almost slight.

Table 8.1 Initial Environmental Examination of the Long-term Development Plan

Examination Item	Alternative 1			Alternative 2			Alternative3			Alternative4			No action
	Preparation period	Construction period	Operation period	Preparation period	Construction period	Operation period	Preparation period	Construction period	Operation period	Preparation period	Construction period	Operation period	
1. Social environment													
Resettlement	*	*	*	*	*	*	*	*	*	*	*	*	*
Economic activity	++/C	++/B	++/B	++/C	++/B	++/B	++/C	++/B	++/B	++/C	++/B	++/B	*
Public facility	++/C	++/C	++/B	++/C	++/C	++/B	++/C	++/C	++/B	++/C	++/C	++/B	*
Tourism	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*
Water right (Fishing right)	*	--/C	++/C	*	--/C	++/C	*	--/C	++/C	*	--/C	++/C	*
Solid waste	*	*	*	*	*	*	*	*	*	*	*	*	*
Wastewater	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	--/C
Hazard	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	--/C
2. Natural environment													
Topography	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*
Hydrology	*	*	*	*	*	*	*	*	*	*	*	*	*
Coastal erosion	*	--/C	--/B	*	--/C	--/B	*	--/C	--/B	*	--/C	--/B	--/C
Bottom sediment	*	*	*	*	*	*	*	*	*	*	*	*	*
Air quality	*	*	*	*	*	*	*	*	*	*	*	*	*
Marine water quality	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*
Noise and vibration	*	--/C	*	*	--/C	*	*	--/C	*	*	--/C	*	*
Biodiversity	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	--/C
Landscape	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*
3. Secondary influence													
Poverty reduction of the surrounding area	*	++/C	++/B	*	++/C	++/B	*	++/C	++/B	*	++/C	++/B	--/C
Change of the land use of the surrounding	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	*
Discharge of the green house gas	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	*	--/C	--/C	--/C
4. Influence concerning a life cycle													
Operation period of port by the sand drift	*	*	*	*	*	*	*	*	*	*	*	*	*
Comprehensive evaluation	○	○	○	○	○	○	○	○	○	○	○	○	—

Note) --/C: The left is directivity (positive or negative) of environmental impact, the right is relative grade (A-C) of environmental impact.

++: positive effect --: negative effect A: relatively severe impact B: relatively medium impact C: relatively slight impact *: No impact or not correspond to Evaluation) ○: The environmental impacts are slight, however, it can be mitigated with environmental and social measures.

(2) Suggested Mitigation Measures for Long-term Development Plan

The measures indicated below are preliminary to the evaluation of the IEE level for the long-term development plan. The enumeration of the measures which are assumed to be required for the environmental and social considerations when carrying out the long-term development plan contributes for the revision of the long-term development plan and financial examination. When the long-term development plan be actually implemented, will be necessary to carry out a detailed environmental research, the environmental impact assessment, and conservation measures must be reexamined.

Social Environment

Preparation Period

- Vocational education should be taught in order to promote the employment of local inhabitants.

Construction Period

- Septic tank should be installed and sludge should be carried out before waste water leak out.
- Invasion of a vessel to the construction zone should be prevented by light buoy and flag buoy.
- Vocational education should be taught in order to promote the employment of local inhabitants.

Operation Period

- Septic tank should be installed and sludge should be carried out before waste water leak out.
- International Regulations for Preventing Collisions at Sea should be applied strictly.
- Vocational education should be taught in order to promote the employment of local inhabitants.

Natural Environment

Construction Period

- A structure that blocks the sand (such as a temporary jetty) must not be built.
- Silt fence should be installed.
- Temporary road should be used, and speed should limited to 60km/h. Driving through the village must be prohibited.
- Monitoring should be conducted exactly.

Operation Period

- Sand recycle should be carried out, and sediment will be transported to the eroded area, and groin should be built according to the situation of erosion.
- The larger and automatic type of oil fence should be prepared.

- The speed limit should be determined to 60km/h. Driving through the village must be prohibited.
- Monitoring should be conducted exactly.

Secondary Influence

Preparation Period

- Urbanization program should be carried out adequately.
- Vocational education should be taught in order to promote the employment of local inhabitants in CIPP area.

Construction Period

- Intentional allocation of infrastructure should be continued in the urban area.
- The restriction of the entrance in some areas should be taken.

Operation Period

- Intentional allocation of infrastructure should be continued in the urban area.
- School Education to the inhabitants should be carried out.

8.7 Stakeholders Meeting

The stakeholder meetings were held on the 16th and 22nd of August, 2005. The participants were divided into Pecém and Fortaleza. Those meetings were used with sole purpose of explaining the background of the project as well as the environmental and social consideration procedures. The participants discussed major issues related to the project.

9 SHORT-TERM DEVELOPMENT PLAN OF PECEM PORT

9.1 Basic Concept

The Short-Term Development Plan has presupposed its target year of 2012 as a given condition. On this condition, the Long-Term Development Plan has been divided into two phased plans taking account of various aspects including size and configuration of the entire plan and economical phasing of construction works. The Short-Term Development Plan corresponds to the first phase plan and the second phase plan to the remaining portion of the Long-Term Development Plan.

The main components of the Short-Term Development Plan pf Pecem Port made and proposed based on the above concept are as follows:

Expansion Plan

- Establishment of new marine terminals
- Construction of new breakwaters
- Creation of a new access channel and basins
- Installation of new railway sidings

Development Plan of the Existing Facilities

- Extension of the existing breakwaters (the west breakwaters)

9.2 Port Capacity Analysis

The berth allocation conditions by vessel type, which were used in the simulation that reveals the cargo movement within a port, are shown in Table 9.1.

Table 9.1 Ship Sizes and Berth Allocation

Cargo Item	Ship Type	Ship Size	Representative Principal Dimensions (DWT/ TEUs)	LOA (m)	Draft (m)	Beam (m)	Annual Cargo Throughput in 2012 ('000	Berth Allocation: Pier 1 No. 1	Pier 1 No. 2	Pier 2 No. 3	Pier 2 No. 4	Pier 3 No. 1	Pier 3 No. 2	Pier 3 No. 3	Container Berth No. 1	Container Berth No. 2
Solid Bulk Cargo																
Iron Ore Pellets	Ore Carrier	Panamax(L)	72,000	225.00	13.52	32.20	2,500	O								
Cokes	Bulk Carrier	Panamax(S)	51,000	182.00	12.00	32.20	120					O	O			
					Solid bulk total		2,620									
Liquid Bulk Cargo																
Refined Petroleum	Petroleum Tanke	Large1	106,000	240.99	14.90	42.00	1,045			O	O					
					Liquid bulk total		1,045									
Break-bulk Cargo																
Thick Slabs	Bulk Carrier	Panamax(S)	51,000	182.00	12.00	32.20	1,500		O			O	O			
Steel Rolls	Bulk Carrier	Handy Size	45,000	186.00	10.95	30.40	147		O			O	O			
Steel Billets	Bulk Carrier	Small 3	26,000	168.05	10.00	25.33	75		O			O	O			
Bagged Cement	Multi-purpose Shi	Multi-purpose	32,000	188.00	11.65	27.70	120		O			O	O			
Fresh Fruits	Reefer Ship	Reefer	6,100	133.92	7.60	15.80	227							O		
					Break- bulk total		2,069									
					Conventional total ('000 tons)		5,734									
Container																
	Main Line Ship	Post-Panamax	9,200	346.98	14.50	46.00									O	O
		Panamax (4th)	4,800	294.00	13.50	32.20									O	O
		Panamax (3rd)	3,700	243.00	12.50	32.20									O	O
					Main line total		295									
	Coaster		1,400	170.00	9.50	24.80	58									
	Feeder Ship		1,400	170.00	9.50	24.80	94								O	O
					Container total ('000 TEUs)		447									

