9. Preliminary Port Facilities Design

9.1 General

According to the Initial Stage Development Plan of Dung Quat 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 Dung Quat 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 1	-16.0	300	
Breakwater 2	-15.0	300	
Breakwater 3	0.0	100	
Breakwater 4	-8.0	270	
Revetment	-4.5	420	Behind Dolphin E3,E4
Inner Breakwater	-4.5	100	
Training Wall	-1.0	200	
Dolphin D4	-13.0	355	1 Berth
Dolphin D1, D2	-8.0	313	2 Berth
Quaywall E1,E2	-8.0	300	2 Berth
Dolphin E3, E4	-8.0	313	2 Berth
Quaywall	-4.0	200	
Bridge	-3.0	200	

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

Table 9.3.1 Design Wave by each Breakwater

Facility	H1/3 (m)	Hmax (m)	HD (m)	T (sec)	Offshore Wave Direction	Incident Wave Angle
Breakwater 1	6.0	10.0	10.0	13.5	NE	42.5°
Breakwater 2	5.3	9.3	9.3	13.5	NE	48.5°
Breakwater 3	4.2	6.9	6.9	13.5	NE	25.5°
Breakwater 4	4.2	6.9	6.9	13.5	NE	25.5°

Source: JICA Study Team

(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.

Table 9.3.2 Berth Dimension

Berth No.	Number of Berth	Berth Length	Berth Depth	Objective Ship Kind	DWT	Length	Width	Draft
D4	1	355m	-13.0	Tanker	50,000	219m	33.1m	12.7m
D1,D2	2	313m	-8.0	Tanker	6,000	110m	17.0m	6.9m
E1,E2	2	300m	-8.0	Cargo	7,000	118m	19.m	7.4m
E3,E4	2	313m	-8.0	Tanker	6,000	110m	17.0m	6.9m
	--	200m	-4.0	Work Vessel	---	---	---	---

(2) Crown Height of Quaywall

+ 3.0m (H.W.L. +1.7 +1.3m)

(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 E1,E2)**

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 9.3.3 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 9.3.4 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 9.3.5 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 9.3.6 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	$60tf/m^2$	$90tf/m^2$

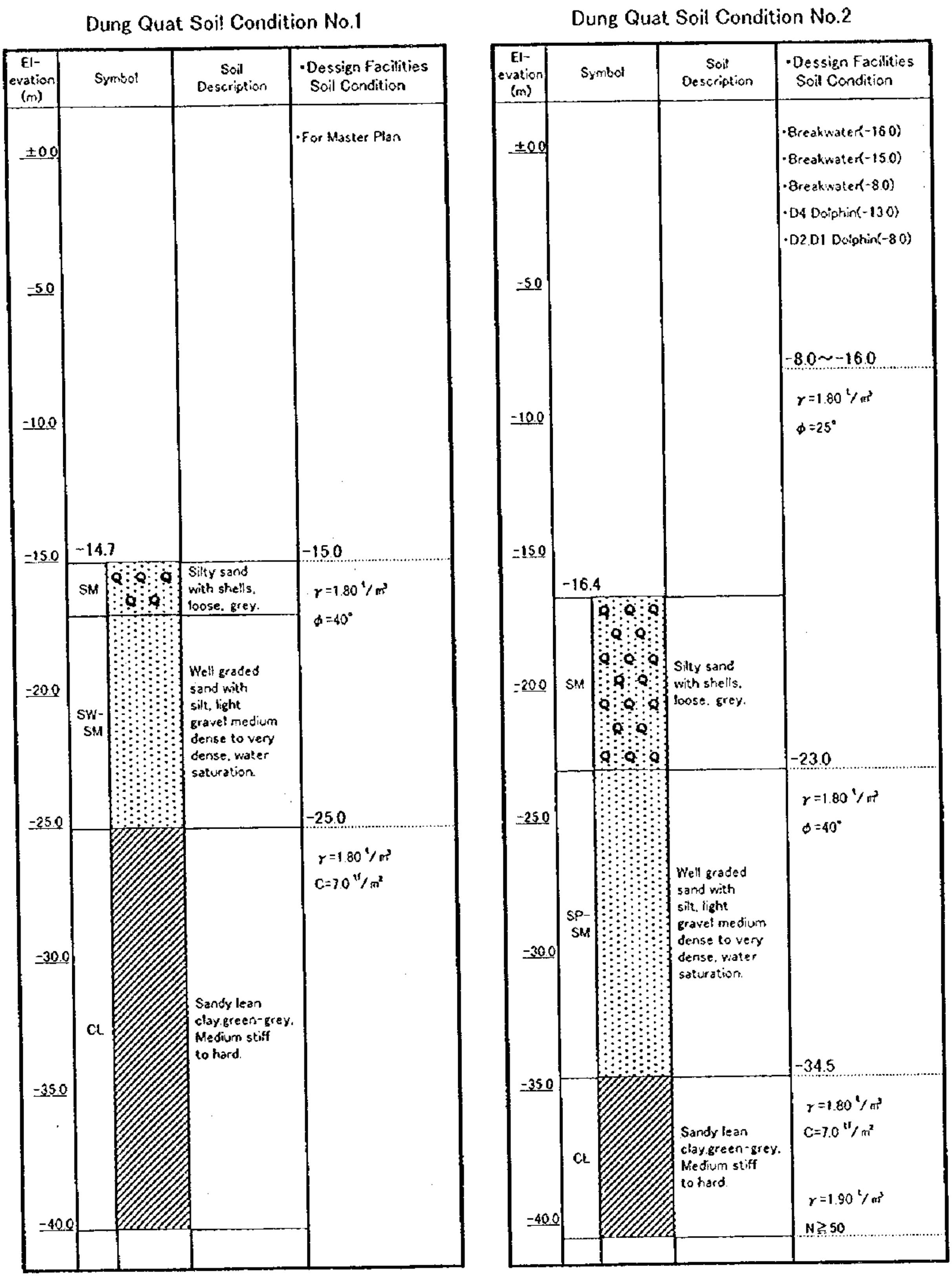

Figure 9.3.1(1) Soil Conditions for Preliminary Design

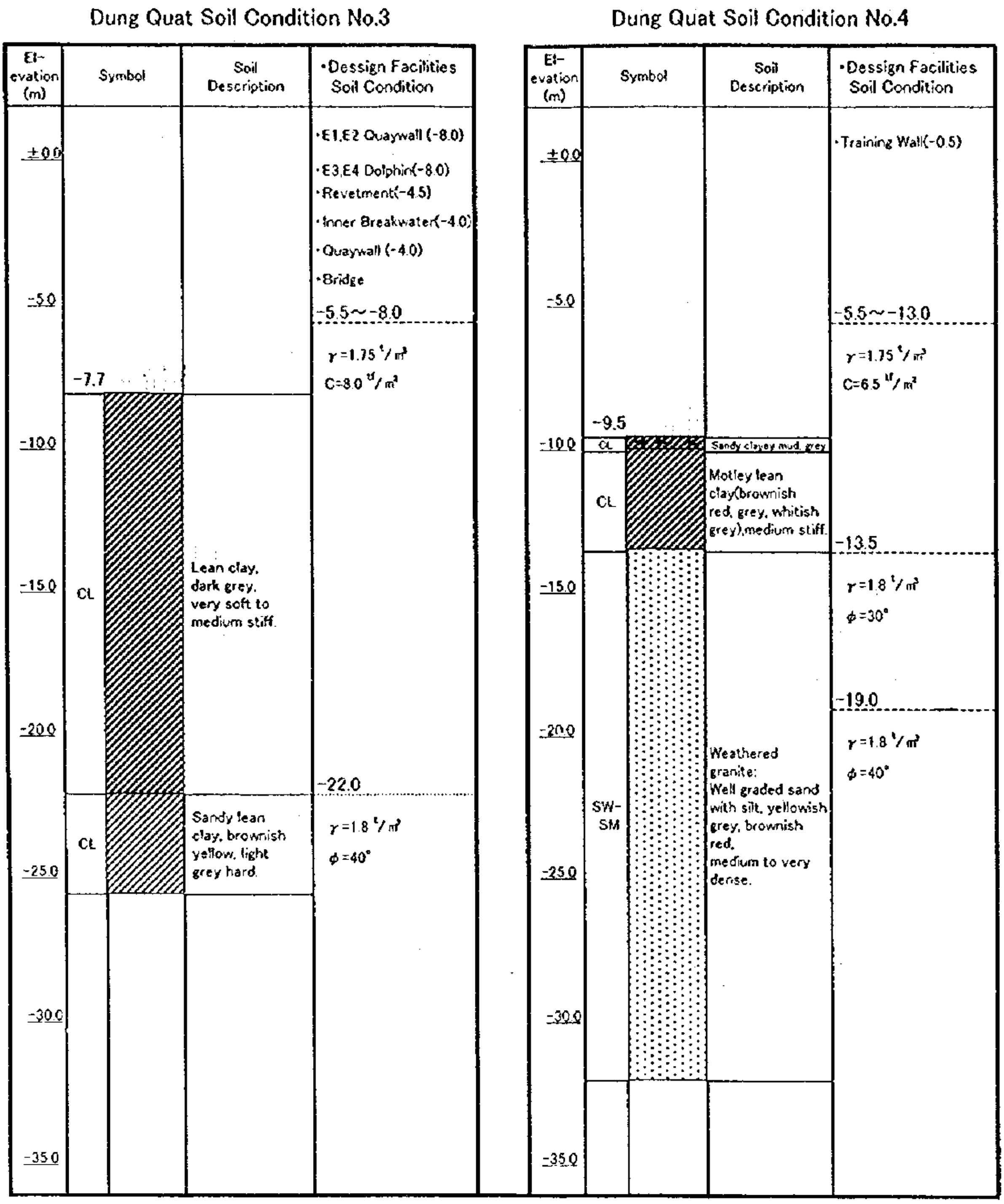

Figure 9.3.1(2) Soil Conditions for Preliminary Design

9.4 Structural Type of Breakwater and Quaywall

9.4.1 Breakwater

The features of the location where the breakwater will be constructed in Dung Quat is such deep area as -16.0m with high waves and fairy good foundation. It means that very large structure against high waves is necessary and for the stability of the structure, improving seabed soil layer for foundation is not necessary.

To prevent waves, generally, sloping ,upright and composite type of breakwaters can be used. Considering the deep seabed sloping type or 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 Dung Quat 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 good enough to bear upper structures. Then circular failure analysis shows that such structure as quaywalls can be constructed without improving these layers.

A pier type quaywall with retaining wall or a pier type jetty without retaining wall also will be possible structures.

As before mentioned in case of a breakwater, improving method of subsoil layer is not necessary. Therefore for the structure of oil handling dolphin reinforced concrete caissons can be used considering good foundation. Pile type dolphins are not recommendable, because rock layers appear at relatively shallow level.

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, an analysis of circular failure shows that without improving soil layers structures for breakwater can be stable to their own gravity force. And they need large gravity force against wave pressure. Then 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 74t/m, while the reinforced concrete caisson in Figure A9.5.1(1) becomes 146t/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. 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. Near behind the breakwater in Dung Quat there are the Dolphins. Therefore in order to protect wave overtopping for safe cargo handling, the crown heights should risen to $1.0H_{1/3}$ at least .

Cost analysis of these two structures shows that the hybrid caisson breakwater is nearly 20% 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 Dung Quat.

