8.1 Initial Stage Development Plan

8.1.1 Industrial Development for the ISP

As explained in chapter 6.4, among the four Industrial Zones which Thua Thien Hue Province plans to construct, Chan May Centralized Industrial Zone (Chan May CIZ) which is in the hinterland of Chan May Port is a particularly important project for economic development in the central region. Therefore the development of Chan May CIZ is indispensable in the Initial Stage Development Plan of Chan May Port. Cargoes generated from Chan May CIZ are expected to account for the greater part of those handled in Chan May Port.

In Chan May CIZ, the development concept is to create a new urban center in the Central Corridor. The Initial Stage Development Plan in Chan May CIZ has a gross area of 300 ha and includes 25 projects. Industries assumed to be in operation by the Initial Stage include basic material, processing machine and regional resource (See Table 8.1.1).

Table 8.1.1 Outline of Chan May Centralized Industrial Zone

Industrial Type	Name of Industrial Sector	Main Products
Basic Material	Construction material	Construction stone
		Brick and concrete products
		Glass and pottery
		Asphalt concrete
	Chemical	Rubber products
		Plastic products
		Cosmetic and chemical products
		Lubricant & Insecticidal products
Processing Machine	Electric and electronic	Electronic equipment
		Electrical parts and equipment
	Machine equipment	Machine equipment
		Automobile assembling
Regional Resource	Garment	Garment and textile
		Leather tanning and processing
	Foodstuff	Fruits and Vegetable processing
		Processed marine products
		Meat products
		Liquor distillery
	Wood processing	Material wood

Source : People's Committee of Thua Thien Hue Province

8.2 Cargo Throughput

8.2.1 Cargo Throughput in Chan May CIZ

In the commodity-wise cargo forecast through Chan May Port in the year 2010, the cargo volume generated from Chan May FTZ is estimated separately. Each cargo volume is estimated by multiplying the area width and the unit product/material volume per ha., which is obtained from "Data of Port Planning by the Japan Ports & Harbour Association".

The export and import cargo volume generated from Chan May CIZ is estimated at 551,300 tons in the Initial Stage (See Table A8.2.1).

8.2.2 Total Cargo Throughput in ISP

Considering the present and future cargoes produced in Thua Thien Hue Province, the international cargo from/to Lao PDR and Thailand and the results in chapter 8.2.1, the major commodities to be handled at Chan May Port are classified and estimated as follows.

Table 8.2.1 Total Cargo Throughput in ISP

Commodities	Foreign		Domestic		Total
	Export	Import	Loaded	Unloaded	
Oil and Oil Products	0	610,000	0	0	610,000
Agricultural Products	307,000	29,000	0	0	336,000
Mining, Clinker and Bulk	101,000	159,000	0	200,000	460,000
Fertilizer and Break Bulk	112,000	75,000	0	33,000	220,000
Cement	200,000	0	450,000	0	650,000
Manufacturing Goods	155,000	149,000	15,000	0	319,000
International Transit Cargo	15,000	45,000	-	-	60,000
Total	890,000	1,067,000	465,000	233,000	2,655,000

Note: International transit cargo from/to Lao PDR and Thailand is included.

In the above cargo volume, the container cargo volume is calculated as mentioned in chapter 6.6 and summarized as follows.

(Container cargo volume) Unit : TEU

Year	Export	Import	Empty	Total

8.3 Ship Calls

Based on trends of the past net tonnage of calling vessels and future cargo volume, future number of calling vessels in target year is estimated for each ship type. Table 8.3.1 shows number of each vessel type in past three years.

Table 8.3.1 Number of Ship Calls

Type of Ship	1994	1995	1996	1997
Cargo Ship (Foreign)	152	173	217	229
Cargo Ship (Domestic)	95	60	64	147
Passenger Ship	31	28	36	35
Total	278	261	317	411

Source: Danang Port Authority

The projected vessels calls in ISP and Year 2020 is estimated as follows (See Table 8.3.2 and Table A8.3.1).

Table 8.3.2 Number of Ship Calls in ISP

Type of Ship (DWT)			Number of ships /year
Container	Foreign	20,000	126
General cargo	Foreign	3,000-10,000	173
Bulk cargo	Foreign	30,000	50
	Coastal	1,000-3,000	695
Car carrier	Foreign	40,000	13
Ro / Ro	Coastal	7,000	15
Oil tanker	Foreign	5,000	203
Passenger ship	Foreign	20,000	40
Total			1,315

8.4 Port Facilities and Layout for ISP

8.4.1 Stage-wise Development

Scale of development affects the viability of a port development project, in particular at the first stage of the development. Special attention should therefore be paid to the scale of economy. Industrial port usually has a base cargo and can invite regular ship calls. Industrial development projects in the hinterland may bear part of the port construction cost. However, commercial port has no guarantee of regular ship calls. A new commercial port also requires a close connection with city to provide shippers, consignees and shipping service agents with offices, bank services, telecommunication services and other city services.

Initial stage development plan should therefore be carefully designed from a view point of the scale of initial investment and the timing of completion of the project. Stage-wise development plan of Chan May Port is shown in Figure 8.4.1, in which the construction works start from the main breakwater from East Chan May Cape. Three alongside berths (W1-2 & E1) will be developed at the initial stage. The main breakwater will be built with a length of 930 m to shelter these three berths. It will be necessary to extend a groin from the coast to prevent littoral sand drift into harbor waters. Its location and length shall be carefully designed at the detailed design stage. Dredging of channel and basin will be carried out up to - 11 m and be deepened to -13 m at the next stage.

8.4.2 Port Facilities for ISP

A multi-purpose berth with a provisional alongside depth of –12 m (under CDL, to be deepened –13 m in the future) will be in need to accommodate 40,000 GT class car carriers, 40,000 DWT class bulk carriers, 20,000 DWT class container vessels, and 20,000 DWT class general cargo trampers if Chan May Industrial Park is realized. Two conventional berths with an alongside depth of –8 m (Under CDL) are also planned to accommodate 7,000 DWT class Ro/Ro vessels, 7,000 DWT class cement carriers, 5,000 DWT class product oil carriers and conventional cargo ships. Heavy cargo carriers and ocean going passenger ships may call at the port.

Small craft basin is designed with a water area of 9,000 m2 and a quay length of 280 m for tug boats, pilot boats, customs ships, coast guard ships and other port service ships. This basin can be used for work vessels during the construction stage.

Main breakwater has a length of 930 m, which is extended to shelter the berths against waves from NW. A 150 m groin is planned on the Chan May beach to prevent beach erosion likely caused by the construction of main breakwater.

Access channel and turning basin will finally have a depth of –13 m, however, it is planned that the basin has a depth of –11 m in the initial stage and can be deepened up to –13 m in the next stage of the development. Port facilities planned for the ISP are summarized in Table 8.4.1 and port facilities layout plan is shown in Figure 8.4.2. Initial Stage Development Plan of Chan May is shown in Figure A.8.4.1 (Appendix).

TABLE 8.4.1 Port facilities planned for the ISP

Port Facilities	Sizes	Remarks
Berths		
W2	L 330 m, D –12m (to be deepened to –13m in the next stage)	Multi-purpose berth for up to 40,000 GT class car carriers; 40,000 DWT class bulk carriers; 20,000 DWT class container vessels; Ocean going passenger ships; and conventional trampers.
W1 & E1	L 150 m each, D -8m	Conventional berths for 7,000DWT class Ro/Ro vessels, 7,000DWT class cement carriers, 5,000DWT class product oil tankers and others
Small craft berths	L 280 m, D –4m	Tug boats, Pilot boats, Customs ships and Others
Land Reclamation	300,000 m2	East and West Wharves
Breakwater/Seawall	L 930 m	Deepest seabed –13.5m
Channel & Turning Basin	D –11 m, Volume 1,300,000 m3	Provisional depth of turning basin –11 m (Pocket dredging -12 m)

8.5 Implementation Plan

The construction works start from the main breakwater from East Chan May Cape. Small craft berths and their back yard shall be firstly developed as the construction work site. W1 berth (-8m) will be firstly built and then W2 berth (-12m) will be constructed in accordance with the development of Chan May industrial zone.

Construction schedule of each berth is planned to cover the cargo throughput demand as shown in Figure 8.5.1, where W1 will be completed in three years after the commencement of construction, W2 in four years, E1 in seven years and so forth. Since Chan May is a new port, there is no basic cargo for the port and consequently the development of port should be carefully examined. The first stage shall be the minimum development of one berth, W1, for conventional cargo trampers and Ro/Ro vessels.

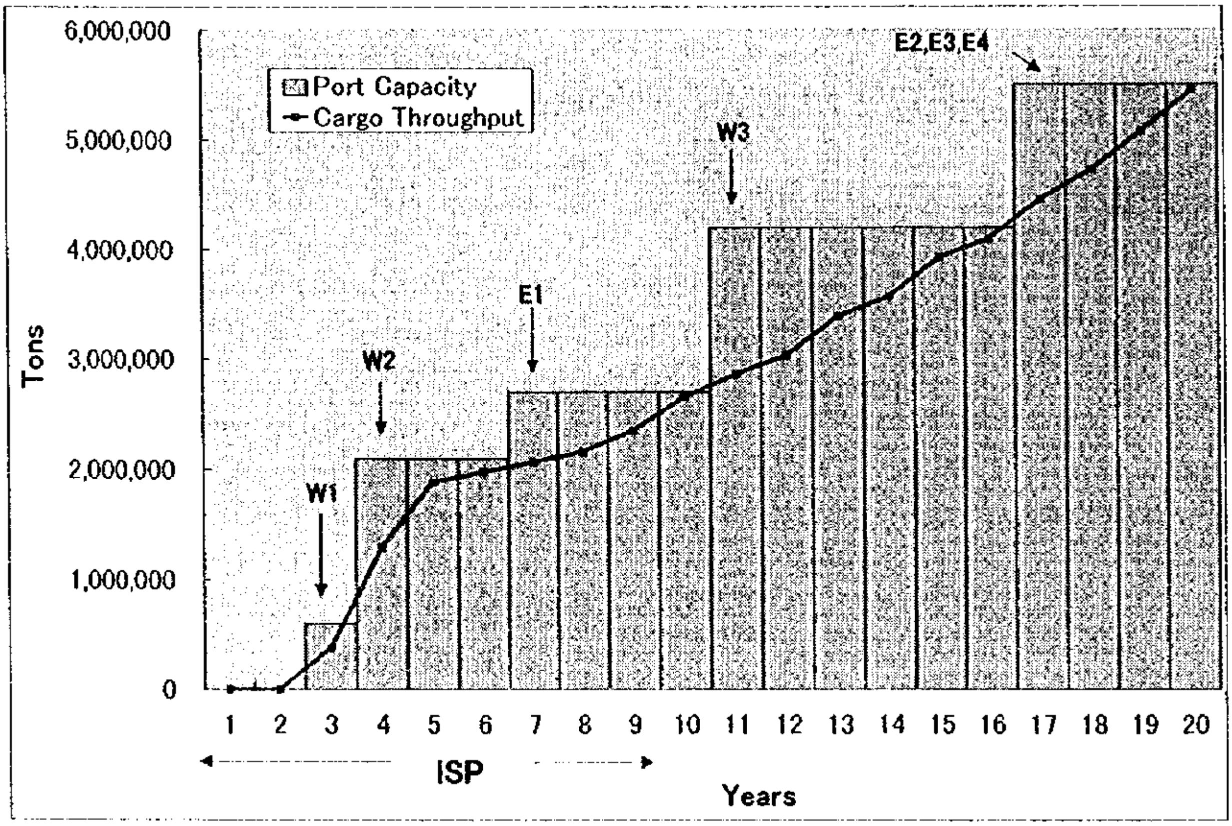


Figure 8.5.1 Implementation Plan

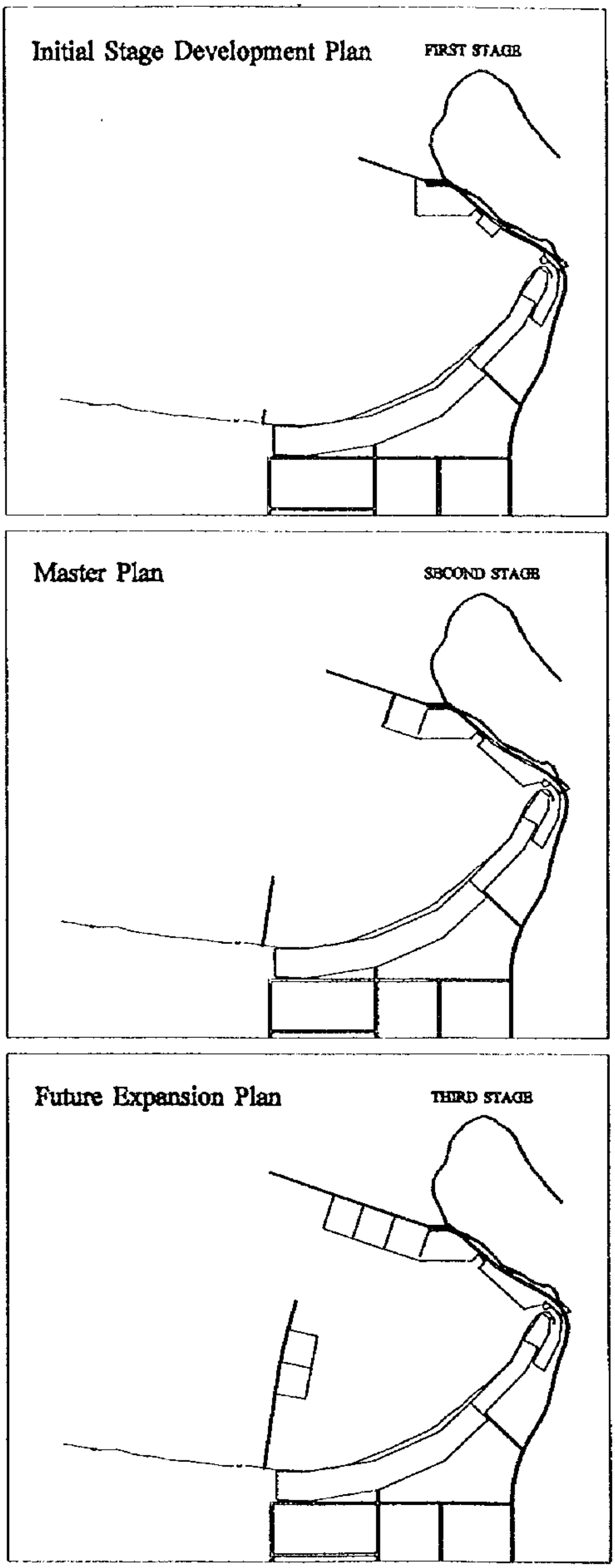
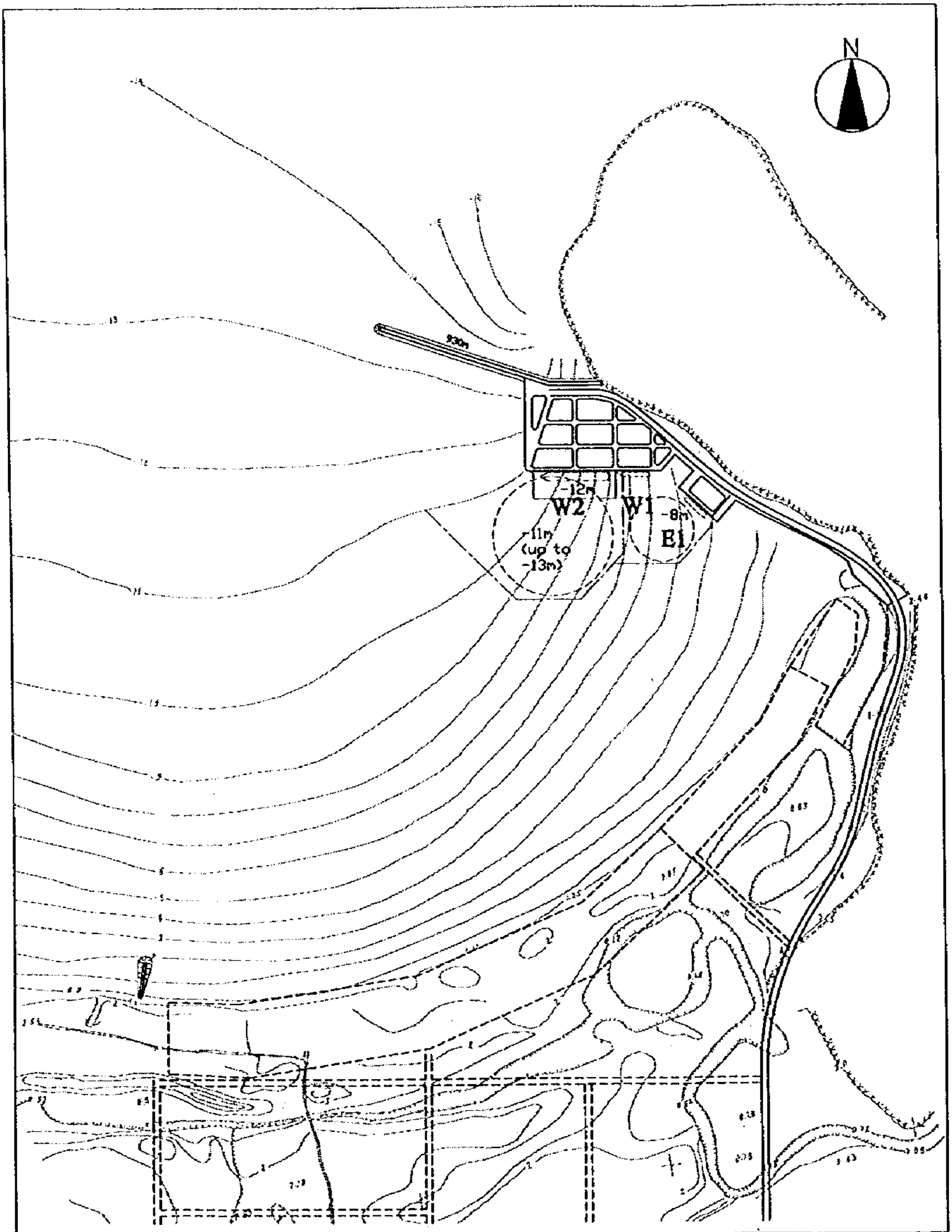


Figure 8.4.1 Chan May Port Development Stage Plan



JICA Port Development Study in Central Region	Figure 8.4.2
Chan May Port Initial Stage Development Plan	0 200 400 600 800 1,000 m
Draft Final Report 1998	FILE CM-ISP-A4

9. Preliminary Port Facilities Design

9.1 General

According to the Initial Stage Development Plan of Chan May New Port shown in the Chapter 8, preliminary design work of such main port facilities as breakwater, seawall, quaywall, revetment etc. has been carried out. Through this preliminary design work technical feasibility can be assured or the results of preliminary design work are used for calculating the cost of the Initial Stage Development Plan of Chan May New Port.

Usually design conditions should be fixed on three categories. These are natural conditions, so-called available or utilized conditions and material or structural conditions including allowable stress of materials and safety factor to evaluate stability. The design conditions hereinafter has been set mainly basing on the results of surveys done by JICA /POWECO Study Team and Japanese Technical Standards of Port and Harbor Facilities for the sake of convenience using the existing computer programs.

9.2 Objective Port Facilities for Preliminary Design

The objective port facilities for preliminary design are listed bellow as Table 9.2.1

Table 9.2.1 Objective Port Facilities for Preliminary Design

Name of Facility	Design Depth(m)	Length(m)	Remarks
Breakwater	-13.5	630	250m shall be seawall in Master Plan
Seawall	-12.0	300	
Revetment	-12.5	370	
Revetment for road	-1.0	150	
Groin	-1.0	350	
Quaywall W2	-13.0(-12.0)	330	1 Berth -13.0m in Master Plan
Quaywall W1, E1	-8.0	300	2 Berth
Quaywall	-4.0	280	

9.3 Design Conditions

9.3.1 Natural Conditions

Natural conditions using for the preliminary design mostly have been derived from such surveys and analysis as tide, wave, and soil which were conducted by JICA/POWECO Study Team during the study period. These are shown as follows.

(1) Tide

H.W.L.= C.D.L. +1.3 m
L.W.L.= C.D.L. ±0.0 m

(2) Wave

Breakwater : $H_{1/3}$ = 6.4m H_{max} = 10.6m H_D = 10.6m T =13.9sec
Offshore Wave Direction : NE, Incident Wave Angle : 20.5°

Seawall : $H_{1/3}$ = 5.8m H_{max} = 9.7m H_D = 9.7m T =13.9sec
Offshore Wave Direction : NE, Incident Wave Angle : 15.5°

(3) **Soil Conditions**

Soil Conditions are decided like as Figure 9.3.1 (1)~(2) by each facilities described in the column of the Design Facility and Soil Condition analyzing the soil borings and test results.

