Socialist Republic of Vietnam
Vietnam National Coal and Mineral Industries Group

Socialist Republic of Vietnam

Preparatory Survey for Song Hau 1 Coal Fired Power Plant Project and its related common infrastructures

(PPP Infrastructure Project)

Final Report

(Imported Coal Transshipment Terminal)

Phase 1

March 2012

Japan International Cooperation Agency

(JICA)

Sumitomo Corporation

Preface

This Final Report has been prepared based on the "Minutes of Meeting" regarding the Preparatory Survey for the Song Hau 1 Coal Fired Power Plant Project and Its Related Common Infrastructures, which were duly agreed and signed on January 18, 2011 between the Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Government of the Socialist Republic of Vietnam (hereinafter referred to as "Vietnam").

This JICA Preparatory Survey (hereinafter referred to as "the Study") for the Song Hau 1 Coal Fired Power Plant (hereinafter referred to as "the Plant") and its related common infrastructures include a site selection study for constructing an imported coal transshipment terminal in the Mekong Delta Area, in Vietnam. This Final Report contains all outputs on site and type selection works for an imported coal transshipment terminal project in the Mekong Delta Area (hereinafter referred to as "the Project") based on collected data and field survey results.

IMPORTED COAL TRANSSHIPMENT TERMINAL PROJECT
Phase 1

FINAL REPORT

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Abbreviations

DWT	Dead Weight Ton	
GDP	Gross Domestic Product	
GIZ	Gesellschaft fur Intrnationale Zusammenarbiet	German International Cooperation Agency
HCM	Ho Chi Minh	
HHWL	Highest High Water Level	
HWL	High Water Level	
IFI	International Financial Institutions	
LLWL	Lowest Low Water Level	
LOA	Length of All	
LWL	Low Water Level	
MWL	Mean Water Level	
OM	Operation and Maintenence	
PPP	Public Private Partnership	
PVN	Petro Viet Nam	
SPP	Steel Pipe Pile	
WNBR	World Network Biosphere Reserve	
WWF	World Wide Fund for Nature	

Chapter 1 Introduction

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Chapter 1 Introduction

1.1 Background of the Project

1.1.1 General Condition of Vietnam

After 2000, foreign direct investment to Vietnam has increased steadily, and the average economic growth from 2000 to 2010 was achieved with a high growth rate of 7.26%. In 2009, during the world economic crisis, the Vietnamese economy achieved an average economic growth rate of 5.3% owing to the government's positive financial and easy-money policies. The economic growth rate of 6.8% in 2010 was over the planned growth rate of 6.5%. However, macroeconomic condition is unclear, such as the rapid rise in prices, unstable Vietnamese currency, etc. Considering such situation, the Vietnamese government determined that the important issues include the stabilization of macroeconomy and counter-inflation measures in 2011's economic management.

The national convention of the Communist Party in 2011 selected a strategy on social and economic growth from 2010 to 2020, in which the economic growth rate of 7-8% and per capita income of USD 3,000 in 2020 were set as the goal. It is required to improve the investment climate in Vietnam in order to achieve the said goal. Especially, development of power sources is strongly requested by foreign countries and enterprises, which have already started their businesses in Vietnam.

1.1.2 General Condition of the Power Sector in Vietnam

Due to the high economic growth rate in Vietnam in recent years, the average demand for electric power in the previous ten years, from 2001 to 2010, has increased with a yearly average of 14%. Furthermore, the maximum demand for electric power jumped approximately three times, from 5,500 MW to 16,000 MW.

Though Vietnamese economy had an influence on the world economic crisis (global synchronous recession) and the GDP growth rate dropped for a short term, it is expected that it will bounce back to high economic growth trend in the middle and long terms. In accordance with the report of the International Monetary Fund (IMF) as of March 2011, the economic growth rate in Vietnam in 2015 is expected to be 7.5%.

In the 7th National Electric Power Master Plan in Vietnam, which was approved by the Vietnamese government in July 2011, it is anticipated that the demand for electric power will increase with yearly averages of 11% toward 2020, and 16% toward 2030 from 2020. Furthermore, developments of power sources are estimated at 75,000 MW toward 2020 and 146,800 MW toward 2030.

However, in the existing situation, only 70% of the power plants started operation among those planned under the 6th National Electric Power Master Plan in Vietnam. Therefore, severe power shortages have occurred in the cities like Hanoi, Ho Chi Minh (HCM), etc. In addition, it is a concern that power demand and supply in Vietnam will be much tighter, as it might be very difficult to keep the investment schedule on power source development, as mentioned in the 7th National Electric Power Master Plan in Vietnam.

Natural resources are unevenly distributed in Vietnam. The energy sources of power plants in northern Vietnam are mainly hydraulic and coal, while that in southern Vietnam is mainly natural gas. In the 7th National Electric Power Master Plan in Vietnam, construction of coal fired power plants and nuclear power plants are planned considering the recent rise in power demand. As for coal fired power plants, it is planned to be approximately 36,000 MW in 2020 and 70,000 MW in 2030.

The total production capacity of power plants in 2010 is about 20,000 MW, where 38% is from hydraulic power plants in the Mekong and the Red basins. Some problems however have been noted.

The first involves a political matter because the source of both basins is China. The second is power shortage during the dry season.

Recently in Vietnam, large-scale power plants (coal, natural gas, etc.) have been constructed and have started operation one after another, and approximately 60% of the present share of power production is from power plants (about 40% by natural gas, etc. and about 20% by coal). At present, Vietnamese government plans to increase the share of power production by coal fired power plants.

1.1.3 Coal Production in Vietnam

Vietnam has an abundant coal reserves mainly in Quang Ninh Province, north of Vietnam. The biggest coal producer in Vietnam is Vietnam National Coal and Mineral Industries Group ("Vinacomin"). Vinacomin is running the business of developing, producing, transporting and exporting coal, and also operating business on coal fired power plants. It is expected that coal demand for common industries except coal fired power plants will grow with a rate of 6% every year, after 2010.

On the other hand, there is a high possibility that domestic coal production will be insufficient to meet the coal demands after 2015, because coal fired power plants will be constructed suddenly after 2011. Thus, it is planned that coal fired power plants will use imported coal during their operation after 2015. It is necessary to raise domestic coal price to the same level as the international coal price until coal import starts on a large-scale.

1.1.4 Background and Necessity of the Project

"Promoting economic growth and strengthening international competitiveness" are among the important support fields under Japan's assistance program to Vietnam (July 2009). The assistance related to electric power, especially basic power plant facilities, and transmission lines, substations and power distribution network, which are indispensable to provide reliable power supply, is taken up as an essential field in the reliable supply of resource and energy. Therefore, the Project is in line with this program. Considering this, the effort of enforcing power supply capacity serves as a link in the chain of said support fields.

Based on the above situation, the Project corresponds to the important assistance field of Japan and JICA. The necessity to supply reliable power in response to the rapidly increasing power demand is also indicated in the Vietnamese governmental development policy. Thus, the implementation of the Project is highly necessary and suitable.

1.2 JICA Study

1.2.1 Objective of the Study

The Project aims to construct imported coal transshipment terminal as a common infrastructure in southern Vietnam, where the plant is to be developed in cooperation with Sumitomo Corporation and Vietnam Oil and Gas Corporation (PVN). Moreover, other new coal fired power plants are also to be developed. Hence, the objective of the Study is to formulate a project outline for the purpose of implementing the Project based on the provisions for yen loan.

1.2.2 Study Area

The Study area covers Binh Thuan Province, Tra Vinh Province, Soc Trang Province, Ba Ria-Vung Tau Province, Nam Du Island (Kien Giang Province), and Con Dao Island (Ba Ria-Vung Tau Province).

1.2.3 Scope of the Study

The scope of the Study is the formulation of a project outline for the purpose of implementing the Project by applying public-private partnership (PPP) scheme.

1.2.4 Study Items

The main study items are as follows:

1) To collect and analyze related data/information
2) To set up the basic condition of the Project
3) To conduct site and type selection
4) To examine environmental and social aspects at the site, and conduct type selection

1.2.5 Study Team

The study team consists of the following members.

Position	Name
Team Leader	Hiroki HONDA
Deputy Team Leader / Port Planning	Nobuyuki IINUMA
Coal Transport Planning	Yoshinori INOUE
Port Facility Design 1	Yushi ANDO
Port Facility Design 2 / Geotechnical	Masanobu ISHIGURO
Floating Facility Design	Tsuyoshi NOMURA
Coal Terminal Operation	Akira HAGA
Construction Planning / Cost Estimate	Hiroshi OTANI
Environment of Coal Terminal	Shigeru KANAYA
Vietnamese Regulation and Condition for Investment / Analyst for PPP Scheme 1	Kumi OTSUKA
Analyst for PPP Scheme 2	Takayuki SAITO

Chapter 2 Arranging Basic Conditions for the Project

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Chapter 2 Arranging Basic Conditions for the Project

2.1 Conditions at Coal Fired Power Plant Side

2.1.1 Coal Fired Power Plants Using Imported Coal and Coal Supply Volume from Coal Transshipment Terminal Abroad to Each Coal Fired Power Plant

Among the coal fired power plants to start operation before 2030, the following will use imported coal in accordance with the 7th National Electric Power Master Plan in Vietnam, which was approved by the Vietnamese government in July 2011.

Table 2.1.1.1 Development Plan of Coal Fired Power Plants That Will Use Imported Coal

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Long Phu Power Center																		
Long Phu Power Plant I	Capacity (MW)	600	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Coal (mil tons)	1.62	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
Long Phu Power Plant II	Capacity (MW)									600	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Coal (mil tons)									1.62	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
Long Phu Power Plant III	Capacity (MW)												1,000	2,000	2,000	2,000	2,000	2,000
	Coal (mil tons)												2.7	5.4	5.4	5.4	5.4	5.4
Song Hau Power Center																		
Song Hau Power Plant I	Capacity (MW)				600	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Coal (mil tons)				1.62	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
Song Hau Power Plant II	Capacity (MW)														1,000	2,000	2,000	2,000
	Coal (mil tons)														2.7	5.4	5.4	5.4
Song Hau Power Plant III	Capacity (MW)																2,000	2,000
	Coal (mil tons)																5.4	5.4
Duyen Hai Power Center																		
Duyen Hai Power Plant II	Capacity (MW)					600	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Coal (mil tons)					1.62	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24	3.24
Bac Lieu Power Center																		
	Capacity (MW)															1,200	1,200	1,200
	Coal (mil tons)															3.24	3.24	3.24
An Giang Power Center																		
	Capacity (MW)																2,000	2,000
	Coal (mil tons)																5.4	5.4
TOTAL	Capacity (MW)	600	1,200	1,200	1,800	3,000	3,600	3,600	3,600	4,200	4,800	4,800	5,800	6,800	7,800	10,000	14,000	14,000
	Coal (mil tons)	1.62	3.24	3.24	4.86	8.10	9.72	9.72	9.72	11.34	12.96	12.96	15.66	18.36	21.06	27.00	37.80	37.80

Source: 7th National Electric Power Master Plan in Vietnam

The target year of the Study is determined as 2030. Hence, imported coal transshipment terminal will cover requirements of coal fired power plants in southern Vietnam, which will start operation until 2030. Consequently, imported coal transshipment terminal will need to provide approximately 38 million t of coal per year to coal fired power plants, namely: Long Phu Power Plant I, II and III, Song Hau Power Plant I, II and III, Duyen Hai Power Plant II, Bac Lieu Power Center and An Giang Power Center. These plants will require a total of about 3.2 million t of coal per month in 2030.

2.1.2 Berth Dimensions, Stockyard Dimensions and Coal Handling Capacity of Identified Coal Fired Power Plants

The JICA Study Team requested Vinacomin to provide information about berth dimensions, stockyard area, and coal handling capacity of mentioned coal fired power plants. However, Vinacomin replied that they could not provide such information to JICA Study Team. Accordingly, the Study was continued based on available information about Song Hau 1 Power Plant. The information on required parameters of said power plant are shown below.

Table 2.1.2.1 Berth and Stockyard Dimensions, and Coal Handling Equipment of Song Hai 1 Power Plant

Berth Dimensions	Length 170 m, depth 9.93 m (seabed -11.7 m, LWL-1.77 m)
Stockyard Area	9 ha (stock for 30 days)
Coal Unloader Capacity	Continuous unloader (850 t/h) x 2

Regarding the stockyard capacities of Long Phu Power Plant I, II and III, Duyen Hai Power Plant II, and other plants, these are also determined to be suitable for 30 days, similar to that of Song Hau 1 Power Plant in the Study.

2.1.3 Coal Transport Plan

Coal will be transported from imported coal transshipment terminal to each coal fired power plant using less than 5,000 DWT ships or barge, as only these small ships are allowed to sail through the Hau River estuary due to its water depth. At present, the Vietnamese government is developing the Bassac Canal. It will allow a fully loaded 10,000 DWT ship to pass through, but will not allow coal carriers at this moment since Bassac Canal has only a one-way passable area. In addition, the Bassac Canal project is delayed as compared to the original schedule, due to Vietnamese economy's stagnation.

Hence, the corresponding dimensions of 5,000 DWT ship adopted in this Study are as follows:

Design Ship:	5,000DWT coal carrier
LOA:	17.0m
Full draft:	6.4m
Breadth:	17.0m

2.2 Condition of Coal Export at Countryside

2.2.1 Examination of Coal Export Places

(1) Loading port and transportation to the loading port

1) Xstrata/Wandoan and Rolleston:

Both brands of coal are transported by railway from the mine sites to the loading port, and gathered into the stockpile of the coal terminal at the port. Both use R.G. Tanna Coal Terminal at Gladstone Port for their stockpiling before shipment and loading onto coal vessels.

2) PT Tuah Turangga Agung/Top Coal:

From the mine located in Central Kalimantan to the first transit port along the riverside, the coals are transported by dump trucks, and loaded onto the river barge at the transit port. After being transported to the second transit port, the coals are reloaded onto bigger barges to access large (ocean-going) coal transportation vessels waiting at anchorage. Due to restriction of depth, etc., of the river travel, the only option is to transport the coals via two transit ports/stock places using different sizes of barges, up to alongside the ocean-going vessels. Taboneo Anchorage Port is used for loading these brands of coal onto the ocean-going vessels.

3) PT Bayan Resources/Wahana Coal:

The mine for the materials sourced for this brand is located in South Kalimantan, and the method of transportation to the anchorage is almost same with Top Coal, i.e., by dump trucks and river barges. Satui Anchorage Port is used for loading this brand of coals onto the ocean-going vessels.

(2) Information about each loading port

Tables 2.2.1.1 and 2.2.1.2 show the information about each loading port:

Table 2.2.1.1 Information on Coal Terminals at Gladstone Port in Australia

Name of Coal Terminal	RG Tanna Coal Terminal	Barney Point Coal Terminal
User	Multi User	Multi User
Nos. of Berth	4 berths	1 berth
Max. Vessel Size OA	315 m	242 m
Same as above EAM	55 m	45 m
Same as above WT	220,000 DWT	105,000 DWT
Same as above Draft	17-18 m	15 m
Nos. and Capacity of Loader	3x6,000 mt/hr	1x2,000 mt/hr
Contractual Loading Rate	25,000-30,000 LT/day	25,000-30,000 LT/day
Working Hours	24 hrs	24 hrs
Annual Throughput Capacity	70 mt/year	8 mt/year
Congestion	0-14 days	0-14 days

Table 2.2.1.2 Information on Coal Loading Ports in Indonesia

Name of Port	Taboneo	Satui
Location	South Kalimantan	South Kalimantan
Type	Anchorage (Open Sea)	Anchorage (Open Sea)
Max.Draft for Handy Size	13 m	10 m
Max.Draft for Panamax	15 m	12 m
Max.Draft for Cape Size	19 m	16 m
Contractual Loading Rate	10,000-15,000 mt/day	8,000-10,000 mt/day
Loading Facility	Ship's Crane/Floating Crane	Ship's Crane/Floating Crane

(3) Special remarks for each loading port

1) Gladstone Port, Australia

In almost all coal terminals in Australia, the congestion of vessels becomes chronic due to lack of capacities of loading equipment against the increasing demand for export. Gladstone Port is not an exception where it generally experiences a maximum of 14 days congestion (waiting for berthing). To solve this problem, it is planned to expand the coal handling yard and to improve the loading equipment at every terminal.

At RG Tanna Coal Terminal, it is planned to increase the annual throughput capacity, which is currently 70 million t, to about 73 million t by 2016. On the other hand, Barney Point Coal Terminal will be closed by 2014 due to the limitation of its expansion. As an alternative, they are planning to construct a new coal terminal, namely, the Wiggins Coal Terminal, which is aimed to be operational by 2014 for handling 30 million t in Phase 1.

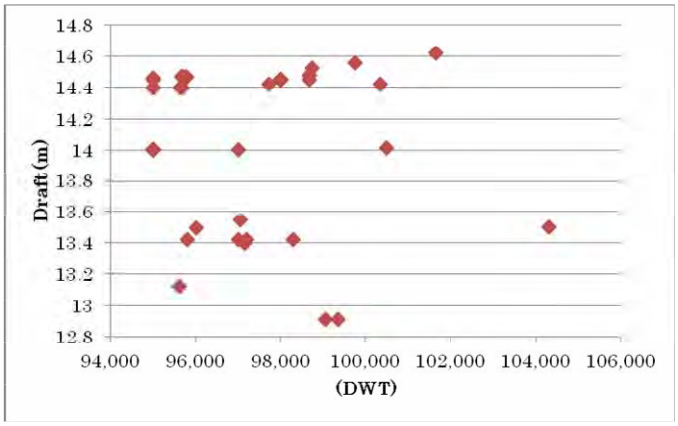
2) Taboneo Port and Satui Port, Indonesia

Taboneo and Satui are both anchorage ports. Compared with fixed berth type of coal terminal, the loading works at anchorage are unstable, subject to weather and sea conditions. In addition, the restrictions in transportation from the mine to the anchorage easily lead to congestion (waiting for loading to start) of coal loading vessels. Each supplier is making efforts to minimize the congestion, using countermeasures such as increasing the stock volume, etc. The main reasons for congestion are considered as follows:

- Waiting time of ocean-going vessels due to the shortage of barges
- Delay in arrangement of floating crane
- Delay of coal supply due to the production trouble at mines
- Delay of coal supply due to trouble in transportation (caused by weather and river conditions)

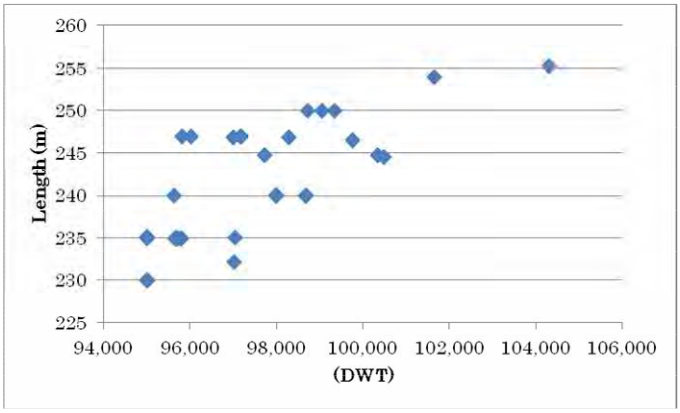
2.2.2 Large Coal Carrier's Dimensions Based on Ship Statistical Data

In order to grasp the world trend of Post-Panamax coal carrier, ship statistical data of around 100,000 DWT coal carrier was purchased from the Fairplay Company, a ship statistical data firm in the UK. These data include not only the existing ships but also ordered ships. Based on these data, the draft, LOA and breadth dimensions are summarized and shown in Figure 2.2.2.1 ~ Figure 2.2.2.3.



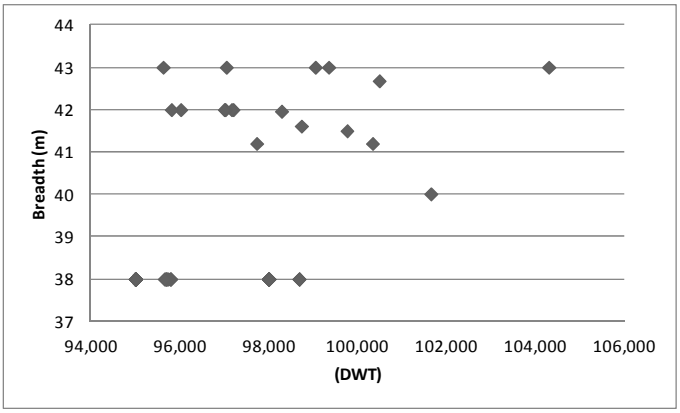
Source: Fairplay

Figure 2.2.2.1 Full Draft of 100,000 DWT Coal Carrier



Source: Fairplay

Figure 2.2.2.2 LOA of 100,000 DWT Coal Carrier



Source: Fairplay

Figure 2.2.2.3 Breadth of 100,000 DWT Coal Carrier

2.2.3 Set-up of Large Coal Carrier

From the above discussion, 100,000 DWT coal carrier is determined as the design vessel of imported coal transshipment terminal in the Study. The following examinations are forwarded based on such conditions. The dimensions of 100,000 DWT coal carrier are therefore shown below.

Design Vessel:	100,000 DWT coal carrier
LOA:	250.0m
Full draft:	14.5m
Breadth:	43.0m

Chapter 3 Understanding the Existing Conditions around Alternative Locations of Imported Coal Transshipment Terminal

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Chapter 3 Understanding the Existing Conditions around Alternative Locations of Imported Coal Transshipment Terminal

3.1 Alternative Locations of Imported Coal Transshipment Terminal

Six alternative sites for fixed terminal, and two alternative sites for floating terminal were given by the Vietnamese government. Therefore, these alternatives are examined in the Study. The locations of the following alternative sites are shown in Figure 3.1.1.

- Binh Thuan (fixed type)
- Cai Mep (fixed type)
- Tra Vinh (fixed and floating types)
- Soc Trang (fixed and floating types)
- Con Dao Island (fixed type)
- Nam Du Island (fixed type)

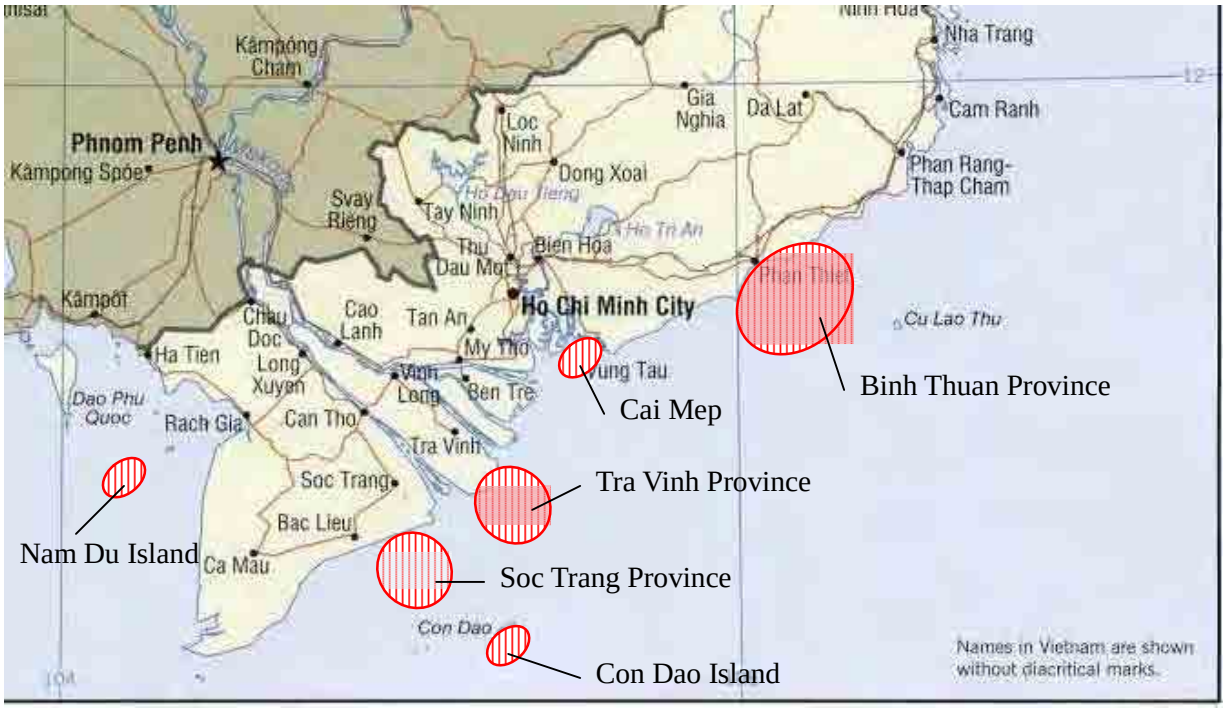


Figure 3.1.1 Alternative Locations of Imported Coal Transshipment Terminal

3.2 Natural Conditions of Each Alternative Location

3.2.1 Existing Data

(1) Binh Thuan (Vinh Tan)

Vinh Tan is located at approximately 200 km northeast from HCM. Dry season at the site is from November to April, and easterly monsoon prevails, while rainy season is from May to November and southwest monsoon prevails. The main natural conditions are described below.

1) Temperature

Monthly average:	24.8~29.5 ºC
Maximum temperature:	39.4 ºC
Minimum temperature:	16.1 ºC

2) Rainfall

Yearly average rainfall:	1,206mm
Yearly maximum rainfall:	1,502mm
Yearly minimum rainfall:	748mm
Monthly maximum rainfall:	206mm

The rainfall from May to October accounts for approximately 90% of yearly rainfall. Rainy days range from 93~153 days in a year.

3) Humidity

Yearly average humidity is 76%, while the maximum is 100% and the minimum is 29%.

4) Fog

Foggy days rarely occur in this area.

5) Wind

According to wind observation from May 2007 to April 2008, the main results are shown below.

Prevailing wind direction:	Southeasterly 12.1%, northeasterly 11%, southwesterly 10.6%
Yearly average wind speed:	3.4m/s
Maximum wind speed:	25.9m/s south-east direction

Strong wind of more than 6 m/s and 7 m/s blows in 43 days and 8 days, respectively.

6) Tide

Tide is governed by irregular diurnal tide regime, with 10 ~ 12 semidiurnal tidal days. Yearly average tidal amplitude is 0.95 m, and yearly maximum tidal amplitude is 2.34 m.

7) Water level

Highest water level (50 years return period):	2.96 m
Designed HWL:	2.42 m
Designed LWL:	0.44 m
Lowest water level (50 years return period):	-0.30 m

8) Wave

Wave direction is significantly affected by monsoon regime.

Prevailing wave direction:	southwesterly (rainy reason), easterly (dry season)

The wave heights observed at the project site from May 2007 to April 2008 are shown below.

Significant wave height (H1/3 average):	0.51 m
Significant wave height (H1/3 maximum):	2.32 m (due to effect of typhoon)

9) Current

Current direction is parallel to the shoreline. The maximum current speed is 0.5 m/s and the average is 0.3 m/s.

10) Soil condition

It is known that there are three kinds of stratum at the site.

Upper layer: This layer consists of mainly marine deposits like broken shell and coral pieces.

The average layer thickness is 5~10m, and N-value is 0~10.

Middle layer: This layer has alternate strata of sand and clay. The average layer thickness ranges from 10~30 m, and N-value is 30~60.

Lower layer: Weathered rock lies with a thickness of 2~8 m. Rock layer lies under the weathered rock layer and its level above is from -30~-37 m. Types of rock vary between granite-porphyry and granodiorite rock.

(2) Cai Mep area

Cai Mep area is located at approximately 60 km southeast from HCM. Its main natural conditions are shown below.

1) Temperature

Yearly average: 27.6 ºC
Maximum: 35.8 ºC
Minimum: 15.0 ºC

2) Rainfall

Yearly average rainfall: 1,347 mm
Yearly maximum rainfall: 1,918 mm
Yearly minimum rainfall: 705 mm
Monthly maximum rainfall: 286 mm

The rainfall from May to October accounts for approximately 90% of yearly rainfall.

3) Humidity

Humidity is between 70% and 80%, while there are some differences between dry and rainy seasons.

4) Fog

Foggy days rarely occur in this area.

5) Wind

Wind data from 1977 to 2005 is shown below. In the rainy season, winds of less than 5 m/s account for over 90%. In the dry season, winds of less than 5 m/s account for approximately 80%, but also vary in some months.

Table 3.2.1.1 Average Wind Speed and Direction in Vung Tau

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average wind speed(m/s)	3.2	4.6	4.7	3.8	2.7	3.2	2.8	2.9	2.3	2.0	2.4	2.1	3.1
Max wind speed(m/s)	15	15	15	15	20	26	20	19	18	14	16	14	26
Wind direction	E	E	E	E	SW	SW	SW	SW	W	NW	E	E	

Source: Vung Tau Station

6) Tide

Tide is governed by irregular semidiurnal tide regime. The tidal amplitude reached by a rising tide is 3.0~4.0 m, and that by falling tide is 1.5~2.0 m. The maximum tidal amplitude is 4.0 m.

7) Water level

HHWL: 4.43 m

HWL: 3.97 m
MWL: 2.67 m
LLWL: 0.58 m

8) Wave

The wave may give a limited effect to the site, because wind speed is slow throughout the year and seabed has a considerably gentle slope. According to the wave observation data at the site from September 1986 to January 1987, the maximum offshore wave height recorded was 3.0 m.

9) Current

About 90% of current in this area is generated by tide. The current direction in a rising tide is N~NE direction, and that in the falling tide is S~SE direction. The maximum current speeds are 1.33 m/s at the surface layer and 0.86 m/s at the bottom layer.

10) Soil condition

Soil composition in this area is classified into five strata as follows:

1st layer: muddy clay, bluish grey to blackish grey, mixed tree root and shell fragments. The layer thickness varies from 16.0 to 34.0 m. The bottom elevation varies from -17.0~-34.0 m (National Datum).

2nd layer: medium sized sand, coarse sand, blackish grey, medium dense, water saturated. The layer thickness varies from 3.3 to 7.0 m. The average bottom elevation is approximately -30.0 m (National Datum).

3rd layer: clay, blackish grey, mixed rotten vegetable and organic fragments, soft plastic. The layer thickness varies from 1.6 to 8.2 m. The bottom elevation varies from -25.2 to -33.5 m (National Datum).

4th layer: clay, whitish grey, yellow, some places mixed sand dune, stiff plastic. The layer thickness varies from 3.5 to 5.1 m. The bottom elevation varies from -25.2 to -33.5 m (National Datum).

5th layer: medium-sized and fine sand, whitish grey, yellow and red, medium dense, water saturated. The layer thickness varies from 1.0 to 4.0 m.

(3) Hau River Estuary (Tra Vinh, Soc Trang)

The Hau River is 319 km from Vietnam – Cambodia border to the river estuary. The Hau River is divided into two branches, 50 km upstream from the river estuary. The main current of said river flows at the western side of Tra Vinh Province, and runs to the sea through Dinh An estuary (Hau River mouth). The sub-current flows at the eastern side of Soc Trang Province, and runs to Tran De estuary (Hau River mouth).

Dry season is from November to April and rainy season is from May to November. The easterly and southwesterly monsoon prevails during the dry season and rainy season, respectively. The main natural conditions are shown below.

1) Temperature
Yearly average: 26.5 ºC
Maximum: 36.2 ºC
Minimum: 20.6 ºC

2) Rainfall
Yearly average rainfall: 2,106 mm
Yearly maximum rainfall: 2,391 mm

Yearly minimum rainfall: 1,821 mm

The rainfall from May to October accounts for approximately 90% of yearly rainfall. Rainy days in a year vary from 137 to 178 days.

3) Humidity

Yearly average humidity is 83% and the maximum humidity is 95%.

4) Fog

Foggy days rarely occur in this area.

5) Wind

According to wind observation from May 2007 to April 2008, the main results are as shown below.

Prevailing wind direction:	Southeasterly 12.1%, northeasterly 11%, southwesterly 10.6%
Yearly average wind speed:	6.79 m/s
Maximum wind speed:	25.7 m/s

Strong winds of more than 9~12m/s blow in 85 days (23.4%) according to offshore wind data from 1999 to 2008.

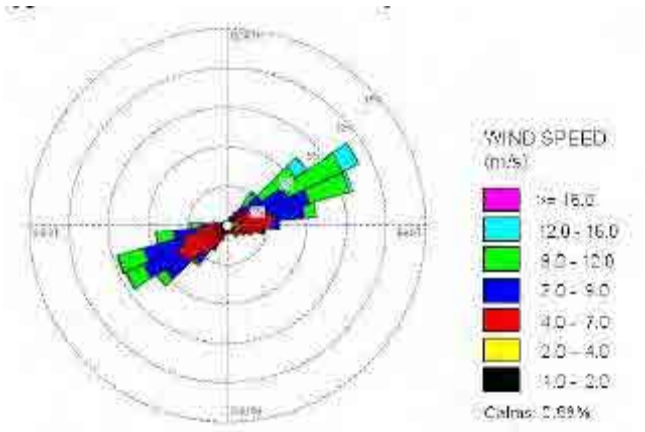


Figure 3.2.1.1 Offshore Wind Rose in the South Center Region from 1999 to 2008

6) Tide

Tide is governed by irregular semidiurnal tide regime. The tidal amplitude reached by a rising tide is 3.0 m, and that by falling tide is 1.8 m. The maximum tidal amplitude is 3.9 m.

7) Water level

HHWL:	5.17 m
HWL:	4.71 m
MWL:	3.13 m
LWL:	1.22 m
LLWL:	0.92 m

8) Wave

Wave direction is considerably affected by the monsoon regime. The offshore wave rose is shown below.

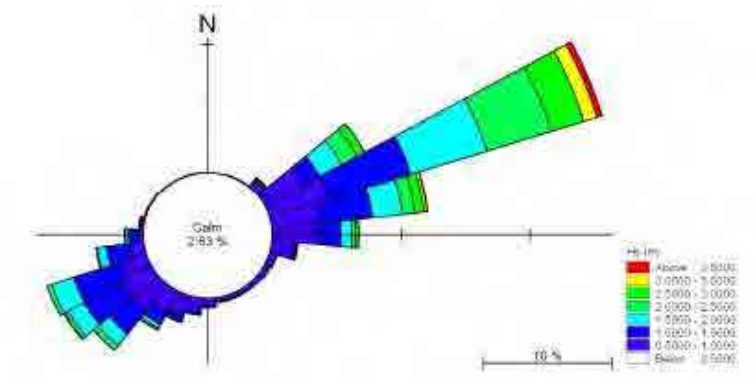


Figure 3.2.1.2 Offshore Wave Rose

Prevailing wave direction: southwesterly (rainy season), easterly (dry season)

Less than 1.0 m wave height accounts for 47%, and less than 2.0 m for 82%.

9) Current

Current direction is parallel to the shoreline. The maximum current speed is 2.1 m/s and the average current speed is 1.6 m/s.

10) Geographic and soil conditions

According to the existing boring data obtained from soil investigation adjacent to the site, geographic and soil conditions are assumed as follows:

a) Geographic features

The soil strata at the site are classified into nine layers according to the sequence of data obtained. Soil conditions and N-value distributions of each soil strata are shown in Table 3.2.1.2.

Table 3.2.1.2 Soil Conditions and N-values of Each Soil Strata

Layer	Soil Description	N-value	
		Range	Average
1	Silty-clayey **Sand** (very loose)	0 ~ 13	5
2	**Clay** (very soft)	0 ~ 2	0
3	**Clay** (stiff)	5 ~ 32	14
4	Clayey **Sand** (medium dense)	7 ~ 50	24
5	**Clay** (stiff to very stiff)	7 ~ 50	19
6	Clayey **Sand** (medium dense)	9 ~ 50	25
7	**Clay** (very stiff)	9 ~ 50	28
8	**Clay** (hard)	30 ~ 50	37
9	Silty-clayey **Sand** (very dense)	39 ~ 50	49

Typical section of soil strata is shown in Figure 3.2.1.3. The sand layer (Layer-1) piles up with a thickness of 2 m to the surface. Under Layer-1, very soft clay layer (Layer-2) with N-value of 0~2 (average N-value of 0) piles up with a thickness of 16 m. Under Layer-2, a stiff clay layer (Layer-3) of average N-value of 14 is laid. Then, under Layer-3, comparatively dense sand layers (Layer-4 and Layer-6) with N-values of more than 20 and stiff clay layers (Layer-5 and Layer-7) pile up alternately

Under such layers, stiff clay layer (Layer-8) with N-value of more than 30, and very dense sand layer (Layer-9) with N-value of 50, are lying. These layers can serve as bearing strata for pile foundation, etc.

Layer	Soil	Elevation (m)
1	Sand	-2
2	Clay	-18
3	Clay	-22
4	Sand	-29
5	Clay	-41
6	Sand	-43
7	Clay	-46
8	Clay	-54

Figure 3.2.1.3 Typical Soil Strata

b) Soil features

Laboratory tests were carried out using disturbed and undisturbed samples from boring works. As a result, soil characteristics of each soil layer in this area were revealed.

Physical features about all soil layers were examined. The examination result is shown in Table 3.2.1.3.

Table 3.2.1.3 Physical Features of Each Soil Layer

(Average)

Item			Layer								
			1 (Sand)	2 (Clay)	3 (Clay)	4 (Sand)	5 (Clay)	6 (Sand)	7 (Clay)	8 (Clay)	9 (Clay)
N-value			5	0	14	24	19	25	28	37	49
Natural Water Content	Wn	(%)	30.0	56.9	27.4	24.2	28.3	23.4	26.0	24.2	23.7
Wet Density	γt	(g/cm^3)	1.86	1.64	1.92	1.91	1.93	1.90	1.93	1.99	1.92
Dry Density	γd	(g/cm^3)	1.43	1.06	1.51	1.54	1.51	1.54	1.53	1.60	1.53
Specific Gravity	Gs	(g/cm^3)	2.68	2.70	2.71	2.69	2.72	2.70	2.71	2.71	2.70
Saturation	Sr	(%)	91.8	96.5	92.3	86.8	95.2	84.4	91.6	94.5	88.7
Void Ratio	e_0		0.887	1.590	0.807	0.755	0.806	0.754	0.776	0.694	0.769
Liquid Limit	LL	(%)	26.8	56.6	44.7	30.0	53.2	29.7	43.8	51.8	32.7
Plastic Limit	PL	(%)	17.9	27.9	21.3	18.0	24.6	17.8	22.7	22.6	19.8
Plasticity Index	Ip		8.9	28.7	23.4	12.1	28.6	11.9	21.1	29.2	12.9
Liquidity Index	I_L		0.99	1.08	0.31	0.53	0.17	0.56	0.19	0.15	0.36

(4) Con Dao Island

Con Dao Island is located about 83 km offshore from the Hau River estuary. Con Dao consists of 16 islands. The sea area between Con Son Island and Hon Ba Island is the Ben Dam basin. Though Ben Dam basin is a sheltered area, it is so shallow that only 2,000 DWT ships can come into the area at present. Dry season is from November to April, and rainy season is from May to November. The main natural conditions are shown below.

1) Temperature

Yearly average temperature:	27.0 ºC
Monthly average maximum temperature:	36.0 ºC
Monthly average minimum temperature:	17.7 ºC

2) Rainfall

Yearly average rainfall:	2,095 mm
Yearly maximum rainfall:	3,000 mm
Monthly maximum rainfall:	338 mm
Monthly minimum rainfall:	6 mm

3) Humidity

Humidity ranges between 70% and 80%, while there are some differences between dry and rainy seasons.

4) Fog

Foggy days rarely occur in this area.

5) Wind

Yearly average wind speed:	4.2~5.1 m/s (dry season: December ~ April), 2.9~4.1 m/s (rainy season: May ~ October)
Maximum wind speed:	47.3 m/s
Prevailing wind direction:	NE~E - W~SW

6) Tide

Tide is governed by irregular semidiurnal tide regime. The maximum tidal amplitude is 4.0m.

7) Water level

HHWL:	1.88 m
MWL:	0.33 m
LLWL:	-1.81 m

8) Wave

NE~N wave prevails during dry season. The average wave height is 1.2 m and the average height of swell is 2.2 m. During rainy season, S~SW wave prevails with average wave height of 0.9 m and average swell height of 1.7 m.