9.5.2 Other Protective Facilities

(1) 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 Dung Quat' case. Generally 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 the revetment behind the dolphin E3, E4 as shown in Figure A9.5.2

(2) Inner Breakwater

In case of the inner breakwater the principle above mentioned can be also adaptable. There are likely a sound foundation located in the inner breakwater with depth of -4.0m～-6.0m. Concrete block type is selected.(c.f. Figure A9.5.3)

(3) Training Wall

The function of the training wall is to lead the current to offshore and to prevent sedimentation caused by literal sand drift and maintain estuary flow or stabilize shore line. There are two types of structure. One is permeable type and the other is not permeable type. A permeable type can transmit wave and sand partially, therefore, not motivate surrounding seabed or shoreline to be turbulent. Considering that the river current, sand drift and wave action in the location are not so severe and there are rocks near river estuary, rubble mound which is the popular ordinary permeable type has been selected. (cf. Figure A9.5.4)

The head of training wall will be extended to -4.0～-5.0m deep area across the wave breaking zone as usual. However to monitor the effect and influence of the training wall at the first stage, the depth of the head is decided around -1.0m.

9.5.3 Mooring Facility

(1) Quaywall

In the previous section, the structure of quaywall has been selected as concrete caisson or hybrid caisson for deep quaywalls, however there is no deep quaywall planned in the initial stage plan, so as for quaywall (-8.0m) and quaywall (–4.0m), normal reinforced concrete caisson and concrete block are selected respectively as same principal as metioned in selecting revetment structure. That is as follows.

The reasonable structure of quaywalls 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.

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. Figure A9.5.5(1) shows an open pier type quaywall with the retaining wall and Figure A9.5.5(2) shows reinforced concrete caisson type. Comparing with two types an open pier type quaywall with the retaining wall has such demerits as the followings. In planned area there might appear rocks which could not be notified in the borings so far executed. A cost analysis reveals that an open pier type quaywall with the retaining wall is more than 50% expensive that of reinforced concrete caisson type even if popular PC piles instead Steel Pipe Piles.

(2) Dolphin

Dolphin type of structure is the most popular and reasonable type in case of handling powder or liquid cargo. At the center of a dolphin a working platform is located where cargo handling machine(for oil handling usually loading arm) is installed. Next to the working platform there are two breasting dolphins both side of the working platform which exist bitts to moor breasting horses. At the both ends there are two mooring dolphins to fix stern and bow horses. Breasting Dolphins is stood just before the frontline of the working platform to avoid berthing energy acting to the working platform directly.

Structural types of dolphins are divided two typical kind. One is pile type dolphin and the other is caisson type dolphin. As same reason as in case of quaywall above said, pile type of dolphin is not suitable in Dung Quat. Whilst there exist rather good soil foundation, so concrete caissons which can be installed without thick rubble mounds will result much easier work and save the cost. (c.f. Figure A9.5.6(1), Figure A9.5.6(2))

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 solely. 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) Existing	Depth(m) Design	Crown Height (m)	Planned Quantity (m)	Remarks
Protective Fa.						
Breakwater 1	HB Caisson	-16.5~-15.0	-16.0	+8.5	300	Fig.A9.5.1(2)
Breakwater 2	HB Caisson	-15.0~-9.0	-15.0	+7.0	300	Fig.A9.5.1(4)
Breakwater 3	Concrete	0.0	0.0	+6.0	100	--
Breakwater 4	RC Caisson	-9.0~-5.0	-8.0	+6.5	270	Fig.A9.5.1(6)
Revetment	Concrete. Block	-5.0~-4.5	-4.5	+3.0	420	Fig.A9.5.2
In.Breakwater	Con. Block	-4.0	-4.0	+3.0	100	Fig.A9.5.3
Training Wall	Rubble Mound	-1.0~ 0.0	-0.5	+2.0	150	Fig.A9.5.4
Mooring Fa.						
Dolphin D4	RC Caisson	-16.5~-15.0 -	-13.0	+3.0	355	Fig.A9.5.6(1)
Dolphin D1, D2	RC Caisson	14.0~-7.0	-8.0	+3.0	313	Fig.A9.5.6(2)
Quaywall E1,E2	RC Caisson	-7.0~- 5.5	-8.0	+3.0	300	Fig.A9.5.5(2)
Dolphin E3, E4	RC Caisson	-5.5~- 3.5	-8.0	+3.0	313	Fig.A9.5.6(1)
Quaywall	Con. Block	-3.5~- 1.0	-4.0	+3.0	200	Fig.A9.5.5(3)
Bridge	From the scale and popularity, Steel Pile with P.C Girder is selected	3.0~0.0	3 span	+4.8	200	Fig.A9.5.7

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 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 will be required more than 190,000 cubic meters for ISP. They can be obtained from quarries at Tinh Tho and other sites, including mountains in the upper catchment of the Tra Bong River.

Location map of quarries and productivity of those quarries are respectively 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, 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 Table 10.2.1 to 10.2.4.

Table 10.1.1 Major Construction Materials for ISP (Dung Quat)

Description	Break water	Break water	Break water	Break water	Revetment R1	Inner breakwater	Training wall
Excavation of soft layer (m^3)*	-	-	-	-	-	-	-
Stone (m^3)	26,500	24,900	-	20,000	16,800	1,500	5,000
Sand (m^3)	40,800	-	233,600	12,300	-	-	-
Concrete (m^3)	32,600	29,600	-	21,300	2,700	900	-
Reclaimed Sand(m^3)	-	-	-	-	-	-	-
Reinforced bar(ton)	1,400	1,200	-	660	-	-	-
Steel (ton)	1,700	1,560	-	590	-	-	-

Description	Dolphin D4 (-13.0m)	Dolphin D1,D2 (-8.0m)	Quaywall E1,E2 (-8.0m)	Dolphin E3,E4 (-8.0m)	Quaywall E6 (-4.0m)	Total
Excavation of soft layer (m^3)*	-	-	26,100	-	2,600	28,700
Stone (m^3)	43,800	7,200	13,100	7,200	10,500	187,000
Sand (m^3)	4,300	7,300	13,200	7,300	-	69,500
Concrete (m^3)	3,500	3,500	6,300	3,500	3,500	343,500
Reclaimed Sand(m^3)	-	-	-	-	-	1,280,000
Reinforced bar(ton)	350	620	620	620	-	5,470
Steel (ton)	-	-	-	-	-	3,850 (pipe line 250)