(4) **Seismic Coefficient**

K_H = 0.05
K_V = 0.00

9.3.2 Utilized Conditions

(1) **Berth Dimension**

Such berth dimension as berth length, berth depth and ship size, etc. are tabulated bellow.

Table9.3.1 Berth Dimension

Berth No.	Number of Berth	Berth Length	Berth Depth	Objective Ship				
				Kind	DWT	Length	Width	Draft
W2	1	330m	-13.0m	Container	47,000	275m	32m	12.0m
W1,E1	2	300m	-8.0m	Ro-Ro	7,000	140m	20m	7.5m
	--	280m	-4.0m	Small Vessel	--	--	--	--

Note: W2 Berth is temporally -12.0m.(in Initial Stage Plan)

(2) **Crown Height of Quaywall**

+ 2.5m (H.W.L. +1.3 +1.2m)

(3) **Ship Berthing Speed**

15cm/sec

(4) **Surcharge**

2.0 t f/m² (ordinary case)
1.0 t f/m² (in case of earth quake)

(5) **Live Load (Berth W1,W2,E1)**

Wheel Load 25tf 10tf/wheel
Tractor Trailer Load 5tf/wheel
Fork Lift Truck(35t) 45tf/wheel
Truck Crane (50t) 50tf/outrigger

9.3.3 Material Condition

(1) **Coefficients of Material**

Coefficients of Material for Design are summarized bellow.

Table 9.3.2 Coefficient of Material for Design

Material	Friction Angle	Friction Angle to Wall	Unit Weight	Unit Weight in Water
Rubble Stone	45°	-----	1.8 tf/m^3	1.0 tf/m^3
Backing Stone	40°	+15°	1.8 tf/m^3	1.0 tf/m^3
Backing Sand	30°	+15°	1.8 tf/m^3	1.0 tf/m^3

(2) Coefficient of Friction

Coefficients of Static friction using stability calculation are shown bellow.

Table 9.3.3 Coefficient of Static Friction

Material	Coefficients of Static Friction
Concrete against Concrete	0.5
Concrete against Rubble	0.6
Concrete against Asphalt Mat	0.7
Rubble against Rubble	0.8

Source : Technical Standards for Port and Harbor Facilities in Japan

(3) Allowable Stress

Allowable Stresses are in accordance with Table 9.3.4

Table 9.3.4 Allowable Stress

Material		Standard Design Strength	Compressive Stress	Bending Compressive Stress	Remarks
Plain Concrete		180 kgf/cm^2	45 kg/cm^2	---	For Concrete Block
Reinforced Concrete		240 kgf/cm^2	---	90 kg/cm^2	For H.B. or Concrete Caisson, L-shape Block
Material		**Axial Compression Stress**	**Axial Tensile Stress**	**Bending Stress**	**Remarks**
Steel	SS 41	1400 kg/cm^2	1400 kg/cm^2	1400 kg/cm^2	Reinforced Bar
	SD35	1800 kg/cm^2	1800 kg/cm^2	1800 kg/cm^2	Deformed Bar
	SY30	1800 kg/cm^2	1800 kg/cm^2	1800 kg/cm^2	Steel Sheet Pile
	SKK41	1400 kg/cm^2	1400 kg/cm^2	1400 kg/cm^2	Steel Pile Pipe

Source : Technical Standards for Port and Harbor Facilities in Japan

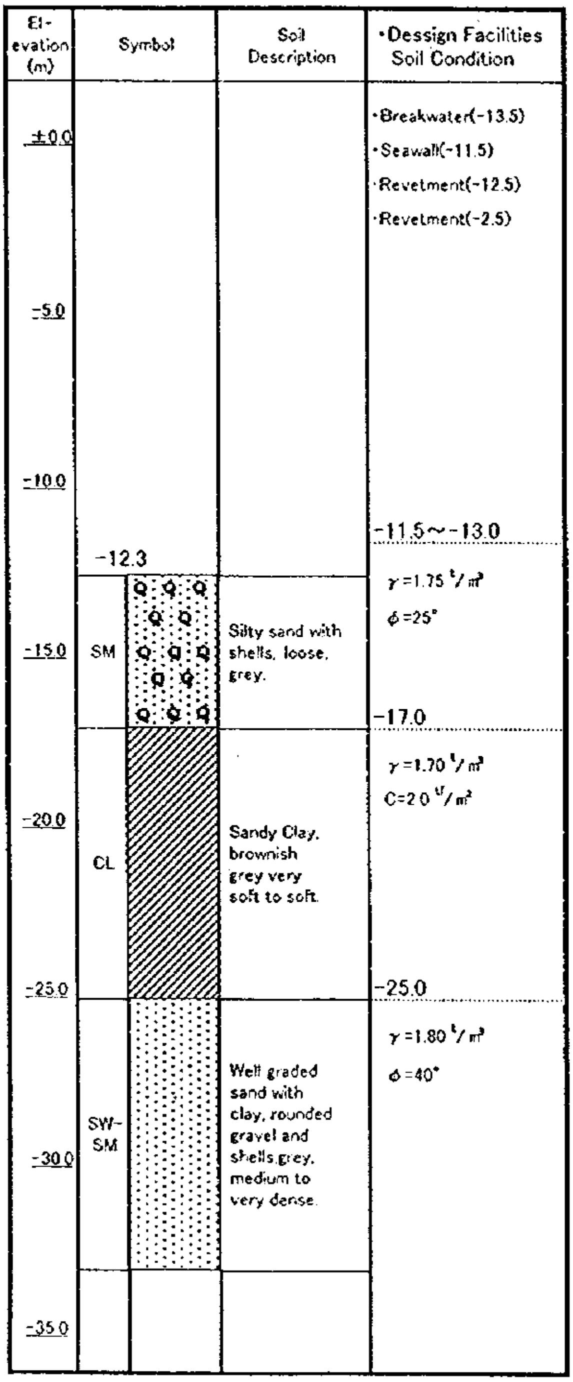
(4) Safety Factor

Safety Factors on checking stability are listed bellow.

Table 9.3.5 Safety Factor

Calculation Item	Ordinary Case	Unordinary Case
Circular Failure	1.2	1.0
Overturn of Wall	1.2	1.0
Sliding	1.2	1.0
Tow Pressure against Rubble Mound	60tf/m^2	90tf/m^2

Chan May Soil Condition No.1



Chan May Soil Condition No.2

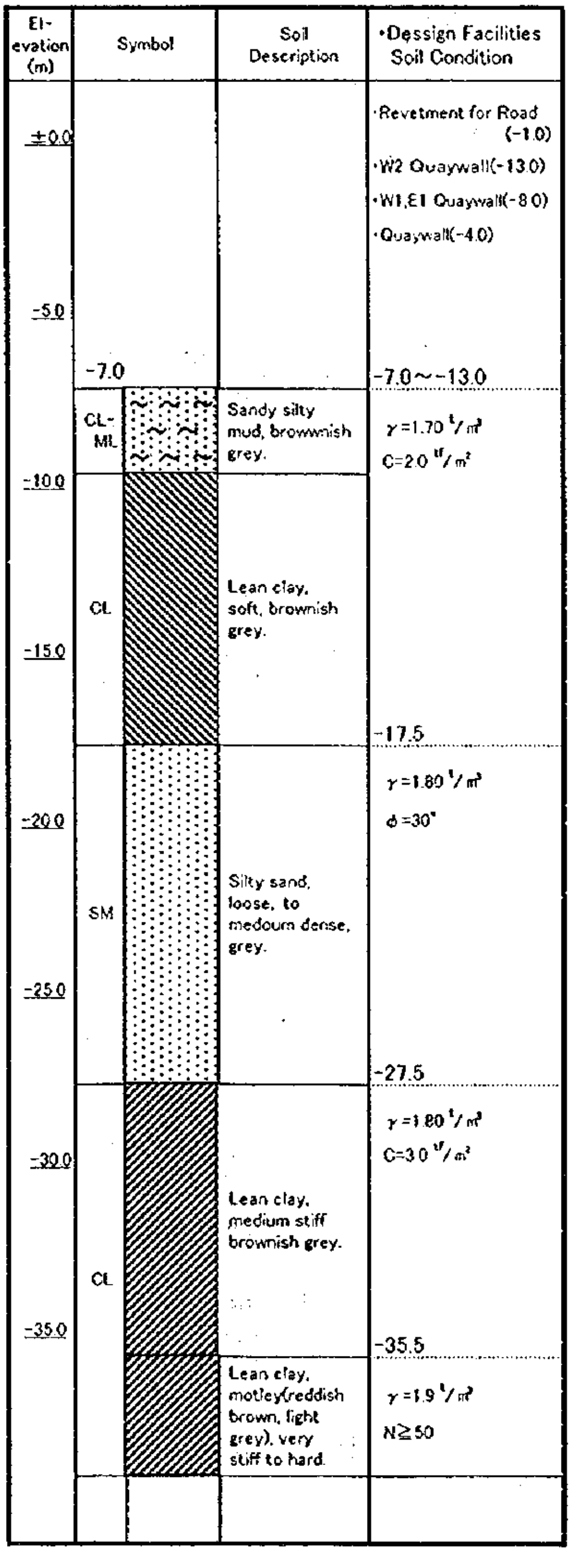
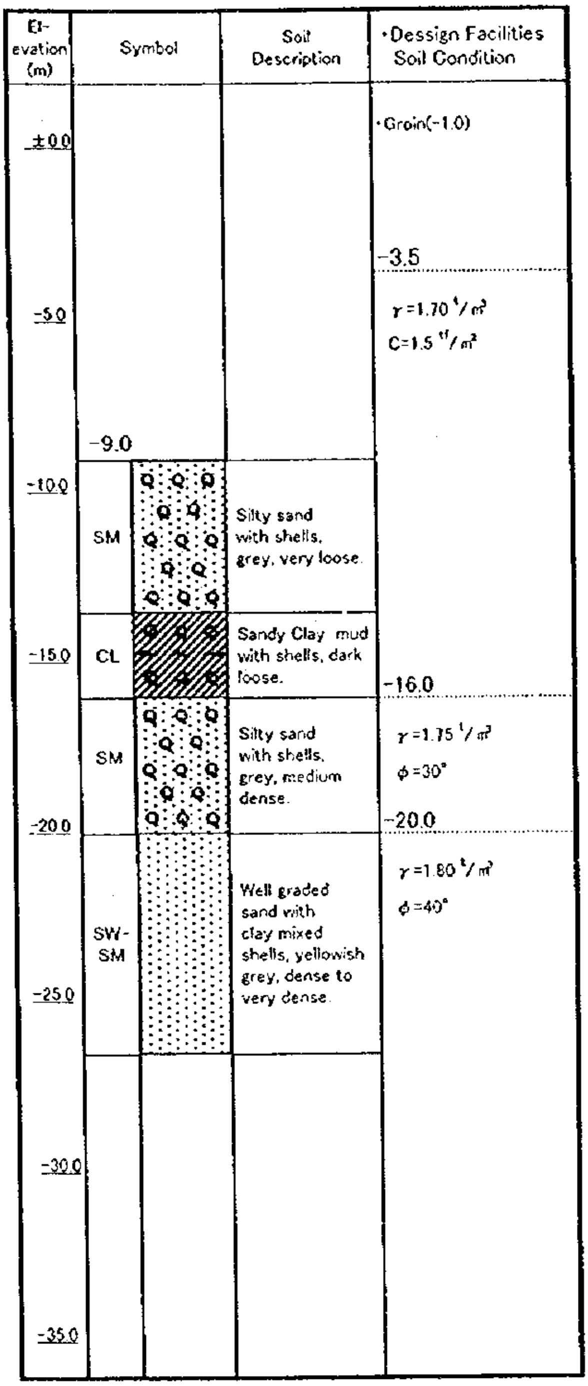


Figure 9.3.1(1) Soil Conditions for Preliminary Design

Chan May Soil Condition No.3



Chan May Soil Condition No.4

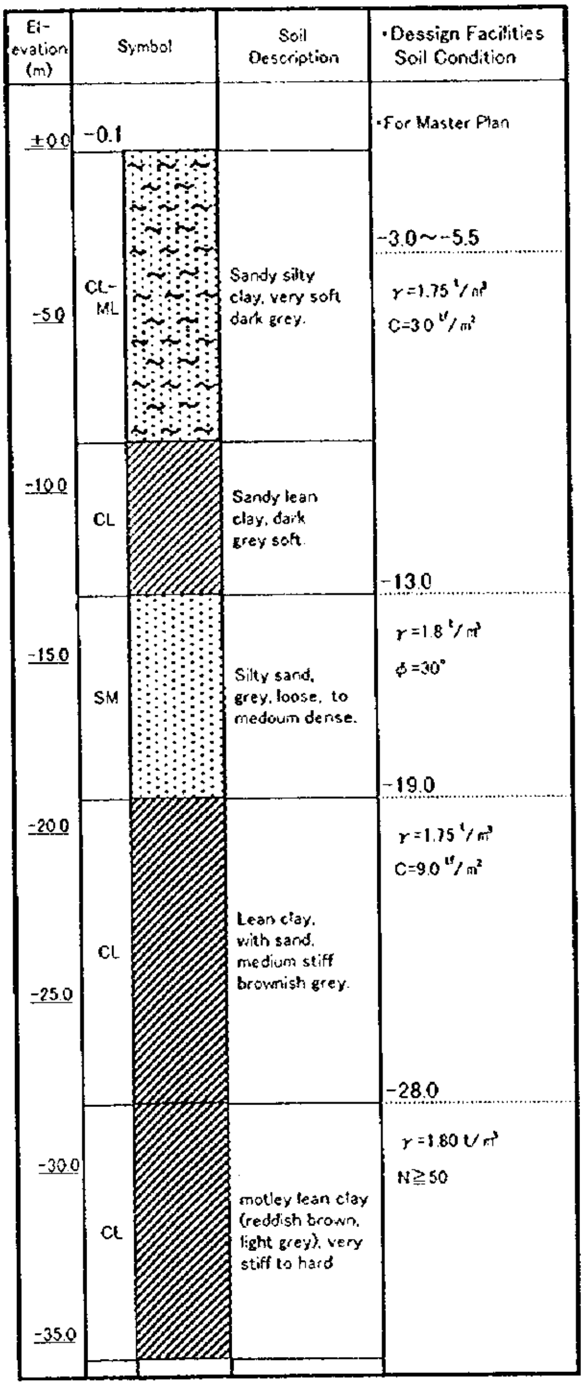


Figure 9.3.1(2) Soil Conditions for Preliminary Design

9.4 Structural Type of Breakwater and Quaywall

9.4.1 Breakwater

The features of the location where the breakwater will be constructed in Chan May is such deep area as –13.5m with high waves and soft foundation. It means that very large structure against high waves is necessary and in order to procure the stability of the structure, improving the soft ground layer for foundation is indispensable as well.

There are several methods to improve the soft soil layer, however, considering the thickness of the soft soil layer, the easiness of work and cost, replacement of the soft soil to the sand can be chosen.

To prevent waves, generally, sloping ,upright and composite type of breakwaters can be used. Considering the depth and soft soil foundation, sloping type and upright type of breakwaters is not suitable then composite type of breakwaters shall be selected.

As an upper structure of composite type of breakwater, we can use mass or block concrete, cellular block and caisson. However in case of Chan May the width of upper structure must be over 10m to have enough resistance force against high wave pressure so a caisson can be selected from economical point of view as far as a yard or other facilities to produce caisson can be prepared.

Evaluation of structural type of breakwater by each checking factor is tabulated.

Table 9.4.1 Selection of Structural Type for Breakwater

Type	Sloping B.	Upright B.	Composite Breakwater		
Structure	Rubble, Concrete Block	Same as Composite Type	Mass or Block Concrete	Cellular Concrete Block	Concrete or Hybrid Caisson
1.Technical Suitability For High Wave and Soft Foundation	△	△	◇	○	◎
2.Easiness of Material Procurement	○	○	○	○	○
3.Easiness of Design and Construction	◎	○	○	◇	◇
4.Preparation of yard or Equipment	○	◇	○	◇	◇
5.Experience of Local Contractor	◎	○	○	◇	△
6.Necessity of Maintenance	△	◇	○	○	○
7.Economical Construction Cost	△	△	◇	○	◎
Comprehensive Evaluation	△	△	◇	◇	◎

◎ Excellent ○ Good ◇ Fair △ Poor

9.4.2 Mooring Facilities

The structural types of mooring facilities should be selected by considering natural conditions particularly soil foundation. As described in design condition, upper subsoil layers in the location of mooring facilities planned are soft with expecting cohesion of 2.0tf/m². Then circular failure analysis shows that such structure as quaywalls cannot be constructed without improving these soft layers.

In case of a pier type quaywall with retaining wall for Berth W2, it needs over 60m wide section to prevent circular failure without any improvement of soil layers. This is not practical design. (cf. Figure A9.5.5(1)) While a pier type jetty without a retaining wall will be a possible structure if the width of pier is not so wide.

As before mentioned in case of a breakwater, for an improving method of soft soil layers is recommendable to replace soft soil layers to stiff soil such as sand or rubble as the most reliable and economical way.

Among several possible types of quaywalls, concrete or hybrid caisson will be selected for deep quaywalls (over-8m depth) through the evaluation shown in Table 9.4.2.

Table 9.4.2 Selection of Structural Type for Quaywall

Type	Pier with Retaining Wall	Steel Sheet or Pile	Gravity type		
Structure	Steel Pile	Steel Sheet or Pile	L-type or Block Concrete	Cellular Concrete Block	Concrete or Hybrid Caisson
1.Technical Suitability for Soft Foundation	△	△	◇	○	◎
2.Easiness of Material Procurement	△	△	○	○	○
3.Easiness of Design and Construction	◇	○	○	◇	◇
4.Preparation of yard or Equipment	○	◇	○	◇	◇
5.Experience of Local Contractor	○	△	○	◇	△
6.Necessity of Maintenance	◇	◇	○	○	○
7.Economical Construction Cost	△	◇	◇	○	◎
Comprehensive Evaluation	△	△	◇	◇	◎

◎ Excellent ○ Good ◇ Fair △ Poor

9.5 Selected Structure for Protective and Mooring Facilities

9.5.1 Breakwater

Through the discussion to select suitable structural type of breakwater in previous section, the composite type of breakwater with concrete or hybrid caisson has been decided. Regarding the foundation, replacement level of the soft layers under the rubble mound for the caisson is determined by an analysis of circular failure showing necessary depth as --25.0m under which level there appear well graded medium and dense sand layers with gravel. In order to increase horizontal resistance force against high wave pressure the asphalt mat between rubble mound and caisson is introduced.

For upper structure normal reinforced concrete and hybrid caisson have been compared. Figure A9.5.1(1) shows normal caisson case and Figure A9.5.1(2) is hybrid caisson case. Merits of hybrid caisson comparing with normal reinforced concrete caisson are as follows.

(1) Hybrid caissons consist of composite slab plates and steel reinforced concrete which have high member strength. So we can make such long footings for basement of caisson as 5.0m which can reduce total weight of caisson a great deal.

(2) The hybrid caisson showing in Figure A9.5.1(2) weighs 46t/m, while the reinforced concrete caisson in Figure A9.5.1(1) becomes 118t/m. It means that we do not need a deep access channel to tow the hybrid caisson toward offshore from a caisson yard because of shallow drought or we can more easier to lift down the hybrid caisson to the sea from land area by any means.

(3) Steel shells inside the hybrid caisson wall function as both form plates and reinforced bars in case of reinforced concrete caisson, then we can reduce concrete work. As a result it contributes to get economical cost.

To stand against large wave energy, the enough weight acting as resistance force is necessary. In this sense lightness of hybrid caisson is demerit. However by making a slope wall of the outside upper concrete above the hybrid caisson, we can change horizontal wave force to vertical force partially to supplement weight of the hybrid caisson. When we adopt a slope wall it needs higher crown height than in case of upright wall to prevent transmitted wave inside of a breakwater. Usually the crown height of a breakwater is $0.6H_{1/3}$ over design water level permitting design wave overtopping. While the crown height of a breakwater with slope wall one to one needs $1.0H_{1/3}$ to procure the same calmness in the basin behind breakwater.

Cost analysis of these two structures shows that the hybrid caisson breakwater is at least 10% cheaper than the reinforced concrete caisson breakwater even though adding a new caisson yard investment. At moment for the candidates of new caisson yard Danang Bay or Ky Ha port are listed.(cf. Chapter 10) As a conclusion the hybrid caisson shown in Figure A9.5.1(2) is recommendable for the Breakwater in Chan May.

9.5.2 Other Protective Facilities

(1) Seawall

The seawall is constructed continuously with the breakwater. Therefore before sand filling work is finished behind the seawall, the seawall itself should stand safely against large wave energy on the soft foundation. So the same consideration as to select the breakwater structure should be taken.

Figure A9.5.2(1) shows the typical cross section of reinforced concrete caisson and Figure A9.5.2(2) is in case of the hybrid caisson. Differently from the breakwater as the seawall needs the function to prevent wave overtopping, a slope wall of crown concrete is not suitable. The crown height +7.5m is decided as the following figure. +7.5m(1 .25 $H_{1/3}$+H.W.L.=1.0×5.0+1.3≒7.5 : It means that within significant wave height as 5.0m the seawall can prevent wave over topping.)