9) Current

W~SW current prevails during dry season, and the average current speed is 0.31 m/s. E~NE current prevails in rainy season, and the average current speed is 0.20 m/s.

10) Soil conditions

The soil composition in this area can be classified into four strata.

Layer 1:	sand mixed dust and gravel, whitish grey, mixed shell, broken coral, medium dense. Layer thickness is 7.5~9.1 m.
Layer 2:	sandy clay, dense, brownish yellow. Layer thickness is 8.5 m.
Layer 3a:	sandy clay, soft plastic, light grey. Layer thickness is 3.6 m.
Layer 3b:	sandy clay, stiff plastic, brownish grey. Layer thickness is 3.6 m.
Layer 4:	rock, whitish grey, stiff. Layer thickness is 0.3 m.

(5) Nam Du Island

Nam Du Island is located in Kien Giang Bay and is about 54 km away from Kien Giang Coast. Dry season in the island is from November to April, and rainy season is from May to November. Its main natural conditions are shown below.

1) Temperature

Yearly average temperature:	27.0 ºC
Monthly average maximum temperature:	30.0 ºC
Monthly average minimum temperature:	23.9 ºC
Maximum temperature:	38.1 ºC
Minimum temperature:	16.0 ºC

2) Rainfall

Yearly average rainfall:	2,500 mm
Yearly maximum rainfall:	3,000 mm

The rainfall from May to December accounts for approximately 80% of yearly rainfall.

3) Humidity

There is no description on the collected data. However, it is expected that the average humidity ranges between 70~80%.

4) Fog

Foggy days rarely occur in this area.

5) Wind

Yearly average wind speed:	3.4 m/s (dry season: December ~ April), 4.3 m/s (rainy season: May ~ October)

Thunderstorm often occurs in the early rainy season, especially in May and June, with an average of 6~8 days in a month. Wind velocity during thunderstorm can reach 20~30 m/s; however, storm and tropical depression hardly affect the site. It is noted that there were only four storms that hit the area during the past 50 years.

6) Tide

Tide is governed by irregular diurnal tide regime with mixed 2~3 days semidiurnal days. The tidal amplitude reached by rising tide is 1.4 m, and that by falling tide is 0.2~0.4 m.

7) Water level

Highest high water level:	1.20 m
HWL (1%):	1.00 m
MWL (50%):	0.03 m
LWL (99%):	-0.70 m
Lowest low water level:	-0.90 m

8) Wave

Wave is significantly affected by monsoon regime. As the easterly monsoon prevails in the dry season, it can be sheltered partly by the island. However, there is no detailed data available. In the rainy season, offshore wave is affected by southeast monsoon and its height reaches 1.5~2.0 m.

9) Current

The current direction is NW-SE, and its average speed is 0.15~0.25 m/s.

10) Soil conditions

The data on soil conditions at the site were not available.

3.2.2 Additional Observation Data

(1) Observation Points

The observations of three items, such as wind direction and speed, wave and current, were conducted in about one week. The observation points are shown below.

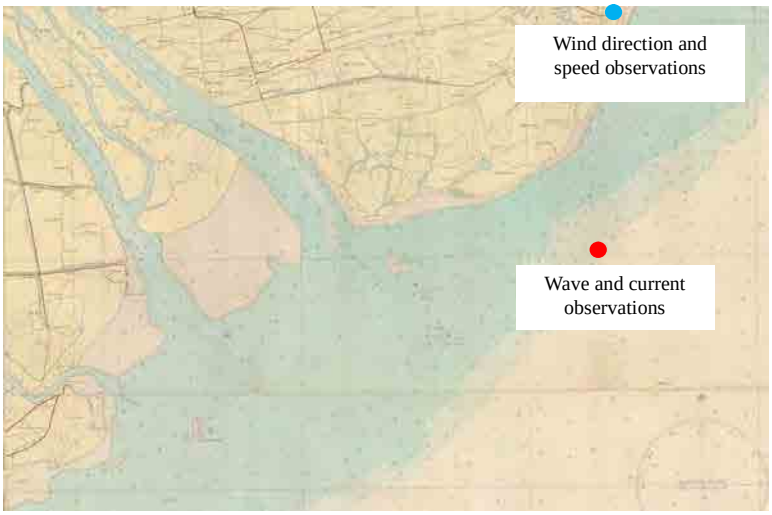
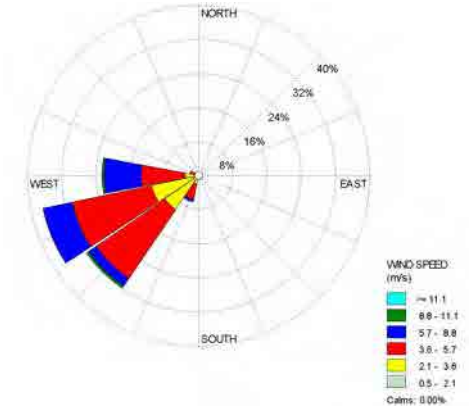


Figure 3.2.2.1 Additional Observation Points

(2) Observation Results

The observation results on wind direction and speed, wave and current are shown in Figures 3.2.2.2 ~ 3.2.2.4.

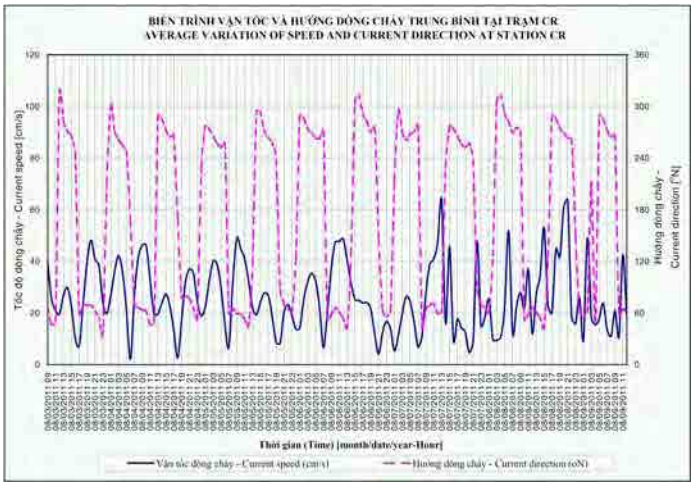


Source: JICA Study Team

Figure 3.2.2.2 Wind Rose from August 2, 2011 to August 9, 2011

Source: JICA Study Team

Figure 3.2.2.3 Time Series of Wave Height and Wave Direction from August 3, 2011 to August 9, 2011



Source: JICA Study Team

Figure 3.2.2.4 Time Series of Current Direction and Speed from August 3, 2011 to August 9, 2011

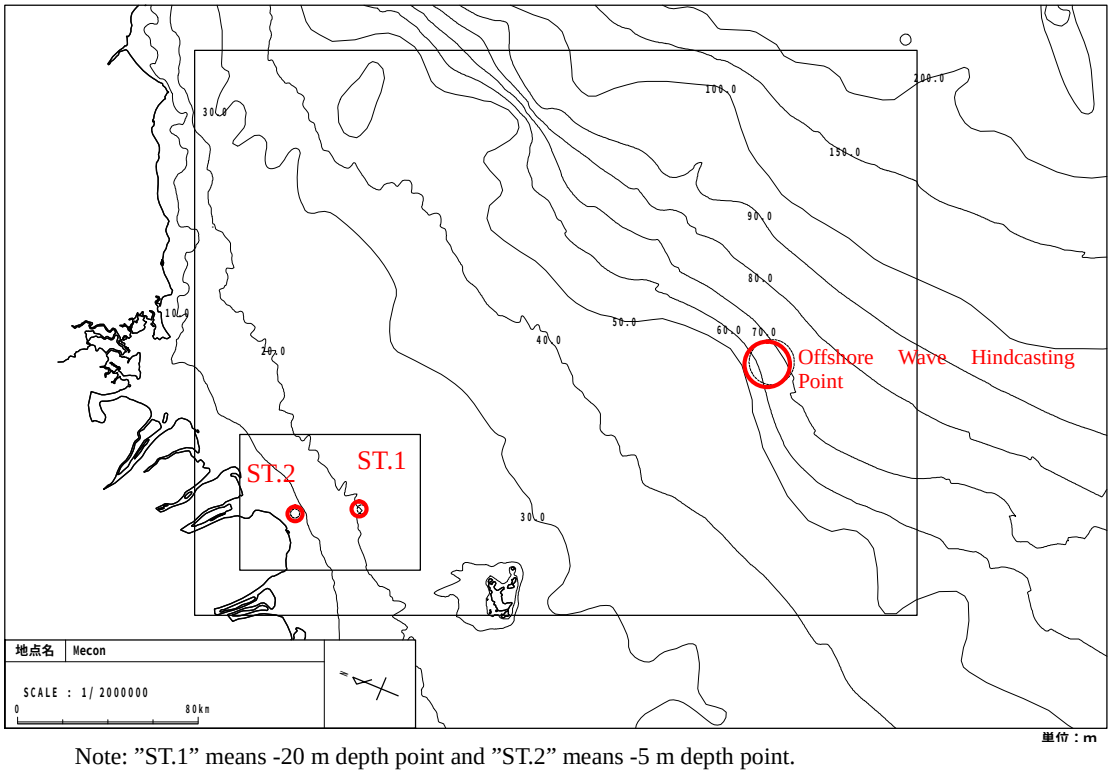
The following were found out in these observations:

- The maximum wind speed during the observation was 18.15 m/s (15.10 on August 6).
- During the observation, the average wave height was 0.62 m, and the maximum was 1.14 m.
- During the observation, the average current speed was 0.26 m/s, and the maximum was 0.64 m/s.

3.2.3 Wave Deformation Calculation

(1) Offshore wave hindcasting point and wave deformation calculation points

The offshore wave hindcasting data from 2000 to 2010 was purchased from the Met Office, which is UK's national weather service. Then, the wave deformation calculation was carried out from the offshore to the Mekong River estuary. The offshore wave hindcasting point and the alternative project site are shown below. As alternative project site, ST.1 for large vessels with a depth of -20 m and ST.2 for small vessels with a depth of -5 m, are set up.



Note: "ST.1" means -20 m depth point and "ST.2" means -5 m depth point.

Figure 3.2.3.1 Location Map of Offshore Wave Hindcasting Point and Wave Deformation Calculation

(2) Calculation result of wave deformation

The wave deformation at ST.1 and ST.2 was calculated using offshore wave data from 2000 to 2010. The results are summarized by wave height and direction as shown in Tables 3.2.3.1 and 3.2.3.2. The compound frequency tables by wave height and direction in every three months are shown in the Appendix of this report.

The directions of EN and SW are prevailing at ST.1. The wave height of less than 4.0 m accounts for 99%. However, it might be difficult to plan imported coal transshipment terminal without breakwater because wave heights of less than 1.5 m account for 67.9%. For reference, in accordance with "Technical Standards and Commentaries for Port Facilities in Japan", it is recommended that wave heights of less than 0.5 m should account for 95% in the usual port planning.

The directions of ENE and SSW prevail at ST.2. It is indicated that waves are refracted while they are travelling from ST.1 to ST.2. It is understood that waves decrease due to refraction and seabed friction during travelling. The percentage of wave heights less than 1.5m is increased from 67.9% at ST.1 to 81.6% at ST.2.

Table 3.2.3.1 Yearly Compound Frequency Table by Wave Height and Direction (ST1:2000 ~ 2010)

Mecon ERR : 640

Deg / H(m)		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	出現頻度 (回)	出現頻度 (%)	超過出現頻度 (回)	超過出現頻度 (%)
CALM																		1201	1201	3.8	1201	3.8
~ 0.1		0	0	14	20	18	21	2	6	3	4	0	0	0	0	0	0		88	0.3	1289	4.1
~ 0.2		0	30	102	95	30	20	16	21	32	34	17	0	0	0	0	0		397	1.3	1686	5.4
~ 0.3		0	40	72	12	15	9	5	12	40	35	7	0	0	0	0	0		247	0.8	1933	6.2
~ 0.4		4	155	173	8	15	8	8	20	32	85	19	0	0	0	0	0		527	1.7	2460	7.8
~ 0.5		13	370	353	37	22	11	15	118	170	225	52	0	0	0	0	0		1386	4.4	3846	12.2
~ 0.6		17	846	533	114	25	11	16	84	180	279	67	0	0	0	0	0		2172	6.9	6018	19.2
~ 0.7		26	865	427	62	16	2	16	42	224	351	79	0	0	0	0	0		2110	6.7	8128	25.9
~ 0.8		24	1029	518	51	14	4	5	50	190	349	88	0	0	0	0	0		2322	7.4	10450	33.3
~ 0.9		14	836	319	46	9	4	5	34	213	441	174	0	0	0	0	0		2095	6.7	12545	39.9
~ 1.0		17	875	374	50	0	2	0	29	190	524	176	0	0	0	0	0		2237	7.1	14782	47.1
~ 1.1		3	795	383	37	2	0	0	12	150	318	105	0	0	0	0	0		1805	5.7	16587	52.8
~ 1.2		16	624	262	5	0	0	0	6	100	261	98	0	0	0	0	0		1372	4.4	17959	57.2
~ 1.3		11	528	223	6	0	0	0	1	79	143	79	0	0	0	0	0		1070	3.4	19029	60.6
~ 1.4		8	638	267	5	0	0	0	6	65	204	82	0	0	0	0	0		1275	4.1	20304	64.7
~ 1.5		3	465	208	2	0	0	0	5	58	199	68	0	0	0	0	0		1008	3.2	21312	67.9
~ 1.6		7	414	143	2	0	0	0	0	101	281	88	0	0	0	0	0		1036	3.3	22348	71.2
~ 1.8		15	1024	334	1	0	0	0	0	106	243	72	0	0	0	0	0		1795	5.7	24143	76.9
~ 2.0		6	1031	157	2	0	0	1	0	59	151	50	0	0	0	0	0		1457	4.6	25600	81.5
~ 2.2		5	983	92	1	0	1	1	0	26	65	36	0	0	0	0	0		1210	3.9	26810	85.4
~ 2.4		8	792	54	1	0	0	0	0	12	41	18	0	0	0	0	0		926	2.9	27736	88.3
~ 2.5		5	316	14	0	0	0	0	0	7	8	5	0	0	0	0	0		355	1.1	28091	89.4
~ 3.0		21	1490	46	0	0	0	0	0	11	19	11	0	0	0	0	0		1598	5.1	29689	94.5
~ 3.5		0	951	17	0	0	0	0	0	0	0	0	0	0	0	0	0		968	3.1	30657	97.6
~ 4.0		0	415	5	0	0	0	0	0	0	0	0	0	0	0	0	0		420	1.3	31077	99.0
~ 5.0		0	321	3	0	0	0	0	0	0	0	0	0	0	0	0	0		324	1.0	31401	100.0
5.0 ~		0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0		5	0.0	31406	100.0
出現頻度	(回)	223	15838	5093	557	166	93	90	446	2048	4260	1391	0	0	0	0	0	1201	31406	100.0		
	(%)	0.7	50.4	16.2	1.8	0.5	0.3	0.3	1.4	6.5	13.6	4.4	0.0	0.0	0.0	0.0	0.0	3.8	100.0			

Source: Wave deformation was calculated by the JICA Study Team based on offshore wave data provided from Met Office (UK).

Table 3.2.3.2 Yearly Compound Frequency Table by Wave Height and Direction (ST2:2000 ~ 2010)

Mecon ERR : 640

Deg / H(m)		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	出現頻度 (回)	出現頻度 (%)	超過出現頻度 (回)	超過出現頻度 (%)
CALM																		1201	1201	3.8	1201	3.8
~ 0.1		0	0	24	52	23	23	2	12	36	1	0	0	0	0	0	0		173	0.6	1374	4.4
~ 0.2		0	0	122	91	57	21	17	56	90	4	0	0	0	0	0	0		458	1.5	1832	5.8
~ 0.3		0	24	322	18	15	11	6	61	264	23	0	0	0	0	0	0		744	2.4	2576	8.2
~ 0.4		0	66	806	96	23	9	17	187	504	41	0	0	0	0	0	0		1749	5.6	4325	13.8
~ 0.5		0	170	1853	205	35	12	21	298	847	46	0	0	0	0	0	0		3487	11.1	7812	24.9
~ 0.6		0	173	1422	144	34	11	27	322	949	71	0	0	0	0	0	0		3153	10.0	10965	34.9
~ 0.7		0	201	1580	122	26	4	11	213	790	57	0	0	0	0	0	0		3004	9.6	13969	44.5
~ 0.8		0	184	1184	143	22	3	3	155	544	40	0	0	0	0	0	0		2278	7.3	16247	51.7
~ 0.9		0	160	1107	101	9	6	5	144	534	34	0	0	0	0	0	0		2100	6.7	18347	58.4
~ 1.0		0	87	918	92	2	2	0	62	380	32	0	0	0	0	0	0		1575	5.0	19922	63.4
~ 1.1		0	66	843	51	0	0	0	84	327	13	0	0	0	0	0	0		1384	4.4	21306	67.8
~ 1.2		0	79	920	42	0	0	0	61	267	13	0	0	0	0	0	0		1382	4.4	22688	72.2
~ 1.3		0	58	715	21	0	0	0	47	147	10	0	0	0	0	0	0		998	3.2	23686	75.4
~ 1.4		0	74	889	10	0	0	0	31	116	6	0	0	0	0	0	0		1126	3.6	24812	79.0
~ 1.5		0	46	688	8	0	0	0	19	45	3	0	0	0	0	0	0		809	2.6	25621	81.6
~ 1.6		0	47	735	7	0	0	0	7	42	1	0	0	0	0	0	0		839	2.7	26460	84.3
~ 1.8		0	103	1062	4	0	0	0	11	40	0	0	0	0	0	0	0		1220	3.9	27680	88.1
~ 2.0		0	86	819	3	1	1	2	5	18	0	0	0	0	0	0	0		935	3.0	28615	91.1
~ 2.2		0	119	669	4	0	0	0	2	5	0	0	0	0	0	0	0		799	2.5	29414	93.7
~ 2.4		0	98	593	3	0	0	0	0	0	0	0	0	0	0	0	0		694	2.2	30108	95.9
~ 2.5		0	40	186	1	0	0	0	0	0	0	0	0	0	0	0	0		227	0.7	30335	96.6
~ 3.0		0	41	663	4	0	0	0	0	0	0	0	0	0	0	0	0		708	2.3	31043	98.8
~ 3.5		0	25	275	1	0	0	0	0	0	0	0	0	0	0	0	0		301	1.0	31344	99.8
~ 4.0		0	12	48	0	0	0	0	0	0	0	0	0	0	0	0	0		60	0.2	31404	100.0
~ 5.0		0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0		2	0.0	31406	100.0
5.0 ~		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	31406	100.0
出現頻度	(回)	0	1959	####	1223	247	103	111	1777	5945	395	0	0	0	0	0	0	1201	31406	100.0		
	(%)	0.0	6.2	58.7	3.9	0.8	0.3	0.4	5.7	18.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0	3.8	100.0			

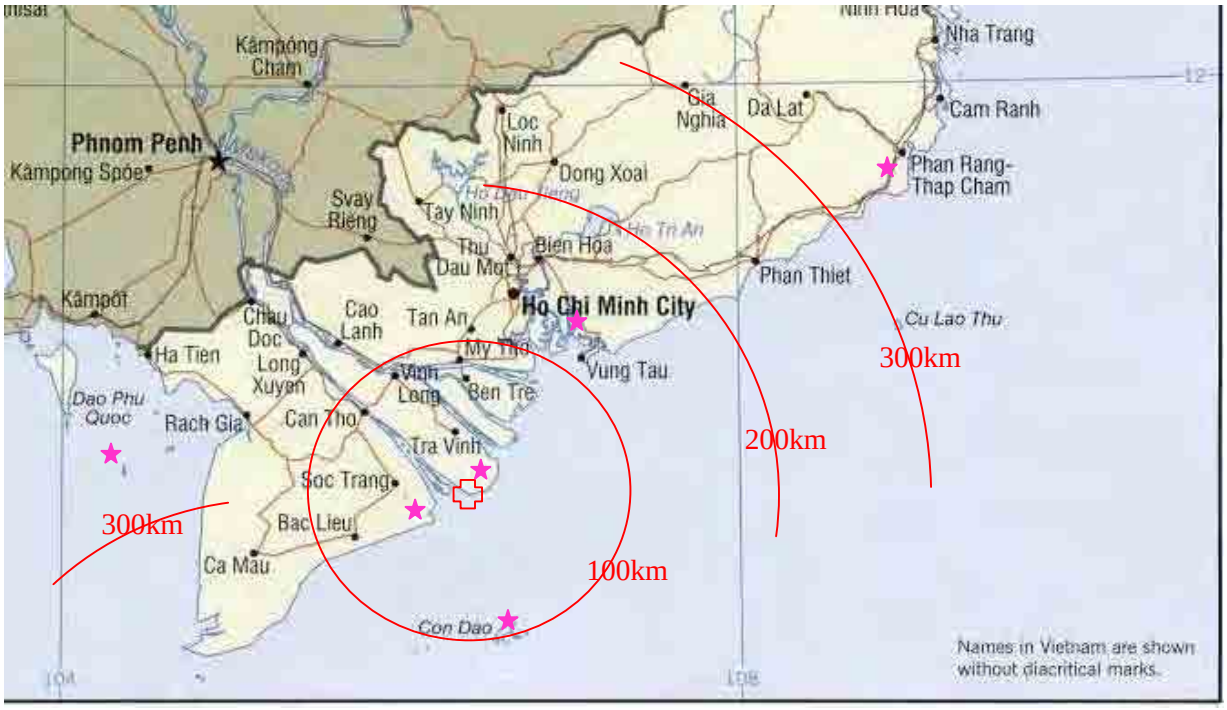
Source: Wave deformation was calculated by the JICA Study Team based on offshore wave data provided from Met Office (UK).

3.3 Geographical Conditions

The distances from the origin of the Hau River estuary to each alternative site for imported coal transshipment terminal are identified as shown below.

Tra Vinh: 15km (offshore transshipment point)
Soc Trang: 20km (offshore transshipment point)
Con Dao: 80km
Cai Mep: 120km
Vinh Tan: 350km
Nam Du: 350km

Here, it is understood that it might not be realistic to transport coal for a distance of 350 km everyday, from the view of both stable coal supply from imported coal transshipment terminal to the related power plant and safe coal transport considering oceanographic condition.



Note: ★ indicates each alternative site for imported coal transshipment terminal.

Figure 3.3.1 Distances from Hau River Estuary to Each Alternative Site for Imported Coal Transshipment Terminal

3.4 Social Condition

3.4.1 Upper Level Plan

The Port Sector Master Plan toward 2020 in Vietnam was approved by the prime minister in December 2009. It includes the following three ports that will receive coal for coal fired power plants:

- Nghi Son Port (Thanh Hoa Province)
- Vung Ang Port (Ha Tinh Province)
- Vinh Tan Port (Binh Thuan Province)

Unfortunately, only Vinh Tan Port (Binh Thuan Province) is related to the Study.

3.4.2 Land Use

(1) Binh Thuan (Vinh Tan)

The following are the construction plans for the Vinh Tan coal fired power plants:

Vinh Tan Phase I (2013):	2x600 MW (domestic coal to be used)
Vinh Tan Phase II (2013):	2x622 MW (domestic coal to be used)
Vinh Tan Phase III (2015):	3x660 MW (imported coal to be used)

A port receiving imported coal is required to import yearly 6 million t of coal under Phase III. There is an option to upgrade this port to an imported coal transshipment terminal. This area has a geographical advantage considering that several kilometers offshore reach -20 m deep. However, it would be unrealistic because the distance to the Hau River estuary is over 350 km.

(2) Tra Vinh (Duyen Hai)

The following are the construction plans for Duyen Hai coal fired power plants.

Duyen Hai I.1 (2014):	600 MW (domestic coal to be used)
Duyen Hai I.2 (2015):	600 MW (domestic coal to be used)
Duyen Hai II.1 (2018):	600 MW (imported coal to be used)
Duyen Hai II.2 (2019):	600 MW (imported coal to be used)
Duyen Hai III.1 (2015):	600 MW (domestic coal to be used)
Duyen Hai III.2 (2016):	600 MW (domestic coal to be used)
Duyen Hai III.3 (2019):	600 MW (domestic coal to be used)

A port receiving 30,000 DWT coal carrier is planned to receive imported coal under Phase II of Duyen Hai. The northern breakwater is planned to be 3.9 km, and that of southern breakwater is 2.5 km. Channel depth is 9.5 m. Yearly coal handling volume is estimated at 12 million t.

(3) Tra Vinh (Bassac Canal)

Bassac Canal is planned adjacent to the said Duyen Hai coal fired power plant. It is a diversion of Dinh An in the Hau River estuary as shown in the location map in Figure 3.4.2.1. When Bassac Canal is opened, 10,000 DWT cargo ships can sail during high tide. The existing Bassac Canal can only accommodate one way travel. Moreover, coal carriers cannot pass through the Bassac Canal. Accordingly, coal carriers from imported coal transshipment terminal to coal fired power plants along the Hau River have to sail through Dinh An.

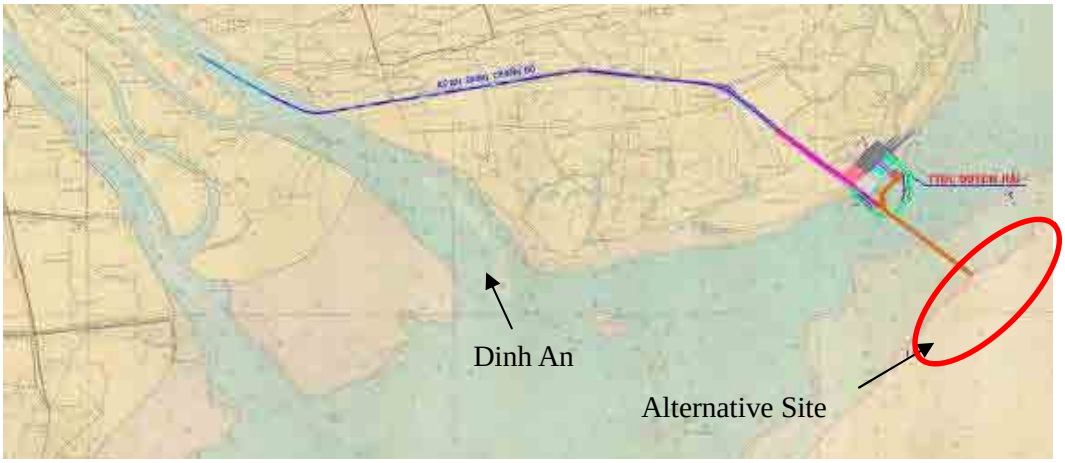


Figure 3.4.2.1 Duyen Hai Coal Fired Power Plant and Bassac Canal (Planned)

(4) Cai Mep

Oil and chemical industrial zone including an oil refinery plant is planned to be constructed in Long Son Island, which is just the eastern side of the alternative study site. Long Son Oil Refinery project is planned on an area of 810 ha, undertaken into two development stages, namely, 650 ha in stage 1 and 160 ha expansion in stage 2. The expected output of said refinery is 10 million t per year and its operation will start in 2012.

Port facilities comprise export port, crude oil pipeline and single point mooring (SPM). The port is planned to have about 1.5 km berth length and 250 m width, including three berths for export products namely, one for 5,000-50,000 t for liquid product, one for 5,000 t for LNG, and one for 20,000-50,000 t for sulfur. Total water area of the port including turning basin is estimated to be 150 ha. The designed access channel is 5 km long, -15 m deep and 300 m wide. The crude oil pipeline is planned to be 25 km in length, connected to the factory from SPM, which will be located 8 km from Vung Tau, toward the southeast offshore.

Gemadept Terminal in Cai Mep, which is located at the western side of the site, is planned to receive 16,000 TEU large container vessels. Its access channel is expected to be deeper than -16 m.

Developing an access channel to imported coal transshipment terminal with branching out of such access channel, can considerably save on dredging cost.

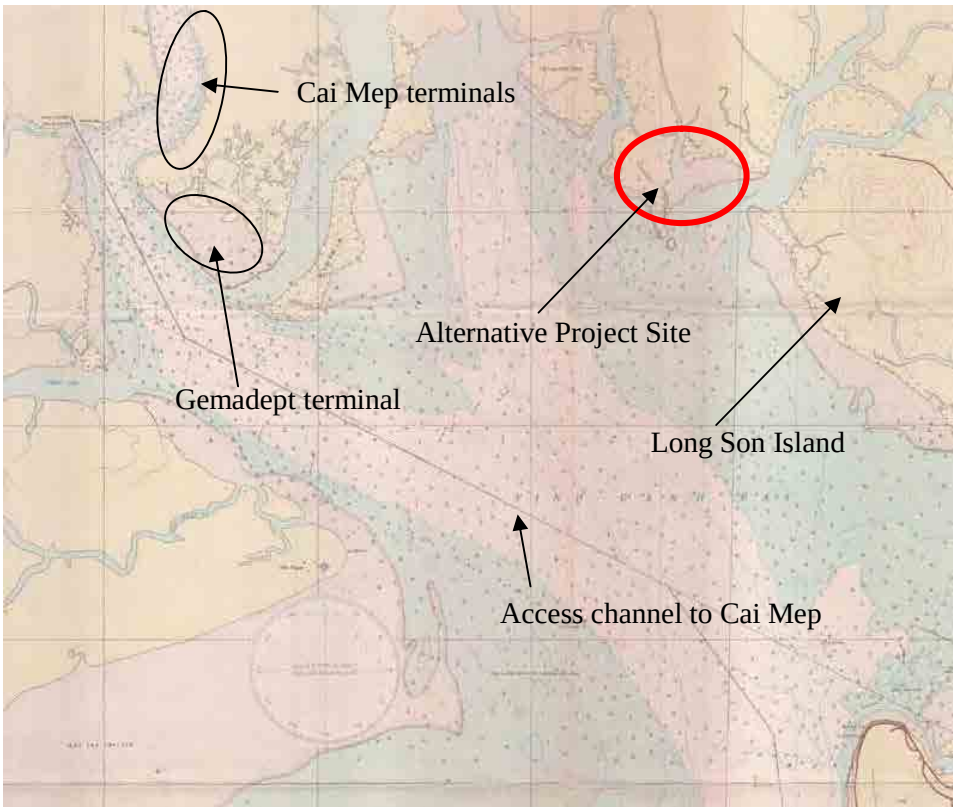


Figure 3.4.2.2 Planned Large-scale Projects in Cai Mep

(5) Nam Du Island

Construction plans for coal fired power plants at Nam Du Island are as follows:

Kien Luong Phase I (2019-2020):	2x600 MW (domestic coal to be used)
Kien Luong Phase II (2023-2024):	2x600 MW (domestic coal to be used)
Kien Luong Phase III (2027-2028):	2x600 MW (domestic coal to be used)

Offshore transshipment port is planned to provide imported coal to these power plants and to serve as a hub port in the Mekong Delta, divided into two phases. Planned cargo throughputs in each phase are as follows:

Phase 1: Imported coal - 12 million t, general cargo - 5 million t
Phase 2: Imported coal - 50 million t, general cargo - 12 million t

3.5 Environmental Condition

3.5.1 Social Environment of Proposed Sites

(1) Con Dau Island

1) Population

According to government census, the population of Con Dao is about 5,700 in 2007, and has increased to 6,000 in year 2010. Based on the socio-economic development plan set up to 2020 by the government, Con Dao is designated to be a modern tourism economic area. As a result, its population will be expected to increase continuously due to increase economic activity in the future.

2) Industry

The scale of tourism investment in the island is steadily growing, with 30 investment projects in the tourism services sector. Increase of industrial production is 11.1%, agriculture - forestry - fishery is 14.24%, and trade - service is 29.1%.

According to Decision No. 264/2005/QD-TTg dated 25th Oct 2005 of the ministry of the government on the approval of industry development for Con Dao District to 2020, the district administrator has made up the following specific action plans for implementation of projects on infrastructures and tourism:

- By 2020, Con Dao will complete all road infrastructures around the island and waterway facilities; upgrade airports and other public welfare facilities; develop electricity, water and telecommunications infrastructure to ensure smooth and high speed communication; expand transport network and diversify methods of high quality transport between the island and the mainland, as well as within Con Dao.
- In 2011 and subsequent years, turn Con Dao Island into a high quality economy - tourism service area associated with preservation and restoration of historical and revolutionary relics of Vietnam.
- Develop and enhance the value of Con Dao National Park, making the island more suitable with its frontline position, to contribute actively in the process of opening, and integrating with the international community, which is closely linked with the development of the southern region.

3) Economy

In 2010, the socio-economic criteria set for Con Dao District was accomplished. The target GDP per capita of USD 1,051 was exceeded. The total social capital invested in Con Dao to the end of 2010 is estimated to be VND 1,470 billion, which is 132.79% of the target. GDP is estimated to be VND 468.12 billion, which is 103.5% of the target, and the average annual increase is 17.85%. The total revenue on trade services reached VND 4,215 billion and annual average growth is 21.17%.

4) Summary of tourism

Con Dao is an archipelago comprising of 16 islands, which belong to Ba Ria–Vung Tau Province. It is famous for its crystal clear blue-green waters, beautiful sand beaches, mangrove forests and beautiful coral reefs. Con Dao National Park is at the center of the archipelago of islands, the largest of which is Con Son. There are no permanent watercourses on any of the islands, only seasonal streams. During the rainy season, water is plentiful, but seriously lacking in the dry season.

The development of the archipelago will focus on sustainable tourism. The proposed master plan prohibits the building of factories or exploitation of the marine environment in any way deemed detrimental to the archipelago's future. Development must be environmentally friendly and in keeping with the island's marine and terrestrial ecology.

5) Number of tourist visitors

According to Con Dao Historical Relic's Management Board, Con Dao District welcomed and served 40,323 tourists who intend to relax, and travel within the island in 2010. It is an increase of 43% over that of the previous year. Among these, nearly 4,000 are foreigners, which is 92% greater than in 2009. The turnover from tourism reached over VND 55 billion. The number of tourists who visited the island still increase sharply to 22,000 in the first five months of 2011, up by 30% compared with that of the same period in 2010.

6) Fishing operation

In addition to travel, Con Dao is the center of marine fishing grounds of the province and the southern region. Con Dao fishery area is an evidently exciting location because the logistics of the provincial fishing vessels can accommodate up to 500 to 600 vessels at the same time.

Con Dao is endowed with Ben Dam Bay, which is about 4 km long, 1.6 km wide, and 6 to 18 m deep. It is protected from wind and can be utilized throughout the year. According to the construction plan, there will be four ports in Ben Dam, namely: seafood port, petroleum technical services port, maritime services port and military port. Ben Dam Port has recently been completed and in operation. It consists of 336 m of pier length, capable of receiving 2,000 t vessels, and complete with all services such as oil, electricity, water, markets fish, and frozen stocks.

The area is suitable for development of high value marine product. Con Dao has an abundant boat fleet, and has an annual catch of about 10,000 t of seafood.

(2) Nam Du Island

1) Population

According to the population census at the end of 2010, the population of Kien Giang is 1,703,500. Kien Hai is an island district of Kien Giang Province located off the southwest coast. The district has a population of about 25,000 living on the islands of Kien Hai Archipelago. Nam Du Islands belong to Kien Hai District. Said islands have a total area of 40 km^2 with a population of nearly 9,000.

2) Industry

The production value is estimated at VND 13,439 billion. Focus on investment is mainly in industries, which has the apparent advantage, especially in the agro fishery production and construction material production. The performance of fish processing establishments need to be expanded and improved, and the development of mechanical industry for boat assembly and repairs, industries for agriculture as well as the development of handicraft production, development of traditional craft villages, traditional products, handicrafts and fine arts must be given particular attention.

3) Economy

GDP has reached VND 18,801 billion, up by 12.05%, in which, agriculture: forestry-fisheries contributed 3%; industry-construction contributed 4.1%; and commercial-service contributed 4.9%. The total harvested area reached 642,626 ha throughout the whole year, up by 3.28% compared to that in 2009. Average yield has reached 5.44 t/ha, with production of 3,497,053 t, an increase of 2.93% compared with 2009, in which high quality rice accounted for nearly 70%, which is the highest output in history.

4) Summary of tourism

Nam Du Archipelago is located on An Son Commune, Kien Hai District, Kien Giang Province. Nam Du is an archipelago comprising 21 islands ingeniously formed. The archipelago is still primitive and has many beautiful and natural landscapes. Islanders live by gardening, fishing and seafood processing. Tourists can visit the island from Phu Quoc, Hon Tre, Hon Son, and Hon Mau using high-speed boats. The smallest island of Nam Du Archipelago is Hon Tre, which is only about 4 km wide. The island peak is 395 m with Lon Island as the largest and highest, and also the central of An Son Commune.

5) Number of tourist visitors of Kien Giang

Number of tourists that visited Kien Giang has reached 2.942 million, which accounts for 97.4% of the plan, an increase of 8.82% over the same period in 2009. The number of visitors from tourist

companies is 780,000, which is 88.6% of the plan, an increase of 3.5% over the same period last year, in which foreign tourists account for 95,500, up by 29.86% over the same period.

6) Fishing operation

Total fishery production in 2010 reached 473,494 t, which is 97.85% of the planned total. Kien Giang has achievements in the field of aquaculture. Currently, aquaculture area of the province has reached 122,000 ha with an output of about 124,000 t. Compared to 1998, aquaculture area increased by 4.3 times, and production increased by 13.7 times. Compared with the resolution of the Kien Giang Provincial Party set out in 2010, aquaculture production tripled. Assorted seafoods with high economic values such as lobsters, snails, groupers, crabs, oysters, clams, etc., have been successfully bred in many waters.

(3) Soc Trang

1) Population

Population of Soc Trang Province is 1,177,800 in 2005 and 1,300,800 in 2010 (an increase of over 10% in 5 years). At the end of 2010, 25 communes and wards in the coastal area at Tran De, Vinh Chau, Cu Lao Dung District and Soc Trang City have 25.8% of the total population of the province. Distribution of population of city/districts in 2005 is shown in Tables 3.5.1.1 and 3.5.1.2.

Table 3.5.1.1 Population of Soc Trang Province

Year	2006	2007	2008	2009	2010
Population (x 1,000)	1,265.6	1,276.3	1,285.1	1,293.2	1,300,8

Source: General Statistics Bureau of Vietnam

Table 3.5.1.2 Population of City/Districts in Soc Trang Province (2005)

No.	City/District	Population	Percentage (%)
1	Soc Trang	114,400	9.7
2	Long Phu	229,500	19.5
3	My Xuyen	185,600	15.8
4	Vinh Chau	139,400	11.8
5	Ke Sach	158,000	13.4
6	My Tu	194,300	16.5
7	Thanh Tri	156,600	13.3
	Total	1,177,800	100

Source: General Statistics Bureau of Vietnam

2) Industry

The total value of industrial production in 2010 reached USD 374 million, which is 106.8% over the planned total, and an increase of 14.9% compared with that in 2009. The specific objective set according to plan is to raise the structure ratio of industry from 14.62% in 2010 up to 25.10% in 2015, and to 39.50% in 2020. Planning of zones and industrial parks in the province is a key factor. It is expected to have at least two industrial parks in operation, namely, Tran De and My Thanh. Total catch and aquaculture production is 265,000 t, of which 42,000 t is sea fish catch.

3) Economy

In recent years, Soc Trang's economy has developed rapidly. Its GDP growth rate is from 12 to 13% per year and its average GDP per capita is expected to reach USD 1,600 to USD 1,700 by 2015.

Table 3.5.1.3 Statistics of Economic Development Results of Soc Trang Province

Year	2006	2007	2008	2009	2010
GDP	12.86%	13.46%	10.23%	10.14%	10%
GDP per population (USD)	544	614	686	881	1070
Total export (USD mil.)	327.40	352.00	420.00	332.15	432,00

Source: General Statistics Bureau of Vietnam

4) Summary of tourism

Soc Trang is covered by vast rice paddies, shrimp lagoons, and luxuriant fruit gardens like rambutan, durian, and orange. Viet (Kinh), Khmer, and Hoa ethnic groups live together in Soc Trang. The province has 89 pagodas of Khmer group, and 47 pagodas of Hoa people. Ma Toc (Bat), Khleang, Chruitim Chas, Chen Kieu, and Buu Son Tu (Set) are the famous among the pagodas. When visiting the province, tourists like to taste the tropical fruit in My Phuoc River Islet, or join many recreation and entertainment activities in Binh An Tourist Resort. Chol Chnam Thmay, Oc Om Boc festivals, and Ngo Boat Race also attract many visitors.

