JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEVELOPMENT STRATEGY INSTITUTE (DSI)
MINISTRY OF PLANNING AND INVESTMENT (MPI)
THE SOCIALIST REPUBLIC OF VIET NAM

THE STUDY
ON
THE INTEGRATED REGIONAL SOCIO-ECONOMIC DEVELOPMENT MASTER PLAN
FOR
THE KEY AREA OF THE CENTRAL REGION
OF
THE SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT
PRE F/S REPORT VOL.2

Dung Quat Industrial Development Project

MARCH 1997

PACIFIC CONSULTANTS INTERNATIONAL
SANYU CONSULTANTS INC.
INTERNATIONAL DEVELOPMENT CENTER OF JAPAN

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The following foreign exchange rate is applied in the study:

US$ 1.00 = 11,000.00 Vietnamese Dong (as of October 1996)

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ABBREVIATIONS

BF	Blast Furnace
BOD	Biochemical Oxygen Demand
BOT	Build, Operate and Transfer
COD	Chemical Oxygen Demand
CRDC	the Central Region Development Committee
C.R.F	Capital Recovery Factor
DC	Direct Current
D/D	Detail Design
DOP	Dioctyl Phthalate
DQI	Dung Quat Industrial Estate
DQIDC	the Dung Quat Industrial Estate Development Corporation
DQP	Dung Quat Port
DWT	Dead Weight Ton
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPZ(s)	Export Processing Zone(s)
F/S	Feasibility Study
FCC	Fluid Catalyst Cracking
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
FTZ(s)	Free Trade Zone(s)
GOV	Government of Viet Nam
GRDP	Gross Resional Domestic Product
HDPE	High Density Polyethylene
I.D.C.	Interest During Construction
IE(s)	Industrial Estate(s)
IEE	Initial Environmental Examination
IPP	Independent Power Producer
IUCN	International Union for Nature and Natural Resources
JICA	Japan International Cooperation Agency
LDPE	Low Density Polyethylene
LLDPE	Linear Low Density Polyethylene
MOC	Ministry of Construction
MOT	Ministry of Transport and Communications
MW	Mega Watt

NOx	Nitrogen Oxide
NPV	Net Present Value
O&M	Operation and Maintenance
ODA	Official Development Assistance
PE	Polyethylene
PET	Polyethylene Terephthalate
PP	Polypropylene
PPM	Parts Per Million
PPP	Polluter Pay Principle
Pre-F/S	Pre-Feasibility Study
PS	Polystyrene
PVC	Polyvinyl Chloride
QN-DN	Quang Nam-Da Nang
RFCC	Residual FCC
ROW	Right of Way
rpm	Revolutions Per Minute
SBM	Single Buoy Mooring
SOx	Sulfur Oxide
SS	Suspended Solids
V.A.T.	Value Added Tax
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TPA	Terephthalic Acid
VND	Vietnamese Dong

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND TO AND RATIONALE OF THE STUDY

This study on the Dung Quat industrial development project (DQI) has been selected by the Government of Viet Nam (GOV) as one of the priority projects to be subjected to a pre-feasibility investigation in "The Study on the Integrated Regional Socio-Economic Development Master Plan for the Key Area of the Central Region of the Socialist Republic of Viet Nam".

The GOV has decided, in principle, to establish a third substantial industrial greenfield growth pole in Viet Nam's Central Region. This decision is apparently motivated, inter alia, by strategic considerations. Those are, firstly, the need to establish an economically viable corridor or bridge between the country's economic powerhouses in the south and north. Secondly, to establish some economic critical mass in Central Viet Nam, which will help jump start accelerated economic and social development in the region.

The currently prevailing conceptional discussion assumes that the DQI will comprise the country's first and second oil refinery, a heavy iron and steel complex, ship repair and ship breaking industries, and oil rig fabrication. In fact, negotiations with an international consortium on the construction of the first oil refinery are on-going and it is anticipated that construction will start by the end of 1996 or beginning 1997 latest. Such a schedule would have to be maintained if the target of 2002 is to be met for start up of refining operations.

Another consideration for favoring this particular location may be the fact that Dung Quat is one of the very few locations at Viet Nam's long coast line, which is, from a technical point of view, suitable for deep sea harbor facilities.

1.1.1 Location

The DQI is located in Binh Son District in the northeastern part of Quang Ngai Province, some 30 km north of Quang Ngai Town and about 100 km south of Da Nang City (Figure 1.1 refers). The construction site for the DQI faces Dung Quat small bay, which has a 4 km long bay coast line reaching from Coco Cape to the Tra Khuc River mouth. The existing water depth ranges from 6 to 20 meters.

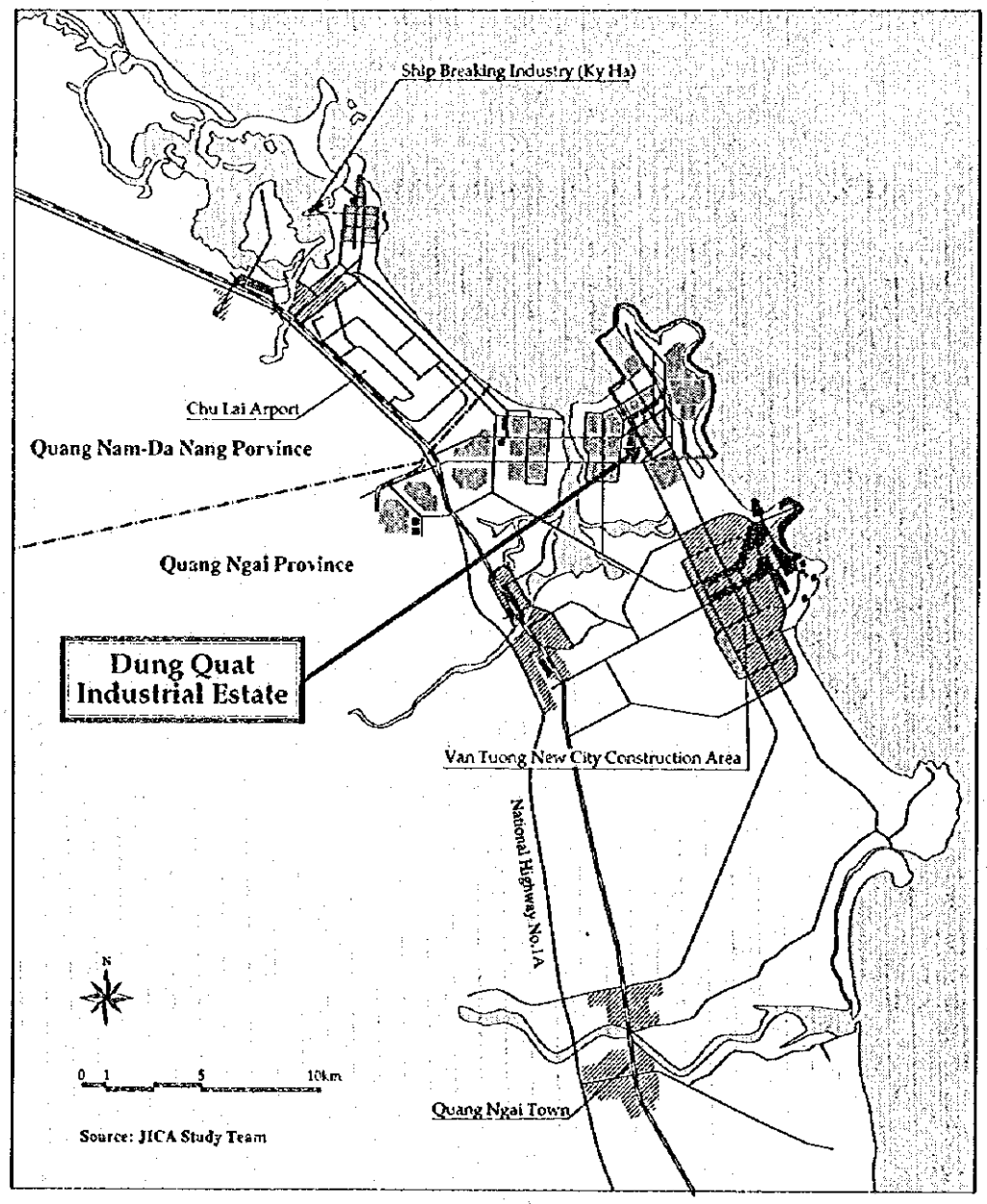
1.1.2 Significance of the DQI

The DQI is designed as a heavy industrial estate including the function of an industrial deep sea port. The planned Dung Quat Port (DQP) will have mooring facilities to accommodate vessels ranging from 10,000 to 80,000 dead weight ton (DWT) and single buoy mooring (SBM) facilities in the offshore for oil tankers of up to 250,000 DWT.

It is also expected that the DQI together with the port will generate significant benefits such :

- Large foreign currency savings through the mainly import substituting production of the refineries and petrochemical industries
- Considerable creation of direct and indirect employment opportunities at all skill levels
- Accelerated infrastructure development, which not only the vicinity of the DQI will benefit, but also the Province and the whole region, and
- Considerable technology transfer, which will take place during construction of the project and the life cycle of the various industries to be located in the DQI.

Figure 1.1 Location Map of the Dung Quat Industrial Development Project



1.2 OBJECTIVE OF THE STUDY

This pre-feasibility study (Pre-F/S) is limited to investigating the viability of the industrial estate (IE) only. Its main purposes are to describe the project's configuration as it is currently planned and, based on that configuration, to determine the project's economic and financial feasibility. Studies of this nature must make quite a number of assumptions and the critical ones in this case refer to the final nature of the industrial sub-projects themselves and their timing. It is obvious and understood that parts of this study will have to be amended, should the project's configuration be altered in the future course of DQI implementation.

CHAPTER 2

PREVAILING SITUATION OF INDUSTRY

CHAPTER 2 PREVAILING SITUATION OF INDUSTRY

2.1 RELATIVE POSITION OF THE CENTRAL REGION

The Central Region comprises the four Provinces of Quang Tri, Thua Thien-Hue, Quang Nam-Da Nang (QN-DN) and Quang Ngai with a total estimated population size of some 4.77 million people (1995), equivalent to about 6.5% of the country's total population. The Central Region's share in national GDP accounted in 1994 for some 4.8%, the share in total gross value of output of agriculture was recorded at 3.9%, that of industry at 3.8% and that for construction and services at 7.0% and 5.8%, respectively. The Central Region has so far played only a marginal role in terms of contribution to national GDP growth. However, QN-DN Province has attracted a total of 557 million US$ in accumulated foreign direct investment (FDI). Hence, QN-DN ranks sixth after Hai Phong and Song Be Province among the 49 Provinces in terms of absolute accumulated FDI (the comparison excludes oil & gas projects and overseas investment projects).

The Central Region's employment is estimated at some 1.96 million people, equivalent to about 41% of the region's population. Out of this total some 76% are employed in agriculture, about 10% in industry and the remainder of some 14% in services.

The contribution of the major economic sectors to the Central Region's GDP in 1995 are estimated at some 27% from agriculture, about 25% from industry (mining, manufacturing, construction and utilities) and some 48% from services.

The share of the urban population in the Central Region as a whole was about 23% in 1995 roughly in line with the national average, although it has to be noted that the urbanization rate among the four Provinces varies considerably. The important urban centers in the Region are Da Nang, which has been elevated to the status of City in November 1996 and Hue.

IEs are either under construction and/or planned in all four Provinces. However, on the coastal line of the four Provinces together only Chan May and Dung Quat are potential locations from a technical point of view for deep sea harbor facilities. This fact, among other strategic factors, gives the area a strong potential as a location for a third industrial growth pole in combination with deep sea harbor facilities.

2.2 INDUSTRIAL CONDITIONS IN QUANG NGAI PROVINCE

Quang Ngai has a fragile manufacturing structure, the gross value of output of which is dominated by food stuff manufacturing worth some 3.1 million US$ and/or about 81% of total Gross Resional Domestic Product (GRDP) in 1993 (Table 2.1 refers). Second is the construction material subsector, the GRDP of which was worth about 0.3 million US$ or 7% of total GRDP. The third rank is occupied by the machine equipment subsector, the GRDP of which was worth some 0.1 million US$ or about 4% of total GRDP.

In other words, the metal production subsector, namely ferrous metallurgy, non-ferrous metallurgy, metal production and machine equipment subsectors in Quang Ngai Province are not yet developed. The same holds true for the fuel and chemical industries. In terms of manufacturing growth, only food, food stuff, textile, leather and artificial leather and other industries showed a positive growth ratio, but all other eight manufacturing subsectors showed minus growth during the period from 1991 to 1993, that is the GRDP contracted, partly quite considerably (Table 2.1 refers).

Table 2.1 GRDP by Province and Manufacturing Subsector

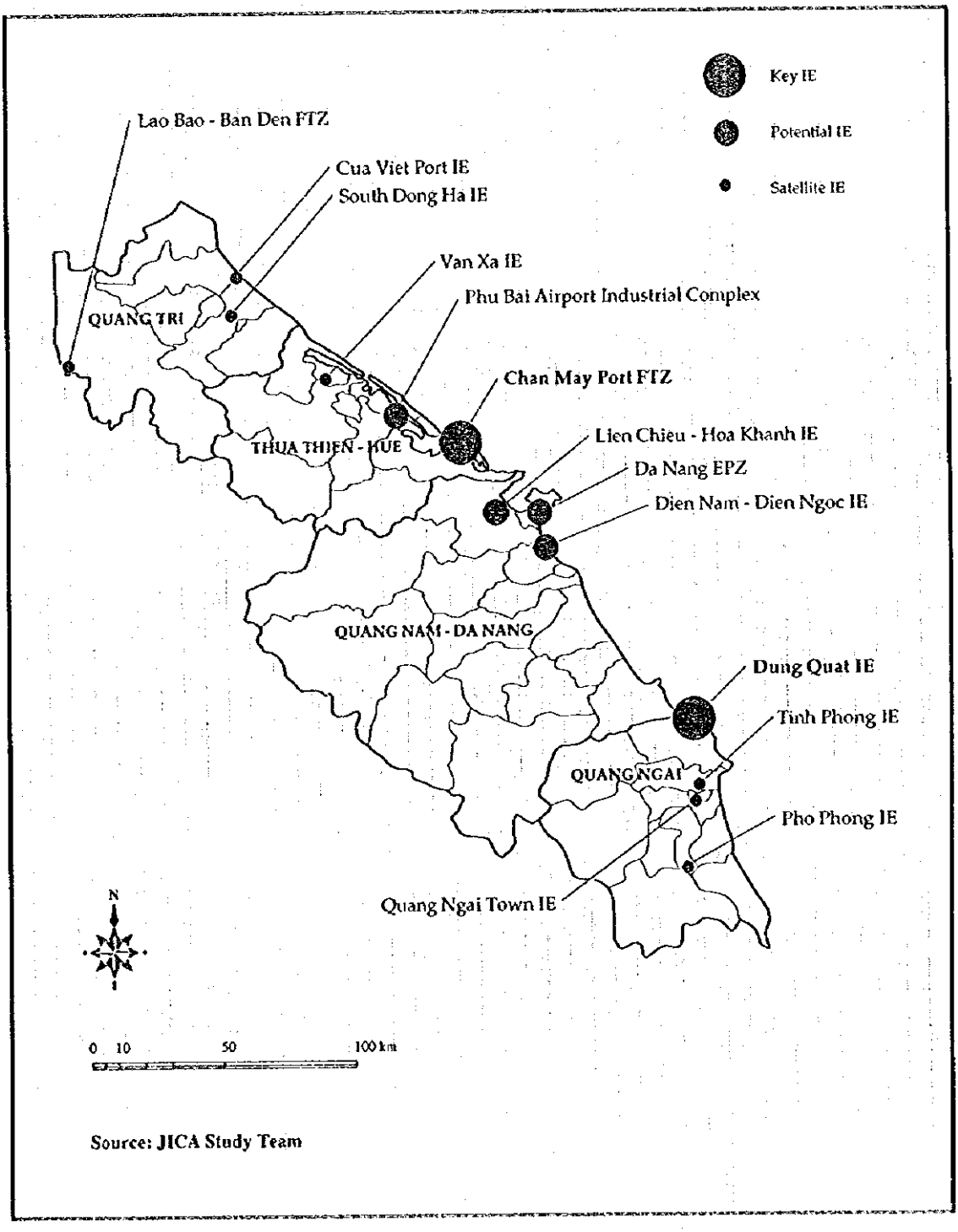
(Unit: US$ 1,000)

Sector No.	Name of Industrial Sectors	Quang Nam-Da Nang				Thua Thien-Hue				Quang Ngai				Quang Tri			
		1991	1992	1993	Growth rate (%)	1991	1992	1993	Growth rate (%)	1991	1992	1993	Growth rate (%)	1991	1992	1993	Growth rate (%)
01	Power	18.1	22.4	34.1	37.3	-	-	-	-	-	-	3.5	-	4.6	2.0	-	-
02	Fuel	81.5	1.5	106.6	14.4	-	-	-	-	-	-	0.1	-	-	-	-	-
03	Ferrous metallurgy	1.5	1.5	437.8	1,583.1	-	-	-	-	-	-	-	-	-	-	-	-
04	Non ferrous metallurgy	37.7	22.4	69.4	35.6	39.7	55.0	29.2	-14.3	-	-	-	-	-	-	-	-
05	Machine equipment	1,503.8	1,593.4	1,345.9	-5.4	156.2	129.4	156.3	0.0	185.5	159.2	137.6	-13.9	24.3	26.4	23.5	-1.5
06	Electric and electronic	55.8	3.2	93.7	29.6	23.3	16.9	9.5	-36.0	-	-	-	-	4.6	-	-	-
07	Metal production	741.3	685.6	1,040.0	18.4	111.9	120.3	139.7	11.7	80.1	69.8	39.6	-29.7	241.9	125.0	137.5	-24.6
08	Chemical	1,429.8	2,005.7	320.3	-52.7	171.7	146.9	146.0	-7.8	219.4	328.8	19.4	-70.3	1.4	2.4	-	-
09	Construction material	1,562.6	1,644.5	889.9	-24.5	302.5	348.2	441.9	20.9	339.0	320.8	285.4	-8.3	289.5	245.8	301.0	2.0
10	Wood processing and forestry	1,600.4	1,155.5	1,050.6	-19.0	411.6	374.8	476.6	7.6	112.1	114.7	103.5	-3.9	133.6	99.1	163.5	10.6
11	Cellulose and paper	83.0	110.3	134.7	27.4	0.5	2.4	25.1	643.0	1.3	1.9	1.1	-7.4	-	-	-	-
12	Glass and pottery	63.5	75.1	4.9	-72.2	9.5	4.8	4.6	-30.3	7.8	6.5	6.5	-8.5	2.3	2.4	3.2	18.3
13	Food	745.8	816.6	1,075.4	20.1	90.9	115.5	193.8	46.0	10.6	14.5	11.3	2.9	135.3	36.7	47.3	-40.9
14	Food stuff	4,060.6	4,494.2	8,422.9	44.0	2,579.8	3,742.7	4,958.8	38.6	2,094.9	2,671.6	3,137.7	-	368.0	760.6	732.9	41.1
15	Textile	2,163.0	2,312.5	1,110.7	-28.3	460.1	856.0	510.4	5.3	46.8	108.2	55.6	9.0	-	-	3.5	-
16	Garment	154.0	158.2	135.2	-6.3	14.1	10.8	10.1	-15.4	-	-	-	-	69.3	3.2	12.2	-58.1
17	Printing	114.7	167.8	199.8	32.0	13.2	4.2	2.9	-53.0	4.7	3.5	1.6	-41.2	1.3	-	-	-
18	Leather and artificial leather	371.5	361.2	197.2	-27.1	21.9	23.5	14.2	-19.5	4.7	8.1	7.7	27.9	1.9	3.0	5.4	67.6
19	Others	309.5	350.0	404.4	14.3	162.2	94.3	129.9	-10.5	32.4	28.4	63.6	40.2	20.8	31.8	52.8	59.3
Total		15,098.3	15,981.5	17,073.5	6.3	4,569.1	6,045.6	7,249.1	26.0	3,139.4	3,836.0	3,874.4	11.1	1,298.7	1,338.4	1,482.9	6.9

Source: Ministry of Industry

The industrial development direction of the Central Region includes the establishment of thirteen IEs (including the DQI), the location of which is identified in Figure 2.1. The lines of manufacturing to be promoted in each IE are listed in Table 2.2. As regards DQI, there are five subsectors to be promoted, namely oil refinery as a fuel industry, chemical industry, ship repair & breaking, ferrous metallurgy and power industry.