Cost estimation indicates the section shown in Figure A9.5.2(2) is less than 20% that of the section shown in Figure A9.5.2(1). We can choose Figure A9.5.2(2) section naturally.

(2) Revetment

The reasonable structure of revetments can be decided mostly from the depth where the revetments are located. Whether the location is deep or shallow we do not need to consider wave pressure for design in Chan May' case. If the depth is shallower than -2.0～-3.0m, a rubble mound revetment is recommendable. When the depth is -4.0m～-6.0m. (height of structure 2.0m～ 4.0m with rubble mound) concrete block is suitable and if the depth changes -6.0m～-8.0m(height of structure 4.0m～ 6.0m with rubble mound) L-shape reinforced block is adaptable. For more than -8.0m(height of structure over 6.0m with rubble mound) deep area, a concrete caisson is an appropriate structure.

According to the above mentioned principle we can choose each revetment as shown in Figure A9.5.3(1),(2),(3)

(3) Groin

The function of the groin is to prevent literal sand drift and stabilize shore line.
There are two types of groin. One is permeable type and the other is not permeable type.
A permeable type groin can transmit wave and sand partially, therefore, not motivate surrounding seabed or shoreline to be turbulent. Considering that sand drift and wave action in the location of groin is not so severe, rubble mound with armor stone which is the most popular permeable type of groin has been selected. (cf. Figure A9.5.4)

As for the depth of groin head it is generally to extend offshore toward -4.0～-5.0m deep area across the wave breaking zone, if it is expected to prevent the sheltered basin from sedimentation. However it is necessary to monitor the effect and influence of the groin carefully, then at the ISP stage it is decided that the depth of the groin head is around -2.0m.

9.5.3 Mooring Facility

In the previous section, the structure of quaywall has been selected concrete caisson or hybrid caisson for deep quaywalls and as for the foundation, replacement of soft soil method recommended. As same as on the breakwater an analysis of circular failure showed that necessary depth of replacement is −35.5m under which level there appear very hard clay layers with more than 50 N value. An open pier type quaywall with the retaining wall can be one of the alternative structure and it is possible without improvement of soft foundation. However to prevent circular failure caused by the retaining wall it needs more gentle slope as nearly one to four which resulted so broad width as 60m with high cost.(c.f. Figure A9.5.5(1) Open pier type is more than double in cost compared with hybrid caisson.)

For upper structure normal reinforced concrete and hybrid caisson have been compared. Figure A9.5.5(2) is hybrid caisson for the −13m quaywall. Merits of hybrid caisson comparing with normal reinforced concrete caisson are as follows.

(1) Hybrid caissons consist of composite slab plates and steel reinforced concrete which have high member strength. So we can make long footing for basement of caisson which contributes enlarging the supposing width of the wall when we calculate stability against earth pressure in spite of narrow width of caisson.

(2) The hybrid caisson showing in Figure A9.5.5(2) weighs 30t/m, while the reinforced concrete caisson equivalent with hybrid caisson becomes 82t/m. It means that we do not need a deep access channel to tow the hybrid caisson toward offshore from a caisson yard because of shallow drought or we can more easier to lift down the hybrid caisson to the sea from land area by any means.

(3) Steel shells inside the hybrid caisson wall function as both form plates and reinforced bars in case of reinforced concrete caisson, then we can reduce concrete work as a result it contributes economical cost.

Cost analysis of these two structures shows that the hybrid caisson quaywall is more than 5% cheaper comparing with the reinforced concrete caisson case even though adding a new caisson yard investment. At moment for the candidates of new caisson yard Danang Bay or Ky Ha port are listed.(cf. Chapter 10) As a conclusion the hybrid caisson shown in Figure A9.5.5(2)is recommendable for the Quaywall in Chan May.

The reasonable structure of other quaywall can be decided mostly from the depth where the quaywall are located. If the quaywall depth is smaller than −4.0m (height of structure 3.0m～ 5.0m) concrete block is suitable and if the depth changes −4.0m～−6.0m(height of structure 4.0m～ 6.0m) L-shape reinforced block is adaptable. For more than −8.0m(height of structure over 6.0m) deep area, a concrete caisson is an appropriate structure.

According to the above mentioned principle we can choose each quaywall as shown in Figure A9.5.5(2),(3),(4).

9.5.4 Conclusion

Based on the study examined so far each facilities selected for the initial stage development plan are tabulated in Table 9.5.1. This study is not aimed at the ultimate design work because of now preliminary design phase. For example the facilities indicated in each figure are typical cross section when the whole initial stage plan implemented solaly. In other word there is less consideration how to continue works toward the master plan. It needs surely more precise design work toward getting the most reasonable and economical structures in next phase. However the purpose of preliminary design work firstly mentioned is enough achieved because basic and fundamental items has been examined. Then there might be no room to choose other particular structure type in detail design phase.

Table 9.5.1 List of Selected Structure

Facility	Structural Type	Depth(m)		Crown Height(m)	Planned Quantity(m)	Remarks
		Existing	Design			
Protective Fa.						
Breakwater	HB Caisson	-13.5	-13.5	+8.0	630	Fig.A9.5.1(2)
Seawall	HB Caisson	-13.0~-10.0	-12.0	+7.5	300	Fig.A9.5.2(2)
Revetment 1	RC Caisson	-13.5~-11.0	-12.5	+2.5	370	Fig.A9.5.3(1)
Revetment 2	Rubble Mound	-3.0~- 2.0	-2.5	+2.5	150	Fig.A9.5.3(2)
Revet. For Road	Rubble Mound	-2.0~- 1.0	-1.0	+2.5	730	Fig.A9.5.3(3)
Groin	Rubble Mound	-2.0~- 1.0	-1.0	+2.5	150	Fig.A9.5.4
Mooring Fa.						
Quaywall W2	HB Caisson	-11.0~-7.0	-13.0	+2.5	330	Fig.A9.5.5(2)
Quaywall W1	RC Caisson	-6.5~- 4.5	-8.0	+2.5	150	Fig.A9.5.5(3)
Quaywall E1	RC Caisson	-4.0~- 3.0	-8.0	+2.5	150	Fig.A9.5.5(3)
Quaywall	Con. Block	-4.5~- 3.5	-4.0	+2.5	280	Fig.A9.5.5(4)

10. Construction Plan

10.1 Production and Procurement of Construction Materials

In general, construction materials for earthworks are available in the nearby hinterland. In principle, steel materials should be imported except iron bars. Cement can also be procured locally domestically.

Major construction materials of ISP are shown in Table 10.1.1. Locations of each structure are shown in the Figure 10.1.1 below. Among the necessary materials, the largest quantity is stones which may amount to more than 340,000 cubic meters for ISP. They can be obtained from quarries at Loc Dien and other sites.

Location map of quarries and their productivity of quarries are shown in Figure 10.1.2 and Table 10.1.2.

10.2 Availability of Work Vessels, Equipment and Machinery

The required formation of work vessels may include, with ample capacity, cutter suction dredgers, grab dredgers, floating crane (F/C), a pile driving barge, a floating mixer plants, barges, and tugs, etc. Most of large capacity work vessels will have to be brought in from abroad. It will probably be necessary to employ floating cranes, capable of lifting 1,000 tones or more, although floating cranes up to a capacity of lifting 600 tons are available in Vietnam.

Construction equipment and machinery are required primarily for earthworks such as crawler cranes, bulldozers, dump trucks, macadam rollers, dredgers, graders, scrapers, and others. Most of them can be obtained from local construction companies.

Equipment and expected unit cost for construction work available in Vietnam are shown in Tables 10.2.1 to 10.2.4.

Table 10.1.1 Major Construction Materials for ISP (Chan May)

Description	Breakwater	Seawall	Revetment R1	Revetment R2	Revetment for road
Excavation of soft layer (m^3)*	281,000	167,700	180,400	-	-
Stone (m^3)	62,700	41,500	85,100	4,800	53,600
Sand (m^3)	435,600	255,800	256,500	-	-
Concrete (m^3)	55,600	21,100	8,800	-	-
Soil for Reclamation (m^3)	-	-	-	-	-
Reinforced bar(ton)	2,690	1,150	780	-	-
Steel (ton)	3,470		-	-	-

Description	Groin	Quaywall W2 (-13.0m)	Quaywall W1 (-8.0m)	Quaywall (-4.0m)	Quaywall E1 (-8.0m)	Total
Excavation of soft layer (m^3)*	-	477,700	45,900	3,700	53,600	1,210,100
Stone (m^3)	9,300	15,900	22,600	14,700	26,400	336,600
Sand (m^3)	-	572,800	51,700	-	63,800	1,636,200
Concrete (m^3)	-	9,600	3,400	4,900	4,000	107,400
Soil for Reclamation (m^3)	-	-	-	-	-	2,394,400
Reinforced bar(ton)	-	530	300	-	350	5,800
Steel (ton)	-	4,040	-	-	-	9,230

* Removal of soft weak foundation underneath the upper structure.

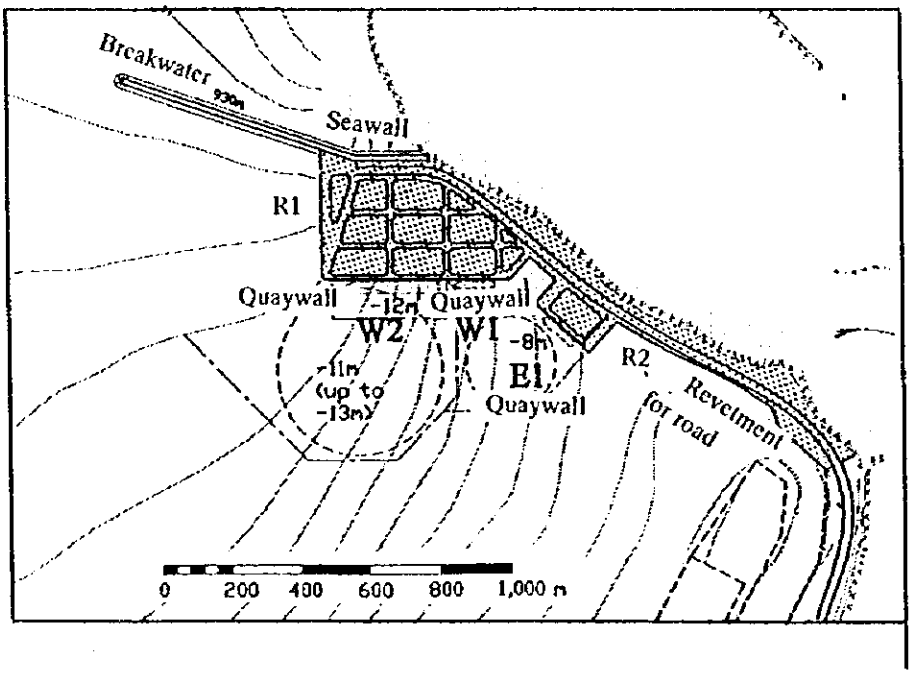


Figure 10.1.1 Locations and Abbreviations of Facilities

Table10.1.2 Site of Quarry-Hue Province

Site Name	Lang Co	Thua Luu	Da Bac	Loc Dien
1. Management Unit	Union of Railway Construction, Ministry Transportation and Communication	Phu Loc District	Union of Building Transportation and Communication	Thua Thien-Hue Material Construction Enterprise. Vietnam/ Japanese Construction Company
2. Exploiting Capacity	10,000-20,000 m^3/year	10,000 m^3/year	10,000-20,000 m^3/year The estimated amount of quarry capacity is 200 million m^3.	20,000-30,000 m^3/year According to Material Construction Planning For the Thua Thien-Hue Province to 2010 by Ministry of Construction in 1995, the enterprise has investment plan to expand the quarry capacity to 50,000 m^3/year of 2000 and after the year 2000 the capacity of 100,000 m^3/year
Raw Material	Granite	Granite	Granite	Granite
4. Geographic Location	The quarry is far from Chan May Port Approximately 6km to the south-east. Up to now the quarry has not yet been investigated. It is exploited by Union of Railway Construction to serve Bac Nam Railway Line	The quarry belongs to Thua Luu village, Loc Tien Commune, Phu Loc District far from Chan May Port approximately 6km to the south-east.	The quarry is far from Chan May Port approximately 26km to the southeast. The stone has massive structural from, which is hard and solid. The quarry has not been investigated carefully, but has been exploited by the Union of Building Transportation to Serve road Construction work.	The quarry belongs to Loc Dien Commune, Phu-Loc District far from Chan May Port approximately 26km to the southeast.

Source: Institute of Building Material, Ministry of Construction, Vietnam, and JICA Study Team

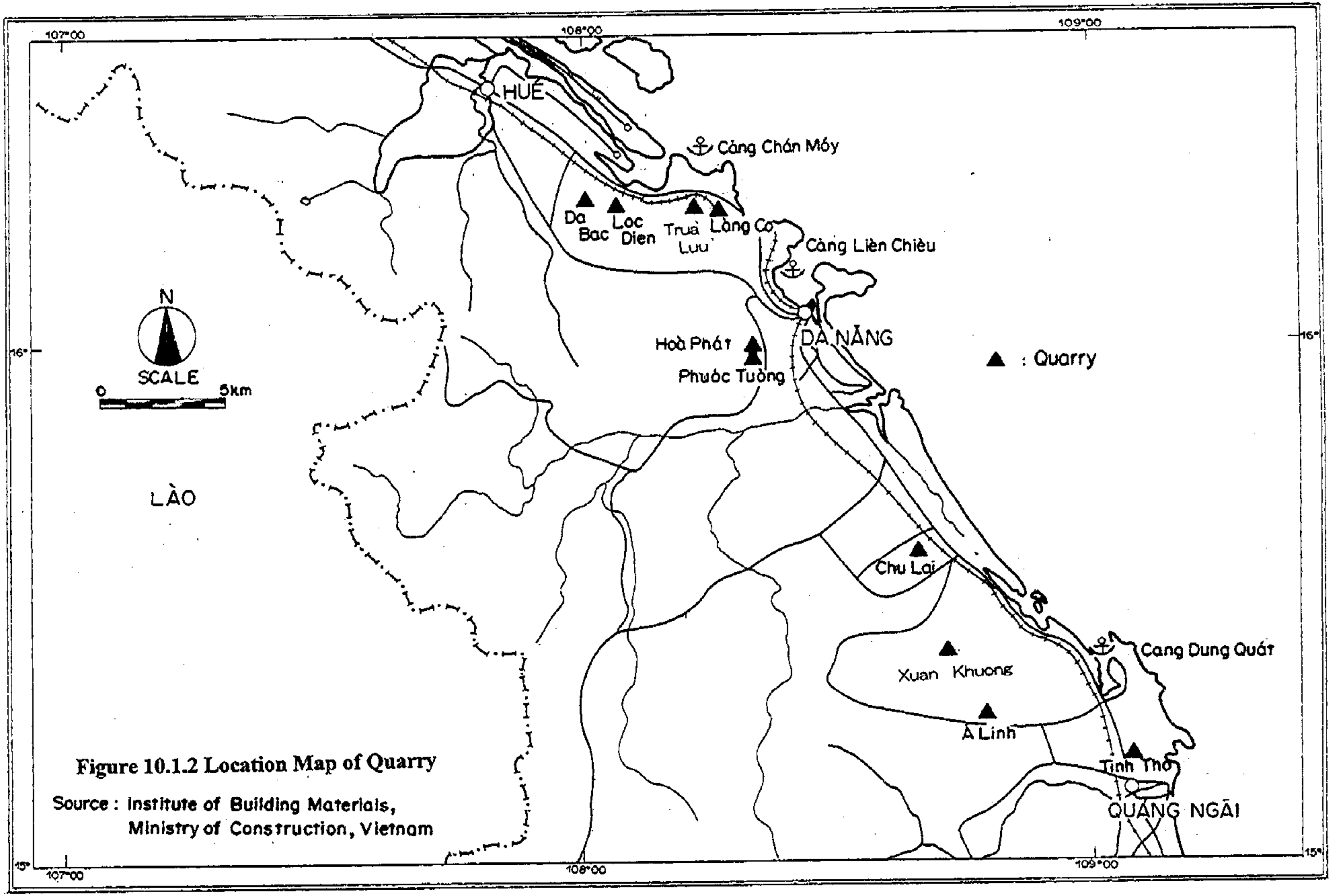


Figure 10.1.2 Location Map of Quarry

Source : Institute of Building Materials, Ministry of Construction, Vietnam

Table 10.2.1 Construction Equipment and Cost for Onshore Works

1 US$ = 11,600 VND

No.	Type of Machine	Capacity	Unit	VND (1,000)	US$
1	Cranes				
	Tire-wheeled Crane	16ton	Shift	1,740	150
	Tire-wheeled Crane	25ton	Shift	2,088	180
	Tire-wheeled Crane	40ton	Shift	2,436	210
	Chain-wheeled Crane	16ton	Shift	1,392	120
	Chain-wheeled Crane	25ton	Shift	1,856	160
	Chain-wheeled Crane	28ton	Shift	2,030	175
	Chain-wheeled Crane	40ton	Shift	2,552	220
	Crawler Crane	30ton	Shift	2,088	180
	Crawler Crane	60ton	Shift	3,480	300
	Crawler Crane	100ton	Shift	4,408	380
2	Trucks				
	Dump truck	10ton	Shift	1,218	105
	Dump truck	11ton	Shift	1,276	110
	Dump truck	12ton	Shift	1,392	120
	Dump truck	15ton	Shift	1,566	135
	Truck	10ton	Shift	1,160	100
	Truck	12ton	Shift	1,276	110
	Trailer	20ton	Shift	2,320	200
3	Earthwork equipment				
	Bulldozer	6ton	Shift	557	48
	Bulldozer	8ton	Shift	1,299	112
	Bulldozer	11ton	Shift	1,682	145
	Bulldozer	15ton	Shift	1,798	155
	Tire-wheeled roller	8~20t	Shift	1,046	90
	Front loader	$1.4m^3$	Shift	1,392	120
	Backhoe	$0.1m^3$	Shift	650	56
	Backhoe	$0.2m^3$	Shift	835	72
	Backhoe	$0.5m^3$	Shift	928	80
	Backhoe	$0.7m^3$	Shift	1,150	100
	Backhoe	$1.0m^3$	Shift	1,346	116

Notes: One "Shift" is equivalent to 8 working hours. Exchange Rate is as of March '97.

Source : JICA Study Team

Table 10.2.2 Construction Equipment and Cost for Onshore Works

1 US$ = 11,600 VND

No.	Type of Machine	Capacity	Unit	VND (1,000)	US$
4	Paving works equip.				
	Wheeled roller	8.5ton	Shift	638	55
	Wheeled roller	10ton	Shift	754	65
	Wheeled roller	12ton	Shift	835	72
	Mixing plant	60m³/hr	Shift	2,320	200
	Cement pump	4m³/hr	Shift	580	50
	Cement pump	6m³/hr	Shift	731	63
	Cement pump	9m³/hr	Shift	928	80
5	Concrete mixer				
	Concrete mixer	250 liters/hr	Shift	1,200	103
	Concrete mixer	425 liters/hr	Shift	1,508	130
6	Concrete pump truck	50m³/hr	Shift	5,568	480
7	Compressor	17m³/min	Shift	510	44
8	Generator				
	Generator	112KVA	Shift	1,218	105
	Generator	125KVA	Shift	1,299	112
	Generator	300KVA	Shift	4,640	400
9	Asphalt concrete spreader	190ps	Shift	1,624	140
10	Asphalt concrete Mixing plant				
	Capacity	20ton/hr	Shift	14,964	1,290
	Capacity	80ton/hr	Shift	22,968	1,980
	Capacity	150ton/hr	Shift	27,492	2,370
11	Diesel hammer	3.5ton	Shift	2,784	240

Notes : One "Shift" is equivalent to 8 working hours. Exchange Rate is as of March '97.

Source : JICA Study Team

Table 10.2.3 Floating Equipment and Cost

1 US$ = 11,600 VND

No.	Equipment	Capacity	Unit	VND (1,000)	US$
1	Cutter Suction Dredger for River Dredging	300 ps	Shift	6,380	550
2	Cutter Suction for Dredger for Off-shore Dredging		Shift	8,120	700
3	Sea Muluti-scuff Dredger for Channel		Shift	11,000	950
4	Berth Bottom excavator (inside ports)		Shift	4,060	350
5	Tug Boat				
	Tug Boat	150 ps	Shift	2,900	250
	Tug Boat	360 ps	Shift	3,600	310
	Tug Boat	400 ps	Shift	4,000	345
	Tug Boat	600 ps	Shift	6,000	517
	Tug Boat	1,000 ps	Shift	10,000	862
6	Barge				
	Barge	100 ton	Shift	640	55
	Barge	200 ton	Shift	1,218	105
	Barge	250 ton	Shift	1,450	125
	Barge	300 ton	Shift	1,914	165
	Barge	400 ton	Shift	2,900	250
	Barge	500 ton	Shift	3,190	275
	Barge	800 ton	Shift	4,060	350
	Barge	1,000 ton	Shift	4,350	375
7	Piling Barge with Hammer	weight: 2.5 ton	Shift	4,350	375
8	Floating Crane				
	Floating Crane	30 ton	Shift	4,524	390
	Floating Crane	35 ton	Shift	4,640	400
	Floating Crane	100 ton	Shift	6,500	560
9	Floating Concrete Mixer Plant		Shift	3,248	280
10	Floating Excavator with bucket	1.2~1.5 m^3	Shift	3,480	300
11	Diving Boat		Shift	4,060	350
12	Anchor Barge		Shift	1,624	140

Notes : One "Shift" is equivalent to 8 working hours. Exchange Rate is as of March '97.