Source: JICA Study Team

9.3 Port Improvement Plan of the Existing Facilities

It has been proposed to extend the existing west breakwater by 300 m to reduce wave agitation especially due to swells in front of Piers No.1 – No.3. By the extension, the probability of penetrating waves not exceeding 50 cm will increase to 95.8% from the current level of 89.7% at the tip of Pier No.1. The probability in front of Pier No3 has been estimated as 95.9%.

9.4 Port Expansion Plan

(1) Necessity of Port Expansion

To meet the forecast demand for the increase in cargo-handling capacity in the stage of the Short-Term Plan, it is necessary to expand port capacity. The new off-shore port area needs to be placed to the east of the existing off-shore port area within the framework of the Long-Term Development Plan.

(2) Marine Terminals

The required number, scale and type of marine terminals at the expanded port area have been verified by computer simulation. In the first step, some number, scale and type of terminals have been assumed, and then it has been verified whether the required service level has been satisfied. In the case when the required service level has not been satisfied, different figures has been input for further simulation trials. After this trial and error procedure, eventually, the optimum number, scale and type of required marine terminals have been determined as shown below.

(3) Required Dimensions of a New Sea Channel and Basins

To have access to a new off-shore port area to be expanded in the direction of the east, it is necessary to create an access channel. In this study, 210 m has been applied as the planned bottom breadth of the sea channel and water depths of 16.5 m in the open sea are required.

The turning basin within the expanded port area protected breakwaters has been designed so as to provide a turning circle with a diameter of twice of the LOA of the design vessel. The maximum length among design vessel is 381 m. Thus a diameter of 760 m for turning circle has been considered in the design of the turning basin.

(4) Required Breakwaters

Breakwaters are required for the new off-shore port area to protect the inner channel, turning basins and berths. The new breakwaters need to be placed so as to halt the waves in the outer sea penetrating to the port waters from ENE as wind waves and NE as swell.

(5) Facility Layout Plan

The main components of the facility layout plan in the Short-Term Plan are shown in Table 9.2. The facility layout plan is shown in Fig. 9.1.

Table 9.2 Main Components of the Facility Layout Plan in the Short-Term Plan

Components			Dimensions
Access channel		Bottom width (m)	210
		Water depth (m)	16.5
Basins		Water depth (m)	16
Breakwaters		Main breakwater north part	1,220
		Main breakwater east part	570
		Sub-breakwater (m)	620
		West breakwater (extension) (m)	300
		Total	2,710
Revetment		Length (m)	270
Marine Terminal	Container Terminal	Berth length (m)	540
		Water depth (m)	16
	Multi-purpose Terminal	Berth length (m)	520
		Water depth (m)	16
		Sheds ('000sq. m)	7.5
	Fruits Terminal	Berth length (m)	160
		Water depth (m)	16
		Cold Storage('000sq. m)	5.5
Land use for expansion (ha)		Terminal area (off-shore)	25.0
		Terminal area (land)	11.1
		Total	36.1

Source: JICA Study Team

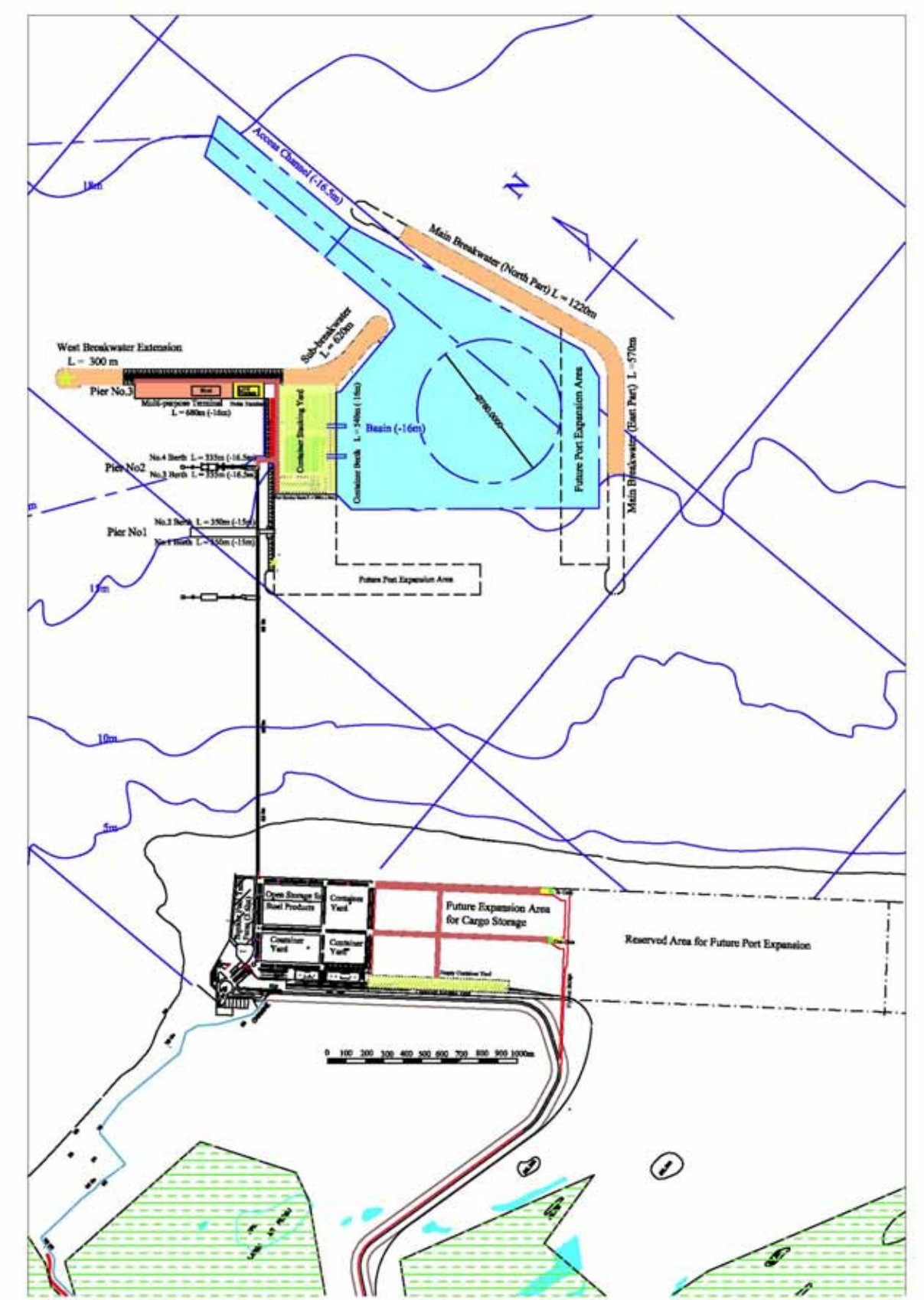


Fig. 9.1 Facility Layout Plan

9.5 Hydrological and Coastal Study

(1) Calmness for Short-Term Development Plan

The calmness projections for short-term development plan have been made by using the same numerical computation as the study for the long-term development plan. The points for consideration are as below.