Figure 2.1 Location of Industrial Estates, Export Processing Zones and Free Trade Zones



Source: JICA Study Team

Table 2.2 Lines of Manufacturing to be Promoted in Each Industrial Estate in Quang Ngai Province

Table DQ2-2 Main Proposed Industries in Future

Name of Province	Name of Industrial Estate	Name of Industrial Sector	Main Proposed Industrues in Future
Quang Ngai	Dung Quat Port IE	Power	Thermal electric power station
		Fuel	Petroleum refinery Lubricating oils and greases
		# Ferrous metallurgy	Iron smelting without blast furnaces Steel with rolling fabricates Coated steel Steel forgings and casting Iron castings Miscellaneous iron and steel
		Chemical	Petrochemicals Industrial plastic products Miscellaneous plastic products Industrial organic chemicals Chemical fibres Miscellaneous chemical and allied products
		# Machine equipment	Ship repair and ship breaking
	Tinh Phong IE	Construction material	Structural clay products Clay reflactories Abrasive products Aggregate and stone products Other ceramic stone and clay products
	Quang Ngai Town IE	Foodstuff	Sugar and sugar syrups Bakery and confectionery products Miscellaneous food and related products
		Leather and artifical leather	Leather tanning and finishing Mechanical leather products Boot and shoe cut stock and findings Leather footwear Leather gloves and mittens Luggage Handbags and small leather goods
	Pho Phong IE	Foodstuff	Suger and suger syrups Bakery and confectionary products Alcohol beverage
		Wood processing and forestry	Furniture Miscellaneous furniture and fixtures Sawing and planning mills and wood products Wooden containers Rubber products Plywood and prefab-wood products Miscellaneous wood products

Note: # Second stage
Source: JICA Study Team

CHAPTER 3

NATURAL AND ENVIRONMENTAL CONDITIONS

CHAPTER 3 NATURAL AND ENVIRONMENTAL CONDITIONS

3.1 OVERALL CONDITIONS

Quang Ngai Province comprises a land area of 5,274 km^2, of which some 75% are mountainous areas. The Province has one major town, five mountainous Districts, six flat land Districts and one island District. The total population in 1995 is estimated at 1.2 million persons and the average population density is therefore 228 persons per km^2. The highest population density in the Province is 2,793 persons per km^2.

Quang Ngai has four main rivers, namely the Tra Bong, Tra Khuc, Ve and Tra Cau Rivers. The Tra Bong River flows into the west side of Dung Quat Bay.

3.2 NATURAL CONDITIONS

3.2.1 Temperature and Humidity

The Quang Ngai Meteorology Gauging Station has statistical data covering the period 1976 to 1992. The maximum and minimum air temperature by month over that period is summarized in Table 3.1. High average air temperatures are 28.6 to 28.9 degrees centigrade in June and August. The highest maximum temperature that has been recorded was 40.5 degrees centigrade in June and the lowest was 12.6 degrees centigrade in January and December.

Table 3.1 Air Temperature by Month in Quang Ngai (1976-1992)

(Unit: °C)

Parameter	January	February	March	April	May	June
Average	21.6	22.6	24.5	26.7	28.5	28.9
Maximum	32.5	35.3	35.0	38.7	39.5	40.5
Minimum	12.6	14.1	13.4	18.6	21.4	22.4
	July	August	September	October	November	December
Average	28.8	28.6	27.3	25.8	24.0	22.0
Maximum	38.1	38.6	37.6	34.5	32.4	30.1
Minimum	22.0	21.4	21.7	17.1	16.4	12.6

Source : Quang Ngai Meteorology Gauging Station.

Data on the relative humidity by month are summarized in Table 3.2. The highest average humidity recorded was 88% during November to December and the lowest minimum was 37% in March and June.

3.2.2 Wind

Wind data are available from Quang Ngai Meteorology Gauging station for the period 1980 to 1988. The maximum annual wind speed ranged from 14m/s to 28m/s, with the latter having been observed during October 1986. Speeds of 20m/s were observed twice during May 1988 and October 1985. Other observed data fell below 17m/s. Table 3.3 and Figure 3.1 show the distribution of wind frequency and velocity.

Table 3.2 Air Humidity by Month in Quang Ngai (1976-1992)

(Unit: %)

Parameter	January	February	March	April	May	June
Average	87	86	84	83	80	80
Minimum	46	45	37	41	41	37

	July	August	September	October	November	December
Average	79	80	84	87	88	88
Minimum	38	38	40	42	46	49

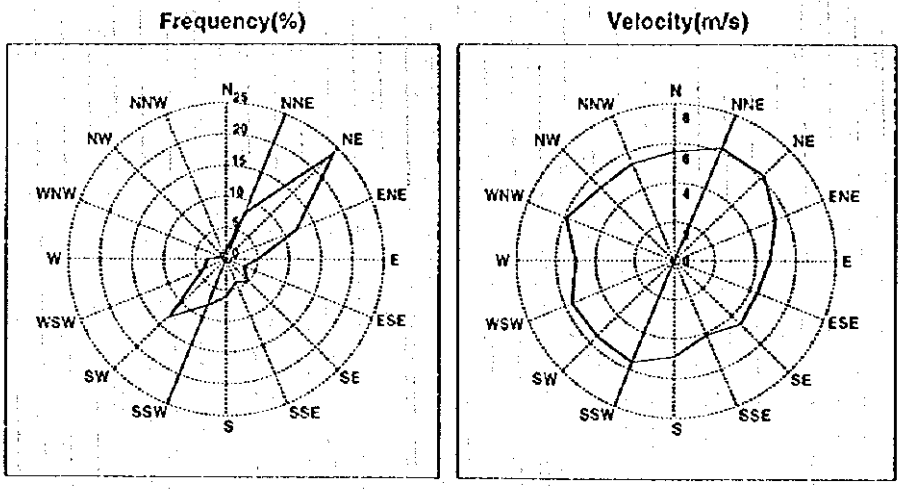
Source : Quang Ngai Meteorology Gauging Station.

Table 3.3 Distribution of Wind Frequency and Velocity

Parameter	Unit	N	NNE	NE	ENE	E	ESE	SE	SSE
Frequency	%	1.5	8.0	24.0	12.0	5.0	3.0	5.0	4.0
Wind velocity	m/s	5.6	6.2	6.2	5.4	4.7	4.4	4.6	4.1
		S	SSW	SW	WSW	W	WNW	NW	NNW
Frequency	%	6.0	8.0	13.0	4.0	3.0	1.0	1.5	1.0
Wind velocity	m/s	4.9	5.6	5.5	5.6	5.0	5.9	5.3	5.4

Source : Quang Ngai Meteorology Gauging Station.

Figure 3.1 Distribution of Wind Frequency and Velocity



A high wind speed always occurs during the summer season (from May to November) with a maximum observed value of 40 m/s.

3.2.3 Rain Fall

Table 3.4 shows the rainfall volume by month. The annual maximum rainfall volume has been 3,052 mm and annual minimum rainfall has been 1,374 mm.

Table 3.4 Rainfall Volume by Month in Quang Ngai

(Unit: mm)

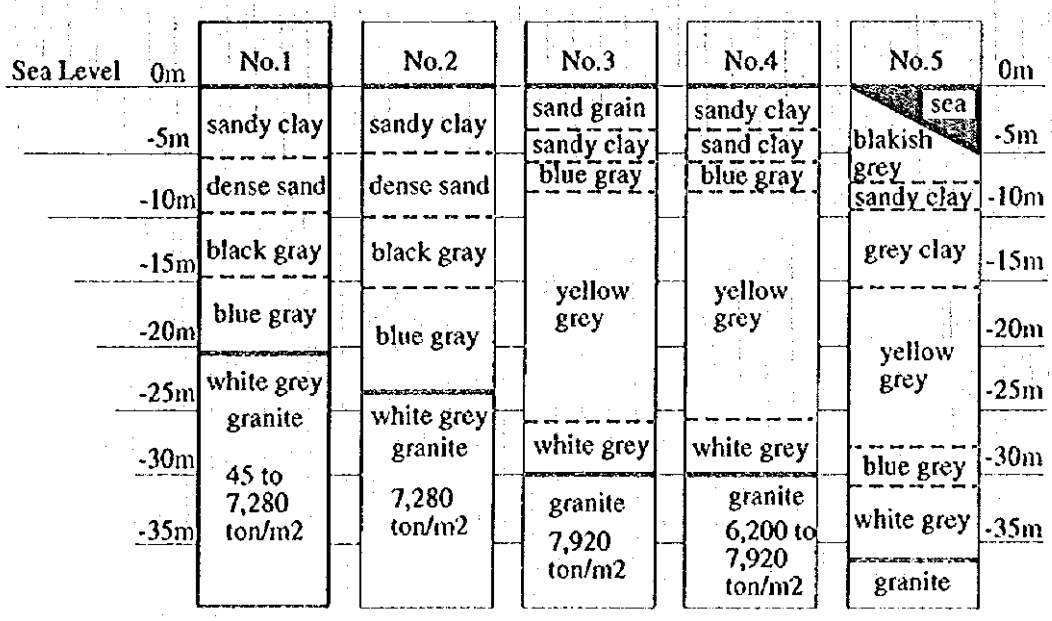
Parameter	January	February	March	April	May	June
Average	108.8	31.0	33.4	25.9	104.0	118.5
Maximum	511.0	101.0	229.0	122.0	381.0	360.0
Minimum	30.0	2.0	0.0	1.0	1.0	5.0
	July	August	September	October	November	December
Average	72.6	132.1	251.6	593.6	506.3	203.4
Maximum	207.0	267.0	513.0	1128.0	1207.0	550.0
Minimum	9.0	17.0	89.0	150.0	110.0	82.0

Source : Quang Ngai Meteorology Gauging Station.

3.2.4 Land and Soil Conditions

The DQI site is a sandy and high dune bay area. Also, there are several boring data available. The boring data suggest that there is a bed rock (granite) at about 21m to 30m depth in the land area with enough strength ranging from 7,280 tons to 7,920 tons per square meter. In the offshore, there is a granite bed rock at about 35m to 40m depth. It should be pointed out, however, that the boring data are insufficient and that it is necessary in future to conduct a detailed boring survey. Figure 3.2 displays the results of the available boring data.

Figure 3.2 Boring Data of the Dung Quat Site



Source: Several companies

With regard to building construction, the cutting area of the hilly site can be used directly to build factories by mat foundation, and the filling area can use pile foundation with 20 to 40 meter piles.

3.2.5 Land Use

People living in this District live on farming and fishing although the fertility of the soil is not very high. Moreover, almost all of the DQI site is sandy land, sand dune and rocky hills. Hence, the majority of inhabitants lives along the river mouth of the Tra Khuc River and Suoi River.

3.2.6 Re-Settlements of Habitants

The people living in this area will be given a priority for jobs in the DQI. In future the habitants can live in the Van Tuong new city, which is designed for the 9,700 workers of DQI (equivalent to some 55,000 people including family members). If the fishermen desire to continue their fishing business, they can resettle to the new fisherman village near Sa Ky, which is coordinated by the Quang Ngai People's Committee. According to the People's Committee, re-settlement of habitants is not a problematic issue and land is available anytime once the DQI project starts.

3.2.7 Industrial Water

Fresh water is scarce in the DQI area, so people use mainly 5 meter depth shallow wells. The Thach Nham irrigation system, namely B3 and B7 canals are going to the Dung Quat area. According to the factories, which are located near Quang Ngai Town, almost all industries use well water and/or river water for their production activities.

3.2.8 Power

The existing high voltage transmission line of 110KV - 185mm^2 x 1C comes from Da Nang City to the substation in Quang Ngai Town: 110/ 35/ 15KV. This 110KV transmission line goes along National Highway No.1 and is about 12 km from the site. Therefore, power for the construction work will be supplied from the proper point of the existing transmission line.

3.2.9 Road and Railway

From National Highway No.1 to the site is about 12 km earth road of 3 to 4 meter width, except the part near to the construction site, where the width is only 2 to 3 meter and the road is running through wet land with small bridges. There are several roads in this District, however road conditions are not good. Therefore, road preparation to support the construction work is necessary.

3.2.10 Port

Viet Nam's two largest ports, namely Sai Gon and Hai Phong, together account for some 80 % of total throughput at VINAMARINE ports. However, since these facilities are located along rivers, they both suffer from two key problems, which are (a) limited channel depth due to constant siltation, and (b) lack of space for port expansion. The growth in marine container transport continues unabated throughout the world. In Viet Nam, however, only the Sai Gon and Hai Phong ports have container berths. Furthermore, only Sai Gon port can accommodate 10,000 DWT class vessels.

There is Sa Ky Port in Quang Ngai with an average throughput of 100,000 tons per year. This port can receive ships of up to 1,000 DWT. However, the capacity of this port to support the construction of DQP is not enough. Hence, a new temporary wharf is required at the DQI site for the import of construction materials.

3.2.11 Airport

The Chu Lai airport has a 3.2 km long and 60 meter wide runway. The airport is now under the control of Viet Nam's Air Force in Da Nang. This airport is planned as a public airport before the year 2010 with a capacity to handle 500,000 passengers per year. If it will be possible to convert the airport for public use, it would make the region more attractive as an industrial location not only for heavy industries, but also air port based industries.

3.2.12 Telecommunications

10,500 telecommunication lines are already installed in Quang Ngai Town together with automatic communicators and micro-wave switchboard. The penetration ratio is 8/1,000 people per telephone. It is planned that by the year 2000 the penetration ratio will be 25/1,000 and that the telecommunication network and micro-wave network will be finished (Table 3.5 refers).

Table 3.5 Telecommunication Service 1991 to 1994

(Unit : number of telephones)

Parameter	1991	1992	1993	1994
Whole country	126,433	163,393	277,470	470,166
Quang Tri Province	565	806	1,507	2,898
Thua Thien Hue Province	1,538	1,940	3,217	5,337
Q.N. Da Nang Province	4,217	5,994	9,306	14,050
Quang Ngai Province	1,226	1,627	2,569	4,955

Source : Statistical Year Book 1995

CHAPTER 4

MARKETS AND DEMAND FORECAST

CHAPTER 4 MARKETS AND DEMAND FORECAST

4.1 PETROLEUM PRODUCTS

4.1.1 Domestic Demand for Petroleum Products

At present almost all domestic demand for petroleum products is met by imports, mainly from Singapore. Domestic demand for petroleum products in Viet Nam from 1992 to 1994 is summarized in Table 4.1.

Table 4.1 Domestic Demand for Petroleum Products in Viet Nam

Item	1992		1993		1994		Annual Growth Rate (%)		
	1000ton	wt.%	1000ton	wt. %	1000ton	wt.%	92-93	93-94	92-94
Gasoline	817	25.10	899	22.48	999	22.20	10	11	11
Kerosene	166	5.10	205	5.13	270	6.00	24	32	28
Jet Fuel	166	5.10	164	4.11	194	4.30	-1	18	8
Diesel Oil	1,384	42.50	1,874	46.85	2,097	46.60	35	12	23
Fuel Oil	628	19.29	716	17.90	743	16.50	14	4	9
LPG	7	0.21	2	0.06	27	0.60	-65	1,025	99
Lubricant	54	1.65	65	1.63	72	1.60	21	10	16
Bitumen	34	1.05	74	1.84	99	2.20	115	35	70
Total	3,256	100.00	4,000	100.00	4,500	100.00	23	13	18

Source: Japan Consulting Institute

4.1.2 Demand Forecast for Petroleum Products

Demand for petroleum products in Viet Nam from 1995 to 2010 was forecasted by using average annual demand growth rates for petroleum products either in Viet Nam over the period 1992 to 1994 or in the ASEAN countries over the period 1971 to 1993.

GRDP per capita of Viet Nam in 1994 was US$ 200. Per capita income in 1995, 2000, 2005 and 2010 are estimated to be US$ 220, US$ 354 and US$ 838, respectively. GRDP per capita and demand data of petroleum products in Indonesia, Philippines and Thailand for the past 23 years that is from 1971 to 1993 were investigated. The past years of the three ASEAN countries were linked with Viet Nam's years of 1994, 1995, 2000, 2005 and 2010 by applying the GRDP per capita of Viet Nam to similar values in the ASEAN countries.

Then average annual demand growth rates of the ASEAN countries in the years corresponding to 1994, 1995, 2000 and 2010 in Viet Nam were compared in order to estimate the demand growth rates in Viet Nam for the period of 1994 to 2000 and for the period of 2000 to 2010, respectively.

Thus, domestic demand forecast for petroleum products in Viet Nam is summarized in Table 4.2.

The regional distribution of domestic demand is roughly estimated at :

- Northern part : about 35% of total demand
- Central part : about 15% of total demand, and
- Southern part : about 50% of total demand.

Table 4.2 Domestic Demand Forecast for Petroleum Products in Viet Nam 1995 to 2010

Item	1995		2000		2005		2010		Growth Rate (%)	
	1000 ton	wt.%	1000 ton	wt. %	1000 ton	wt.%	1000 ton	wt.%	1994 to 2000	2000 to 2010
Gasoline	1,109	22.0	1,869	21.2	2,385	19.1	3,044	17.1	11 (*1)	5 (*2)
Kerosene	292	5.8	428	4.8	497	4.0	576	3.2	8 (*3)	3 (*4)
Jet Fuel	209	4.2	307	2.8	356	2.8	413	2.3	8 (*3)	3 (*4)
Diesel Oil	2,391	47.5	4,603	56.7	7,082	56.7	10,897	61.2	14 (*5)	9 (*6)
Fuel Oil	809	16.1	1,245	12.1	1,515	12.1	1,843	10.4	9 (*7)	4 (*8)
LPG	31	0.6	62	0.8	101	0.8	162	0.9	15 (*9)	10 (*9)
Lubricant	79	1.6	128	1.5	187	1.5	275	1.5	10 (*10)	8 (*11)
Bitumen	114	2.3	229	3.0	369	3.0	594	3.3	15 (*5)	10 (*9)
Total	5,033	100.0	8,871	100.0	12,491	100.0	17,803	100.0	12	7

Notes: (1) Based on the annual growth rate of gasoline demand in Viet Nam in 1992 - 1994 and the annual growth rate of gasoline demand in Indonesia 1974 to 1979.
(2) Based on the annual growth rate of gasoline demand in Indonesia from 1979 to 1993.
(3) Based on the annual growth rate of kerosene/jet fuel demand in Indonesia from 1974 to 1979.
(4) Based on the annual growth rate of kerosene/jet fuel demand in Indonesia from 1979 to 1993.
(5) Based on the annual growth rate diesel oil demand in Indonesia from 1974 to 1979.
(6) Based on the annual growth rate diesel oil demand in Indonesia from 1979 to 1993.
(7) Based on the annual growth rate fuel oil demand in Viet Nam from 1992 to 1994
(8) Based on the annual growth rate fuel oil demand in Indonesia from 1979 to 1993.
(9) Based on Petrovietnam's suggestions.
(10) Based on the annual growth rate of total demand for petroleum products in Viet Nam in Petrovietnam's base case for 1994 to 2000.
(11) Based on the annual growth rate of total demand for petroleum products in Viet Nam in Petrovietnam's base case for 2000 to 2010.

Source: Japan Consulting Institute

4.1.3 Oil Refinery

1) First Phase Oil Refinery

The first phase oil refinery will have a technical capacity of 6,500,000 tons per year and two objectives. Firstly, the refinery should supply the domestic market especially with gasoline and diesel oil. It is assumed that the refinery will have a FCC (Fluid Catalyst Cracking) or RFCC (Residual FCC) unit to increase production of gasoline and diesel oil. Secondly, it should have a polypropylene (PP) unit. The PP unit should meet the demand in and around 2003. The demand and supply balance for petroleum products in 2003 is shown in Table 4.3.

Table 4.3 Demand and Supply of Petroleum Product in 2003

(Unit: 1000 t/y)

Item	1st Phase refinery Production	Demand in 2003	Production Minus Demand
LPG	361	83	278
Gasoline	1,800	2,164	-364
Jet/Kerosene	827	803	24
Diesel Oil	2,778	5,961	-3,183
Fuel Oil	22	1,400	-1,378
Asphalt	150	305	-155

Source: Japan Consulting Institute

The refinery's production amounts for gasoline, diesel oil, fuel oil and asphalt are insufficient to meet the forecasted domestic demand for 2003.