Source : JICA Study Team

Table 10.2.4 Available Dredgers in Vietnam

Description	Trailing Hopper Suction Dredger	Cutter Suction Dredger	Cutter Suction Dredger	Bucket Dredger
Capacity	5,000 ton	3,800 ps	4,170 ps	-
Hopper capacity	3,200 m^3	-	-	-
Dredging capacity	3,200 m^3/hr	1,500 m^3/hr	1,500 m^3/hr	800 m^3/hr
Dredging depth	4~21 m	max. 17 m	max. 17.7 m	16 m
Discharging distance	-	5,000 m	6,000 m	-

Source : JICA Study Team

10.3 Construction Bases

Preparation of construction bases are necessary for provision of ample apace for construction of project facilities; storage and supply of construction materials, fabrication of concrete blocks and caissons; and mooring of small harbor crafts and work vessels such as tug boats, floating cranes, barges equipped with pile driving hammer and the like.

Such spaces will have to be secured near the proposed location of the project breakwater for ordinary construction works as well as for yard for manufacturing of large-scale structures such as concrete caissons and H.B. caissons. One preferable place is at the foot of breakwater. It has, however, a disadvantage or it cannot be available for a certain period of time until the breakwaters will have been extended to a required length. Two of other candidate places are Danang Port area and Ky Ha where ample space for such fabricating yard is available near berthing facilities for work vessels. There are some medium sized shipyard in the Bay of Danang and along the river banks of Son Han River, where open spaces are available for caisson yards at near of those shipyards. Water depth of 11 meters can be maintained in Tien Sa Port, where a floating dock can be moored and caissons and the like can be fabricated on it. An advantage of Ky Ha also has an enough yard space is available in Ky Ha Port in the viumity of an iron reinforcing bar factory (DSSCO). Location of Ky Ha is shown in Figure 10.3.1.

Required area for the yard will be about 2.0ha, namely, 200 meters along the shoreline and 100 meters land-wards. The surface of leveled ground for the yard shall be paved with concrete. On the shoreline a 50-meters wide slipway shall be constructed to launch caisson which are to be lifted with a floating crane (capable of lifting about 1,000 tons) and pulled out until the floating crane can maintain enough clearance under her keel, where the hauling line is to be wound around the caisson and with its end tied to a tug boat for towing to the designated point.

Thorough investigations in those are necessary to choice the most appropriate base prior to execution of the project.

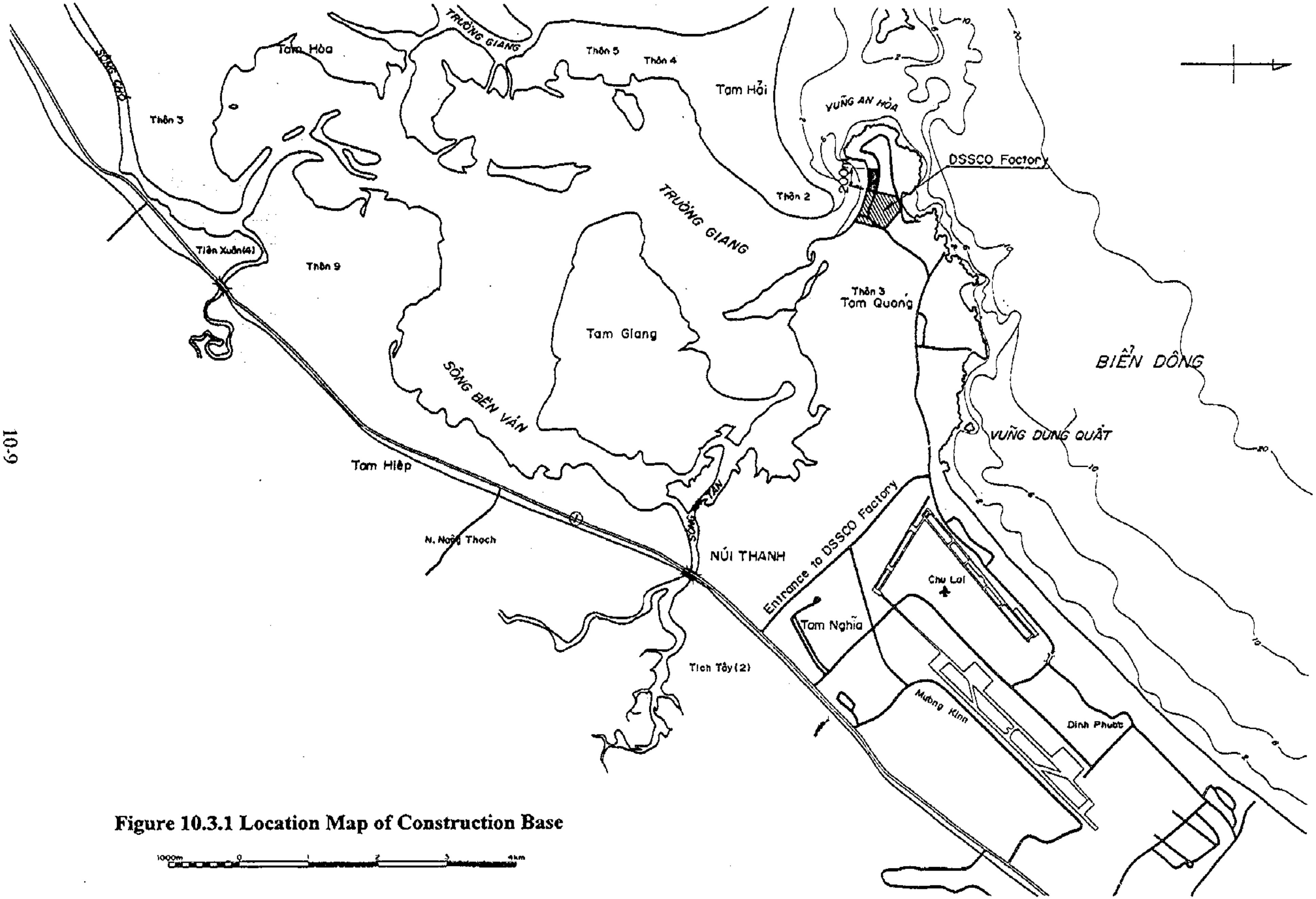


Figure 10.3.1 Location Map of Construction Base

10.4 Dredging and Disposal of Dredged Materials

As those materials to be dredged from the channels, mooring basins and foundation of various facilities are according to the result of soil investigation, mostly not suitable for reclamation of wharf and filling as structural foundation. They should be dumped in the offshore. Dredging work channels basins will be carried out by a trailing suction hopper dredger, capable of dredging without being much swayed by the wave. Excavation for foundation will be carried out by a grab dredger or cutter suction pump dredger (or similar type of dredger), and the dredged materials are to be transported by hopper barge for ocean dumping.
Approximate volume of dredged materials are tabulated below.

Table 10.4.1 Volume to be Dredged

Source	Volume (m^3)
Channels and Basins	1,293,000
Excavation for foundation	1,210,000
Total	2,503,000

However, good quality sand deposited on surface layer of near-shore area should be collected into sand pits by employing a small pumps dredger and bulldozers or the like, and such sandy soils should be saved for replacement work of foundation or similar purpose and help reduce the construction costs. The side trailing suction hopper dredger to be employed for dredging the access channel and basins is of self-propeller type, capable dredging while sailing along predetermined courses.

The dredged materials are pumped into the strong hold through the drag head and arms and they are dumped through the doors a specified area of sea.

10.5 Construction Time Scheduling

In order to prepare a proper construction schedule, the local natural conditions, such as wave and wind, records should be thoroughly examined and taken into account. Statistics show that wave heights off the Chan May Bay would exceed 1 meter for more than 50 percent of occurrence. Rainfall and wind velocity as well as the wave height affect the progress of construction work at sea and on the land. Therefore, in the executing stage these natural phenomena should be taken into consideration and the result of examinations should be reflected in the detailed construction schedule.

Particularly, the construction works should be carefully scheduled so as to avoid or at least minimize possible damage to the facilities or structure under construction due to high waves and strong wind during the typhoon season.

In order to complete the project within six years, an integrated long-range program should be prepared to carry out all types of construction works, mobilize and demobilize construction plant, procure necessary machines and equipment, and timely supply various construction materials.

The proposed schedule of ISP schedule is shown in Table 10.5.1. Constructing this time schedule, it is supposed that various procedures will be done smoothly and quickly for, for example, fund arrangement, execution of engineering services and conclusion of contracts. The schedule in general should be understood to be rather tight specifically in the case of ISP.

10.6 Other Important Points to be Noted

In order to Implement the construction works nationally and smoothly, there are several points to be taken into account. Among other items, the following are most important:

(1) Prudent and In-depth Surveys

Various site surveys should be planned and carried out prior to and during the construction works. One of the most important is examination of soil characteristic with closer intervals than those of this Study. The result of the soil investigation should be reflected in the detailed design, planning of the process of construction in order to avoid unexpected accidents such as failure of the structure.

Other important surveys include monitoring of behavior of the structures, reclaimed land, etc. To manage the construction schedule or to discuss, for example, change in construction method.

One of the subjects to be carefully followed during construction period is the monitoring of the effect of the training jetty, which is to protect the channel and harbor basins from siltation and sedimentation of solids. If an adverse effect is observed, appropriate measures should be taken, for example, extension of the jetty.

(2) Execution of Foundation Construction

The quality of the replacement works of soft soils by sand affect the stability of, for example, quaywall very critically. Full attention should be paid not to remain soft muds in the bottom ditches.

(3) Necessity of Details Planning of Reclamation Works

After obtaining detailed soil data, execution method of reclamation should be discussed so as to avoid, if any, excessive settlement, flow out of fluid mud, etc.

(4) Construction Safety Measures and Environment Protection

In planning construction methods, full attention shall be paid to safety of workers and works both on the land and sea throughout the execution to completion of the works. All the reasonable steps shall be taken to protect the environment of construction site to avoid damage or nuisance to persons or to property of the public, resulting from pollution which arises as a consequence of, for example, dredging work.

(5) Necessity of Vocational Training of Local Laborers

Port construction works require, besides engineers, many skilled, specialized and qualified laborers such as operators of various equipment, welders, divers, and mechanics. During the course of port construction, ways and means of training of local workers should be sought to upgrade their capability to get them to adapt themselves to any grade of works involved in the construction.

Table 10.5.1 Construction Schedule for I S P (Chan May)

Description	Quantity	1stYear	2ndYear	3rdYear	4thYear	5thYear	6thYear	7thYear	8thYear	9thYear	10thYear	11thYear	12thYear	13thYear	Remarks
1 Finance Arrangement															
2 Selection of Consultant															
3 Protective Facility															
1) Breakwater	630 m														
2) Seawall	300 m														
3) Revetment R1	370 m														
4) Revetment R2	120 m														
5) Revetment for Road	730 m														
6) Groin	150 m														
4 Dredging	1,293,000 m^3														
1) Channel & Basin	1,293,000 m^3														
5 Berthing Facility															
1) Quaywall W2	-13m, 360 m														
2) Ditto W1	-8m, 180 m														
3) Ditto E1	-8m, 210 m														
4) Ditto	-4m, 280 m														
6 Yard East & West Wharf	300,000 m^2														
7 Road	36,740 m^2														
8 Building & Utilities															
1) C.F.S(Steel frame)	1 no.														
2) Gate(Steel frame)	1 no.														
3) Others	L.S.														
9 Cargo Handling Equip															
1) Forklifts	3 nos.														
2) Yard Trailers	4 nos.														
3) Yard Trucks	1 nos.														
10 Navigation System															
1) Tug Boat	2 nos.														
2) Buoy&Beacon	L.S.														
11 Engineering Service															
Note:				Apr. 3rd year. Commencement of Construction						Dec. 8th year. Completion of QuayWall W2(-13m),W1 & E1(-8m), Quaywall for SmallCraft(-4m)					

11 Cost Estimates

11.1 Basic Condition of Cost Estimates

Bases of the preliminary cost estimates of construction costs are as follows:

(1) Cost of construction have been estimated using the prices and exchange rates in December, 1997.

(2) The inflation factor is excluded from estimates.

(3) The estimated costs of construction are expressed both in respect of foreign currency and local currency portions using the exchange rates as follows:
US$1.00=JP¥130=VND12,280 (as of December,1997).

(4) The cost of foreign portion includes the following:

1) Foreign currency portion of operation includes depreciation costs and products cost for imported equipment,
2) Cost for imported equipments,
3) Imported materials and products,

(5) Turnover and Profit taxes are 6% of contract price.

(6) Physical contingency for civil work is 8% and that for equipment is 3%.

(7) Estimate engineering services are base on necessary items.

11.2 Cost Estimates of Master Plan

Table 11.2.1 presents the result of preliminary cost estimates for the construction of the individual elements the project. The cost for the implementation of Master Plan is the total of which is about US$258 million, inclusive of the cost of cargo handling equipment and navigation aids.

11.3 Cost Estimates of Initial Stage Development Plan

Table 11.3.1 presents the result of preliminary cost estimates for the construction of the individual elements of the project. Cost for the implementation of Initial Stage Development Plan is estimated at about US$151 million, inclusive of the cost of cargo

Table 11.2.1 Preliminary Cost Estimate for M S P (Chan May)

Facility	Structure	Depth (m)	Length/ Quantity	Unit Cost (US$)	Amount (Thous.US$)	Remarks
1.Protective Facility					66,830	
1) North Breakwater	H.B Caisson	-13.5	720 m	46,300	33,340	Crown Height+8.0m
2) Seawall	Ditto	-12.0	260 m	45,600	11,860	〃 +7.5m
3) Ditto	Ditto	-12.0	300 m	45,600	13,680	〃 +5.5m
4) Revetment	Ditto	-12.5	350 m	17,900	6,270	〃 +2.5m
5) Ditto	Rubble	-0.5	250 m	1,500	380	〃 +2.5m
6) Bulkhead	Ditto	0.0	300 m	910	270	〃 +2.5m
7) Groin	Ditto	-4.0	720 m	1,430	1,030	〃 +2.5m
2.Dredging					19,810	
Channel & Basins	(-5.5m,-8.0m,-13.0m)		3,961,000 m^3	5	19,810	
3.Berthing Facility					56,990	
1) Quaywall	H.B Caisson	-13.0	390 m	59,300	23,130	Crown Height+2.5m
2) Ditto	Ditto	-13.0	340 m	59,300	20,160	〃 +2.5m
3) Ditto	R.C Caisson	-8.0	180 m	15,600	2,810	〃 +2.5m
4) Ditto	Concrete block	-4.0	280 m	6,160	1,720	〃 +2.5m
5) Ditto	R.C Caisson	-8.0	480 m	15,600	7,490	〃 +2.5m
6) Ditto	Ditto	-5.5	130 m	12,950	1,680	〃 +2.5m
4.Yard					34,470	
East & West Wharf			492,400 m^2	70	34,470	
5.Road					2,570	W= 22m
	Surface : Asphalt Base : Rubble		36,740 m^2	70	2,570	L=1,670m
6.Building & Utilities					5,300	
1) CFS	Steel frame 80m*25m		1 no.		800	Single-story
2) Gate	Steel frame 27.5m*24m		1 no.		500	Single-story
3) Others			L.S.		4,000	Adm.Building, Maintenance Shop, Generator Building, Substation ,etc.
Sub Total (1)					185,970	
7.Cargo Handling Equip.					12,770	
1) Container Cranes			2 nos.	4,500,000	9,000	
2) Transfer Cranes			4 nos.	510,000	2,040	
3) Chassis			10 nos.	50,000	500	40'
4) Yard Tractors			7 nos.	122,000	850	
5) Forklifts			6 nos.	63,000	380	40'
8.Navigation System					4,290	
1) Tug Boats	2,500HP		2 nos.		4,000	
2) Buoys & Beacons			L.S.		290	
Sub Total (2)					17,060	
Total	(Sub-Total(1)+Sub-Total(2))				203,030	
Physical Contingency	(8% of Sub-Total(1)+3%of Sub-Total(2))				15,390	
Engineering Services	Estimate base on necessary items				27,000	
Tax	6% of Total				12,180	Turnover and Profit Taxes
Grand Total					257,600	

Notes:1)Based on costs in December,1997. Exchange rate : US$1.00=JPY130=VND12,280
2) Excludes Price Contingency

handling equipment and navigation aids.

The disbursement schedule of the project is shown in Table 11.3.2 based on the time schedule and the cost breakdown in foreign/local currencies.

11.4 Summary on Cost Estimates

Cost of construction for the implementation of the Master Plan Project is estimated at US$245 million, and ISP is estimated at US$144 million, except for taxes.

The total construction cost directly related to the civil and building works are estimated at US$186 million or 76 %, of the total project cost of the Master Plan Project, and the same works estimated at US$116 million or 81 %, of the entire cost of the ISP.

The above costs were estimated based on market surveys of unit costs, surveys of the breakdown of actual tendered costs of similar port construction projects, and confirmation of them from relevant authorities in the government by the Study Team.

It should be noted, however, that prior to the execution stage the above cost estimates will have to be reviewed and revised through detailed surveys and estimates, reflecting the results of finalized detailed design and, among other factors, inflation rate and taxation system at that time.