* Removal of soft work foundation underneath the upper structure

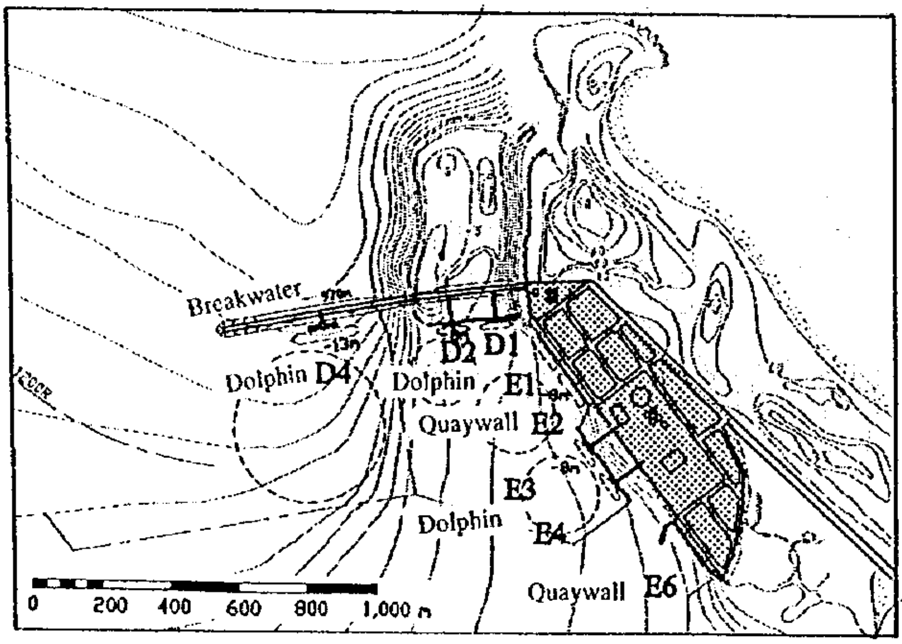

Figure10.1.1 Location and Abbreviations of Facilities

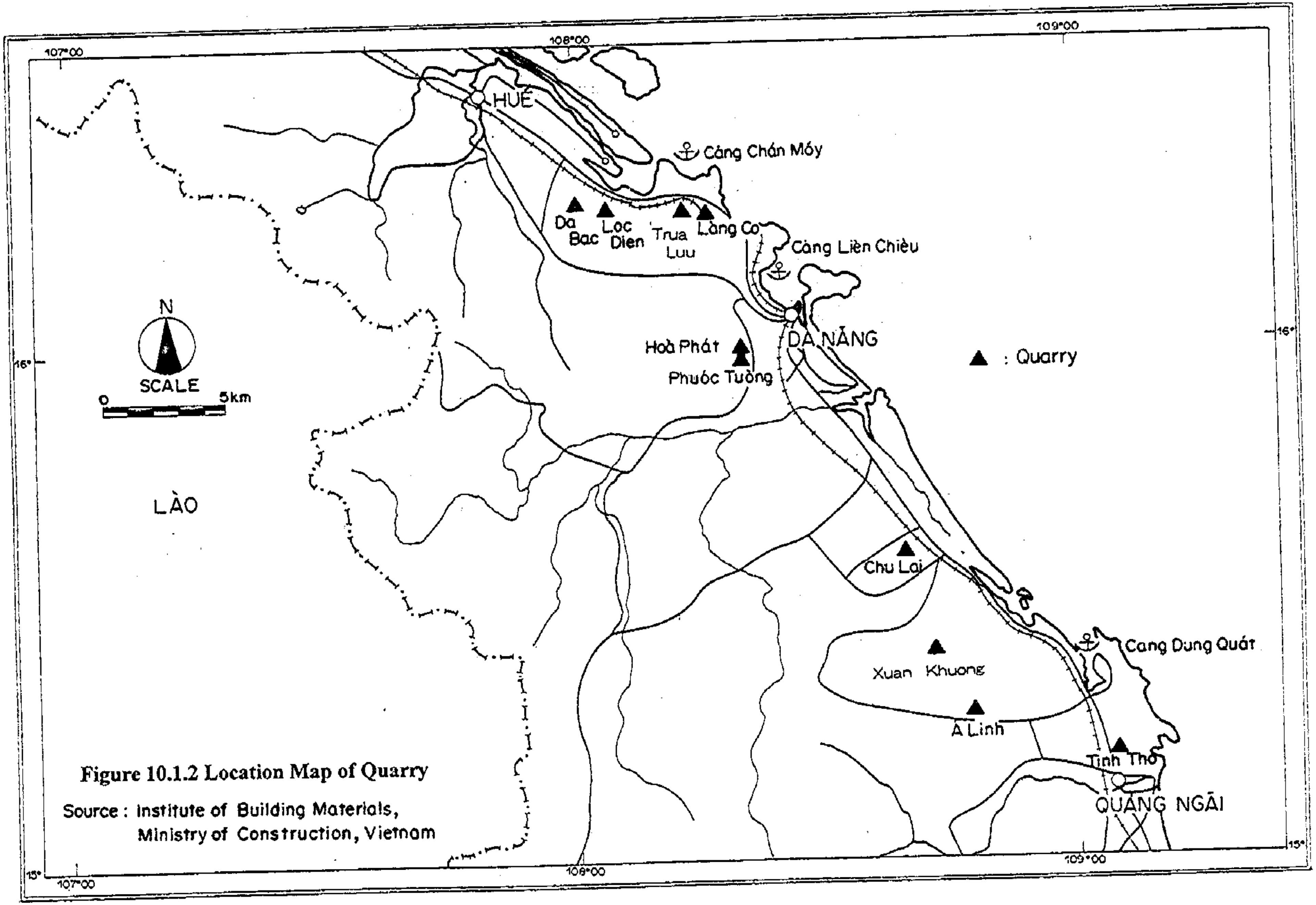

Figure 10.1.2 Location Map of Quarry

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

Table10.1.2 Site of Quarry-Quang Ngai Province

Site Name	Chu Lai	Xuan Xhuong	A Linh	Tinh Tho
1. Management Unit	Danang Construction Department	Quang Ngai Province	Quang Ngai Province	Material Construction Company which Belongs to Quang Ngai Construction Department
2. Exploiting Capacity	Now, it is 50,000m³/year. The Danang Construction Department has plan to invest in a stone exploitation line with capacity of 250,000m³/year.	Unknown, according to "Material Construction Planning for South and Central of Vietnam to 2010" by of Construction in 1996,a quarry with capacity of 250,000 m³/year will be built here in the period 2000 to 2010.	Unknown, according to "Material Construction Planning for South and Central of Vietnam to 2010" by of Construction in 1996,a quarry with capacity of 100,000 m³/year will be built here by the year of 2000.	The company has been exploiting with capacity of 50,000 m³/year. According to "Material Construction Planning for South and Central of Vietnam to 2010" by Ministry of Construction in 1996,the company has investment plan to increase the capacity of the quarry to 100,000 m³/year. by the year 2000.
Raw Material	Granite	Granite	Basalt	-
4. Geographic Location	The quarry belongs to Ky Lien Commune, Tamky District far from Danang City about 9km to southeast and Dung Quat Port Approximately 13km to the southeast.	The quarry belongs to Xuan Khoung village, in the east of Tra Bong District far from Dung Quat Port approximately 4km to the southeast.	The quarry belongs to Binh Ton Commune, Binh Son District far from Dung Quat Port approximately 3km to the northeast.	

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

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	1.4m³	Shift	1,392	120
	Backhoe	0.1m³	Shift	650	56
	Backhoe	0.2m³	Shift	835	72
	Backhoe	0.5m³	Shift	928	80
	Backhoe	0.7m³	Shift	1,150	100
	Backhoe	1.0m³	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 in front of the proposed location of the project breakwater for ordinary construction works as well as for manufacturing of large-scale structures such as concrete caissons and H.B. caissons. 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 shipyards 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 vicinity 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.

10.4 Dredging and Disposal of Dredged Materials

Although most of dredged materials are sandy and suitable for reclamation, some portions of the materials to be dredged from the channels, mooring basins and foundation of various facilities are not suitable for site reclamation, they should be dumped in the ocean. Dredging work for 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)
Channel and Basins	784,00
Excavation for foundation	28,700
Total	813,000

However, good quality sand deposited on the surface layer of near-shore area should be collected into sand pits by employing a small pump dredger and bulldozers or the like. 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 mooring basin is of self-propeller type, capable of dredging while along predetermined courses.

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

10.5 Construction Time Scheduling

In order to prepare a proper construction schedule, local natural conditions, such as wave and wind, records should be thoroughly examined and taken into account. Statistics show that wave heights off the Dung Quat Bay would exceed 1 meter for more than 60 percent of occurrence. Rainfall and wind velocity as well as the wave height affect the progress of construction work on the sea and on the land. Therefore, in the execution 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 five years, an integrated long-range program should be prepared to carry out all types of construction works, mobilize and demobilize construction plants, procure necessary machines and equipment, and timely supply various construction materials.

The construction 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 rationally 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.

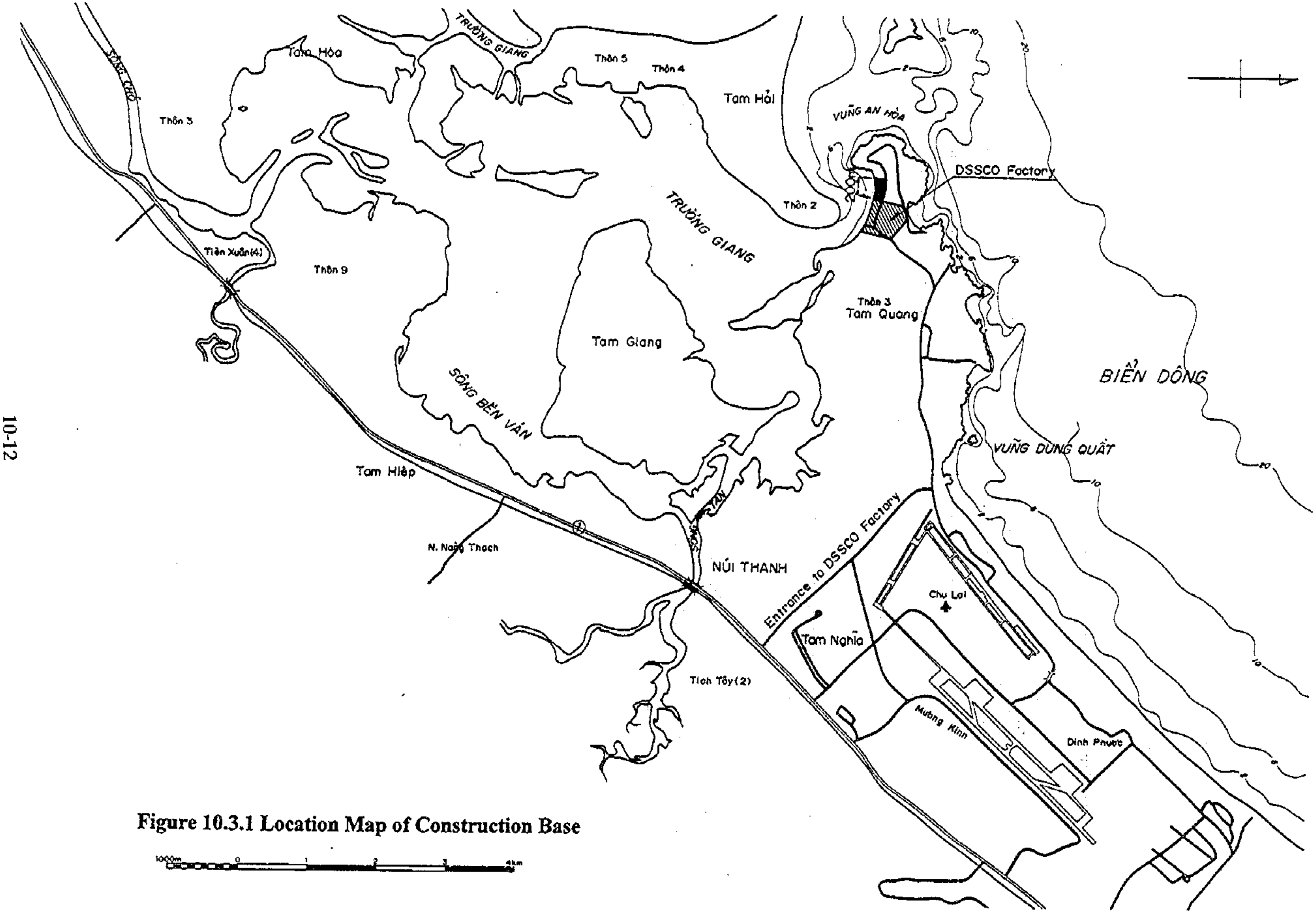

Figure 10.3.1 Location Map of Construction Base

Table 10.5.1 Construction Schedule for I S P (Dung Quat)

Description	Quantity	1stYear	2ndYear	3rdYear	4thYear	5thYear	6thYear	7thYear	8thYear	9thYear	10thYear	11thYear	12thYear	13thYear	Remarks
1 Finance Arrangement															
2 Selection of Consultant															
3 1.Protective Facility															
1) Breakwater(1)	300 m														
2) Breakwater(2)	300 m														
3) Breakwater(3)	100 m														
4) Breakwater(4)	270 m														
5) Revetment R1	420 m														
6) Inner Breakwater	100 m														
7) Training Jetty	200 m														
4 Dredging	784,000 m^3														
1) Channel & Basins	784,000 m^3														
5 Bridge	T-25,L=200m m														
6 Berthing Facility															
1) Dolphin D4	-13m, 355 m														
2) Dolphin D1 & D2	-8m, 313 m														
3) Quwywall E1 & E2	-8m, 360 m														
4) Dolphin E1 & E2	-8m, 313 m														
5) Quwywall for small craft	-4m, 200 m														
7 Yard East & West Wharf	225,000 m^2														
8 Access Road	38,940 m^2														
9 Oil Tretment Pond															
10 Pipe Line															
1) 12"	2,000 m														
2) 8"	1,000 m														
3) 6"	650 m														
11 Loading Arm															
1) 12"	3 nos.														
2) 8"	8 nos.														
3) 6"	3 nos.														
11 Navigation System															
1) Tug Boat	2 nos.														
2) Buoy&Beacon	L.S.														
12 Engineering Service															

Note:

Apr. 3rd year. Commencement of Construction

Dec. 5th year. Completion of Dolphin D1 & D2 ,E3 & E4(-8m), W2(-13m),W1 & E1(-8m). Quaywall E1 & E2,Quaywall(-7m)

Dec. 7th year. Completion of Dolphin D4(-13m),W1 & E1(-8m). Quaywall for SmallCraft(-5m)

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 for implementation of Master Plan, the total of which is about US$353 million, inclusive of the cost of oil pipe line in port area and navigation aids.

Table 11.2.1 Preliminary Cost Estimate for M S P (Dung Quat)