2) Second Phase Oil Refinery

The second phase oil refinery will likewise have a technical capacity of 6,500,000 tons per year. This refinery should supply the domestic market with higher quality gasoline and diesel oil. To this end, a hydrocracker unit will be installed. A hydrocracker is employed so that the refinery can respond to:

- Strict sulfur content specification for diesel oil
- The large domestic demand for diesel oil, and
- More Dubai crude to be processed (Bach Ho crude / Dubai crude at a 50 to 50 ratio).

Secondly, this oil refinery is to supply the domestic market with petrochemical products. To this end, naphtha produced in the second oil refinery will be used as feedstock to an ethylene plant of 210,000 tons per year technical capacity, which will start up in 2006.

The demand and supply balance for petroleum products in 2006 is summarized in Table 4.4.

Table 4.4 Demand and Supply of Petroleum Products in 2006

(Unit: 1000 T/Y)

Item	1st + 2nd Phase Refinery Production	Demand in 2006	Production Minus Demand
LPG	720	111	609
Gasoline	2,759	2,504	225
Jet/Kerosene	1,498	879	619
Diesel Oil	5,788	7,719	-1,931
Fuel Oil	325	1,576	-1,251
Asphalt	300	406	-106

Source: Japan Consulting Institute

As for diesel oil, fuel oil and asphalt, the combined refinery production of the first and the second phase oil refineries are insufficient to meet domestic demand in 2006.

4.2 PETROCHEMICAL PRODUCTS

4.2.1 Demand Forecast

The petrochemical market in Viet Nam is still immature and no sufficient market data are available for forecasting future petrochemical demand.

It is therefore assumed that the past records of economic indices and local consumption of each petrochemical product in the neighboring ASEAN countries would be helpful for analyzing and forecasting the Vietnamese market demand.

ASEAN countries' data have been compared with Vietnamese data and they are utilized as reference data for forecasting the Vietnamese market demand for petrochemical products.

4.2.2 Petrochemical Phase 1 and 2

In order to meet future domestic demand for petrochemical products, petrochemical plants will be installed in two phases, with the plant start up in 2003 and 2006, respectively. A polypropylene (PP) plant is planned as the first phase petrochemical plant, since it can make good use of propylene produced in the first phase oil refinery. The output of PP will meet the forecasted demand in 2003.

In order to meet increased demand for polyethylene in and after 2005, polyethylene plants are planned in the second phase. An ethylene plant of 210,000 tons per year is also included in the second phase plan, which uses naphtha from the first and second phase oil refineries as feed stock.

Aimed at meeting future of polyethylene terephthalate (PET) demand, a purified terephthalic acid (PTA) plant and a PET plant are included in the 2nd phase plan. A para-xylene production section is incorporated in the second phase oil refinery.

Table 4.5 summarizes the rough demand estimation for petrochemical products.

Table 4.5 Demand Forecast for Petrochemical Products

Item	1994		1995		2000		2005		2010	
	1000 ton	Consu mp per Capita kg/y	1000 ton	Consu mp per Capita kg/y	1000 ton	Consu mp per Capita kg/y	1000 ton	Consu mp per Capita kg/y	1000 ton	Consu mp per Capita kg/y
PVC	40	0.55	55	0.74	123	1.49	258	2.85	440	4.40
DOP	12	—	15	—	34	—	70	—	120	—
Polyester	20	0.28	25	0.34	79	0.97	184	2.02	323	3.23
Polystyrene	6.5	0.09	8	0.11	20	0.25	45	0.50	100	1.00
Polypropylene	27	0.37	33	0.45	100	1.22	180	1.99	340	3.40
Polyethylene										
LDPE	10	—	25	—	40	—	80	—	110	—
LLDPE	0.34	—	0.57	—	1.22	—	2.43	—	2.90	—
HDPE	15	—	25	—	60	—	140	—	180	—
Synthetic Detergent	100	1.38	115	1.55	200	2.44	400	4.41	550	5.50

Source: Japan Consulting Institute

The regional domestic demand for petrochemical products is estimated at :

- Northern part : about 35% to 40%
- Central part : about 5% to 10%, and
- Southern part : about 60% to 70%.

4.3 IRON AND RELATED INDUSTRIES

There is no reliable market analysis and easily available data are sketchy and contradictory. A qualitative market survey among steel manufacturers, importers and distributors was carried out in order to supplement information available in newspapers, journals and other publications. Hence, the results presented in this section have to be read and interpreted with caution, since the data are by no means comprehensive.

Demand for domestically produced steel (excluding imports) has increased from some 450,000 tons in 1993 to an estimated 884,000 tons in 1996. Growth in demand has been 19.5% from 1993 to 1994, 45.3% from 1994 to 1995 and some 13.1% from 1995 to 1996. This would translate into a rough 25% compounded growth rate over the period. Unit sales prices (excluding joint venture operations) of the largest manufacturer Vietnam Steel Corporation (VSC) have been increasing from 368 US $ per ton in 1993 to some 400 US $ ton in 1996.

Total accumulated production over the period 1993 to 1996 (without joint venture production) has been recorded in the order of magnitude of some 2.65 million tons or 0.66 million tons annual average over the period. Based on the accumulated production and sales reported in the survey, Viet Nam's overall market demand structure and distribution would appear as :

- Northern part : about 50% of demand
- Central part : about 10% of demand, and
- Southern part : about 40% of demand.

This demand pattern excludes demand for imported steel as well as demand for steel manufactured in joint venture steel companies.

Reliable data on total steel imports are not available. However, it is widely reported that considerable volumes of steel are being imported into Viet Nam and that some 450,000 of steel products are currently stockpiled in the domestic market. Plants are operating at 30% to 50% capacity, since the production volume is outstripping domestic demand.

Steel manufacturers and distributors estimate total demand for steel products to be between 3.0 to 5.0 million tons by the year 2005. Given the many uncertainties in data availability, demand for steel products is estimated in Table 4.6 using a high, medium and low demand approach.

Table 4.6 Demand Ranges for Steel Products 1996 to 2010

(Unit : million tons)

Parameter	2000	2005	2010
High demand	2.44	7.45	22.74
Medium demand	1.75	3.52	7.08
Low demand	1.46	2.36	3.8

Source : JICA study team.

Underlying the above projections is a simple linear trend extrapolation at 25% for the high demand, 15% for the medium and 10% for the low demand scenario. These numbers will have to be adjusted when the outcome of the present feasibility study on the establishment of an integrated steel mill will be available by late 1997 or early 1998. The study is also to investigate technology choices and decide on a location out of 11 potential mill locations distributed in Quang Ninh (3 locations), Nge An (1 location), Ha Tinh (1 location), Q.N. Da Nang (3 locations) and B.R. Vung Tau (3 locations).

4.4 SHIP REPAIR AND BREAKING

From the year 2000 onwards there will be strong demand for ship breaking. The world's shipbuilding industries have a roughly 20 years production cycle, the average life span of ships being around 20 years. Hence, the ship breaking industry follows behind the shipbuilding industry in 20 to 25 years cycles. The historic shipbuilding and shipbreaking pattern over the period 1975 to 1994 is displayed in Table 4.7.

These historic data suggest that, on a global scale, for every ton new ship built, some 0.51 ton of old ship needs to be scrapped. Hence, the Government of Viet Nam intends to establish in Dung Quat ship scrapping facilities of up to 500,000 tons per year. The rough phasing for this project is summarized in Table 4.8.

Table 4.7 Output of Shipbuilding and Ship Breaking Industry

Year	Shipbuilding (1,000 tons)	Ship breaking (1,000 tons)
1975	34,203	5,077
1976	33,922	6,615
1977	27,532	6,093
1978	18,194	10,070
1979	14,289	6,665
1980	13,101	6,022
1981	16,932	7,252
1982	16,820	13,624
1983	15,911	16,759
1984	18,334	17,751
1985	18,157	22,229
1986	16,845	20,288
1987	13,111	12,009
1988	11,312	5,015
1989	14,503	2,477
1990	16,039	1,807
1991	16,859	2,366
1992	18,641	6,569
1993	20,530	10,756
1994	18,966	10,415

Source: Japan Shipbuilding Association

Table 4.8 Rough Phasing for Ship Scrapping Facility in the DQI

(Unit : thausend tons)

Parameter	2005	2010	Total
First Phase	200 ~ 300		300
Second Phase		(+) 200	500

Source : JICA study team.

4.5 POWER SUPPLY

4.5.1 Power Demand in Central Region

A demand forecast for electricity in the study area is provided by the power company PC3 and summarized in Table 4.9.

Table 4.9 Power Demand in the Study Area

(Unit: MW)

Province	1995		1998		2000	
	High	Low	High	Low	High	Low
Quang Tri	15	10	25	14	31	16
Thua-Tien Hue	55	30	66	35	86	45
Quang Nam Da Nang	100	80	134	88	185	120
Quang Ngai	25	17	46	18.5	60	25
Total Study Area	195	138	273	155.5	362	206

Source: PC3 Da Nang as of 1991

The forecast covers the period from 1995 up to 2000 with an electricity demand increase of 167 MW for the high case and 68 MW for the low case. Therefore, an average 100MW electricity demand will be expected in the study area.

4.5.2 Power Demand for Dung Quat Industrial Estate

The electricity demand that will originate from the DQI is summarized in Table 4.10.

Table 4.10 Power Demand for Industrial Estate

Name of Industry	Electricity Demand	Year
Petroleum Refinery No. 1	14 MW	2003
Petroleum Refinery No. 2	57 MW	2006
Petrochemical No. 1 & No. 2	60 MW	(2003 to 2006)
Ship Repair & Breaking	6 MW	2007
Steel Scrap & Recycling Mill	97 MW	2007
Iron & Steel Related Industry	17 MW	2008
Petrochemical Related Industry	23 MW	2008
Total	274 MW	

Source : JICA Study Team

At present, the total demand for electric power for industrial use and use in the study area is assumed at approximately 300MW. This capacity will be supplied by a new thermal power plant to be installed in the DQI.

CHAPTER 5

DEVELOPMENT PLAN OF THE DUNG QUAT INDUSTRIAL ESTATE

CHAPTER 5 DEVELOPMENT PLAN OF THE DUNG QUAT INDUSTRIAL ESTATE

5.1 SELECTION OF INDUSTRIES

The following items were considered for the selection and features of industrial estates to be a core of economic growth :

- Existing accumulation of industries
- Accumulation of urban agglomeration
- Availability of labor supply
- Existing and planned industrial estates in each province
- Relationship among the industrial estates
- Location and land condition of the industrial estate
- Condition of transportation
- Availability of utility supply, and
- Development of industrial estates by political inducement.

According to the detailed investigation of the industrial site, thirteen industrial estates were selected together with target industries. The Dung Quat Port Industrial Estate has been assigned the following function :.

- One of the core of the industrial belt between Da Nang (light industries) and Quang Ngai (heavy industries)
- A heavy industrial zone based on petroleum, ship repair & breaking and steel scrap and recycling mill
- Electric power supply base for the Central Region, and
- Deep sea port oriented industrial estate.

5.2 OUTLINE OF THE INDUSTRIES

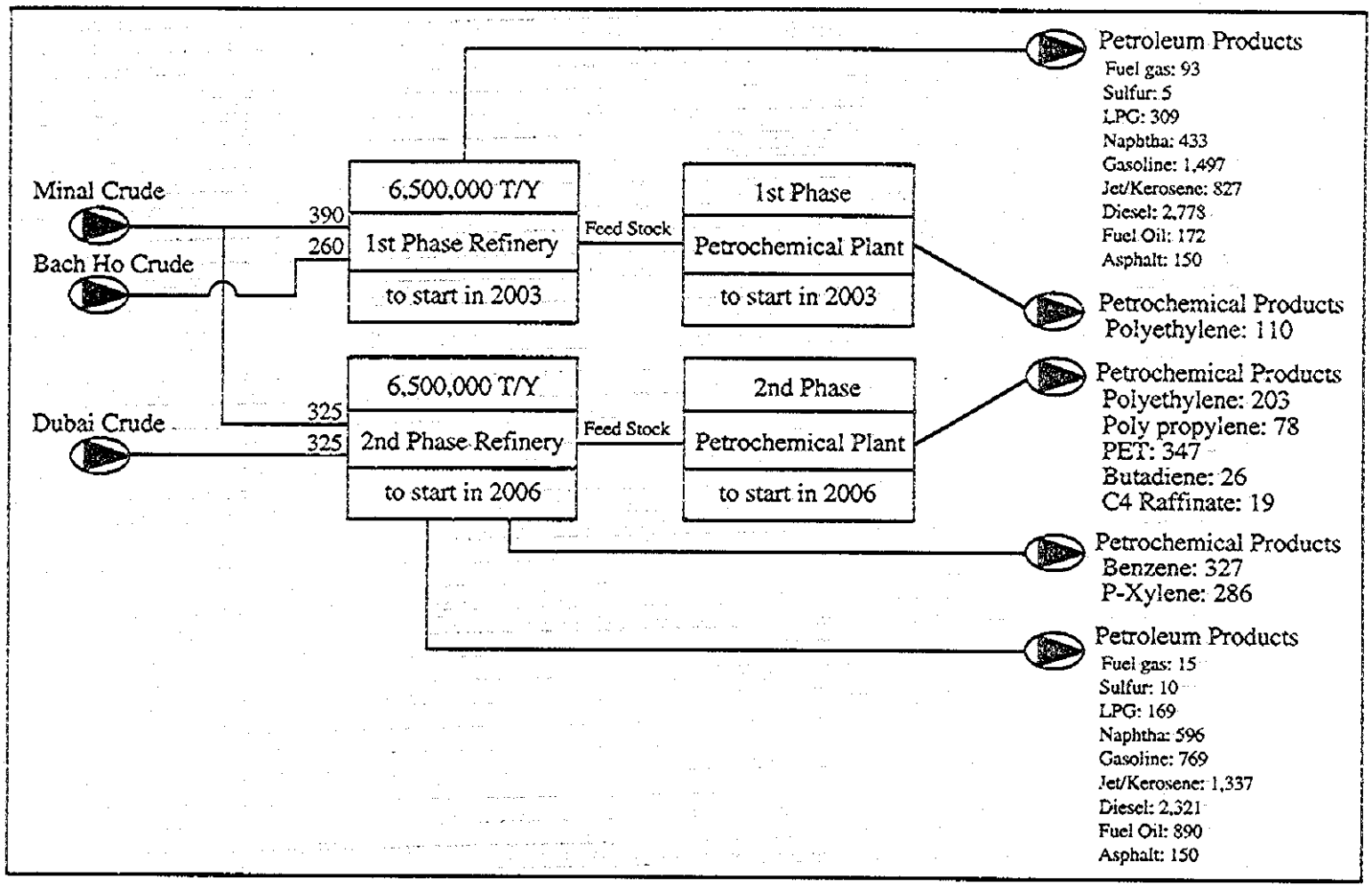
Based on the forecasted domestic demand for petroleum products and petrochemical products up to the year 2010, the refineries and petrochemical plants will be constructed and operated in two phases.

5.2.1 Oil Refinery

In order to supply the forecasted future domestic demand for petroleum and petrochemical products, a tentative phasing of plants to be constructed in Dung Quat has been made.

As summarized in Figure 5.1, the first phase oil refinery and petrochemical plant will start up in 2003, the second phase oil refinery and petrochemical plant will start up in 2006.

Figure 5.1 Outline of Refineries and Petrochemical Plants in the Dung Quat Industrial Estate



1) First Oil Refinery

The first phase oil refinery has two objectives. The first is to meet domestic demand for petroleum products from 2003 to 2006, especially for gasoline, diesel oil and petroleum products.

- The first phase oil refinery, with a capacity of 6,500,000 tons per year (domestic crude 60% and imported crude 40%) adopts a FCC (RFCC) unit to increase production of gasoline and diesel oil.
- It is estimated that even after the operation of the first phase oil refinery, some 5.08 million tons will be in short supply in the domestic market in 2003.

2) Second Oil Refinery

The purpose of the second oil refinery is to supply petroleum products and a polyethylene (PE) plant (the first phase petrochemical plant) with polypropylene, a byproduct from the refinery.

- The second phase oil refinery, with a capacity of 6,500,000 tons per year (domestic crude 50% and imported crude 50%) aims at maximum production of diesel oil and para-xylene. A hydrocracker is employed to respond to a largely increased domestic demand for diesel oil with stringent sulfur specifications.
- Combined production of petroleum products by the first and second phase oil refineries will not be sufficient to meet future domestic demand. Domestic supply for petroleum products will be short of domestic demand by 1.8 million tons and 6.9 million tons in 2005 and 2010, respectively.

3) Other Main Offsite Facilities

Main offsite facilities to be constructed are summarized as shown in Table 5.1. According to the plant operation, crude oil storage tanks are very important for continuous plant operations and the national oil storage policy. Hence, four crude oil storage tanks with a capacity of 120,000 liter each are required next to the oil refineries.

Table 5.1 Crude Un-Loading and Product Loading

Item	First Phase Refinery	Second Phase Refinery	Petrochemical Plants
Crude Unload, SBM 80,000 & 250,000 DWT	1	1	-
Petroleum &18,000 - 25,000 DWT	1	1	-
Petrochemical 3,000 - 18,000 DWT	2 (*)	-	-
Loading Berth 3,000 - 5,000 DWT	-	-	1
1,000 - 3,000 DWT	2 (*)	-	1

Note: (*) These berths are also used for the second phase refinery.
Source: JICA Study Team

4) Utility Requirement

The following utilities are required for the operations of the two oil refineries as identified in Table 5.2.

Table 5.2 Utilities Requirement for First and Second Oil Refineries

	First Phase Refinery	Second Phase Refinery	First &Second Petrochemical
Electricity	14,000 kW	57,000 kW	60,000 kW
Steam	250 T/H	490 T/H	600 T/H (L.P.)
Treated Water	710 T/H	1,200 T/H	1,700 T/H
Cooling Water	20,000 T/H	34,000 T/H	58,000 T/H
Fuel	320 MM Kcal/H	750 MM Kcal/H	650 Mm Kcal/H

Source: JICA Study Team

5.2.2 Petrochemical Phase 1 and 2

- A polypropylene (PP) plant is planned as the first phase petrochemical plant, using propylene produced in the first phase oil refinery as its feed stock.
- The second phase petrochemical plant includes an ethylene plant of 210,000 tons per year capacity, polyethylene plants, PP plant, a para-xylene plant, a terephthalic acid plant and a PET plant.

5.2.3 Ship Repair and Ship Breaking

The shipbuilding industry in Viet Nam is viewed as a key industry capable of creating output and high technology competitive with international norms.

Corresponding to the increasing demand and requirement in terms of conservation of the marine environment and navigational safety in sea transport, the renovation and reinforcement of hull-structures especially for tankers in shipbuilding is essential. Therefore, the ship breaking, steel scrap and recycling industry has an attractive business opportunity. The main activities of these industries are as follows :

- Repairing of various types of vessels, mainly tankers up to 250,000 DWT
- Demolition and breaking of vessels, mainly tankers up to 250,000 DWT
- Repairing and fabricating of facilities and equipment for off-shore oil rigs and other steel construction, and
- Steel production from scrap, recycling to be used for shipbuilding.

Throughput in this ship yard is estimated at 800,000 tons per year by year 2005 and 2.5 million tons by year 2010.

5.2.4 Electric Arc Furnace and Rolling Mills

The location features for a blast furnace (BF) are raw material oriented and/or scale economy oriented, be near the market and have access to deep sea port facilities. In the Central Region, there is no iron ore mining and only a limited market. However, there is a possibility to establish of deep sea port for up to 80,000 DWT in DQI. In relation with the ship breaking industry, it is recommendable to set up an electric arc furnace and recycling mill for iron and steel. Normally, the electric furnace industry belongs to the market oriented industries, so that iron sheet should be exported and iron rod for construction should be locally used for the construction market in the Central Region.

5.2.5 Electric Thermal Power Station

Taking into consideration the price and stable supply, the adequate fuel to be selected for the new power plant is to be heavy oil supplied immediately from the oil refineries of DQI.

The first 150 MW unit should be constructed by 2002 to meet the power demand of the DQI and supply surplus electricity to the national grid. So that the 220 KV transmission line should be constructed up to 2002. The second 150 MW unit should be constructed by 2006 to meet the electricity demand of the petrochemical plant No.2, the iron & steel mill project and so on.