Table 11.3.1 Preliminary Cost Estimate for I S P (Chan May)

Facility	Structure	Depth (m)	Length/ Quantity	Unit Cost (US$)	Amount (Thous.US$)	Remarks
1 Protective Facility					51,630	
1) Breakwater	H.B. Caisson	-13.5	630 m	48,000	30,240	Crown Height+8.0m
2) Seawall	Ditto	-12.0	300 m	45,600	13,680	〃 +7.5m
3) Revetment R1	R.C. Caisson	-12.5	370 m	18,000	6,660	〃 +2.5m
4) Revetment R2	L-Shaped Block	-2.5	120 m	1,500	180	〃 +2.5m
5) Revetment for Road	Ditto	-1.0	730 m	910	660	〃 +2.5m
6) Groin	Ditto	-1.0	150 m	1,430	210	〃 +2.5m
2 Dredging					6,470	
Channel & Basins	(-8.0m,-11.0m,-12.0m)		1,293,000 m	5	6,470	
3 Berthing Facility					29,090	
1) Quaywall W2	H.B. Caisson	-13.0	360 m	59,100	21,280	Crown Height+2.5m
2) Quaywall W1	R.C. Caisson	-8.0	180 m	15,600	2,810	〃 +2.5m
3) Quaywall	Concrete Block	-4.0	280 m	6,160	1,720	〃 +2.5m
4) Quaywall E1	R.C. Caisson	-8.0	210 m	15,600	3,280	〃 +2.5m
4 Yard					21,000	
East & West Wharf			300,000 m	70	21,000	
5 Access Road					2,570	W=22m
	Surface : Asphalt Base : Rubble		36,740 m	70	2,570	L=1,670m
6 Buildings & Utilities					5,300	
1) CFS	Steel frame 80m*25m		1 no.		800	Single-story
2) Gate	Steel frame 27.5m*24.0m		1 no.		500	Single-story
3) Others					4,000	Adm.Building, Maintenance Shop, Generator Building, Substation ,etc.
Sub-total (1)					116,060	
7 Cargo Handling Equip					510	
1) Forklifts			3 nos.	63,000	190	
2) Chassis			4 nos.	50,000	200	40'
3) Yard Tractors			1 nos.	122,000	120	
8 Navigation System					4,150	
1) Tug Boats	2,500HP		2 nos.		4,000	
2) Buoys & Beacons			L.S.		150	
Sub-total (2)					4,660	
Total	(Sub-total(1)+Sub-total(2))				120,720	
Physical Contingency	(8% of Sub-total(1)+3% of Sub-total(2))				9,420	
Engineering Services	Estimate base on necessary items				13,500	
Tax	6% of Total				7,240	Turnover and Profit Taxes
Grand Total					150,880	

Notes: 1)Based on costs in December,1997. Exchange rate : US$1.00=JPY130=VND12,280
2) Excludes Price Contingency

Table 11.3.2 Disbursement Schedule for I S P (Chan May)

Unit:'000US$

Description	Quantity	Amont Construction Cost			1stYear			2ndYear			3rdYear			4thYear			5thYear			6thYear			7thYear			8thYear			Remarks
		Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	
1 Finance Arrangement																													
2 Engineering																													
3 Protective Facility		21,513	30,117	51,630																									
1) Breakwater	630 m	13,608	16,632	30,240										4,536	5,544	10,080	6,048	7,392	13,440	3,024	3,696	6,720							
2) Seawall	300 m	6,156	7,524	13,680							4,617	5,643	10,260	1,539	1,881	3,420													
3) Revetment R1	370 m	2,664	3,996	6,660													1,332	1,998	3,330	1,332	1,998	3,330							
4) Revetment R2	120 m	72	108	180							36	54	90	36	54	90													
5) Revetment for Road	730 m	264	396	660							140	210	350	124	186	310													
6) Groin	150 m	84	126	210							84	126	210																
4 Dredging		2,588	3,882	6,470																									
1) Channel & Basins	1,293,000 m3	2,588	3,882	6,470																						2,588	3,882	6,470	
5 Berthing Facility		11,636	17,454	29,090																									
1) Quaywall W2	360 m	9,576	11,704	21,280																2,176	2,660	4,836	5,223	6,384	11,607	2,176	2,660	4,836	
2) Quaywall W1	180 m	1,265	1,545	2,810													1,265	1,545	2,810										
3) Quaywall	280 m	774	946	1,720													194	236	430	581	709	1,290							
4) Quaywall E1	210 m	1,476	1,804	3,280																369	451	820	1,107	1,353	2,460				
6 Yard		14,700	6,300	21,000																									
1) East & West Wharf	300,000 m2	14,700	6,300	21,000																1,633	700	2,333	6,533	2,800	9,333	6,533	2,800	9,333	
2) East wharf		1,028	1,542	2,570																									
3) West wharf	36,740 m2	1,028	1,542	2,570							771	1,157	1,928	257	386	643													
7 Buildings & Utilities		4,770	530	5,300																									
1) CFS	1 no.	720	80	800																						720	80	800	
2) Gate	1 no.	450	50	500																						450	50	500	
3) Others	L.S.	3,600	400	4,000																						3,600	400	4,000	
8 Sub-total (1)		57,630	58,430	116,060							5,648	7,190	12,838	6,492	8,051	14,543	8,839	11,171	20,010	9,115	10,214	19,329	12,863	10,537	23,400	16,067	9,872	25,939	
9 Cargo Handling Equip		510		510																									
1) Forklifts	3 nos.	190		190																						190		190	
2) Chassis	4 nos.	200		200																						200		200	
3) Yard Tractors	1 nos.	120		120																						120		120	
10 Navigation System		4,150		4,150																									
1) Tug Boats	2 nos.	4,000		4,000																						4,000		4,000	
2) Buoys & Beacons	L.S.	150		150																						150		150	
11 Sub-total (2)		4,660		4,660																						4,660		4,660	
12 Total		62,290	58,430	120,720							5,648	7,190	12,838	6,492	8,051	14,543	8,839	11,171	20,010	9,115	10,214	19,329	12,863	10,537	23,400	20,727	9,872	30,599	
13 Physical Contingency		7,536	1,884	9,420							452	575	1,027	519	644	1,163	707	894	1,601	729	817	1,546	1,029	843	1,872	1,425	790	2,215	
14 Engineering Services		10,800	2,700	13,500							1,157	289	1,446	1,543	386	1,929	1,543	386	1,929	1,543	386	1,929	1,543	386	1,929	1,543	386	1,929	
15 Grand Total		87,866	63,014	150,880							7,596	8,485	16,081	8,944	9,564	18,508	11,619	13,121	24,741	11,934	12,030	23,964	16,207	12,398	28,605	24,939	11,640	36,579	

Apr. 3rd year. Commencement of Construction

Dec.8th year.Completion of Quaywall W2(-13m), W1 & E1(-8m)

Quaywall for small Craft(-4m)

12. Economic Analysis

12.1 Methodology

12.1.1 Purpose

The purpose of the economic analysis is to appraise the economic feasibility of the development plan for the new port and show whether the project is justifiable from the view point of the economy by assessing its contribution to the national economy.

12.1.2 Methodology

An economic analysis was carried out according to the following method. The port development plan will be defined and compared with the "Without Case". There are various methods to evaluate the feasibility of this type of development project. Here, the economic internal rate of return (EIRR) based on a cost-benefit analysis is used to appraise the feasibility of the project. The EIRR is a discount rate which makes the costs and the benefits of the project during the project life equal.

12.2 Prerequisites

12.2.1 Base Year

The "Base Year" here means the standard year in the estimation of costs and benefits. Taking into consideration the base year in cost estimation of construction, 1997 is set as the "Base Year" for this study.

12.2.2 Project Life

Taking into consideration the depreciation period of civil engineering structure, the period of calculation (project life) in the economic analysis is assumed to 30 years for the main facilities and period for construction.

12.2.3Foreign Exchange Rate

The exchange rate adopted for this analysis is US$ 1.00 = 130 ¥ = 12,280 VND, the same rate as used in the cost estimation.

12.2.4 "With" and "Without " Case

A cost-benefit analysis is conducted on the difference between the "With" case where investment is made and the "Without" case where no investment is made. In other words, incremental benefits and costs arising from the proposed investment are compared.

In this study, following conditions are adopted as the "Without" case.

1) No investment is made for construction of new port and new industrial area.
2) The cargo from/to the study hinterland is assumed to be handled in Danang Port and transported by land. When the cargo from/to the hinterland exceeds the handling capacity of Danang Port, the cargo which can not be handled in Danang Port is assumed to be handled in Qui Nhon Port and transported by land.

12.3 Economic Prices

12.3.1 Methodology

The economic analysis for short term development plan is estimated by economic prices based on the border concept. There are various methods to convert the market prices into border prices. Here, the border prices (economic prices) are calculated by eliminating transfer items, such as taxes, subsidies, etc.

In general, all the costs and benefits are divided into three categories : labor, tradable goods and non-tradable goods. And labor is further classified into skilled labor and unskilled labor. As for skilled labor, the economic price is determined by multiplying the market wage by the conversion factor for consumption. On the other hand, the economic price of unskilled labor is determined by multiplying the nominal wage by the shadow wage rate and the conversion factor for consumption. The prices of tradable goods are expressed in CIF and FOB value for import goods and export goods respectively.

These values show the actual border prices. However, as the border price of non-tradable goods cannot be converted directly, the border price of the inputs needed to produce the non-tradable goods is considered. After some classification of the non-tradable goods, the economic price of a small amount of the non-tradable goods is calculated by multiplying the market prices by the standard conversion factor directly. The procedure used for economic analysis is shown in Figure 12.3.1.

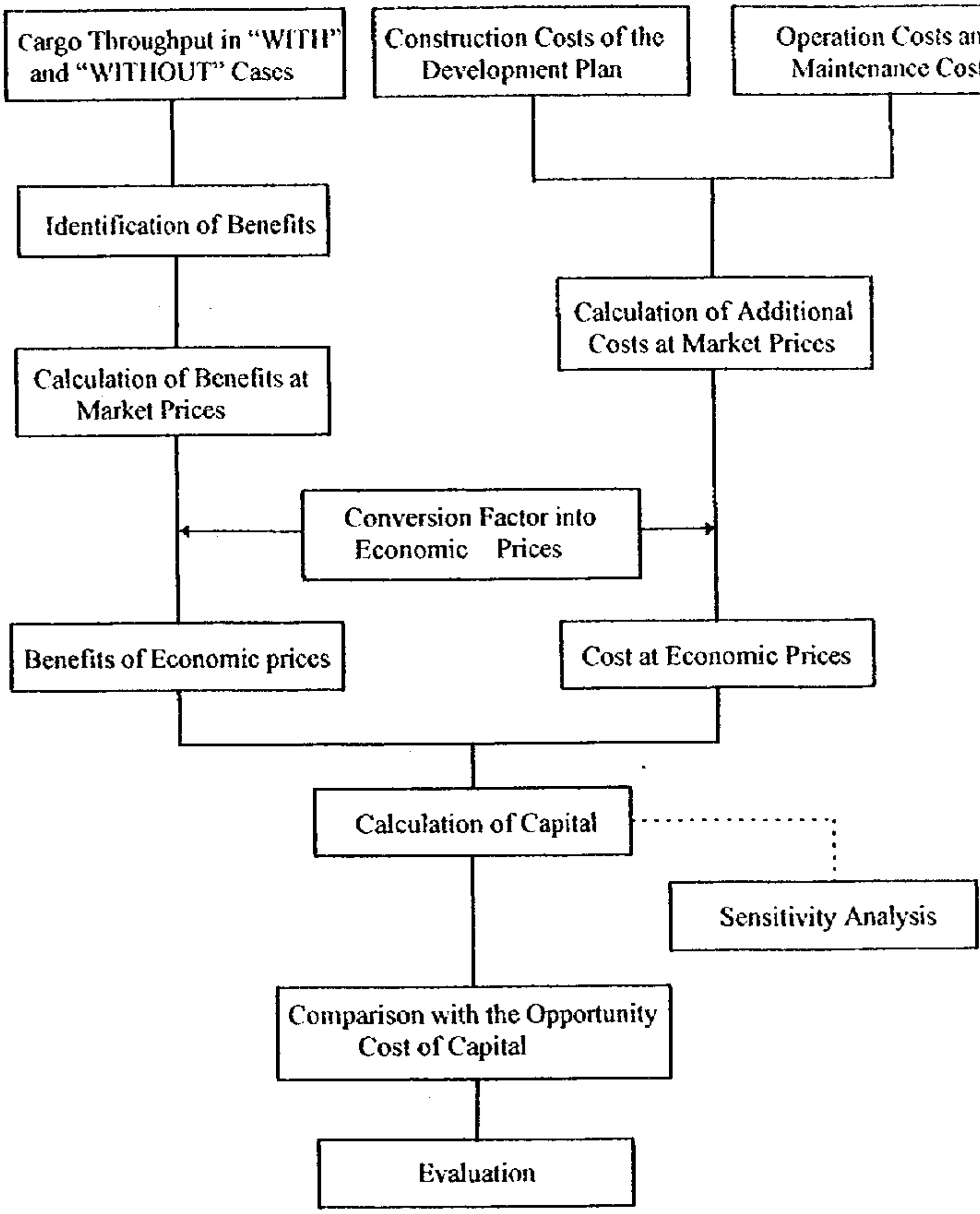


Figure 12.3.1 Procedure of the Economic Analysis

12.3.2 Applying conversion Factors

(1) Standard Conversion Factor (SCF)

The standard conversion factor is used to determine the economic prices of certain goods which cannot be directly revalued at border prices. These goods include most non-tradable goods and services. The standard conversion factor is expressed by the following formula.

$$SCF = \frac{(X + M)}{(X - Tx) + (M + Tm)}$$

where, X: Value of exports
M: Value of imports
Tx: Value of taxes on export
Tm: Value of taxes on import

In this study, the SCF of 0.994 is adopted using the above equation based on the past records of trade and customs.

(2) Conversion Factor for Consumption

The conversion factor for consumption is used for converting the prices of consumer goods from domestic market prices to border prices. This is particularly required in converting domestic labor costs to corresponding border prices. The CFC is usually calculated in the same manner as the SCF, replacing total imports and total exports by imports and exports of consumer goods only.

In this study, the SCF of 0.985 is adopted using the above equation based on the past records of trade and customs.

(3) Conversion Factor for Labor

For the economic analysis, labor costs should be measured in terms of the opportunity cost of skilled labor; that is, the value of the marginal product of labor forgone elsewhere because of its use in a given project.

1) Conversion for Skilled Labor

The cost of skilled labor is calculated based on actual market wage rate, assuming that the market mechanism is functioning properly. However, as these are domestic prices or market prices, they should be converted into border prices by multiplying the actual market wage rate by the CFC. The convention factor for skilled labor is calculated by the following formula.

Convention Factor for Skilled Labor = Market Wage Rate × CFC

= 1 × 0.985

= 0.985

2) Conversion Factor for Unskilled Labor

The opportunity cost of unskilled labor is generally far below the actual wage rate, since the rate is controlled by a minimum wage system and other regulations, nevertheless there are many unskilled labors.

When the project is conducted, the inflow of unskilled labor to the project is mainly from the agricultural sector which is relatively elastic in its use of labor. Therefore, it is often assumed that the opportunity cost of unskilled labor is equal to the per capita income of the agricultural sector. According to Statistics of the World Bank, value added of agriculture sector is US$ 5.606billion and labor force of agriculture sector is 25.2million persons in 1996. Opportunity cost is calculated by the following formula.

$$\text{Opportunity Cost} = \frac{\text{Value Added of Agriculture Sector}}{\text{Labor Force of Agriculture Sector} \times 365}$$

$$= 5{,}606{,}000{,}000 \;/\; 25{,}200{,}000 \;/\; 365$$

$$= \text{US\$}0.609/\text{day}$$

The average wage of an unskilled laborer is US$3.58/day according to the study team's investigation. Thus, the conversion factor for unskilled labor is obtained using the following formula.

$$\text{Conversion Factor for Unskilled Labor} = \frac{\text{Opportunity Cost}}{\text{Unskilled Labor Wages}} \times \text{CFC}$$

$$= 0.609 \;/\; 3.58 \times 0.985$$

$$= 0.168$$

12.4 Benefits and Costs of Project

12.4.1 Benefits of the Project

As benefits brought about by the master plan of the study port, the following items are identified. In this study the monetary benefits of items 1), 2) and 3) are calculated.

1) Savings in land transportation costs
2) Value added by new industrial development
3) Saving in sea transportation costs by international transit cargo
4) Promotion of regional economic development
5) Increase in employment opportunities and incomes

(1) Savings in Land Transportation Cost

If a new port is not constructed at Chan May, a port of cargoes produced and consumed in the study hinterland excluding the new industrial zone is assumed to be handled at Danang Port and Qui Nhon Port. And then these cargoes are to be transported from/to the study hinterland by land transportation. After the implementation of the project, all cargoes will be transported from/to the new port, Chan May Port.

The benefit from the project can be calculated by the following formula.

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

(2) Value Added by New Industrial Development

Contribution of port development project to the whole industrial development in the area is deemed as a benefit of the project, amount of which is calculated by the share of the contribution of port development to the whole benefit of industrial development. The value of the whole industrial development is calculated from the unit value added per development area. Based on statistical data in Japan, the unit value added per hectare is adjusted for application in this study, since Japanese industries use land very densely compared with other countries on account of its extremely high cost.

According to the ratio of port construction cost to all infrastructure construction cost of the industrial zone , it is assumed that the share of benefit originated in the port will be 18.6 % of whole value added which will accrue from the industrial zone. As to infrastructure construction cost of the industrial zone, it is estimated based on "The Study on the Integrated Regional Socio-Economic Development Master Plan for the Key Area of the Central Region (JICA)". The benefit of value added by industrial zone can be calculated by the following formula.

Value added of industrial factories
= Net area of each industry × Value added per area (unit cost)
× Share of benefit originated in the port

(3) Saving in Sea Transportation Costs

Sea transport cost of transit cargo from/to Lao PDR and Thailand is saved in case of transport via central Vietnamese port. The benefit can be calculated by the following formula.

Savings in sea transportation costs
= Number of vessels × Reduced days × Vessel running cost (US$/day)

Benefits of the project is summarized in Table 12.4.1.

Table 12.4 1 Benefits of the Project

(Initial Stage Development Plan) Unit: Thous. US$

Year	Saving Costs		Value Added	Total
	Land Transport	Sea Transport	Production of IZ	
9^{th}	12,917	128	18,414	31,459
10^{th}	12,372	138	19,242	31,752
11^{th}	12,904	154	20,070	33,128
12^{th}	14,042	168	21,842	36,050
13^{th}	15,872	182	24,685	40,739
$\sim 38^{th}$	15,872	182	24,685	40,739

Note: 1^{st}, 2^{nd} year…Preparation for construction (detail design, finance arrangement)
$3^{rd}\sim 8^{th}$ year…Construction

12.4.2. Cost of the Project

The items that should be considered as costs of the projects (difference between "With" case and "Without" case) are construction costs, re-investment costs, maintenance costs and operation costs. The project costs must be converted from market prices into economic prices for the economic analysis.

(1) Construction Costs

Construction costs are divided into such categories as foreign currency portion, local currency portion, skilled labor, unskilled labor and others. The costs of local currency portion and others at market prices are converted to economic prices by multiplying by the SCF. The costs of skilled labor and unskilled labor at market prices are converted to economic prices by multiplying by the CFC for skilled labor and the conversion factor for unskilled labor respectively. Construction cost converted to economic prices are shown in Table 12.4.2(1).

(2) Re-investment Costs

The re-investment costs for facilities and equipment after their useful lifetimes are considered.

(3) Maintenance Costs

The costs of maintaining the port facilities are estimated as a fixed proportion (1% for structures, 4% for handling equipment) of the original construction costs and the maintenance dredging cost is estimated in addition.

(4) Operation Costs

Personnel costs are based on the estimation in the following section "Financial analysis" and the costs are converted to economic prices by multiplying by the CFC for skilled labor.

Administration costs are set at 15.2% of the personnel costs except for labor and operator . The economic prices of the administration costs are calculated by multiplying the market costs by the SCF.

Costs of the project is summarized in Table 12.4.2(2).

12.5 Economic Viability

12.5.1 Economic Internal rate of Return (EIRR)

The economic internal rate of return (EIRR) based on cost-benefit analysis is used to appraise the economic feasibility of the project. The EIRR is the discount rate which makes the costs and benefits of a project during the project life equal. It is calculated by using the following formula. Results of the EIRR calculation are shown in Table 12.5.1(1) and the EIRR calculation table are shown in Table 12.5.1(2). Here, sensitivity analysis is made in which costs increase by 10% and benefits decrease by 10%

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

where,
- n: Period of economic calculation (project life)
- Bi: Benefits in i-th year
- Ci: Costs in i-th year
- r: Discount rate

Table 12.5.1(1) Result of EIRR Calculation

(Initial Stage Development Plan)

EIRR	(Sensitivity)
17.2%	14.7%

In addition, the EIRR of long-term development plan is calculated as shown in Table 12.5.1(3). Since details of construction plan is not decided, the EIRR is estimated on the assumption that the investment will be equally distributed in the term of construction and cost of project is estimated by using market prices.

Table 12.5.1(3) Result of EIRR Calculation

(Long-term Development Plan)

EIRR	Sensitivity
17.5%	15.6%

12.5.2 Net Present Value and Benefit Cost Ratio

On the assumption that discount rate is 8%, 12% and 16%, the Net Present Value (NPV) and the Benefit Cost Ratio (BCR) of initial stage development plan is summarized in Table 12.5.1(4).

Table 12.5.1(4) Net Present Value and Benefit Cost Ratio
(Initial Stage Development Plan)

Discount Rate	8%	12%	16%
NPV (Thous.US$)	166.523	61,188	9,794
BCR	2.30	1.55	1.10

12.5.3 Evaluation

There are various views concerning the critical percentage of EIRR to judge whether a project is feasible or not. In general, a project is deemed feasible if the EIRR exceeds 15%.

As for this project, even though the economic calculation only takes into account the items which are easily quantified, the EIRR exceeds 17%. Therefore, this initial stage development plan is viable from the viewpoint of the national economy.