Facility	Structure	Depth (m)	Length/ Quantity	Unit Cost (US$)	Amount (Thous.US$)	Remarks
1.Protective Facility					87,350	
1) North Breakwater	H.B Caisson	-15.0	360 m	43,600	15,700	Crown Height+8.0m
2) Ditto	Ditto	-15.5	330 m	45,200	14,920	〃 +8.7m
3) Ditto	Ditto	-16.0	300 m	42,300	12,690	〃 +8.5m
4) Ditto	Ditto	-15.0	300 m	37,000	11,100	〃 +6.5m
5) Ditto	In-situ Concrete	+0.0	100 m	4,420	440	〃 +6.0m
6) Ditto	H.B Caisson	-8.0	270 m	25,200	6,800	〃 +6.5m
7) Revetment	Concrete block	-4.5	420 m	4,860	2,040	〃 +3.0m
8) Inner Breakwater	Ditto	-4.0	100 m	4,420	440	〃 +3.0m
9) West Breakwater	R.C Caisson	-10.5	340 m	12,400	4,220	〃 +3.5m
10) Seawall	Ditto	-8.5	670 m	12,900	8,640	〃 +3.5m
11) Ditto	Ditto	-5.5	630 m	10,000	6,300	〃 +3.5m
12) Ditto	Rubble	-2.0	530 m	1,520	810	〃 +3.5m
13) Revetment	R.C Caisson	-9.5	350 m	8,200	2,870	〃 +3.0m
14) Bulkhead	Rubble	-2.0	250 m	1,520	380	〃 +3.0m
2.Dredging					25,260	
Channel & Basins	(-4.0m,-8.0m,-13.0m)		5,051,000 m	5	25,260	
3.Bridge	P.C.Beams,Class:T-25		L.S.		5,000	W=22m,L=200m
4.Berthing Facility					53,390	
1) Dolphin	R.C Caisson	-13.0	680 m	23,300	15,840	Crown Height+3.0m
2) Ditto	Ditto	-8.0	390 m	10,000	3,900	〃 +3.0m
3) Quwywall	Ditto	-8.0	360 m	13,100	4,720	〃 +3.0m
4) Dolphin	Ditto	-8.0	390 m	10,000	3,900	〃 +3.0m
5) Quwywall	Concrete block	-4.0	200 m	6,160	1,230	〃 +2.0m
6) Ditto	H.B Caisson	-13.0	630 m	25,300	15,940	〃 +2.0m
7) Ditto	R.C Caisson	-8.0	600 m	13,100	7,860	〃 +2.0m
5.Yard					95,900	
East & West Wharf			1,370,000 m	70	95,900	
6.Road					2,730	
	Surface : Asphalt Base : Rubble		38,940 m	70	2,730	W= 22m L=1,770m
7.Oil Tretment Pond	40m*50m*3m		L.S.		1,000	
8.Pipe Line					8,680	
	12"		L= 3,100 m	1,400	4,340	
	8"		L= 2,200 m	1,200	2,640	
	6"		L= 1,700 m	1,000	1,700	
Sub Total (1)					279,310	
9.Loading Arm					6,420	
	12"		6nos.	350,000	2,100	
	8"		10nos.	300,000	3,000	
	6"		6nos.	220,000	1,320	
10.Navigation System					4,600	
1) Tug Boats	2,500HP		2nos.		4,000	
2) Buoys & Beacons			L.S.		600	
Sub Total (2)					11,020	
Total	(Sub-Total(1)+Sub-Total(2))				290,330	
Physical Contingency	(8% of Sub-Total(1)+3%of Sub-Total(2))				22,680	
Engineering Services	Estimate base on necessary items				22,800	
Tax	6% of Total				17,420	Turnover and Profit Taxes
Grand Total					353,230	

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

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$120 million, inclusive of the cost of oil pipe line in the port area 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

The cost of construction for the implementation of the Master Plan Project is estimated at US$336 million, and ISP is estimated at US$113 million, except for taxes.

The total construction cost directly related to the civil works are estimated at US$279 million or 83 %, of the total project cost of the Master Plan Project, and the same works estimated at US$87 million or 77 %, of the entire cost of the ISP.

The above costs were estimates based on market surveys of unit costs, surveys of the breakdown of actual tendered costs of similar port construction projects, of these 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 (Dung Quat)

Facility	Structure	Depth (m)	Length/ Quantity	Unit Cost (US$)	Amount (Thous.US$)	Remarks
1 1.Protective Facility					33,470	
1) Breakwater(1)	H.B. Caisson	-16.0	300 m	41,300	12,390	Crown Height+8.5m
2) Breakwater(2)	Ditto	-15.0	300 m	37,700	11,310	〃 +7.0m
3) Breakwater(3)	In-situ Concrete	-10.0	100 m	3,150	320	〃 +6.0m
4) Breakwater(4)	H.B. Caisson	-8.0	270 m	25,600	6,910	〃 +6.5m
5) Revetment R1	Concrete Block	-4.5	420 m	4,860	2,040	〃 +3.0m
6) Inner Breakwater	Ditto	-4.0	100 m	4,420	440	〃 +3.0m
7) Training Jetty	Rubble	-0.5	200 m	300	60	〃 +2.0m
2 Dredging					3,920	
Channel & Basins	(-4.0m,-8.0m,-13.0m)		784,000 m^3	5	3,920	
3 Bridge	P.C.Beams,Class:T-25		L.S.		5,000	W=22m,L=200m
4 Berthing Facility					20,040	
1) Dolphin D4	R.C. Caisson	-13.0	355 m	23,300	8,270	Crown Height+3.0m
2) Dolphin D1 & D2	Ditto	-8.0	313 m	10,000	3,130	〃 +3.0m
3) Quwywall E1 & E2	Ditto	-8.0	360 m	11,900	4,280	〃 +3.0m
4) Dolphin E1 & E2	Ditto	-8.0	313 m	10,000	3,130	〃 +3.0m
5) Quwywall for small craft	Concrete Block	-4.0	200 m	6,160	1,230	〃 +2.0m
5 Yard					15,750	
East & West Wharf			225,000 m^2	70	15,750	
6 Access Road					2,730	
	Surface : Asphalt Base : Rubble		38,940 m^2	70	2,730	
7 Oil Tretment Pond			L.S.		1,000	
8 Pipe Line					4,650	
	12"		L= 2,000 m	1,400	2,800	
	8"		L= 1,000 m	1,200	1,200	
	6"		L= 650 m	1,000	650	
Sub-total (1)					86,560	
9 Loading Arm					4,110	
	12"		3 nos.	350,000	1,050	
	8"		8 nos.	300,000	2,400	
	6"		3 nos.	220,000	660	
10 Navigation System					4,220	
1) Tug Boats	2,500HP		2 nos.		4,000	
2) Buoys & Beacons			L.S.		220	
Sub-total (2)					8,330	
Total	(Sub-total(1)+Sub-total(2))				94,890	
Physical Contingency	(8% of Sub-total(1)+3% of Sub-total(2))				7,170	
Engineering Services	Estimate base on necessary items				11,400	
Tax	6% of Total				5,690	Turnover and Profit Taxes
Grand Total					119,150	

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 (Dung Quat)

Unit:,000$

Description	Quantity	Amont Construction Cost			1stYear			2ndYear			3rdYear			4thYear			5thYear			6thYear			7thYear			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	
1 Finance Arrangement																										
2 Engineering																										
3 Protective Facility		13,866	19,604	33,470																						
1) Breakwater(1)	300 m	5,576	6,815	12,390							4, 182	5, 111	9, 293	1, 394	1, 704	3, 098										
2) Breakwater(2)	300 m	5,090	6,221	11,310										3, 817	4, 665	8, 482	1, 272	1, 555	2, 827							
3) Breakwater(3)	100 m	128	192	320										128	192	320										
4) Breakwater(4)	270 m	2,764	4,146	6,910							2, 488	3, 731	6, 219	276	415	691										
5) Revetment R1	420 m	816	1,224	2,040										408	612	1, 020	408	612	1, 020							
6) Inner Breakwater	100 m	176	264	440										176	264	440										
7) Training Jetty	200 m	24	36	60							24	36	60													
4 Dredging		1,568	2,352	3,920																						
Channel & Basins	784,000 m^3	1,568	2,352	3,920													523	784	1, 307				1, 045	1, 568	2, 613	
5 Bridge	L.S.	4,500	500	5,000							1, 227	136	1, 363	1, 636	182	1, 818	1, 636	182	1, 818							
6 Berthing Facility		10,449	9,591	20,040																						
1) Dolphin D4	355 m	3,722	4,549	8,270																744	910	1, 654	2, 977	3, 639	6, 616	
2) Dolphin D1 & D2	313 m	1,409	1,722	3,130										1, 056	1, 291	2, 347	352	430	782							
3) Quwywall E1 & E2	360 m	1,926	2,354	4,280										385	471	856	1, 541	1, 883	3, 424							
4) Dolphin E1 & E2	313 m	1,409	1,722	3,130													1, 409	1, 721	3, 130							
5) Quwywall for small craft	200 m	554	677	1,230													554	677	1, 231							
7 Yard		11,025	4,725	15,750																						
East & West Wharf	225,000 m^3	11,025	4,725	15,750										3, 675	1, 575	5, 250	7, 350	3, 150	10, 500							
8 Access Road		1,092	1,638	2,730																						
	38,940 m^2	1,092	1,638	2,730							655	983	1, 638	437	655	1, 092										
9 Oil Tretment Pond	L.S.	400	600	1,000													400	600	1, 000							
10 Pipe Line		4,185	465	4,650																						
12"	2,000 m	2,520	280	2,800																1, 260	140	1, 400	1, 260	140	1, 400	
8"	1,000 m	1,080	120	1,200													1, 080	120	1, 200							
6"	650 m	585	65	650																			585	65	650	
11 Sub-total (1)		46,723	39,837	86,560							8,576	9,997	18,573	13,388	12,026	25,414	16,525	11,714	28,239	2,004	1,050	3,054	5,867	5,412	11,279	
Loading Arm		3,699	411	4,110																						
12"	3 nos.	945	105	1,050																			915	105	1, 050	
8"	8 nos.	2,160	240	2,400													2, 160	240	2, 400							
6"	3 nos.	594	66	660																			594	66	660	
Navigation System		4,220		4,220																						
Tug Boats	2 nos.	4,000		4,000																			4, 000		4, 000	
Buoys & Beacons	L.S.	220		220																			122		122	
Sub-total (2)		7,919	411	8,330													2,160	240	2,400				5,661	171	5,832	
Total		54,642	40,248	94,890							8,576	9,997	18,573	13,388	12,026	25,414	18,685	11,954	30,639	2,004	1,050	3,054	11,528	5,583	17,111	
Physical Contingency		7,170		7,170							686	800	1,486	1,071	962	2,033	1,387	944	2,331	160	84	244	639	438	1,077	
Engineering Services		9,120	2,280	11,400							1, 140	285	1, 425	1, 520	380	1, 900	1, 520	380	1, 900	1, 520	380	1, 900	1, 520	380	1, 900	
Tax		5,690		5,690							515	600	1, 114	803	722	1, 525	1, 121	717	1, 838	120	63	183	692	335	1, 027	
Grand Total		76,622	42,528	119,150							10, 917	11, 682	22, 598	16, 782	14, 090	30, 872	22, 713	13, 995	36, 708	3, 804	1, 577	5, 381	14, 379	6, 736	21, 115	

Apr. 3rd Year. Commencement of Construction

Dec. 7thyear. Completion of Dolphin D4(-13m)

Dec. 5th year. Completion of Dolphin D1 & D2, E3 & E4,
Quaywall E1 & E2(-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.

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.