5) Number of tourist visitors

In 2010, the number of tourists coming to Soc Trang is estimated at 620,000 (average increase of 8.08% from 2006-2010), including 7,800 international tourists and 85,250 stay in tourists, in which 5,750 are foreigners. The total turnover from tourism in 2010 is estimated at VND 60.7 billion.

6) Fishing operation

Soc Trang has 72 km coastline and two major estuaries, namely, Hau River and My Thanh River. These rivers are abundant sources of maritime products including freshwater fish, seawater fish, and shrimps. Soc Trang has many advantages in terms of integrated economic development in marine-related sectors such as aquatic products, agriculture-forestry-aquaculture, marine-based industry, commercial seaports, fishing ports, seaport services, import and export, tourism and shipping.

The total area of aquaculture has reached 71,500 ha in 2010, up by 3.3% over 2009. The total output of aquatic products was 168,000 t. In particular, southwest fishery is a fishing place of inhabitants of Soc Trang. The area consists of about 661 species of fish with total reserves of 50,600 t/year, and capable of being exploited up to 202,000 t/year. It also has 35 species of shrimps, and 23 species of squid and crabs with a total output of about 100,000 t/year, capable of being exploited to 40,000 t/year.

(4) Tra Vinh

1) Population

The rate of natural population growth in 2010 is 1.13%. If this rate is kept, the population in 2011 will be about 1,282,550. Distribution of population in the city/districts is shown in Tables 3.5.1.4 and 3.5.1.5

Table 3.5.1.4 Population of Tra Vinh Province

Year	2006	2007	2008	2009	2010
Population (x 1,000)	993.7	997.2	1000.8	1004.4	1135.0

Source: General Statistics Bureau of Vietnam

Table 3.5.1.5 Population of City/Districts in Tra Vinh Province (2005)

No.	City/District	Population	Percentage (%)
1	Tra Cu	164,371	16.6
2	Duyen Hai	94,925	9.6
3	Cau Ke	120,792	12.2
4	Tieu Can	161,000	16.3
5	Cau Ngang	136,244	13.8
6	Chau Thanh	141,416	14.3
7	Cang Long	169,552	17.2
	Total	1,028,300	100

Source: General Statistics Bureau of Vietnam

2) Industry

Craft industry has been well developed in some business sectors. Products include textiles, mats for export, coconut shell charcoal, and related machineries. The province has 8,520 industrial manufacturing firms, and handicraft industries. Share of industry in GDP has increased from 14.52% in 2005 to 18.35% in 2010. So far, the province has 1,037 enterprises, with total registered capital of VND 8,050 billion. In 2010, industrial production value is estimated to reach VND 3,580 billion, which is two times higher than in 2005.

3) Economy

The provincial economy continues to grow at a fair rate, and investment in all economic sectors inside and outside the province have been mobilized more than that in 2001-2005. However, Tra Vinh is still in a less developed state compared to other provinces in the region. The following is Tra Vinh's situation in terms of its economy:

- Economic restructuring and investment mobilization is still slow;
- Planning of agricultural production is not good;
- Non-uniform investment in business sectors;
- Lack of uniform application of technical progress;
- Expansion of cost-effective model is limited; and
- Fisheries development is not commensurate with the potentials and advantages.

4) Summary of tourism

Surrounded by two rivers, Tien and Hau, with a long coastline, Tra Vinh's economy depends on agriculture, aquaculture, and fish and shrimp breeding. The province is covered by verdant plants in garden village along its riverbank. Some of its interesting places to visit include Ba Dong Beach, Ba Om Lake, and many Kinh, Hoa and Khmer pagodas. Ba Dong Beach coast is lined with white sand for tens of kilometers where air is clear and fresh. Tra Vinh tourism office also plans to renovate and exploit Ba Dong Seaside Resort, and turn it into an attractive tourist site in the Cuu Long River Delta. There are 140 Khmer pagodas, 50 Viet (Kinh) pagodas and 5 Hoa pagodas. The famous ones include Ang, Sam-rong-ek, Hang, and Nodol Pagoda. It is home to thousands of birds including storks, cong coc (local aquatic birds) and pigeons.

5) Number of tourist visitors

According to the development plan set by the Tra Vinh Government, the number of tourists who visited Tra Vinh in 2010 was over 300,000. Revenue from tourism will reach over USD 27 million.

6) Fishing operation

Estimated output of aquatic products in 2010 has reached 157,000 t, up by 2.44% over 2005. There is aquaculture development in all three (salt water, brackish, and fresh), in addition to breeding of shrimps, crabs, clams, fish and other aquatic products with high economic values.

The inland fish stocks estimated at Tra Vinh is 3,000-4,000 t, with operators regularly harvesting from 2,000-2,500 t. Fisheries resources of coastal areas of Tra Vinh include resources such as estuaries, mangroves and coastal waters with depth of 30-40 m of water to the shore.

(5) Cai Mep

1) Population

Population of Ba Ria-Vung Tau Province is shown in Table 3.5.1.6, and the distribution of population in 2005 in its city and districts is shown in Table 3.5.1.7.

Table 3.5.1.6 Population of Ba Ria-Vung Tau Province

Year	2006	2007	2008	2009	2010
Population (x 1,000)	955.7	970.2	983.6	996.9	1012.0

Source: General Statistics Bureau of Vietnam

Table 3.5.1.7 Population of City/Districts in Ba Ria-Vung Tau Province (2005)

No.	City/District	Popularion	Percentage (%)
1	Vung Tau	278,188	30.6
2	Ba Ria	89,320	9.8
3	Long Dien	127,947	14.1
4	Xuyen Moc	136,662	15.1
5	Chau Duc	154,506	17
6	Con Dao	5,847	0.6
7	Tan Thanh	115,298	12.7
	Total	907,768	100

Source: General Statistics Bureau of Vietnam

2) Industry

Industrial production value is increasing by 15.4% per year and sales of services by 24.39% per year. Trade turnover increased by 25.52% per year and service revenue by 21.7% per year. Finally, exports of crude oil reached USD 7,280 million, and the growth rate is 13.5% per year.

Ba Ria-Vung Tau Province has high potential to become the largest energy center of the country because of its abundant gas resources. Oil and gas industry makes up a large proportion (over 82.5%) of the total value of industrial production, and influences the development rate in the area. In addition, oil industry services include: ship repair, rig repair, replacement of the production of metal components for drilling and production of chemicals for exploration and exploitation, metal protection, and mechanical engineering components for oil and gas.

3) Economy

GDP growth rate is above 18%. The sales of commercial services in the province increased by 29.07%, and export value by 38.04%. Moreover, agricultural production value increased by 4.95%.

GDP per capita in 2010 reached USD 5,872, up by 2.28 times of that in 2005. One important goal of Ba Ria-Vung Tau Province is to achieve an average GDP growth rate of 14% per year within five years,, in which GDP per capita is expected to reach USD 11,500.

4) Summary of tourism

Vung Tau has long been well-known for its attractive and high potential tourism seaside city. Two mountains, the Big Mountain and Small Mountain, form like a long green dragon swimming and bending to the sea surface. Particularly, Vung Tau is prominent for its hundreds of kilometers of lovely and graceful seaside beaches.

There are many historical landmarks in the province such as the tall Jesus' Statue overlooking the East Sea, the tranquil Buddha's Alta, the solemn Nirvana Buddhist Temple, the majestic White Place and many others. All have been displaying the eternal special cultural characteristics of this city. Having a rapidly developed economy, Vung Tau City is one of the prosperous lands in the Southeast Delta.

5) Number of tourist visitors

The number of visitors coming to Vung Tau is steadily increasing because of its advantageous attractive landscapes. Statistics on tourists who visited Vung Tau are shown in Table 3.5.1.8.

Table 3.5.1.8 Number of Tourists who Visited Vung Tau

No.	Sector	Unit	Sum of 6 months (2011)	Sum of 6 months (2010)	% increase
1	Tourism service	VND (billion)	1,377	1,092	26
2	Number of visitors	(x1,000)	6,960	5,489	26.8

Source: Department of Culture, Sport and Tourism of Ba Ria – Vung Tau Province

6) Fishing operation

The province has 4,952 fishing vessels with a total capacity of more than 651,118 Hp. In 2007, the total production reached 205,000 t. Fisheries shift to offshore fishing, reducing the craft causing depletion, and killing of aquatic resources. In recent years, the area of marine aquaculture has mostly been developed by households converting from rice farming to aquaculture. Of the total 8,952 ha of water surface area of aquaculture, 8,560 ha has so far been exploited. The annual production has reached 8,500 t in the province, mainly focused on industrial shrimp farming areas.

(6) Vinh Tan

1) Population

According to the data of General Statistics Bureau of Vietnam, the population of Binh Thuan Province at the end of 2010 is 1,176,900, as shown in Table 3.5.1.9.

Table 3.5.1.9 Population of Binh Thuan Province

Year	2006	2007	2008	2009	2010
Population (x1000)	1142.1	1151.9	1162.0	1171.7	1176.9

Source: General Statistics Bureau of Vietnam

Table 3.5.1.10 Population of City/Districts in Binh Thuan Province (2005)

No.	City/District	Population	Percentage (%)
1	Phan Thiet	189,900	18.1
2	Bac Binh	112,000	10.7
3	Duc Linh	123,400	11.7
4	Ham Tan	154,700	14.7
5	Ham Thuan Bac	147,600	14.0
6	Ham Thuan Nam	85,900	8.2
7	Phu Quy	21,000	2.0
8	Tanh Linh	92,600	8.8
9	Tuy Phong	123,700	11.8
	Total	1,050,800	100

Source: General Statistics Bureau of Vietnam

2) Industry

Regarding industrial production, handicraft industry reached 93.1% in 2010, up by 8.3% over the previous year, excluding hydroelectric power which increased by 13.9%. In particular, the state economy decreased by 2.2% (hydropower production value accounted for 27.7% of industrial

production and down by 3.9%), non-state economy increased by 13.9%, and areas of foreign investment increased by 10.1%. For the development plan for industries of Binh Thuan Province, the average growth rate of industry value from 2011 to 2015 is set at 15.5%/year (in which industry is set at 15.5% to 16% a year).

3) Economy

GDP per capita in 2010 reached USD 850, and GDP growth rate reached 11.5%. The growth rates of industrial sectors are as follows:

- Construction Industry: 11.2%
- Service: 15.9%
- Agriculture, forestry and fisheries: 6.2%

Aquaculture has been restored in both scale and production, with a total area of 530 ha. It is noted that shrimp production reached 3,400 t/year. Seed shrimp production has been developed stably, and reached 6 billion, which is over 2 billion more than the set targets. In five years (2006-2010), the district has 914.4 ha of replanted forest, raising the forest coverage from 43% to 50%.

4) Summary of tourism

The province is famous for its white sand beaches such as Phan Thiet – Mui Ne, Doi Duong, Mui Dien – Ke Ga, and beaches situated near the mountains such as Vinh Hao and Binh Thanh (Tuy Phong). Besides, the province has many other places of interest such as Hang Pagoda, Tien Stream, etc.

5) Number of tourist visitors

It is estimated that over 2.5 million visitors came to Binh Thuan in 2010, up by 13.6% compared with the previous year. Of these, 250,000 are international tourists, which is an increase of 12.6% from the previous year. In particular, Tuy Phong District annually attracts around 370,000 visitors.

6) Fishing operation

Aquaculture and seafood exploitation of Tuy Phong is quite developed, creating jobs and stable incomes for thousands of fishermen. Particularly in 2009, the district developed 18 vessels, bringing the total to 2,035 vessels with a total capacity of 3,694 Hp. Initially, the district has formed 109 organizations for the exploitation of marine resources, including 716 boats, which provided jobs to 3,736 workers.

The total volume is about 230,000-260,000 t, capable of exploiting 100,000 to 200,000 t/year. In addition, the Tuy Phong Sea marine resources are rich, diverse and relatively developed, with large deposits of industrial farming, mining and processing. Fishing output in 2009 reached 41,000 t, equal to 105.5% of the plan. The district has 530 ha of white shrimp farming, and production of 3,400 t of seed production is also quite developed.

3.5.2 Natural Conditions of Proposed Sites

(1) National Parks and Reserved Area

1) National Park

National parks are either a natural area in the mainland or a component of the wetland or sea. Parks have areas that are big enough for conservation purposes of one or many endemic species, and their representatives; and for protecting endemic species from present and future threats. National parks serve as foundation of spiritual, scientific, educational activities and ecotourism that is under control, causing only limited negative impacts (Decision 62/2005 - MARD).

The coastal area of Mekong Delta and island in the south of Vietnam have many natural resources. The four sites in Table 3.5.2.1 were designated as national parks by the government. Con Dau Island is planned as one of the project sites for coal transshipment terminal. Forests in Con Dao are mainly proterozoic, belonging to the tropical island ecosystem with 882 species of fauna, and nearly 150 species of animal. Among these, only some rare species are found in the area. This island is the first place in Vietnam where sea turtle conservation is implemented. Government prohibited all activities of harvesting, processing, trading and use of sea turtles, including their eggs and other related products.

Table 3.5.2.1 National Parks in the Coastal Area of Southern Vietnam

Name	Area (km^2)	Location
Con Dao	150.43	Bà Rịa-Vũng Tàu
U Minh Thuong	80.53	Kiên Giang
Cape Ca Mau	418.62	Cà Mau
Phú Quốc	314.22	Kiên Giang

Source: Department of Science and Technology and German Development Cooperation Conservation and Development of the Kien Giang Biosphere Reserve Project, 2011

2) Nature Reserve Areas

Nature reserve areas are natural areas in either the mainland or with a component of wetland or sea. Such reserved areas are established for the sustainable development of ecological systems that have not or have been marginally impacted. These areas also have endemic or endangered species, as well as special natural or cultural features. These reserves are mainly managed for protecting the ecological system of species, research methods, and environment monitoring and education.

Table 3.5.2.2 Reserve Areas in the Coastal Regions of Southern Vietnam

Name	Area (km^2)	Location
Can Gio Bioshpere reserve	757.4	Ho Chi Minh
Lung Ngoc Hoang	60	Can Tho
Thanh Phu	45.1	Ben Tre
Vo Doi	33.94	Ca Mau
Kalong Song Mao	400	Binh Thuan
Ha Tien [13]	69.81	Kien Giang
Kien Luong [14]	146.05	Kien Giang

Source: Department of Science and Technology and German Development Cooperation Conservation and Development of the Kien Giang Biosphere Reserve Project, 2011

3) Biosphere Reserves

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments, and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a world network: the World Network of Biosphere Reserves (WNBR). Within this network, exchanges of information, experience and personnel are facilitated.

Source: Cartography and Reproduction Enterprise "Vietnam Ecotourism Map"

Figure 3.5.2.1 National Parks and Nature Reserves in the South of Vietnam

Source: Con Dao Island Tourist Office

Figure 3.5.2.2 Ecology of Con Dao National Park

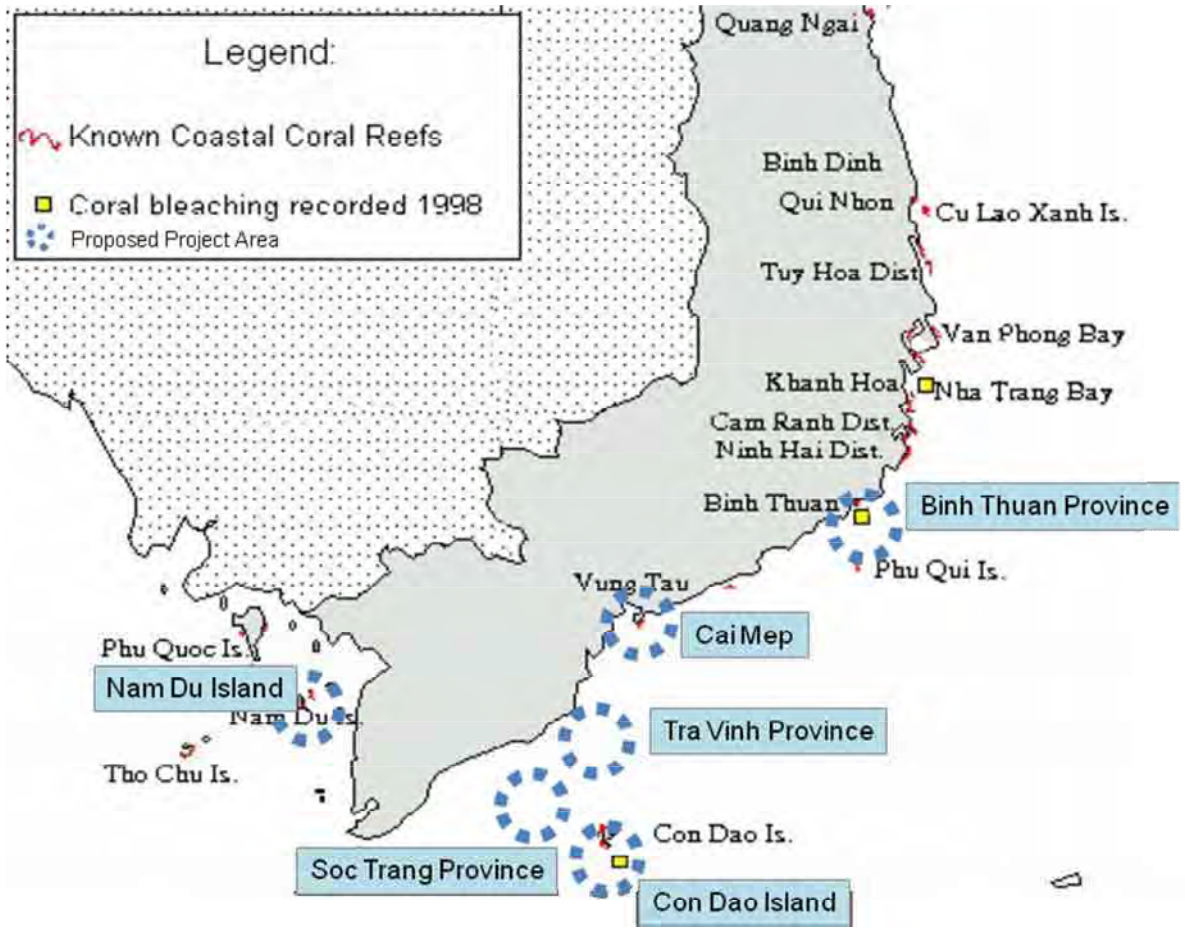
(2) Con Dao Island Tourist Office

1) Coral reefs distribution in the south of Vietnam

a) Location and kinds of corals

Coral reefs are the most biologically diverse marine habitats in Vietnam. Over 350 species of scleractinian corals are found in south Vietnam's coastal waters (Figure 3.5.2.3). All coral reefs in the northern half of the country are fringing reefs, and although these are also the most common reef type, the more complex coastline and the less significant impacts of rivers have favored the development of platform reefs[1] in the south. In particular, atolls in the Spratly archipelago enclose reefs of hundred meters in length, with high species diversity and cover.

[1] platform reef： also called patch reef, a coral reef found on continental shelves and characterized by a primarily radial growth pattern.

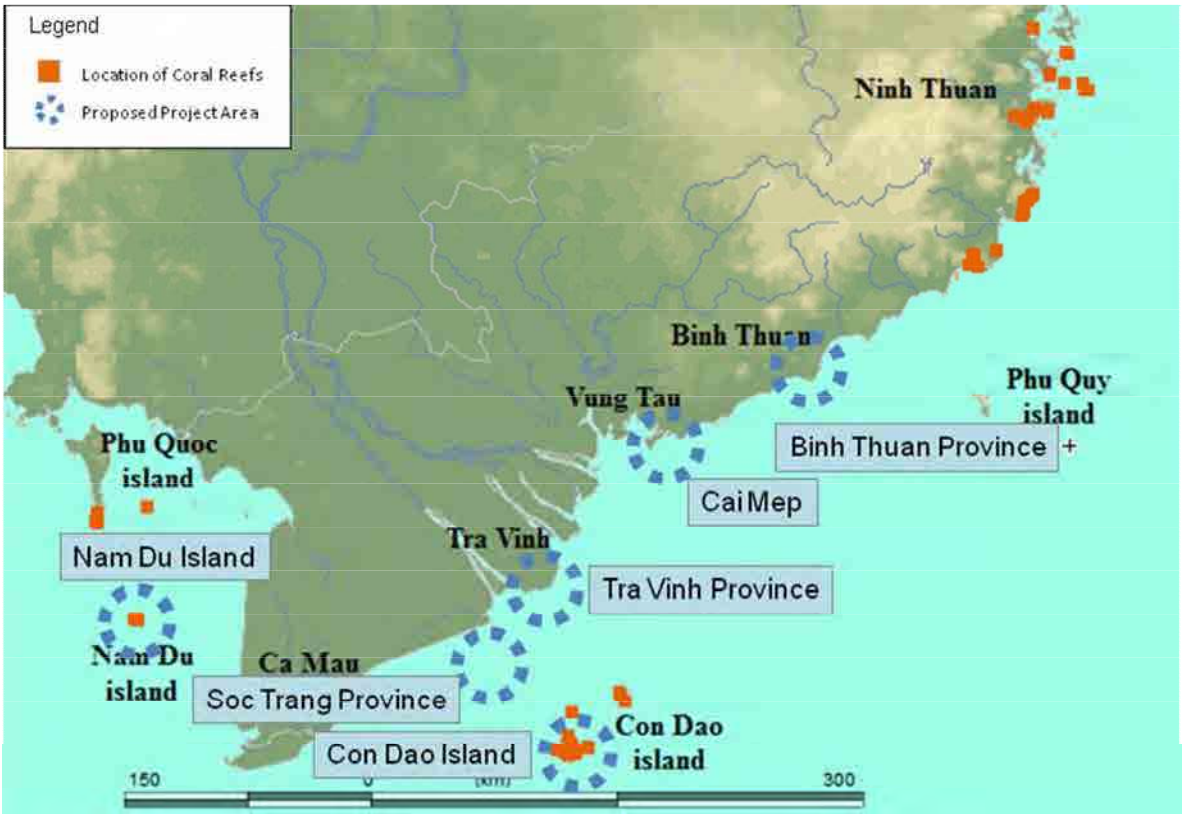


Source: Report No. 12 BirdLife International Vietnam Programme,
"The Conservation of Key Wetland Sites in the Mekong Delta".

Figure 3.5.2.3 Coral Reef Distribution and Monitoring Sites in Vietnam

There are 28 reef areas in the coastal waters of Vietnam. Approximately 20 of these reefs are located in the southern half of the country. The five distinct marine areas of Vietnam are, (1) western Gulf of Tonkin, (2) middle central Vietnam, (3) south central Vietnam, (4) southeastern Vietnam, and (5) southwestern Vietnam. The south central area has the most diverse coral diversity with recorded 66 hermatypic coral genera. The specific areas with significant reef abundance and high coral coverage in the south include Van Phong Bays (Khanh Hoa Province), Nha Trang Bays (Khanh Hoa Province), Ninh Thuan Coast, Ca Na Bay (Binh Thuan Province), Con Dao Islands (Ba Ria-Vung Tau Province), Phu Quoc Island (Kien Giang Province), and Nam Du and Tho Chu Islands (Kien Giang Province).

According to information on current condition of coral reefs from ReefBase, there is no appearance of coral reefs in the coastal line of southern Vietnam, from Tra Vinh coast to Binh Thuan provincial coast (See Figure 3.5.2.4).



Source: Coral Reefs Map, ReefBase, 2011.

Figure 3.5.2.4 Location of Coral Reefs in the South of Vietnam

2) Current status of coral reefs in Vietnam

From 1994 to 1997, 15 reef areas were surveyed with a total of 142 study sites. The results from these surveys showed that the overall condition of the coral reefs has decreased. Based on the IUCN criteria for assessing coral reefs, only 1.4% of the total study reefs in southern Vietnam were considered to be in excellent condition. In contrast, the number of poor reefs occupied 37.3% while those in fair and good conditions occupied 48.6% and 31%, respectively. These data indicate that the conditions of the reefs located in offshore islands, or at the sites most distant from population centers, are significantly better than those located close to the populated coastal zone. Moreover, data collected at 30 transects of monitoring done in 2000 or 2001 show the same situation of coral cover in these same reefs. Change in trends of coral cover and coral reef communities could be assessed based on long-term monitoring in some sites.

3) Mangrove distribution in the coastal area in the south of Vietnam

The largest concentration of mangroves in the Mekong Delta is located at the coastal provinces of Ca Mau, Kien Giang, Bac Lieu, Soc Trang, Tra Vinh, and Ben Tre. The area with the most population of mangroves is Ca Mau, and mainly in Ca Mau Peninsula, where the state was planning to build Mui Ca Mau National Park. Ca Mau Peninsula is a new ground, constantly being enriched, with encroachment into the sea extending from 50 to 100 m each year to the west and south. Area of mangrove forests near the coast and inland is quite concentrated due to weak wave. In addition, mangroves are distributed in many areas, which are just small ones scattered at coast and deep inland.

The largest extent of mangroves can be found in southern Vietnam associated with Dong Nai and the Mekong River estuaries, with over 191,800 ha, while the second largest extent, i.e., 39,400 ha, lies in the northeastern Quang Ninh Province followed by those in the estuaries of Thai Binh and Hong (Red) rivers, which is 7,000 ha located in the northern part of Vietnam.

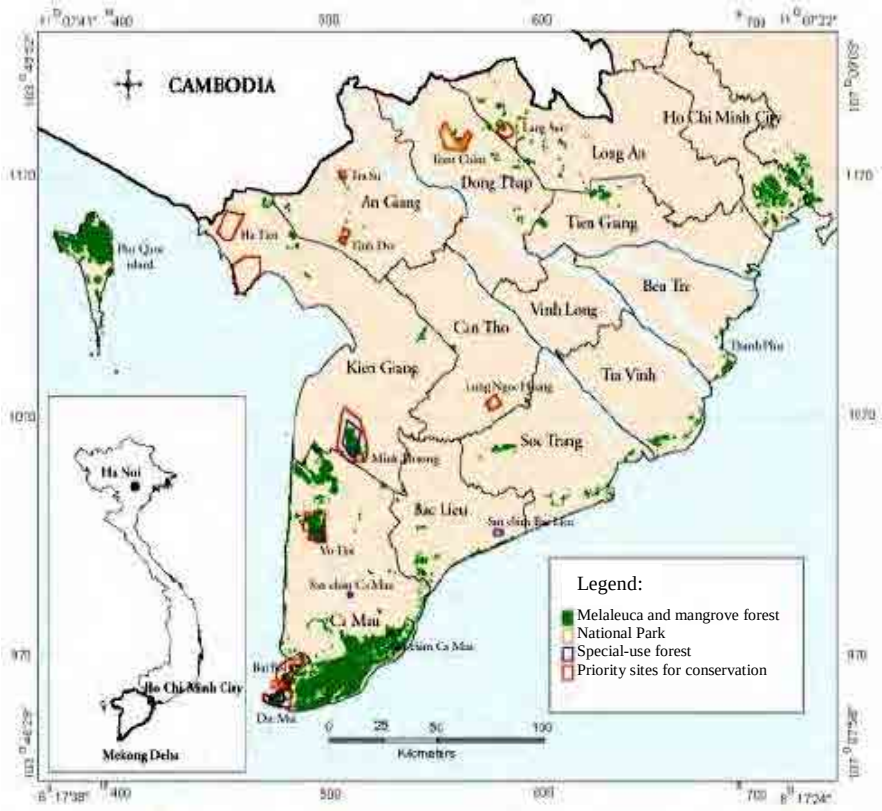
4) Mangrove replanting

According to the report on wetlands in the Mekong Delta, its natural mangrove forests have almost been entirely lost due to a combination of wartime conflict, especially defoliant spraying, and more recent clearance for aquaculture, and exploitation of forest products.

The coastal dynamics of the Mekong Delta vary, with high erosion rates occurring along parts of the eastern coastline and rapid accretion rates on the Ca Mau Peninsula, and at the mouths of the major discharge points of the Mekong River distributaries (See photo 01 and 02). Highest rates of erosion have occurred where mangrove has been destroyed, often through reduced protection from tropical storms and typhoons, leading to the loss of valuable agricultural land and an increase in saline water intrusion into rice growing areas further inland. This has resulted in the recognition of the important role that mangrove plays in maintaining the agricultural system in the delta, at least in part. To combat this, widespread mangrove planting has taken place, often with the assistance of substantial funds from international donors.

Photo 01 Erosion Site

Photo 02 Erosion Site



Source: Report No. 12 BirdLife International Vietnam Programme,
"The Conservation of Key Wetland Sites in the Mekong Delta".

Figure 3.5.2.5 Distribution of Special Use Forest and Ten Priority Sites for Biodiversity Conservation in the Mekong Delta

(3) Typhoon

An average of 26 typhoons is generated per year during the last 30 years (1981-2010) in South Pacific Ocean. Vietnam is located in Southeast Asia, far from typhoon track route and has small possibility of direct hit. However, within the last ten years (2000-2011), typhoons hit the southern area of Vietnam (see Figure 3.5.2.6). In fact, mangrove planted in the coastal area suffered from damages several times. For the safety operation of coal transshipment terminal, considerations on the influence caused by typhoon is required such as rough sea, tidal wave and storm. Figure 3.5.2.6 shows the tracking chart of typhoons.

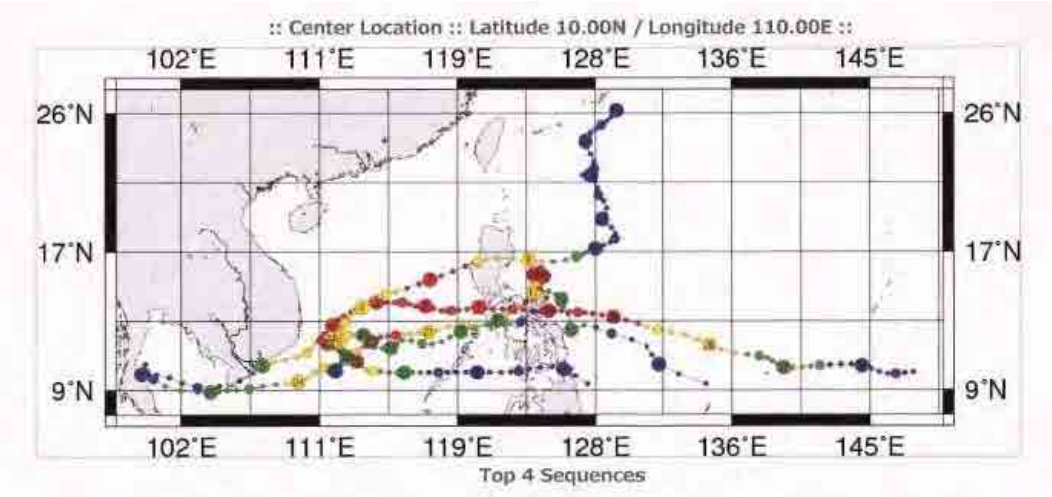


Figure 3.5.2.6 Tracking Chart of Typhoons

Table 3.5.2.3 List of Typhoons that Hit the South of Vietnam

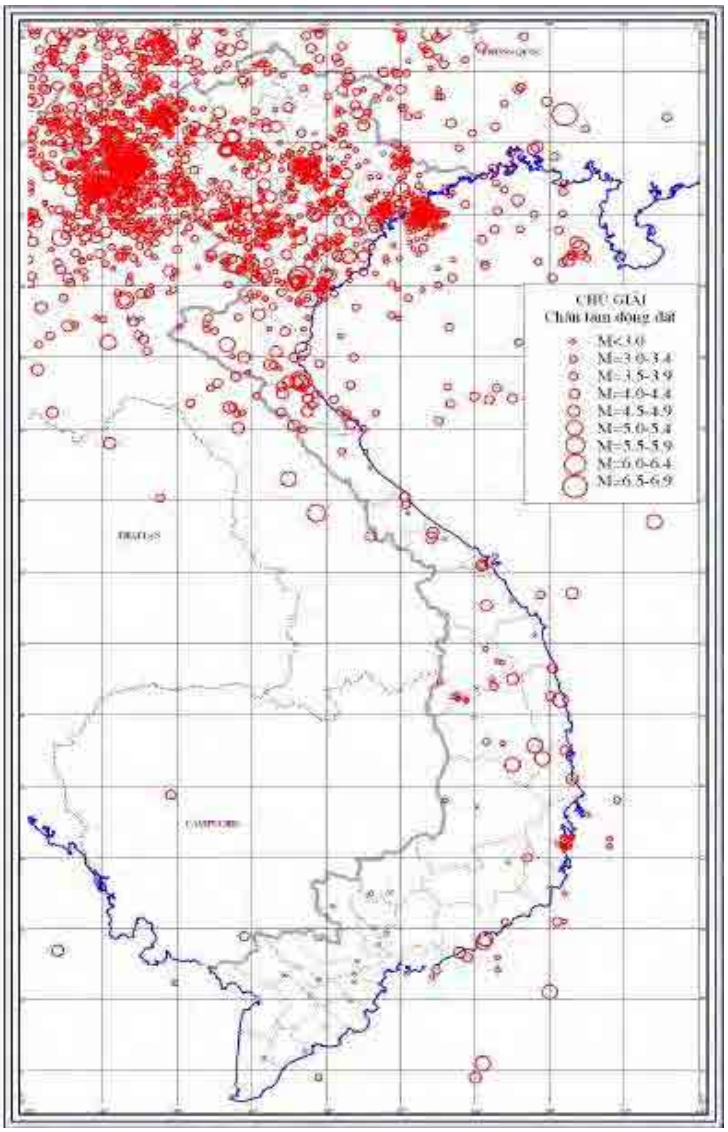
Number	Name	Birth	Death	Duration	Min-pressure (hpa)
200425	Muifa	Nov.14,2004	Nov.25,2004	10 days 18 hr	950
200621	Durian	Nov.26,2004	Dec.05,2004	8 days 18hr	915
200724	Hagibas	Nov.20,2007	Nov.27,2007	6 days 18hr	970
200902	Chan-hom	May.3, 2009	May.9, 2009	5days 12hr	975

Source: National Institute Information, Japan

(4) Earthquake

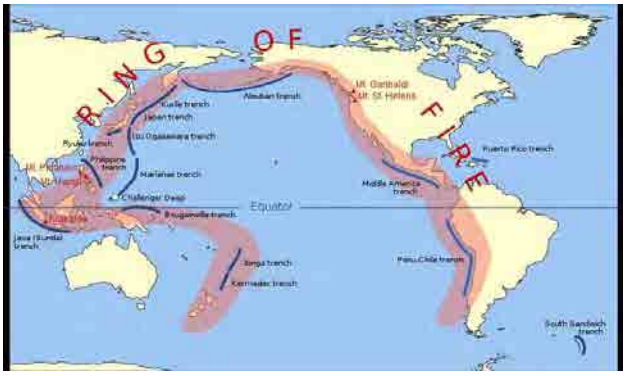
Vietnam is near the “Ring of Fire,” an area around the Pacific Ocean where 90% of the earthquakes occur. In simple terms, the ring is where huge plates of the earth are colliding against each other. In case of earthquake, impact on coastal fishing communities and the people living there, some of the poorest in the region, will be devastating with high losses of income, boats and fishing gears. Fishing fleet and industrial infrastructure in the coastal regions destroyed by the wave surges will have adverse economic effects at both local and national levels. In addition, operation of terminal will be suspended for long periods of time.

From past records, 90% of earthquakes have taken place in northwestern Vietnam. The largest earthquake occurred in Dien Bien in 1935 (magnitude 6.8) and Tuan Giao in 1983 (magnitude 6.7). In November 2007, the southern city was also affected when a 4.5-5 magnitude earthquake hit the coast of Binh Thuan and Vung Tau. Earthquake map of Vietnam as of 2005 is shown in Figure 3.5.2.7.



Source: Nguyen Anh Duong, "Earthquake observation in Vietnam", Institute of Geophysics, 2006

Figure 3.5.2.7 Earthquake Map of Vietnam as of 2005



Source: Nguyen Anh Duong, "Earthquake observation in Vietnam", Institute of Geophysics, 2006

Figure 3.5.2.8 Map of Ring of Fire

3.5.3 Study of Environment and Social Considerations

Results of study on environmental conditions for the site selection for coal transshipment terminal was carried out according to JICA's scoping form and matrix of port development project. Results of the evaluation are shown in attached Appendix 2.

Six sites are proposed by the Vietnamese side for the coal terminal. However, the locations of the two sites (Nam Du Island and Vinh Tan) are very far from the targeted power plants and thus, are not recommended based on economical point of view as the coal transportation cost will be very costly. Therefore, the environmental study does not include Nam Du Island and Vinh Tan sites. Site selection of coal transshipment terminal was carried out based on the following basic environmental considerations and policies:

- Do not select the site of national park and reserved areas designated by government
- Select the site which could minimize deforestation of the existing mangrove forest
- Select the site which could minimize involuntary resettlement
- Select the site which could minimize dredging and land reclamation
- Select the site which could minimize construction and operation cost

Table 3.5.3.1 Result of Evaluation

Site	Main Characteristics of Environmental Conditions	Requirement of mitigation	Evaluation
Con Dau Island	- All of island area is designated as national park. There are many important ecology in this island and surrounding sea area. - From 1995 to 2006, preservation project of sea turtle was conducted by WWF - The proposed master plan prohibits the building of factories or exploitation of the marine environment. - Island was developed as a base of tourism by the Government.	-	Not recommended
Nam Du Island	- The distance between the power plants and terminal is very far, that the value of transportation cost of coal will be very high. - There are many Coral Reefs to be protected in the coastal area.	-	Not recommended
Soc Trang	- Large scale erosion was observed in the coastal zone which proposed for coal storage site. - For countermeasure of erosion, many mangrove plants were forested in the proposed project site by GIZ project - Depth of sea in the coastal area is shallow, and expected large volume of dredging for access channel and terminal. - Province has many site of tourism as pagoda, the number of tourists that visited the province is estimated at 620,000 in 2010 - Fishermen are conducting fishing operation in the coastal area.	-	Not recommended
Tra Vinh	- There is a mangrove forest but the density is lower than the other sites relatively. - Required minimizing deforestation of mangrove forest - Several families live in coastal area in small wooden house. - Construction of Duyen power plant project is implemented nearby. - Fishermen are conducting fishing operation in the coastal area.	-Replanting of mangrove -Preparation of RAP, if required	Recommended with mitigation
Cai Mep	- There is a mangrove forest in and adjacent of the site and required minimizing deforestation of mangrove forest. - Province is a base of tourism, the number of tourists that visited the province is estimated at 696,000/half year in 2010 - Fishermen are conducting fishing operation in the coastal area. - Resort/recreational area is located 10km far from the proposed site. - Access channel of vessels was completed by other project and it is possible to minimize the dredging work.	-Replanting of mangrove -Preparation of RAP, if required -Pay close attention to resort/recreational area	Recommended with mitigation
Vinh Tan	- The distance between the power plants and terminal is very far, the value of transportation cost of coal will be very high.	-	Not recommended

Chapter 4 Preliminary Examination of Imported Coal Transshipment Terminal Plan

Contents

Chapter 4 Preliminary Examination of Imported Coal Transshipment Terminal Plan

4.1 Examination of Coal Handling Equipment

4.1.1 Analysis of Coal Unloaders

Coal unloaders are classified into three main types: continuous unloaders, bridge-type unloaders, and grab unloaders. The advantages and disadvantages of said three types are described below.