Table12.4.2(1) Construction Costs in Economic Prices

(Initial Stage Development Plan)

Unit: Thous. US$

Year	Facilities	Cost of Investment in Market Prices	Foreign Portion (CIF)	Local Portion: Total	Local Portion: Unskilled Labour (CFL) 0.168	Local Portion: Skilled Labour (CFC) 0.985	Local Portion: Local Products (SCF) 0.994	Investment Costs in Economic Prices	Overall Conversion Factor
3rd	Revetment R1	10,260	4,617	5,643	49	40	5,555	10,186	0.993
	Revetment R2	90	36	54	0	0	53	89	0.992
	Revetment for Road	350	140	210	2	1	207	347	0.992
	Groin	210	84	126	1	1	124	208	0.992
	Yard	1,928	771	1,157	1	10	1,145	1,920	0.996
	Engineering Serv.	2,250	1,800	450	450	0	0	1,876	0.834
	Contingency	1,024	449	575	0	0	575	1,021	0.997
	(Total)	16,112	7,897	8,215	503	53	7,659	15,647	0.971
4th	Breakwater	10,080	4,536	5,544	48	39	5,458	10,007	0.993
	Seawall	3,420	1,539	1,881	16	13	1,852	3,395	0.993
	Rvetment R2	90	36	54	0	0	53	89	0.992
	Revetment for Road	310	124	186	2	1	183	308	0.992
	Yard	643	257	386	0	3	382	640	0.996
	Engineering Serv.	2,250	1,800	450	450	0	0	1,876	0.834
	Contingency	1,163	519	644	0	0	644	1,159	0.997
	(Total)	17,956	8,811	9,145	516	57	8,572	17,474	0.973
5th	Breakwater	13,440	6,048	7,392	64	52	7,277	13,343	0.993
	Revetment R2	3,330	1,332	1,998	17	14	1,967	3,304	0.992
	Quaywall W1	2,810	1,265	1,545	13	11	1,521	2,790	0.993
	Quaywall	430	194	236	2	2	232	427	0.993
	Engineering Serv.	2,250	1,800	450	450	0	0	1,876	0.834
	Contingency	1,601	707	894	0	0	894	1,596	0.997
	(Total)	23,861	11,346	12,515	546	78	11,891	23,334	0.978
6th	Breakwater	6,720	3,024	3,696	32	26	3,638	6,671	0.993
	Revetment R1	3,330	1,332	1,998	17	14	1,967	3,304	0.992
	Quaywall W2	4,836	2,176	2,660	22	18	2,619	4,801	0.993
	Quaywall	1,290	581	709	6	5	698	1,281	0.993
	Quaywall E1	820	369	451	4	3	444	814	0.993
	Yard	2,333	1,633	700	1	6	693	2,328	0.998
	Engineering Serv.	2,250	1,800	450	450	0	0	1,876	0.834
	Contingency	1,546	729	817	0	0	817	1,541	0.997
	(Total)	23,125	11,644	11,481	532	72	10,876	22,616	0.978
7th	Quaywall W2	11,607	5,223	6,384	55	45	6,284	11,523	0.993
	Quaywall E1	2,460	1,107	1,353	12	9	1,332	2,442	0.993
	Yard	9,333	6,533	2,800	3	25	2,772	9,313	0.998
	Engineering Serv.	2,250	1,800	450	450	0	0	1,876	0.834
	Contingency	1,872	1,029	843	0	0	843	1,867	0.997
	(Total)	27,522	15,692	11,830	520	79	11,231	27,021	0.982
8th	Dredging	6,470	2,588	3,882	6	17	3,859	6,442	0.996
	Quaywall W2	4,836	2,176	2,660	23	19	2,619	4,801	0.993
	Yard	9,333	6,533	2,800	25	3	2,772	9,296	0.996
	CFS	800	720	80	1	3	76	799	0.998
	Gate	500	450	50	1	2	48	499	0.998
	Others	4,000	3,600	400	5	14	380	3,993	0.998
	Forklift	190	190	0	0	0	0	190	1.000
	Chassis	200	200	0	0	0	0	200	1.000
	Yard Tracktor	120	120	0	0	0	0	120	1.000
	Tug Boat	4,000	4,000	0	0	0	0	4,000	1.000
	Buoy	150	150	0	0	0	0	150	1.000
	Engineering Serv.	2,250	1,800	450	450	0	0	1,876	0.834
	Contingency	2,215	1,425	790	0	0	790	2,210	0.998
	(Total)	35,064	23,952	11,112	511	58	10,543	34,575	0.986
	(Grand Total)	143,640	79,342	64,298	3,128	397	60,772	140,667	0.979

Note: 1st, 2nd year···Preparation for construction (detail design, finance arrangement)

Table 12.4.2(2) Costs of the Project

(Initial Stage Development Plan) Unit: Thous.US$

Year	Construction	Re-investment	Maintenance	Operation	Total
3	15,647		0	0	15,647
4	17,474		0	0	17,474
5	23,334		0	0	23,334
6	22,616		0	0	22,616
7	27,021		0	0	27,021
8	34,575		0	0	34,575
9		0	1,259	368	1,627
10		0	1,259	378	1,637
11		0	1,259	394	1,653
12		0	1,259	429	1,688
13		0	2,295	484	2,779
14		0	1,259	484	1,743
15		0	1,259	484	1,743
16		510	1,259	484	2,253
17		0	1,259	484	1,743
18		0	2,295	484	2,779
19		0	1,259	484	1,743
20		0	1,259	484	1,743
21		0	1,259	484	1,743
22		0	1,259	484	1,743
23		0	2,295	484	2,779
24		510	1,259	484	2,253
25		0	1,259	484	1,743
26		0	1,259	484	1,743
27		0	1,259	484	1,743
28		0	2,295	484	2,779
29		0	1,259	484	1,743
30		510	1,259	484	2,253
31		0	1,259	484	1,743
32		0	1,259	484	1,743
33		0	2,295	484	2,779
34		0	1,259	484	1,743
35		0	1,259	484	1,743
36		0	1,259	484	1,743
37		0	1,259	484	1,743
38		510	2,295	484	3,289

Note: 1st, 2nd year···Preparation for construction (detail design, finance arrangement)

Table12.5.1(2) Calculation of EIRR

(Initial Stage Development Plan) Unit: Tous.US$

Year	Cost Total	Benefit Total	Benefit - Cost	Net Present Value (NPV)		
				Benefit	Cost	Benefit - Cost
3	15,647	0	(15,647)	0	15,647	(15,647)
4	17,474	0	(17,474)	0	14,911	(14,911)
5	23,334	0	(23,334)	0	16,990	(16,990)
6	22,616	0	(22,616)	0	14,051	(14,051)
7	27,021	0	(27,021)	0	14,325	(14,325)
8	34,575	0	(34,575)	0	15,641	(15,641)
9	1,627	31,459	29,832	12,143	628	11,516
10	1,637	31,752	30,115	10,459	539	9,919
11	1,653	33,128	31,475	9,311	465	8,846
12	1,688	36,050	34,363	8,646	405	8,241
13	2,779	40,739	37,959	8,337	569	7,768
14	1,743	40,739	38,995	7,114	304	6,809
15	1,743	40,739	38,995	6,070	260	5,811
16	2,253	40,739	38,485	5,180	287	4,893
17	1,743	40,739	38,995	4,420	189	4,231
18	2,779	40,739	37,959	3,771	257	3,514
19	1,743	40,739	38,995	3,218	138	3,080
20	1,743	40,739	38,995	2,746	118	2,629
21	1,743	40,739	38,995	2,343	100	2,243
22	1,743	40,739	38,995	1,999	86	1,914
23	2,779	40,739	37,959	1,706	116	1,590
24	2,253	40,739	38,485	1,456	81	1,375
25	1,743	40,739	38,995	1,242	53	1,189
26	1,743	40,739	38,995	1,060	45	1,015
27	1,743	40,739	38,995	905	39	866
28	2,779	40,739	37,959	772	53	719
29	1,743	40,739	38,995	659	28	630
30	2,253	40,739	38,485	562	31	531
31	1,743	40,739	38,995	480	21	459
32	1,743	40,739	38,995	409	18	392
33	2,779	40,739	37,959	349	24	325
34	1,743	40,739	38,995	298	13	285
35	1,743	40,739	38,995	254	11	243
36	1,743	40,739	38,995	217	9	208
37	1,743	40,739	38,995	185	8	177
38	3,289	40,739	37,449	158	13	145
Total	200,854	1,191,593	990,739	96,469	96,469	(0)

Note: 1st, 2nd year···Preparation for construction (detail design, finance arrangement)

EIRR= 0.17192

13. Port Management and Operations Plan

13.1 Port Administration

13.1.1 Port Administration

The Vietnamese maritime administrative framework is under the Ministry of Transport (MOT). Ports are divided into the following two categories. Basically, Vietnam National Maritime Bureau (VINAMARINE) is responsible for the sea ports, and Inland Waterway Bureau (IWB) is responsible for the river ports.

There are also two different forms of port administration. Four ports, Saigon Port, Haiphong Port, Quang Ninh Port and Tan Cang Port, and all other specialized ports governed by state-owned corporations are under their own delegated management control. The management corporation of Saigon Port, Haiphong Port, Quang Ninh Port and other specialized ports are given charters and responsibilities as public organizations under either the central or local government. Tan Cang Port is an exceptional general port in terms of being administered by the Ministry of Defense.

The management of ports is performed (except in the case of Tan Cang Port) by the following public organizations.

a) central government (MOT)
b) local government (Province, City authorities)
c) a state-owned corporation organized and operated by the Prime Minister (Vietnam National Shipping Lines: VINALINES)
d) state-owned corporations organized and operated by other central government ministries
e) public corporations organized and operated by provincial governments

(1) VINAMARINE

VINAMARINE is responsible for regulatory functions in the maritime sector and for some ship, port and shipyard operational management functions. In the past, VINAMARINE acted as coordinator of maritime enterprises and assumed governmental responsibility for managing Vietnamese shipping activities including seaports, merchant fleets, shipyard, ship servicing companies and registration of ships. The role of functions of VINAMARINE are defined in Prime Minister's Decree which defines VINAMARINE's responsibilities as:

- developing plans for the maritime industry and acting as owner of state maritime infrastructure,
- developing maritime law,
- drafting policy on international maritime projects and controlling operations of foreign maritime organization,
- undertaking activities to ensure maritime safety,
- administrating sea-going vessels and operations, sea ports and navigational aids through developing plans, issuing licenses, managing infrastructure in accordance with government instructions, and providing search and rescue services.

Now almost all these commercial functions have been transferred to VINALINES (ship and port management) or VINASHIN (a similar organization in shipyard management), leaving VINAMARINE mainly to concentrate on its important regulatory function. This is performed through its head office, three branch offices, 17 port authorities and other agencies directly under its control.

The port authorities are delegated to monitor enforcement of maritime rules and regulations, including those covering maritime safety, environmental pollution and maritime sanitation in all Vietnamese seaways and seaports. Remaining non-regulatory functions of VINAMARINE include operations management of

- the ports of Quang Ninh, Nghe Tinh, Da Nang, Qui Nhon, Nha Trang and Can Tho, and
- the Vietnam Maritime Commercial Stock Bank (Maritime Bank).

Following the transfer of management and staff to VINALINES, certain weaknesses in the Investment Planning, Legal and Safety Inspection Departments have been identified.

(2) VINALINES

The first and second largest ports in Vietnam, Saigon Port, Haiphong Port and Cai Lan Port are managed by Vietnam National Shipping Lines (VINALINES). VINALINES is a state-owned corporation and it was established under Decision No.250/Ttg by the Prime Minister in January 1996, in order to engage in comprehensive shipping and maritime related activities, including the management and operation of main ports. VINALINES started its operation on 1st January 1996. VINALINES took over the management of three ports from VINAMARINE when it was established. Although these three ports are inclusively under MOT, they are supervised directly by the Prime Minister in the same way that VINALINES is administered.

VINALINES undertake the following activities:

- shipping, port operation, maritime services and other maritime related business,
- export/import of specialized materials, equipment and labor deployment, and
- participation in shipping joint-venture, business corporations with foreign and domestic partners and carrying out other businesses and tasks assigned by the government.

(3) Inland Waterway Bureau

The Inland Waterway Bureau (IWB) was established on 30th January 1993 and is responsible for administration of inland waterways transport in Vietnam. IWB is mandated, firstly, to supervise water-borne transportation on rivers, lakes and river port waters and some sea routes between rivers and, secondly, to manage inland waterways, river ports and state-owned river vessel operators.

VINAMARINE used to administer part of the rivers but IWB is now responsible for provision of infrastructure for all river waters after the issues of Government Decree. However since Vietnam Maritime Safety Agency (VMS), under the control of VINAMARINE, still manages the entry channels of rivers, the physical boundary between IWB and VINAMARINE is unclear.

13.1.2 Port Management and Operations in the Central Port (Danang Port)

(1) Roles and Functions

VINAMARINE, which is under the Ministry of Transport, is charged with the administration of the shipping industry in Vietnam. VINAMARINE administrates the Port of Danang through Danang Port Authority and Port Authority of Danang.

Danang Port Authority is responsible for:

- Cargo loading and unloading, delivery and consigning, and cargo maintenance
- Pilotage and tug boat services
- Construction and repair of small and medium size construction works
- Land transportation from the port
- Navigational services and others

Danang Port Authority owns a waterway & road transport enterprise, a construction enterprise and other related servicing enterprises such as tallying and weighing cargo, water and fuel supply and garbage disposal.

On the other hand, Port Authority of Danang is responsible for entry/exit procedures of vessels, management of port access channels and collection of port dues.

(2) Organization

The organization chart of Danang Port is shown in Figure 13.1.1. The organization is focused on cargo handling, and has a number of divisions and departments to carry out this task. Some of them are independent as "enterprises". Number of staff and workers is about 1,100 excluding 200 temporary workers.

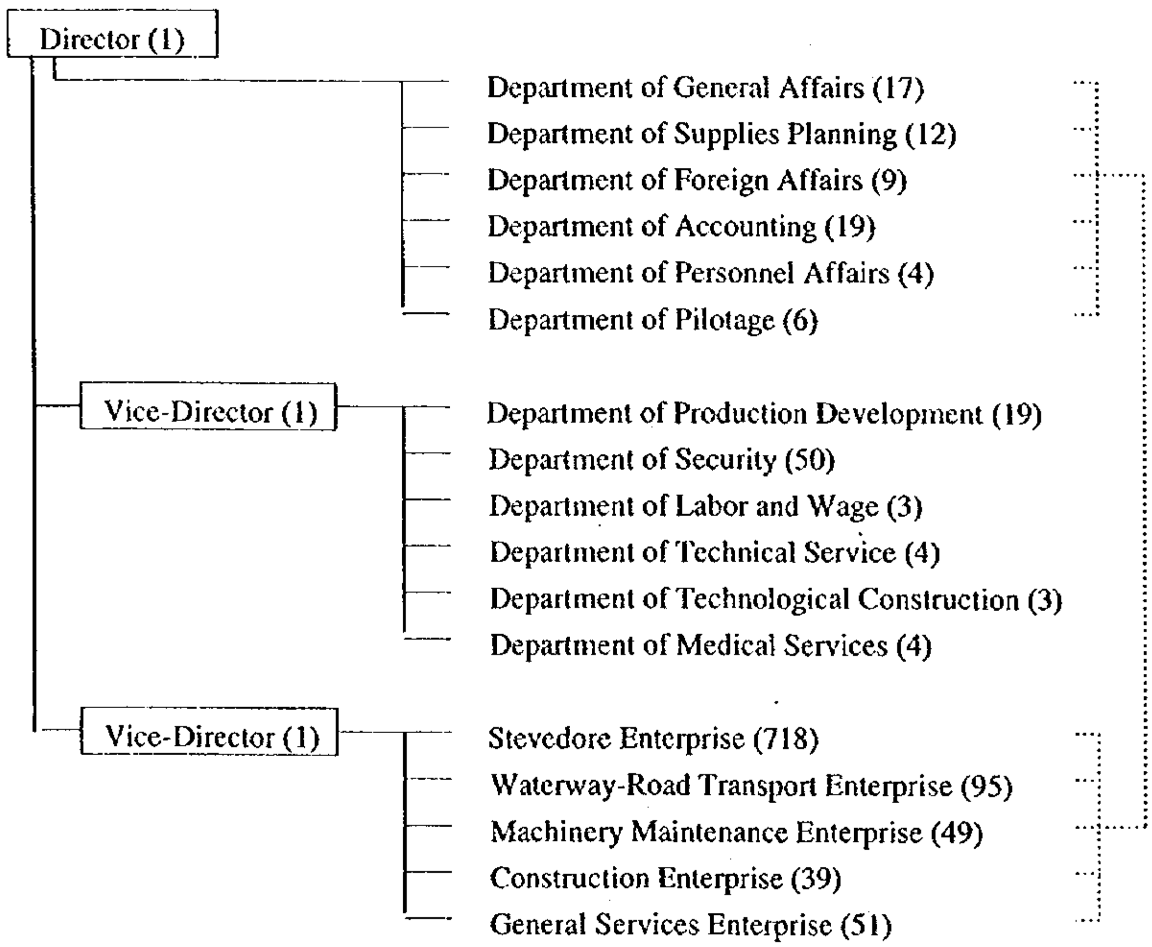


Figure 13.1.1 Organization of Danang Port

Danang Port owns organized port related enterprises, such as cargo handling service and cargo transport services which it carries out using its own staff. At currently personnel cost accounts for a large portion of port expenditures and it may increase in near future in line with economic growth. The labour force should be rationalized under adequate personnel management.

As various port operations are monopolized, it is difficult to improve the efficency and quality of services.

(3) Port Administration and Operations

Port administrators have an insufficient sense of accountability in developing ports. In this connection, most data is not stored and statistics are not utilized even though they are quite important. There is also a lack of systematic training to improve staff's capability.

Quay side cranes and ship cranes are used to load/unload containers directly. Road transportation has a problem associated with the weight limitation on bridges. Cargo handling equipment and warehouses are 15-20 years, so that replacement or rehabilitation is necessary to ensure productive and safe cargo handling.

(4) Tariff

The port tariff is classified into two kinds: port user charges and port entry dues. The port user charges include berthage dues, charges on cargo handling, storage charges, assistant service charges, and others. The port entry dues include tonnage dues, clearance fees, pilotage dues, navigational maintenance dues and others (See Table A13.1.1).

Port charge system for coastal shipping vessels differ from that for international shipping vessels. The difference is two to four-fold in port user fees and five to ten times in port entry fees (excluding pilotage fee).

(5) Computerization

A computer system is now developed in Danang Port. The system is intended to cover all kinds of cargo-related activities in the port. In the future, a computer network will be established between ports and shipping agencies.

(7) Supply of Port Services

Table 13.1.1 shows suppliers of port services at the Danang Port. As shown in the table, private companies provide a few port services.

Some activities are suitable for privatization, which others are not. It depends on objects and functions of each port activity. From the point of the national economy and public benefit, suitability of each activity for privatization is evaluated as follows.

a) Control & regulation management (Activities: No 1 - 4)

These activities are not suitable for privatization. Control and regulation management has a great influence on other port activities. Essentially, regulation is just the opposite of privatization. These activities are not profitable in a liberalized competitive market, so private companies will not provide.

b) Construction and maintenance of infrastructure, port management (activities: No5-10)

Regarding these activities, suitability for privatization is shown as follows according to characteristics of each activity.

- Planning of port development

  A master plan of the port should be made from the viewpoint of long term development. Therefore, the master plan should be drawn by the public sector.

- Construction and maintenance of infrastructures

  Generally speaking, a huge investment cost is required to construct port infrastructures. Infrastructures such as channels, breakwaters and roads are nonprofitable and public in nature, therefore private participation is not expected. Except profitable infrastructures -though it is practically only container terminals- construction and maintenance of infrastructure should be implemented by public sector.

- Management of infrastructures

  It is natural that the body which constructs the infrastructure is also responsible for its management. For example, in berths constructed by the public sector, public sector should be in charge of management, while in berths constructed by private companies, private companies should have competence to manage infrastructures.

- Marine service

Regarding these activities, initial investment costs are not as large as the above infrastructures, and they are profitable. Therefore, it is suitable for provision by private companies.

(c) Construction, maintenance and operation of superstructures (No 11)

These are the most profitable business in port activities. Provision body should be able to respond to market needs while maintaining high productivity, therefore, provision by private companies is suitable.

13.1.3 Privatization

(1) Privatization in Vietnam

The Government recently conceded that there is a need for infrastructure and a need for foreign capital given the high costs involved in infrastructure projects. Decree No.87 / CP provided the legal framework for the new approach, allowing 100% foreign capital enterprises, joint ventures, and business cooperation contracts. Infrastructure development on a BOT basis has become an investment vehicle.

(2) Privatization of the ports

Throughout the world, there is a tendency for port management and operation to move toward privatization. Many port authorities have already adopted privatization or are considering its adoption. However, it is very difficult to define and evaluate this so-called "privatization" because of peculiarities among individual ports and countries. In addition, each port authority has its own control and duties.

Main objectives of privatization are as follows.

1) Introduction of liberalized competitive markets to the port

Possession and management of the port by the public sector generally means a monopoly by the public sector. By introduction of privatization, competition in the market improves quality and quantity of port services. A reduction in port service prices and improvement in port productivity can also be expected.

2) Improvement of efficiency of port management body

Some public organizations are not flexible in managing financial systems or in coping with user's needs because they tend to emphasize safety, fairness and so on. Private sector, however, responds to movements of the market quickly because the objective is to maximize profit. Therefore, it is expected that efficiency and flexibility of the organization are improved through privatization.

3) Diversification of fund raising methods

Fund raising methods concerned with privatization are divided roughly into two patterns. One is to utilize private funds as with construction by BOT (Built Operate and Transfer) system, the other is selling public property to private companies.

However, it is important to recognize that these effects of privatization such as improvement of efficiency of port management body and diversification of fund raising methods work only on the condition that liberalized competitive markets are well cultivated. Immoderate introduction of privatization in immature competitive markets is accompanied by risk to public benefit.