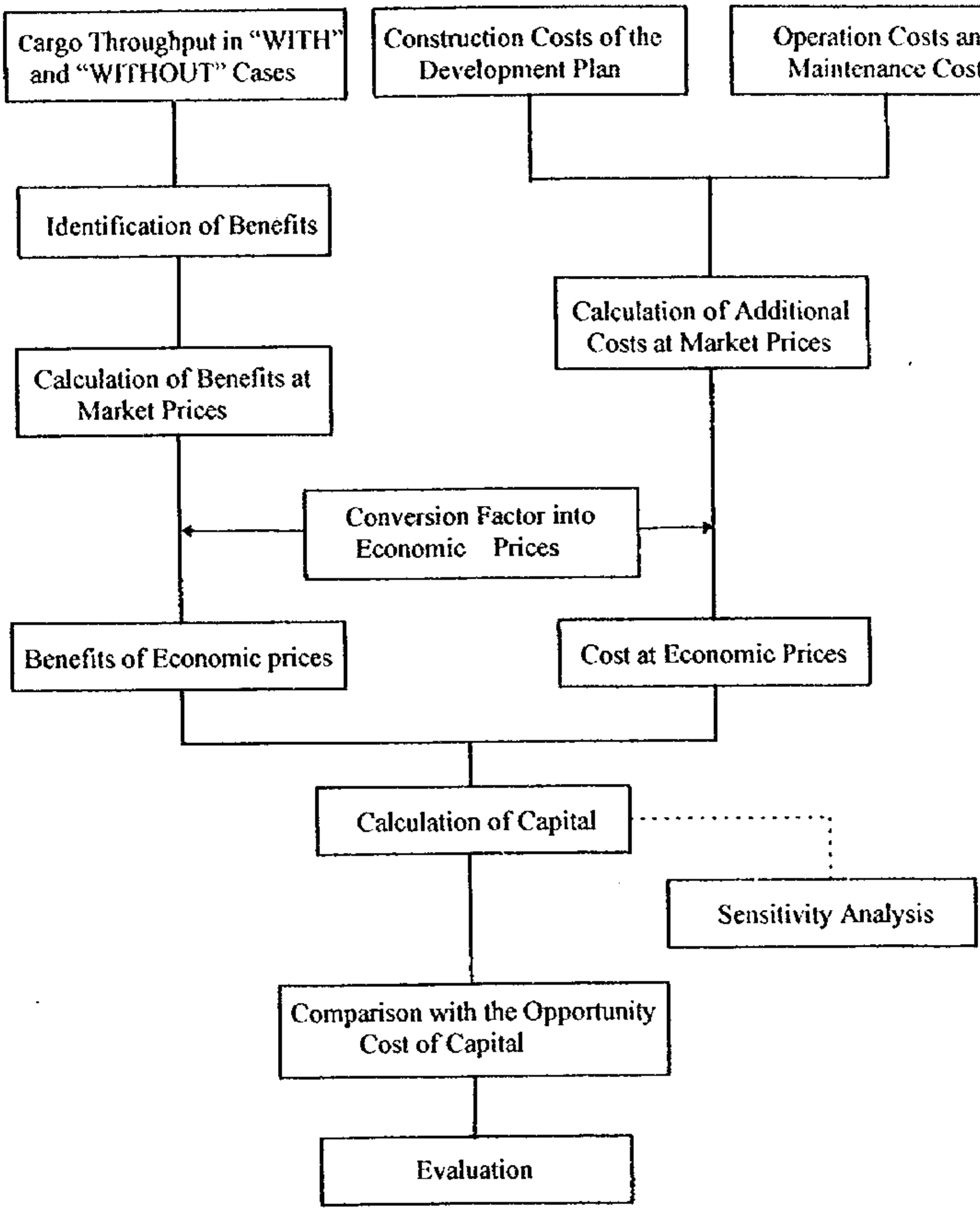

Figure 12.3.1 Procedure of the economic analysis

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.

$$\text{Convention Factor for Skilled Labor} = \text{Market Wage Rate} \times \text{CFC}$$
$$= 1 \times 0.985$$
$$= 0.985$$

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.

$$\text{Opportunity Cost} = \frac{\text{Value Added of Agriculture Sector}}{\text{Labor Force of Agriculture Sector} \times 365}$$
$$= 5{,}606{,}000{,}000 \ / \ 25{,}200{,}000 \ / \ 365$$
$$= \text{US\$0.609/day}$$

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) Saving 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 Dung Quat, a port of cargoes consumed in the study hinterland excluding the new industrial zone is assumed to be handled at Danang 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, Dung Quat 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 18.5 % 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	
8th	6,000		19,965	25,965
9th	6,400		19,965	26,365
10th	6,800.	54	19,965	26,819
11th	7,200	86	39,912	47,198
12th	7,600	114	39,912	47,626
13th	8,000	140	39,912	48,052
~37th	8,000	140	39,912	48,052

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

3rd~7th 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)
20.8%	18.2%

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)
19.8%	17.6%

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 short-term 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$)	243,435	110,996	42,997
BCR	3.17	2.09	1.46

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 20%. 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				Investment Costs in Economic Prices	Overall Conversion Factor
				Total	Unskilled Labour (CFL) 0.168	Skilled Labour (CFC) 0.985	Local Products (SCF) 0.994		
3rd	Breakwater (1)	9,293	4,182	5,111	44	36	5,031	9,226	0.993
	Breakwater (4)	6,219	2,488	3,731	32	26	3,673	6,170	0.992
	Training jetty	60	24	36	0	0	35	60	0.992
	Bridge	1,363	1,227	136	1	1	134	1,361	0.999
	Access Road	1,638	655	983	1	9	973	1,631	0.996
	Engineering Serv.	2,280	1,824	456	456	0	0	1,901	0.834
	Contingency	1,486	686	800	0	0	800	1,481	0.997
	(Total)	22,339	11,086	11,253	535	72	10,646	21,829	0.977
4th	Breakwater (1)	3,098	1,394	1,704	15	12	1,677	3,076	0.993
	Breakwater (2)	8,482	3,817	4,665	40	33	4,592	8,421	0.993
	Breakwater (3)	320	128	192	2	1	189	317	0.992
	Breakwater (4)	691	276	415	4	3	409	686	0.992
	Revetment R1	1,020	408	612	5	4	602	1,012	0.992
	Inner Breakwater	440	176	264	2	2	260	437	0.992
	Bridge	1,818	1,636	182	2	1	179	1,816	0.999
	Dolphin	2,347	1,056	1,291	11	9	1,271	2,330	0.993
	Dolphin	856	385	471	4	3	464	850	0.993
	Yard	5,250	3,675	1,575	2	14	1,559	5,239	0.998
	Access Road	1,092	437	655	1	6	648	1,087	0.996
	Engineering Serv.	2,280	1,824	456	456	0	0	1,901	0.834
	Contingency	2,033	1,071	962	0	0	962	2,027	0.997
	(Total)	29,727	16,283	13,444	543	88	12,813	29,197	0.982
5th	Breakwater	2,827	1,272	1,555	13	11	1,531	2,807	0.993
	Revetment	1,020	408	612	5	4	602	1,012	0.992
	Dredging	1,307	523	784	1	3	779	1,301	0.996
	Bridge	1,818	1,636	182	2	1	179	1,816	0.999
	Dolphin	782	352	430	4	3	423	776	0.993
	Quaywall	3,424	1,541	1,883	16	13	1,854	3,399	0.993
	Dolphin	3,130	1,409	1,721	15	12	1,694	3,107	0.993
	Small Craft	1,231	554	677	6	5	666	1,222	0.993
	Yard	10,500	7,350	3,150	4	28	3,118	10,478	0.998
	Oil Pond	1,000	400	600	5	4	591	992	0.992
	Oil Pipe Line	1,200	1,080	120	0	0	120	1,199	0.999
	Loading Arm	2,400	2,160	240	0	0	240	2,399	0.999
	Buoy	110	110	0	0	0	0	110	1.000
	Tug Boat	4,000	4,000	0	0	0	0	4,000	1.000
	Engineering Serv.	2,280	1,824	456	456	0	0	1,901	0.834
	Contingency	2,331	1,387	944	0	0	944	2,325	0.998
	(Total)	39,360	26,006	13,354	527	85	12,742	38,844	0.987
6th	Dolphin	1,654	744	910	8	6	896	1,642	0.993
	Oil Pipe Line	1,400	1,260	140	0	0	140	1,399	0.999
	Engineering Serv.	2,280	1,824	456	456	0	0	1,901	0.834
	Contingency	244	160	84	0	0	84	243	0.998
	(Total)	5,578	3,988	1,590	464	6	1,120	5,185	0.930
7th	Dredging	2,613	1,045	1,568	2	7	1,559	2,602	0.996
	Dolphin	6,616	2,977	3,639	31	25	3,582	6,568	0.993
	Oil Pipe Line	1,400	1,260	140	0	0	140	1,399	0.999
	Oil Pipe Line	650	585	65	0	0	65	650	0.999
	Loading Arm	1,050	945	105	0	0	105	1,049	0.999
	Loading Arm	660	594	66	0	0	66	660	0.999
	Buoy	110	110	0	0	0	0	110	1.000
	Engineering Serv.	2,280	1,824	456	456	0	0	1,901	0.834
	Contingency	1,077	639	438	0	0	438	1,074	0.998
	(Total)	16,456	9,979	6,477	490	32	5,955	16,012	0.973
	(Grand Total)	113,460	67,342	46,118	2,558	284	43,276	111,068	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	21,829	0	0	0	21,829
4	29,197	0	0	0	29,197
5	38,844	0	0	0	38,844
6	5,185	0	0	0	5,185
7	16,012	0	0	0	16,012
8		0	1,142	69	1,211
9		0	1,142	70	1,212
10		0	1,142	72	1,214
11		0	1,142	126	1,268
12		0	2,264	127	2,391
13		0	1,142	128	1,270
14		0	1,142	183	1,325
15		2,399	1,142	183	3,724
16		0	1,142	183	1,325
17		660	2,264	183	3,107
18		0	1,142	183	1,325
19		0	1,142	183	1,325
20		0	1,142	183	1,325
21		0	1,142	183	1,325
22		0	2,264	183	2,447
23		0	1,142	183	1,325
24		0	1,142	183	1,325
25		2,399	1,142	183	3,724
26		0	1,142	183	1,325
27		660	2,264	183	3,107
28		0	1,142	183	1,325
29		0	1,142	183	1,325
30		0	1,142	183	1,325
31		0	1,142	183	1,325
32		0	2,264	183	2,447
33		0	1,142	183	1,325
34		0	1,142	183	1,325
35		2,399	1,142	183	3,724
36		0	1,142	183	1,325
37		660	2,264	183	3,107

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	21,829	0	(21,829)	0	21,829	(21,829)
4	29,197	0	(29,197)	0	24,171	(24,171)
5	38,844	0	(38,844)	0	26,622	(26,622)
6	5,185	0	(5,185)	0	2,942	(2,942)
7	16,012	0	(16,012)	0	7,521	(7,521)
8	1,252	25,965	24,713	10,096	487	9,610
9	1,261	26,365	25,104	8,487	406	8,081
10	1,270	26,819	25,549	7,147	338	6,809
11	1,288	47,198	45,910	10,413	284	10,129
12	2,429	47,626	45,197	8,699	444	8,255
13	1,325	48,052	46,727	7,266	200	7,065
14	1,325	48,052	46,727	6,015	166	5,849
15	3,724	48,052	44,328	4,979	386	4,594
16	1,325	48,052	46,727	4,122	114	4,009
17	3,107	48,052	44,945	3,413	221	3,192
18	1,325	48,052	46,727	2,825	78	2,747
19	1,325	48,052	46,727	2,339	64	2,274
20	1,325	48,052	46,727	1,936	53	1,883
21	1,325	48,052	46,727	1,603	44	1,559
22	2,447	48,052	45,605	1,327	68	1,259
23	1,325	48,052	46,727	1,099	30	1,068
24	1,325	48,052	46,727	909	25	884
25	3,724	48,052	44,328	753	58	695
26	1,325	48,052	46,727	623	17	606
27	3,107	48,052	44,945	516	33	483
28	1,325	48,052	46,727	427	12	415
29	1,325	48,052	46,727	354	10	344
30	1,325	48,052	46,727	293	8	285
31	1,325	48,052	46,727	242	7	236
32	2,447	48,052	45,605	201	10	190
33	1,325	48,052	46,727	166	5	162
34	1,325	48,052	46,727	138	4	134
35	3,724	48,052	44,328	114	9	105
36	1,325	48,052	46,727	94	3	92
37	3,107	48,052	44,945	78	5	73
Total	166,483	1,375,273	1,208,790	86,674	86,674	0

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

EIRR= 0.20794

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.