	Grab Type	Bridge Type	Continuous Type
Mechanism	Simple	A bit more complex	Complex
Rotary	Possible	Impossible	Possible
Travel	Possible	Possible	Possible
Hold work	Bulldozers make up	Bulldozers make up	No bulldozers
Automation	Almost impossible	Almost impossible	Possible
Own weight	600 t	1,000 t	800 t
Efficiency	0.5 of nominal capacity	0.5 of nominal capacity	0.5 of nominal capacity

Continuous unloaders

Unloading capacity: 1,500t/h
Maximum vessel size: 80,000DWT
Traversing rail span: 20m
Boom rotation radius: 41.5m
Boom rotation: ±105 degrees
Boom elevation: -16 to 36 degrees

Bridge type unloaders

Unloading capacity: 1,000t/h
Maximum vessel size: 60,000DWT
Traversing rail: span: 20m
Boom outreach: 35m

Grab unloaders

Unloading Capacity: 600t/h
Maximum vessel size: 60,000DWT
Traversing rail span: 20m
Boom rotation radius: 46m

Bulldozers make up coal in a hold

Bulldozers scrape coal in a hold

Accordingly, fixed type terminal will be equipped with continuous unloaders to increase the work efficiency in case of securing the calmness, and with grab unloaders or bridge type unloaders if otherwise. Floating type terminal will be equipped with grab unloader because it is lighter than other types.

4.1.2 Coal Ship Loader

There are two kinds of loader: coal ship loader and coal stocker. Considering the environmental aspect, ship loader is applied in the Study.

Coal ship loader

Loading capacity: 6,000 t/h
Maximum vessel size: 125,000 DWT
Traversing rail span: 15 m
Boom rotation radius: 49.5 m

Coal stoacker

Loading capacity: 2,200 t/h
Traversing rail span: 8 m
Boom rotation radius: 38 m

4.2 Facility Scale of Imported Coal Transshipment Terminal

Based on the required coal volume of planned coal fired power plants in 2030, the scale of imported coal transshipment terminal is determined to enable handling 38 million t of imported coal per year. In case of 100,000 DWT coal carriers to be employed, it is necessary to receive them approximately 400 times per year. In case that two unloaders with a capacity of 2,500 t/h are installed per berth, the unloading time is estimated to be 27 hours. Three or four berths might be required, though the number of berths will depend on wave calmness around the berths.

As for stockyard, more than 1,000 m x 1,600 m area shall be ensured with the lowest limit of 160 ha. It appears that about 10% of the total area will be increased to include internal roads, administration building, etc. In such case, 1,000 m x 2,000 m area (200 ha) is tentatively set up for facility scale. Based on this facility scale, the following examinations are carried out:

<Introduction of the Largest Coal Transshipment Terminal in Europe>

The largest coal transshipment terminal in Europe is EMO dry bulk terminal in the Port of Rotterdam. Figure 4.2.1 shows the panoramic view of EMO dry bulk terminal. This coal transshipment terminal can stock a maximum of 6 million t of coal in 100 ha stockyard. The annual coal throughput is approximately 20 million t. The unloading berth, which has a depth of 23 m and a length of 1,275 m, accommodates four working unloaders. The maximum unloading volume at this terminal is 140,000 t per day. Four capesize coal carriers can be positioned along the berth at the same time. The discharging berth to barges, which is located at the side of the terminal as shown in Figure 4.2.1, is equipped with three ship loaders. About 100,000 t of coal and iron ore are loaded on barges everyday and transported on the inland waterway. Also, European railway is utilized to transport coal and iron ore. To meet customers' requirements, different grades of coal are blended in six silos at the left side of the terminal as shown in Figure 4.2.1. Dimensions of the main facilities are summarized below.

Source: Website "http://emo.nl/en

Figure 4.2.1 Panoramic View of EMO Dry Bulk Terminal (Port of Rotterdam)

Facility		Dimension
Unloading berth	Length	1,275 m
	Depth	21.65 m (Berth 1-3), 23.0 m (Berth 4)
Unloader		50 t grab unloader x 2 units (Berth 1 and 2)
		85 t grab unloader x 2 units (Berth 3 and 4)
Loading berth	Length	800 m
	Depth	21.65 m
Loader		5,000 t/h x 1 unit
Barge berth	Length	950 m
	Depth	5.25 m
Loader		3,500 t/h x 3 units
Stockyard	Area	100 ha
	Capacity	Maximum 7 million t
Yard equipment (stacker and reclaimer)		5,000 t/h x 6 units

Source: Website "http://emo.nl/en

Chapter 5 Preparatory Screening of Alternative Sites

Contents

Chapter 5 Preparatory Screening of Alternative Sites

5.1 Setup of Basic Dimensions of Imported Coal Transshipment Terminal

Based on Chapter 4, the basic dimensions of imported coal transshipment terminal are set up as shown below. Though the area of stockyard is actually required from the result of coal logistics examination as part of the total coal logistics system, preliminary facility scale is determined considering Chapter 4 in order to conduct the preparatory screening of alternative sites. Also, the berth length is tentative based on a certain degree of wave calmness secured, as it is part of the total coal logistics system and greatly affected by wave calmness.

Table 5.1.1 Basic Dimensions of Import Coal Transshipment Terminal

	Long-term Plan
Annual throughput	38 million t
Design vessel	100,000 DWT
Stock yard	200 ha
Unloading berth	4 berths (length 1,200 m, depth 16 m or more)
Discharging berth	8 berths (length 2,080 m, depth 8 m or more)

Source: JICA Study Team

5.2 Preparatory Screening

Based on the above discussions, alternative sites for imported coal transshipment terminal are initially screened. The four screening items include environmental aspect, secondary transport distance, land acquisition and required water depth.

Table 5.2.1 Preparatory Screening of Alternative Sites for Imported Coal Transshipment Terminal

Item \ Alternative site	Vinh Tan	Cai Mep	Tra Vinh	Soc Trang	Con Dao	Nam Du
Environmental aspect	-	Fair	Good	Good	Poor	-
Secondary transport distance	Poor	Good	Good	Good	Good	Poor
Land acquisition	Good	Good	Good	Good	Fair	Good
Required water depth	Good	Good	Fair	Poor	Fair	Good
Screening Result	Poor	Good	Good	Poor	Poor	Poor

Source: JICA Study Team

Con Dao Island is promoting tourist business. Therefore, Con Dao is not suitable as site for imported coal transshipment terminal. Nam Du and Vinh Tan islands are also unsuitable due to long secondary transport distance. In Soc Trang, mangrove planting is being implemented as countermeasure against beach erosion through funds from the German government. It is therefore necessary to consider such matters in the development of the surrounding coastal area. The natural conditions in Tra Vinh and Soc Trang are similar because both are at the lower reaches of the Mekong River. However, the seabed slope in Soc Trang is more gentle than that in Tra Vinh, because the coastal current from the northeast to the southwest prevails. Thus, Tra Vinh has an advantage over Soc Trang.

Based on abovementioned, Cai Mep and Tra Vinh pass the preparatory screening. Thus, detailed examination of both will follow.

Chapter 6 Coal Logistics and Basic Plan of Imported Coal Transshipment Terminal

Contents

Chapter 6 Coal Logistics and Basic Plan of Imported Coal Transshipment Terminal

6.1 Set-up of Working Limit Condition

(1) Threshold wave height for coal handling works

Based on "Technical Standards and Commentaries for Port and Horbour Facilities in Japan", the following threshold wave heights for coal unloading and loading works are determined in accordance with ship size:

Ship Size	Threshold Wave Height for Coal Handling Works
100,000 DWT	1.5 m
5,000 DWT	0.5 m

(2) Threshold wave height for ship sailing

The threshold wave height for 5,000 DWT coal carrier sailing is determined in the Study to be 2.0 m while for 100,000 DWT, no particular figure is determined.

(3) Threshold wind speed for coal handling works

The law on safe operation of crane in Japan requires cranes to stop operating when the average wind speed in ten minutes is over 10 m/s. Thus, based on this law, the threshold wind speed for coal handling works is determined in the Study to be 10 m/s.

6.2 Operation Ratios of Coal Handling Works and Secondary Coal Transport

According to Sections 3.2.3 and 6.1, the annual average operation ratios of coal handling works and secondary coal transport are shown below. Wave deformation calculation in Cai Mep is not carried out in the Study. The operation ratios of coal handling with 100,000 DWT and 5,000 DWT ships are assumed to be 90% and 80%, respectively.

Imported coal transshipment terminal, especially floating type, is affected not only by wave but also by wind. However, effect of wave is more severe and it is understood that wind speed has a relation to wave height. Therefore, the operation ratio of coal handling works is mainly decided based on the threshold wave height for coal handling works.

The operation ratios of coal handling works and secondary coal transport in Tra Vinh and Cai Mep are summarized in Table 6.2.1.

Table 6.2.1 Summary of Operation Ratios of Coal Handling Works and Secondary Coal Transport

Location	Breakwater	Ship Size	Wave Height	Annual Average Ratio
Tra Vinh offshore point with a depth of 20 m	Without	100,000 DWT	1.5 m	67.9%
	With	5,000 DWT	0.5 m	12.2%
	With	100,000 DWT	1.5 m	90.0%
	With	5,000 DWT	0.5 m	90.0%
Secondary transport from offshore point with a depth of 20 m	-	5,000 DWT	2.0 m	81.6%
Coal handling at a point withadepth of 5 m	Without	5,000 DWT	0.5 m	24.9%
	With	5,000 DWT	0.5 m	90.0%
Secondary transport from offshore point with a depth of 5 m	-	5,000 DWT	2.0 m	91.2%
Cai Mep	Without	100,000 DWT	1.5 m	90.0%
	Without	5,000 DWT	0.5 m	80.0%
Secondary transport from CaiMep	-	5,000 DWT	2.0 m	91.2%

Source: JICA Study Team

6.3 Coal Logistics and Basic Plan of Imported Coal Transshipment Terminal

As shown in Figure 6.3.1, the alternative sites for berths receiving 100,000 DWT coal carrier and stockyard in Tra Vinh are expected to be “A” and “B”, and “C” and “D”. It is essential that coal transport to/from the imported coal transshipment terminal does not block ships sailing through the Bassac Canal. Considering this, in case that coal receiving berth is located at “B” and stockyard is located at either “C” or “D”, 5,000 DWT coal carrier shall sail across the access channel of Bassac Canal. As a result, combination of sites “A” and “C” enables 5,000 DWT coal carrier to transport coal without sailing across the access channel of Bassac Canal.

Figure 6.3.1 Alternative Sites for Imported Coal Transshipment Facilities and Stockyard in Tra Vinh

The coal logistics are examined based on Table 6.2.1, considering five cases in Tra Vinh and one case in Cai Mep. This is intended to verify stability of coal supply to the power plants

Case 1: Tra Vinh (fixed type), without breakwater, with trestle
Case 2: Tra Vinh (fixed type), with landside breakwaters, without trestle
Case 3: Tra Vinh (fixed type), with offshore and landside breakwaters, with trestle

Case 4: Tra Vinh (fixed type), with offshore and landside breakwaters, without trestle
Case 5: Tra Vinh (floating type), with offshore and landside breakwaters, without trestle
Case 6: Cai Mep (fixed type), without breakwater, with trestle

Preconditions set in the Study are as follows:

<Preconditions>

Ship size for marine transport:	100,000 DWT coal carrier
LOA:	250.0 m
Full draft:	14.5 m
Breadth:	43.0 m
Ship size for secondary transport:	5,000 DWT coal carrier
LOA:	107.0 m
Full draft:	6.4 m
Breadth:	17.0 m
Berth occupancy rate:	70%
Unloader work efficiency ratio:	75% (continuous type), 50% (grab type)
Shiploader work efficiency ratio:	75%
Stock capacity of stock yard:	30,000 t/ha

Below is a summary of the examination results of each case, shown in Table 6.3.1.

In Case 1, fixed type imported coal transshipment terminal without breakwater and with trestle in Tra Vinh was examined. Though power plants need a total of approximately 3.2 million t per month, supply volume is insufficient throughout the year. The maximum supply volume is about 1.8 million t in May. Thus, coal logistics system of Case 1 is not feasible. The expected main reason is that the operation ratio of coal handling works for 5,000 DWT ship is low.

In Case 2, the operation ratio of coal handling works for 5,000 DWT ship was improved by applying 15 km trestle into coal transport to stockyard, and by providing landside breakwater to protect discharging berths from the stockyard. Coal can be stocked in the stockyard from July to December while coal stock volume is insufficient from January to May. It indicates that coal logistics system in Case 2 is not feasible. It is understood that the operation ratio of 67.9% for coal handling works for 100,000 DWT ship is insufficient under the condition that stock coal volume at power plants is for 30 days operation.

Based on the above, Case 3 (fixed type, with trestle), Case 4 (fixed type, without trestle) and Case 5 (floating type) are examined. Plans in these cases include offshore and landside breakwaters to protect offshore transshipment facilities and unloading/discharging berths to/from stockyard, aiming at improvement of the operation ratio of coal handling works for 5,000 DWT ships.

In Case 3, coal stock volume in March is minimum but not considerable. Coal logistics system in said case is thus feasible. The stockyard capacity in the imported coal transshipment terminal needs to be 4 million t. Offshore transshipment facilities consist of 1,200 m unloading berths for 100,000 DWT ships and 1,040 m discharging berths from stockyard for 5,000 DWT ships. These facilities are required to be sheltered by breakwaters. The total length of offshore breakwaters is 6 km and that of landside breakwaters is 5 km.

In Case 4, same as Case 3, coal stock volume in March is minimum but not significantly low. Therefore, coal logistics system in Case 4 is also feasible. The stockyard capacity in the imported coal transshipment terminal needs to be 5 million t. Offshore transshipment facilities consist of 1,500 m unloading berths for 100,000 DWT ships, 1,170 m discharging berths for 5,000 DWT ships to

stockyard, 780 m of unloading berths to stockyard, and 910 m discharging berths from stockyard for 5,000 DWT ship. These facilities are required to be sheltered by breakwaters. The total length of offshore breakwaters is 8 km and that of landside breakwaters is 5 km.

In Case 5, coal stock volume in March is minimum but not significantly low. Moreover, coal stock volume in the stockyard of imported coal transshipment terminal is above zero throughout the year. Therefore, coal logistics system in Case 5 is feasible. The stockyard capacity in the imported coal transshipment terminal needs to be 5 million t. A total of nine floating type imported coal transshipment facilities are needed. One floating type facility is equipped with two unloaders and two ship loaders. These facilities are required to be sheltered by breakwaters. The total length of offshore breakwaters is 10 km and that of landside breakwaters is 5 km.

In Case 6, fixed type imported coal transshipment terminal without breakwater and with trestle in Cai Mep was examined. High operation ratio of coal handling works in Cai Mep is expected, because it is sheltered by the peninsula. It was found that coal logistics system can be feasible, even if the stockyard capacity in the imported coal transshipment terminal is down to 2 million t. In case that the berth occupancy rate is 70%, three berths (total 900 m) for unloading and seven berths (910 m) for discharging are needed.

From the above discussions, Cases 3 to 6 are feasible coal logistics systems. Hence, preliminary structural examination and cost estimate are carried out in Chapters 7 to 10. Finally, the best location and structural type are selected based on economic evaluation using present value conversion.

Case 3: Tra Vinh (fixed type), with offshore and landside breakwaters, with trestle
Case 4: Tra Vinh (fixed type), with offshore and landside breakwaters, without trestle
Case 5: Tra Vinh (floating type), with offshore and landside breakwaters, without trestle
Case 6: Cai Mep (fixed type), without breakwater, with trestle

Table 6.3.1 Comparative Examination of Coal Logistics System of Alternative Sites (1/2)

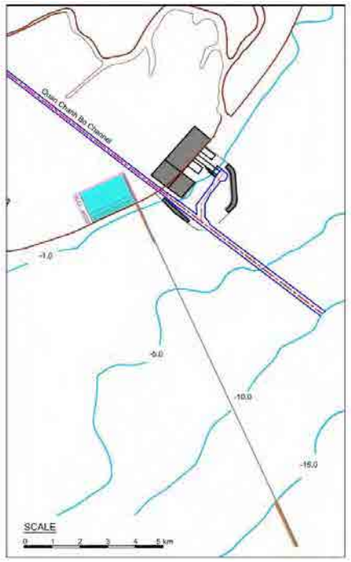
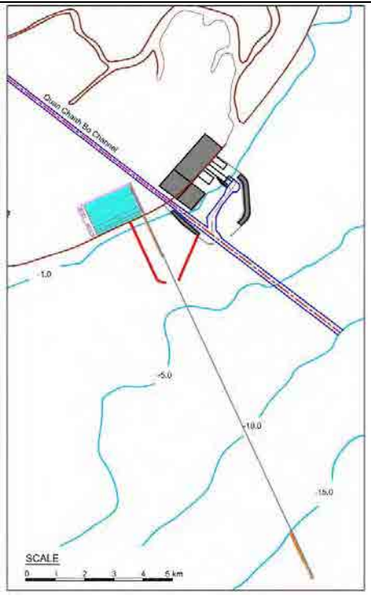
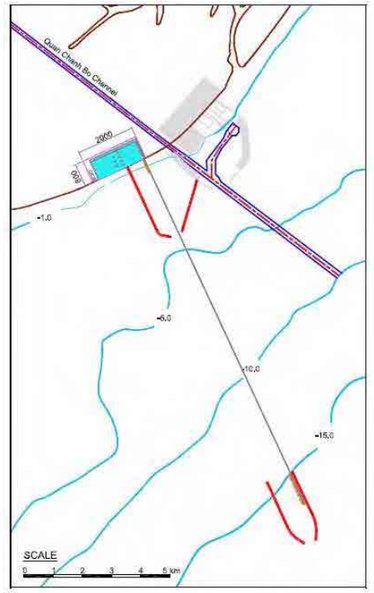
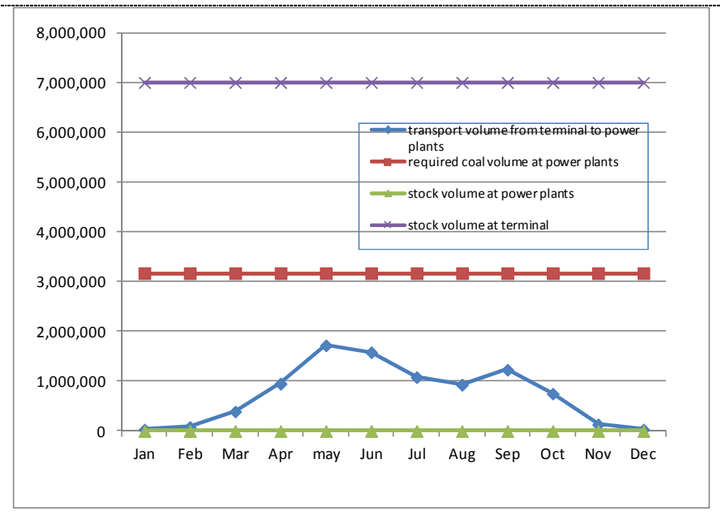
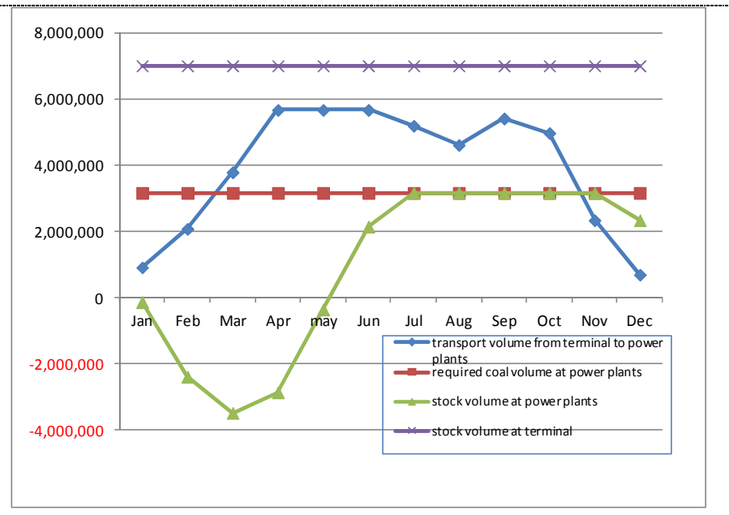
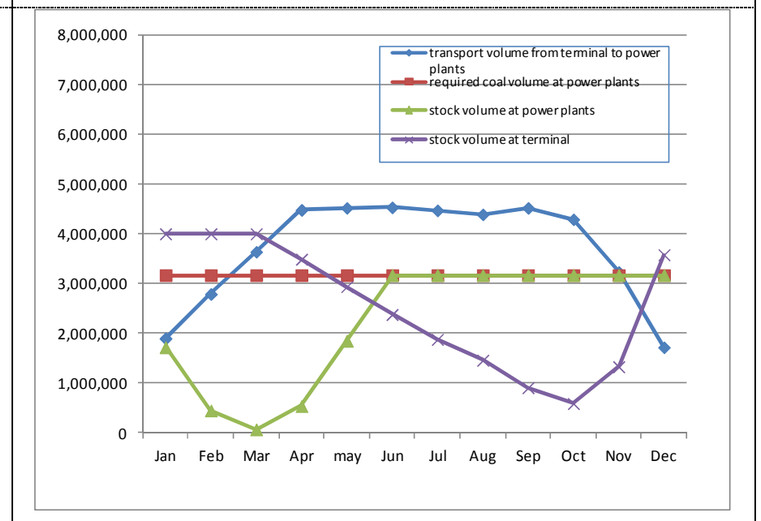
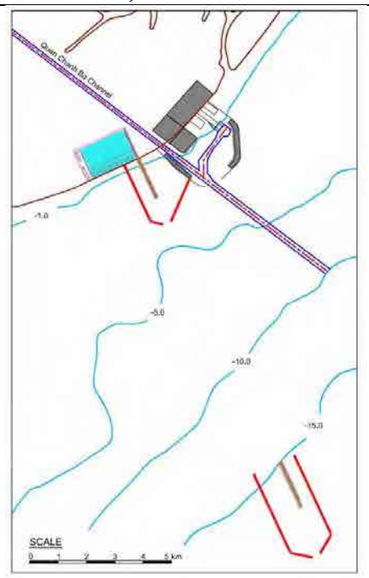
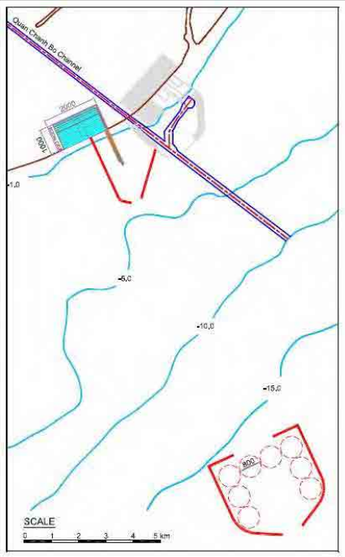
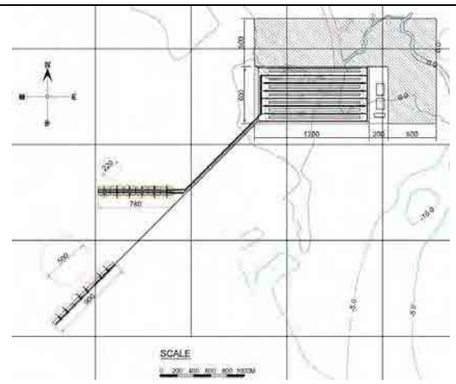
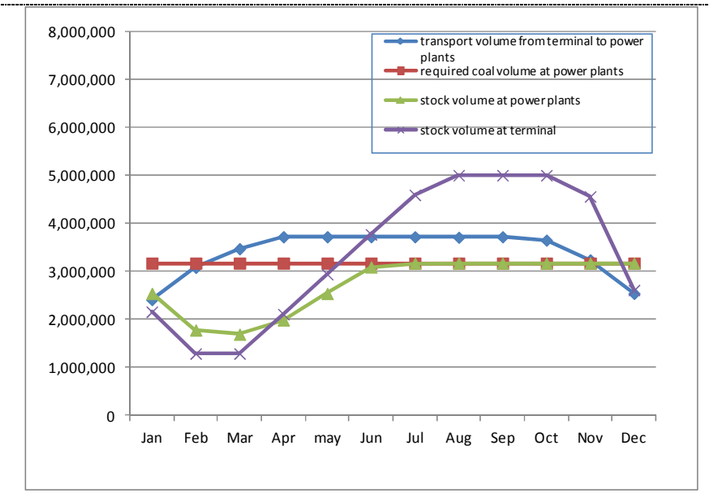
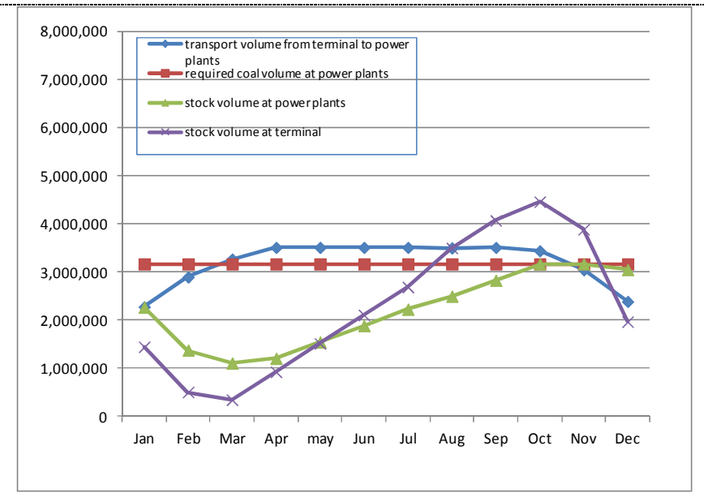
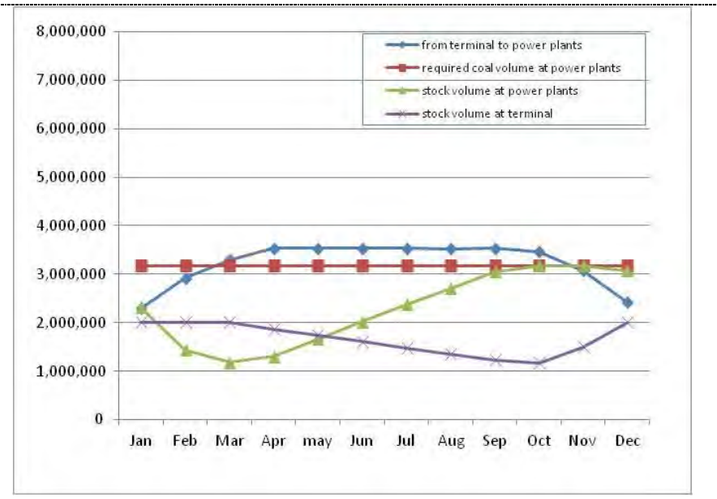
	Case 1: Tra Vinh (fixed type), without breakwater, with trestle	Case 2: Tra Vinh (fixed type), with landside breakwaters, without trestle	Case 3: Tra Vinh (fixed type), with offshore and landside breakwaters, with trestle
Terminal Plan	 Annual coal throughput: 16 million t Terminal stock capacity: 7 million t Unloading berth:1,800 m (6 berths) Unloader: 1,500 t/h x 12 nos. Discharging berth:1,560 m (12 berths) Ship loader: 1,500 t/h x 12 nos. Breakwater: not included Trestle: included	 Annual coal throughput: 41 million t Terminal stock capacity: 7 million t Unloading berth: 3,600 m (12 berths) Unloader: 1,500 t/h x 24 nos. Discharging berth: 1,300 m (10 berths) Ship loader : 2,500 t/h x 10 nos. Landside breakwater: 3 km (south), 2 km (north) Trestle:15 km	 Annual coal throughput: 44 million t Terminal stock capacity: 4 million t Unloading berth: 1,200 m (4 berths) Unloader: 2,500 t/h x 8 nos. Discharging berths: 1,040 m (8 berths) Ship loader: 2,500 t/h x 8 nos. Landside breakwater: 3 km (south), 2 km (north) Offshore breakwater: 3 km (south), 3 km (north) Trestle: 15 km
Coal Logistics Examination	 Coal supply to power plants: impossible	 Coal supply to power plants: impossible	 Coal supply to power plants: possible

Table 6.3.2 Comparative Examination of Coal Logistics System of Alternative Sites (2/2)

	Case 4: Tra Vinh (fixed type), with offshore and landside breakwaters, without trestle	Case 5: Tra Vinh (floating type), with offshore and landside breakwaters, without trestle	Case 6: Cai Mep (fixed type), without breakwater, with trestle
Terminal Plan	 Annual coal throughput: 47 million t Terminal stock capacity: 5 million t <Offshore> Unloading berth: 1,500 m (5 berths) Unloader: 2,500 t/h x 10 nos. Discharging berth: 1,170 m (9 berths) Ship loader: 2,500 t/h x 9 nos. <Landside> Unloading berth: 780 m (6 berths) Unloader: 2,500 t/h x 6 nos. Discharging berth: 910 m (7 berths) Ship loader: 2,500 t/h x 7 nos. Landside breakwater: 3 km (south), 2 km (north) Offshore breakwater: 4 km (south), 4 km (north) Trestle: not included	 Annual coal throughput: 44 million t Terminal stock capacity: 5 million t <Offshore> Floating facility 9 nos. (unloader 1,500 t/h x 2 nos., ship loader 1,500 t/h x 2 nos., each) <Landside> Unloading berth: 1,300 m (10 berths) Unloader: 2,500 t/h x 10 nos. Discharging berth: 1,430 m (11 berths) Ship loader: 2,500 t/h x 11 nos. Landside breakwater: 3 km (south), 2 km (north) Offshore breakwater: 5 km (south), 5 km (north) Trestle: not included	 Annual coal throughput: 45 million t Terminal stock capacity: 2 million t Unloading berth: 900 m (3 berths) Unloader: 2,500 t/h x 6 nos. Discharging berth: 910 m (7 berths) Ship loader: 2,500 t/h x 7 nos. Breakwater: not included Trestle: 3 km and 1.5 km
Coal Logistics Examination	 Coal supply to power plants: possible	 Coal supply to power plants: possible	 Coal supply to power plants: possible

6.4 Secondary Freight from Imported Coal Transshipment Terminal to Power Plants

Based on the current charterage of coaster vessels, secondary freight from alternative sites for imported coal transshipment terminal to the Mekong River estuary are calculated preliminarily. At that time, it is assumed that the same power plant as Song Hau 1 is located at the Mekong River estuary.

(Preconditions)

- Alternative site: Cai Mep and Tra Vinh are assumed
- Transport distance (Nm=1,852 km): Cai Mep – Mekong River estuary, 65 Nm approx.
  Tra Vinh – Mekong River estuary, 8 Nm approx.
- Speed of coaster vessel: 5.5 knot/hr
- Loading rate at imported coal transshipment terminal: 2,500 MT/hr
- Unloading rate at Song Hau 1 power plant: 1,700 MT/hr
- Current charterage in Vietnam market: 5,000 DWT, USD 1,300/day
  These charterages do not include fuel charge, port charge, etc., and these charges are estimated at 50% of the charterage, and were added on the charterage.
- Loadable quantity: DWT x 90%
- Berth occupancy (power plant side): 0.5
- Berth occupancy (terminal side): 0.7
- Loading and unloading efficiency: 75%
- Preparation at ports: 2 hours each

Table 6.4.1 Secondary Freight Calculation

Location of Terminal	Cai Mep	Tra Vinh
Transport time (one way) + spare time 1hour	12hrs	2.5hrs
Loading port stay 5,000 DWT	5.5hrs	5.5hrs
Unloading port stay 5,000 DWT	9.1hrs	9.1hrs
Cycle time 5,000 DWT	38.6 hrs (1.6 d)	19.6 hrs (0.9 d)
Charterage 5,000 DWT	USD 3,120	USD 1,755
Freight rate 5,000 DWT	USD 0.70/MT	USD0.40/MT

Note:
1) Due to current shortage of big size coaster vessels in Vietnam, charterage for larger size coaster vessels is rather expensive than smaller size coaster vessels.
2) The above freight is based on T/C contract base, and same coaster vessels are used continuously.
3) Risks for congestion and waiting for high tide are not included.
4) The above freights are covering freight costs only without loading and unloading expenses.

Chapter 7 Examination of Floating Type Imported Coal Transshipment Terminal (Tra Vinh: Without Trestle)

Contents

Chapter 7 Examination of Floating Type Imported Coal Transshipment Terminal (Tra Vinh: Without Trestle)

7.1 Layout of Main Facilities of Floating Type Imported Coal Transshipment Terminal

The layout of floating type imported coal transshipment terminal in Tra Vinh is shown in Figure 7.1.1.

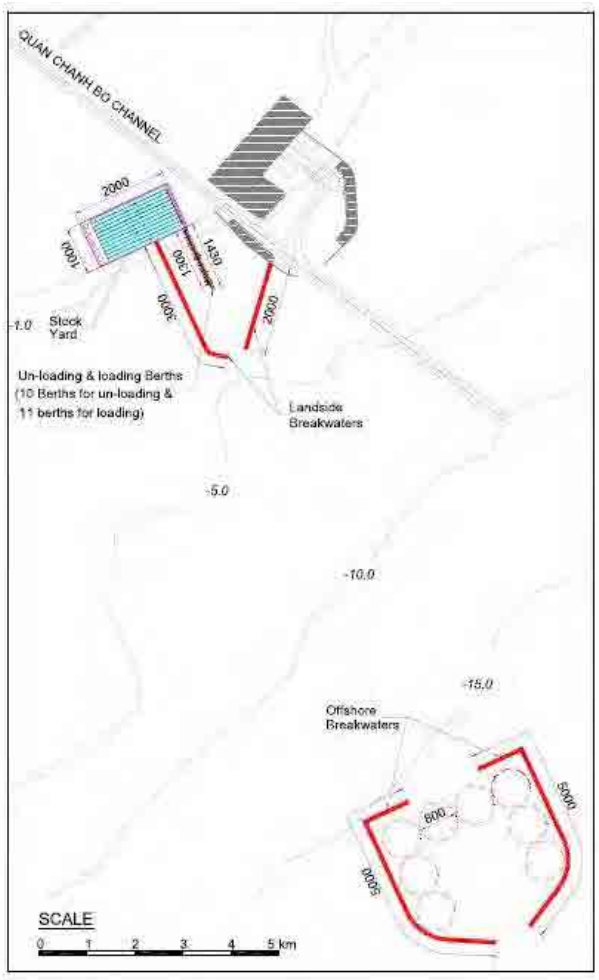


Figure 7.1.1 Layout of Floating Type Imported Coal Transshipment Terminal in Tra Vinh

7.2 Floating Type Coal Transshipment Facility

This preliminary design is based on parameters known at the time of preparing this report. Detailed design is normally handled by the construction contractor and requires checking to determine whether design parameters have changed.

This preliminary design also provides some discussions of the design philosophy. This discussion is proven useful at the detailed design stage and facilitates changes in design parameters.

7.2.1 Study of the Major Dimensions of the Floating Structure

The transshipment terminal under consideration in Vietnam will be used to transfer imported coal. Since the facility will resemble the reclaimer used in Japan, considerations of major dimensions are based on a reclaimer model.

Toyo-Go Reclaimer L=100 m B=30 m D=6 m d=2 m 2,200 m^3/h

Figure 7.2.1.1 Sample of Reclaimer

(1) Considerations of overall length and width

The following provisional dimensions were selected:

Overall length (L) is 100 m and overall width (B) is 40 m. Thus, B/L = 0.4, based on reclaimer dimensions. The facility will be towed or pushed by tugboats. A small B/L ratio will reduce propulsion resistance and minimize the propulsion power required.

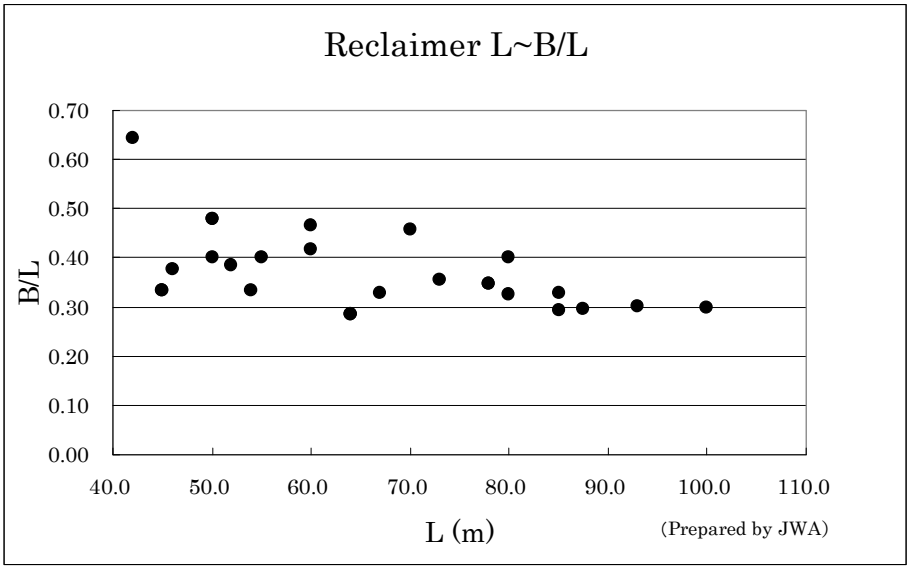


Figure 7.2.1.2 Overall Length and Ratio of Overall Width per Overall Length of Reclaimer

(2) Estimated displacement (light weight)

The displacement (light weight) of reclaimer covering a given water plane area was calculated. The displacement (light weight) for a dredging barge with a water plane area of 4,000 m^2 (L x B = 100 m x 40 m = 4,000 m^2) is 7,500 t.

The transshipment terminal is considered equivalent to a reclaimer lacking the two backhoes (100 t x 2) but fitted with two unloaders (600 t x 2 = 1,200 t), and two ship loaders (500 t x 2 = 1,000 t). The displacement (light weight) is therefore estimated as follows:

Δ_1 = 7,500 – 200 + 1,200 + 1,000 = 9,500 t

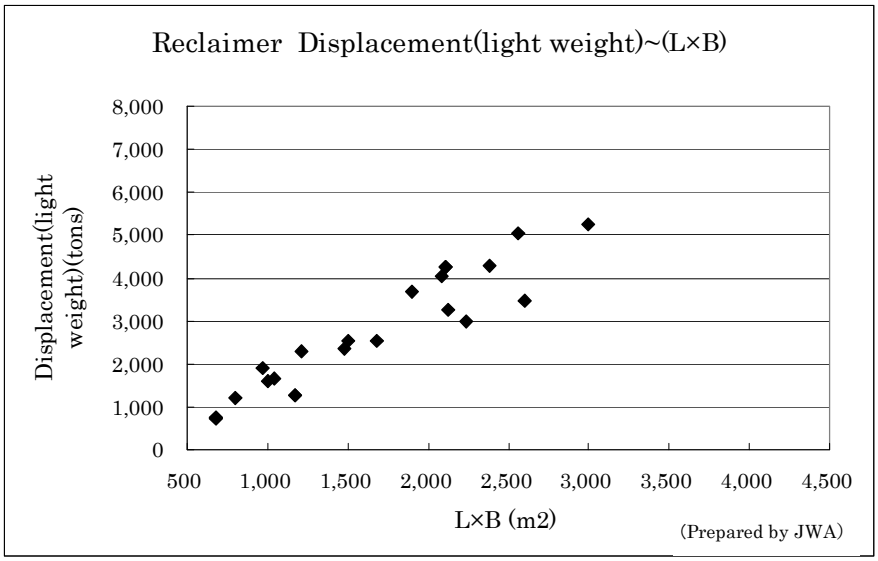


Figure 7.2.1.3 Relationship between Displacement and Water Plane Area of Reclaimer

(3) Estimated draft (light weight)

The draft (light weight) for this transshipment terminal is estimated. The block coefficient for most reclaimers is roughly C_b = 0.90. Since this facility is also designed to be towed or pushed, the bottom of the vessel should be cut at bow and stem ends. In this case, with a block coefficient of C_b = 0.90, the draft (light weight) was calculated to be $d_1 = \Delta_1$/(water plane area x C_b) = 9,500 t/(100 m x 40 m x 0.90 m x 1.025) = 2.57 m. This is rounded to d_1 = 2.6 m.