Table 13.1.1 Suppliers of Port Services at the Danang Port

Activities	Danang Port Authority	Port Authority of Danang	Other Public Sector	Private Company
a) Control & regulation management				
1. Authorization of Master Plan			○ *1	
2. Regulation of port development			○ *1	
3. Customs clearance			○ *2	
4. Quarantine			○ *3	
b) Construction and maintenance of infrastructure, port management				
5. Planning of port development	○		○ *1	
6. Port security control				
1) Coast guard		○		
2) Security (land area)	○			
7. Construction of infrastructure				
1) Channels			○ *1	
2) Breakwaters			○ *1	
3) Berths			○ *1	
4) Yards			○ *1	
5) Roads			○ *1	
8. Maintenance of infrastructure				
1) Dredging		○		
2) Breakwaters	○			
3) Berths	○			
4) Yards	○			
5) Roads	○			
9. Port management				
1) Charge, due collection	○	○		○
2) Berthing arrangement	○			
3) Permission for use	○			
4) Entrance / Departure of ships	○			
10. Marine services				
1) Pilot	○			
2) Tug boat	○			○
3) Mooring	○			
4) Water supply, Bunkering	○			○
c) Construction, maintenance and operation of superstructures				
11. Construction, maintenance and operations of superstructures				
1) Warehouses, CFS	○			
2) Cranes (Loading / Unloading)	○			
3) Equipment for loading / unloading	○			
4) Tally, Truck	○			

Note : *1 Vinamarine, *2 Custom Department, *3 Provincial Government

13.2 Port Development and Management Options

13.2.1 Patterns of Port Development, Management and Operations Body

(1) Basic concept of Port Management and Operations Body

Ports are managed in a variety of ways depending on the state system, local characteristics, economic conditions, etc. In order to raise the capacity of the port management body to its highest level, it is necessary to keep the following essential principles strictly.

1) Autonomy

In view of the importance of the port to the national economy, it is desirable that proper relations be established with the central government while maintaining the independence of the port management body.

2) Financial independence

The management system is required to have its own budget, maintain a reasonable level of port charges, and be able to further depreciate and renew facilities besides repaying debts.

3) Principle of competition

For port management, it is essential to have a clear definition of responsibilities and a rational organization based on it, so that an adequate profit level can be maintained without disregarding competition with the outside world.

4) Unitary management

It is vital for the management system to have the necessary and sufficient authority over the port area and main functions.

(2) Patterns of Port Development, Management and Operations Body

Port management and operation systems differ by each port. However, in order to establish a new system for the new port, Danang port will be adopted as a typical example in the ports of central region.

Possible patterns of development, management and operations for the new port are shown in Table 13.2.1.

Table 13.2.1 Patterns of Port Development, Management and Operations Body

Pattern		A	B	C	D	E	F
Master Plan		○					
Construction	Channels	○		○		○	○
	Breakwater						
	Infrastructure					●	●
	Superstructure			○	●		
Ownership	Land	○		○	○	○	●
	Terminal facilities			●*2	●*2	●*2	
Berthing Scheme		○	○*1	●	●	●	●
Terminal Operations		○	●	●	●	●	●
Tug & Pilotage		○ or ●					

Note1: ○: Public, ●: Private, (*1 : Exclusive system, *2 : Land lease system)

Note2: [shaded] Recommended patterns

The main advantages and disadvantages of each pattern are as follows;

(1) Case A, B

1) Advantages

- Since public sector owns the berths, public sector can improve facilities or equipment easily in case of need according to a master plan in the future.
- (Case B) Generally speaking, cargo handling performed by private stevedoring companies is more efficient than that by public sector.

2) Disadvantages

- (Case A) Generally speaking, cargo handling efficiency of public sector is lower compared with the private sector due to the absence of competition in the market.
- (Case B) There is possibility that only some selected shipping companies can use the berth and other shipping companies stop calling to the port.

(2) Case C, D

1) Advantages

- In case of need for the master plan in the future, public sector can improve facilities or equipment since it owns the land, although the berths are occupied by a private company.
- (Case D) Since the superstructure is built by the private sector, this type is useful when the public sector does not have sufficient funds and the construction of port is urgent.

Table 13.2.1 Patterns of Port Development, Management and Operations Body

Pattern		A	B	C	D	E	F
Master Plan		○	○	○	○	○	○
Construction	Channels	○	○	○	○	○	○
	Breakwater	○	○	○	○	○	○
	Infrastructure	○	○	○	○	●	●
	Superstructure	○	○	○	●	●	●
Ownership	Land	○	○	○	○	○	●
	Terminal facilities	○	○	●*2	●*2	●*2	●
Berthing Scheme		○	○*1	●	●	●	●
Terminal Operations		○	●	●	●	●	●
Tug & Pilotage		○ or ●	○ or ●	○ or ●	○ or ●	○ or ●	○ or ●

Note1: ○: Public, ●: Private, (*1 : Exclusive system, *2 : Land lease system)

Note2: [shaded] Recommended patterns

The main advantages and disadvantages of each pattern are as follows;

(1) Case A, B

1) Advantages

- Since public sector owns the berths, public sector can improve facilities or equipment easily in case of need according to a master plan in the future.
- (Case B) Generally speaking, cargo handling performed by private stevedoring companies is more efficient than that by public sector.

2) Disadvantages

- (Case A) Generally speaking, cargo handling efficiency of public sector is lower compared with the private sector due to the absence of competition in the market.
- (Case B) There is possibility that only some selected shipping companies can use the berth and other shipping companies stop calling to the port.

(2) Case C, D

1) Advantages

- In case of need for the master plan in the future, public sector can improve facilities or equipment since it owns the land, although the berths are occupied by a private company.
- (Case D) Since the superstructure is built by the private sector, this type is useful when the public sector does not have sufficient funds and the construction of port is urgent.

2) Disadvantages

- (Case C) Since the public sector is responsible for construction work, public sector needs to provide funds.

(3) Case E

1) Advantages

- In case of need according to a master plan in the future, public sector can improve facilities or equipment since it owns the land, although the berths are occupied by a private company.
- Since a private company reclaims land from the sea and builds the berth, public sector does not need to provide funds.

2) Disadvantages

- In the case that a private company performs reclamation, inappropriate development of public property can not be prevented. Therefore the master plan should be drawn by the public sector.

(4) Case F

1) Advantages

- Since a private company reclaims land from the sea and builds the berth, public sector does not need to provide funds.

2) Disadvantage

- Because the berths are owned by a private company for a long time, public sector can not improve port facilities or equipment easily in case of need for the implementation of own development plan in the future. In particular, in the case that main berths of the port are occupied by specific shipping companies, there is a risk that public sector cannot control the port.

13.2.2 Port Development and Management Options

(1) Port Development, Management and Operations Plan

Based on the analysis above, recommendations on the new system of port development, management and operations for Masterplan are as follows:

1) Master plan for the new port must be drawn by the public sector and construction of infrastructure such as the breakwater, dredging and so on must also be performed by

the public sector.

2) The land shall be owned by the public sector, even if a private company constructs infrastructure through the reclamation. Public sector shall be in a position to develop facilities or equipment in case of need for the implementation of its master plan.

3) Construction of terminals including the pavement and superstructures, can be carried out by the private sector. Port services such as cargo handling, pilotage, tug boats, and other service activities shall be carried out by the private sector to provide efficient services.

(2) Organization for Master Plan

As a result of the above examination, management and operations system of the New Port is summarized as follows. (See Figure 13.2.1)

1) Port management body
   a) Administration Division
      - Employee's payroll and welfare
      - Inspects the management of business
      - Provides pilots
   b) Business Division
      - Makes masterplan and short-term plans
      - Promotes port sales and takes statistic
      - Establishes the Port Authority's policy
   c) Engineering Division
      - Improves technical ability
      - Plans and executes civil engineering work
      - Provides technical training to employees

2) Port operations body
   - Stevedoring enterprise
   - Water transport and ship enterprise
   - Construction enterprise
   - Machinery maintenance enterprise
   - Tug boat and other port service enterprise

13.2.3 Methods to Support Efficient Management and Operations

(1) Port Promotion and Statistic System

Port promotion activities are one of the most important factors to attract port users and to secure adequate level of revenue. In order to accomplish this aim, following actions by a port management body are necessary.

- To collect information on port user's requirements.
- Establishment of port promotion strategy focusing on the most effective target groups of users.
- Under the action program based on the above strategy, the port management body should call for sales at shipping companies or shippers through active appeals in getting their understanding on the real merits of utilizing the new port.

It is necessary to introduce a statistics system, to support formulation of the port plan, port strategy and promotion of the port. Examples of data and information to be prepared are as follows:

- Origin/destination, type of cargo and volume (TEU for containers)
- Vessel type, specification (length, width, draft and others)
- Data on freight handling efficiency : berthing time, items and volume of loading/unloading, loading/unloading time, machinery and equipment for loading/unloading, number of workers and others
- Conditions and users of wharves, loading/unloading machinery and equipment, warehouse, yard and others

(2) Tariff

Port management body should set its tariff at a proper level to obtain sufficient income for maintaining financial soundness and making the necessary investments. On the other hand, tariff should be set taking levels of neighboring ports into consideration to attract port users. Port management body should always study tariffs of the ports of neighboring country.

In Vietnam, fees for vessels for overseas and coastal services are charged differently. In most countries that exercise different fees, the level of difference is up to twice of the domestic fees. In Vietnam, setting different fees may be unavoidable, since the industry is still immature. However, the current level of difference in Vietnam is way to large. The difference should be corrected.

Navigational maintenance dues is particular high among the various tariffs. Currently Vietnam Maritime Safety Agency (VMS) is collecting the fee from all the ports which are divided into 3 areas. Each port management body should adopt a self-supporting accounting system in which it collect tariffs including tonnage and clearance fees and maintains maritime routes.

(3) Training System

With respect to staff training, the port management body should send several staff members and operators to foreign ports to acquire knowledge or skill based on the latest management and operation or cargo handling techniques. They should pass on their knowledge or skill to other staffs or operators. Also, specialists could be employed or invited from abroad. Since field training is very useful for skill acquisition, the employment or invitation of technical supporting experts or engineers makes it possible to accelerate technology transfer.

In order to keep knowledge or skill based on the latest techniques, the port management body needs to develop its own training courses in order to make up for the lack of expertise in the new port. It is also important to instill in them cost-conscious and the need for efficiency in conducting their duty and assignment. The following training courses are necessary to foster capable operation staff, operators and engineers.

1) Training for administrative staffs

In this course, staffs can gain basic knowledge on general administration. In addition, more specialized courses on financial management, accounts system, related laws, regulations and so on, should be established.

2) Training for engineers

For better understanding of port construction and maintenance, training courses on civil engineering, architecture, electrical engineering, mechanical engineering and so on should be established and experts for each field should be fostered.

3) Training for operators

In the courses of cargo handling, operation of port equipment, operators can attain a higher level of skill and thus the efficiency of port operations will be enhanced.

4) Training for computer operators

For the employees who belong to not only cargo operation sections but administrative sections, it is necessary to participate in training courses about on-line operation of terminal computers. The company compiling programs and setting up net work systems should dispatch instructors to every section where terminal computers are installed. Participants of training need to operate computers by themselves with the aid of instructors.

(4) Establishment of effective maintenance system

Maintenance work on the structures can be divided into two categories, namely the routine maintenance and the urgent rehabilitation. While the former consists of preventive measures in which required cost is minor, the latter consists of corrective measures against large scale damage in which required cost is large. In general, if preventive maintenance is appropriately performed, the required cost for corrective maintenance works will be minimized.

In order to perform effective maintenance, the following measures are considered.

1) To prepare a list of facilities together with possible damage.
2) To carry out monitoring of the present usage and damage inspection periodically.
3) To maintain a sufficient supply of all spare parts.

(5) Computerization

Computer system includes the connection between ports in country and abroad. This kind of connection should be established not only between ports but also between the port and the port related organizations and agents such as customs and shipping agencies in order to simply the present documentation procedure by Electric Data Interchange (EDI) Systems.

(6) Project Funding

The following points should be taken into consideration to lighten the burden imposed on main constructor as much as possible.

1) A portion of the budget for the planned industrial zone can be allocated to the port development plan, given the significance of the new port not only as the center of distribution but also the core of the development of industrial zone in the hinterland.

2) The port management body shall encourage active participation of private enterprises in certain areas where it is possible such as cargo handling to raise private funds.

3) The government shall provide funds in the form of subsidy or low interest loan since ports are important national assets which play a major role in the nation's economic development.

Furthermore it is also important to curtail labor costs which account for the greatest part of public spending.

(Port Management Body)

- Director
  - Personnel Affairs department
  - Finance and Accounting Department
  - Vice Director Administration Division
    - General Affairs Department
    - Salary and Labor-force Department
    - Inspection and Control Department
    - Pilotage Department
    - Welfare and Medical Service Department
  - Vice Director Business Division
    - Planning Department
    - International Department
    - Port sales and Statistics Department
    - Computer Department
  - Vice Director Engineering Division
    - Technical Department
    - Civil Engineering Department
    - Training Center

(Operations Body)

- General service Enterprise
  - Port Security Department
  - Import & Export Service Department
- Stevedoring Enterprise
  - Cargo handling Department
  - Container handling Department
- Water Transport and Ship Enterprise
- Construction Enterprise
- Machinery Maintenance Enterprise
- Tug boat Enterprise

Figure 13.2.1 Example of Organization of the New Port

14. Initial Environmental Examination

14.1 Natural Environment

14.1.1 Overview

This chapter develops, amends and updates the environmental information and discussions presented in the Interim Report, September 1997[1], which provided a preliminary discussion of the natural environment conditions and resources within the Chan May bay project area. This preliminary Progress Report was based on existing environmental information obtained through literature searchers and discussions with various agencies and individuals. However, the Study Team was unable to identify much relevant environmental information and an environmental baseline survey was designed in March 1997, following a field visit to the area. These field investigations included surveys on the fauna, flora, marine life and water quality within the project area. The field surveys were conducted by local experts from reputable institutions who had been selected based upon their experience and expertise in this field.

Four field surveys were carried out in May 1997, to investigate the fauna, flora, marine life and water quality within the project area. The methods that were employed by each survey team, the results that they obtained, and the implications of these for Environmental Impact Assessment of a port development at the project area are described in Sections 14.1.3, 14.1.4, 14.1.5 and 14.1.6 following.

Chan May bay is situated a few kilometres north of An Cu, which is at the foot of the Hai Van Pass, very close to the southern border of Thua Thien Hue Province. At this point in Central Vietnam, an eastern arm of the country's central highland ranges extends down to the coast, bisecting the coastal plain and forming a mountainous divide, the Hai Van Pass range between the more temperate climate of the northern coastal plains and the sub-tropical climate of the plains to the south. Climatically and ecologically it represents an important biophysical divide and transition zone between these two regions.

Extending north from the Hai Van Pass range as it runs down to the coast are two lines of smaller hills approximately 10 km and 8 km long and approximately 8 km apart. The more western of these two lines of hills comprises Dong Nhut (592 m) and Nui Vinh Phong (482 m) which extends seawards to form West Chan May cape, a rocky cape at the southern end of the Thua Thien Hue coastal lagoon system. However, between Dong Nhut

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[1] / Interim Report: The Study on the Port Development Plan in the Key Area of the Central Region. O.C.D.I. & J.P.C. September 1997.

and the main Hai Van Pass range there is a narrow gap (Phuoc Tuong) through which Highway 1 passes en route to the Hai Van Pass. The eastern line of hills, which is more or less continuous with the main range at the foot of the Hai Van Pass, comprises Phu Gia (334 m) and Nui Tron (282 m), which extends into the raised headland of East Chan May cape. Chan May bay itself extends in a sweeping arc of golden sand between the West Chan May cape and the East Chan May headland. The bay faces to the north and is well protected on the eastern side by the approximately 200 m high headland of East Chan May cape.

The hinterland of the bay is a flat plain of approximately 70 km^2, confined within the two lines of hills and the mountains of the Hai Van Pass ranges to the south.

Two small rivers flow from the foothills across the plain, the Bu Lu on the western side and the Chu Moi river in the east. The Chu Moi is the smaller of the two, and runs along the foot of the headland in its lower reaches. When visited by the JICA Study Team in March 1997, the flow appeared to be low, with only a small current, and it is likely that seawater intrusion extends for some distance upstream depending on the state of the tide.

Behind the sandy beach there are partially wooded sand dunes (mainly *Pinus* species and some *Casuarina* species which appear to have been planted along and behind the beachfront as a means of anchoring the sands). The density of trees varies along the beachfront, in some places young trees are only thinly planted and extend back about 100 m or so, whilst other parts contain a dense low forest growth of more mature trees extending back into the hinterland for several hundred metres.

There are a few small villages located about the plain, surrounded by garden plots of vegetables and occasionally some fruit trees, beyond which extended the village paddy fields out across the plain. There are several plots of woodland scattered about the plain, some of several hectares size, which probably provide a source of fuel wood for the local villages.

The soils of the area appear to be of poor quality and low fertility, being very sandy with a low loam content, and with possibly a high pH and almost certainly a low nutrient / organic content.

The apparent poor quality of these soils, together with the distance from commercial centres and markets appears to limit the opportunities for trade and commerce in this rural setting. Most of the population depends upon subsistence farming and some coastal fishing for their living and the area is, as yet, only poorly developed.

The project area, which comprises the eastern side of Chan May bay and the area of flat hinterland behind the bay do not appear to contain any natural environmental resources, habitats or species of particular or notable value. Although only poorly developed, the sparse vegetation and lack of habitat diversity, which is characteristic of this type of coastal environment in the central region of Vietnam, together with the long history of human settlement, clearance of natural forest and rural development in the area, have resulted in an already highly modified ecosystem with only a few of the more common fauna and flora species present.

Beyond the immediate project area, in the regional context, there are areas of high conservation and environmental resource value. These include the mountain ranges of the Bach Ma-Hai Van National Parks which rise from the foothills on the southern border of the Chan May project area; and beyond the hills of Dung Nhut and Nui Vihn Phong to the west of the project area, there is the Dan Cau Hai lagoon, which is the largest and southernmost lagoon in the Thua Thien Hue lagoon system. This lagoon system supports one of Vietnam's more important shrimp fisheries, yielding approximately 2,000 tonnes of shrimp each year[2] as well as a number of other fishery products.

14.1.2 Photo Map and Land Cover Classification Map

In order to obtain the latest and precise information of geography and land usage conditions, and to utilize in port planning and environmental assessment of this Study, the Study Team constructed a land contour map and a land cover classification map with a scale of 1/50,000. They are produced by means of photos taken by the Spot Satellite in 1996.

The reduced copy of the latter map is attached in this report which covers an area of about 400 km^2, including the project site. The land areas are classified into eight kinds by color as shown in the map.

Generally in the coastal area near the project site, the land consists of bare ground, forest, shrub / glassland and farmland / villages.

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[2] / Vietnam Coastal Zone Vulnerability Assessment. Report No.5 Pilot Study. Flooding and Lagoon Management. Thua Thien Hue Province. November 1995.

14.1.3 Fauna around the Project Area

The fauna of the project area was surveyed along three census routes, as shown in Figure 14.1.1, Environmental Survey Locations at Chan May. These three census routes were:

- Chan May mountain area (the East Chan May headland);
- From Chan May mountain along the sea-front to Phuoc Kieng at the mouth of the Bu Lu river;
- From Chan May beach inland across the flat hinterland to the National Highway 1A which follows the southern border of the project area.

These three routes were selected to give a comprehensive and representative coverage of the range of habitats that are present in the project area, with particular emphasis on these areas in close proximity to the development site, such as the Chan May headland, and the seafront from the eastern margins of the bay around to the Bu Lu river, which includes the full extent of the sea-front development area. The third route follows a transect from the sea-front at the mid-point of the eastern side of the bay, approximately south across the bay's hinterland, to the National Highway 1A. This transect crosses the area in which much of the proposed port's infrastructure will be located.

The survey results were based on information obtained from direct observations and from comments of the local people. The fauna of the area was classified into two categories;

- Feeding, or domestic fauna;
- Natural wildlife fauna

Most of the domestic (feeding) fauna that were recorded were kept for agricultural purposes and as a food source for the families. The numbers of domestic animals recorded were described as "poor in number and composition of species"[3]. The only domestic animals observed on the survey routes were cow, buffalo, pig and other poultry such as chickens and ducks.

Very little natural wildlife was observed on any of the three census routes, indicating that the fauna of the project area is both poor in numbers and species composition. A few of the common birds, such as the red-whispered bulbul and the

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[3] / Preliminary Report. Environmental Field Survey (Phase 1). Part 1: Chan May (Thua Thien-Hue). May 1997.

magpie robin, were recorded from Kep mountain (the Chan May headland), but no other observations were recorded by the survey.

The results from all three census routes confirms the findings and preliminary assessments of the site visit by the JICA Study Team earlier this year, namely, that the project area at Chan May bay does not appear to contain any habitats or natural wild fauna species of particular scarcity or value. In the absence of any notable fauna, within the eastern side of Chan May bay and its immediate hinterland south to the National Highway 1A (the project area), there is unlikely to be any significant impacts on important natural wild fauna of particular scarcity or notable conservation value.

Those fauna that do inhabit the area, particularly the common bird species, may well suffer some disturbance and dislocation of their populations during any development of the area that may occur. Although this would not be regarded as significant in terms of conservation value, or the protection of rare or endangered species, this potential loss of birdlife could be alleviated to some degree by retaining small areas of representative habitats as recreational parks, (for example, some areas of wetland and woodland), which would provide a refuge for the birds and enhance the aesthetic value of the neighbourhoods within the project development area.