- To determine the necessary length of the West Breakwater to secure sufficient calmness for Pier No.1, especially for swell waves
- To determine the necessary length of the Main Breakwater to secure the container berth

The layout of the breakwaters and estimation points for calmness are shown in Fig. 9.2.

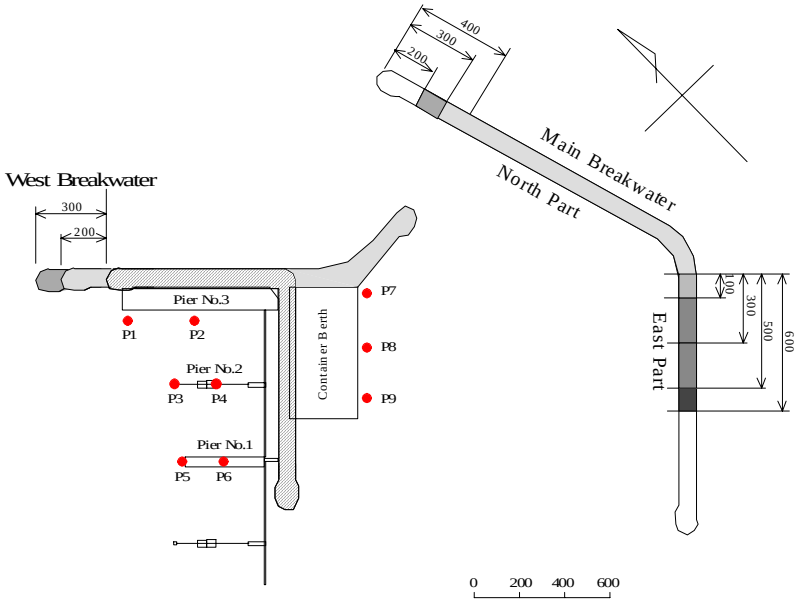


Fig. 9.2 Study Layout of Breakwaters and Estimation Points

The calmness at the container berth decreases from the offshore side (P7) toward the onshore side (P9). When the shortening of the north breakwater does not exceed 300 m, sufficient calmness is secured. From this, the shortening of the North Breakwater has been proposed as 300m for the short-term development. When the length of the East Breakwater is more than 600 m, sufficient calmness is secured. From this, the length of the East Breakwater has been proposed as 600 m.

Even though the calmness at Piers No.2 and No.3 is secured if the extension of the West Breakwater is 200 m, the calmness at Pier No.1 is still insufficient. When the extension of the West Breakwater is 300 m, the calmness at Pier No.1 also becomes to be sufficient. From this, the extension of the West Breakwater has been proposed as 300 m.

The calmness for proposed final layout of short term development plan is summarized in Table 9.3.

Table 9.3 Calmness for the Proposed Layout

Berth	Position	Point No.	Hcr(cm)	Short-Term Plan	Present
Pier No.3	Head	1	30	100%	-
	Center	2		100%	-
Pier No.2	Head	3	50	100%	93.0%
	Center	4		100%	100%
Pier No.1	Head	5	50	95.7%	89.3%
	Center	6		99.2%	93.0%
Container Berth	Offshore	7	30	100%	-
	250m	8		100%	-
	450m	9		99.8%	-

(2) Coastal Impact Study

Fig. 9.3 shows the comparison of shoreline change for the layout of the existing port, short-term and long-term development plans after 20 years. The pattern of shoreline change is almost the same as that for the long-term development plan; however, the degree of change is considerably decreased with about a 70% reduction. This change of tendency is caused by a decrease of the wave shadow area due to shortening the length of the breakwater. Table 9.4 shows the sediment balance for each development term. The sand deposition due to the offshore port facility is estimated about 100,000 to 150,000 m3/year. This estimated volume for the short-term development plan is about 80% of that for the long-term development plan. The computation result shows that the retreat occurs from the north area of Pecém village to Colonia village over ten years. However, it is difficult to predict the area of retreat under the condition of dynamic equilibrium of littoral drift considering the influence of the cape. That explains why it is very important to do the monitoring surveys to determine the influence of the existing port.

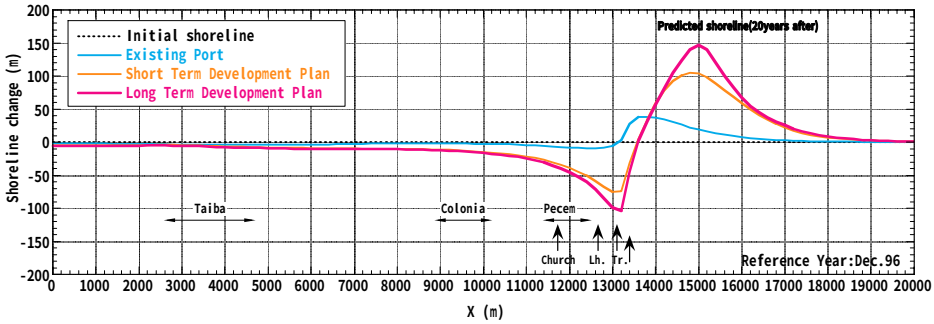


Fig. 9.3 Comparison of Shoreline Change for Each Layout

Table 9.4 Sediment Balance for the Short-Term Development Plan

Layout	Net annual littoral transport (m3/year)		Sediment Loss due to Natural Conditions (m3/year)	Net Accumulation due to Existence of Port (m3/year)
	Up-Drift Side (East Side)	Down Drift Side (West Side)		
Existing Port	280,000 - 360,000	210,000 - 280,000	40,000	30,000 - 40,000
Short-Term Development Plan	280,000 - 360,000	140,000 - 190,000	40,000	100,000 - 130,000
Long-Term Development Plan	280,000 - 360,000	120,000 - 160,000	40,000	120,000 - 160,000

9.6 Design

(1) Design of Breakwaters, Quaywall

Refer to 6.6(3) and 6.6(4).

(2) Design of Temporary Port Road in Urgent Project

In Remain Project of the First Phase, a port road will be constructed on the existing breakwater. This road, with four lanes is planned to be utilized for access to both the container yard and Pier No.3. However, Pier No.3 should be constructed in Urgent Project, and therefore it is necessary to prepare another port road to access Pier No.3 in Urgent Project. As mentioned above, this port road will be used temporarily until the completion of the permanent port road on the existing breakwater in the Remain Project. It was originally planned to use a pile pier type bridge the same as the existing access bridge. However, considering cost comparison and the utilization of the space between Piers No.2 and No.3 as the basin for port service boats, it is proposed to use the rubble structure type. This is constructed inside of the existing breakwater to widen the crown part of breakwater. The typical cross section of the temporary port road is shown in Figure 9.4.