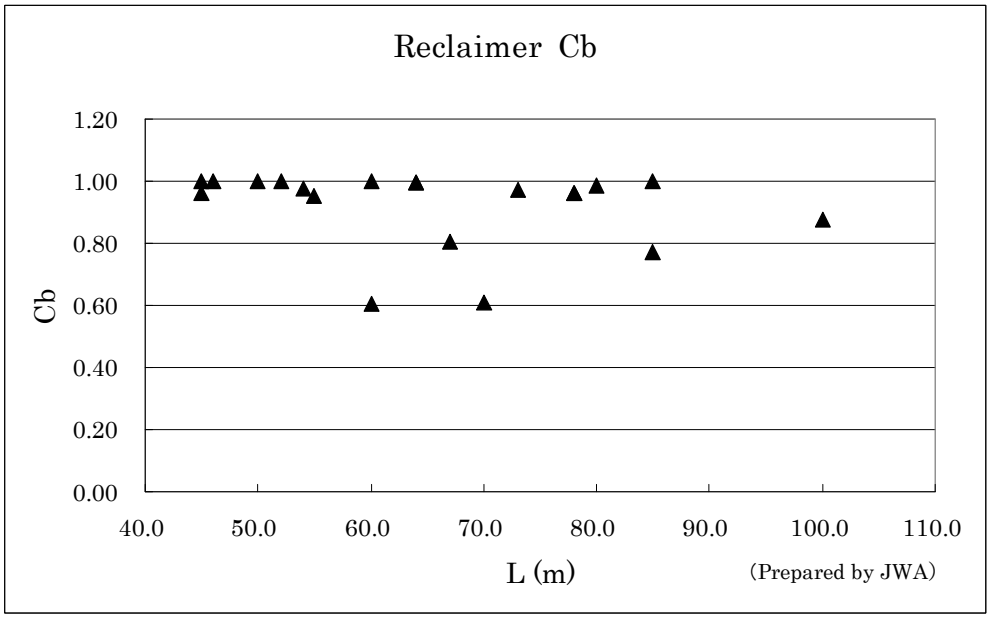


Figure 7.2.1.4 Relationship between Block Coefficient (Cb) and Overall Length of Reclaimer

(4) Examining increased draft due to coal storage

This facility is designed to be used to store coal temporarily. It is therefore vital to allow the draft to increase in a stable manner.

Assuming a coal storage capacity of 6,720 t (storage volume of 8,400 m^3 with a specific gravity of 0.8 for coal), it was estimated that the draft would increase by 6,720 t/(100 m x 40 m x 1.025) = 1.64 m, causing a draft of 4.2 m when loaded (increase of 1.64 m added to draft of 2.6 m when light weight). Note that these calculations exclude draft increases attributable to other factors, such as ballast water or fuel. Thus, the draft varies by 24.4 mm per 100 t of load.

(5) Examining freeboard

The freeboard for this facility was set to a minimum of 4 m, since reclaimers have a freeboard of 4 m for a width, B, of 40 m and length, L, of 100 m when fully loaded. This facility must be designed to avoid swamping by waves. It may be necessary to increase the freeboard depending on wave height and wave cycles at the deployment site.

It may also be necessary to increase the freeboard to ensure adequate lifting height for the unloaders and ship loaders, depending on the hatch heights of the mother vessel and shuttle vessels.

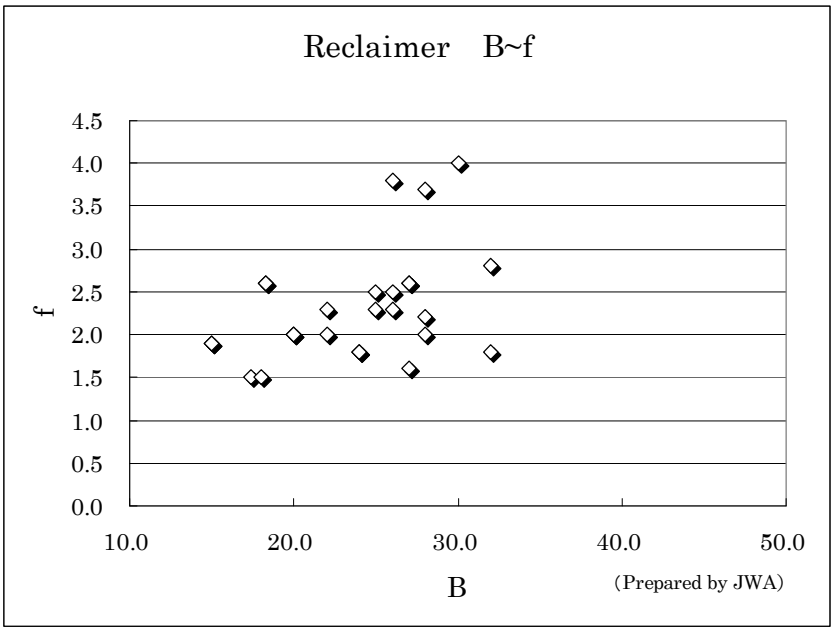


Figure 7.2.1.5 Relationship between Width and Freeboard of Reclaimer

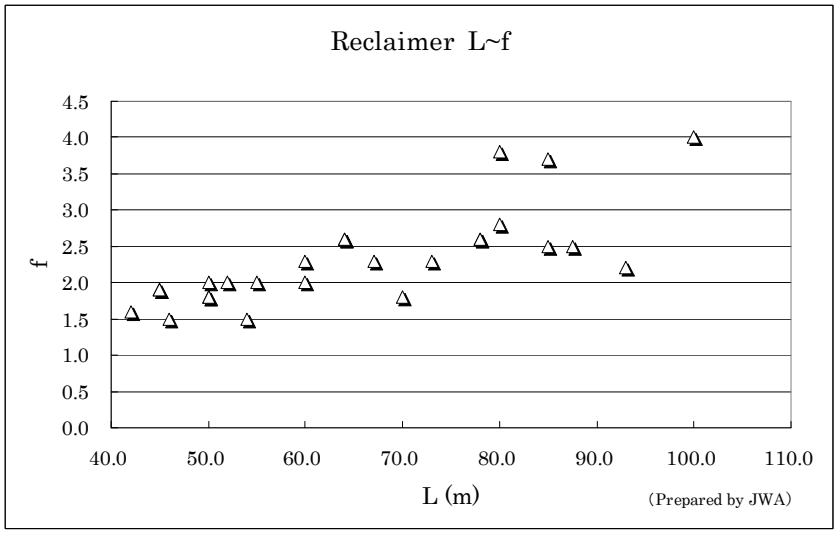


Figure 7.2.1.6 Relationship between Overall Length and Freeboard of Reclaimer

(6) Considerations of depth

The depth (D) for this facility is set to a minimum of 8.2 m (lightweight draft, 2.6 m + increased draft when fully loaded, 1.64 m + minimum freeboard 4.0 m).

The ballast weight required for draft adjustments when loading and for attitude control is estimated to be 4,920 t. This increases the draft by 1.2 m, necessitating a total depth of 9.5 m. Refer to Section 7.2.3 (5) for details.

(7) Provisional major dimensions determined for floating coal transshipment terminal

The provisional major dimensions for the floating coal transshipment terminal were determined as follows, based on the results of the examinations described above:

Length over all (L)	100.0 m
Breadth over all (B)	40.0 m
Depth (D)	9.5 m
Draft light weight (d_l)	2.6 m
Operation (d_o)	5.5 m (Coal 6,720 t, ballast 4,920 t)
full load (d_f)	6.5 m (Coal 6,720 t, ballast 9.350 t)
Free board (f)	3.0 m ~ 6.4 m
Displacement light weight (Δ_l)	9,500 t

7.2.2 Analysis of Coal Handling Machinery

(1) Analysis of coal unloaders

This study excluded bridge-type unloaders, due to their weight and inability to rotate.

Continuous unloaders are also excluded as they are impossible to be equipped on the floating body, due to their weight and that of the counterweights required for longer booms.

Therefore, grab unloaders were selected.

If two grab unloaders with a nominal handling capacity of 1,500 t per hour per unloader are installed, the estimated unloading efficiency of 0.5 means that the actual handling capacity is 750 t per hour per unloader, or a total of 1,500 t per hour for two unloaders. It is desirable that grab unloaders are of a level type from the viewpoint of efficiency.

The unloaders have a rotation radius of 27 m. The bucket attached to the tip of the boom can be operated from a depth of 5 m below sea level, to 18 m above sea level. Each unloader weighs 600 t. Coal is unloaded intermittently before loading onto the transfer conveyor, which induces conveyor pulsing. Ideally, the conveyor belt should have a width of 1,600 mm.

This type of unloader grabs coal using a grab bucket. This requires shoveling of the coal using two bulldozers within the cargo hold of the mother vessel.

The two unloaders are each located at a fixed distance of 30 m fore and aft of the center of the floating facility. The centerline of the transfer conveyor is 5 m from the side of the floating facility.

The unloader fixed column height, boom rotating radius, and boom vertical angle are determined based on factors such as vessel type, hatch size, and draft. The draft for the mother vessel rises by approximately 10 m when unloading is complete.

Among various other factors to be considered, unloading from a single cargo hold on the vessel may introduce problems related to the strength of the vessel hull. The specifics of unloading procedures must be discussed with the shipping operators, during the detailed design stage.

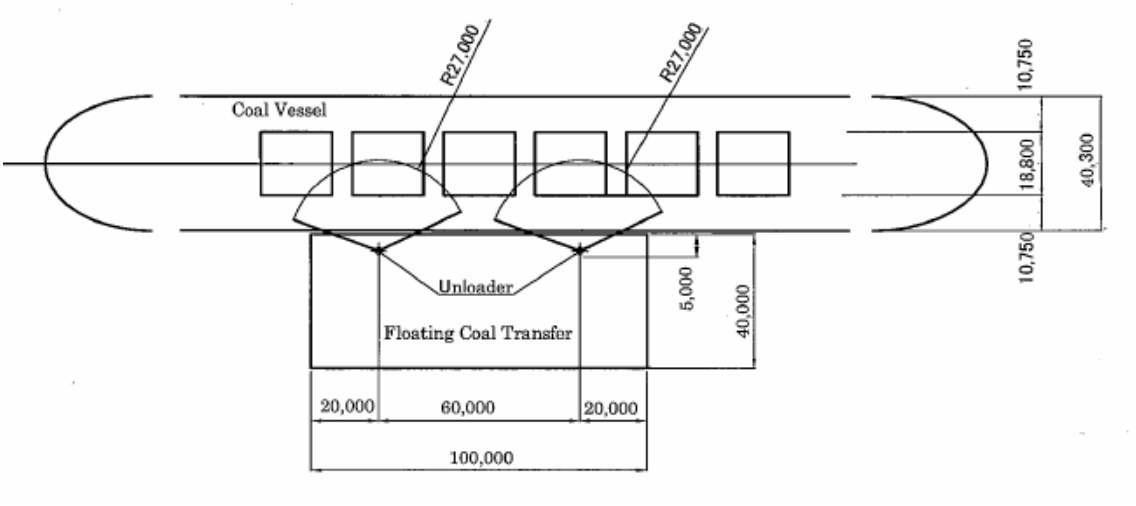


Figure 7.2.2.1 Illustration of Coal Unloading (Mother Vessel: 100,000 DWT)

(2) Analysis of coal transfer conveyors

The figure below illustrates the correlation between coal conveyor belt width and conveyor capacity.

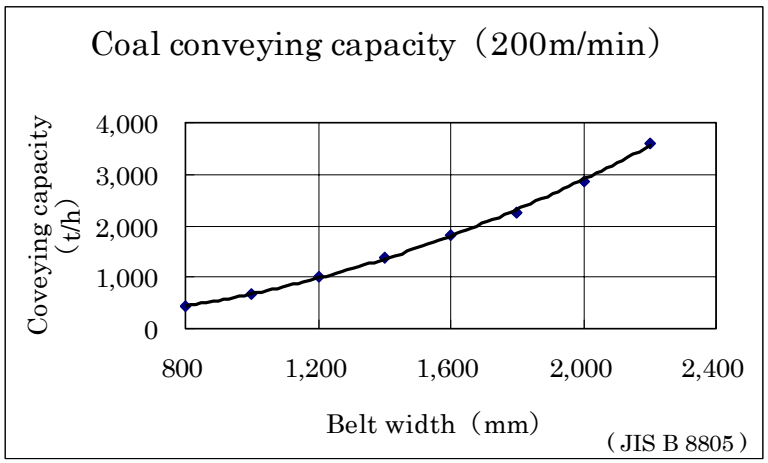


Figure 7.2.2.2 Coal Conveying Capacity in case Belt Speed is 200 m/min

If the belt width is 1,600 mm and belt speed is 200 m/min, as shown in the above figure, the coal conveying capacity will be 1,800 t/h. This is considered adequate with a margin of 20%, compared to the 1,500 t/h nominal handling capacity of the unloaders.

A height difference of 2 m is specified for the conveyor connections, but this will need to be examined at the detailed design phase.

The coal transfer conveyor route consists of two separate fore and aft circuits for transferring unloaded coal by the unloaders, to the respective ship loaders. The coal transfer conveyors have a belt width of 1,600 mm and a total length of 148 m. These are expected to weigh 74 t.

The transfer conveyor route for the forward end is illustrated below. The transfer conveyor route for the aft end is a mirror image of the fore end.

a) A conveyor is installed along the port side from the unloader to the forward-port point (A). The centerline of the conveyor is 5 m from the port side and 4 m above the deck. The conveyor belt is 1,400 mm wide. Total conveyor length is 27 m.

b) A second conveyor is installed from the fore-port point (A), to the fore-starboard point (B). The centerline of the conveyor is 5 m from the forward side. The conveyor is positioned 2 m above the deck at Point A and 10.3 m above the deck at Point B, with an upward gradient not exceeding 15 degrees. The conveyor belt is 1,600 mm wide. Total conveyor length is 32 m.

c) A distributor is installed at the intersection between the stockpile conveyor and transfer conveyor at the fore-starboard point (B).

d) A third conveyor is installed from the fore-starboard point (B), along the starboard side. The centerline of the conveyor is 4 m from the starboard side, and 8 m above the deck. This feeds coal to the ship loader. The conveyor belt is 1,600 mm wide. The total conveyor length is 15 m.

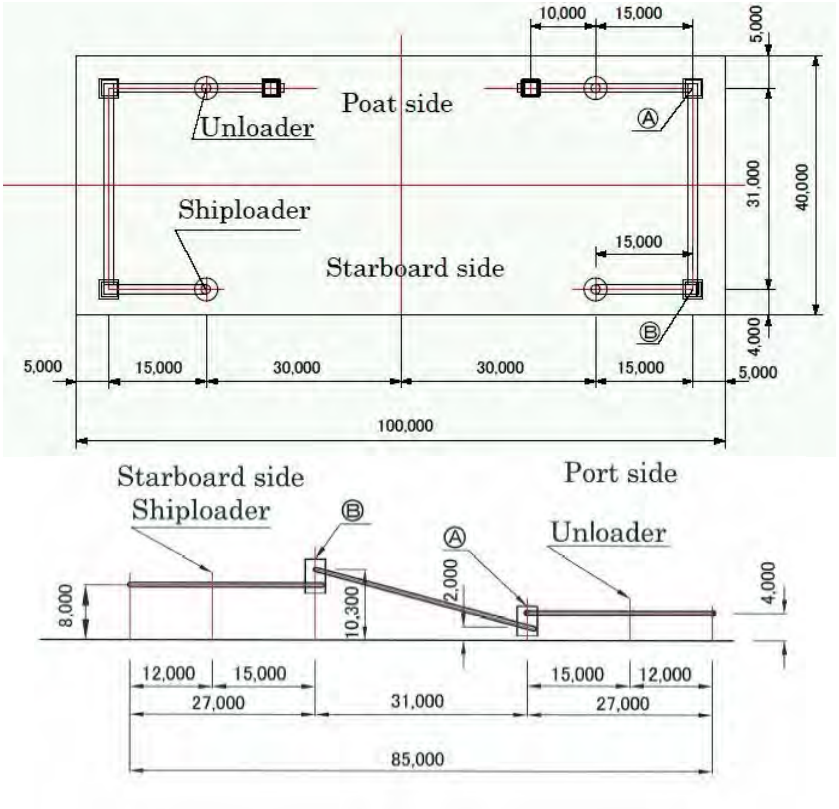


Figure 7.2.2.3 Illustration of Coal Transfer Conveyor Route

(3) Analysis of stockpile conveyors

Unloaded coal that cannot be transferred directly to a shuttle vessel is carried to the coal stockpile area by two separate coal stockpile conveyor circuits at the fore and aft points of the floating facility. The stockpile conveyor has a belt width of 1,600 mm, total length of 112 m, and projected weight of 56 t.

The stockpile conveyor extends from beneath the distributor at the fore-starboard point (B) to the fore-center point (C), with a distance of 16 m on the inside of the transfer conveyor. The conveyor is configured with an upward slope rising from 7 m to 10 m. A second conveyor measuring 40 m in length extends from Point C along the centerline of the floating facility, at a height of 8 m. The stockpile conveyor is then fitted with moving trippers. The stockpile conveyor system at the rear of the floating facility is a mirror image of the conveyor system at the front of the floating facility.

The coal stockpile area extends 12 m to either side of the centerline. It extends 40 m toward the front end and 30 m toward the rear end. It has an area of 1,680 m^2 and is surrounded by a fence measuring 6 m high.

Coal is discharged by gravity from the stockpile conveyor by the moving trippers, forming a triangular mound with a base length of 12 m, and a height of 7 m, based on a 40-degree repose angle for coal. This mound is spread by four bulldozers to stockpile coal, in the coal stockpile area.

The predicted stockpile capacity will be 8,400 m^3, assuming a mean height of 5 m and an area of 1,680 m^2. This corresponds to a stockpile weight of 6,720 t, calculated considering the specific gravity of 0.8 t/m^3 of coal.

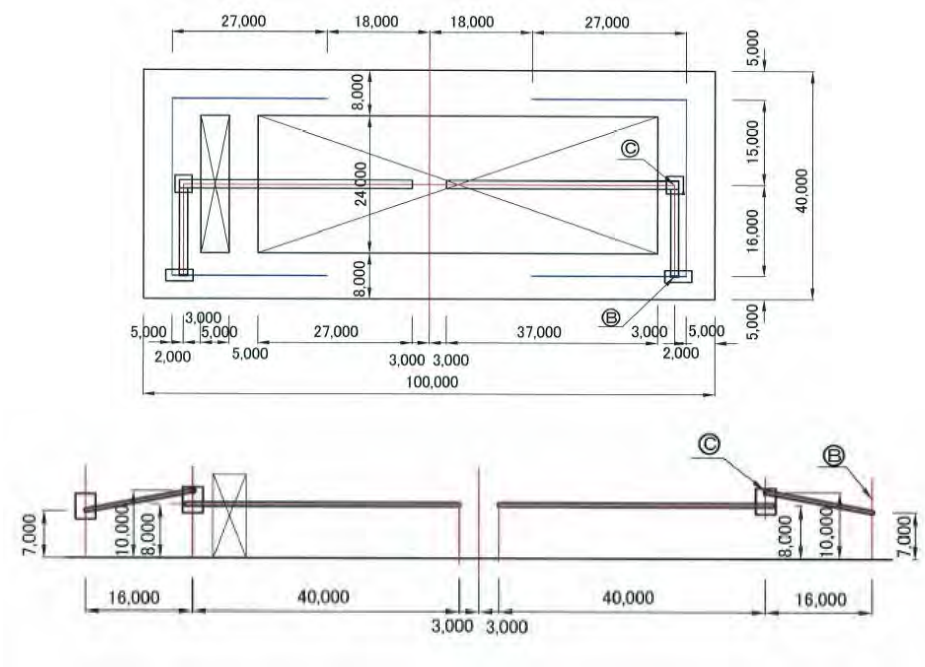


Figure 7.2.2.4 Illustration of Stockpile Conveyor Route

(4) Analysis of discharge conveyors

Loading stockpiled coal onto shuttle vessels involves transferring coal from the stockpile area to ship loaders, via two separate discharge conveyor circuits at the fore and aft points of the floating facility. The discharge conveyor has a belt width of 1,600 mm, total length of 120 m, and a projected weight of 60 t.

The discharge conveyor route at the front of the floating facility is described below. The discharge conveyor route at the rear of the floating facility is a mirror image of the front.

Two coal discharge positions are located on the upper deck of the coal stockpile area. The discharge conveyor is positioned 5 m to the starboard side of the terminal centerline. One straight conveyor is positioned 3 m below the deck. This has an upward gradient from a point 24 m from the front of the terminal, to a Point D, which is 7 m from the front. Point D is positioned 1.5 m above the deck. A second straight conveyor is positioned from Point D to Point E, close to Point A, at a height 0.5 m below the deck at Point D, and 4 m above the deck at Point E.

Coal to be discharged is transferred to the transfer conveyor at Point A, then conveyed to the ship loader by the transfer conveyor, for discharging into the shuttle vessel.

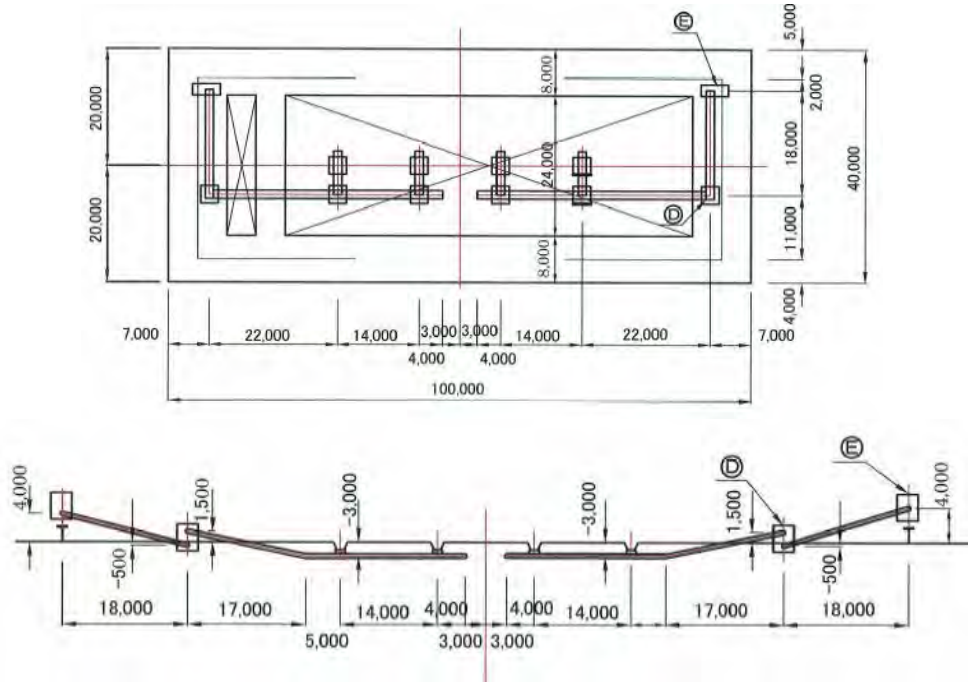


Figure 7.2.2.5 Illustration of Discharge Conveyor Route

(5) Analysis of coal ship loaders

Ship loaders transfer unloaded coal via unloaders onto the shuttle vessels, and transfer coal temporarily stockpiled on the floating facility onto the shuttle vessels.

Two ship loaders are provided at fixed positions on the starboard side of the floating facility. If each ship loader has a nominal handling capacity of 1,500 t per hour per unloader, the estimated handling efficiency of 0.75 means that the actual handling capacity is 1,125 t per hour per unloader, or a total of 2,250 t per hour for two ship loaders. Each loader weighs 500 t, for a total of 1,000 t for two loaders.

The ship loader boom has a rotation radius of 15 m. The tip of the boom can be operated from a depth of 4 m above sea level, to 10 m above sea level. The shuttle vessels used here are estimated to weigh between 5,000 and 10,000 DWT.

The two ship loaders are each located at a fixed distance of 30 m fore and aft of the center of the floating facility. The centerline of the transfer conveyors from the ship loaders is 4 m from the side of the floating facility.

The ship loader fixed column height, boom rotating radius, and boom vertical angle are determined based on factors such as vessel type, hatch size, and draft.

Note that the ship loaders may be able to operate simply by rotating an extendable conveyor, depending on the shuttle vessel type.

(6) Summary of floating coal transshipment terminal handling capacity

Based on the studies described above, the cargo handling machinery on the floating coal transshipment terminal handling capacity is estimated as shown below.

Equipment	Quantity	Nominal Capacity	
Unloaders (grab)	2 units	1,500 t/h per 1 unit	Boom rotation radius: 27 m, Lifting height: 5 m below and 18m above sea level
Transfer conveyors	2 routes 74 m/route	1,880 t/h per 1 route	Belt width: 1,600 mm Belt speed 200 m/min 4 m above, 10.3 m above and 8m above the deck
Stockpile conveyors	2 routes 56 m/route	1,880 t/h per 1 route	Belt width:1,600 mm Belt speed 200 m/min 7 m above, 10 m above and 8m above the deck
Discharge conveyors	2 routes 60 m/route	1,880 t/h per 1 route	Belt width:1,600 mm Belt speed 200 m/min 3 m below, 1.5 m above and 4m above the deck
Ship loaders	2 units	1,500 t/h per 1 unit	Boom rotation radius: 15 m, Lifting height: 4 m to 18 m above sea level
Stockpile area	1,680 m^2	6,720 t	Surrounded by a fence of 6 m height

7.2.3 Analysis of the Ballast Adjustment Function

The floating facility is wide and has an adequate freeboard, making it statically stable, and possesses adequate restoring force. Nevertheless, thorough analysis at the detailed design stage is still required.

This stage involves incorporating a ballast adjustment function to adjust to draft changes of the mother vessel during unloading, and to adjust tilt along the roll and pitch axes.

(1) Ballast adjustment during unloading

1) When the mother vessel docks and coal loading starts

The mother vessel has a maximum draft of 14 m. The hatch height is 22.4 m, putting the hatches 8.4 m above sea level. The freeboard is 4 m. The height of the boom vertical pivot point must be at least 4.4 m above the deck.

2) When the coal has been unloaded from the mother vessel

The mother vessel has a draft of 4.7 m when lightly loaded. The hatch height is 22.4 m, putting the hatches 17.7 m above sea level. The freeboard is 4 m. The height of the boom vertical pivot point must be at least 13.7 m above the deck.

3) Ballast adjustment required for unloading

To summarize the requirements described above, an unloader boom with a vertical pivot point at a height 18 m above sea level will enable unloading of standard 100,000 DWT vessels.

The unloader vertical pivot point is therefore 14 m above the deck. No ballast adjustments are required.

(2) Ballast adjustment for ship loading

For the purpose of loading coal onto a shuttle vessel using the ship loaders, the hatch height of the shuttle vessel will change from 9.4 m to 4.3 m. The shuttle vessel here is estimated to weigh between 5,000 and 10,000 DWT.

If the ship loader vertical pivot point is 6 m above sea level, its end will be 10 m above sea level with a conveyor vertical angle of 15 degrees, allowing coal to be loaded onto the ship loader.

No ballast adjustments are required for the ship loader.

(3) Ballast adjustment for coal stockpiling or transfer

The forward stockpile area has a capacity of 3,840 t. The aft stockpile area has a capacity of 2,880 t. A ballast adjustment of 960 t is required at the rear of the floating facility.

With a single transfer conveyor system, the total length of the transfer conveyor is 74 m, and the weight of coal conveyed is calculated as 1,800 t/h / 60 min/h / 200 m/min x 74 m = 11 t. This value may thus be ignored.

(4) Ballast adjustments for the floating facility infrastructure

The floating facility includes an operation monitoring room and staff room at the rear end. The main engines and generators are also located at the rear, necessitating ballast adjustments.

The port side has two unloaders totaling 1,200 t. The starboard side has two ship loaders totaling 1,000 t, necessitating ballast adjustments of 200 t.

The fuel and drinking water tanks may also be large, depending on replenishment intervals.

(5) Analysis of ballast adjustment function

1) Ballast tanks

The ballast weight is specified below, based on the analyses described above.

Stockpile	960 t rear side, up and down
Handling Equipment	212 t starboard side, always
Attitude control	2,000 t every place
Allowance	1,000 t
Total	4,172 t

Attitude control ballast calculations here were based on the following total capacity of the ballast tanks for *Toyo-Go*.

Ballast tanks for *Toyo-Go*	Fore-starboard	583.2 m^3 x 1
	Fore-port	583.2 m^3 x 1
	Aft-starboard	440.5 m^3 x 1
	Aft-port	440. 5 m^3 x 1
	Total	2,047.4 m^3

The port and starboard ballast tanks are 10 m long, 8 m wide, and 9.5 m deep, giving a capacity of 760 m^3. Six tanks are arranged on either side, giving a total of 12 tanks with a total ballast tank capacity of 9,120 m^3. Filling the ballast tanks with seawater to a depth of 5 m gives a ballast weight of 4,920 t.

This ballast weight increases the draft by 1.2 m, resulting in a draft of 5.5 m. If the freeboard is 4.0 m, the resulting depth is 9.5 m.

Filling the ballast tanks completely results in a ballast weight of 9,350 t. The fully loaded draft is 6.5 m and the fully loaded freeboard is 3.0 m.

The ballast tanks are configured as shown in the figure below. Each tank is equipped with water level gauges.

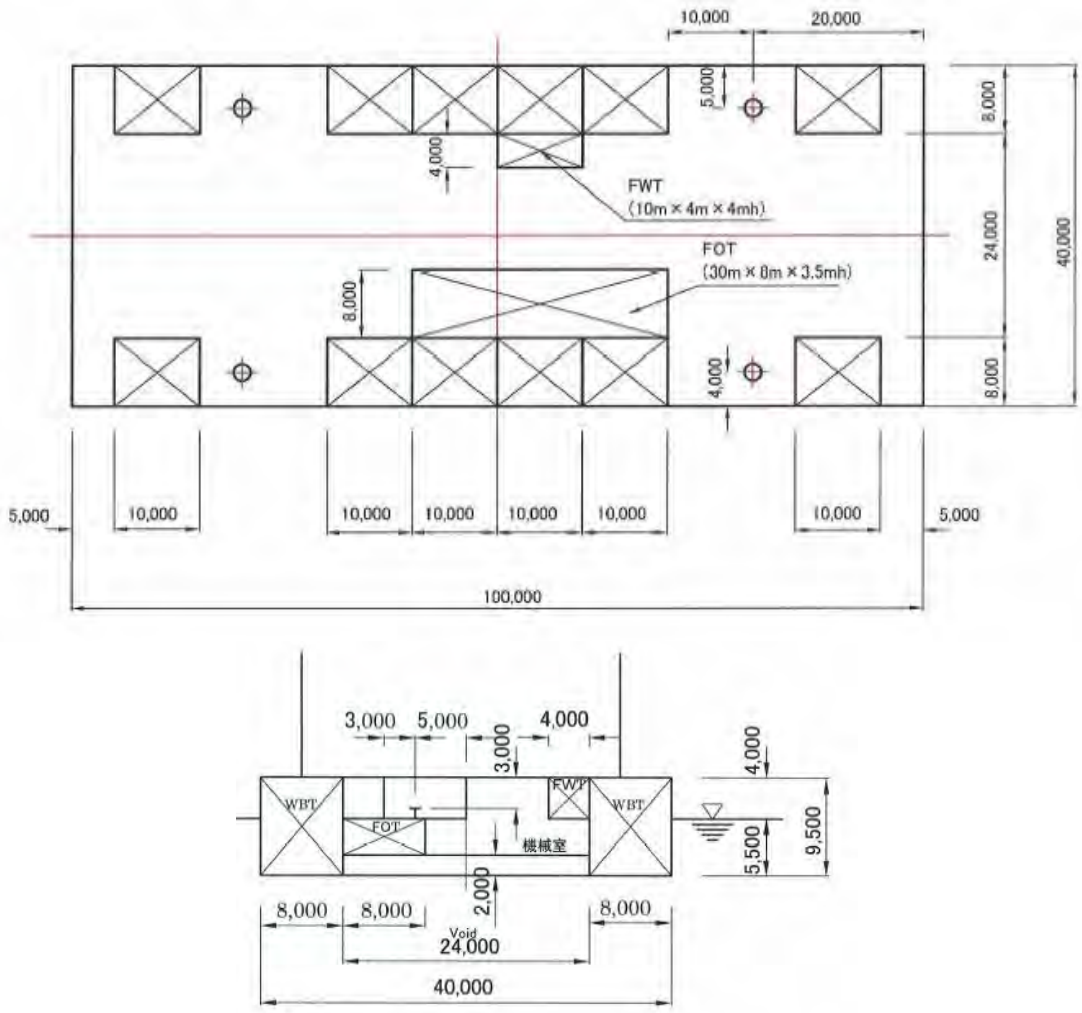


Figure 7.2.3.1 Illustration of Ballast Tanks Arrangement

2) Intake/discharge pumps

Each ballast tank is fitted with one intake/discharge pump. Water is injected and discharged via the seawater intake compartment located on the side of the floating facility. Intake/discharge pumps are operated independently using a manual or automatic control system.

The intake/discharge pumps have an individual capacity of 400 m^3/h for a total capacity of 4,800 m^3/h when all pumps operate. Two spare pumps are provided in a storage in case of pump failure or maintenance.

The time required to unload when the coal stockpile area is fully loaded is 6,720 t/3,000 t/h = 2.24 hours. The amount of ballast water required is 960 t. The time required to provide this is 960 t/(400 m^3/h x 6 pumps x 1.025 t/m^3) = 24 minutes. The pump capacity is therefore adequate. Pump capacity is an important factor considering the automatic control system described later. This must be analyzed at the detailed design phase.

3) Automatic attitude control system

Automatic attitude control system is used to maintain the floating facility at level attitude by operating the intake/discharge pumps when the floating facility tilt exceeds a preset value. This system is used in Japanese caisson construction barges.

The tilt of the floating facility is defined in terms of trim (longitudinal inclination) and heel (lateral inclination). For caisson construction barges in Japan, trim and heel are normally maintained within 2 and 1 degrees, respectively. Attitude control for the floating facility is designed to maintain trim within 2 degrees and heel within 1 degree. More detailed analysis must be performed once the specifics of equipment and their respective locations are determined.

Attitude control for the floating facility uses draft gauges at each of the four corners, and trim and heel gauges, as well as water level gauges in the ballast tanks.

The automatic attitude control system requires a computer program to correct the attitude of the floating body by operating pumps, when the trim or heel exceeds preset values in anticipation of attitude variations. A range of attitude correction patterns must be prepared beforehand.

(5) Overview of ballast adjustment function

The ballast adjustment function for the floating coal transshipment terminal is specified below, based on the considerations above.

Function			
Ballast tanks(both sides)	12 units	760 m^3/unit	Total 9,120m^3
Intake/discharge pumps	12 units	400m^3/h/unit	2 spare units in storage
Automatic attitude control	1 set		

7.2.4 Mooring Analysis

(1) Analysis of anchor and chains

The floating facility is assumed to be a vessel (equipped with propulsion equipment). On this basis, the anchor and chain details required for the floating facility must be determined.

The number of structures on the floating facility is determined by the following equation, in accordance with the "Guidelines for Number of Ship Structures."

N=N1+N2+N3=4,900+75+360=5,335 rounded up to N = 6,000 to provide for the margin of error

where,

N1=L(B+D)=100×(40+9)=4,900
N2=5×15=75 (assuming an operation monitoring room measuring 5 m long×20 m wide×15 m high)
N3=0.5×80×8=360 (assuming unloaders, ship loaders, and conveyors on the deck)

The mooring equipment is specified below, based on the Japanese "Guidelines for Number of Ship Structures."

Mooring Equipment	Specification
Anchors	3 units with minimum weight of 5,535 kg/unit
Anchor chains	600 m length with minimum diameter of 73 mm
Mooring line	4 fiber ropes, 220 m long with minimum tension strength of 235 kN
Tow line	1 steel rope, 240 m long with minimum tension strength of 1,230 kN

(2) Analysis of four-point mooring configuration

Four-point mooring for the floating facility, a standard configuration used for sea mooring, was analyzed using four anchors.

If the floating type facility is moored using a four-point mooring configuration, the chains will form catenary curves. These can be approximated as straight lines.

It is assumed that the draft, d_1, of the floating facility is 2.1 m. Then, sea depth, h, is 15 m (adding a margin of 1 m to the 14 m draft for the 100,000 DWT mother vessel, Fairplay data), and chain length, L, is 600 m. The angle formed between the seafloor and the chain is θ. Θ, which is calculated to be 1.3 degrees, based on the equation $\sin \theta = (h - d_1) / L$. In other words, the angle formed by the anchor chain is 1.3 degrees from 2.1 m below the sea surface. This configuration prevents the mother vessel from mooring alongside the floating facility.

A configuration whereby the mooring chains are vertical is also possible (with chain lengths of 15 m) to enable mooring of the mother vessel; however, this would prevent the chains from forming a catenary and subject them to excessive forces. Increasing anchor size and the number of anchors to increase anchor resistance is impractical. For these reasons, the four-point mooring configuration was abandoned.

(3) Mother vessel mooring methods

Examples of floating coal terminals are described below.

The coal transshipment terminal in Kalimantan does not use independent mooring for the terminal, and mother vessel or mooring between the terminal and mother vessel.

From the photograph below, it is understood that the tugboats on the left side push the shuttle barges to maneuver them as well as the floating facility against the mother vessel. The wind in the photograph is likely blowing from the right.

(Source: http://www.bayan.com.sg/index.php/Ports-Shipping.html)

Figure 7.2.4.1 Coal Transshipment Scene 1 (for export) in Kalimantan, Indonesia

For the coal transshipment terminal in Adang Bay, Indonesia, the mother vessel is anchored, while the floating facility is moored against the ship. In the photograph below, the wind appears blowing from the right.

(Source: The Japan Workvessels Association)

Figure 7.2.4.2 Coal Transshipment Scene 2 (for export) in Kalimantan, Indonesia

For the coal transshipment terminal situated in Samarinda, Indonesia, floating facility is not moored while the mother vessel is moored.

(Source: International Bulk Journal Issue 4 2010 p.37)

Figure 7.2.4.3 Coal Transshipment Scene 3 (for export) in Kalimantan, Indonesia

For coal transshipment terminals situated in Terneuzen and Vlissingen, Netherlands, the terminal, as well as the mother vessel, is not moored. The sea is also assumed to be calm.

(Source: International Bulk Journal Issue 3 2011 p.50)

Figure 7.2.4.4 Coal Transshipment Scene in Terneuzen and Vlissingen, Netherlands

These examples show that the transshipment terminals are not moored for unloading when the sea is calm. If slight wind is present, the mother vessel is anchored, and the floating facility is moored to the mother vessel.

(4) Summary of mooring methods

Based on the above analyses, the floating facility will be moored to the anchored mother vessel. The floating facility is then maneuvered using the mooring equipment on the terminal.

The shuttle vessels are moored to the floating facility. If the shuttle vessels must be maneuvered, this is done using the mooring equipment on the shuttle vessels or on the floating facility.

Specifications of the mooring equipment on the floating facility are shown below.

Mooring equipment	Specifications
Anchor	Minimum 5,535 kg × 1, installed at center aft location.
Anchor chain	Diameter 75 mm plus 12 mm corrosion margin × length 600 m.
	The anchor chain shall include a corrosion margin, since it is left unattended for extended periods.
	The steel corrosion rate is assumed to be 0.3 mm per year. Corrosion will progress 6 mm if left unattended for 20 years, corresponding to a diameter reduction of 12 mm.
Anchor winch	One unit installed at center aft position.
	Laws stipulate the provision of three anchors for shipping vessels. Since this floating facility is not intended for use on the open sea, it is equipped with a single anchor.
Mooring lines	Rope lines with minimum strength of 235 kN × length 220 m× 4
Mooring line winches	Each unit is located at the fore and aft of port side for mooring to the mother vessel.
	Each unit is located at the fore and aft starboard side for mooring shuttle vessels.
Towing ropes	Steel rope with minimum strength 1,230 kN × length 240 m × 2

7.2.5 General Plan of Floating Type Facility

The general plan of floating type facility is shown below.