Discussions with local people suggested that the Vinh Phong mountain area, which is protected and in which the forests are recovering, has a much richer fauna, including wild boar, muntjac deer, porcupine (*Hystrix*), jungle fowl (*Gallus gallus*), pangolin (*Manis*), squirrel (*Callosciurus swinhoerus*), civet weasel (*Mates pennanti*), black collared dove (*Streptopelia chinesis*), black necked grackle (*Sturnus nigricollis*), drongo, Chinese laughing thrush, greater boucal (*Centropus sinensis*) and pythons. However, the Vinh Phong mountain area lies to the west of Chan May bay, and providing future developments do not extend into this mountain area, and providing access to the area remains limited to minimise disturbance to the habitats and species present there so that the current level of conservation protection is maintained, then the wildlife of the area should not be significantly impacted by the development of the port on the eastern side of Chan May bay.

14.1.4 Flora around the Project Area

The flora of the eastern side of Chan May bay was surveyed in three survey areas as shown on the survey map in Figure 14.1.1. These three survey areas were:

- The coastal sandy delta adjacent to Binh An 1 and Binh An 2 hamlets;
- The Chan May headland;

- The sandy delta adjacent to Phu Son cooperative which is located at the foot of the Phu Gia mountain pass and borders the lower mountains of Bach Ma in the west.

The selection of these three areas was based upon obtaining a comprehensive and representative coverage of the range of floral habitats and vegetation types within the project area. The survey results were based upon direct observation, supplemented with local comment.

The coastal sandy delta adjacent to Binh An 1 and Binh An 2 hamlets, which is located in the south-eastern corner of Chan May bay at the foot of the headland, is composed of partially wooded sand dunes of coastal pine, mixed with some *Eucalyptus*, *Pandanus* and *Caotus*, with a ground cover of *Iponoea aquatica* and *Poaceae* species. Garden areas are planted with coconut and mango trees, with typical crops of sweet potato, manioc, calabash and pumpkin.

Further inland, behind the partially wooded sand dunes, there is a more diverse garden flora including bamboo, Japanese lilac, jackfruit, wet nurse, mango and banana trees. Crops in this part of the area include sweet potato, manioc, peanut, beet green, chilli, calabash, pumpkin and rice.

The Chan May headland is covered with grassland, with a herbaceous and shrub layer of *Convolvulaceae* and rattans, *Combretaceae*, which only covers about 50 % of this area during the dry season (which includes the survey period in May) when the vegetarian is only weakly developed. There is also a small area on the headland used to plant *Eucalyptus*.

The sandy delta adjacent to Phu Son cooperative on the southern margin of the hinterland area contains a mix of agricultural and forested lands. The forested land occupies rather more than 50% of the total and consists mainly of tropical pine, *Eucalyptus* and *Melaleuca*. A large proportion of the agricultural area is planted with rice, which gives two crops a year although the yield (productivity) is relatively low. Agriculture crops in this area include sweet potato, water melon, large cucumber, manioc, peanut and sesame. Tree crops include jackfruit, wet nurse, mango, banana and papaya, with some bamboo and white sandalwood.

The results from all three survey areas indicate that there is no vegetation communities or species that are of particular scarcity or conservation value within the Chan May bay project area. Apart from the grass and herbaceous shrub cover of the headland, and the partially wooded sand dunes behind the beach front, most of the project area is under gardens or relatively low productivity agricultural crops, principally rice. Most of the garden and crop produce is consumed locally, with little incentive or opportunity for trade for the area at the present time. In view of the absence of any notable, scarce or valuable flora in the project area, there is unlikely to be any significant impacts on important floral communities or species as a result of any port development at Chan May.

14.1.5 Marine Life around the Project Area

Marine life was surveyed throughout the coastal waters of Chan May bay, as shown in Figure 14.1.1., using a variety of techniques based on the transect line/quadrat survey methods developed in Kenchington R.A., 1978, 1984 and Wilkinson C. and Baker V., 1994[4].

The transects were calibrated using a 5mm nylon rope stretched from the shoreline to the offshore edge of the reef. Quadrat samplings of coral reefs were taken at 5m to 7m intervals along the transects where corals were present. Line intercept transects, at depths of 3m and 10m, were used to visually assess the sessile benthic community of coral reefs. This method used life form categories to characterise the community and provide a morphological description of the reef community. A visual census of coral reef fishes was carried out along 50m to 100m transects during daylight hours. A manta tow technique was used to visually assess the broad changes in the benthic communities of coral reefs over larger areas.

Surveys on seaweed and seagrass beds were carried out using the transect line/quadrat method to assess the community structure, species composition and percentage cover. Beam trawls were also used to sample juvenile fish, prawn, shrimp and crab species amongst these beds.

Sampling soft bottom communities was carried out using sledges, grabs, trawls and various seine, gill and trap nets.

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[4] / Visual survey on large areas of coral reefs. In "Coral reefs-research methods" Kenchington R.A., UNCESCO, Paris. 1978

Large area surveys of coral reefs. Kenchington R.A. UNESCO Reports in Marine Science No. 21. 1984

Survey manual for tropical marine resources. Wilkinson C. and Baker V. (Ed.). AIDAB, Townsville, Australia. 1994.

The bottom of Chan May bay is mainly composed of fine sand, and muddy sand at a limited area behind the East Chan May cape, and occupies an area of more than 1700 ha. from the shoreline to an isodepth of 6 fathoms. Tidal estuary flats with a sandy and/or rocky bottom occupy 30 ha., whilst muddy estuary flats occupy an area of 20 to 25 ha (including 10 to 15 ha of mangrove). Coral reefs occupy 20 ha around the point of East Chan May cape (Chan May headland) and Loc Thuy rock outcrop. Some shoals and sand-bars occur in the Bu Lu and Phu Hai (Chu Moi) rivers.

In contrast to the terrestrial fauna and flora of the project area, the biodiversity of marine life at Chan May bay is considerable greater, consisting of more than 140 taxa. This relatively high biodiversity (number of taxa) was also recorded from Danang and Dung Quat bays. These taxa included:

- marine flora > 15 taxa
- jelly fish 2 taxa
- corals 9 taxa
- gastropods 8 taxa
- bivalves 7 taxa
- sea squirts 5 taxa
- sea prawns 5 taxa
- sea crabs 3 taxa
- sea cucumbers 3 taxa
- sea urchins 2 taxa
- food fish 35 taxa
- coral fish 46 taxa

Although the biodiversity (the number of taxa) in the waters of Chan May bay is relatively high, the abundance (actual numbers of individual taxa) of many taxa are fairly low, being recorded as scarce or fairly scarce in the survey. This situation was also recorded at Danang and Dung Quat bays as indicated in Table 14.1.1 .

Table 14.1.1 Relative Abundance of Seaweeds / Seagrasses at Danang, Chan May and Dung Quat

	Danang	Chan May	Dung Quat
Seaweeds:			
Sargassum spp	Common	Fairly common	Common
Turbinaria spp	Fairly common	Fairly scarce	Fairly common
Gracillaria spp	Fairly common	Fairly common	Scarce
Gelidiella acerosa	Fairly scarce	Fairly common	Fairly common
Porphyra spp	Fairly common	Fairly common	Fairly common
Liagona spp	Fairly scarce	Scarce	Fairly common
Enteromorpha spp	Fairly common	Fairly common	Fairly common
Padina spp	Common	Common	Common
Caulera spp	Fairly scarce	Fairly common	Fairly common
Codium spp	Scarce	Scarce	No information
Sea-grass			
Halophita spp	Scarce	Fairly Common	Fairly scarce
Thalassia spp	No information	Scarce	Scarce
Enhalus spp	No information	No information	Scarce

In addition to the species abundance, as common, fairly common, fairly scarce or scarce, information was also collected on their distribution as being either widespread or restricted, and in the latter case (restricted) the distribution was classified into "restricted to..." coral reefs or rocks; muddy bottoms; estuaries; sandy bottoms; or seaweeds and seagrass.

The value of each species was also classified according to conservation value (as defined in the Vietnamese Red Data Book); economic value, as a local food, as an export food, as an aquaculture resource, as a medicine or medicinal resource, and as of value to tourists and potential tourist industries. There was also a traditional/cultural value category which took account not only of their traditional presence in the area, but also their relative importance to biological diversity and the maintenance of the ecological balance of the area.

Several species of conservation value were recorded during the marine life survey at Chan May. These were:

- two taxa of hard corals: *Porites spp.* and *Acropora spp.*
- three taxa of gastropods: *Trochus spp.*, *Murex ramosus* and *Babylonia areolata*
- two taxa of crustaceans: *Panulirus spp.* and *Scylla serata*
- three taxa of sea cucumbers (Holothuroidea): *Actinopyga spp.*, *Halodeima atra* and *Microthele nobilis*

- two species of sea urchin (Echinioidea): *Diadema setosum* and *Tripneustes gratilla*
- the fish taxa: *Hyppocampus spp*, the sea-horse

A similar range of species with conservation value were also recorded from Danang and Dung Quat. Other taxa of conservation value that may be present in the area, but were not recorded during this survey, include:

- the coral taxa: *Corallium spp.* and *Corgonia spp.*
- other members of the Halothuroidea such as *Halothuria scabra* and *Thelenota ananas*

Many of the species and taxa recorded during this survey, including many of those possessing conservation value as delineated above, are inhabitants of coral reefs. In addition to their biodiversity value, the reefs support productive fisheries which can provide an essential protein source for the local people living around these bays.

At Chan May, the coral reefs already show some significant deterioration in condition, with only 30 % of the coral reefs having a living coral cover of more than 50 %, The actual observed deteriorations were: 10% being found in good condition (with a living coral cover of 75 - 100 %), 20% in fair condition (living coral cover of 50 - 75 %), 55% in poor condition (living coral cover of 25 - 50 %) and 15% in bad condition (living coral cover of 0 - 25 %). This level of deterioration is the same as that observed at Dung Quat, but significantly less than the very marked deterioration observed at Danang. This deterioration in condition indicates that these corals have already been subjected to some level of environmental stress. The possible causes of this include a deterioration in water quality through the effects of upland deforestation in the area, increasing loads of silts and organic materials entering the bay from growth in agriculture and village developments within the bay's catchment hinterland, and increasing pressure on the fishery resource of the reefs which could result in direct physical damage through contact with nets and lines, and particularly if the reefs have been subject to explosive fishing in more recent years.

Obviously the condition of these coral reefs will affect their biodiversity and fisheries value, and the generally poor condition of these coral reefs suggests that these values have already been significantly reduced. Although it is likely that there will be further deterioration in their condition as a result of impacts associated with port development, the overall regional significance of these impacts on biodiversity and fisheries values would probably be less than if the corals were in a pristine (close to 100 % good) condition. Furthermore, although such a loss may have a significant effect on the local biodiversity value of this area, this can reasonably be regarded as inevitable given the nature and scale of the proposed development and should be balanced against the socio-economic benefits that the development will bring to the area.

Seaweeds and seagrass communities are associated with coral reefs, rocky flats and soft bottoms, often in the vicinity of estuaries. Seaweeds and seagrass communities were estimated to be abundant by the marine survey team, occupying "tens" of hectares of area around the bay. They are highly productive communities and provide important shelter and a nutrient rich habitat for a diverse fauna and flora, including shrimps, crabs, large gastropods and turtles. As such they are an important component of the bay's ecosystem, and careful consideration will need to be given to the planning and management of any port development at Chan May in order to conserve, as far as practicable, the ecological value of the seaweed and seagrass communities around Chan May bay.

Both coral reefs and seaweed/seagrass communities may suffer significant impacts during the construction phase of any marine development which could severely affect their health and long-term viability. These impacts may occur through:

- Direct physical damage caused by physical impact, dislocation, abrasion or smothering with construction materials or equipment, or as a result of pressure waves from rock blasting;

- Direct physical damage caused by dislocation and disturbance of the coral and / or seagrass and seaweed communities during channel dredging activities;

- Direct physical dislocation and smothering of the coral and / or seagrass and seaweed communities that are close to site operations by the silts and heavier sediments derived from construction activities along the shore and in the near-shore coastal waters, and from offshore dredge spoil dumping operations;

- Disruption to the growth and other vital metabolic processes of the coral and seagrass / seaweed communities (including the symbiotic algal components associated with corals) by increased light attenuation and the choking effect on respiratory and feeding apparatus caused by the finer sediments derived from these construction and dredge spoil dumping activities. These finer sediments are capable of being transported, by inshore currents and turbulence, much further from their source than the heavier silts. Consequently this effect, although not so immediate as the preceding effects, tends to be more pervasive, being longer lasting (as these finer materials remain suspended in the water column for much longer) and more widespread in their effects;

- Long-term disruption to the coastal ecosystem, of which these communities are an integral part. This disruption is frequently caused by changes to the inshore current patterns resulting from the construction of breakwaters and other submersed structures, and from dredging and channel clearance activities which can change sedimentation patterns and the flow of nutrients and microscopic food organisms upon which these coral and / or seagrass and seaweed communities depend.

Coral reef communities are particularly susceptible to sediment laden discharges, discharges of a high organic or toxic nature, and oil films and emulsions in the water column. These are likely to be the main environmental threats to the coral communities when construction is completed and the port commences operations.

It is not just coral reef and seagrass / seaweed communities that are susceptible to these impacts, all the benthic communities which are largely composed of sessile (non-mobile) organisms, are susceptible to damage from sediments and contaminants in the water column. Unlike the pelagic species which live in the open water, and are capable of movement through the environment (either like the plankton, carried by water currents or like the fish, moving under their own volition), benthic communities are stationary and do not have the capability of avoiding pollution by moving to new and less polluted areas. However, it can be argued that this is less so for the smaller plankton (particularly the phytoplankton), which depend on transport by water currents. Frequently, the water currents will also carry with them the sediments and contaminants from the polluted area, and thus the plankton do not escape the effects of these pollutants, as they are carried along in the currents that contain the pollutant load.

Thus benthic communities (including corals), and to a slightly lesser degree, the plankton, are the most susceptible to pollution. Because of this they can also serve as reliable indicators of pollution, and consequently monitoring of these components at selected sites around the project area before and during the development programme can provide an effective pollution monitoring system. However, the poor condition of many of the existing corals at Chan May suggests that these corals are already subject to a significant level of environmental impact, either from as yet unidentified pollution sources or some other form of anthropogenic impact. This is likely to have affected the corals susceptibility to further pollution and may well have compromised their effectiveness as a reliable and accurate pollution indicator.

Although it is unlikely that further significant damage to local coral and other benthic communities can be prevented during the construction phase of the port development, it can be reduced by minimising the spread of waterborne sediments from onshore construction activities. Runoff from on-shore construction sites can be intercepted by perimeter drains around the sites, and reticulated to small settlement ponds or baffle screen tanks to facilitate settlement of sediments prior to discharge to the sea, or river (e.g. the Chu Moi river in the eastern part of the bay). Runoff from workshop areas can likewise be treated, with the addition of oil interceptor traps. Effective management controls on the storage, handling, use and disposal of all hazardous materials, including oils, fuels, paints, resins, chemical additives and surfactants, will minimise the risk that these potential contaminants will be entrained in the site run-off and so escape to the river or sea. However, it is most likely that some residual sediments, particularly the slower settling finer sediments, will escape in the runoff that is discharged to the river or sea, and these will have some impact on the coral communities, and other benthic communities in the coastal area.

With regard to sediments that are generated within the sea during construction of off-shore structures and facilities, there is not much that can be done apart from minimising the amount of sediment generated through the application of careful management controls, particularly on the sites selected for dredge spoil dumping, and the use of low-impact construction techniques for offshore / submerged structures. In inland water bodies, some success has been achieved using silt curtains to contain the spread of silts and heavier sediments. However these are critically dependent on operating within a fairly static, low-turbulence water column, and are thus less likely to be effective in the inshore and coastal waters around Chan May bay.

14.1.6 Water Quality

The water quality of coastal marine and river waters was monitored at 10 sites in the Chan May project area. Surface water samples were collected from 8 coastal marine sites and from 2 river water sites at locations close to the river mouth. The location of all 10 sampling sites is shown in Figure 14.1.1.

Water Temperature (in ^{0}C), Salinity (in parts per thousand) and pH were measured in situ at the site. Immediately following collection, all water samples were stored in the dark at $1^{o}C$ to $4^{o}C$ until analysis. All samples were analysed by standard methods according to TCVN, 1995 and APHA, 1992. Each sample was analysed for Suspended Solids (0.45 micron cut off) and Chemical Oxygen Demand (for seawaters) or 5 day Biological Oxygen Demand (for river waters).

Table 14.1.2 Water Quality at Chan May Survey Sites

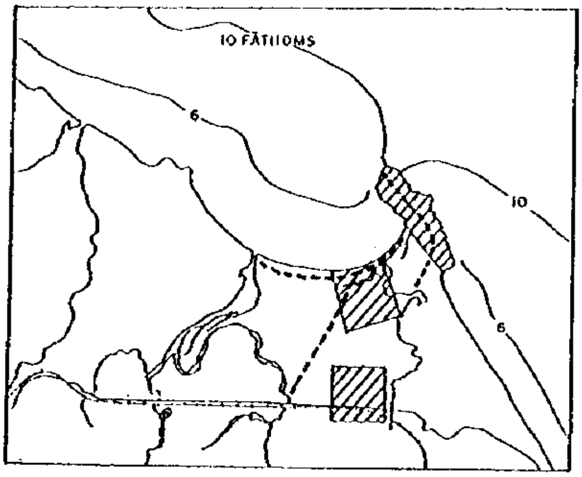
Sample Number *	Water Temp. (^{o}C)	Salinity (‰)	pH	Diss. Oxygen (mg / l)	Susp. Solids (mg / l)	C.O.D. (mg / l)	B.O.D. (mg / l)
CM-01	24.8	32.4	8.1	6.8	6.1	10	
CM-02	25.3	32.2	8.1	7.2	7.2	10	
CM-03	24.6	32.5	8.1	7.3	6.0	2	
CM-04	24.3	32.4	8.1	7.0	5.8	45	
CM-05	24.3	32.4	8.1	7.2	5.2	45	
CM-06	24.3	32.4	8.1	7.2	5.6	1.5	
CM-07	23.8	32.5	8.1	7.3	4.9	1.5	
CM-08	28.8	29.4	8.2	7.3	8.0	5	
CM-09	26.6	17.5	6.8	6.8	1.2		2
CM-10	29.3	11.6	7.6	7.2	1.8		1

* Samples CM-01 to CM-08 are coastal water samples;

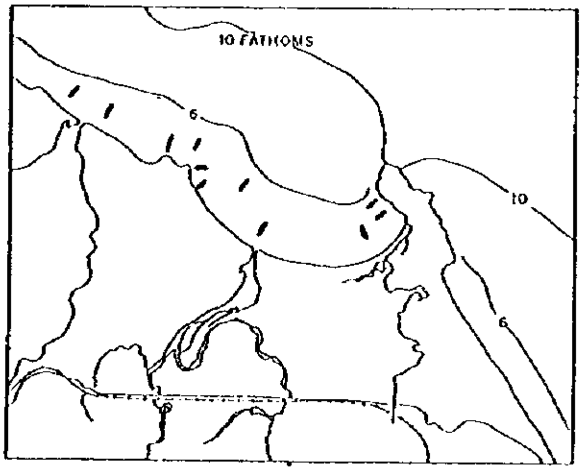
* Samples CM-09 to CM-10 are river water samples.

The eight coastal water quality samples all comply with the Vietnamese coastal water quality standards (TCVN 5943-1995), and indicate a clear (low sediment), well-oxygenated water which is typical of this type of coastal environment where there has been little development of the shoreline or hinterland, and which is not receiving any major river discharges.

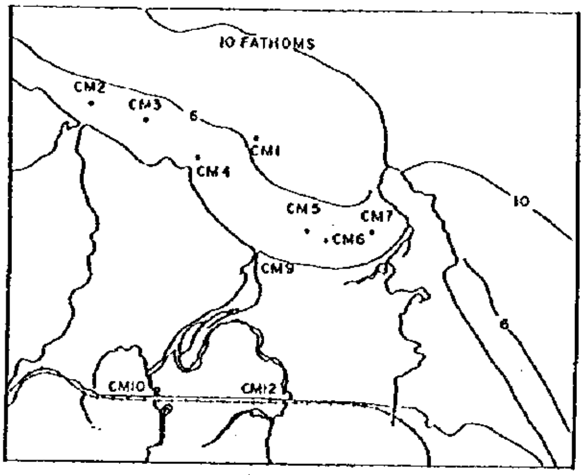
The two river water samples both comply with the Vietnamese surface water quality standard (TCVN 5942-1995), and indicate a clear (low sediment), well-oxygenated water which is typical for the lower tidal reaches of rivers in this type of natural coastal environment, where elevated salinity levels indicate the intrusion of seawater into these lower reaches according to the state of the tides and river flow conditions.



(1) Flora (hatching area) and Fauna (dotted line)



(2) Marine Life



(3) Water Quality

Figure 14.1.1 Locations of Natural Environmental Survey by the JICA Study Team