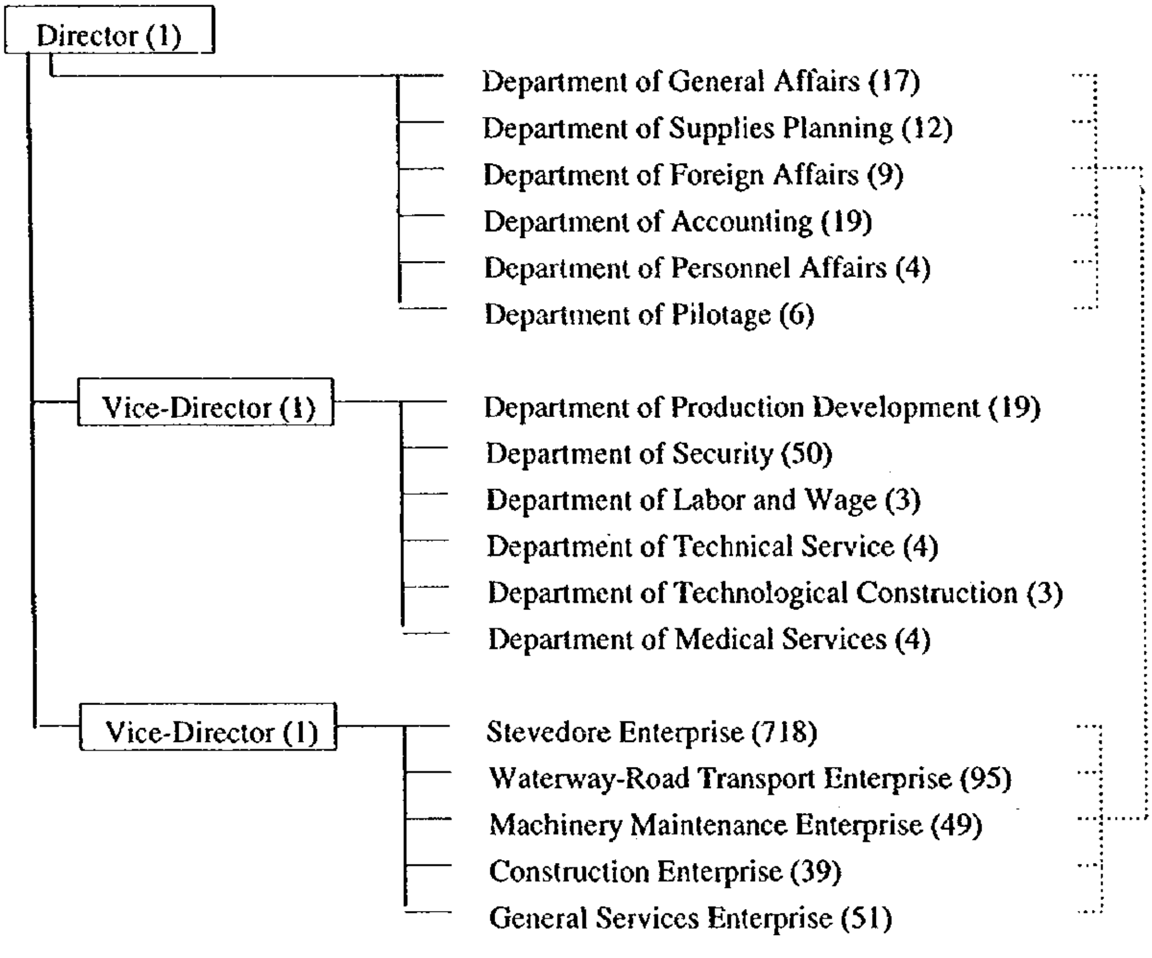

Figure 13.1.1 Organization of Danang Port

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

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

<table>
<tr><th colspan="2">Pattern</th><th>A</th><th>B</th><th>C</th><th>[redacted]</th><th>E</th><th>F</th></tr>
<tr><td colspan="2">Master Plan</td><td colspan="6">○</td></tr>
<tr><td rowspan="4">Construction</td><td>Channels</td><td rowspan="4" colspan="2">○</td><td rowspan="3" colspan="2">○</td><td rowspan="2">○</td><td rowspan="2">○</td></tr>
<tr><td>Breakwater</td></tr>
<tr><td>Infrastructure</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
<tr><td>Superstructure</td><td>○</td><td>●</td></tr>
<tr><td rowspan="2">Ownership</td><td>Land</td><td rowspan="2" colspan="2">○</td><td>○</td><td>○</td><td>○</td><td rowspan="2">●</td></tr>
<tr><td>Terminal facilities</td><td>●*2</td><td>●*2</td><td>●*2</td></tr>
<tr><td colspan="2">Berthing Scheme</td><td>○</td><td>○*1</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td colspan="2">Terminal Operations</td><td>○</td><td>●</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td colspan="2">Tug & Pilotage</td><td colspan="6">○ or ●</td></tr>
</table>

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

Note2: [redacted] 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

<table>
<tr><th colspan="2">Pattern</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
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<tr><td rowspan="4">Construction</td><td>Channels</td><td colspan="2" rowspan="4">○</td><td colspan="2" rowspan="3">○</td><td rowspan="2">○</td><td rowspan="2">○</td></tr>
<tr><td>Breakwater</td></tr>
<tr><td>Infrastructure</td><td rowspan="2">●</td><td rowspan="2">●</td></tr>
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Note1: ○: Public, ●: Private, (*1 : Exclusive system, *2 : Land lease system)

Note2: ▒ 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.

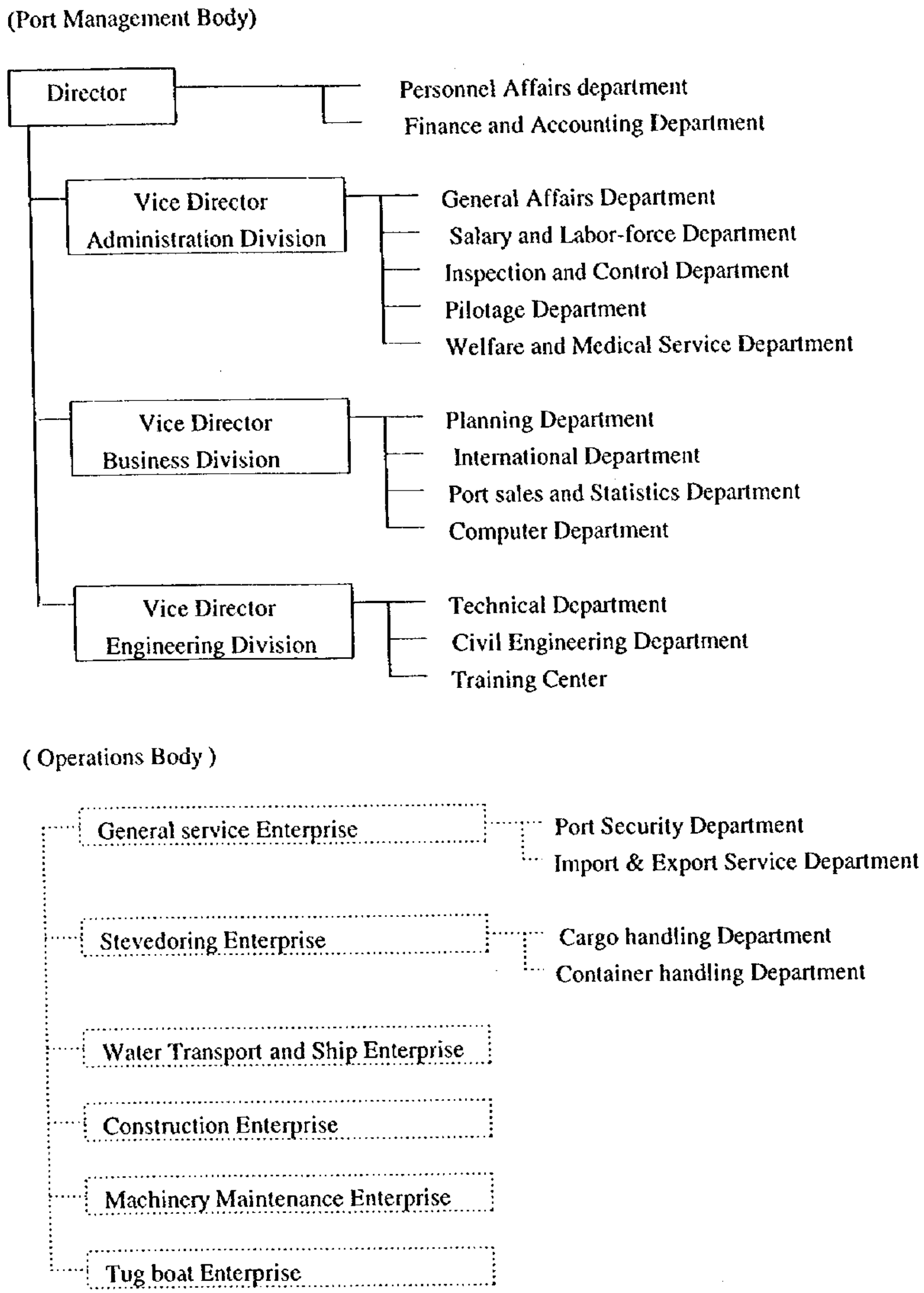

Figure 13.2.1 Example of Organization of the New Port

14. Initial Environmental Examination

14.1 Natural Environment

14.1.1 Overview

This chapter discusses the results and findings of 4 natural environment field surveys carried out in the Dung Quat project area in May 1997. These survey results and the following discussion update the findings and discussions on the natural environment of the Dung Quat project area which were presented in the Interim Report of September 1997[1]. This earlier report was based upon existing information obtained through literature searches and discussions with various agencies and individuals. Although some useful information was obtained on the area from various studies carried out during the early and mid 1990's, there remained significant gaps in this information base, and following a field visit to the area by the JICA Study Team, an environmental baseline survey was designed in March 1997 to investigate the fauna, flora, marine life and water quality within the project area. These 4 field surveys were carried out in May 1997 by local experts who were recruited from Vietnamese institutes with experience and expertise in these areas.

The investigation methods that were used, the results that were obtained, and the implications of these for the Environmental Impact Assessment of a port development at Dung Quat are described and discussed in the following sections.

Dung Quat bay is located approximately 40 km north of the provincial capital Quang Ngai. The north-east facing bay extends for approximately 15 km from Thanh Long cape in the north-west to the low promontory and headlands of Nam Tram mountain (141 m) in the south-east. Nam Tram mountain forms the highest point on a low bifurcated headland at the eastern end of Dung Quat bay. Nam Tram mountain is located on the eastern arm of this split headland, whilst the western arm forms a 2 km long promontory, Co Co cape, extending seawards in a north-westerly direction, providing a well sheltered anchorage in the easternmost corner of this large bay, where the proposed seaport development would be located.

Dung Quat bay is bisected by the Tra Bong river, which opens to the sea at the most southerly point on the bay's arc, which is about three-quarters of the distance around the bay from Thanh Long cape, a distance of approximately 11 km. This river effectively divides the bay into

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[1] / Interim Report: The Study on the Port Development Plan in the Key Area of the Central Region. OCDI & JPC. September 1997

two parts, the smaller eastern bay which curves in a tight arc of golden sands for 4 km around to the foot of the eastern promontory, and the much larger western bay which curves in a very gradual arc north-west towards Thanh Long cape. The proposed seaport would be developed within the smaller eastern bay, where the natural shelter provided by the north-eastern promontory of the headland makes it most suitable for a seaport.

Tra Bong river is a moderately sized river, having an estimated flow[2] of 20 m^3 / s and about 60 km long, with a catchment area of approximately 760 km^2 which flows from the Truong Son mountains located to the south and east of Dung Quat bay. The river widens considerably in its lower reaches, and at the river mouth it is a few hundred metres from shore to shore. There are several small islands (each < 1 ha) located at the mouth of the river, and on the eastern shore a small hill (Tuyet Diem mountain) rises steeply from the shore to a height of about 30 m.