1) Basic Concept for Design

(1) Basic concept for the project of the power plant

Figure 5.2 shows the system diagram of a general oil fired power plant. An oil fired power plant consists of a boiler, turbine, generator and associated facilities. Oil fuel has many of the desirable features including ease of handling. The environmental characteristics provided by

the oil fired power plants are also very good. Effectiveness, availability and reliability, easy operation and maintenance and safety are considered as important design factors in the project plant of the Dung Quat thermal power station.

(2) Basic concept of environmental protection measures

The SOx content is determined by the sulfur content of the oil. Since the sulfur content of the oil is approximately 2%, the SOx at the boiler outlet is about 1,000 ppm. As for nitrogenely low at 70mg at the boiler, the content in the oil is so low at approximately 0.2% - 0.3% that NOx at the boiler outlet is 300 to 350ppm. Since the ash content of the oil is as low as 0.1%, the dust emission is extra outlet.

The ground level concentration of SOx and NOx has been estimated as an example, using a Bosanque-Sutton's equation. The results satisfy Vietnamese environmental criteria, which are decided by the Ministry of Science, Technology and Environment as provisional environmental standards. Accordingly, de-SOx and de-NOx equipment has not been included into the new power station in DQI.

As for water pollution control, effluent, which will be disposed to outside of the power station, will be treated in the waste water treatment equipment of the power plant and discharged to the common sewage treatment plant in the DQI. As for thermal pollution control, the measure taken is to reduce the temperature rise of cooling water across the condenser. Currently, the normal temperature rise is selected to be below 7 °C to 8 °C. Cooling water is in some cases taken from deep in the sea through suction pipes laid down on the sea bed, resulting in a reduced temperature difference between the sea water and the cooling water discharged.

As for noise and vibration, sound-insulating devices and a silencer should be adopted to the places where it is needed, based upon the calculation results of the noise level prediction.

2) Outline of Generating Facilities and Construction Schedule

(1) Basic factor of design

1.	Installed Capacity	300MW (2 units of 150MW each)
2.	Annual Utilization Factor	80%
3.	Thermal Efficiency	37.2% (annual average)
4.	Station Service Factor	4%
5.	Fuel (Oil)	10,100 Kcal/kg
6.	Annual Oil Consumption	480 x 103 ton (2 x 240,000 ton/unit)
7.	Site area	Total 15 ha
8.	Fresh water	800 m^3/ day (2 x 400 m^3/unit),and
9.	Condenser cooling sea water	20 m^3/sec (2 x 10 m^3/unit).

(2) Brief specifications

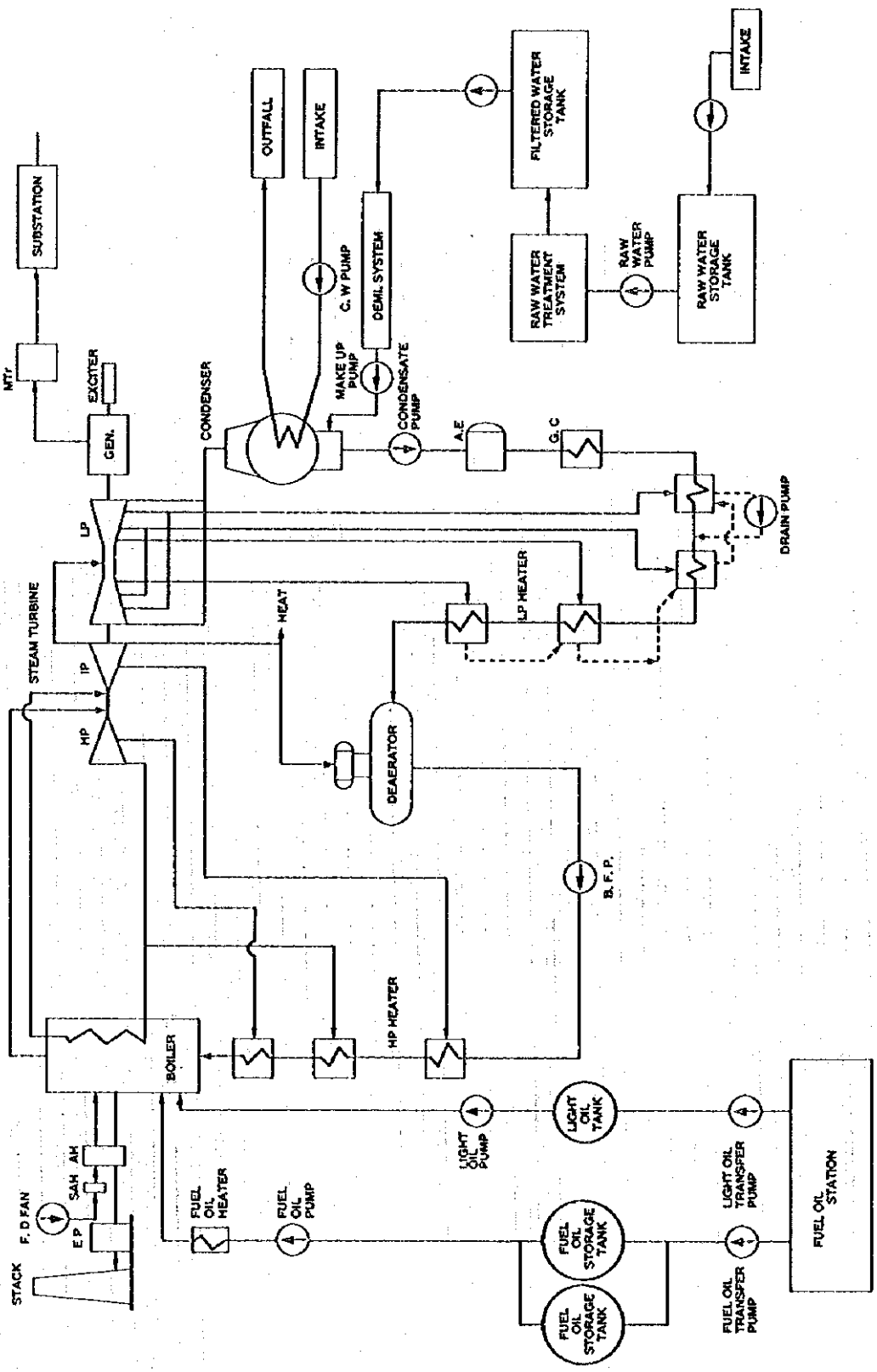
This power station has two (2) units and the output per unit is 150MW, consisting of boiler, steam turbine, generator and associated facilities.

a) Steam Generating Facilities

(a) Boiler

- Type: outdoor, single drum, oil fired boiler
- Max. evaporation : Approx. 500 t/h

Figure 5.2 General Oil Fired Plant System Diagram



(b) Fuel system:

Heavy oil is used as fuel and continuously transported mainly from the oil refineries adjacent to the power station and stored in tanks. The fuel is supplied from the oil tanks to the boiler by oil pumps.

b) Steam turbine facilities

(a) Steam turbine

- Type: Indoor, tandem compound, re-heat, regenerative, condensing steam turbine.
- Rated output: 150,000 kW
- Speed: 3,000 rpm

(b) Circulating water system

Turbine exhaust steam is condensed by a surface type condenser. The cooling system of the condenser is a circulating water system of once throughput type.

(c) Feed water heating system

The feed water system is to supply clean, heated de-aerated feed water to the boiler. The system will consist of low pressure heaters, one (1) de-aerator and high pressure heaters.

(d) Heat supply system

Heat demand for the oil refinery and the petrochemical plant may be supplied from the feed water heating system and the turbine steam extraction line.

c) Generator and auxiliary circuits

(a) Generator

- Type: Indoor, horizontal shaft, 3 phase, hydrogen-cooled generator
- Generator output: 150,000 kW
- Power factor: 0.9 (logging)
- Voltage: 18,000 V - 22,000 V
- Excitation method: Static excitation system
- Cooling method: Hydrogen cooled with gas cooler installed in the generator stator housing.

(b) Switchyard and auxiliary circuits with electrical equipment:

The power system of switchyard and auxiliary circuits with transformers, distribution board, direct current (DC) power system, uniterruptible power supply (UPS) system and D/G system shall be equipped with the power plant.

d) Other major facilities

The following facilities will be provided for the power plant:

- Make up water system,
- Waste water treatment system,
- Water intake and discharge system from the sea,

- Potable water system,
- Buildings and stack,
- Instrument and control system,
- Compressed air system (instrument and service air),
- Fire fighting system,
- Lighting system, and
- Other appurtenances.

5.3 INFRASTRUCTURE

5.3.1 Basis of the Dung Quat Industrial Estate Planning

1) Consideration of Layout

The Ministry of Construction designed the Dung Quat Industrial Zone with a total of 15,000 hectare, in which 2,000 hectare are assigned for the oil refinery site. Taking into account the conditions of the Dung Quat area, we choose the northeast side with a total of 1,800 hectares (land area; 1,262 hectares, sea surface; 538 hectares) for the oil refinery, petrochemical industries, ship repair and ship building, steel scrap & recycling mill and iron & related industries.

However, the Management Board of the Dung Quat Industrial Zone requests that this master plan should be followed for any kind of development plan. Hence, the concept structure for the DQI was designed under the existing master plan with only minor arrangements.

2) Layout Map

There are three components of this industrial estate, namely petrochemical industries, iron and steel related industries and the estate's administration function. The east sides of DQI are the location for the petrochemical industries with single buoy mooring (SBM) and 25 meter water depth to accommodate up to 250,000 DWT oil tanker. The west sides of the DQI of Dung Quat Bay are reserved for iron & steel related industries with the calm and wide area for ship repair, ship breaking and the steel scrap & recycling mill. The two major areas should be divided by a trunk road with a 100 meter wide right of way (ROW) and a 69 meter ROW road. The administration buildings' area will be located in the southern part of the DQI, except for the port related facilities. The port related facilities must be located near the port.

5.3.2 Deep Sea Port

1) Type and Scale of the Port

Dung Quat Port (DQP) will consist of three inter-related components:

- Refinery and petrochemical products wharf
- Shipyard and steel recycling mill, and
- Public wharf.

(1) Refinery and petrochemical products wharf

To further illustrate the scale of the planned port, the required number of berths has been estimated based on findings detailed in the demand forecast and industrial estate as well as capacities specified in Table 5.3.

Table 5.3 Scale of Refinery & Petrochemical Wharf

ITEM	Stage I: 2003		Stage II: 2006		Remarks
	Throughput (million tons)	No. & scale of Berth (DWT)	Throughput (million tons)	No. & scale of Berth (DWT)	
1. Crude Oil	6.5	1 - SBM 80,000-250,000	6.5	1 - SBM 80,000-250,000	Off-shore single buoy mooring (SBM)
2. Refinery & Petrochemical Products	6.2	1 - 30,000 2 - 20,000 3 - 5,000	5.7	1 - 30,000 2 - 5,000	Including oil of 200,000 tons

Source: JICA Study Team

(2) Shipyard and steel recycling mill

The shipbuilding industry in Viet Nam is viewed as a key industry capable of creating output and high technology competitive with international norms.

Corresponding to the increasing demand and requirement in terms of conservation of marine environment and navigational safety in sea-transport, the renovation and reinforcement of hull-structure (especially tankers) in shipbuilding is essential. Therefore, the ship breaking, steel scrap and recycling industry has attractive business opportunities.

The outlay of the shipyard and steel recycling mill in DQP are as follows:

- Repairing of various type of vessels, mainly tankers up to 250,000 DWT
- Ship breaking, mainly tankers up to 250,000 DWT
- Repairing and fabricating of facilities and equipment for off-shore oil rigs and other steel construction, and
- Steel production from scrap, recycling and iron ore to be used for shipbuilding.

Throughput in this ship yard is estimated at 800,000 tons per year by the year 2005 and 2.5 million tons by year 2010 (Table 5.4 refers).

Table 5.4 Shipyard Throughput

(Unit: mil. ton)

	Phase 1	Phase 2
Throughput	2005	2010
1. Ship Breaking	0.3	0.5
2.) Steel production		
a) From scrap & recycling	0.5	1.0
b) From iron ore		1.0
Total	0.8	2.5

Source : JICA study team.

(3) Public Wharf

Major commodities would include construction materials and equipment, refinery and shipyard related products as well as general cargo. The principal Phase 1 general cargo is forecasted to be of the break-bulk variety. Five wharves are required to meet the demand of 2.4 million tons forecasted for the year 2005.

Increasing container demand suggests that two general cargo wharves of 30,000 DWT can be utilized as container wharves by the year 2010 with the installation of container cranes (Table 5.5 refers).

Table 5.5 Scale of Public Wharf

(Unit: mil. ton)

Scale of Public Wharf	Phase 1 2005	Phase 2 2010
1. Demand	2.4	3.3
2. Number & Scale of Berth		
Vessel, DWT		
General Cargo	2 - 30,000	Convert to cntainer
General Cargo	2 - 15,000	Wharves
General Cargo	2- 5,000	
Container		
		2 - 20,000

Source : JICA study team.

2) Port Development Plan

Based on the requirements of the first phase oil refinery, a wharf for construction material and equipment, including a breakwater of 300 meter and a causeway of 1.2km, must be provided by the year 2000. In addition, the first phase oil refinery wharf, including a breakwater of 900 meter and an embankment of some 500 meter is scheduled for construction by the year 2002 as part of the urgent phase.

Wharves for the second phase oil refinery products and phase 1 public wharves are scheduled to be constructed by the year 2005. The extension of a west side groin and breakwater is subject to the amount of sand-drift and calmness of the water basin. However, an extension of the breakwater is likely to be needed by the year 2010.

Responding to the increase of container activity after 2005, container cranes are provided to assist in converting two general cargo wharves to container wharves as summarized in Table 5.5.

a) Regional Domestic Demand for Petroleum Products

The following basis was set according to Petrovietnam's information :

- Northern Part in Viet Nam: 35%
- Central Part in Viet Nam: 15%, and
- Southern Part in Viet Nam: 50%

b) Petroleum Product Shipping Method

The following shipping method for petroleum products is assumed, based on Petrovietnam's information :

- To the Northern part of Viet Nam : by ship
- To the Central part of Viet Nam: by tank truck, and
- To the Southern part of Viet Nam: by ship.

c) Size of Ships for Marine Facility Sizing

The following size of ships is assumed according to Petrovietnam's information :

- Bach Ho crude Oil: 80,000 DWT
- Dubai Crude Oil: 250,000 DWT
- LPG: 1,000 to 3,000 DWT, and
- Other Petroleum Products: 3,000 to 25,000 DWT.

5.3.3 Water Supply

1) General

- A series of water supply and sanitation facilities are proposed in order to preserve the natural and human environment in the DQI and to support the industrial development. Besides the industrial estate, Van Tuong New City, where employees for the firms in the DQI will mainly live, and the adjacent area encompassing the DQI shall be equipped with facilities of water supply and sanitation. Thus, the service area of the water supply facilities and the sanitation facilities consists of not only DQI, but also Van Tuong New City and certain areas in the adjacent area, which will reach a higher-population density in 2010.

At present, this area is not endowed with safe water and depends mainly on unprotected shallow wells. Also, there are no reliable sanitation facilities in the fields of sewage disposal, storm water drainage and solid waste disposal. In the course of industrial development, the following development schemes on water supply and sanitation are proposed:

- Water supply facilities: The service area will be provided with safe water for industrial, potable, living and other purposes by a centralized water supply system with a central water production station purifying surface water from rivers. Water for fire fighting will be supplied by this system, too.
- Sewage disposal facilities: DQI and Van Tuong New City will be covered by sewage disposal facilities attached with a sewage treatment plant in the form of centralized treatment. Waste water will be discharged to the East Sea, after having been purified under specified limitations.
- Storm water drainage: The service area will be equipped with open channels and/or pipes to drain out storm water and to prevent the area from submersion. Rain water retention ponds will also be constructed, if required.
- Solid waste disposal facilities: The service area will be served by periodical garbage collection by solid waste disposal facilities, and collected waste be disposed in a sanitary landfill site.

Table 5.6 Phased Development Plan

Construction Work	Description	Urgent Phase		Phase 1	Phase 2	Size of Wharf		
		2000	2002	2005	2010	Length	Width	Depth
1. WHARF FOR FIRST STAGE REFINERY PRODUCTS								
1) Wharf for Construction Material & Equipment		○						
a) East Breakwater	300m							
b) Wharf	1 - 5,000 DWT					150 x	30 x	7.5 m
c) Causeway	1,200 m							
d) Dredging and Reclamation	500,000 m3							
2) Wharf for First Stage Refinery Product			○					
a) East Breakwater	900M							
b) Wharf	1 - 30,000 DWT					240 x	25 x	12 m
	2 - 20,000 DWT					210 x	40 x	11 m
	2 - 5,000 DWT					150 x	40 x	7.5 m
c) Embankment	520 m							
d) Dredging and Reclamation	1,3000,000 m3							
e) Building & Utilities	One set							
2. WHARF FOR SECOND STAGE REFINERY PRODUCTS AND PHASE 1 PUBLIC WHARF AND SHIPYARD				○				
a) Groin	1,000 m							
b) Second Phase Refinery Wharf	1 - 30,000 DWT					240 x	15 x	12 m
	2 - 5,000 DWT							
c) Phase 1 Public Wharf (General Cargo)	2 - 30,000 DWT					520 x	200 x	12 m
	2 - 15,000 DWT					380 x	100 x	10 m
	1 - 5,000 DWT					140 x	100 x	7.5 m
	-Transit shed							
	-Open storage yard							
	-Equipment and Utilities: One set							
d) Phase 1 Shipyard	-Embankment: 1,600 m							
	-Wharf					400 x	30 x	9 m
	-Multi-purpose Pier: 2 - 10,000/5,000 DWT					300 x	30 x	9 m
e) Dredging and Reclamation	20,000,000 m3							
3. WHARF FOR PHASE 2 PUBLIC WHARF					○			
a) Container Crane	4 sets for 2 - 20,000 DWT Container Wharf							
b) West Breakwater								
c) Phase 2 Shipyard								

Source: JICA Study Team

2) Design Policy

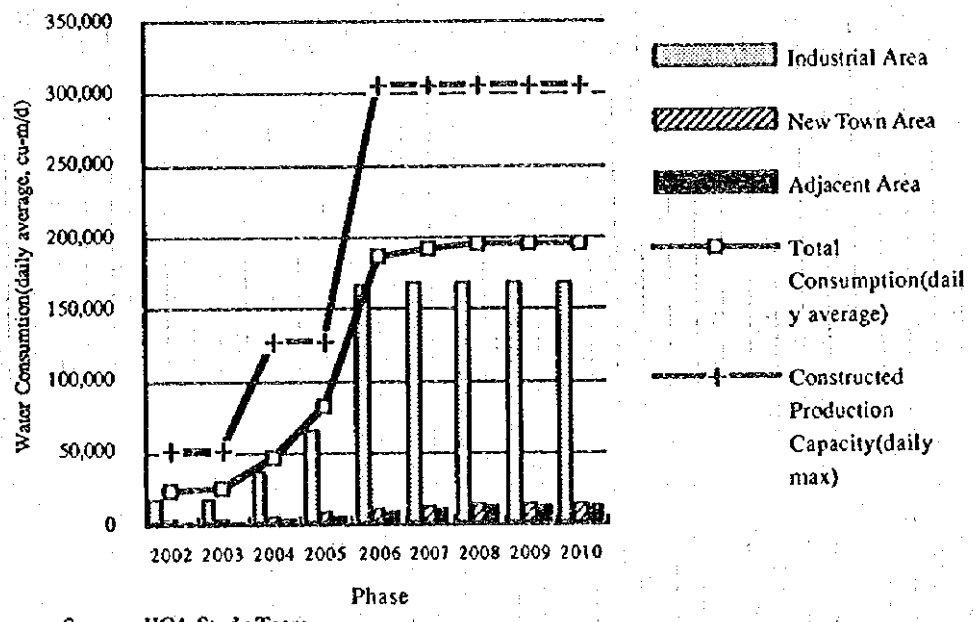
(1) Water supply facilities

The major portion of the water to be produced by the water supply facility will be consumed as makeup water for product manufacturing and processing by industries in DQI. The larger volume water for indirect cooling use is taken from the river and/or sea nearby. In this study, the population in the target year of 2010 to be served by water supply is based on: (1) 64,000 people in new city area including employee's families and related people, and (2) 56,000 equivalent to 88 % service ratio in the adjacent area (some 11,000 ha) closely encompassing DQI in the Binh Son District.