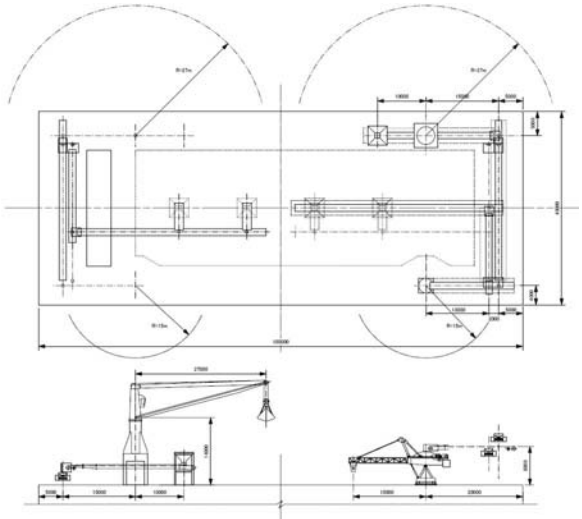


Figure 7.2.5.1 General Plan of Floating Type Facility (Grab Unloaders)

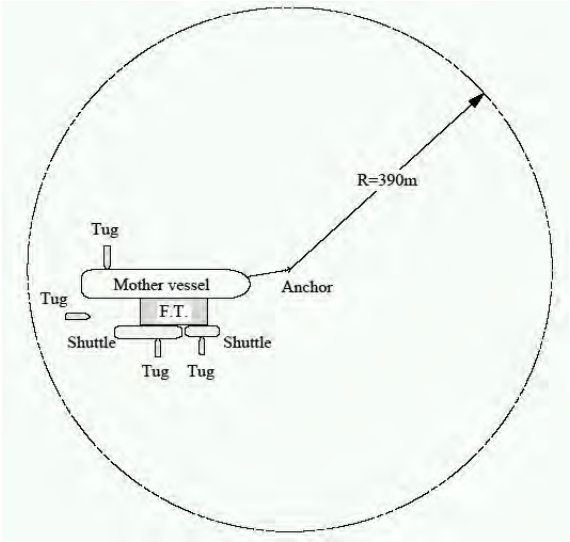
7.3 Offshore Breakwater

The occupied sea area is calculated in accordance with the "Technical Standards and Commentaries for Port and Harbour Facilities in Japan".

The mother vessel is moored by lowering a single anchor to the seabed. The radius of the anchoring is calculated using the following equation:

$$Ra = LOA + 6D + 30 = 250 + 6 \times 18 + 30 = 388 \text{ m} \rightarrow 390 \text{ m}$$

Here, LOA is the length of the mother vessel and D is the depth of the anchoring area.



Mother Vessel L=250m B=43.0m
Shuttle L=110m B=18m、L=50m B=15m
Tug L=36m B=10m、L=28m B=8m

Figure 7.3.1 Illustration of Sea Area Occupied

A total of nine sets of above ships are required. Breakwaters are needed to protect the water area for such ships, and the total length is about 10 km (5 km breakwater x 2). The design wave height of breakwater for Bassac Canal is 6.45 m at the location of the breakwater. Based on this information, the design wave height of offshore breakwater for the Project is determined to be 8.4 m, which is increased by 30% to the design wave height of breakwater for Bassac Canal, considering the depth of construction location. Wave dissipating block is calculated at 64 t size if Tetra block is applied. The typical cross section of offshore breakwaters is shown in Figure 7.3.2.

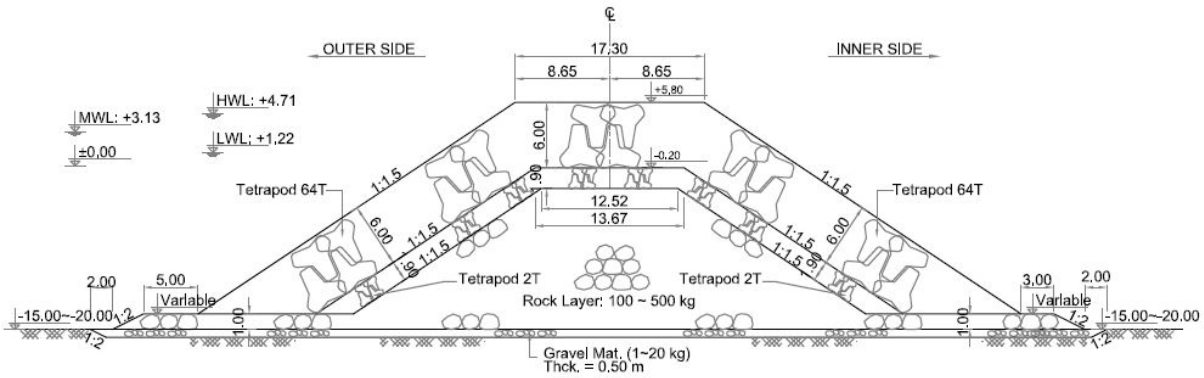


Figure 7.3.2 Typical Cross Section of Offshore Breakwater in Tra Vinh

7.4 Landside Breakwaters

The landside breakwaters are necessary to secure the calmness for unloading and discharging berths to/from the stockyard. The typical cross section of landside breakwaters is shown in Figure 7.4.1. Wave dissipating block is calculated at 8 t size if Tetra block is applied.

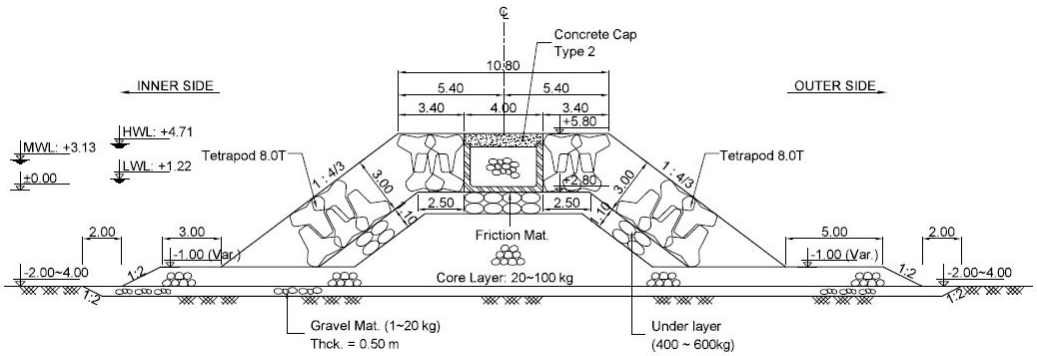


Figure 7.4.1 Typical Cross Section of Landside Breakwater in Tra Vinh

7.5 Unloading and Discharging Berths for Stockyard

The typical cross section of unloading and discharging berths to/from the stockyard is shown in Figure 7.5.1. The right side is an unloading berth and the left side is a discharging berth. Ten unloading berths with total length of 1,300 m are required and equipped with a continuous unloader per berth, with a capacity of 2,500 t/h. Eleven discharging berths with total length of 1,430 m are needed and equipped with a ship loader per berth, with a capacity of 2,500 t/h.

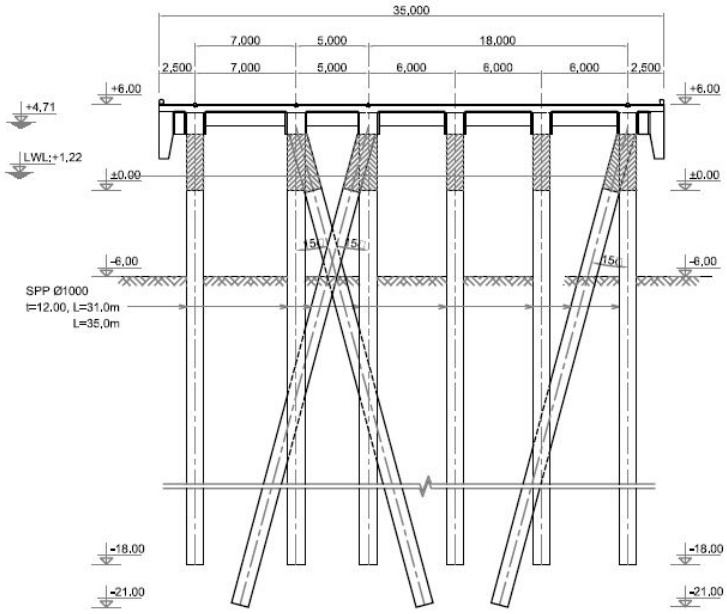


Figure 7.5.1 Typical Cross Section of Unloading and Discharging Berths for Stockyard

7.6 Stockyard

Figure 7.6.1 shows the plan of stockyard. The area of stockyard is 1.0 km x 1.8 km, and can store approximately 5 million t of coal. The required coal handling equipment in the yard are as follows:

Stacker: 4 nos.

Reclaimer: 5 nos.
Stacker/Reclaimer: 2 nos.

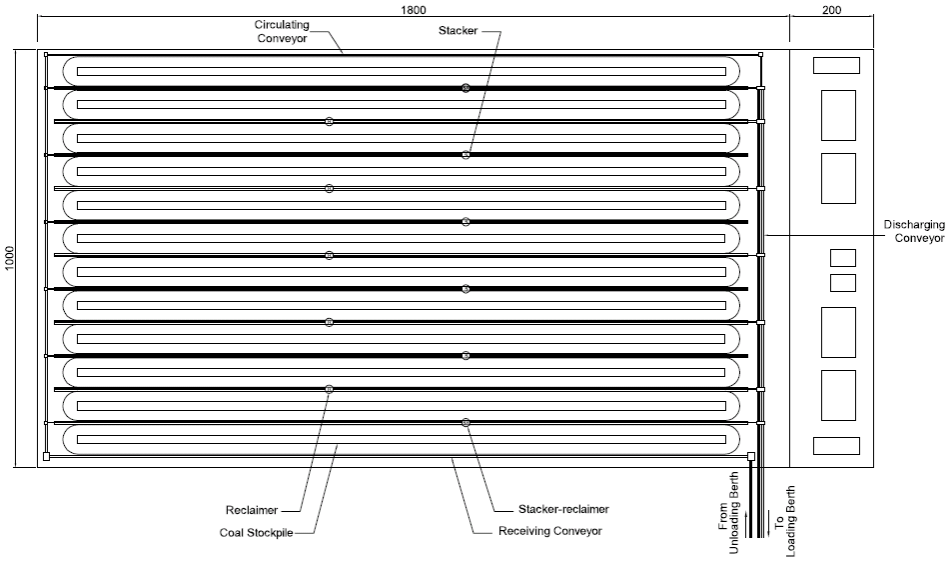


Figure 7.6.1 Plan of Stockyard in Tra Vinh (5 million t)

7.7 Dredging of Access Channel and Turning Basin

The floating type imported coal transshipment facilities are planned to be located offshore, so that dredging works will not be necessary. Dredging works for unloading and discharging berths to/from stockyard are needed. The capital dredging volume is estimated at approximate 6 million m^3.

7.8 Preliminary Construction Schedule and Cost Estimate of Floating Type Imported Coal Transshipment Terminal

The preliminary ship building and construction schedules and costs of floating type imported coal transshipment terminal in Tra Vinh are shown below.

Table 7.8.1 Preliminary Ship Building and Construction Schedules of Floating Type Imported Coal Transshipment Terminal

Facility	Structure	Unit	Quantity	Construction period (year)				
				1	2	3	4	5
Floating facility	Floating body	Ls	9					
	mechanical equipment	Ls	9					
Offshore breakwater	soil improvement	m3	5,000,000					
	Rubble core	m3	9,750,000					
	wave disapating block	m3	4,800,000					
Berths for stock yard	piles for foundation	nos	2,574					
	upper structure	m3	50,050					
	mechanical equipment	Ls	1					
Landside breakwater	soil improvement	m3	600,000					
	Rubble core	m3	375,000					
	wave disapating block	m3	300,000					
Stock yard	reclamation and paving	m2	2,000,000					
	buildings	Ls	1					
	mechanical equipment	Ls	1					
Dredging works for landside port facility		m3	6,000,000					
Total								

Source: JICA Study Team

Table 7.8.2 Preliminary Ship Building and Construction Costs of Floating Type Imported Coal Transshipment Terminal

Facility	Structure	Unit	Quantity	Unit Rate (USD)	Construction Cost (mil.USD)
Floating facility	Floating body	Ls	9	7,500,000	68
	mechanical equipment	Ls	9	35,000,000	315
Offshore breakwater	soil improvement	m3	5,000,000	20	100
	Rubble core	m3	9,750,000	40	390
	wave disapating block	m3	4,800,000	150	720
Berths for stock yard	piles for foundation	nos	2,574	14,400	37
	upper structure	m3	50,050	250	13
	mechanical equipment	Ls	1	133,000,000	133
Landside breakwater	soil improvement	m3	600,000	20	12
	Rubble core	m3	375,000	40	15
	wave disapating block	m3	300,000	100	30
Stock yard	reclamation and paving	m2	2,000,000	100	200
	buildings	Ls	1	30,000,000	30
	mechanical equipment	Ls	1	30,000,000	30
Dredging works for landside port facility		m3	6,000,000	15	90
Total					2,182

Source: JICA Study Team

7.9 Operation and Maintenance Cost of Floating Type Imported Coal Transshipment Terminal

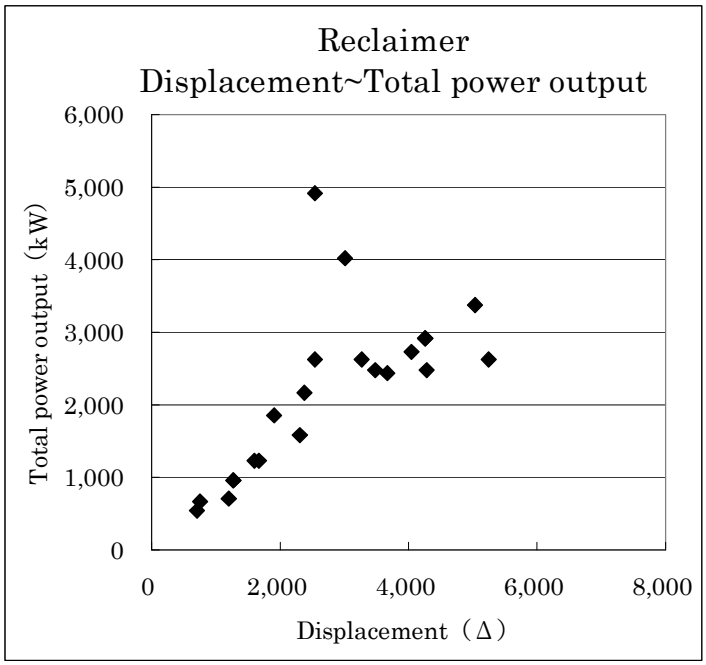
The preliminary operation and maintenance costs of floating type imported coal transshipment terminal in Tra Vinh are shown below.

Table 7.9.1 Preliminary Operation and Maintenance Cost of Floating Type Imported Coal Transshipment Terminal

Facility	Structure	Unit	Quantity	Unit Rate (USD/year)	OM cost (mil.USD/year)
Maintenance cost					
Floating facility	Floating body	%	2	67,500,000	1.4
	mechanical equipment	%	3	315,000,000	9.5
Berths for stock yard	structure	%	1	49,578,100	0.5
	mechanical equipment	%	3	133,000,000	4.0
Stock yard	structure	%	1	230,000,000	2.3
	mechanical equipment	%	3	30,000,000	0.9
Sub-total					18.5
Operation cost					
Floating facility		Ls	9	16,200,000	145.8
Stock yard	management	人	10	200,000	2.0
	worker	人	50	12,000	0.6
	energy, water,etc	Ls	1	4,000,000	4.0
Sub-total					152.4
Maintenance dredging cost		m3	600,000	15	9.0
Total					179.9

Source: JICA Study Team

The following graph illustrates the relationship between displacement and total installed power output for reclaimers.



The total installed power output for the floating facility was calculated based on the following data:

Total power output	3,500 kW	Reclaimer total power output
Backhoes	－ 1,300 kW	Backhoes are installed on the reclaimer, but not installed on the floating facility
Unloaders	＋ 2,000 kW	Unloaders are installed on the floating facility, but not installed on the reclaimer
Ship loaders	＋ 600 kW	Unloaders are installed on the floating facility, but not installed on the reclaimer
Total	4,800 kW	

Electric voltage of 400 V is transformed to 220 V or 110 V to meet the equipment requirements.

All power ratings refer to the power supplied from the engines. Hourly fuel consumption is calculated as follows:

4,800 kW x 1.356 PS/kW x 200 g/PS/h / 0.83 t/m^3 = 1.5 m^3/h
200 g/PS/h: Fuel consumption per hour per engine PS
0.83 t/m^3: Specific gravity of heavy fuel oil A

Assuming that the floating facility handles coal for 12 hours per day and is left moored for 12 hours at night, the daily fuel consumption will be:

1.5 m^3/h x 12 h + 1.5 m3/h x 0.3 x 12 h = 23.4 m^3/d

Assuming monthly refueling, the volume of fuel will be 23.4 m3/d x 30 d = 700 m3. The fuel tank capacity must be at least 700 m3.

Assuming drinking water requirements of 0.15 m3/d per crew member, with a crew of 30, the drinking water tank capacity for one month will be at least 0.15 m3/d x 30 p x 30 d = 135 m^3.

Note that generators are subject to exhaust gas regulations in accordance with the MARPOL 73/78 CONVENTION REVICED ANNEX VI Regulation for the Prevention of Air Pollution from Ships.

The operation cost per a group of floating type imported coal transshipment facility is estimated as follow.

Table 7.9.2 Operation Cost per a Group of Floating Type Imported Coal Transshipment Facility

	Item	Unit rate	Amount (USD million)
floating type imported coal transshipment facility	Fuel: 23.4 m^3/day x 365 days	USD 700/m^3	6.0
	Drinking water: 135 m^3/day x 365 days	USD 0.1/L	4.5
	Worker: 30 persons	USD 20/day	0.2
Sub-total			10.7
Assistant vessels	Fuel: 21.2 m^3/day x 365days	USD 700/m^3	5.4
	Worker: 12 persons	USD 20/day	0.1
Sub-total			5.5
Total (USD)			16.2

Accordingly, the annual operation cost of total nine groups of floating type imported coal transshipment facility is calculated at USD 145.8 million/year (USD 16.2 million x 9 groups).

Chapter 8 Examination of Fixed Type Imported Coal Transshipment Terminal (Tra Vinh: With Trestle)

Contents

Chapter 8 Examination of Fixed Type Imported Coal Transshipment Terminal (Tra Vinh: With Trestle)

8.1 Layout of Main Facilities of Fixed Type Imported Coal Transshipment Terminal (with Trestle)

The layout of fixed type imported coal transshipment terminal in Tra Vinh (with trestle) is shown in Figure 8.1.1.

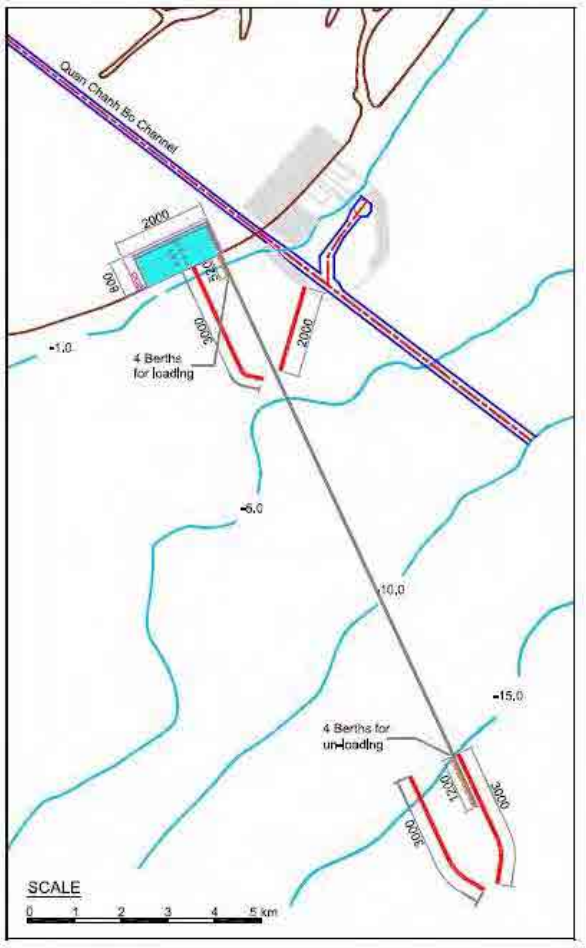


Figure 8.1.1 Layout of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (with Trestle)

8.2 Offshore Unloading Berth

The typical cross section of offshore unloading berth is shown in Figure 8.2.1. Four unloading berths with total length of 1,200 m are required and equipped with two continuous unloaders per berth with a capacity of 2,500 t/h.

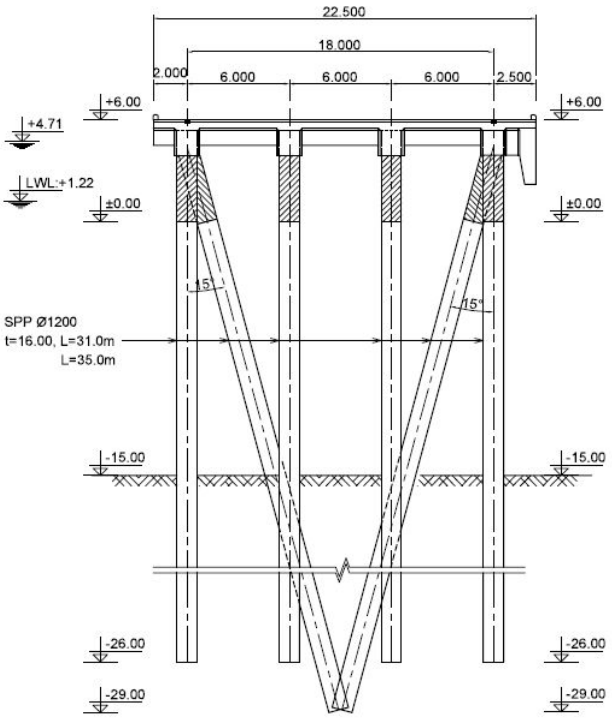


Figure 8.2.1 Typical Cross Section of Offshore Unloading Berth

8.3 Offshore Breakwater

The offshore breakwaters with approximate total length of 6 km (3 km x 2) are necessary to secure the calmness for offshore unloading berths, access channel and turning basin. The typical cross section of offshore breakwaters is shown in Figure 8.3.1.

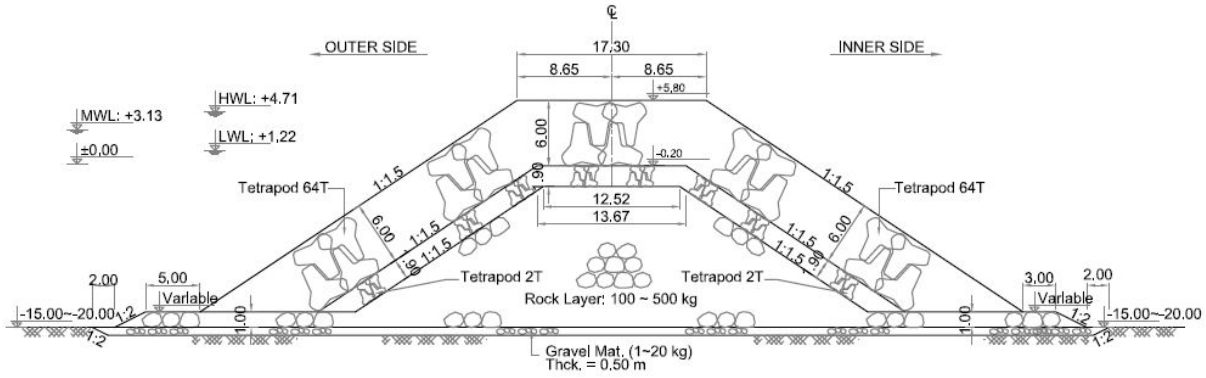


Figure 8.3.1 Typical Cross Section of Offshore Breakwater in Tra Vinh

8.4 Trestle for Belt Conveyor

The typical cross section of trestle for an unloading belt conveyor is shown in Figure 8.4.1. A two-tier type belt conveyor is applied, and passage for maintenance vehicle is included. The length of trestle for the belt conveyor is about 15 km.

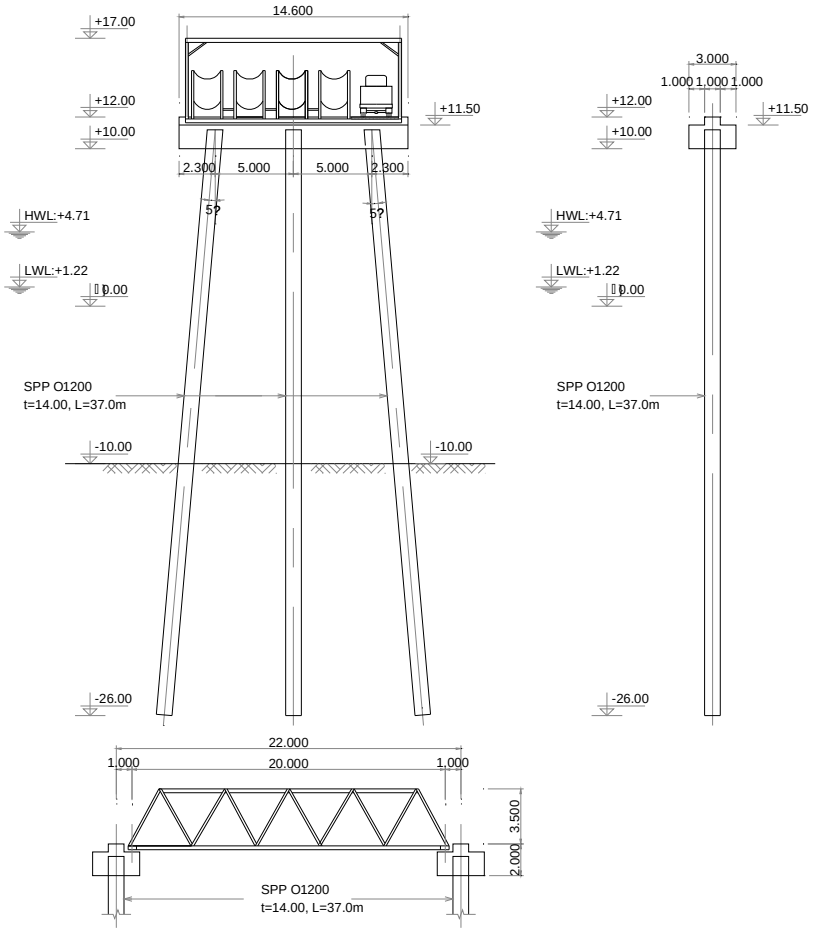


Figure 8.4.1 Typical Drawings of Trestle for Belt Conveyor

8.5 Landside Breakwater

The landside breakwaters with approximate total length of 5 km (3 km + 2 km) are necessary to secure the calmness for discharging berths from the stockyard. The typical cross section of landside breakwaters is shown in Figure 8.5.1.

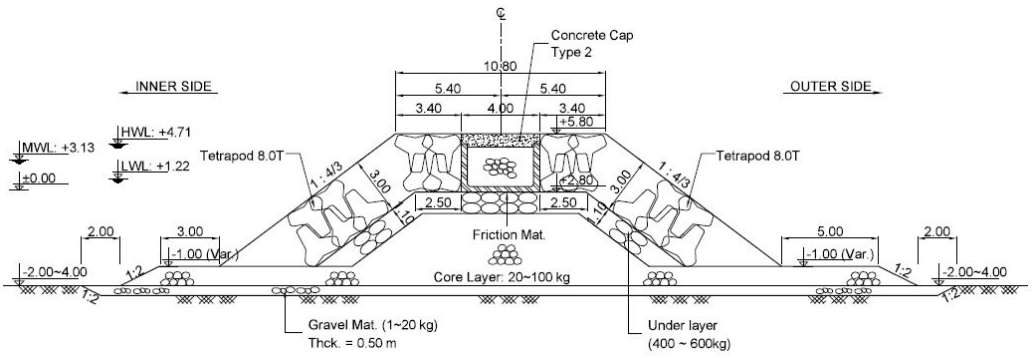


Figure 8.5.1 Typical Cross Section of Landside Breakwater in Tra Vinh

8.6 Discharging Berth from Stockyard

The typical cross section of discharging berth from stockyard is shown in Figure 8.6.1. Eight discharging berths with total length of 1,040 m are needed and equipped with a ship loader per berth with a capacity of 2,500 t/h.

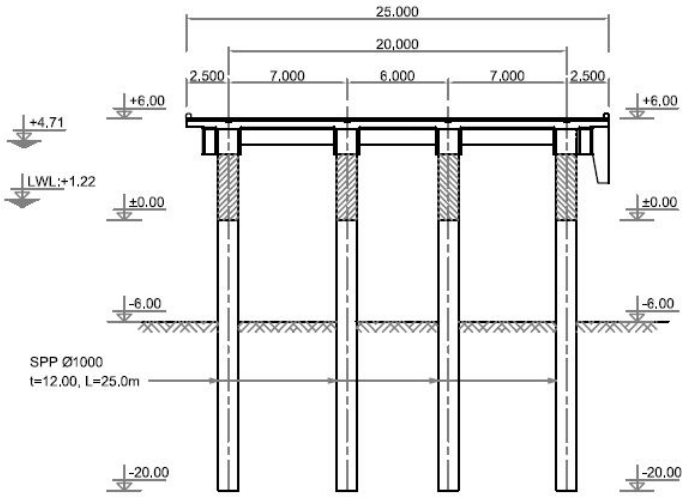


Figure 8.6.1 Typical Cross Section of Discharging Berth from Stockyard

8.7 Stockyard

Figure 8.7.1 shows the plan of the stockyard. The area of the stockyard is 0.8 km x 1.8 km and the stockyard can stock approximately 4 million t of coal. The required coal handling equipment in the yard are as follows:

Stacker:	3 units
Reclaimer:	4 units
Stacker/Reclaimer:	2 units

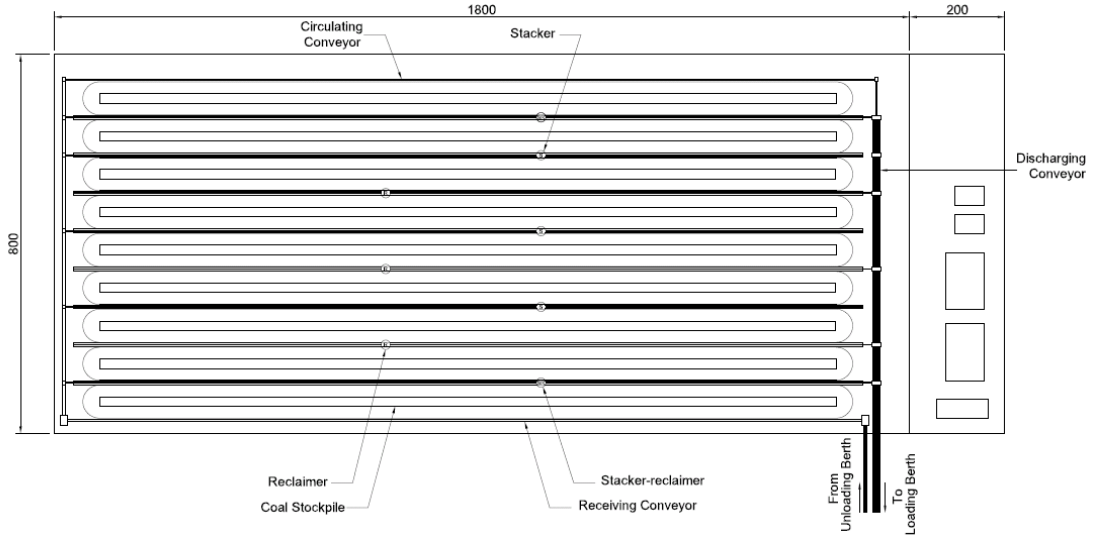


Figure 8.7.1 Plan of the Stockyard in Tra Vinh (4 million t)

8.8 Dredging of Access Channel and Turning Basin

The unloading berths are planned to be located offshore so that dredging works will not be necessary. Dredging works for discharging berths from the stockyard, access channel and turning basin are needed. The capital dredging volume is estimated at approximately 6 million m^3.

8.9 Preliminary Construction Schedule and Cost Estimate of Fixed Type Imported Coal Transshipment Terminal

The preliminary construction schedule and construction cost estimate of fixed type imported coal transshipment terminal with trestle in Tra Vinh are shown in Tables 8.9.1 and 8.9.2, respectively.

Table 8.9.1 Preliminary Construction Schedule of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (with Trestle)

Facility	Structure	Unit	Quantity	Construction period (year)				
				1	2	3	4	5
Offshore unloading berth	piles for foundation	nos	1,440					
	upper structure	m3	27,000					
	mechanical equipment	Ls	1					
Offshore breakwater	soil improvement	m3	3,000,000					
	Rubble core	m3	5,850,000					
	wave disapating block	m3	2,880,000					
Trestle	piles for foundation	nos	12,000					
	upper structure	m3	180,000					
	mechanical equipment	Ls	1					
Berths for stock yard	piles for foundation	nos	832					
	upper structure	m3	26,000					
	mechanical equipment	Ls	1					
Landside breakwater	soil improvement	m3	600,000					
	Rubble core	m3	375,000					
	wave disapating block	m3	300,000					
Stock yard	reclamation and paving	m2	1,440,000					
	buildings	Ls	1					
	mechanical equipment	Ls	1					
Dredging works for landside port facility		m3	6,000,000					
Total								

Source: JICA Study Team

Table 8.9.2 Preliminary Construction Cost Estimate of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (with Trestle)

Facility	Structure	Unit	Quantity	Unit Rate (USD)	Construction Cost (mil.USD)
Offshore unloading berth	piles for foundation	nos	1,440	24,000	35
	upper structure	m3	27,000	250	7
	mechanical equipment	Ls	1	80,000,000	80
Offshore breakwater	soil improvement	m3	3,000,000	20	60
	Rubble core	m3	5,850,000	40	234
	wave disapating block	m3	2,880,000	150	432
Trestle	piles for foundation	nos	12,000	24,000	288
	upper structure	m3	180,000	250	45
	mechanical equipment	Ls	1	5,000,000	5
Berths for stock yard	piles for foundation	nos	832	11,680	10
	upper structure	m3	26,000	250	7
	mechanical equipment	Ls	1	24,000,000	24
Landside breakwater	soil improvement	m3	600,000	20	12
	Rubble core	m3	375,000	40	15
	wave disapating block	m3	300,000	100	30
Stock yard	reclamation and paving	m2	1,440,000	100	144
	buildings	Ls	1	30,000,000	30
	mechanical equipment	Ls	1	26,000,000	26
Dredging works for landside port facility		m3	6,000,000	15	90
Total					1,573

Source: JICA Study Team

8.10 Operations and Maintenance Cost of Fixed Type Imported Coal Transshipment Terminal (With Trestle)

The preliminary operations and maintenance costs for fixed type imported coal transshipment terminal in Tra Vinh (with trestle) are shown in Table 8.10.1.

Table 8.10.1 Preliminary Operations and Maintenance Costs of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (with Trestle)

Facility	Structure	Unit	Quantity	Unit Rate (USD/year)	OM cost (mil.USD/year)
Maintenance cost					
Offshore unloading berth	structure	%	1	41,310,000	0.4
	mechanical equipment	%	3	80,000,000	2.4
Trestle	structure	%	1	333,000,000	3.3
	mechanical equipment	%	3	5,000,000	0.2
Berths for stock yard	structure	%	1	16,217,760	0.2
	mechanical equipment	%	3	24,000,000	0.7
Stock yard	structure	%	1	174,000,000	1.7
	mechanical equipment	%	3	26,000,000	0.8
Sub-total					9.7
Operation cost					
	management	人	15	200,000	3.0
	worker	人	100	12,000	1.2
	energy, water, etc	Ls	1	6,000,000	6.0
Sub-total					10.2
Maintenance dredging cost		m3	600,000	15	9.0
Total					28.9

Source: JICA Study Team

Chapter 9 Examination of Fixed Type Imported Coal Transshipment Terminal (Tra Vinh: Without Trestle)

Contents

Chapter 9 Examination of Fixed Type Imported Coal Transshipment Terminal (Tra Vinh: Without Trestle)

9.1 Layout of Main Facilities of Fixed Type Imported Coal Transshipment Terminal (Without Trestle)

The layout of fixed type imported coal transshipment terminal in Tra Vinh (without trestle) is shown in Figure 9.1.1.

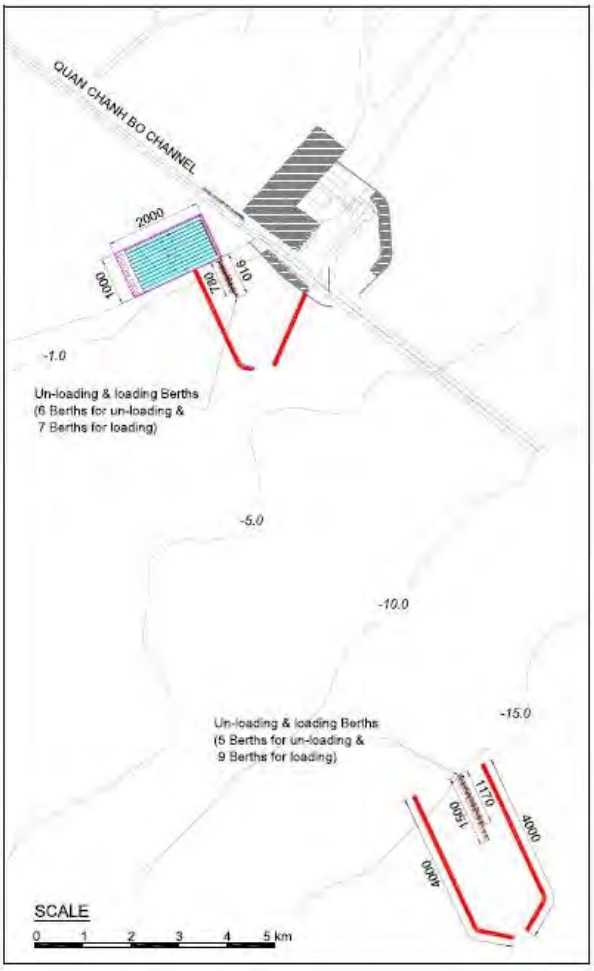


Figure 9.1.1 Layout of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (Without Trestle)

9.2 Offshore Unloading and Discharging Berths

The typical cross section of offshore unloading and discharging berths is shown in Figure 9.2.1. The right side is the unloading berth and the left side is the discharging berth. Five unloading berths with total length of 1,500 m are required and equipped with two continuous unloaders per berth with a capacity of 2,500 t/h. Nine discharging berths with total length of 1,170 m are needed and equipped with a ship loader per berth with a capacity of 2,500 t/h.

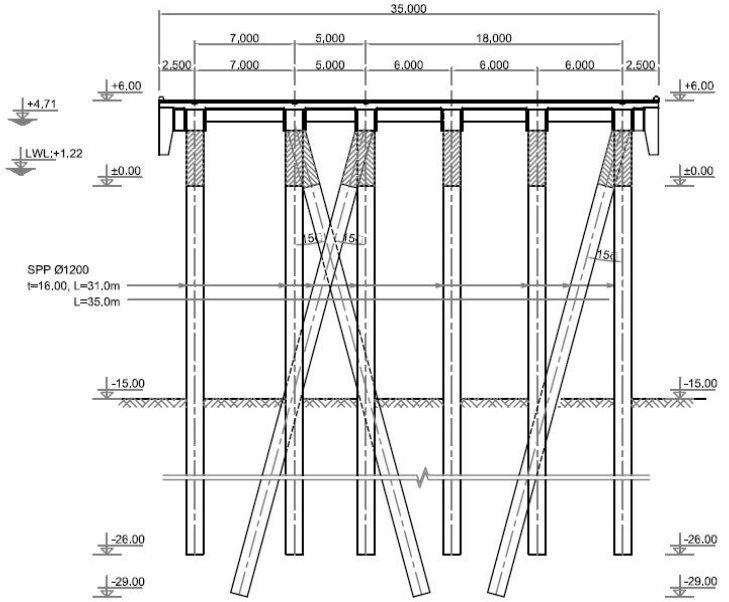


Figure 9.2.1 Typical Cross Section of Offshore Unloading and Discharging Berths

9.3 Offshore Breakwater

The offshore breakwaters with approximate total length of 8 km (4 km x 2) are necessary to secure the calmness for the offshore unloading and discharging berths, access channel and turning basin. The typical cross section of the offshore breakwaters is shown in Figure 9.3.1.