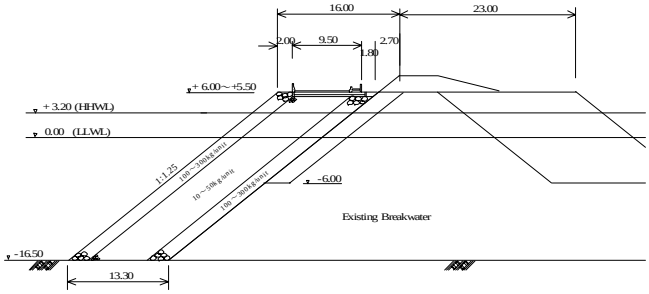
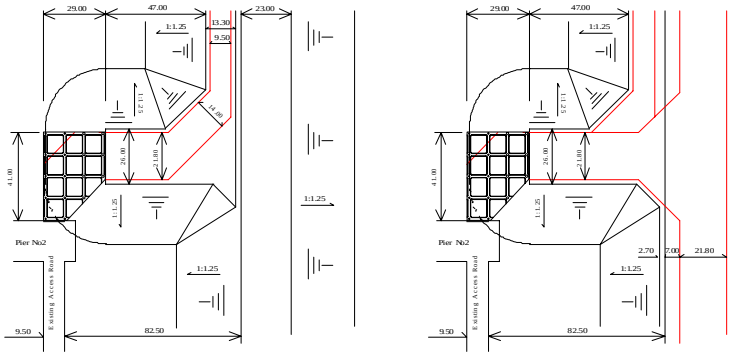


Fig. 9.4 Typical Cross Section of Temporary Port Road

(3) Junction from Existing Access Bridge to Port Road

An 80m section is required to act as a junction to connect the existing access bridge and the temporary port road. This section has been proposed to be constructed as a combined pier structure and rubble mound. Fig. 9.5 shows the image of this part before (Urgent Project) and after (Remain Project) construction of the port road. The proposed junction is shown in Fig. 9.6.



(1) Urgent Project (2) Remain Project of First Phase

Fig. 9.5 Image of Junction

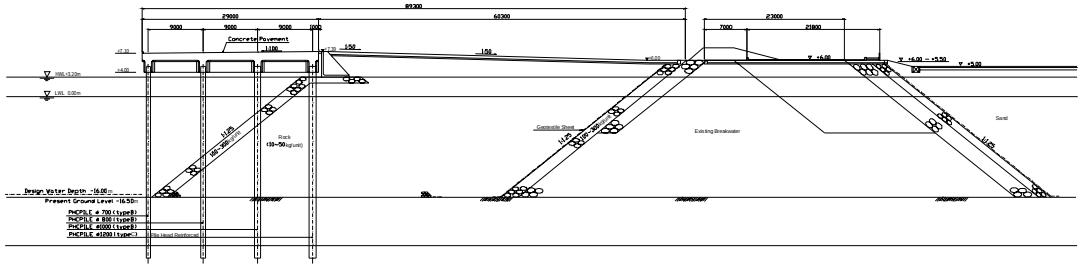


Fig. 9.6 Typical Cross Section of Junction

9.7 Cost Estimates

(1) Cost Estimates

Unit Price

SEINFRA re-examined the unit prices of the former project to determine current prices and he found that the price of stones will be approximately 70% higher than the list shown to the JICA Study Team previously. The main changes are as follows.

Armor stone	100-1000kg	quarry to site	1m3	20.59R$	→ 34R$
Armor stone	1 – 6 tons	quarry to site	1m3	26.30R$	→ 42R$
Rubble stone	5-100kg	quarry to site	1m3	20.59R$	→ 34R$

Cost estimates

1) Composition of cost item

Cost estimate is composed of the following items:

A Offshore Civil Works

Port road and temporary port road	m	1,015
Breakwater	m	2,710
Container Terminal offshore (d=300m)	m	540
Reclamation	m3	4,040,000
Pier No.3	m	680
-4m port service boats	m	276
Dredging	m3	500,000

B Civil Works on land

Site preparation, Fences, Gates, Buildings	Ha	20
Railway,	m	2,700

C Procurement of Equipment gantry crane, etc units 39

D - G (The same as 6.7(1))

2) Project cost

The preliminary project cost is R$ 616 million as shown in Table 9.5. An engineering service cost of 3% is estimated in the total cost of the civil works and training of equipment operators is estimated to be 1% of cost for procurement of equipment.

Table 9.5(1) Preliminary Project Cost for Short Term Development Plan (1/2)

Item		Description	Detail	Unit	Quantity	Unit Price	Amount
A		CIVIL OFFSHORE WORKS					
1		Mobilization / Demobilization					
	1-1	Sea & land transport of equipment	in Brazil	LS	1		3,000,000
	1-2	Floating dock and other materials	from abroad	LS	1		4,000,000
		TOTAL of ITEM 1					7,000,000
2		Temporary works					
	2-1	Access road					
	2.1.1	Access road near and in the port	200mx7m	m2	1,400	95	133,000
	2.1.2	Deposit sediments of the quarry		L.S	1		0
	2.1.3	Repairing works of surface paving	10m2x20	m2	200	95	19,000
	2.1.4	Transport material above		m3	880	17	14,960
		Sub total					166,960
							166,000
	2-2	Container Berth and Pier No.3					
	2.2.1	Soil investigation and testing	35x20units	m	700	64	44,800
		Sub total					44,800
	2-3	Quarry site					
	2.3.1	Soil investigation and testing	35mx10units	m	350	64	22,400
		Sub total					22,400
		TOTAL of ITEM 2					233,200
3		Temporary port road					
	3-1	Temporary port road					
	3.1.1	Stone foundation		sum	1		2,130,000
	3.1.2	Foundation of pile		units	17	142,000	2,414,000
	3.1.3	Beams and Supporting/staging works		m2	1,008	1,430	1,441,440
	3.1.4	Slab concrete and accessories		m2	1,008	1,040	1,048,320
	3.1.5	Concrete pavement for road		m2	670	207	138,690
	3.1.6	Temporary port road on the breakwater	L=475m	m2	4,512	1,010	4,557,120
		TOTAL of ITEM 3		m2	6,190	1,890	11,699,100
4		Pier No.3					
	4-1	Foundation works					
	4.1.1	Pier fondation	ϕ1000	units	725	135,000	97,875,000
	4.1.2	Super structure of pier	22m width	m	680	37,000	25,160,000
	4.1.1	Crane girder		m	1,360	2,250	3,060,000
	4.1.2	Accessoris		m	680	7,900	5,372,000
	4.1.1	Bulkhead foundation		m	710	26,000	18,460,000
	4.1.2	Bulkhead concrete		m	710	9,320	6,617,200
	4.1.1	Reclamation		m3	709,000	9	6,381,000
		Sub total		m	680	239,596	162,925,200
	4-2	Pavement & Building / Equipment					
	4.2.1	Port road at Pier No.3	20mx680m	m2	13,600	96	1,305,600
	4.2.2	Building of Shed	150x50x2	m2	7,500	1,210	9,075,000
	4.2.3	Building of Cold Storage	120x50x1	m2	6,000	1,210	7,260,000
	4.2.4	Yard pavement external buildings		m2	14,340	96	1,376,640
	4.2.5	Yard pavement concrete D=250mm		m2	10,300	96	988,800
	4.2.6	Yard pavement PC panel		m2	1,300	510	663,000
		Sub total		m	680	30,396	20,669,040
		TOTAL of ITEM 4		m	680	270,000	183,600,000
5		Breakwater					
	5-1	Sub-breakwater		m	620	57,100	35,402,000
	5-2	Main breakwater		m	1,790	39,900	71,421,000
	5-3	West breakwater		m	300	57,400	17,220,000
		TOTAL of ITEM 5		m	2,910	42,626	124,043,000