Based on the estimation of industrial use*1, living use*2 and other purposes, total water consumption is projected to reach a total of some 195,000 m³ per day in 2010 as shown in Figure 5.3, with the share of 168,000 m³ per day for DQI, 14,400 m³ per day for the new city area and 12,600 m³ per day for the adjacent area.

The water supply facilities will be build up in a step-wise expansion mode with three (3) stages in response to the planned water consumption at each phase. The water production capacity to be constructed on the daily maximum basis will increase like: (1) 51,000 m³ per day in 2002, (2) 127,500 m³ per day in 2004, and (3) 306,000 m³ per day in 2006 as referred to in Table 5.7.

Figure 5.3 Water Demand Projection



Source : JICA Study Team

*1 : The water consumption is estimated for the industries investing into the industrial area by applying the Japanese Standards of unit water consumption.

*2 : The unit consumption of 150 lit/cap on living water of daily average base in 2010 is applied in this study accompanied by some 50 % of commercial and institutional use.

Table 5.7 Design Basis of Water Supply Facilities

Design Parameters		Desin Basis		
		up to 2002	up to 2004	up to 2006
Production Plant Capacity(daily max)	(cu-m/d)	51,000	127,500	306,000
Raw Water Intake	(cu-m/d)	45,000	145,000	350,000
Hourly Max. Distribution Flow	(cu-m/h)	1,971	6,347	11,049

Notes : 1.4, 15%, 10%, and 1.4 are applied to daily max. coefficient, leakage loss, production loss and hourly max. coefficient, respectively.
Source : JICA Study Team

Apart from the water required from the start up of operations in 2003, the water for workers' living, and construction works' use will be necessary during site construction work. This water should be provided by proper water supply equipment to be installed temporarily at the site or wells.

The proposed water supply facilities will use river water as raw water. There are three (3) raw water sources available for this project, that is:

- B7 irrigation canal: First Step : At present, the B7 irrigation canal is diverting water for agriculture use in the Dung Quat area of Binh Son District from the Thach Nham Weir in the Tra Khuc River. Raw water will be taken from the inlet gate of the B7 canal to be constructed in this project.
- Pho Tinh Reservoir: Second Step : This reservoir is to be newly built. It will be located 500 m to the upstream from the Rail Way in the Tra Bong River. Raw water will be lead to the water production station through a newly constructed conveyance pipe of 7.5 km in length.
- Nuoc Truong Reservoir: Third Step : The Nuoc Truong Reservoir is planned in future at the upstream of the Tra Khuc River for multi-purpose use. After this reservoir is completed, some portion of water will be discharged from the Nuoc Truong Reservoir to the Thach Nham Reservoir located at the downstream of the Tra Khuc River. The newly constructed conveyance pipe line of 42 km in length along with the existing B7 canal will divert raw water to the water production station.

These three (3) raw water sources will be allocated in the following three (3) steps: (1) 45,000 m^3 per day from the B7 irrigation canal up to 2002, (2) 100,000 m^3 per day from Pho Tinh Reservoir up to 2004, attaining a total raw water intake of 145,000 m^3 per day, and (3) 205,000 m^3 per day from Nuoc Truong Reservoir via Thack Nam weir up to 2006, attaining a total raw water supply of 350,000 m^3 per day.

In terms of water quality, as shown in Table 5.8, the examination results of water sampled from the Tra Khuc River indicate that water has a relatively low level of mineral and metal concentration and it is therefore quite suitable as raw water for industrial use as well as drinking use. At the water production station, raw water will be purified to meet the drinking water standard in Viet Nam.

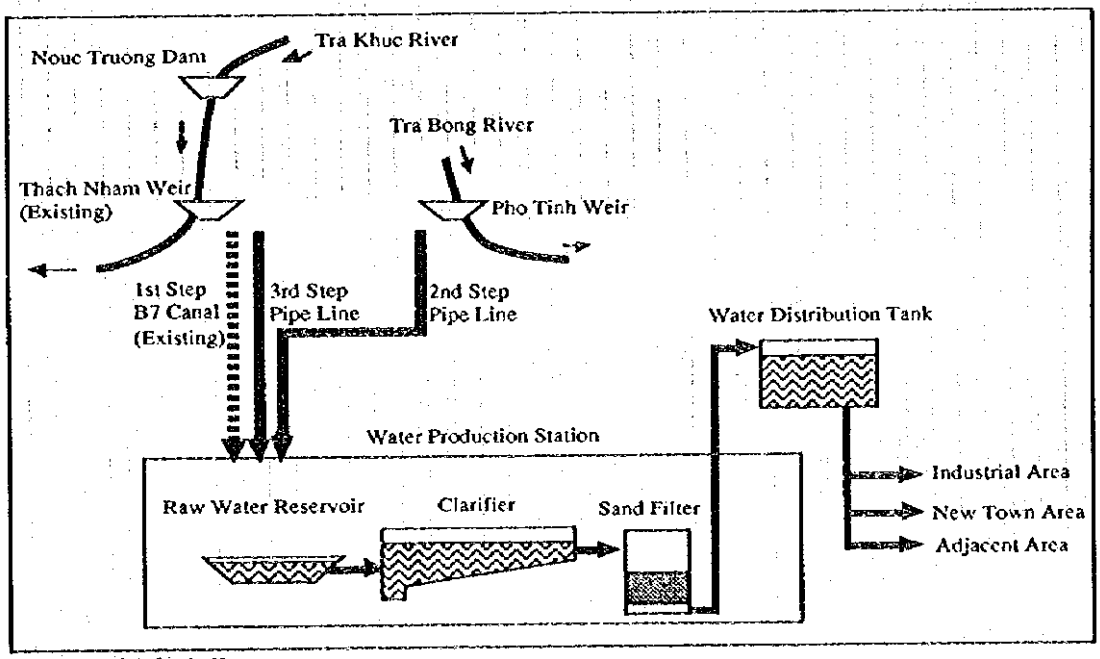
Table 5.8 Water Quality of the Tra Khuc River

Items	Unit	Water Qualities	
		Raw Water	Supplied Water Standard
pH		6.6	6.5-8.5
Temperature	degree	14	
Transparence	cm		<30
Color(Pt-Co scale)	degree		<10
Conductivity	micromhos/cm	39	
Suspended solids(SS)	mg/l		<5
Turbidity as Silica	mg/l	25	
Total dissolved solids(TDS)	mg/l	58	<500
Hardness(as calcium carbonate)	mg/l	14	<500
Calcium	mg/l	4.4	
Magnesium	mg/l	0.7	
Bicarbonate	mg/l	24	
Sodium chloride(NaCl)	mg/l		<250
Total organic carbon(TOC)	mg/l		0.5-2.0
Organic matters	mg/l	1.5	
Ammonia(NH3)	mg/l		not detected
Nitrite	mg/l		not detected
Nitrate	mg/l		<10
Aluminium(Al)	mg/l		<0.2
Copper(Cu)	mg/l		<1
Iron(Fe)	mg/l	0.05	<0.3
Manganese(Mn)	mg/l		<0.1
Sodium(Na)	mg/l		<200
Sulfate(SO4-)	mg/l		<400
Zinc(Zn)	mg/l		<5

Notes :
(1) The raw water qualities are based on the measurment result on the water sampled in the Tra Khuc River.
(2) The supplied water standards are according to the drinking water standards in Viet Nam.

Water purified in the central water production station by sedimentation with coagulation and rapid sand filtration as shown in Figure 5.4 will be transferred to the distribution tanks to be constructed on the hills nearby and then be distributed to each use point in the DQI, new city area and adjacent area with the residual pressure of some 1.5 kg per cm^2.

Figure 5.4 Conceptual Flow Diagram of the Proposed Water Supply Facilities



Source : JICA Study Team

(2) Sewage disposal facilities

The DQI and new city area are planned to be independently covered by their respective centralized sewage disposal facilities, since they are separately located in a distance of 10km or so. In terms of sewage collection and transportation, the proposed sewage disposal system will apply the "separated type", giving more priority to the qualities of discharged sewage to the water course*1. The adjacent area, which may accommodate some community sewage disposal facilities and/or individual treatment equipment in the future, is beyond the subject of this study.

Based on the consumed water by each user in the service area, sewage discharge is projected to be 260,000 m³ per day in the industrial area and 22,000 m³ per day including infiltrated ground water in 2010 on the daily maximum base as shown in Table 5.9.

Table 5.9 Design Basis of Sewage Disposal Facilities

Design Parameters		Industrial Area			New Town Area	
		up to 2002	up to 2004	up to 2006	up to 2002	up to 2006
Daily Max Discharge	(cu-m/d)	30,000	100,000	260,000	11,000	22,000
Hourly Max Discharge	(cu-m/h)	14,000	5,600	15,000	630	1,300

Notes : 15%, 1.3, and 1.4 are applied to ground water infiltration ration, daily max. coefficient, hourly max coefficient.
Source : JICA Study Team

Pollutant concentration of inflow sewage is estimated to be BOD 240 mg/l, SS 200 mg/l for the industrial area and BOD 230 mg/l, SS 200 mg/l for the new town area, according to the unit pollutant discharge standards of Japan.

In connection with the water qualities of industrial waste, concentration level and their compositions are in general highly diversified. Consequently, certain limitations as referred in Table 5.10 are applied to sewage pipes in order to prevent them from over loading and adverse constraints to the central treatment plant. Thus, the factories in the DQI will be obliged to establish some proper pre-treatment system in their lots, if either their waste water contains some toxic/hazardous constituents or the pollutant concentration of their waste water are beyond specified limitation.

Table 5.10 Effluent Standards

Items	(Unit)	Limitation	
		Influent to Sewerage	Treated Sewage to the Sea
1. General Pollutants or Indicators			
pH	(-)	6-9	6.5-8.5
Temperature	(℃)	40	40
Biological Oxygen Demand(BOD)	(mg/l)	600	30
Chemical Oxygen Demand(COD by Cr)	(mg/l)	1,000	100
Suspended Solids(SS)	(mg/l)	600	50
Mineral Oil	(mg/l)	5	1
Total Nitrogen(T-N)	(mg/l)	250	-
Total Phosphorous(T-P)	(mg/l)	30	-
Total Chromium(T-Cr)	(mg/l)	1	1
Copper(Cu)	(mg/l)	1	1
Zinc(Zn)	(mg/l)	2	2
Phenol	(mg/l)	5	0
Iron(Fe)	(mg/l)	5	5
Manganese(Mn)	(mg/l)	1	1
Coliform	(MPN/100ml)	-	10,000
2. Toxic Pollutants			
Cadmium(Cd)	(mg/l)	0.02	0.02
Cyanide(CN)	(mg/l)	0.1	0.1
Organic Phosphorus(Org-P)	(mg/l)	0.5	0.5
Lead(Pb)	(mg/l)	0.5	0.5
Hexavalent Chromium(Cr+6)	(mg/l)	0.05	0.05
Arsenic(As)	(mg/l)	0.1	0.1
Total Mercury	(mg/l)	0.005	0.005

Source : JICA Study Team

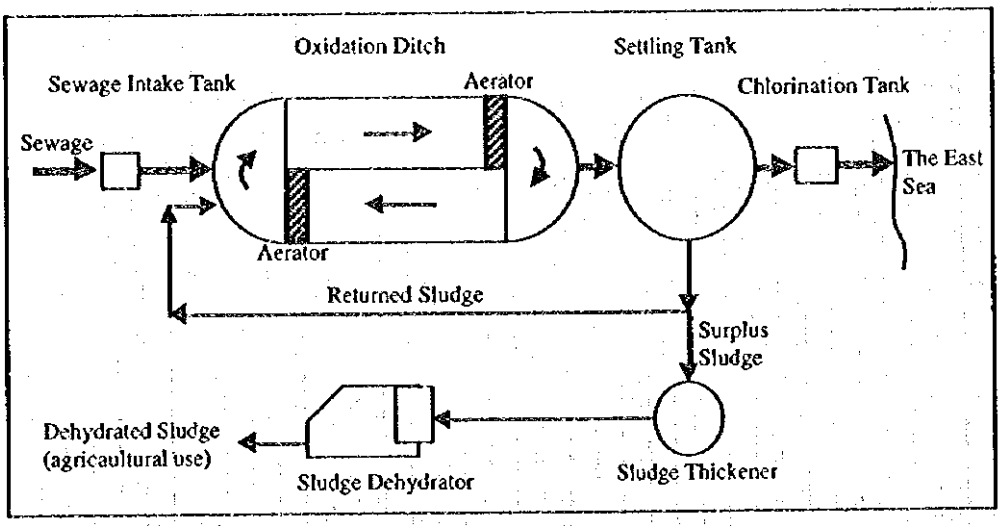
*1 : The "separated type" disposal facilities does not collects rain water. Unlike the separated type sewage disposal facilities, in the combined type facilities some portions of pollutant is inevitably discharged to the water courses at the beginning stage of rainfall. Thus, the separated type sewerage is recommended in this section.

Sewage purified by the treatment plant less than of BOD 30 mg/l and SS 50 mg/l, which meet the effluent standard in Viet Nam, will be discharged to the East Sea. The "Oxidation Ditch Process" as shown in Figure 5.5 employing the aerobic biological purification principle is recommended. The reasons are: (1) strong durability against low temperature in January to March in the region, (2) lower construction cost including land acquisition expense, (3) easier operation and maintenance.

(3) Storm water drainage

Open channels and/or pipes will be constructed in the DQI and the new city area to prevent submersion when it rains. Because hourly rainfall data in the service area are not available at the moment, the following empirical equation in five (5) years probability derived from the daily rainfall data collected in Quang Ngai Meteorological Observatory is recommended to be applied to the calculation of design rainfall.

Figure 5.5 Conceptual Flow Diagram of the Proposed Sewage Disposal Facilities



Source : JICA Study Team

In the area where the flow capacity of the water course to receive rain water is limited, some retention ponds should be constructed based on 10-years probability.

- Rainfall intensity to be applied:

$$I = R_{24}/24 \times (24/t)^{2/3} = 95 \times 1/t^{2/3}$$

where, R_{24} : Daily rainfall (mm/d)
I : Design rainfall intensity (mm/h)
t : Rainfall duration (min).

(4) Solid waste disposal facilities

Solid waste, which is discharged from the manufacturing process of factories should be individually disposed in a proper manner in line with the polluter pay principle (PPP), because their characteristics are extremely diversified depending on the line of manufacturing. General solid waste (garbage), which is discharged from offices and household and commercial activities/public services is collected and disposed by centralized solid waste disposal facilities. The solid waste discharge in the DQI, new city area and adjacent area is projected to reach some 110 ton per day in 2010 as referred in Table 5.11.

Table 5.11 Solid Waste Discharge Projection and Development Plan

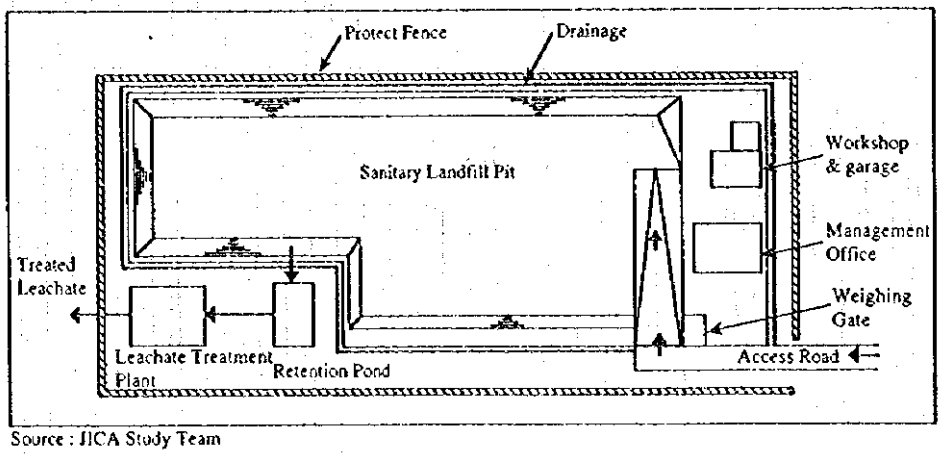
Items	Phase	
	2002 to 2005	2006 to 2010
Projected Discharge (ton/d)		
Industrial Area	2- 6	14
New Town Area	9 -26	34 - 51
Adjacent Area	8 - 22	22 - 45
Total Discharge	19 - 54	70 - 110
Planned Capacity (ton/d)	54	110

Note : The above waste discharges are computed using unit discharge rate: 2000g/cap.d for office, 600g/cap.d for resident and 30 % of resident garbage for commercial, other services.
Source : JICA Study Team

A set of waste packer vehicles for garbage collection service will be provided, and collected garbage will be transported and disposed to a landfill site as shown in Figure 5.6 in the manner of a sanitary landfill. To prevent adverse effects from the landfill site, the sanitary landfill will be executed by the method of : (1) provision of shield resin sheet to isolate the deposit layer from the ground soil, (2) application of soil cover to prevent ill odor and keep the landscape beauty, (3) attachment of leachate*1 treatment plant to prevent from outflow of polluted and toxic waste water.

The location of landfill site will be selected in light of such criteria as : (1) the surrounding area is dispersedly populated, (2) the location is easily accessible by vehicles from the service area, (3) there is no possibility to impede on the natural environment and landscapes, and (4) the site is not close to the waterway leading to the intake source for water supply.

Figure 5.6 Conceptual Layout of the Proposed Solid Waste Disposal Facilities



Source : JICA Study Team

*1 : The word "Leachate" stands for waste water generated from landfill site resulting from decomposition of solid waste and rainfall.

3) Outline of the Proposed Facilities

(1) Water Supply Facilities

The proposed water supply facility consists of raw water intake and conveyance system, water production system and water distribution system. Table 5.12 lists the main specifications for the proposed water supply facilities.

Table 5.12 Outline of the Proposed Water Supply Facilities

Work items	Quantities		Description
1. Raw water intake and conveyance system			
1.1 From Thach Nam Reservoir			(existing irrigation water intake weir, Tra Khuc River)
Max intake capacity			45,000 cu-m/d
Conveyance canal	42	km	existing earthen canal(B7) representative 1.0mWidth x 1.6mHeight
Intake gate and inlet canal	0.5	km	1.0mWidth x 1.6mHeight
1.2 From Pho Tinh Reservoir			(Tra Bong River)
Max intake capacity			100,000 cu-m/d
Intake weir	1	lot	70mWidth, newly constructed
Intake pump	3	units	including 1 standby, 0.6cu-m/sec
Conveyance pipe	7.5	km	carbon steel pipe, 900mmDia
1.3 From Nuoc Truong Reservoir			(Tra Khuc River via existing Thach Nam weir)
Max intake capacity			205,000cu-m/d
Intake pump	5	units	including 1 standby, 0.60cu-m/sec
Conveyance pipe	42	km	carbon steel pipe, 1200mmDia
2. Water production system			
2.1 Raw water reservoir	1	lot	reinforced concrete, volume 450,000cu-m
2.2 Water purification facilities			
Purification plant	12	units	coagulation sedimentation + sand filtration type 25,500cu-m/d x 12units, total 306,000 cu-m/d
Component equipment			coagulation basin, clarifier, sand filter disinfection basin, engine generator
Site area			19.0 ha including the raw water reservoir
Appurtenances			operation room, laboratory, electrical room, workshop, storage room
3. Water distribution system			
3.1 Transfer pump	5	units	including 1 standby, 0.90cu-m/sec
3.2 Distribution tank	2	lots	total volume 80,000cu-m
3.3 Distribution pipes for Industrial Area			
Trunk pipes	23	km	cast iron pipe, 800 to 1,600mmDia
Fire hydrant	1	lot	cast iron
3.4 Distribution pipes for New Town Area			
Trunk pipes	9.0	km	cast iron pipe, 300 to 400mmDia
3.5 Distribution pipes for Adjacent Area			
Trunk pipes	20	km	cast iron pipe, 200 to 400mmDia
Main pipes	20	km	cast iron pipe, 150mmDia
Branch pipes	35	km	cast iron pipe, 100mmDia
Fire hydrant	1	lot	cast iron

Notes : The Quantities and the capacities in this table are at the final construction stage.
Source : JICA Study Team

(2) Sanitation Facilities

The sanitation facilities will be configured by a series of: (1) the sewage disposal facilities consisting of sewage collection system and sewage treatment system, (2) the storm water drainage consisting of ditches/pipes and retention ponds, if required, and (3) the solid waste disposal facilities consisting of waste haulage vehicles and landfill sites. Main specifications of the sanitation facilities are listed in Table 5.13.