From the base of Tuyet Diem mountain, the eastern bay extends in a sweeping curve of golden sand to a small river mouth which emerges at the end of the beach at the southern end of the promontory. This river, the Sung Moi (although it is referred to as the Cau river in the DOSTE, VITTEP report of 1996) extends inland, in a southerly direction, for about 7 km. Beyond this river, an area of higher relief (< 20 m) forms the eastern margin of the eastern bay's hinterland.

The eastern bay's sandy beach is between 50 m and 100 m wide, behind which a patchily distributed mix of woodland, shrub and ground creeping vegetation extends back from the beachfront for distances of between a few hundred metres and more than 1 km. Most of the land behind the beachfront and extending back for 2 km or more is comprised of low-relief sand dunes with little organic / soil content and consequently low productivity. This mix of vegetation cover anchors the sands and stabilises the land surface. In areas where this vegetation cover is absent, or has been removed, the sands became windswept into dunes of a higher relief, which are then more readily mobilised under windy or storm conditions. This windblown sand can then accumulate in other areas, smothering small shrub and plants and causing irritation and some damage to householders and their gardens. However, there are only a few houses and gardens in this area, probably because soil productivity is so low.

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[2] / Assessment of Environmental Situation and Proposal of Environmental Pollution Control Measures for Dung Quat Deep Seaport and Industrial Zone. DOSTE, VITTEP. 1996.

Further back through the hinterland, as soil quality appears to improve, the density of houses and the size and quality of garden plots increases, so that further inland, a few kilometres from the coast, paddy fields increase in number.

Directly to the south of Tuyet Diem mountain lies the village of Son Tra, one of the larger villages of the Binh Dong commune. This village, and neighbouring villages to the south, extend along the eastern riverbank of the Tra Bong river for a few kilometres. A similar succession of villages belonging to the Binh Thanh commune occurs along the western riverbank of the Tra Bong.

During our site visit in March 1997, the JICA Study Team observed approximately 50 fishing vessels anchored off this stretch of the eastern riverbank. Another 20 to 30 similar vessels were observed anchored off the western riverbank, and would probably be part of the fishing fleet belonging to the villages within the Binh Thanh commune on the western side of Tra Bong river. In both these communes, fisheries are an important component of the economic sector, providing up to 50% of the economic base (VITTEP, DOSTE, 1996). The importance of fishing to the communities of the eastern bay of Dung Quat was reinforced by the large number of small, round, inshore fishing craft observed all along the beach at eastern bay.

Around the river mouth on both sides and between the villages along the river banks, quite dense stands of mixed woodland including mangroves occur, but these thin out quite rapidly a few hundred metres back from the river.

In fact much of the hinterland behind the eastern bay (the project area) at Dung Quat is only poorly vegetated, with patches of denser woodland interspersed with more extensive areas of sparsely covered sand and sandy soils. In several areas even this sparse covering of small shrubs and ground creeping plants is more or less absent, leaving areas of exposed sand.

Throughout this area, villagers attempt to maintain small garden plots within this poor regime, but the productivity of such plots is likely to be low or very low. Under these circumstances, it appears that the villagers focus their efforts more in other areas such as fishing, and consequently the level of agricultural development throughout much of the immediate hinterland is low. This is supported by the data on the plantation area per capita, provided in the DOSTE, VITTEP report of 1996, which gives figures of 0.054 ha/capita in the hinterland of the eastern bay at Dung Quat, compared to a national average of 0.11 ha/capita.

From cursory observations made during the JICA Study Team's visit to the Dung Quat project area, there appears to be at least four different types of habitat present in the hinterland area. These are:

- Mixed shrub and "heathland", composed of small trees and shrubs with a ground cover understorey of creeping plants, herbs and grasses. This type of habitat is patchily distributed throughout the hinterland, particularly along the promontory and around the woodland areas, where it grades into the mixed woodland described below;

- Mixed woodland, composed of a mixture of species including *Casuarina*, *Pinus*, *Acacia* and *Eucalyptus* species, with some mangrove stands. These woodland areas are distributed in patches, occurring along and behind the beachfront and along the riverbanks, with the mangroves occuring along the estuary flats and tidal reaches;

- Areas of exposed sand and sand dunes which are only partially vegetated with soil-creeping plants and low/stunted shrubs;

- Agricultural land comprised of mainly small garden plots, and further inland, paddy fields and grazing watermeadows.

None of these habitats appears to be particularly unusual for this region of Vietnam and as the area is fairly well populated and consequently suffers a fairly high degree of continual human disturbance, it is less likely that it contains any unusual or valuable plants or animals.

The marine and coastal environments around Dung Quat also probably suffer a moderate degree of disturbance due to human influence as fishing plays such an important role in the local socio-economic status of these communities. Although many of the large vessels in the fishing fleets will work at some distance offshore, the many small round fishing boats observed along the beach suggest that the close-inshore waters are also heavily fished. Such continual disturbance is likely to limit the variety of species present in the coastal marine communities, and most of those present will be species that can adapt well to human disturbance, and as such are likely to be fairly widespread throughout this region of Vietnam.

However there is one marine area at Dung Quat that does require special mention, this is the Ordnance Jettison Area which is situated approximately 10 km north, north-east of the eastern bay at

Dung Quat. During the war this area was used by returning aircraft to jettison unused ordnance such as bombs, mines and missiles, before landing at airfields near Quang Ngai. This unused ordnance now lies on the seabed, between 20 m and 30 m depth, covering an area of approximately 120 km^2. As it has now been lying underwater for over 20 years, this ordnance is likely to be in an unstable state and as such it may pose a significant threat to any large or deep-keeled vessels passing over this area. Although routes could be charted to navigate around this area, its proximity to the proposed sea-port could cause some inconvenience, and possibly marginally increase pilotage costs and other operational expenses.

From the environmental perspective, the principle concern is the possibility that an explosion of ordnance, even at this depth, could cause a loss of control or actual structural damage to a vessel in the area, and under these circumstances, a loss of cargo, or fuel oils, may occur. In the case of fuel oils or any toxic or hazardous cargo, such as oils, petroleum or chemical products, this would have a major impact on the coastal marine environment, not only of Dung Quat bay, but also much further afield. As this Ordnance Jettison Area is situated between 10 km and 20 km offshore, the potential impact of any oil or other hazardous cargo spill at this point could extend for many kilometres and cause widespread damage along the coast of several provinces. This issue will need to be addressed in the course of further assessment of this project area.

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.

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 Dung Quat. These three census routes were:

- Tuyet Diem village
- Nam Tram mountain and Co Co cape
- Phuoc Hoa and Thuong Hoa villages

The survey was conducted by direct observation and by interviewing households along the census route. Fauna was classified into two categories:

- Feeding, or domestic, fauna;
- Natural wildlife fauna.

The numbers of domestic fauna in the three census areas are fairly low, and consist of some buffalo and cattle, pigs and poultry such as duck and chicken.

The numbers, and range of species, of wildlife fauna along all three census routes is also described as " poor ", with the greatest numbers of species being observed on Nam Tram mountain[3]. Several species of birds were observed during the survey including the Magpie Robin, the Red-whispered Bulbul, the Spotted Dove, Mynah and *Amourornis phoenicurus*. Although no animal species were recorded during the survey, discussions with the local people suggested that there were wild animals on Nam Tram mountain, including the long-tailed monkey, pangolin and weasel. However, Nam Tram mountain lies outside, but directly adjacent to, the proposed port development area at Dung Quat, and if these populations of long-tailed monkey and pangolin do exist on the mountain, their populations can possibly be protected by establishing a protected reserve on the mountain and restricting any development on the eastern side of the access road that follows a route to the west of Nam Tram mountain.

With the possible exception of the Nam Tram mountain, the results of the field survey and other information obtained to date from a variety of sources strongly suggests that the project area at Dung Quat does not contain any fauna species or habitats of particular or notable value, and

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[3] / Preliminary Report. Environmental Field Survey (Phase 1). Part 3: Dung Quat Area (Quang Ngai). May 1997

consequently any potential environmental impacts on the wild fauna within the development area are unlikely to be of any notable significance. In the event that populations of long-tailed monkey, pangolin or any other notable species are found to be present on Nam Tram mountain, this may require the establishment of a protective reserve on the mountain and the imposition of some restrictions on development along the access road to the west of the mountain.

14.1.4 Flora around the Project Area

The principle vegetation types have been briefly described in the Overview to this chapter (Section 14.1.1), based on observations made by the JICA Study Team during their brief visit to the area in March 1997.

Flora surveys were carried out in three census areas within the proposed project development area, as shown in Figure 14.1.1. These were:

- Tuyet Diem village
- Nam Tram mountain and Co Co cape
- Phuoc Hoa and Thuong Hoa villages

Tuyet Diem village is situated adjacent to the tidal flats close to the mouth of the Sung Moi river (sometimes referred to as the Cau river) at the eastern end of Dung Quat bay. At high tide these tidal flats are submerged and the water can reach as far as some of the houses. In these areas mangrove species, *Rhizophora apiculata* and *Bruguiera sexangula*, provide a hedgerow line which separates the tidal area from the residential areas. The areas around the village are given over to gardens and agricultural production, but the ground is very sandy and of poor quality, and yields are low to very low. Coconut, jackfruit, custard apple and lemon trees are planted, with garden crops of sweet potato, manioc, peanut, sesame and in recent years, watermelon. Some rice has been planted, but the productivity is very low. In areas of uncultivated land, the main plants are; *Myrtle*, *Cajuput*, *Gardenia*, *Breynia fruticosa* and *Poaceae*.

Nam Tram mountain and the promontory along to Co Co cape are covered with a mixed bush and heathland of regenerating forest, up to 2 or 3 m height, which is similar to the " mixed shrub and heathland " which occurs in patchy distribution throughout the Dung Quat hinterland as described earlier in the Overview. This regenerating forest contains members of *Dipterocarpaceae*, *Fagaceae*, *Anacardiaceae*, *Xcerosspermum* and *Terminia*, with an understorey including *Combretaceae* and rattans.

The villages of Phuoc Hoa and Thuong Hoa are situated on the Tra Bong river in an area that is frequently flooded with the partially saline waters of the lower Tra Bong river. Here the vegetation is limited to salt tolerant species such as the mangroves, *Rhizophora apiculata*, *Avicennia officinalis* and *Bruguiera sexanguila*. Where the salinity levels are lower, further back from the main channel and flooded areas, there are coconuts.

On the basis of these survey results, together with the JICA Study Team' s own observations earlier in 1997, there do not appear to be any flora of particular conservation or scarcity value within the project area at Dung Quat, although the presence of mangrove stands along the Tra Bong and lower Sung Moi rivers is worthy of note as these stands are often important nursery areas for a wide variety of river, estuarine and coastal water species which may support commercial or important subsistence fisheries.

In the case of a major port development at Dung Quat, these mangrove stands will probably suffer significant impacts, particularly during the construction phase when elevated levels of sediments and finer silts in the inshore waters will accumulate amongst the tree stands, smothering and suffocating their roots causing severe impacts on the health of the trees. Unless measures are taken to protect the tree stands from this excessive accumulation of sediments and silts, considerable die-back of the tree stands may occur with a consequent loss of coastal habitat and the species that live there. Even after construction has ceased, these mangrove stands will still be susceptible to impacts from contaminants (particularly surface films of oils and waste discharges to the bay from ship and land based sources) which could cause dieback of the stands. Protection of the mangroves from these impacts will require effective pollution control measures to be strictly enforced throughout the life of the port operations. In practice this can rarely be achieved and some loss of mangrove stand quality is probably inevitable. Although the impact of the loss of these mangrove stands (those on the Sung Moi river and in the lower reaches and rivermouth of the Tra Bong river) may affect the potential fishery value of stocks in Dung Quat bay, other factors, particularly those associated or caused by the construction works, and those associated with the operations of the port once it is established, will also have a major and probably a more profound effect, on the long-term fishery potential of this part of the bay.