Table 9.5(2) Preliminary Project Cost for Short Term Development Plan (2/2)

Item		Description	Detail	Unit	Quantity	Unit Price	Amount
6		Container terminal					
	6-1	Container Berth					
	6.1.1	Foundation works		m	540	4,890	2,640,600
	6.1.2	Concrete caisson		units	27	2,000,000	54,000,000
	6.1.3	Super structure and accessories		m	540	15,300	8,262,000
	6.1.4	Crane foundation L=35m 108units		m	536	33,000	17,688,000
		Sub total		m	540	152,946	82,590,600
	6-2	Container Terminal					
	6.2.1	pavement		m2	145,800	140	20,412,000
	6.2.2	Reclamation		m3	2,989,000	10	29,890,000
	6.2.3	Port road		m	547	3,110	1,701,170
		Sub total		m	540	96,302	52,003,170
	6-3	Basin for port service boats	-4m quay				
	6.3.1	Concrete works		m	276	29,600	8,169,600
	6.3.2	Foundation works		m	276	22,500	6,210,000
		Sub total		m	276	52,100	14,379,600
	6-4	Juncktion of breakwaters					
	6.4.1	Concrete caisson and foundation	20m+20m	m	40	120,000	4,800,000
		TOTAL of ITEM 6		m	540	284,766	153,773,370
7		Channel & Basin					
	7-1	Dredging		m3	430,000	18	7,740,000
	7-2	Navigation aids		LS	1	500,000	500,000
		Sub total		LS	1		8,240,000
		TOTAL of ITEM 7		LS	1		8,240,000
		TOTAL OF OFFSHORE WORKS					488,588,670
B		CIVIL ON LAND WORKS					
	1	Site preparation		Ha	20	11,550	231,000
	2	Fence with seaside retaining wall		m	2,000	270	540,000
	3	Gate/Watch house, Truck scale		LS	1		600,000
	4	Railway	for container	m	2,700	1,800	4,860,000
		TOTAL OF ON LAND WORKS					6,231,000
		TOTAL OF CIVIL WORKS					494,819,670
C		Procurement of equipment					
	1	Quay Side Gantry Crane		units	2	17,000,000	34,000,000
	2	Rubber Tire Mounted Gantry Crane		units	4	2,800,000	11,200,000
	3	Tractor head / Trailer		units	33	150,000	4,950,000
		TOTAL OF EQUIPMENT					50,150,000
D		TOTAL OF CONSTRUCTION COST					544,969,670
E		Engineering services					
	1	Consultation of the Project	Civil x 0.03	%	494,819,670	0.03	14,844,590
	2	Training of equipment	Equipment x 0.01	%	50,150,000	0.01	501,500
		Sub Total					15,346,090
F		Indirect Cost + Contingency		%	560,315,760	0.10	56,031,576
G		GRAND TOTAL	Exclude VAT				616,347,336
		Equivalent Japanese Yen				¥	30,817,366,806

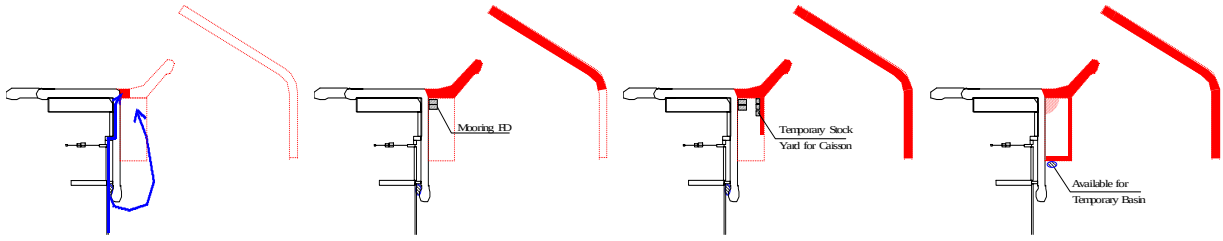
(2) Construction Schedule

Table 9.6 shows the Construction Schedule for the Short Term Plan.

Table 9.6 Construction schedule for the Short Term Plan

Item		Description		amount	Short Term						
					Urgent			Remain			
				2006.July→	2006	2007	2008	2009	2010	2011	2012
A		Off shore Works									
	1	Mobilization & Demobilization	LS	1							
	2	Temporary works	LS	1							
	3	Access Road & Bridge									
	3-1	Temporary port road	m	440	junckti	on	road				
	4	Pier No.3	m	680	170m	340m	170m				
	5	Breakwater									
	5-1	Sub-breakwater	m	620				200m	420m		
	5-2	Main breakwater	m	1,790				300m	600m	600m	290m
	5-3	West breakwater	m	300	70m	150m	80m				
	6	Container Terminal									
	6-1	Container Berths	m	540					260m	280m	
	6-2	Container Terminal	m	540							540m
	6-3	Reclamation	m3	2,989,000							2,989,000m3
	6-4	Revetment (-4m quay)	m	276						276m	
	7	Channel & Basin	LS	1					Dredging	Navigation aids	
B		On land works									
	1	Site preparation	Ha	20				20Ha			
	2	Fence with seaside retaining wall	m	2,000					1,000m	1,000m	
	3	Gate/Watch house, Truck scale	ls	1							
	4	Railway	m	2,700				900m	900m	900m	
C		Procurement of equipment									
	1	Quayside Gantry Crane	unit	2							2 units
	2	Rubber Tire Mounted Gantry Crane	unit	4							4 units
	3	Tractor head & Trailer	unit	33							33 units

Year is shown as the Fiscal Year that start in April and end in March of next year



Dec. 2008
(Under construction of Sub B-W)

Dec. 2009
(Under construction of Main B-W)
(Mobilization of FD for fabrication of Caisson)

Dec. 2010
(Completion of offshore B-W)
(Under construction of Caisson Walf)

Dec. 2011
(Completion of Quaywall and Revetment)
(Under construction of Reclamation)

9.8 Phased Implementation Plan of the Project in the Short-Term Plan

(1) Phasing of the Short-Term Plan

The Short-Term Plan has been divided into two phased projects, viz. the Urgent Project and the Remain Project of the First Phase Project. The Urgent Project needs to be completed by the completion of the construction of a steel mill factory in CIPP scheduled in the year 2008.