Figure 5.7 shows the layout of the proposed water supply and sewage disposal facilities and Figure 5.8 shows the route plan of raw water conveyance pipes.

Table 5.13 Outline of the Proposed Sanitation Facilities

Work items	Quantities		Description
1. Sewage disposal facilities			
1.1 For Industrial area			
1.1.1 Sewage collection system			
Trunk pipes	18	km	concrete pipe, 1,000 to 1,650mmDia
Sewage relay pump	3	sets	centrifugal
1.1.2 Sewage treatment facilities			
Treatment plant	20	units	biological oxidation ditch type
			13,000cu-m/d x 20units, total 260,000cu-m/d
Component equipment			grit chamber, oxidation ditch, settling basin
			chlorination basin,
			treated sewage discharge mouth
			sludge thickener, sludge dehydrator
Site area			21.0 ha
Appurtenances			operation room, laboratory, electrical room,
			workshop, storage room,
			sludge dehydration room
1.2 For New Town area			
1.2.1 Sewage collection system			
Trunk pipes	10.0	km	concrete pipe, 400 to 600mmDia
Sewage relay pump	3	sets	centrifugal
1.2.2 Sewage treatment facilities			
Treatment plant	4	units	biological oxidation ditch type
Capacity			5,400cu-m/d x 4units, total 21,600cu-m/d
Component equipment			grit chamber, oxidation ditch, settling basin
			chlorination basin,
			treated sewage discharge mouth
			sludge thickener, sludge dehydrator
			treated sewage reuse plant
Site area			4.0 ha
Appurtenances			operation room, laboratory, electrical room,
			workshop, storage room,
			sludge dehydration room
2. Storm water drainage for Industrial Area, New Town Area and Adjacent Area			
Open channel	1	lot	concrete
Embedded pipe	1	lot	concrete
Retention pond	1	lot	brick or stone
3. Solid waste disposal facilities for Industrial Area, New Town Area and Adjacent Area			
3.1 Waste haulage vehicle			
Waste haulage vehicle(2ton)	6	units	
Waste haulage vehicle(4ton)	12	units	
Workshop	1	lot	
3.2 Landfill facilities			
Landfill site	8.0	ha	sanitary landfill type
Appurtenances			access road, weighing gate, bulldozer
			workshop, administration office
			leachate treatment plant

Notes : The Quantities and the capacities in this table are at the final construction stage.
Source : JICA Study Team

Figure 5.7 Layout of the Proposed Water Supply Facilities and Sewage Disposal Facilities

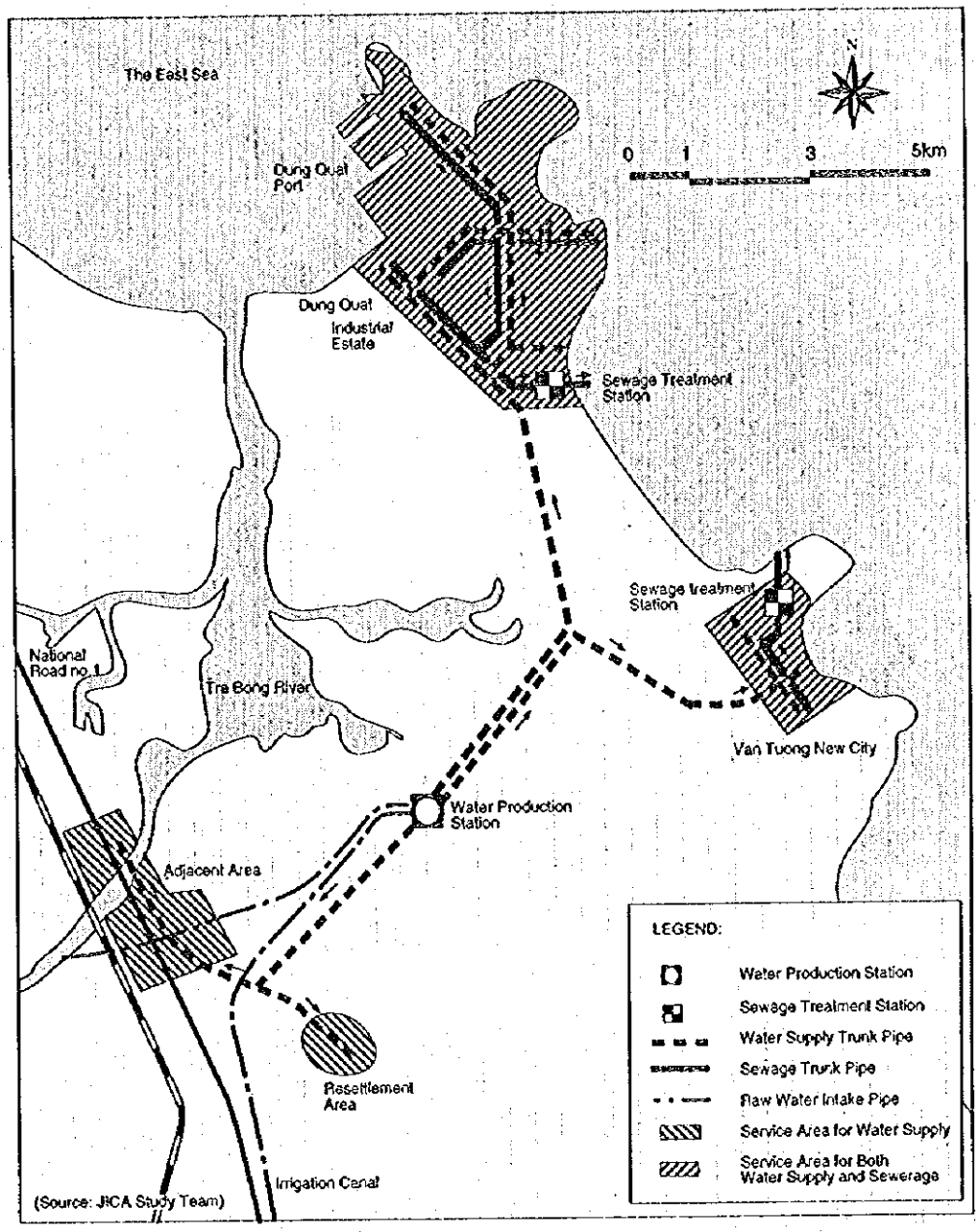
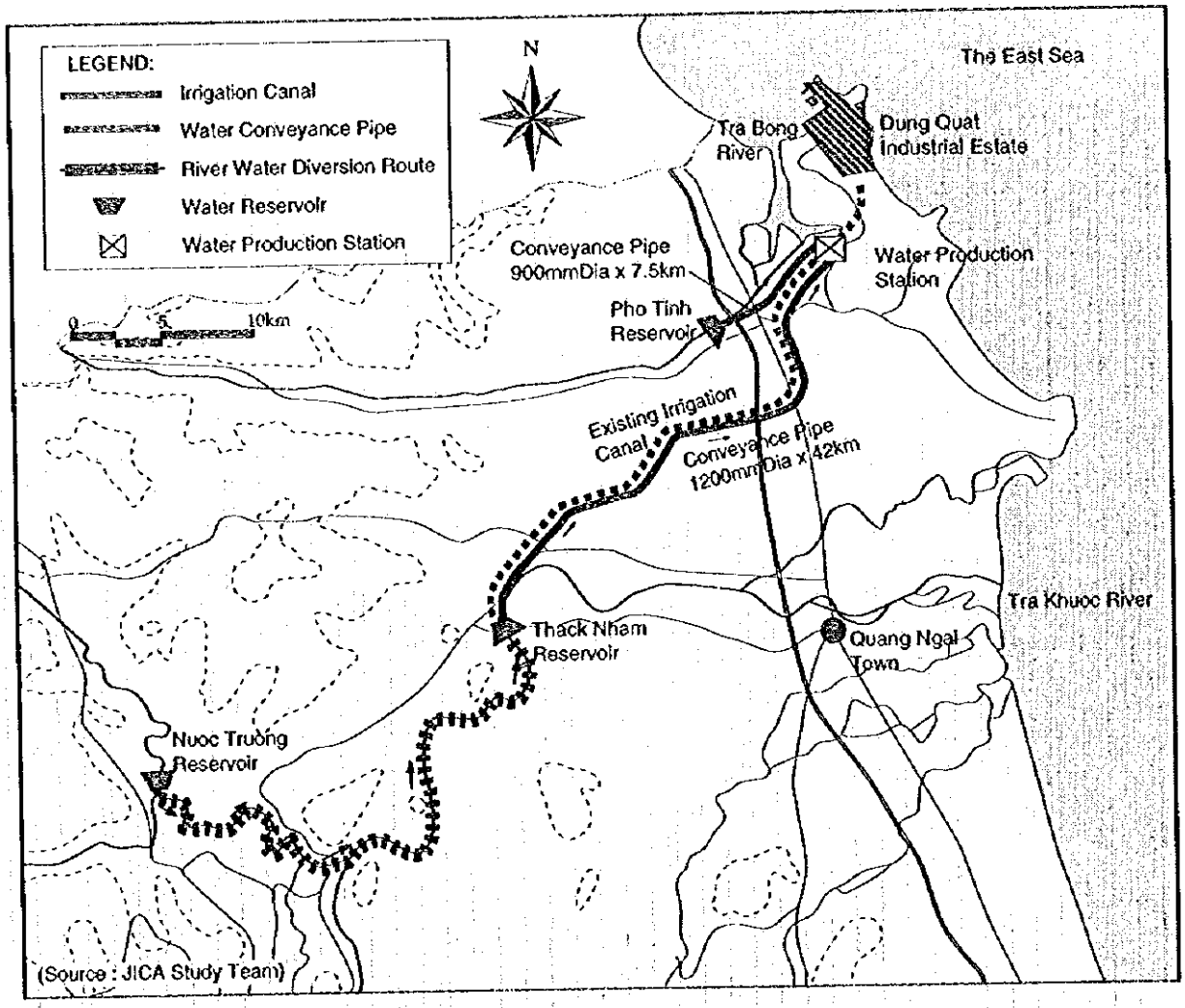


Figure 5.8 Route Plan of Raw Water Conveyance Pipes



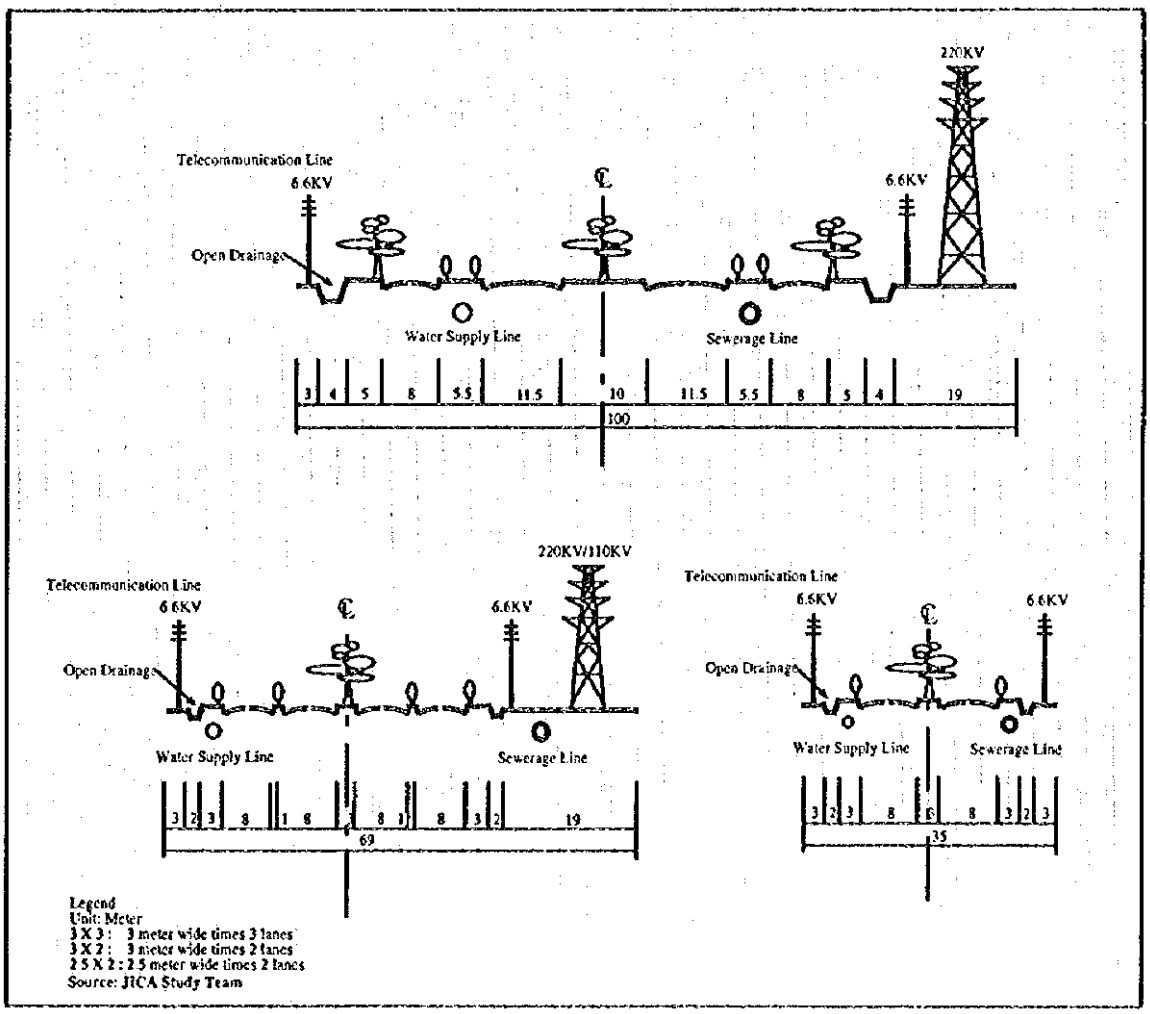
5.3.4 Road Planning

The basic concept for the development of the road system is as follows :

- Planning should be coordinated with the national road No. 1 and also the by-pass road for Quang Ngai Town,
- Roads in the DQI should be designed for heavy industrial use,
- Access roads from national highway No. 1 should have two parallel roads taking into account emergency cases,
- Smooth flow of heavy duty trucks, people and motor bicycle as well as comfortable and safe transportation should be ensured, and
- The road shoulder should be for the utilities supply lines, namely electric, water, sewerage, open drainage and telecommunication lines.

The standard road sections to be applied in the DQI are shown in Figure 5.9.

Figure 5.9 Standard Road Section of Dung Quat Industrial Estate



5.3.5 Administration and Common Service Facilities

There are two type of administrative facilities which are required for the port type of industrial estate, namely for the normal administration of the industrial estate and port administration facilities.

1) Normal Administration Center

The administrative area provides overall services for enterprises, employees and other users of the DQI and its promotes the interrelationship among enterprises. The Zone Development Company will operate the Center area and also operate and manage the DQI in its entirety. About twenty hectares of land will be secured for the center area in a place easily accessible from the industrial and port areas.

The following facilities will be established in the area in response to the roles of the center area :

- Administrative office
- Information center
- Shop and restaurant
- Service facilities, such as bank and post office
- Police
- Hospital and/or first aid clinic related to the port administration
- Helicopter port
- Social welfare facilities
- Open space and parks, and
- Utilities' supply.

2) Port Administration Center

The port administration will have the following functions :

- Immigration
- Quarantine
- Customs
- Police
- Marine Safety Agency
- Marine Fire Station, and
- Hospital.

5.3.6 Parks and Green Plan

The DQI aims to be a core of industrialization and heavy industries, which are known to be polluting industries. In the DQI the sand dune of Vi An Ka and Nam Tram Cape are planned to be kept as a form of shelter against the east wind and separator of the heavy industries. In addition, roads are planned with 100, 69 and 39 meter right of way (ROW) including a green belt. The total industrial land in the DQI will be some 58% of the total land and remained land is for amusement park and/or green area. However, each industrial lot should be planned keeping a 20% ratio for the green area.

5.3.7 Land Preparation Plan

The basic policy for the land development plan is as follows :

- To keep and maintain the natural sand dunes as a protection against the east wind
- To minimize earth work in order to reduce cost and offer inexpensive site supply
- To apply a balanced earthwork on the site, and
- To establish a flood resistance.

The Ministry of Construction suggests a 5.2 meter above sea level high taking into consideration a 100 years probability of surge. On the other hand, the features of sea water level of the Dung Quat area are as follows :

- The mean water elevation from April 1993 to January 1994 was 0.13 meter
- The mean high water elevation was 1.03 meter, and
- The mean highest water elevation with cumulative probabilities of 1% was 1.73 meter.

Normally, the elevation of the port should be added at 2.0 to 2.5 meter, so that the elevation of the DQP should be 4 meter of elevation from sea level.

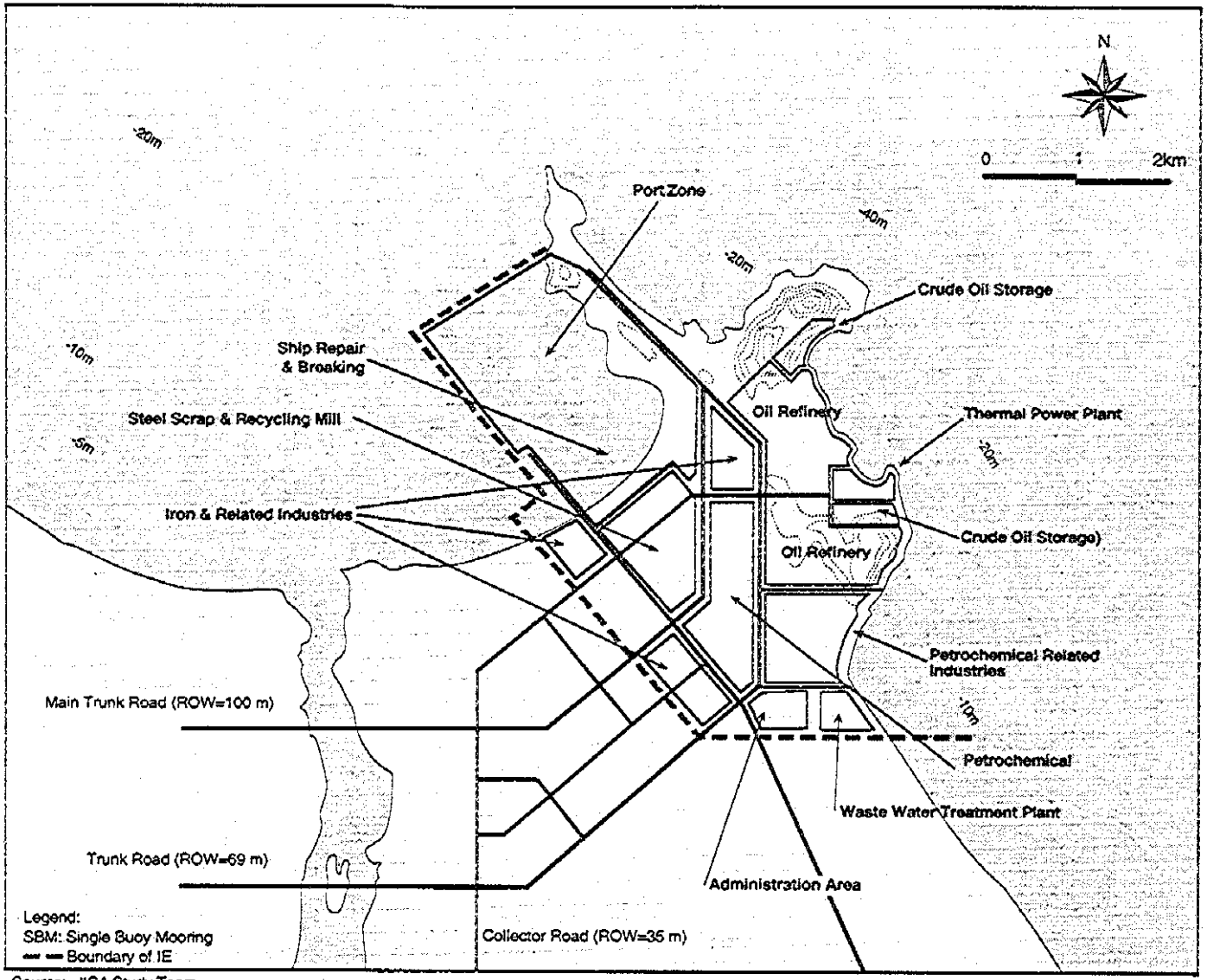
5.4 LAYOUT PLAN AND PLOT PLAN

The layout plan should take into account the industrial features, energy balance and material balance among the industries. Hence, the following features have been considered for the layout plan :

- Oil refineries and petrochemical industries: The oil refineries require a deep sea port and/or single buoy mooring (SBM) for 250,000 tons oil tanker as an unloading facility and a small port for loading facilities for 3,000 to 80,000 DWT ships
- Thermal power plant: The thermal power plant needs an inlet for 20 m^3 of cooling water and an outlet for the same amount of water. The outlet must be located outside of the port, because the temperature of the discharged cooling water is 7 degree centigrade higher than that of the intake water
- Ship repair & ship breaking industries: This industry requires a huge and specialized port, dry dock and wharf. The port should be in a calm location of the port
- Iron & seal related industries: Iron and steel related industries require port and/or railway for heavy transportation. Hence, they should be located near the raw material supplier and/or port facilities.