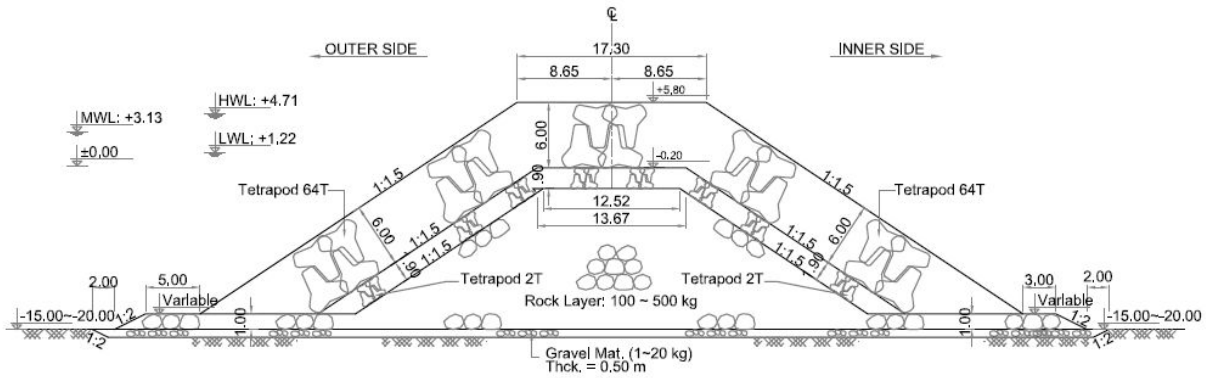


Figure 9.3.1 Typical Cross Section of Offshore Breakwater in Tra Vinh

9.4 Landside Breakwater

The landside breakwaters with approximate total length of 5 km (3 km + 2 km) are necessary to secure the calmness for the unloading and discharging berths to/from the stockyard. The typical cross section of landside breakwaters is shown in Figure 9.4.1.

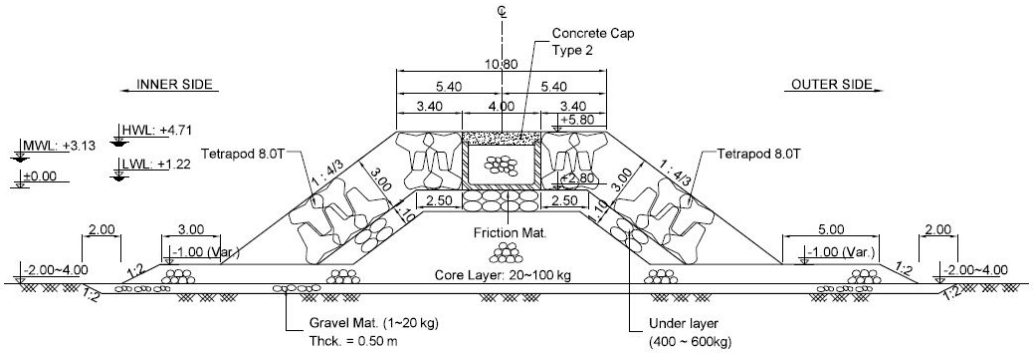


Figure 9.4.1 Typical Cross Section of Landside Breakwater in Tra Vinh

9.5 Unloading and Discharging Berths for Stockyard

The typical cross section of the unloading and discharging berths to/from the stockyard is shown in Figure 9.5.1. The right side is the unloading berth and the left side is the discharging berth. Ten unloading berths with total length of 1,300 m are required and equipped with a continuous unloader per berth with a capacity of 2,500 t/h. Eleven discharging berths with total length of 1,430 m are needed and equipped with a ship loader per berth with a capacity of 2,500 t/h.

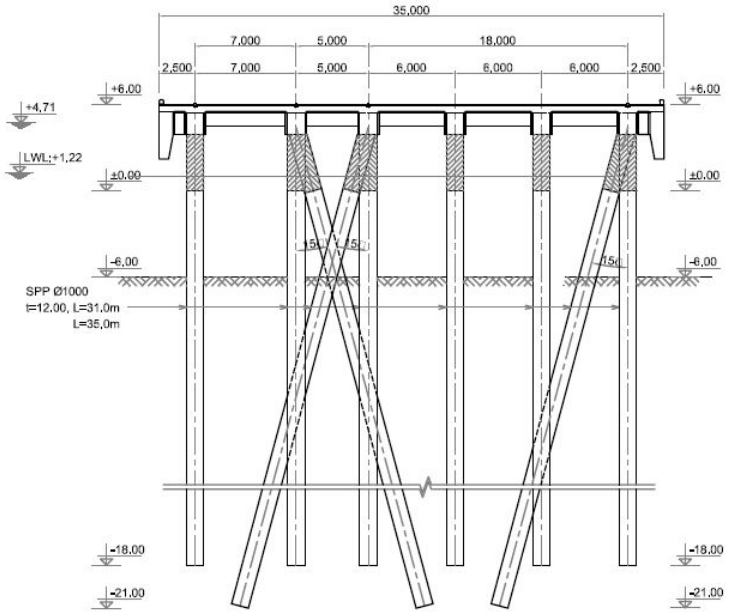


Figure 9.5.1 Typical Cross Section of the Unloading and Discharging Berths for the Stockyard

9.6 Stockyard

Figure 9.6.1 shows the plan of the stockyard. The area of the stockyard is 1.0 km x 1.8 km. The stockyard can stock approximately 5 million t of coal. The required coal handling equipment in the yard are as follows:

Stacker:	4 units
Reclaimer:	5 units
Stacker/Reclaimer:	2 units

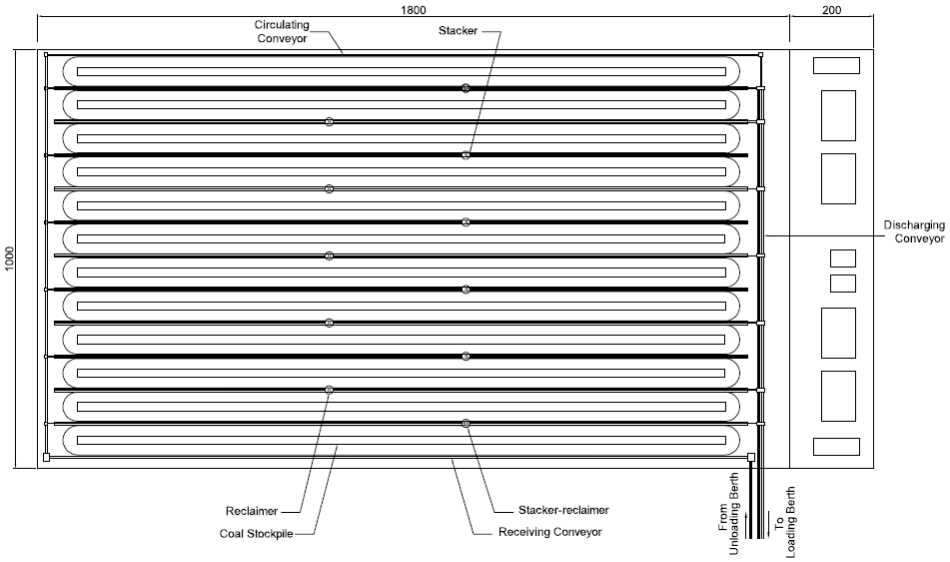


Figure 9.6.1 Plan of the Stockyard in Tra Vinh (5 million t)

9.7 Dredging of Access Channel and Turning Basin

The offshore unloading and discharging berths are planned to be located offshore so that dredging works will not be necessary. Dredging works for unloading and discharging berths for the stockyard, access channel and turning basin are needed. The capital dredging volume is estimated at approximately 6 million m^3.

9.8 Preliminary Construction Schedule and Cost Estimate of Fixed Type Imported Coal Transshipment Terminal (Without Trestle)

The preliminary construction schedule and construction cost estimate of fixed type imported coal transshipment terminal without trestle in Tra Vinh are shown in Tables 9.8.1 and 9.8.2, respectively.

Table 9.8.1 Preliminary Construction Schedule of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (Without Trestle)

Facility	Structure	Unit	Quantity	Construction period (year)				
				1	2	3	4	5
Offshore unloading berth	piles for foundation	nos	1,800					
	upper structure	m3	27,000					
	mechanical equipment	Ls	1					
Offshore breakwater	soil improvement	m3	4,000,000					
	Rubble core	m3	7,800,000					
	wave disapating block	m3	3,840,000					
Berths for stock yard	piles for foundation	nos	1,144					
	upper structure	m3	26,000					
	mechanical equipment	Ls	1					
Landside breakwater	soil improvement	m3	600,000					
	Rubble core	m3	375,000					
	wave disapating block	m3	300,000					
Stock yard	reclamation and paving	m2	1,440,000					
	buildings	Ls	1					
	mechanical equipment	Ls	1					
Dredging works for landside port facility		m3	6,000,000					
Total								

Source: JICA Study Team

Table 9.8.2 Preliminary Construction Cost Estimate of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (Without Trestle)

Facility	Structure	Unit	Quantity	Unit Rate (USD)	Construction Cost (mil.USD)
Offshore unloading berth	piles for foundation	nos	1,800	24,000	43
	upper structure	m3	27,000	250	7
	mechanical equipment	Ls	1	127,000,000	127
Offshore breakwater	soil improvement	m3	4,000,000	20	80
	Rubble core	m3	7,800,000	40	312
	wave disapating block	m3	3,840,000	150	576
Berths for stock yard	piles for foundation	nos	1,144	14,400	16
	upper structure	m3	26,000	250	7
	mechanical equipment	Ls	1	133,000,000	133
Landside breakwater	soil improvement	m3	600,000	20	12
	Rubble core	m3	375,000	40	15
	wave disapating block	m3	300,000	100	30
Stock yard	reclamation and paving	m2	1,440,000	100	144
	buildings	Ls	1	30,000,000	30
	mechanical equipment	Ls	1	30,000,000	30
Dredging works for landside port facility		m3	6,000,000	15	90
Total					1,652

Source: JICA Study Team

9.9 Operations and Maintenance Cost of Fixed Type Imported Coal Transshipment Terminal (Without Trestle)

The preliminary operations and maintenance costs for fixed type imported coal transshipment terminal in Tra Vinh (without trestle) are shown in Table 9.9.1.

Table 9.9.1 Preliminary Operations and Maintenance Cost of Fixed Type Imported Coal Transshipment Terminal in Tra Vinh (Without Trestle)

Facility	Structure	Unit	Quantity	Unit Rate (USD/year)	OM cost (mil.USD/year)
Maintenance cost					
Offshore berths	structure	%	1	49,950,000	0.5
	mechanical equipment	%	3	127,000,000	3.8
Berths for stock yard	structure	%	1	22,973,600	0.2
	mechanical equipment	%	3	133,000,000	4.0
Stock yard	structure	%	1	174,000,000	1.7
	mechanical equipment	%	3	30,000,000	0.9
Sub-total					11.2
Operation cost					
	management	人	15	200,000	3.0
	worker	人	100	12,000	1.2
	energy, water, etc	Ls	1	8,000,000	8.0
Sub-total					12.2
Maintenance dredging cost		m3	600,000	15	9.0
Total					32.4

Source: JICA Study Team

Chapter 10 Examination of Fixed Type Imported Coal Transshipment Terminal (Cai Mep: With Trestle)

Contents

Chapter 10 Examination of Fixed Type Imported Coal Transshipment Terminal (Cai Mep: With Trestle)

10.1 Layout of Main Facilities of Fixed Type Imported Coal Transshipment Terminal in Cai Mep

The layout of fixed type imported coal transshipment terminal in Cai Mep is shown in Figure 10.1.1.

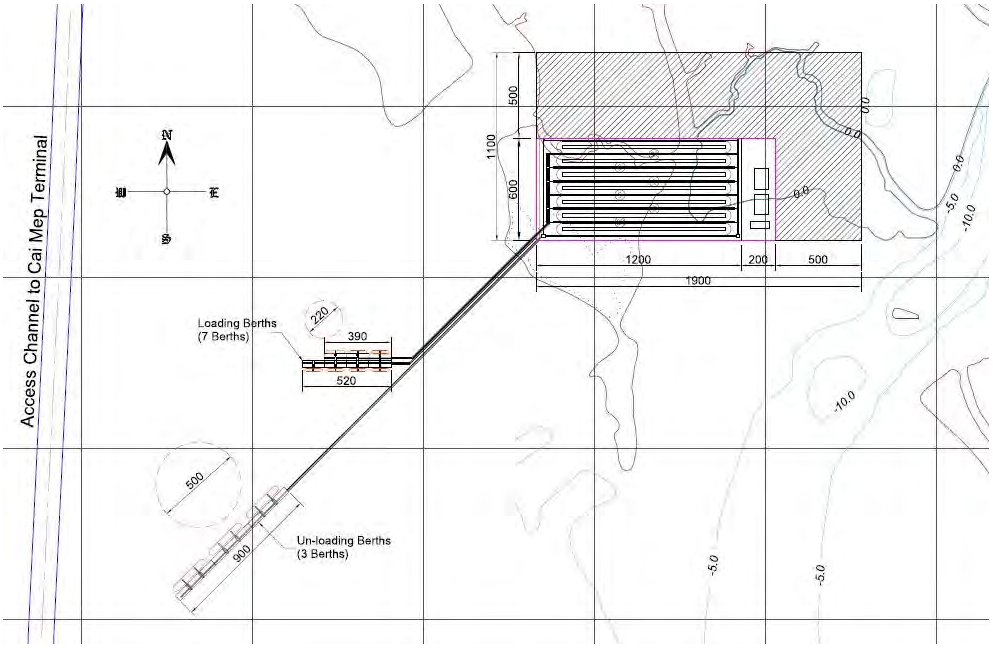


Figure 10.1.1 Layout of Fixed Type Imported Coal Transshipment Terminal in Cai Mep

10.2 Unloading and Discharging Berths

The typical cross sections of the unloading and discharging berths are shown in Figures 10.2.1 and 10.2.2, respectively. Three unloading berths with total length of 900 m are required and equipped with two continuous unloaders per berth with a capacity of 2,500 t/h. Seven discharging berths with total length of 910 m are needed and equipped with a ship loader per berth with a capacity of 2,500 t/h.

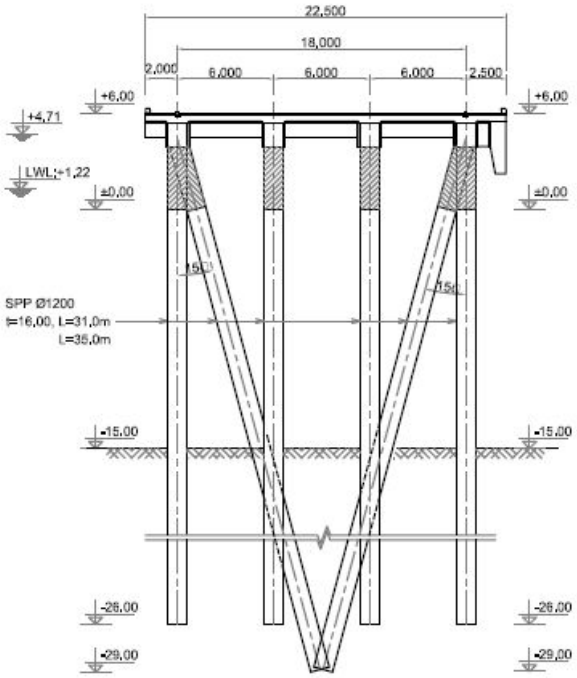


Figure 10.2.1 Typical Cross Section of the Unloading Berth

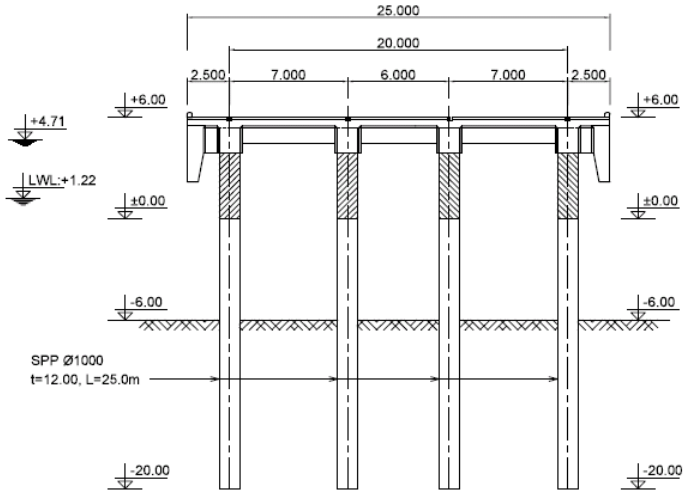


Figure 10.2.2 Typical Cross Section of the Discharging Berth

10.3 Trestle for Belt Conveyor

The typical cross section of trestle for the unloading belt conveyor is shown in Figure 10.3.1. A two-tier type belt conveyor is applied, and passage for maintenance vehicle is included. The lengths of trestles for the belt conveyor for unloading and discharging are about 3 km and 1.5 km, respectively.

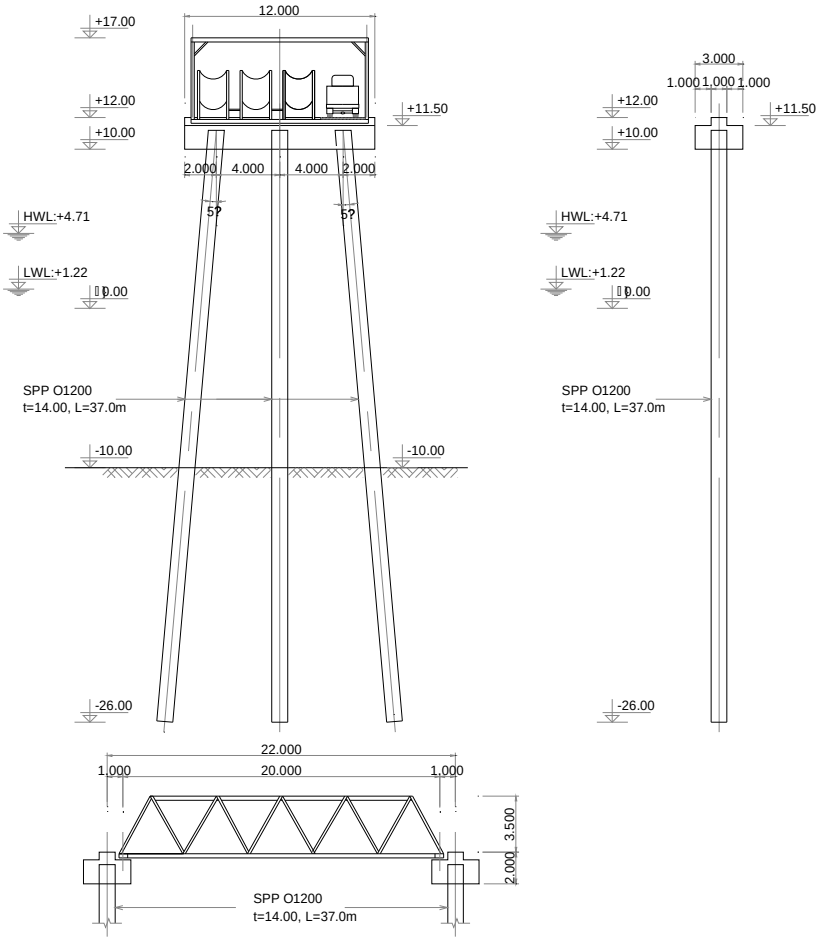


Figure 10.3.1 Typical Drawings of Trestle for Belt Conveyor

10.4 Stockyard

Figure 10.4.1 shows the plan of the stockyard. The area of the stockyard is 0.6 km x 1.2 km. The stockyard can stock approximately 2 million t of coal. The required coal handling equipment in the yard are as follows:

Stacker:	2 units
Reclaimer:	3 units
Stacker/Reclaimer:	2 units

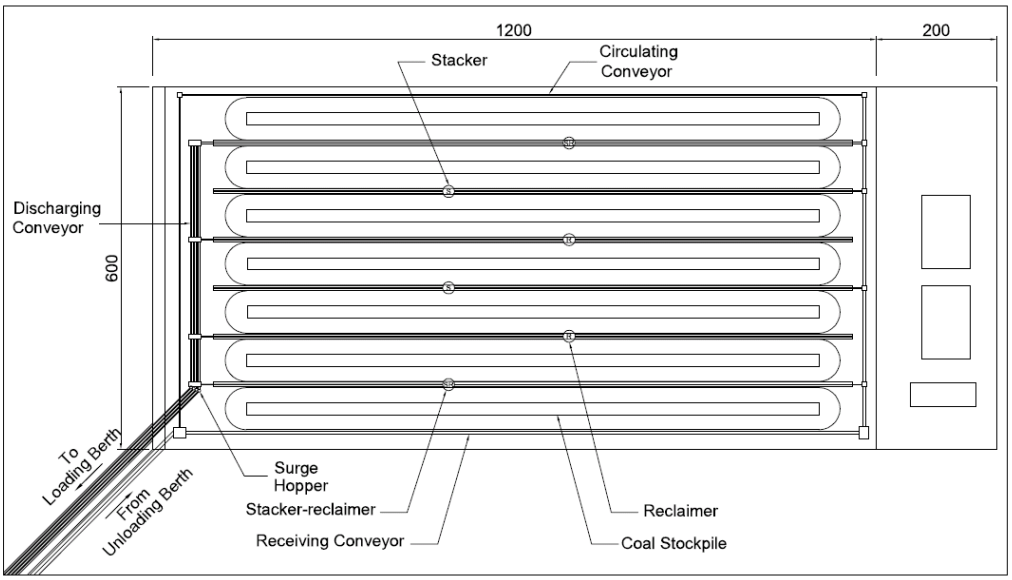


Figure 10.4.1 Plan of the Stockyard in Cai Mep

10.5 Dredging of Access Channel and Turning Basin

The project site is located along the access channel, with a depth of -14 m, to Cai Mep – Thi Vai Ports, so that this access channel is available to the Project. However, it is necessary to develop the branch channel from the access channel to Cai Mep – Thi Vai Ports and turning basin in the Project. The capital dredging volume is calculated at approximately 8 million m^3.

10.6 Preliminary Construction Schedule and Cost Estimate of Fixed Type Imported Coal Transshipment Terminal

The preliminary construction schedule and construction cost estimate of fixed type imported coal transshipment terminal with trestle in Cai Mep are in Tables 10.6.1 and 10.6.2, respectively.

Table 10.6.1 Preliminary Construction Schedule of Fixed Type Imported Coal Transshipment Terminal in Cai Mep

Facility	Structure	Unit	Quantity	Construction period (year)				
				1	2	3	4	5
Unloading berth	piles for foundation	nos	1,092					
	upper structure	m3	20,475					
	mechanical equipment	Ls	1					
Discharging berth	piles for foundation	nos	416					
	upper structure	m3	13,000					
	mechanical equipment	Ls	1					
Trestle	piles for foundation	nos	2,700					
	upper structure	m3	5,400					
	mechanical equipment	Ls	1					
Stock yard	reclamation and paving	m2	840,000					
	buildings	Ls	1					
	mechanical equipment	Ls	1					
Dredging works for port facility		m3	10,000,000					
Total								

Source: JICA Study Team

Table 10.6.2 Preliminary Construction Cost Estimate of Fixed Type Imported Coal Transshipment Terminal in Cai Mep

Facility	Structure	Unit	Quantity	Unit Rate (USD)	Construction Cost (mil.USD)
Unloading berth	piles for foundation	nos	1,092	24,000	26
	upper structure	m3	20,475	250	5
	mechanical equipment	Ls	1	60,000,000	60
Discharging berth	piles for foundation	nos	416	11,680	5
	upper structure	m3	13,000	250	3
	mechanical equipment	Ls	1	21,000,000	21
Trestle	piles for foundation	nos	2,700	24,000	65
	upper structure	m3	5,400	250	1
	mechanical equipment	Ls	1	5,000,000	5
Stock yard	reclamation and paving	m2	840,000	100	84
	buildings	Ls	1	30,000,000	30
	mechanical equipment	Ls	1	22,000,000	22
Dredging works for port facility		m3	10,000,000	15	150
Total					478

Source: JICA Study Team

10.7 Operations and Maintenance Cost of Fixed Type Imported Coal Transshipment Terminal

The preliminary operations and maintenance costs for fixed type imported coal transshipment terminal in Cai Mep are shown in Table 10.7.1.

Table 10.7.1 Preliminary Operations and Maintenance Cost of Fixed Type Imported Coal Transshipment Terminal in Cai Mep

Facility	Structure	Unit	Quantity	Unit Rate (USD/year)	OM cost (mil.USD/year)
Maintenance cost					
Unloading berth	structure	%	1	31,326,750	0.3
	mechanical equipment	%	3	60,000,000	1.8
Discharging berth	structure	%	1	8,108,880	0.1
	mechanical equipment	%	3	21,000,000	0.6
Trestle	structure	%	1	66,150,000	0.7
	mechanical equipment	%	3	5,000,000	0.2
Stock yard	structure	%	1	114,000,000	1.1
	mechanical equipment	%	3	22,000,000	0.7
Sub-total					5.4
Operation cost					
	management	人	15	200,000	3.0
	worker	人	100	12,000	1.2
	energy, water, etc	Ls	1	6,000,000	6.0
Sub-total					10.2
Maintenance dredging cost		m3	800,000	15	12.0
Total					27.6

Source: JICA Study Team

Chapter 11 Economic Evaluation

Contents

Chapter 11 Economic Evaluation

11.1 Summary of Preliminary Coal Logistics Cost

The preliminary coal logistics costs in Tra Vinh and Cai Mep are summarized in Table 11.1.1. In cases of floating type and fixed type without trestle in Tra Vinh, it is possible to transport some amount of imported coal from the offshore coal transshipment facility directly to the power plants, and not through the stockyard in the terminal. However, the entire amount of imported coal is to be transported to power plants through the terminal. Based on such assumption, the operational costs in the said cases were calculated, as shown in Table 11.1.1.

Table 11.1.1 Summary of Preliminary Coal Logistics Costs in Tra Vinh and Cai Mep

Unit: mil.USD

Item	Tra Vinh			Cai Mep (Fixed type)
	Floating type	Fixed type 1 (with Trestle)	Fixed type 2 (without Trestle)	
Terminal construction cost	2,182.0	1,573.0	1,652.0	478.0
Operations and maintenance cost/year	179.9	28.9	32.4	27.6
Secondary transport cost/year	15.2	15.2	15.2	26.6

Source: JICA Study Team

11.2 Economic Comparison by Present Value Conversion

The coal logistics costs in Tra Vinh and Cai Mep are converted into present values under the following preconditions, and the present values are compared economically:

(Preconditions)

- Construction will start in 2016, and the period of economic comparison is 30 years, from 2016 to 2045.
- Coal handling volume is 5 million t at the start of operations and will increase by 10% per year up to 38 million t.
- Consumption tax, price escalation, etc. are not considered.

The present values are shown in Table 11.2.1. It was understood that the present value in Cai Mep is the lowest in the alternative comparison because its capital investment amount is the smallest and its construction period is the shortest.

Table 11.2.1 Present Value of Coal Logistics Costs in Tra Vinh and Cai Mep

	Tra Vinh (floating type)					Tra Vinh (fixed type: with Trestle)					Tra Vinh (fixed type: without Trestle)					Cai Mep (fixed type)				
	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 0.4 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 0.4 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 0.4 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 0.7 US$/t	OM cost mil.US$	Ammount mil.US$
0																				
1	200.0				200.0	200.0				200.0	200.0				200.0	100.0				100.0
2	400.0				400.0	350.0				350.0	300.0				300.0	150.0				150.0
3	600.0				600.0	400.0				400.0	500.0				500.0	150.0				150.0
4	550.0				550.0	350.0				350.0	400.0				400.0	78.0				78.0
5	432.0				432.0	273.0				273.0	252.0				252.0		5.0	3.5	27.6	31.1
6		5.0	2.0	179.9	181.9		5.0	2.0	28.9	30.9		5.0	2.0	32.4	34.4		5.5	3.9	27.6	31.5
7		5.5	2.2	179.9	182.1		5.5	2.2	28.9	31.1		5.5	2.2	32.4	34.6		6.1	4.2	27.6	31.8
8		6.1	2.4	179.9	182.3		6.1	2.4	28.9	31.3		6.1	2.4	32.4	34.8		6.7	4.7	27.6	32.3
9		6.7	2.7	179.9	182.6		6.7	2.7	28.9	31.6		6.7	2.7	32.4	35.1		7.3	5.1	27.6	32.7
10		7.3	2.9	179.9	182.8		7.3	2.9	28.9	31.8		7.3	2.9	32.4	35.3		8.1	5.6	27.6	33.2
11		8.1	3.2	179.9	183.1		8.1	3.2	28.9	32.1		8.1	3.2	32.4	35.6		8.9	6.2	27.6	33.8
12		8.9	3.5	179.9	183.4		8.9	3.5	28.9	32.4		8.9	3.5	32.4	35.9		9.7	6.8	27.6	34.4
13		9.7	3.9	179.9	183.8		9.7	3.9	28.9	32.8		9.7	3.9	32.4	36.3		10.7	7.5	27.6	35.1
14		10.7	4.3	179.9	184.2		10.7	4.3	28.9	33.2		10.7	4.3	32.4	36.7		11.8	8.3	27.6	35.9
15		11.8	4.7	179.9	184.6		11.8	4.7	28.9	33.6		11.8	4.7	32.4	37.1		13.0	9.1	27.6	36.7
16		13.0	5.2	179.9	185.1		13.0	5.2	28.9	34.1		13.0	5.2	32.4	37.6		14.3	10.0	27.6	37.6
17		14.3	5.7	179.9	185.6		14.3	5.7	28.9	34.6		14.3	5.7	32.4	38.1		15.7	11.0	27.6	38.6
18		15.7	6.3	179.9	186.2		15.7	6.3	28.9	35.2		15.7	6.3	32.4	38.7		17.3	12.1	27.6	39.7
19		17.3	6.9	179.9	186.8		17.3	6.9	28.9	35.8		17.3	6.9	32.4	39.3		19.0	13.3	27.6	40.9
20		19.0	7.6	179.9	187.5		19.0	7.6	28.9	36.5		19.0	7.6	32.4	40.0		20.9	14.6	27.6	42.2
21		20.9	8.4	179.9	188.3		20.9	8.4	28.9	37.3		20.9	8.4	32.4	40.8		23.0	16.1	27.6	43.7
22		23.0	9.2	179.9	189.1		23.0	9.2	28.9	38.1		23.0	9.2	32.4	41.6		25.3	17.7	27.6	45.3
23		25.3	10.1	179.9	190.0		25.3	10.1	28.9	39.0		25.3	10.1	32.4	42.5		27.8	19.5	27.6	47.1
24		27.8	11.1	179.9	191.0		27.8	11.1	28.9	40.0		27.8	11.1	32.4	43.5		30.6	21.4	27.6	49.0
25		30.6	12.2	179.9	192.1		30.6	12.2	28.9	41.1		30.6	12.2	32.4	44.6		33.6	23.5	27.6	51.1
26		33.6	13.5	179.9	193.4		33.6	13.5	28.9	42.4		33.6	13.5	32.4	45.9		37.0	25.9	27.6	53.5
27		37.0	14.8	179.9	194.7		37.0	14.8	28.9	43.7		37.0	14.8	32.4	47.2		38.0	26.6	27.6	54.2
28		38.0	15.2	179.9	195.1		38.0	15.2	28.9	44.1		38.0	15.2	32.4	47.6		38.0	26.6	27.6	54.2
29		38.0	15.2	179.9	195.1		38.0	15.2	28.9	44.1		38.0	15.2	32.4	47.6		38.0	26.6	27.6	54.2
30		38.0	15.2	179.9	195.1		38.0	15.2	28.9	44.1		38.0	15.2	32.4	47.6		38.0	26.6	27.6	54.2
Total	2182.0		188.4	4,497.5	6,867.9	1573.0		188.4	722.5	2,483.9	1652.0		188.4	810.0	2,650.4	478.0		356.3	717.6	834.3
			Present value		2,648.7			Present value		1,370.8			Present value		1,445.4			Present value		608.4

Source:JICA Study Team

Chapter 12 Conclusions

Contents

Chapter 12 Conclusions

Based on the collected data and the results of field survey, six alternative sites for fixed terminal and two alternative sites for floating terminal, given by the Vietnamese government, were examined and compared in the Study.

- Binh Thuan (fixed type)
- Cai Mep (fixed type)
- Tra Vinh (fixed and floating types)
- Soc Trang (fixed and floating types)
- Con Dao Island (fixed type)
- Nam Du Island (fixed type)

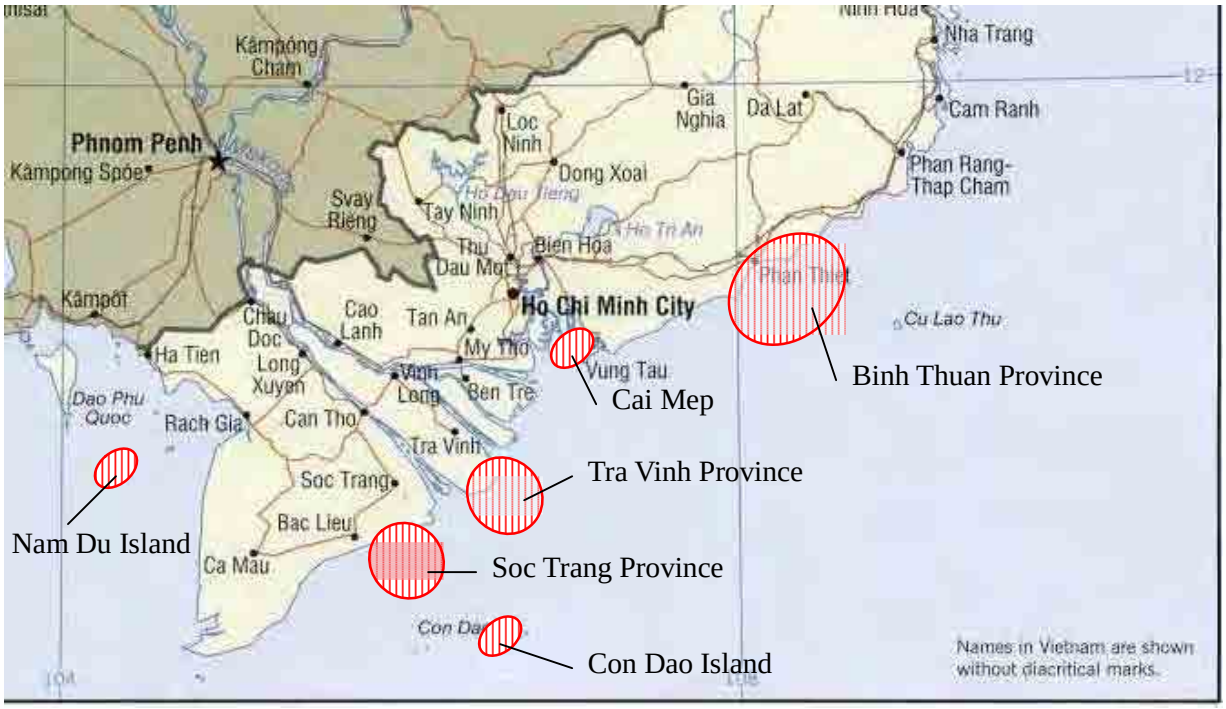


Figure 12.1 Location Map of Alternative Sites for Imported Coal Transshipment Terminal

Preparatory screening was conducted for the total eight alternatives from the aspects of environmental, land acquisition, etc. As a result, the following four alternatives passed the preparatory screening:

- Tra Vinh floating type
- Tra Vinh fixed type (with trestle)
- Tra Vinh fixed type (without trestle)
- Cai Mep fixed type (with trestle)

With regard to these alternatives, coal logistics were examined and basic terminal plans were prepared. Based on each basic plan, preliminary facility design and cost estimate were carried out. Also, the terminal operations cost, maintenance cost and secondary transport cost were estimated preliminarily. Then, counting the operation start time as the first year, the total amounts of coal logistics cost in 30 years were calculated. These total amounts were converted to present values. The comparative examination reached the results as shown in Table 12.1.

Table 12.1 Summary of Present Values of Coal Logistics Costs in Tra Vinh and Cai Mep

Alternative site/type	Present value (USD million)
Tra Vinh floating type	2,684.2
Tra Vinh fixed type (with trestle)	1,370.8
Tra Vinh fixed type (without trestle)	1,445.4
Cai Mep fixed type	608.4

Source: JICA Study Team

Accordingly, the fixed type imported coal transshipment terminal in Cai Mep has been ranked first in the Study. The layout and outline of related facilities of fixed type imported coal transshipment terminal in Cai Mep are described below.

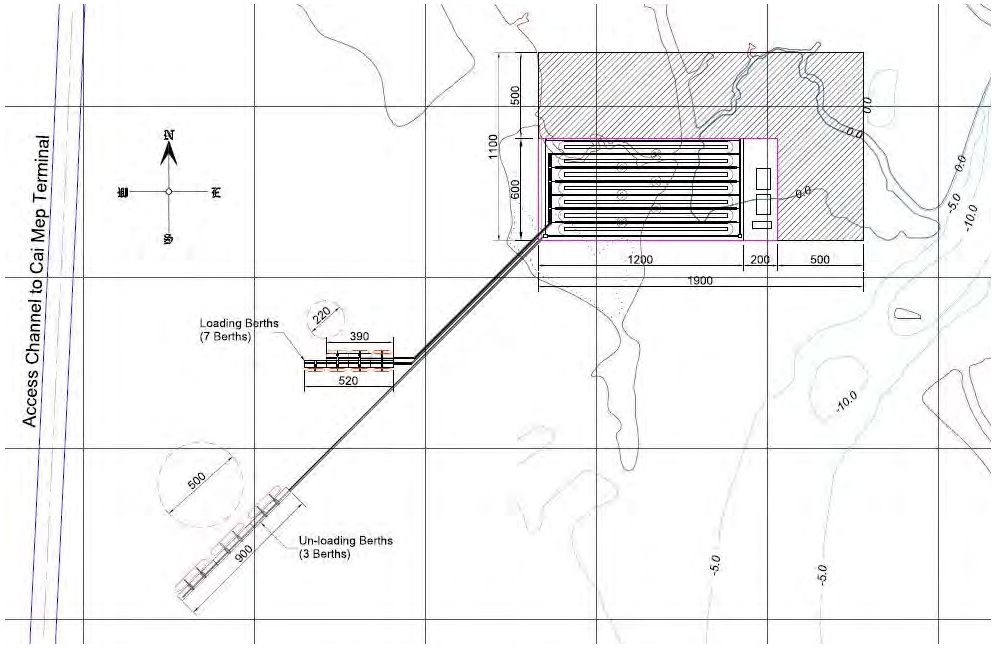


Figure 12.2 Layout of Fixed Type Imported Coal Transshipment Terminal in Cai Mep

<Outline of related facilities of imported coal transshipment terminal in Cai Mep>

Unloading berth: 900 m (3 berths) depth 15.0 m
Unloader: 2,500 t/h x 2 units per berth
Discharging berth: 910 m (7 berths) depth 6.0 m
Ship loader: 2,500 t/h x 1 unit per berth
Trestle for belt conveyor: 3 km (to unloading berth), 1.5 km (to discharging berth)
Stockyard: 72 ha (0.6 km x 1.2 km)
Administration building, maintenance shop, etc.
Dredging of channel and basin: approximately 8 million m^3

Both Tra Vinh fixed type with and without trestle have been ranked second because there is little difference between them. The outlines of related facilities are omitted in the report.

Chapter 13 Recommendations for Phase 2 Study

Contents

Chapter 13 Recommendations for Phase 2 Study

The JICA Study Team recommended the following points for the Phase 2 Study:

(1) Updating of coal logistics planning based on the latest information on the stockyards of the power plants

The JICA Study Team obtained information about Song Hau 1 Power Plant, such as stockyard, etc. However, the JICA Study Team could not reach information about the other coal fired power plants. Therefore, it was assumed in the Study that the facilities, such as stockyard, etc., of the related coal fired power plants have equivalent scale as those of the Song Hau 1 Power Plant. Especially, the areas of related coal fired power plants are important for coal logistics planning. It should be updated based on the latest information about the related coal fired power plants.