(2) Implementation Schedule of the Short-Term Plan

The schedule of the Short-Term Plan consisting of the Urgent Project and the Remain Project of the First Phase in terms of implementation has been roughly drafted as follows:

1) Urgent Project

a. 2006: Start of construction works

b. In mid 2008: Completion of construction works

c. In mid 2008: Start of terminal operations

2) Remain Project of the First Phase

a. In mid 2008: Start of construction works

b. At the end of 2012: Completion of construction works

c. At the end of 2012: Start of terminal operations.

The item of the plans for each phase project is shown in Fig. 9.7.

9.9 Economic Appraisal

A comparison between the “Without-the-project” case and the “With-the-project” case has been carried out to evaluate the economic feasibility of the port development project composed of the construction of breakwaters, the terminals of containers, multi-purpose and fruits proposed in the Short-Term Plan from the viewpoint of the national economy of Brazil. The main economic benefits of the project are (1) saving in container land transportation costs, (2) saving in container transhipment costs and (3) saving in sea transportation costs.

The resulting economic internal rate of return (EIRR) for the above mentioned project is 22.5% which exceeds the general criterion to assess the economic feasibility.

9.10 Financial Appraisal

The financial revenues are generated from the existing port dues and charges set up by referring to the tariff level of the neighbouring ports.

The resulting financial rates of return (FIRR) for the Short-Term project is 11.4% which exceeds the weighed average interest rate (8%) of assumed fund raising and hence the project has been considered to be financially viable.

1st Phase Project (2006 - 2008 -Urgent Development-)

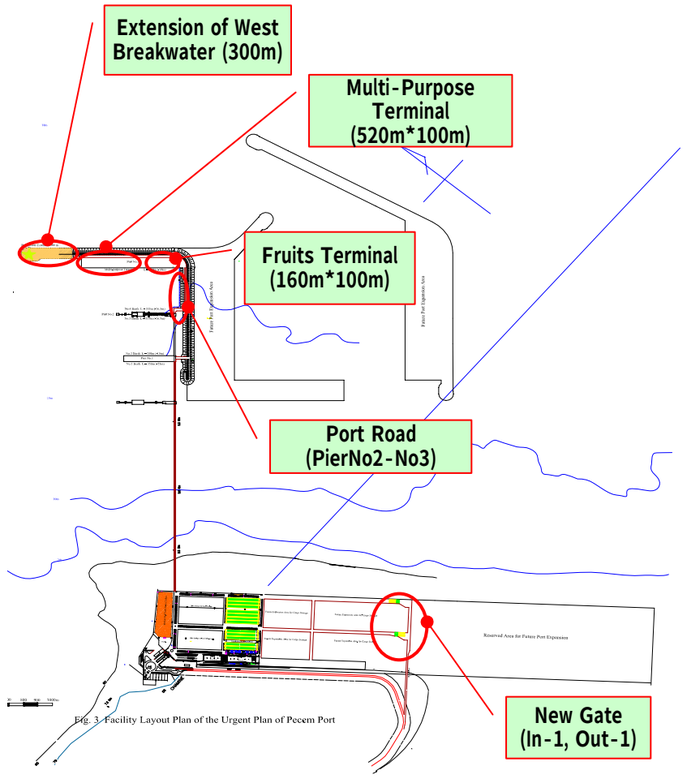
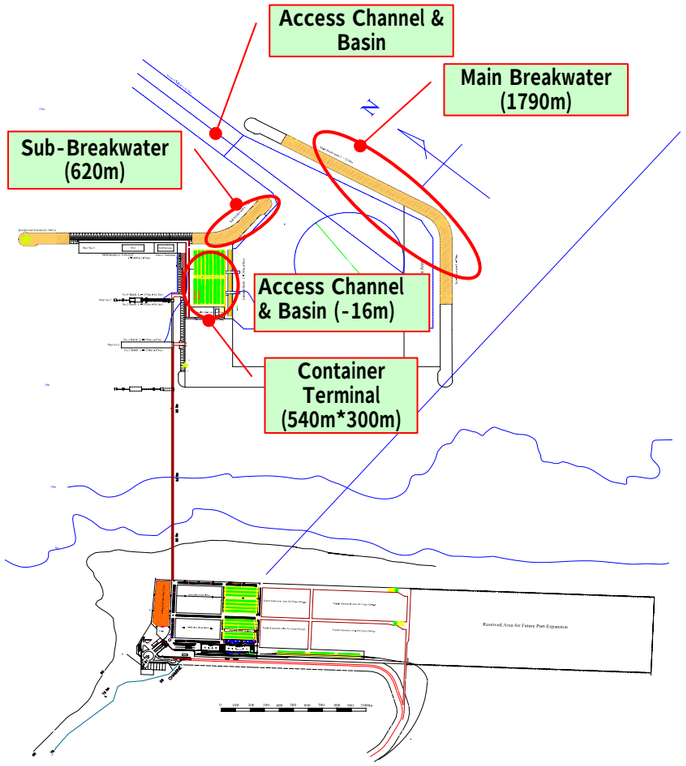


Fig. 3 Facility Layout Plan of the Urgent Plan of Pecem Port

Facility components		
Breakwater	length	300m
Multi-purpose terminal (pier 3)	berth length	520m
	water depth	16m
	terminal area	4.2ha
Fruits terminal (pier 3)	berth length	160m
	water depth	16m
	terminal area	1.3ha
New gates	In and out gate	2units
Construction cost	**million R$**	289

1st Phase Project (2008 - 2012)



Facility components		
Access channel	width	210m
	water depth	16.5m
Basins	water depth	16m
Breakwater	length	2,410m
Container terminal	length	540m
	water depth	16m
	terminal area	14.6ha
	container crane	2units
Multi-purpose terminal (pier 3)	sheds	7,500m^2
Fruits terminal (pier 3)	sheds	5,500m^2
Construction cost	**million R$**	327

2nd Phase Project (2013 - 2022)