Figure 5.10 shows the proposed layout and lot plan.

Figure 5.10 Layout and Lot Plan for the Dung Quat Industrial Estate



Source: JICA Study Team
Note: Water depth indicates the existing condition
ROW=Right of Way

5.5 DEVELOPMENT SCHEDULE

5.5.1 Rough Development Schedule

Taking into account the rapid construction requirements for the oil refinery, a temporary wharf with causeway for construction material and equipment should be done until 1999. Related to this wharf construction, upgrading of the existing road, temporary water supply and sewerage system and land formation for the first oil refinery should be undertaken in parallel.

The wharf for the first stage refinery products, road network of stage 1 for the first refinery, water supply and sewerage system and land formation stage 1 are the next stage. Depending on factory construction inside the DQI, infrastructure should be constructed step by step. Below is the start of operation schedule for each industry :

- First oil refinery (including national oil storage with 240,000 liters) in 2003
- First petrochemical industry in 2003
- Second oil refinery (including national oil storage with 240,000 liters) in 2006
- Second petrochemical industry in 2006
- Ship repair & breaking industry in 2007
- Steel scrap & recycling mill in 2007
- Petrochemical related industries in 2008
- Iron & related industries in 2008

The basic configuration of the industries in the DQI are summarized in Table. 5.14.

5.5.2 Main Schedule for Construction

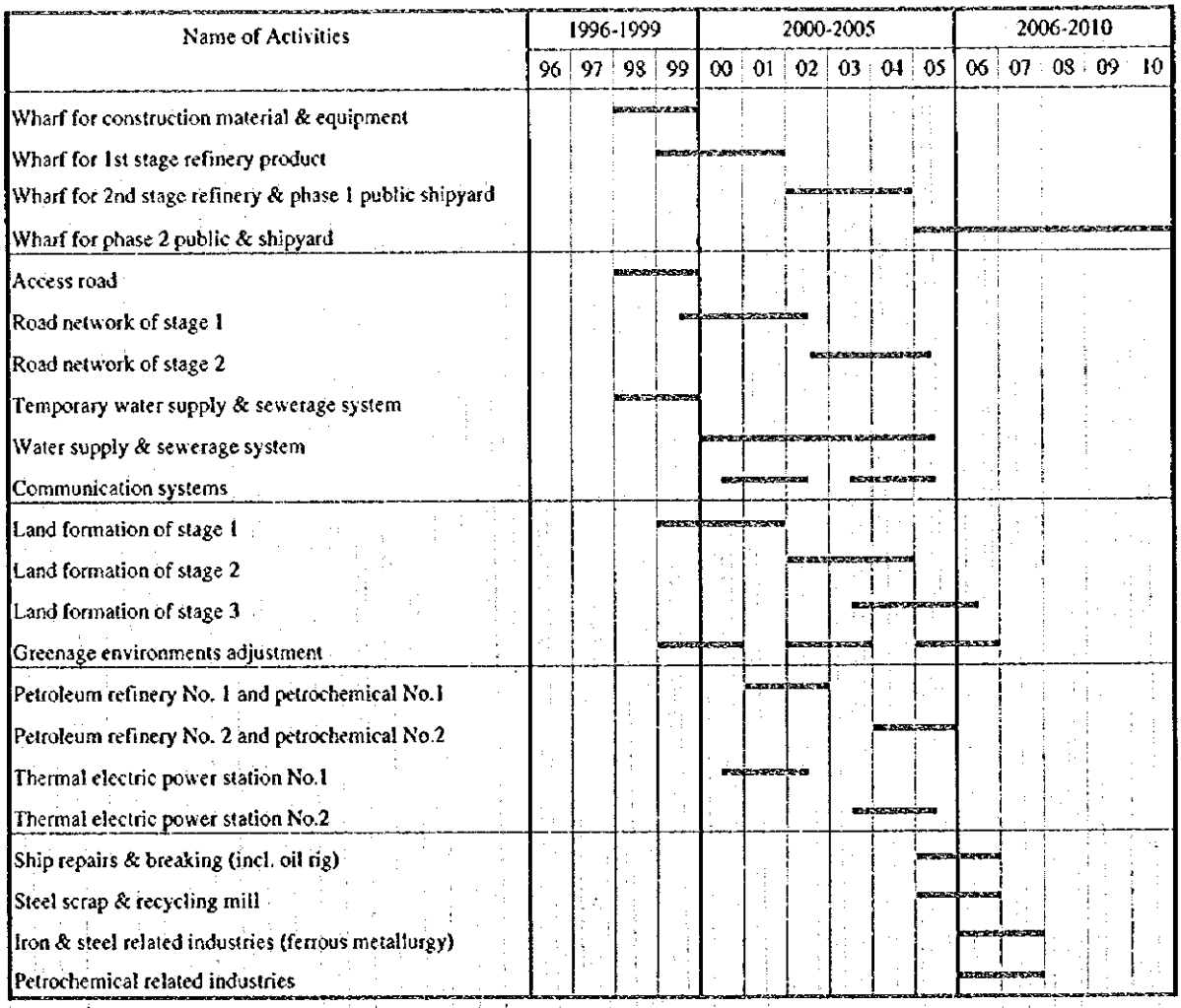
This construction schedule has been prepared taking into consideration the construction experience of a similar scale plant constructed overseas. The schedule prior to the contract award will be one and half year for procurement of funds, basic/definite design and preparation of tender documents and tendering. The schedule for performing construction will be 30 months from the award of contract until handing over. The main schedule for construction is summarized in Figure 5.11.

Table 5.14 Main Configuration of the Dung Quat Industrial Estate 2000 to 2006

Name of Industry	Production Capacity	Industrial Land	Number of Employee	Industrial Water Consumption	Electric Power	Freight Volume
Petroleum Refinery No. 1 (year 2003)	6.5 mill. t/year	110 ha	400 persons	11,040 t/day	14,000 KWH	6.500 mil. t/year 5.938 mil. t/year
Petroleum Refinery No. 2 (year 2006)	6.5 mill. t/year	110 ha	500 persons	17,040 t/day	57,000 KWH	6.500 mil. t/year 5.454 mil. t/year
Petrochemical No. 1 (year 2003) and Petrochemical No.2 (year 2006)	1,197 thous. t/year	100 ha	400 persons	26,400 t/day	60,000 KWH	0.063 mil. t/year
Electric Thermal Power Plant (year 2002)	150 MW	8 ha	200 persons	250 t/day	-	0.165 mil. t/year (Oil)
Electric Thermal Power Plant (year 2005)	150 MW	7 ha	100 persons	250 t/day	-	0.165 mil. t/year (Oil)
Ship Repair and Breaking (year 2007)	Ship Breaking upto 250,000 (500,000 tons/year) Repair 80,000 to 250,000 DWT X 50/year	100 ha	1,500 persons	2,800 t/day	5,800 KWH	1.5 mil. t/year
Steel Scrap and Recycling Mill Electric Arc Furnace and Rolling Mills (year 2007)	Electric Arc Furnace 500,000 tons Hot & Cold Mills	100 ha	1,500 persons	16,000 t/day	97,000 KWH	2.5 mil. t/year
Iron and steel related industries (year 2008)	14 kinds of industries Output: 121 mil. US$	110 ha	2,800 persons	12,000 t/day	17,000 KWH	1.7 mil. t/year
Petrochemical related industries (year 2008)	8 kind of industries Output: 103 mil. US$	90 ha	2,300 persons	72,000 t/day	23,000 KWH	1.5 mil. t/year
Total		735 ha	9,700 persons	157,780 t/day	273,800 KWH	31.985 mil. t/year

Source: JICA Study Team

Figure 5.11 Main Schedule for Construction



Source: JICA Study Team

CHAPTER 6

PROJECT COST

CHAPTER 6 PROJECT COST

6.1 PROJECT COST ESTIMATION FOR DUNG QUAT INDUSTRIAL ESTATE

6.1.1 Principal Cost Categories

Project cost have been estimated in three principal cost categories, namely :

- On site development cost
- Off site development cost, and
- Cost for temporary works.

All three cost components together have been taken into account in the economic analysis. For the financial analysis, however, only on site industrial estate development cost have been included.

Basic assumptions and cost features are presented below in the reverse order.

6.1.2 Total Investment Cost Inside the Industrial Estate

The total on site development cost for the industrial estate cover the following cost items :

- Land development
- Port development
- Road development
- Water & sanitation development, and
- National oil storage development.

1) Land Development

About 2.1 million m^2 will have to be cut at 4 meter. Land cutting cost have been estimated at US$ 3.60 per m^3, hence total land cutting cost are estimated at US$ 30,240,000. Landfilling using soil removed from inside the industrial estate will involve some 3.9 million m^2 at 2 meter highs. Hence, Total land filling cost are estimated at US$ 18,720,000. In addition, about 2.8 million m^2 (also at 2 meter highs) will have to be filled using soil from outside the industrial estate. The total cost for this are estimated at US$ 20,160,000. Total land grading and land filling cost are therefore estimated at US$ 69,120,000.

2) Road Construction

Three types of road construction will be needed, namely with 100m ROW, 69m ROW and 35m ROW. About 128,700 m^2 of 100m ROW will be needed costing an estimated total of US$ 7,722,000. Some 256,000 m^2 of 69m ROW roads will be needed. Total investment cost are estimated at US$ 15,360,000. About 107,200 m^2 of 35m ROW roads will be needed. Total investment cost for those are estimated at US$ 6,432,000. Total investment cost of this item has been estimated at US$ 29,514,000.

3) Green Belt Construction

Green belt construction comprises also 100m ROW, 69m ROW and 35m ROW roads. Total investment cost for the green belt construction is estimated at US$ 3,909,360.

4) Electric Wiring

Some 6,600 meter of 110 KV lines will be needed, which, with a unit cost of US$ 132/m translated into a total investment cost of some US$ 871,200. In addition, about 36,000 meter of 66 KV lines will be needed, the total investment cost of which is estimated at US$ 2,678,400. Total investment cost for street lamp lines is estimated at US$ 2,160,000. Consequently, total cost of this item has been estimated at US$ 5,709,600.

5) Telecommunication

Two lines with 400 circuits will be needed at a total investment cost of US$ 302,400.

6) Water Supply

Total investment cost for industrial and other use inside the industrial estate is estimated at US$ 23,400,000 (for details, please refer to the Section on water supply and sanitation implementation cost).

7) Sanitation Plant

Total investment cost for the open drainage system and waste water and treatment plant have been estimated at US$ 147,352,000 (for details, please refer to the Section 6.4 on water supply and sanitation implementation cost.)

8) Port Construction

Total investment cost for the industrial port have been estimated at US$ 465,432,000 (for details, please refer to the Section on the port bellow).

9) Administration Building

A 4 stories and 3,500 m^2 administration building is anticipated at a total investment cost of US$ 798,000.

10) Helicopter Port

The helicopter port will comprise an area of 400 m^2 and cost some US$ 24,000.

11) Crude Oil Tanks

Four 120,000 liter tanks will be needed at a total investment cost of some US$ 48,000,000.

Those costs are excluded in the investment costs, however, the costs describe as follows:

- Land acquisition & resettlement compensation
- Sea and river surface acquisition & resettlement compensation

1) Land Acquisition & Resettlement Compensation

Land acquisition will comprise about 1,262 ha and some 1,000 farmers will have to be resettled and compensated. Land acquisition cost have been estimated at 150 US$/ha and for a 50 year period. Total land acquisition cost amount therefore to US$ 9,465,000. Farmers are compensated at US$ 4,000 per family. Hence, compensation for resettlement will amount to US$ 4,000,000.

2) Sea and River Surface Acquisition & Resettlement Compensation

Surface acquisition for the port facilities will comprise some 150 ha, which, at a unit cost of US$525, will require a total of US$3,937,500. Sea surface acquisition outside the port area will comprise some 388 ha at a unit cost of US$ 75/ha. Hence, total outside surface acquisition cost also for 50 years are estimated at US$1,455,000.

About 1,000 fishing families will have to be resettled at US$4,000 per family. Total compensation for resettlement are estimated at US$ 4,000,000. Consequently, total cost of this item has been estimated at US$9,392,500.

Total investment cost outside the industrial estate are estimated at some US$ 793,561,360.

6.1.3 Investment Cost Outside the Industrial Estate

Investment cost outside the industrial estate covers the following cost categories :

- Land development
- Road construction
- Green belt construction
- Bridge construction
- Water supply
- Sanitation
- Electricity supply, and
- Telecommunication facilities.

1) Land Development

About 200,000 m^3 will have to be graded and filled. Total land cutting and filling and grading cost have been estimated at US$ 624,000.

2) Road Construction

Three types of road construction will be needed, namely with 100m ROW, 69m ROW and 35m ROW. About 429,000 m^2 of 100m ROW will be needed costing an estimated total of US$ 25,740,000. Some 352,000 m^2 of 69m ROW roads will be needed. Total investment cost of 69m road are estimated at US$ 21,120,000. About 107,200 m^2 of 35m ROW roads will be needed with US$ 6,432,000 of investment cost. Total investment cost for those are estimated at US$ 53,292,000.

3) Green Belt Construction

Green belt construction comprises also 100m ROW, 69m ROW and 35m ROW roads. Total investment cost for the green belt construction is estimated at 8,147,880.

4) Bridges

Bridges will have to be constructed for the 48m wide (100m ROW) and 32m wide (69m ROW) roads. Some 80,000 m^2 of bridges will be needed at a total estimated investment cost of US$ 107,827,200.

5) Water Supply

Total investment cost for water supply has been estimated at US$ 141,037,000 (for details, please refer to the separate Section 6.4 on water supply and sanitation implementation cost).

6) Sanitation

Total investment cost for sanitation has been estimated at US$ 72,950,000 (for details, please refer to the separate Section 6.4 on water supply and sanitation implementation cost).

7) Electricity Supply

About 100 km of 220 KV lines will be needed, the total investment cost for which have been estimated at US$ 15,000,000. This trank mission line will be needed until the year 2002. The cost of street lamps are US$ 660,000. Consequently, total cost of this item has been estimated at US$ 15,660,000.

8) Telecommunication

Two lines with 400 circuits will be needed at a total investment cost of US$ 482,160.

Those costs are excluded in this investment costs, however, the costs describe as follows:

- Land acquisition & resettlement compensation, and
- River surface acquisition & resettlement compensation

1) Land Acquisition & Resettlement Compensation

About 500 farming families will have to be resettled. Resettlement compensation is estimated at US$ 4,000 per family. Land acquisition cost for offsite is US$ 31,403. Hence, resettlement compensation together with land acquisition cost has been estimated at a total of US$ 2,031,403.

2) River Surface Acquisition & Resettlement Compensation

About 200 fishery families will have to be resettled. As is the case for farming families, fishery families will be compensated at US$ 4,000 per family. Total resettlement compensation together with river surface acquisition is estimated at US$ 800,510.

Total investment cost outside the industrial estate are estimated at some US$ 400,020,240.

6.1.4 Cost for Temporary Works

Cost for temporary works cover two types, namely roads and bridges. About 38 single roads with an accumulated length of 20 km will be needed with some 10 meter ROW. Unit cost per meter have been assumed at 19 US$/m. Hence, total cost are estimated at 14,592,000 US $. Two bridges of 5 and 20 meter length will be needed. Unit cost of 720 US$/m^2 are assumed. Total cost for bridges is therefore some US$ 180,000.

Total investment cost for temporary works is therefore estimated at US$ 14,772,000.

6.1.5 Summary of Total Investment Cost

The total investment cost inside the industrial estate, but excluding the power station, are estimated at some US$ 816 million. Off site development costs have been estimated at about US$ 403 million and cost for temporary work are estimated at a total of some US$ 15 million as identified in Table 6.1.

Hence total cost, that is for the industrial estate itself and related off site facilities would amount to a total of US$ 1,234 million (Table 6.1 refers). Total investment cost have been estimated within a plus/minus 10% margin, which is satisfactory for pre feasibility level.

Table 6.1 Total Investment Cost for Dung Quat Industrial Estate

Main Cost Category	Activity	Estimated Investment Costs (in 1996 price US$)
A.) On site Development		
	Land Development	69,120,000
	Port Development	465,432,000
	Road Development	39,435,360
	Water & Sanitation Development	170,752,000
	Oils Storage Tank Development	48,000,000
	Others	822,000
Sub-Total On Site Development		793,561,360
B.) Off Site Development		400,020,240
C.) Temporary Works		14,772,000
Total Investment Costs		1,208,353,600

Source : JICA study team.

6.2 PROJECT COSTS ESTIMATION FOR PETROLEUM INDUSTRIES

The summary of the required funds is summarized in Table 6.2. The petroleum industries are main industries in DQI, however, this item is excluding of this Pre-F/S calculation.

Table 6.2 Project Cost Estimation for Petroleum Industries

(unit: million US$)

Item	First Phase *-1 Refinery	Second Phase *-2 Refinery	Petrochemical *-3 Project
(1) Plant Cost	1,053	1,503	1,110
- Process Units	(351)	(713)	(541)
- Utility Facilities	(129)	(216)	(241)
- Storage facilities	(288)	(275)	(58)
- Other Offsite Facilities	(285)	(299)	(270)
(2) Others (Including Initial Working Capital)	337	356	317
Total Required Funds	1,390	1,859	1,427

note: *-1 Required funds for First Phase Refinery is approximate figures, based on JCI's data

*-2 Required funds for Second Phase Refinery is a rough estimate of the project done by JCI's Pre-F/S.

*-3 Required funds for Petrochemical is approximate figures based on JCI's data.

Source: JICA Study Team

6.3 PROJECT COST ESTIMATION FOR THERMAL POWER PLANT

The construction cost of the Dung Quat Power Project is estimated as a standard construction cost for a 150 MW oil fired power plant. The overall construction cost including in-direct cost and interest during construction (I.D.C.) is approximately US$162 million for the first 150 MW Unit. The estimated construction cost is shown in Table 6.3.

Table 6.3 Construction Cost for Power Plant

(unit: US$1,000)

Item	Cost (150 MW-1 unit)	Cost (150MW-2 units)
1. Direct Cost	130,000	250,000
(Electrical & Mechanical Cost)	(98,000)	(188,000)
(Civil & Architectural Works)	(32,000)	(62,000)
2. Indirect Cost	13,000	25,000
(Direct Cost x 10%)		
3. I.D.C	19,000	37,000
(Direct Cost x 15%)		
Total	162,000	312,000

Source : JICA Study Team

6.4 WATER SUPPLY AND SANITATION IMPLEMENTATION COST

The estimated cost for the construction works on the proposed water supply facilities and sanitation facilities are summarized in Table 6.4 and Table 6.5 with the breakdown for the inside and the outside portion of the industrial area, which are divided by the property boundary of the DQI.

The following conditions have been assumed for the cost estimation :

- Direct construction cost cover purchase of equipment and material, shop manufacturing, ocean and inland transportation, preparatory site works, site installation works and startup operation.
- Equipment and material necessary for construction works will be purchased in local markets in Viet Nam, if reliable and competitive ones are available. Otherwise, they are imported from foreign countries.
- Indirect construction cost covers expenses for engineering services and physical contingency. Any taxation such as import tax and V.A.T (Value Added Tax), and I.D.C. are excluded from the construction cost.
- All prices of equipment and material, labor and so on are on 1996 basis.
- Community sewage disposal facilities or individual sewage treatment systems necessary for the adjacent area are excluded from the construction cost.
- Only trunk pipes of water supply and sewage collection in the DQI and Van Tuong New City area are included in the construction cost, assuming that main pipes, branch pipes and house connections will be constructed by lot developers.