Mangrove stands also provide an important coastal protection function by anchoring the lose sediments and muds that occur in these areas, particularly around rivermouths. Their potential loss could represent a significant threat to rivermouth stability and the incursion of tidal waters, which can result in larger areas of flooding, particularly under conditions of high river flows and high tides. In the event that significant dieback of the mangroves is likely to occur, which will be the case unless effective sediment control measures can be established at an early stage in the development's construction program, and unless their protection from contaminants (see above) can be maintained during port operations, consideration will need to be given to incorporating artificial shoreline protection measures in areas from which the mangroves might be, or have been, lost.

14.1.5 Marine Life around the Project Area

The location of the marine life survey transect lines in the Dung Quat project area is shown in Figure 14.1.1. The marine survey methods employed were the same as those used elsewhere, and were based on the transect line/quadrat survey methods described in Kenchington R.A., 1978, 1984 and Wilkinson C. and Baker V., 1994[4].

Coral reefs were sampled with quadrats 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. A visual census of coral reef fishes was carried out along 50m to 100m transects during daylight hours. Manta tow were used to visually assess the benthic communities 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 towed behind a small boat 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 Dung Quat bay, which occupies an area of more than 2,200 ha from the shoreline to the isodepth 6 fathoms, is mainly composed of fine sands, with mud a in a part of sheltered area by the Co Co cape. There are 80 to 90 ha of tidal muddy estuary flats which include between 70 and 80 ha of mangrove stands, approximately 100 ha of tidal sandy / rocky estuary flats and approximately 70 ha of coral reefs, around the Thanh Long, Co Co and Tuyet Diem rock outcrops. These latter two (Co Co and Tuyet Diem rock outcrops) are located within the proposed port development site, Thanh Long is located at the western end of Dung Quat bay and is unlikely to be significantly affected by a port development to the east of the Tra Bong river in the eastern side of Dung Quat bay. Several islands lie offshore from the Tra Bong rivermouth, with other small islands around Thanh Long and Co Co rock outcrops.

The results of the marine life survey around Dung Quat bay are closely similar to those obtained at Chan May and Danang, with the same number of taxa recorded for the major groups. These 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 Dung Quat bay is relatively high, the abundances of most taxa are fairly low, with many being recorded as scarce or fairly scarce in this survey, which is similar to the survey findings obtained at Chan May and Danang.

Although the number of taxa are the same as for Chan May and Danang, there were some differences in the relative abundances that were recorded. In general there was a lower abundance of seagrasses (*Halophita* spp) at Dung Quat than at Chan May, but a marginally greater abundance of some of the more common seaweeds such as *Sargassum* spp and *Turbinaria* spp, as the Table 14.1.1 indicated.

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 accrosa	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 these species abundances, 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.

Thanh Long cape, a distance of approximately 11 km. This river effectively divides the bay into two parts, the smaller eastern bay which curves in a tight arc of golden sands for 4 km around to the foot of the eastern promontory, and the much larger western bay which curves in a very gradual arc north-west towards Thanh Long cape. The proposed seaport would be developed within the smaller eastern bay, where the natural shelter provided by the north-eastern promontory of the headland makes it most suitable for a seaport.

Tra Bong river is a moderately sized river, having an estimated flow[2] of 20 m^3 / s and about 60 km long, with a catchment area of approximately 760 km^2 which flows from the Truong Son mountains located to the south and east of Dung Quat bay. The river widens considerably in its lower reaches, and at the river mouth it is a few hundred metres from shore to shore. There are several small islands (each < 1 ha) located at the mouth of the river, and on the eastern shore a small hill (Tuyet Diem mountain) rises steeply from the shore to a height of about 30 m.

From the base of Tuyet Diem mountain, the eastern bay extends in a sweeping curve of golden sand to a small river mouth which emerges at the end of the beach at the southern end of the promontory. This river, the Sung Moi (although it is referred to as the Cau river in the DOSTE, VITTEP report of 1996) extends inland, in a southerly direction, for about 7 km. Beyond this river, an area of higher relief (< 20 m) forms the eastern margin of the eastern bay's hinterland.

The eastern bay's sandy beach is between 50 m and 100 m wide, behind which a patchily distributed mix of woodland, shrub and ground creeping vegetation extends back from the beachfront for distances of between a few hundred metres and more than 1 km. Most of the land behind the beachfront and extending back for 2 km or more is comprised of low-relief sand dunes with little organic / soil content and consequently low productivity. This mix of vegetation cover anchors the sands and stabilises the land surface. In areas where this vegetation cover is absent, or has been removed, the sands became windswept into dunes of a higher relief, which are then more readily mobilised under windy or storm conditions. This windblown sand can then accumulate in other areas, smothering small shrub and plants and causing irritation and some damage to householders and their gardens. However, there are only a few houses and gardens in this area, probably because soil productivity is so low.

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[2] / Assessment of Environmental Situation and Proposal of Environmental Pollution Control Measures for Dung Quat Deep Seaport and Industrial Zone. DOSTE, VITTEP. 1996.

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 highly likely that there will be further deterioration in their condition as a result of impacts associated with port development, particularly to those corals around the rock outcrops at Co Co and Tuyet Diem which lie within the port development area, the overall regional significance of these impacts on biodiversity and fisheries values may be less than if the corals were in a pristine (close to 100 % good) condition.

It appears from the preliminary port design plans that the coral reefs at Co Co and Tuyet Diem will be severely impacted by the construction of breakwaters very close to these two sites. The severity of the impacts, particularly the severe impacts caused by direct physical damage and smothering with heavy sediments, could result in the loss of these coral communities, and given their close proximity to the construction sites, it is unlikely that effective mitigation measures can be developed and implemented to ensure that these corals are adequately protected. However, as noted above, 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, occupying "tens" of hectares of area around the bay[5]. They are highly productive communities and are an important component of the bay's ecosystem. Careful consideration will need to be given to the planning and management of any port development at Dung Quat in order to conserve, as far as practicable, the ecological value of the seaweed and seagrass communities around Dung Quat bay, particularly in the event that the coral reefs at Co Co and Tuyet Diem are severely impacted and there are substantive impacts on the mangrove stands around the Song Moi and Tra Bong rivers.

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:

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[5] / Preliminary Report. Environmental Field Survey (Phase 1). Part 3: Dung Quat Area (Quang Ngai). May 1997

- 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 activities;

- 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 change sedimentation patterns and the flow of nutrients and microscopic food organisms upon which these coral and seagrass/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 Dung Quat 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 operations. 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 Song 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/submersed 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 Dung Quat bay.

14.1.6. Water Quality

The water quality of coastal marine and river waters was monitored at 10 sites in the Dung Quat 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 °C), Salinity (in parts per thousand) and pH were measured in situ at the site. All water samples were stored in the dark at 1°C to 4°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 Dung Quat Survey Sites

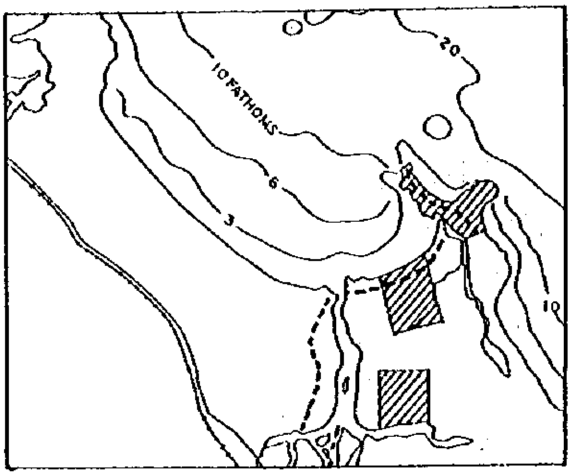
Sample Number *	Water Temp. (°C)	Salinity (‰)	pH	Diss. Oxygen (mg/l)	Susp. Solids (mg/l)	C.O.D. (mg/l)	B.O.D. (mg/l)
DQ-01	25.9	32.6	7.8	7.0	2.1	19	
DQ-02	25.5	32.6	7.8	7.4	3.7	19	
DQ-03	25.3	32.6	7.8	7.0	3.2	6	
DQ-04	25.6	32.6	7.9	7.2	4.0	6	
DQ-05	26.1	32.7	7.9	7.6	3.4	15	
DQ-06	26.1	32.7	8.0	7.3	2.8	15	
DQ-07	26.2	32.8	7.9	7.4	2.8	39	
DQ-08	26.2	32.5	7.9	6.9	2.1	12	
DQ-09	30.3	31.8	7.9	7.3	8.4		6.5
DQ-10	26.6	31.8	7.9	7.4	3.5		1.5

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

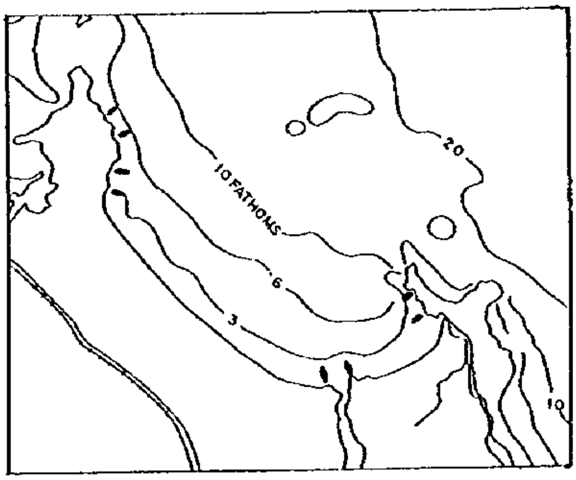
* Samples DQ-09 to DQ-10 are river water samples.

The result of the tests shown in Table 14.1.2 revealed that 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.

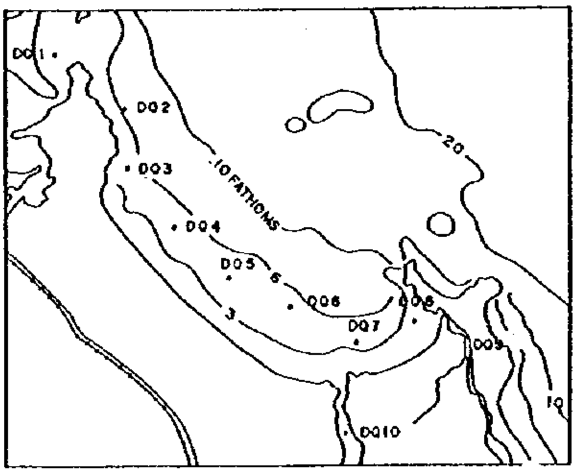
The two river water samples both comply with the Vietnamese surface water quality standard (TCVN 5942-1995), and indicate a clear (low sediment), well-oxygenated water which is typical for the lower tidal reaches of rivers in this type of natural coastal environment. The high salinity recorded in these two samples indicates that they were taken within the tidal zone of the river and reflect the presence of substantial sea water intrusion at these sampling sites at this time (state of the tide).



(1) Flora (hatching area) andFauna (dotted line)



(2) Marine Life



(3) Water Quality

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