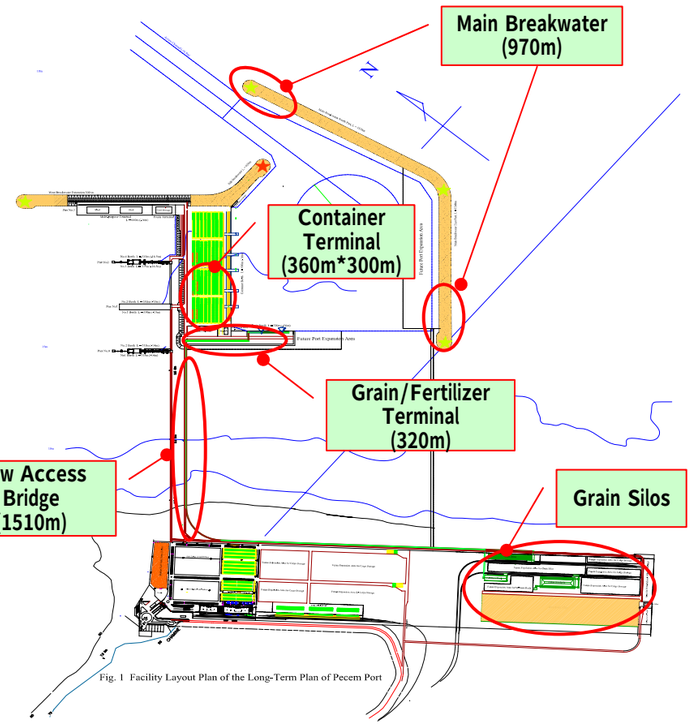


Fig. 1 Facility Layout Plan of the Long-Term Plan of Pecem Port

Facility components		
Breakwater	length	970m
Container terminal	length	360m
	water depth	16m
	terminal area	9.5ha
	container crane	4units
Multi-purpose terminal (pier 3)	sheds	7,500m^2
Grain/fertilizer terminals	berth length	320m
	water depth	16m
	ship loaders/unloaders	2units
	silos(grains)	230,000ton
	warehouse(fertilizer)	76,000ton
New access bridge	length	1,510m
Construction cost	**million R$**	819

Fig 9.7 Item of the Plans for Each Phase Project

10 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS FOR SHORT-TERM DEVELOPMENT PLAN

10.1 General

Short-Term development plan includes new large scale constructions. Several environmental licensing are necessary for the implementation of the plan. The different kinds of licensing and necessary processes to take legal permissions are identified in this chapter.

Notice that among those, the Environmental Impact Assessment, which may be required by IBAMA for the port construction, is mostly important for the environmental and social considerations with respect to the implementation of the Short-Term development plan. A few items that may cause certain magnitude of environmental and social impacts are examined in this chapter, so that:

- It would help Ceara State government in the implementation of environmental and social considerations.
- The feasibility of the project would be examined in terms of environmental and social considerations.

10.2 Environmental Authorization

(1) Environmental Licensing Process for the Short-Term Development Plan

CONAMA Resolution n° 237/97 was published considering the need to establish criteria for the exercise of the licensing competence. It is important to point out that projects and activities will be licensed in only one competence level. It also states that IBAMA is responsible for licensing projects and or activities with significant environmental impact in national or regional area, and when those are located within territorial sea; IBAMA proceeded the licensing after considering the technical exam by an environmental organization from the state and/or the municipal level. This law foresees that IBAMA, in its complementary competence, may delegate licensing to the competent state organization.

Therefore, port extension works shall be licensed by IBAMA.

CONAMA Resolution n° 237/97 (Art. 8th), states that IBAMA will give License of Installation (LI) and License of Operation (LO) for the extension of Pecém Port.

(2) Expected Content of the Environmental Study

The elaboration of the environmental studies EIA -RIMA will be oriented by the Terms of Reference (TOR) and follow the general guidelines and the technical activities. The expedition of the Term of Reference by IBAMA – Brasília doesn't prevent the institute of requesting, at any moment, an analysis of the environmental studies EIA - RIMA, complementation if necessary, for better understanding of the project and its consequences.

Table of Contents for the EIA

1. Identification of the entrepreneur

2. Identification of the consulting firm

3. Identification of the enterprise

4. Enterprise technical data

5. Areas of influence of the project

6. Environmental diagnosis of the area of influence of the enterprise

7. Integrated analysis

8. Identification and evaluation of the environmental impacts

9. Mitigation measures

10. Plans of control and environmental monitoring

11. Risk analysis

12. Environmental legal embasement

13. Conclusions and recommendations

14. Technical team

15. Bibliography

16. Glossary

17. Attachments

(3) Environmental Impact Report (RIMA)

The RIMA should contain objectives, description of the project and its technological and locational alternatives, results of studies of environmental diagnosis, description of the analyzed impacts, characterization of the future environmental quality, description of the expected effect of the mitigation measures, impact control and monitoring plan, and recommendations.

10.3 Examinations of Significant Impact Items

(1) Selection of Significant Items

Significant items were selected from IEE items of long-term development plan. The items were compared in terms of the magnitude of impact, examination cost, difficulty of examination and the relation with locals. As a result of comparison, shoreline, marine water quality and life quality are selected. Life quality includes some social items because the measures of them should be integrated.

(2) Shoreline

1) Evaluation on Present Impacts Caused by the Existing Port

In the numerical computation, a 300,000 m^3/year of littoral transport has been estimated around the tip of Pecem. The decrease of the littoral transport rate is 13% for the case of existing port, and 40,000 m^3/year has been accumulating. As a result, accumulation and retreat happens. The sand accumulates around Pecem port and retreat around Pecem village.

2) Analysis of the Short-Term Development Plan

The sand deposition due to the short-term development plan numbers at about 150,000 m^3/year. The computation result shows that the retreat is caused from the north area of Pecem village to Colonia village during ten years. However, those results are only computation results that makes difficult the prediction of the area of retreat, taking into account the conditions of dynamic equilibrium of the littoral drift around when considering the influence of Pecem tip. In order to revise the scale and location of retreat, an appropriate monitoring should be conducted.

3) Future Shoreline Monitoring and Mitigation Plan

a. Monitoring

The result from the computation may differ of the actual phenomenon. In order to grasp the actual change of shoreline, monitoring is necessary. The monitoring items are such as point observation, and should be conducted periodically with same method.

b. Mitigation

There are many mitigation measures to protect the shoreline. In this study, three measures such as sand bypass, groin with sand bypassing, and revetment were thought as affordable and are realistic ones.

According to the comparison of measures, sand bypassing was evaluated as the best and appropriate. Approximately 150,000 m^3 of sand is estimated to be accumulated. The cause of the erosion is the changing on the equilibrium situation of sand drift. The total sand quantity will not diminish, and only the balance of sand drift is to be changed by the extension of the breakwater. Therefore, application of sand bypassing is appropriate.

4) Feedback Plan

a. Model of feedback

A working group is necessary for the data collection, decision making, evaluation and feedback to the management adaptively. The working group should comprise relevant agencies. The discussion meeting should be held at least once in six months.

b. Decision making

Examination of measures to protect the shoreline shall be determined by the working group based on the monitoring results. The monitoring institute shall prepare the report in which the monitoring data is listed and analyzed. Then the report shall be presented to the members of working group. Issues and measures shall be discussed in the meeting, which shall be held at about once within six months. The decision taken on the meeting should be executed, therefore, the authorized right should be given to the working group.

c. Evaluation and feedback

Evaluation shall take place in the meeting of working group. If the members find out that is necessary to modify some measures in order to protect the shoreline better, then those alterations should be applied. The feedback procedure and responsible organization shall be determined in the meeting. As this process must be examined

scientifically, the specialists should participate the meeting and the modified measures should be approved by the specialists. And in order to secure the implementation, the minutes of meeting of working group should be disclosed in public, within public audiences.

(3) Marine Water Quality

1) Appraisal of Available Information

Regarding marine water quality in the surrounding of the Pecem port, the scarcity of data is observed, mainly due to the absence of surveys, either systematic or not. Even the environmental assessment for construction of port lacks information on this item. The detail data on the marine water quality come from spare samples collected by the CAGECE for monitoring the sewer emissary of the existing thermoelectric plant.