Table 6.4 Construction Cost of the Proposed Water Supply Facilities

Items	Quantities		Unit Cost (1000US$)	Cumulative cost (1000US$)
A. Inside of Industrial Area				
1. Distribution pipes for Industrial Area				
Trunk pipes	18	km	1,000	18,000
Sub -total				18,000
Total(Direct Cost)				18,000
Engineering service	10.0	%		1,800
Physical contingency	20.0	%		3,600
A-total(Construction cost)				23,400
B. Outside of Industrial Area				
1. Raw water intake and conveyance system				
1.1 From Thach Nam Reservoir				
Intake gate and inlet canal	0.5	km	(L.S)	500
1.2 From Pho Tinh Reservoir				
Intake weir	1	lot	(L.S)	700
Intake pump	3	units	400	1,200
Conveyance pipe	7.5	km	550	4,125
1.3 From Nuoc Truong Reservoir				
Intake pump	5	units	400	2,000
Conveyance pipe	42	km	850	35,700
Sub-total				44,225
2. Water production system				
2.1 Raw water reservoir	450,000	cu-m	0.015	6,750
2.2 Water purification facilities				
Purification plant	12	units	3,600	43,200
Sub-total				49,950
3. Water distribution system				
3.1 Transfer pump	5	units	550	2,750
3.2 Distribution tank	80,000	cu-m	0.07	5,600
3.3 Distribution pipes for Industrial Area				
Trunk pipes	5.0	km	1,800	9,000
3.4 Distribution pipes for Van Tuong New City				
Trunk pipes	9.0	km	230	2,070
3.5 Distribution pipes for Adjacent Area				
Trunk pipes	20	km	180	3,600
Main pipes	20	km	80	1,600
Branch pipes	35	km	50	1,750
Sub-total				26,370
Total(Direct Cost)				120,545
Engineering service	7.0	%		8,438
Physical contingency	10.0	%		12,055
Land acquisition	33.0	ha	50	1,650
B-total(Construction cost)				141,037
Grand-total(A+B)				164,437

Source: JICA Study Team

Table 6.5 Construction Cost of the Proposed Sanitation Facilities

Items	Quantities		Unit Cost (1000US$)	Cumulative cost (1000US$)
A. Inside of Industrial Area				
1. Sewage disposal facilities				
1.1 Sewage collection system				
Trunk pipes	18	km	850	15,300
Sewage relay pump	3	sets	80	240
1.2 Sewage treatment facilities				
Treatment plant	20	units	4,800	96,000
Sub-total				111,540
2. Storm water drainage				
Trunk open channels and pipes	1,300	ha	3.0	3,900
Retention pond	3.9	ha	150	585
Sub-total				4,485
Total(Direct Cost)				116,025
Engineering service	7.0	%		8,122
Physical contingency	20.0	%		23,205
A-total				147,352
B. Outside of Industrial Area				
1. Sewage Disposal Facilities				
1.1 Sewage collection system				
Trunk pipes	10.0	km	130	1,300
Sewage relay pump	4	sets	50	200
1.2 Sewage treatment facilities				
Treatment plant	4	units	3,700	14,800
Sub-total				16,300
2. Storm water drainage for Van Tuong new city area				
Trunk open channels and pipes	500	ha	3.0	1,500
Retention pond	1.5	ha	150	225
Sub-total				1,725
3. Storm water drainage for adjacent area				
Open channels and pipes	1,500	ha	1.5	2,250
Retention pond	4.5	ha	150	675
Sub-total				2,925
4. Solid waste disposal facilities for new town area				
4.1 Waste haulage vehicle				
Packer car(2ton)	6	units	100	600
Packer car(4ton)	12	units	150	1,800
4.2 Landfill facilities				
Landfill site	13	ha	3,000	39,000
Sub-total				41,400
Total(Direct Cost)				62,350
Engineering service	7.0	%		4,365
Physical contingency	10.0	%		6,235
B-total				72,950
Grand total				220,302

Source: JICA Study Team

6.5 DUNG QUAT PORT DEVELOPMENT

It is assumed that port development will be carried out in four principal phases the costing of which is summarized in Table 6.6.

Table 6.6 Dung Quat Port Development Phasing and Costing

(unit: million US$)

Item	Remarks	2000	2002	2005	2010
A. WHARF FOR FIRST STAGE REFINERY PRODUCTS					
1) Wharf for Construction Material & Equipment					
a) East Breakwater	300m	6.0			
b) Wharf	1 - 5,000 DWT 150x30x7.5m	3.8			
c) Causeway	1,200 m	4.7			
d) Dredging and Reclamation	500,000 m3	2.5			
e) Equipment		1.2			
f) Miscellaneous		1.8			
g) Physical Contingency		4.0			
Sub-Total		**24.0**			
2) Wharf for First Stage Refinery Product					
a) East Breakwater	900M		60.0		
b) Wharf	1 - 30,000 DWT 240x25x12 m		12.5		
	2 - 20,000 DWT 210x40x11 m		10.0		
	2 - 5,000 DWT 150x40x7.5 m		3.8		
c) Embankment	520 m		6.1		
d) Dredging and Reclamation	1,3000,000 m3		6.5		
e) Administration Building & Utilities	one		1.6		
f) Working Boat			0.4		
g) Miscellaneous			10.1		
h) Physical Contingency			22.2		
Sub-Total			**133.2**		
B. WHARF FOR SECOND STAGE REFINERY PRODUCTS AND PHASE 1 PUBLIC WHARF AND SHIPYARD					
a) Groin	1,000 m			4.9	
b) Second Phase Refinery Wharf	1 - 30,000 DWT 240x15x12 m			12.0	
	2 - 5,000 DWT 2x150x20x7.5 m			7.5	
c) Phase 1 Public Wharf (General Cargo)	2 - 30,000 DWT 520x200x12 m			26.0	
	2 - 15,000 DWT 380x100x10 m			15.2	
	1 - 5,000 DWT 140x100x7.5 m			3.5	
	Transit shed			2.5	
	Yard Pavement			5.4	
	Utilities: 1 set			2.0	
	Working Boat and Equipment			5.5	
d) Phase 1 Shipyard	Embankment: 1,600 m			8.9	
	Wharf: 400 m 400x30x9 m			12.0	
	Multi-purpose Pier: 2 - 10,000/5,000 DWT 300x30x9 m			9.0	
e) Dredging and Reclamation	20,000,000 m3			10.0	
f) Reclamation	8,800,000 m3			44.0	
g) Miscellaneous				16.8	
h) Physical Contingency				37.0	
Sub-Total				**222.2**	
C. WHARF FOR PHASE 2 PUBLIC WHARF					
a) Container Crane	4 sets for 2 - 20,000 DWT Wharf				24.0
b) West Breakwater					40.5
c) D.F.S.					0.7
d) Miscellaneous					6.5
e) Physical Contingency					14.3
Sub-Total					**86.0**
D. CUMULATIVE INVESTMENT COST		**24.0**	**157.1**	**379.4**	**465.4**

Source: JICA Study Team

First stage, which comprises construction of the wharf for construction material & equipment, is estimated to cost a total of US$ 24,000,000. Total investment cost, which will cover the construction of the wharf for the first stage refinery products, is estimated at US$ 133.2 million as detailed in Table 6.6. Total investment cost for second stage, covering the wharf for the 2nd stage refinery products and phase 1 of the public wharf and shipyard, are estimated at US$ 222.3 million. Total investment cost, that is the wharf for phase 2 of the public port area, is estimated at US$ 86.1 million.

Hence, total investment cost for the Dung Quat port development are estimated at about 465.5 million US$.

CHAPTER 7

ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 7 ECONOMIC AND FINANCIAL ANALYSIS

7.1 ECONOMIC ASPECT

The economic effect of the DQI project can be estimated by determining the difference of net income or value added between the agricultural and fishery production ("without the project") and the industrial production ("with the project"). Items affecting the net value added are examined separately for their negative and positive impacts.

7.1.1 Negative Impact

1) Construction and Operation & Maintenance Cost

All the facilities planned to be constructed for the DQI should be included in the cost calculation for the purpose of economic analysis, whether or not they are managed by the DQI management company. This is because they are indispensable and directly related to the production activities of the enterprises in the DQI. Thus, the construction for DQI includes the following:

- Infrastructure inside the DQI: land preparation, roads, electric wiring, telecommunication lines, water supply system and sanitation plant, administration building, helicopter port, and crude oil tanks
- Port and its related facilities
- Power plants
- Infrastructure outside the DQI: land preparation, roads, electric wiring, telecommunication lines and bridges, and
- Temporary work for construction : roads and bridges.

The estimated construction cost includes engineering service cost, physical contingency, but no price contingency. A factor of 0.9 is employed in order to convert the financial to economic cost. The conversion takes into consideration transfer items, such as taxes and tariffs in addition to a shadow wage rate. The estimation of construction cost results in about US$1,368 million. This cost is allocated evenly in the construction period of each construction item.

The O&M cost is 1% of the construction cost for the DQI infrastructure, with the exception of 4% for the water supply system and sanitation plant and 3% for the power plant. It accrues after the completion of each construction.

2) Land Acquisition Cost

The opportunity cost of land to be used for the DQI is the reduction of net income of the farmers and fishermen, who are presently living and making products in the project area. After such net income reduction is included in the project cost, all amounts arising from compensation money paid to them should be considered as a transfer item.

The DQI management body has to pay rent to the government. Such rent is considered to be a transfer item.

3) Agricultural and Fishery Production (Income Reduction)

Farmers and fishermen affected by the project will be resettled in the year previous to construction.

(1) Farmers

It is estimated that approximately 1,000 households are engaging in agricultural production inside the DQI and 500 farming households are affected by the project in the outside area. Their main products are cassava, sweet potato and peanut. The yearly net income per household is estimated at US$ 473 as detailed in Table 7.1.

Table 7.1 Estimation of Farmer's Income

Products	Land(ha)	Yield(t/ha)	Farm Gate Price(VND M/t)	Cost(VND M/t)	Net Return(VND M)
Cassava	95	11.7	1.5	0.3	1,334
Sweet Potato	90	9.1	1.8	0.3	1,229
Peanut	90	1.2	6.0	0.8	562
Total					3,125

Note: The yearly net income per household is estimated at VND5.2 million or US$473.

Source: Ministry of Agriculture and Rural Development

(2) Fishermen

It is estimated that approximately 1,000 households are engaging in fishing inside the DQI and 200 fishing households are affected by the project in the outside area. From the result of the social survey by the JICA study team, their yearly gross income per household is about US$ 1,342. Then their net income is safely assumed at 50% or US$671.

7.1.2 Positive Impact

In the DQI, all plants are assumed to be heavy industries. Thus, the data of value added per ha of site area is more suitable than that per employee, since heavy industry production is closely related to capital investment. For the estimation of value added in the DQI, survey data of Japanese industries is referred to, since those plants which would work in the DQI should employ the latest technology to compete in the international markets.

However, Japanese industries use the land very intensively, since the land cost is extremely high in Japan. Thus, these data were adjusted for application in this study. Considering the Nagoya Port Industrial Area in Japan, the value added per area must be one fourth for iron & steel industry, one sixteenth for petroleum industry. Therefore, the value added per hectare is shown in Table 7.2.

Table 7.2 Value Added per Hectare

Industry	Area (ha)	Value Added (US$/ha)
Oil refinery	220	545,000
Petrochemical	100	1,687,000
Ship breaking & repair	100	204,000
Steel scrap & recycling mill, electric arc furnace & rolling mills	100	147,000
Iron & steel related industries	110	231,000
Petrochemical related industries	90	1,760

Source: JICA Study Team

7.1.3 Economic Analysis

The economic internal rate of return (EIRR) is calculated for fifty years since the land rent is allowed for fifty years in Viet Nam. The EIRR calculation results in 20.06%. It can be said that the DQI project has a significant positive effect for the national economy. It is recommendable to promote the project under the environment of foreign direct investment, which is foreseeable and well prepared. Details of the EIRR calculation are summarized in Table 7.3.

Table 7.3 Economic Analysis of Dung Quat Industrial Estate

Economic Analysis (Port, Oil Tank, and Power Plants Included)

(Unit: US $1,000)

Year		Negative Side: Income Reduction		Negative Side: Cost for I.E.			Positive Side: Value Added						Net Benefit	
		Farmers	Fishermen	Cost	O & M	Total Cost	Oil Refinary	Petrochemical	Fetilizer Related	Steel Mill	I & S Related	Total Value Added	Annual	Cumulative
1	1997	3	5	13,295	0	13,303	0	0	0	0	0	0	-13,303	-13,303
2	1998	143	160	36,469	0	36,769	0	0	0	0	0	0	-36,769	-50,072
3	1999	216	205	94,847	0	95,268	0	0	0	0	0	0	-95,268	-145,340
4	2000	216	205	169,839	216	170,476	0	0	0	0	0	0	-170,476	-315,815
5	2001	436	458	221,292	216	222,412	0	0	0	0	0	0	-222,412	-538,227
6	2002	583	626	198,182	4,445	203,837	0	0	0	0	0	0	-203,837	-742,064
7	2003	658	738	202,767	7,155	211,311	59,998	84,326	0	0	0	144,324	-66,987	-809,051
8	2004	671	750	251,643	7,155	260,219	59,998	84,326	0	0	0	144,324	-115,893	-924,944
9	2005	671	750	111,203	19,008	131,618	59,998	84,326	0	0	0	144,324	12,686	-912,258
10	2006	710	805	17,147	28,977	47,658	119,996	168,652	0	0	0	288,648	241,009	-671,249
11	2007	710	805	12,910	29,104	43,528	119,996	168,652	0	14,665	0	303,313	259,785	-411,464
12	2008	710	805	12,910	29,104	43,526	119,996	168,652	158,380	14,665	25,414	487,105	443,577	32,111
13	2009	710	805	12,910	29,104	43,526	119,996	168,652	158,380	14,665	25,414	487,105	443,577	475,688
14	2010	710	805	12,910	29,104	43,526	119,996	168,652	158,380	14,665	25,414	487,105	443,577	919,265
15	2011	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	1,374,977
16	2012	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	1,830,689
17	2013	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	2,286,401
18	2014	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	2,742,112
19	2015	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	3,197,824
20	2016	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	3,653,536
21	2017	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	4,109,248
22	2018	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	4,564,960
23	2019	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	5,020,672
24	2020	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	5,476,384
25	2021	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	5,932,096
26	2022	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	6,387,808
27	2023	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	6,843,520
28	2024	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	7,299,232
29	2025	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	7,754,944
30	2026	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	8,210,656
31	2027	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	8,666,368
32	2028	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	9,122,080
33	2029	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	9,577,792
34	2030	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	10,033,504
35	2031	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	10,489,216
36	2032	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	10,944,928
37	2033	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	11,400,640
38	2034	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	11,856,352
39	2035	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	12,312,064
40	2036	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	12,767,776
41	2037	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	13,223,488
42	2038	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	13,679,200
43	2039	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	14,134,912
44	2040	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	14,590,624
45	2041	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	15,046,336
46	2042	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	15,502,048
47	2043	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	15,957,760
48	2044	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	16,413,472
49	2045	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	16,869,183
50	2046	710	805	0	29,878	31,393	119,996	168,652	158,380	14,665	25,414	487,105	455,712	17,324,895
		32,692	38,918	1,366,319	1,259,196	2,697,126	5,093,815	7,167,717	6,276,857	586,528	951,130	20,022,021	17,324,895	

NPV (12%): 769,193
B/C (12%): 1.87
EIRR: 20.06%

7.2 FINANCIAL ASPECT

The financial analysis has been carried out by calculating cash inflow and outflow from the viewpoint of the DQI development company.

7.2.1 Cash Outflow

1) Construction Cost and Operation & Maintenance Cost

Since the DQI management company does not have responsibility for the facilities listed below, costs and profits accruing from such facilities have been excluded :

- Power plants,
- Infrastructure outside the DQI: land preparation, roads, electric wiring, telecommunication lines and bridges, and
- Temporary work for construction: roads and bridges.

The estimated construction cost includes physical contingency but no price contingency. This cost is allocated evenly in the construction period for each construction item. The estimated total construction cost is about US$794 million within a plus/minus 15% margin.

The O&M cost is 1% of the construction cost for the DQI infrastructure, with the exception of 4% for the water supply system and sanitation plant. O&M cost accrue after the completion of each construction.

2) Land Acquisition Cost

It is assumed that land is acquired in the previous year of each construction. Compensation is paid at once to the re-settlers at the time of acquisition. Land rents are paid every year for fifty years from the year of acquisition.

(1) Compensation for Re-settlers

It is estimated that there are 1,000 farming families and 1,000 fishery families in the DQI site. Considering their income, the average income in the region and other industrial estate cases in Viet Nam, about US$4,000 for each family is appropriate for the DQI. This is approximately 20 times the average yearly income in the area.

(2) Rents

Land is owned by the government in Viet Nam. The government just allows the DQI management company to use land for fifty years and the DQI management company has to pay rent to the government. The actual rent is uncertain at the time if the study. According to regulations on land rents presently enforced ("Regulations on Land, Water and Sea Surfaces for the Forms of Foreign Investment in Viet Nam" – Decision No. 1417 TC/TCDN dated December 31, 1994 by the Ministry of Finance), about US$150 per ha is appropriate for the land, US$525 for the sea surface inside the port and US$75 for the sea surface outside the port taking into consideration present area conditions.

(3) Taxes

Taxation on this kind of infrastructure construction is uncertain at the time of the study. Any percentage of taxes would be misleading. Thus, it is assumed for simplification and convenience that the DQI project is exempted from taxes.

7.2.2 Cash Inflow

1) Lots and Sea Surfaces Sales

Land lots and sea surface lots are assumed to be sold at the previous year of each construction. In this case, "sold" means that the right of use for fifty years is transferred to the purchaser, because the owing right itself is still held by the government. Enterprises make payment at once. Lot prices must be set considering other industrial estate projects in Viet Nam and other countries as well as keeping profitability of the project. Prices are tentatively set as summarized in Table 7.4 and comparative rates are shown in Table 7.5.

Table 7.4 Land and Sea Surface Sales

Item	Industries/Factories	US$/m²
Land sales:	No. 1 Oil refinery	30
	No. 2 Oil refinery	30
	Petrochemical Phase 1 & 2	30
	Petrochemical related industry	30
	Ship Repair & breaking industry	30
	Steel scrap & recycling mil	30
	Iron & related industry	30
	Electric thermal power plant No. 1	30
	Electric thermal power plant No. 2	30
Sea surface sales:	SBM for No. 1 oil refinery	90
	SBM for No. 2 oil refinery	90
	Specialized port sea surface sales (oil refinery & petrochemical)	630
	Specialized port sea surface sales (Ship breaking & repair)	630

Source: JICA Study Team

Table 7.5 Examples of Lot Prices in other DTI's

Location	US$/m²
Ha Noi (Viet Nam)	60
Ho Chi Minh City (Viet Nam)	110
Shanghai (China)	110
Shenzhen (China)	100
Bangkok (Thailand)	81.6
Jakarta (Indonesia)	85

Source: Japan External Trade Organization (JETRO) and JICA Study Team

2) Port Charge

Revenues accrue from the operation of the port and related facilities. They include, among others, entrance fee, dock charge, storage fee and office floor sales. Rates must be set considering other ports in Viet Nam and other countries as well as keeping profitability of the project. Rates are tentatively determined in Table 7.6.

Table 7.6 Port Charges

Item	Apply	Unit	
Entrance fee	General port/Container port	0.20	US$ per entrance
	Specialized port entrance fee (No. 1 oil refinery & petrochemical)	0.20	US$ per entrance
	Specialized port entrance fee (No. 2 oil refinery & petrochemical)	0.20	US$ per entrance
	Specialized port entrance fee (Ship breaking & repair)	0.20	US$ per entrance
	Specialized port entrance fee (Iron & Related Industry)	0.20	US$ per entrance
	Specialized port entrance fee (Petrochemical Related Industry)	0.20	US$ per entrance
Dock charge	General port/Container port	0.0035	US$/ton/hour
Storage fee	Open storage	0.10	US$/m2/day
	Warehouse/transit shed	2.00	US$/m2/day
Floor sales	Office building	30.00	US$/m2/month

Source: JICA Study Team