2) Quality Survey

a. Survey parameters

The survey was conducted by CAGECE at 10 stations around the port. Environmental sea water conditions were evaluated from physical-chemical conditions of water. Parameters were salinity, temperature, pH, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids, metals (As, Cd, Pb, Cu, Cr^{+6}, Cr total, Sn, Fe total, Hg, Ni, Ag, Se, and Zn), phenol index, cyanides, fluorides sulphides, oil and grease.

b. Results and Evaluation

i) Physical-chemical parameters

Temperature, salinity, pH, and dissolved oxygen (DO)

Temperature kept constant values, averaging around 21.7°C, both in vertical and spatial distribution. pH of samples, in general had values above 7, characterizing the water mass as a low alkalinity, which favors development of sea species. Dissolved oxygen revealed a vertical gradient of decreasing values with depth. It is observed that plant effluents present values within those of sea waters.

Turbidity and suspended materials

Port basin waters corresponding to the area directly influenced by plant effluents revealed a light extinction coefficient of 0.46 (low transparence waters) at the depth of 3.0 m. Suspended solids are composed by organic material, silt and clay. Total suspended solids values ranged from 22.8 mg/L to 96.4 mg/L, with larger values in stations along the coast line, in function of sampling being done in the breaker zone.

Organic material and BOD

The percent of organic material in sediments collected in marine substratum presents relatively low values. The largest concentration was found in Station 7, associated to its location in relation to port construction, which make the area protected from tides, waves, and currents. Determinations of BOD showed minimum value of 0.59 mg/L in Station 8 and 9, and maximum value of 3.0 mg/L, in Station 2. Sampling in the thermoelectric plant (Station11) showed value around 4.75 mg/L for water of industrial effluent, still within admissible value.

Heavy metals

Results are compared to the average concentrations in oceanic water and maximum limits allowed by legislation. Results is strongly suggested the analysis error, since concentrations are much superior to results found for oceanic waters and even in areas which are contaminated. No evidence exists for significant sources of all the analyzed metals, indicating low probability that the results derive from artificial emissions. There is no basis for a detailed discussion of the results. New sampling and analyzing should be done.

Concentrations of major parameters in sediments in the area influenced by the port compared to concentration reported for other regions of the continental platform. Metal concentrations in the area influenced by the port were lower than those found in the outer continental platform of Northeast and Southeast Brazil, and are in the range reported for sediments were lower concentration except for Fe.

3) Impact Assessment on Marine Water Quality

a. Existing impact

Marine water quality in the Pecem port tends to be deteriorated both chemically and biologically by the operation of Pecem port and existing of Pecem village. However the level is thought to be slight according to the water quality survey results.

So far no important cargo spills or accidents have occurred. However the lack of a plan for management of ballast water may produce deterioration of water quality.

b. Expected impacts by the short-term development plan

Expected impacts on marine water quality are quite variable. During construction, the main impact is the turbidity increasing, due to movement of the operation of equipment and movement of materials. During operation, there is danger of outflows of the oil by stranding of vessels or even the collision of vessels. Discharges of effluents from industries are also predicted to increase.

4) Marine Water Quality Management Plan

a. Methods and procedures

A plan for marine water quality management can only be accomplished through well work practise, i.e. avoidance of contamination.

Specific management shall be carried out through the following monitoring and feedback plan.

b. Marine Water Monitoring Plan

Chemical conditions of sea water will be bimonthly evaluated through physical-chemical conditions.

5) Ordinary Feedback Plan

The monitoring institute shall collect and analyze reports of monitoring actions. The institute shall evaluate reports of monitoring actions. On basis of those evaluations, the institute shall produce semester reports. According to the reports, SEINFRA and CEARAPORTOS should transfer interpretations and suggestions to the environmental

authorities, municipal authorities, the state attorney office, the federal attorney office. Then if necessary, working group should be structured. Working group should discuss solutions and compensations in public audiences, in case water quality deterioration causes the serious problem.

(4) Life Quality

1) Interview Survey

This research collected life conditions and issues related to short-term development plan. This research supplied considerations for an improvement planning of life quality and estimation of the inhabitants' actions towards shoreline change.

2) Social Impact Assessment

Social impacts are alterations in the life of social groups, caused, mostly by human productive activities. In the case of the study area, delimited by the coastal area between the districts of Caucaia and Sao Goncalo do Amarante, those impacts have their origin in activities as: industry, fishery, port activities and tourism.

a. Industry

The main positive social impacts of industry are:

- Increase the number of available jobs,
- Implantation of basic infrastructure in the districts,
- Increase of income generation,
- Increase the local population training by the government, and
- Increase the district income.

The main negative social impacts of industry are:

- Increase the number of cases of diseases related to the water contamination due to no treated sewer release,
- Increase of the number of cases of breathing diseases caused by the emission of particles in the atmosphere, coming of all of the industrial operations, and
- Increase the number of accidents caused by the circulation of trucks.

b. Port activities

The main positive social impacts of port activity are:

- Increase of the number of available jobs
- Increase in the income generation

The main negative social impacts of port activity are:

- Degradation of the fishing activity caused by oil spills,
- Food access loss for the suppression coastal ecosystems,
- Loss of coastal areas of work and housing, and

- Alterations in the landscape.

c. Tourism

The positive social impacts of tourist activity are:

- Increase of available jobs,
- Implantation of basic infrastructure in the districts,
- Increase of income generation,
- Improvement in the wave condition from Pecem to Cologne, and
- Increase the district income.

The negative social impacts of tourist activity are:

- Disaggregating of family,
- Increase of the drug use,
- Increase of prostitution,
- Increase of criminality,
- Loss of local culture

3) Quality of Life Improvement Planning

a. Mitigation measures

The life quality improvement plan should embody the education, environmental protection, health, infrastructure, commerce and industry, public safety, and workforce and income to be effective.

b. Monitoring and evaluation

Monitoring and evaluation are important since difficulties confronted and successes gained in the implementation of projects can be measured. It is essential that the adaptations adhere to the culture of a given place in order for the monitoring to be satisfactory.

The evaluation and monitoring of the social programs should happen with indicators. The process should involve as much as the local associations, committees and local residents interested in the improvement of the quality of life of the population.

c. Feedback and decision making

The feed back process must occur through community participation and consultation while local people have opportunity to comment on governmental plans regarding to impacts on the communities.

It is suggested that the decision making group prepare reports in a regularity to be decided, and presenting these reports results during public meetings.

The issues on the report should be relevant to all community and embodies productive activities such as: industry; fishing; port activities; and tourism along with all other socio-economic matters.

It is important to suggest the development of projects to monitor existing programs. The structure of developed programs is in agreement with the strategic plan as the social, economical and environmental programs developed are efficient.

10.4 Stakeholders Meeting

The stakeholders meetings were held for the short-term plan. The meetings were held for several stakeholders separately at Fortaleza and Pecem. The main topics were the necessity and benefits of the Pecem port development, economy and its environmental and social considerations. JICA Study Team has reflected their opinions to the study, and recommended continuous discussions to the counterpart organizations