(2) Finalization of the Project area in the selected site

In the Study, alternative sites suggested by the Vietnamese government have been compared, and the most suitable site has been selected as a result. It is necessary in the Phase 2 Study to identify landowner(s) and land use plan(s) in the selected site. Based on the result, some plans shall be made in the available land area, and compared based on economic and environmental aspects, etc. The Project area shall be finalized based on such examination.

(3) Examination of stepwise development plan

In the Study, the target imported coal throughput through the imported coal transshipment terminal in 2030 has been determined to be 38 million t per year. On the other hand, as mentioned in Chapter 4, the annual coal throughput in the largest coal transshipment terminal in Europe is 20 million t. Therefore, a stepwise development plan of the imported coal transshipment terminal in Vietnam should be required in harmony with the progress of related coal fired power plants.

(4) Review of design ship size

The design vessel has been decided to be post-Panamax coal carrier (100,000 DWT), and the site and type selections have been carried out in the Study. It is understood that the size of the design vessel for the terminal affects directly the project cost of the terminal. Therefore, the JICA Study Team recommended comparing post-Panamax and Capesize vessels, at the selected site, in the overall economic aspect including annual maintenance dredging cost. Also, the JICA Study Team also recommended for the design vessel to be determined carefully. In case that public-private partnership (PPP) scheme is applied to the Project, potential private investors' opinions in this matter would be considered.

(5) "Environmentally friendly" type imported coal transshipment terminal

The selected site in Cai Mep is located between container terminals and tourist area in Vung Tau. Thus, it is necessary to consider the environment for the planning and designing of the imported coal transshipment terminal. The following items for environmental consideration are expected at the moment:

- Tall fences will be installed along the outer edge of the terminal in order to prevent coal dust from scattering around the terminal. In addition, the area within approximately 500 m from the fence will be a green belt. Planting tall trees in the green belt will also help prevent the scattering of coal dust.
- Continuous type unloader and ship loader for coal handling works would be applied as much as possible in order to prevent coal dust from scattering on the sea during coal

handling.

- Sprinkler system will be installed in the terminal, and it will give stocked coal a certain extent of moisture. This will prevent the scattering of coal dust.
- Separator will be installed in the drainage system, and it will minimize the volume of coal dust flowing into the sea.

(6) Geological investigation in Cai Mep, and soil consolidation settlement and circular failure analyses

Boring data in the project site is not available. The preliminary design in the Study has been conducted based on boring data in the container terminal being constructed under a Yen Loan project. Geological investigation will be needed in the Phase 2 Study in order to review the preliminary design and cost estimate prepared in the Study. A thick soft layer is piled up in the site. It is very important in designing a safe structure to carry out consolidation settlement and circular failure analyses. However, it is difficult to sample and analyze undisturbed samples accurately using Vietnamese technique of soil sampling including transport process. The JICA Study Team recommended that some boring works and laboratory tests should be offered to a Japanese geological survey company.

(7) Wave calmness and operation ratio of coal handling works in Cai Mep

The operation ratio in Cai Mep was set at 90% in the Study. The reason is that the frequency of SSE~S~SSW in the offshore wave data at approximately 250 km offshore from Tra Vinh is less than 10%. It is expected that the area Cai Mep is sheltered by the peninsula. However, the JICA Study Team recommended that wave deformation calculations should be done in the Phase 2 Study to review the operation ratio for coal handling works in Cai Mep.

(8) (In case that Tra Vinh is selected) Detailed comparative study between with and without trestle

From the results of the Study, the cost difference between with and without trestle in Tra Vinh is about 5%. If Tra Vinh is selected as the project site of the coal transshipment terminal, a detailed comparative study of with and without trestle cases should be carried out in the Phase 2 Study.

(9) Threshold wave height for a ship sailing

In the Study, a 5,000 DWT coal carrier was set as the coaster vessel. However, information on the threshold wave height for a sailing 5,000 DWT ship is not available. In the Study, it was set at 2.0 m to examine the coal logistics planning. The JICA Study Team recommended that the threshold wave height for a sailing 5,000 DWT ship should be reviewed based on the interview with concerned Vietnamese people in the Phase 2 Study.

Chapter 14 Environmental and Social Considerations

Contents

Chapter 14 Environmental and Social Considerations

14.1 General Conditions of Environment

14.1.1 Background

JICA had established the scheme of public-private partnership (PPP). The construction of coal transshipment terminal project was planned to be implemented under PPP. The conditions of the proposed PPP project consist of the following three sub-projects which are equally indispensable to ensure smooth operations and availability of power supply:

- Construction of coal transshipment terminal project
- Construction of Song Hau Power Plant project Phase1
- Construction of transmission line project

Each sub-project is essential for the smooth operation of the 1,200 MW power plant. The completion date of construction work will be planned in the same period. These three projects were categorized as PPP projects and thus, a study of environmental and social considerations is required according to the Vietnamese government laws and new JICA guidelines.

The recent international guidelines on infrastructure development suggest that environmental and social consideration has become a critical factor that affects the feasibility of projects. Environmental and social consideration is mandatory, especially in cases when financial resources are mobilized or sourced from international financial institutions (IFIs). In the case of JICA, it has established the new JICA Guidelines on Environmental and Social Considerations in April 2010. The guidelines will be compulsorily applied to all its lending operations.

This Study aims to select the most appropriate location of the coal transshipment terminal for the existing and proposed power plant project, and clarify the environmental and social considerations for site selection. The proposed projects would surely require a clearance for environmental and social safeguard based on the policies of IFIs such as WB, IFC and JICA, which mandate adequate environmental and social considerations for development projects.

14.1.2 Terms of Reference of Environmental Study

The environmental study would carry out the evaluation of environmental conditions for the site being selected for the proposed coal transshipment terminal in accordance with the approach described in Table 14.1.2.1.

Table 14.1.2.1 Terms of Reference for Review of EIA Report

No.	TOR	Approach
1	Data collection for environment	The environmental experts carry out the data collections for natural and social conditions in the proposed six sites.
2	Study of environmental and social conditions for site selection	The environmental experts carry out the study of environmental conditions for site selection of the coal transshipment terminal.
3	Evaluation of environmental conditions for proposed six sites	The environmental experts carry out the evaluation of environmental conditions for the site selection according to JICA's screening form for port development projects.
4	Environmental issues identification	The environmental experts propose recommendations of the environmental elements to be considered for preparation of EIA in accordance with new JICA Guidelines on Environment and Social Considerations.

14.1.3 Brief Description of the Project

Study of environmental considerations for site selection is carried out for the following proposed construction sites being considered for the coal transshipment terminal:

- Con Dao Island
- Nam Du Island
- Soc Trang
- Tra Vinh
- Cai Mep
- Vinh Tan

14.1.4 Scope of the Project

Construction of the coal transshipment terminal project involves the following:

- Land acquisition
- Berth for loading and unloading
- Berth for delivery
- Connection bridge
- Coal storage yard
- Dredging of access channel and berth

The proposed layout of the coal transshipment terminal and structures of facilities are shown in the attached drawings in Annex E1.

14.1.5 Land Use Plan Outline of Works

Conditions of the required land use plan for the coal transshipment terminal is shown in Table 14.1.5.1.

Table 14.1.5.1 Land Use Plan for Coal Transshipment Terminal

Items	Quantity	Unit	Notes
Berth for loading and unloading	900	m	Cai Mep
Berth for delivery	910	m	
Belt conveyer for connection bridge: loading and unloading	1.5	km	
Belt conveyer for connection bridge: delivery	1	km	
Coal storage yard	72	ha	
Dredging of access channel and turning basin	8,000,000	m3	

14.2 Social Environment of Proposed Sites

14.2.1 Con Dao Island

(1) Population

According to the government census, the population of Con Dao is about 5,700 in 2007 and has increased to 6,000 in 2010. Based on the socioeconomic development plan set by the government up to 2020, Con Dao is designated to be a modern tourism economy area, and as a result, the population will be expected to increase continuously due to increased economic activity in the future.

(2) Industry

The scale of tourism investment in the island is steadily growing, with 30 investment projects in the tourism services sector. Increase of industrial production is 11.1%, agriculture-forestry-fishery is 14.24%, and trade-service is 29.1%.

According to Decision No. 264/2005/QD-TTg dated October 25, 2005 on the approval of industry development for Con Dao District up to 2020, the district administrator has made up the following specific action plans for the implementation of projects on infrastructure and tourism:

- By 2020, Con Dao will complete all road infrastructure and waterway facilities around the island; upgrade airports and other public welfare facilities; develop electricity, water, and telecommunications infrastructure to ensure smooth and high-speed communication; and expand and diversify high quality transport modes and networks between the island and the mainland as well as within Con Dao.
- From 2011 to the following years, Con Dao island will be transformed into a high quality economy-tourism-service area linked with the preservation and historical restoration of the revolutionary relics of Vietnam.
- Develop and enhance the value of Con Dao National Park, make Con Dao more suitable with its frontline position, contribute actively in the process of opening, integration with international economy, security and defense guarantee, closely linked with the development of the southern region.

(3) Economy

In 2010, the socioeconomic criteria set for Con Dao District were accomplished and the target GDP per capita of USD 1,051 was exceeded. The total social capital invested in Con Dao by the end of 2010 was estimated to be VND 1,470 billion, which was 132.79% of the target. GDP was estimated to be VND 468.12 billion, which was 103.5% of the target, and the average annual increase was 17.85%. The total revenue in trade service reached VND 4,215 billion and the annual average growth was 21.17%.

(4) Summary of tourism

Con Dao is an archipelago comprised of 16 islands which belong to Ba Ria–Vung Tau Province. It is famous for its crystal clear blue-green waters, beautiful sand beaches, mangrove forests and beautiful coral reefs. Con Dao National Park is centered on an archipelago of islands, the largest of which is Con Son. There are no permanent watercourses on any of the islands, only seasonal streams. During the rainy season, water is plentiful but there is a serious lack of water during the dry season.

The development of the archipelago will focus on sustainable tourism. The proposed master plan prohibits the building of factories or exploitation of the marine environment in any way deemed detrimental to the archipelago's future. Development must be environmentally friendly and maintain the island's marine and terrestrial ecology.

(5) Number of tourist visitors

According to Con Dao Historical Relic's Management Board, Con Dao District welcomed and served 40,323 tourists for relaxing and traveling in 2010 which is an increase of 43% over the previous year. Among those, nearly 4,000 tourists are foreigners, up by 92% from 2009. Turnover from tourism reached over VND 55 billion. The number of tourists that visited the island still increased sharply to 22,000 tourists in the first five months of 2011, which is 30% more compared to that during the same period in 2010.

(6) Fishing operations

In addition to travel, Con Dao is the center of marine fishing grounds of the province and the south. The fishing area of Con Dao is really exciting because the logistics of provincial fishing vessels can accommodate up to 500 to 600 vessels at the same time.

Con Dao is endowed with Ben Dam Bay with length of about 4 km, average width of 1.6 km, and depth of 6 to 18 m. It is protected from wind and can be exploited throughout the year. According to the construction plan, there will be four ports in Ben Dam, namely for seafood, petroleum technical services, maritime services and military. Ben Dam Port has recently been completed and has been in operations with a pier length of 336 m, capable of receiving 2,000 t vessels, and complete with all services such as oil, electricity, water, fish markets, and frozen stock.

The area is suitable for the development of high value marine products. Con Dao has an abundant boat fleet, and has an annual catch of about 10,000 t of seafood.

14.2.2 Nam Du Island

(1) Population

According to the population census at the end of 2010, the population of Kien Giang is 1,703,500. Kien Hai is an island district of Kien Giang Province located off the southwest coast. The district has a population of about 25,000 people living on the islands of Kien Hai archipelago. Nam Du islands belong to Kien Hai District. Nam Du islands have a total area of 40 km^2 with a population of nearly 9,000 people.

(2) Industry

The production value was estimated at VND 13,439 billion. Investment focus is mainly on industries which have apparent advantage, especially in agro-fishery production and construction material production. The performance of fish processing establishments needs to be expanded and improved, and the development of mechanical boat installation and repairing and agricultural industries as well as the development of handicraft production, traditional craft villages, traditional products, handicrafts and fine art must be given particular attention.

(3) Economy

GDP has reached VND 18,801 billion, up by 12.05%, in which agriculture: forestry-fisheries contributed 3%, industry-construction contributed 4.1%, and commercial-service contributed 4.9%. The total harvested area reached 642,626 ha throughout the whole year, up by 3.28% compared to 2009. The average yield has reached 5.44 t/ha, with production of 3,497,053 t, an increase of 2.93% compared with 2009, in which high quality rice accounted for nearly 70%, the highest output in history.

(4) Summary of tourism

Nam Du is located in An Son Commune, Kien Hai District, Kien Giang Province. Nam Du is an archipelago comprised of 21 islands created in ingenious arrangement. The archipelago is still primitive and has many beautiful and natural landscapes. Islanders live on gardening, fishing and seafood processing. Tourist can visit the island from Phu Quoc, Hon Tre, Hon Son, and Hon Mau by transport of high-speed boats. The smallest island of Nam Du is Hon Tre, which is only about 4 km wide, and has a peak of 395 m. Lon Island is the largest and highest, and also the center of An Son Commune.

(5) Number of tourist visitors in Kien Giang

The number of tourists that visited Kien Giang has reached 2.942 million which accounts for 97.4% of the plan, an increase of 8.82% over the same period in 2009. The number of visitors from tourist companies is 780,000, which is 88.6% of the plan, an increase of 3.5% over the same period last year, in which foreign tourists account for 95,500, up by 29.86% over the same period last year.

(6) Fishing operation

The total fishery production in 2010 reached 473,494 t, which is 97.85% of the plan. Kien Giang has achievements in the field of aquaculture. Currently, the aquaculture area of the province has reached 122,000 ha with an output of about 124,000 t. From 1998, the aquaculture area has increased 4.3 times, and its production has increased by 13.7 times. Compared with the resolution of the Kien Giang Provincial Party set out in 2010, aquaculture production tripled. Assorted seafood with high economic values, such as lobsters, snails, groupers, crabs, oysters, and clams, have been successfully bred in many waters.

14.2.3 Soc Trang

(1) Population

The population of Soc Trang Province is 1,177,800 in 2005 and 1,300,800 in 2010 (an increase of over 10% in five years). At the end of 2010, 25 communes and wards in the coastal areas of Tran De, Vinh Chau, Cu Lao Dung districts and Soc Trang City accounts for 25.8% of the total population of the province. The distribution of population of city/districts in 2005 is shown in Tables 14.2.3.1 and 14.2.3.2.

Table 14.2.3.1 Population of Soc Trang Province

Year	2006	2007	2008	2009	2010
Population (x 1,000)	1,265.6	1,276.3	1,285.1	1,293.2	1,300,8

Source: General Statistics Bureau of Vietnam

Table 14.2.3.2 Population of City/Districts at Soc Trang Province (2005)

No.	City/District	Population	Percentage (%)
1	Soc Trang	114,400	9.7
2	Long Phu	229,500	19.5
3	My Xuyen	185,600	15.8
4	Vinh Chau	139,400	11.8
5	Ke Sach	158,000	13.4
6	My Tu	194,300	16.5
7	Thanh Tri	156,600	13.3
	Total	1,177,800	100

Source: General Statistics Bureau of Vietnam

(2) Industry

The total value of industrial production in 2010 reached USD 374 million, which is 106.8% higher than the planned production, an increase of 14.9% compared in 2009. The specific objective set in the plan is to raise the structure ratio of industry from 14.62% in 2010 up to 25.10% in 2015 and then to 39.50% in 2020. Planning of zones and industrial parks in the province is a key factor. The province is expected to have at least two industrial parks, namely, Tran De and My Thanh, to be in operation. The total catch and aquaculture production is 265,000 t, 42,000 t of which is sea fish catch.

(3) Economy

In recent years, Soc Trang's economy has developed rapidly. GDP growth rate is from 12% to 13% per year and average GDP per capita is from USD 1,600 to USD 1,700 by 2015.

Table 14.2.3.3 Statistics of Economic Development Results of Soc Trang Province

Year	2006	2007	2008	2009	2010
GDP	12.86%	13.46%	10.23%	10.14%	10%
GDP per population (USD)	544	614	686	881	1070
Total export (USD million)	327.40	352.00	420.00	332.15	432,00

Source: General Statistics Bureau of Vietnam

(4) Summary of tourism

Soc Trang is covered by vast rice paddies, shrimp lagoons, luxuriant gardens of fruits such as rambutan, durian, and orange. Viet (Kinh), Khmer, Hoa ethnic groups live together here. The province has 89 pagodas of Khmer group and 47 pagodas of Hoa people. Ma Toc (Bat), Khleang, Chruitim Chas, Chen Kieu, and Buu Son Tu (Set) are famous pagodas. Going there, tourists like to taste the tropical fruit in My Phuoc River Islet, or join many recreational and entertainment activities in Binh An Tourist Resort. Chol Chnam Thmay, Oc Om Boc festivals and Ngo Boat Race also attract many visitors.

(5) Number of tourist visitors

In 2010, the number of tourists coming to Soc Trang was estimated at 620,000 (an average increase of 8.08% from 2006 to 2010), including 7,800 international tourists and 85,250 stay-in tourists with 5,750 international tourists. The total turnover from tourism in 2010 was estimated at VND 60.7 billion.

(6) Fishing operations

Soc Trang has a 72 km long coastline and two major estuaries, namely, Hau River and My Thanh River. These rivers are abundant sources of maritime products such as freshwater fish, seawater fish, and shrimp. Soc Trang has many advantages of integrated economic development in marine-related sectors such as aquatic products, agriculture-forestry-aquaculture, marine-based industry, commercial seaports, fishing ports, seaport services, import and export, tourism and shipping.

The total area of aquaculture has reached 71,500 ha in 2010, up by 3.3% from 2009. The total output of aquatic products was 168,000 t. In particular, the southwest fishery is a fishing area for fishermen living in Soc Trang. It has about 661 species of fish with total reserves of 50,600 t/year and capable of being exploited up to 202,000 t/year. It also has 35 species of shrimp, 23 species of squid, crabs with a total output of about 100,000 t/year and capable of being exploited to 40,000 t/year.

14.2.4 Tra Vinh

(1) Population

The rate of natural population growth in 2010 is 1.13%. If this rate is kept, the population in 2011 would be about 1,282,550. The distribution of the population in city/districts is shown in Tables 14.2.4.1 and 14.2.4.2.

Table 14.2.4.1 Population of Tra Vinh Province

Year	2006	2007	2008	2009	2010
Population (x 1,000)	993.7	997.2	1000.8	1004.4	1135.0

Source: General Statistics Bureau of Vietnam

Table 14.2.4.2 Population of City/Districts at Tra Vinh Province (2005)

No.	City/District	Population	Percentage (%)
1	Tra Cu	164,371	16.6
2	Duyen Hai	94,925	9.6
3	Cau Ke	120,792	12.2
4	Tieu Can	161,000	16.3
5	Cau Ngang	136,244	13.8
6	Chau Thanh	141,416	14.3
7	Cang Long	169,552	17.2
	Total	1,028,300	100

Source: General Statistics Bureau of Vietnam

(2) Industry

Craft industry has been well developed in some business sectors such as textiles, mats export, coconut shell, charcoal, and mechanical works. The province has 8,520 industrial manufacturing firms and handicraft industries. The share of industry in GDP has increased from 14.52% in 2005 to 18.35% in 2010. So far, the province has 1,037 enterprises, with total registered capital of VND 8,050 billion. In 2010, the industrial production value was estimated to reach VND 3,580 billion, which is two times higher than in 2005.

(3) Economy

The provincial economy continues to grow at a fairly stable rate and investments in all economic sectors inside and outside the province have been mobilized more than from 2001 to 2005. However, Tra Vinh is still in a less developed state compared to other provinces in the region. Economic restructuring and investment mobilization are still slow; planning of agricultural production is not good; investments in business sectors are not uniform; there is lack of uniform application of technical progress; expending of cost-effective model is limited; and fisheries development is not commensurate with the potentials and advantages.

(4) Summary of tourism

Surrounded by two rivers, Tien and Hau, and having a long coastline, Tra Vinh's economy depends on agriculture, aquaculture, and fish and shrimp breeding. The province is covered by verdant plants in the garden village along the riverbank. Some interesting places for tourism are Ba Dong Beach, Ba Om Lake, and many Kinh, Hoa and Khmer pagodas. The coast of Ba Dong Beach is lined with white sand for tens of kilometers. The air is clear and fresh. The tourism office of Tra Vinh also plans to renovate and exploit Ba Dong Seaside Resort and turn it into an attractive tourist site in the Cuu Long River Delta. There are 140 Khmer pagodas, 50 Viet (Kinh) pagodas and five Hoa pagodas. The famous ones include Ang, Sam-rong-ek, Hang, and Nodol Pagoda, which is home to thousands of birds including storks, cong coc and pigeons.

(5) Number of tourist visitors

According to the development plan set by Tra Vinh government, the number of tourists visiting Tra Vinh would be over 300,000 in 2010. Revenue from tourism will reach over USD 27 million.

(6) Fishing operations

Estimated output of aquatic products in 2010 has reached 157,000 t, up by 2.44% over 2005. There is aquaculture development in all three areas, namely: salt, brackish, and fresh waters. There is also breeding of shrimp, crabs, clams, fish and other aquatic products with high economic value.

The inland fish stock at Tra Vinh was estimated at 3,000-4,000 t, with operators regularly harvesting 2,000-2,500 t. Fisheries resources of coastal areas of Tra Vinh include resources such as estuaries, mangroves and coastal waters with depth of 30-40 m of water from the shore.

14.2.5 Cai Mep

(1) Population

The population of Ba Ria-Vung Tau Province is shown in Table 14.2.5.1 and the distribution of population in 2005 in the city and districts is shown in Table 14.2.5.2.

Table 14.2.5.1 Population of Ba Ria-Vung Tau Province

Year	2006	2007	2008	2009	2010
Population (x 1,000)	955.7	970.2	983.6	996.9	1012.0

Source: General Statistics Bureau of Vietnam

Table 14.2.5.2 Population of City/Districts at Ba Ria-Vung Tau Province (2005)

No.	City/District	Population	Percentage (%)
1	Vung Tau	278,188	30.6
2	Ba Ria	89,320	9.8
3	Long Dien	127,947	14.1
4	Xuyen Moc	136,662	15.1
5	Chau Duc	154,506	17
6	Con Dao	5,847	0.6
7	Tan Thanh	115,298	12.7
	Total	907,768	100

Source: General Statistics Bureau of Vietnam

(2) Industry

Industrial production value increased by 15.4% per year, sales of services increased by 24.39% per year, trade turnover increased by 25.52% per year, service revenue increased by 21.7% per year, exports of crude oil reached USD 7,280 million, and the growth rate is 13.5% per year.

Ba Ria-Vung Tau Province has high potential to become the largest energy center of the country because of the province's abundant gas resources. The oil and gas industry makes up a large proportion (over 82.5%) of the total value of industrial production and decides the development rate in the area. In addition, industry oil services include ship repair, rig repair, replacement of the production of metal components on drilling and production of chemicals for exploration and exploitation, metal corrosion, and mechanical engineering for oil and gas.

(3) Economy

GDP growth rate is above 18%, sales of commercial services increased by 29.07%, export value increased by 38.04%, and agricultural production value increased by 4.95%.

GDP per capita in 2010 reached USD 5,872, up by 2.28 times in 2005. One important goal of Ba Ria-Vung Tau Province in five years is to achieve an average GDP growth rate of 14% per year in which GDP per capita is expected to reach USD 11,500.

(4) Summary of tourism

Ever since, Vung Tau is well-known as an attractive and high potential tourism seaside city. Two mountains, namely, Big Mountain and Small Mountain, look like a long green dragon swimming and

bending themselves on the sea surface. Particularly, Vung Tau is covered with hundreds of kilometers of seaside with lovely and graceful beaches.

There are many historical landmarks such as the hundred-meter high statue of Jesus overlooking the East Sea, the tranquil Buddha's Alta, the solemn Nirvana Buddhist Temple, the majestic White Place and many others in Vung Tau. All of which display the eternal special cultural characteristics of this city. Having a rapidly developed economy, Vung Tau City is one of the prosperous lands in the Southeast Delta.

(5) Number of tourist visitors

The number of visitors coming to Vung Tau has been increasing steadily because of its advantage and attractive landscapes. The statistics of tourists who visited Vung Tau is shown in Table 14.2.5.3.

Table 14.2.5.3 Number of Tourist Visitors in Vung Tau

No.	Sector	Unit	Sum of six months (2011)	Sum of six months (2010)	% increase
1	Tourism service	VND billion	1,377	1,092	26
2	Number of visitors	(x1,000)	6,960	5,489	26.8

Source: Department of Culture, Sport and Tourism of Ba Ria – Vung Tau Province

(6) Fishing operations

The province has 4,952 fishing vessels with a total capacity of more than 651,118 Hp. In 2007, the total production reached 205,000 t. Fisheries shift to offshore fishing, reducing the craft causing depletion and killing of aquatic resources. In recent years, the area of marine aquaculture has mostly been developed by households converting from rice farming to aquaculture. Of the total 8,952 ha of water surface area for aquaculture, 8,560 ha has so far been exploited. The annual production has reached 8,500 t in the province, mainly focused on industrial shrimp farming areas.

14.2.6 Vinh Tan

(1) Population

According to the data of the General Statistics Bureau of Vietnam, the population of Binh Thuan Province at the end of 2010 is 1,176,900, as shown in Table 14.2.6.1.

Table 14.2.6.1 Population of Binh Thuan Province

Year	2006	2007	2008	2009	2010
Population (x1000)	1142.1	1151.9	1162.0	1171.7	1176.9

Source: General Statistics Bureau of Vietnam

Table 14.2.6.2 Population of City/Districts at Binh Thuan Province (2005)

No.	City/District	Population	Percentage (%)
1	Phan Thiet	189,900	18.1
2	Bac Binh	112,000	10.7
3	Duc Linh	123,400	11.7
4	Ham Tan	154,700	14.7
5	Ham Thuan Bac	147,600	14.0
6	Ham Thuan Nam	85,900	8.2
7	Phu Quy	21,000	2.0
8	Tanh Linh	92,600	8.8
9	Tuy Phong	123,700	11.8
	Total	1,050,800	100

Source: General Statistics Bureau of Vietnam

(2) Industry

The value of industrial production of the handicraft industry reached 93.1% in 2010, up by 8.3% over the previous year, excluding hydroelectric power which increased by 13.9%. In particular, the state economy decreased by 2.2% (hydropower production value accounted for 27.7% of industrial production and down by 3.9%), non-state economy increased by 13.9%, and areas of foreign investment increased by 10.1%. In the development plan for industries of Binh Thuan Province, the average growth rate of industry value from 2011 to 2015 was set at 15.5%/year (in which industry is set at 15.5% to 16% a year).

(3) Economy

GDP per capita in 2010 reached USD 850 and GDP growth rate reached 11.5%. The growth rates of industrial sectors are as follows:

- Industry-construction: 11.2%
- Service: 15.9%
- Agriculture, forestry and fisheries: 6.2%

Aquaculture has been restored in both scale and production with a total area of 530 ha. Shrimp production reached 3,400 t/year. Seed shrimp production has been developed stably, and seed shrimp production reached 6 billion, which is 2 billion more than the set targets. In five years (2006-2010), the district has 914.4 ha of replanted forest, raising the forest coverage from 43% to 50%.

(4) Summary of tourism

The province is famous for its white sand beaches such as Phan Thiet – Mui Ne, Doi Duong, Mui Dien – Ke Ga, and beaches situated near mountains such as Vinh Hao and Binh Thanh (Tuy Phong). Besides, the province has many other places of interest such as Hang Pagoda, Tien Stream, etc.

(5) Number of tourist visitors

It was estimated that over 2.5 million visitors came to Binh Thuan in 2010, up by 13.6% compared to the previous year. Of the 2.5 million visitors, 250,000 tourists are international tourists, an increase of 12.6%. In particular, Tuy Phong District annually attracts around 370,000 visitors.

(6) Fishing operations

Aquaculture and seafood exploitation of Tuy Phong is quite developed, creating jobs and stable income for thousands of fishermen. Particularly in 2009, the district developed 18 vessels, bringing the total to 2,035 vessels with a total capacity of 3,694 Hp. Initially, the district has formed the

exploitation of marine resources with 109 organizations, including 716 boats, which attracted 3,736 workers.

The total volume is about 230,000-260,000 t. It is able to exploit 100,000 to 200,000 t/year. In addition, the marine resources of Tuy Phong are rich and diverse. There are large deposits for industrial farming; and mining and processing are relatively developed. Fishing output in 2009 reached 41,000 t, equal to 105.5% of the plan. The district has 530 ha of white shrimp farming, and seed production of 3,400 t is also quite developed.

14.3 Natural Conditions of Proposed Sites

14.3.1 National Park and Reserved Area

(1) National park

A national park is a natural area in the mainland or a component of the wetland or the sea. A national park has an area big enough for conservation purposes of one or many endemic species or their representatives and for protecting endemic species from threats at the present and the future. A national park is the foundation for spiritual, scientific and educational activities and ecotourism that is under control and introduces little negative impacts (Decision 62/2005 - MARD).

The coastal areas of Mekong Delta and the island in the south of Vietnam have many natural resources. Four sites were designated as national parks by the government. Con Dau Island was planned as one of the project site for coal transshipment terminal. Forests in Con Dao are mainly proteozoic, belonging to the tropical island ecosystem with 882 species of fauna and nearly 150 species of animal, some of which are rare species only found in the area. This island is the first place in Vietnam where sea turtle conservation is in place. The government prohibited all activities such as harvesting, processing, trading and use of sea turtles, eggs and sea turtle-related products.

Table 14.3.1.1 National Park in the Coastal Area in the South of Vietnam

Name	Area (km^2)	Location
Con Dao	150.43	Bà Rịa-Vũng Tàu
U Minh Thuong	80.53	Kiên Giang
Cape Ca Mau	418.62	Cà Mau
Phú Quốc	314.22	Kiên Giang

Source: Department of Science and Technology and German Development Cooperation Conservation and Development of the Kien Giang Biosphere Reserve Project, 2011

(2) Nature reserve area

A nature reserve area is a natural area in the mainland or with a component of wetland or the sea. A nature reserve is established for the sustainable development of ecological systems that have not or been marginally affected. The reserve also has endemic or endangered species. It can also have special natural or cultural features. The reserve is mainly managed for protecting the ecological system of species, research methods, environment monitoring and education.

Table 14.3.1.2 Reserve Areas in the Coastal Area in the South of Vietnam

Name	Area (km^2)	Location
Can Gio Bioshpere reserve	757.4	Ho Chi Minh
Lung Ngoc Hoang	60	Can Tho
Thanh Phu	45.1	Ben Tre
Vo Doi	33.94	Ca Mau
Kalong Song Mao	400	Binh Thuan
Ha Tien [13]	69.81	Kien Giang
Kien Luong [14]	146.05	Kien Giang

Source: Department of Science and Technology and German Development Cooperation Conservation and Development of the Kien Giang Biosphere Reserve Project, 2011

(3) Biosphere reserves

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a world network, i.e., the World Network of Biosphere Reserves (WNBR). Within this network, exchanges of information, experience and personnel are facilitated.

Source: Cartography and Reproduction Enterprise "Vietnam Ecotourism Map"

Figure 14.3.1.1 National Parks and Nature Reserves in the South of Vietnam

Source: Con Dao Island Tourist Office

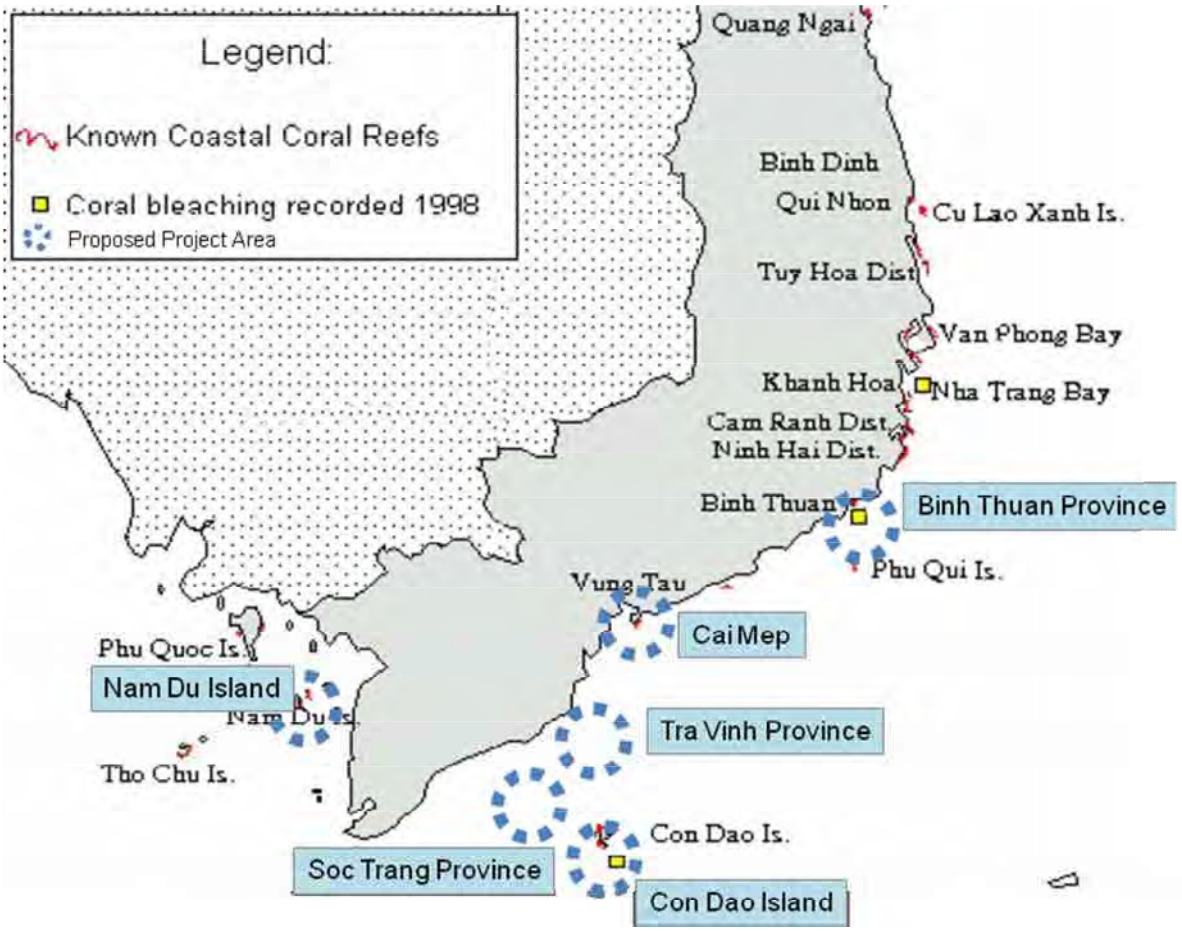
Figure 14.3.1.2 Ecology of Con Dao National Park

14.3.2 Con Dao Island Tourist Office

(1) Coral reefs distribution in the south of Vietnam

1) Location and kinds of coral

Coral reefs are the most biologically diverse marine habitats in Vietnam. Over 350 species of scleractinian corals are found in South Vietnam's coastal waters (see Figure 14.3.2.1). All coral reefs in the northern half of the country are fringing reefs, and although these are also the most common reef type, in the south, the more complex coastline and the less significant impacts of rivers have favored the development of platform reefs. In particular, atolls in the Spratly archipelago enclose reefs hundreds of meters in length with high species diversity and cover.

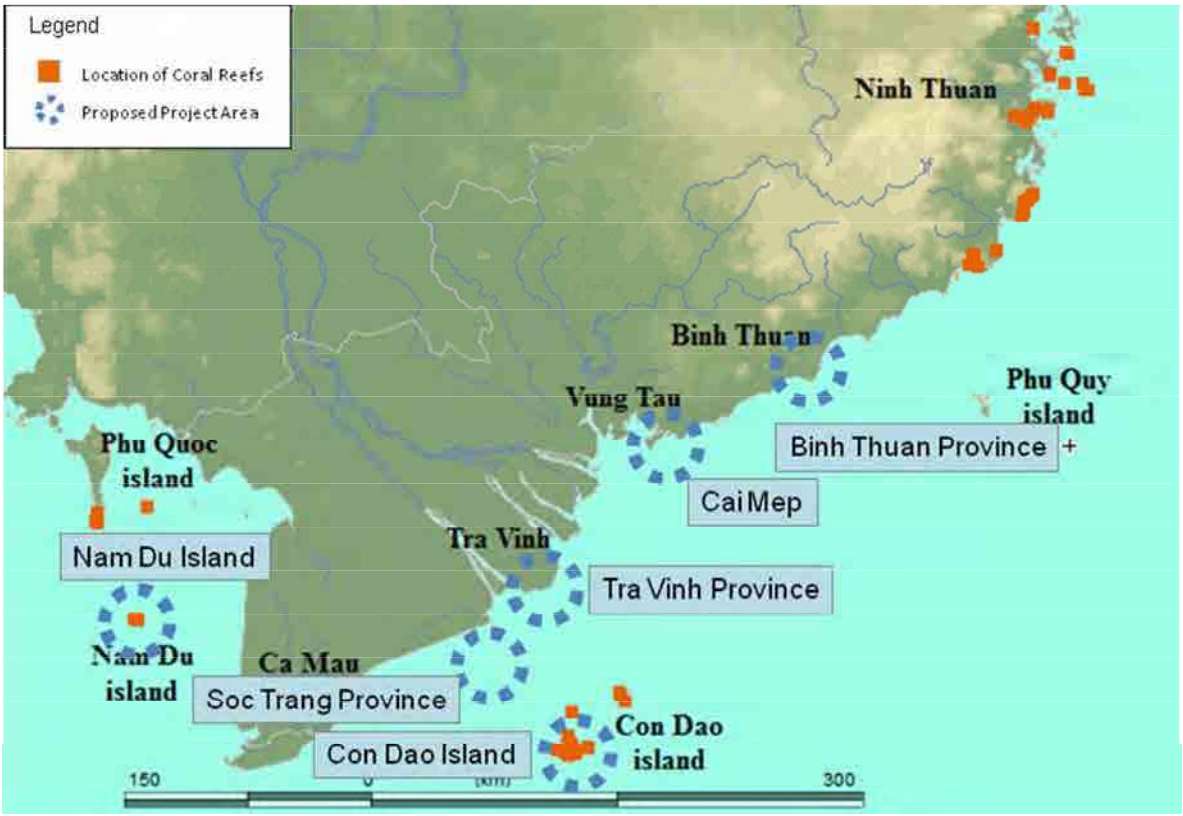


Source: Report No. 12 BirdLife International Vietnam Programme,
"The Conservation of Key Wetland Sites in the Mekong Delta".

Figure 14.3.2.1 Coral Reef Distribution and Monitoring Sites in Vietnam

There are 28 reef areas in the coastal waters of Vietnam, with approximately 20 of these reefs located in the southern part of the country. There are five distinct marine areas in Vietnam, namely: (1) western Gulf of Tonkin, (2) middle central Vietnam, (3) south central Vietnam, (4) southeastern Vietnam, and (5) southwestern Vietnam. South central has the most coral diversity with records of 66 hermatypic coral genera. The specific areas with significant reef abundance and high coral coverage in the south include Van Phong Bays (Khanh Hoa Province), Nha Trang Bays (Khanh Hoa Province), Ninh Thuan Coast, Ca Na Bay (Binh Thuan Province), Con Dao Islands (Ba Ria-Vung Tau Province), Phu Quoc Island (Kien Giang Province), Nam Du and Tho Chu Islands (Kien Giang Province).

According to information from ReefBase on the current condition of coral reefs in the south of Vietnam, there is no appearance of coral reefs in the coastal line from Tra Vinh coast to Binh Thuan Province coast (see Figure 14.3.2.2).



Source: Coral reefs map, ReefBase, 2011.

Figure 14.3.2.2 Location of Coral Reefs in the South of Vietnam

(2) Current status of coral reefs in Vietnam

From 1994 to 1997, 15 reef areas were surveyed with a total of 142 study sites. The results from these surveys showed the overall condition that the coral reefs have decreased. Based on the IUCN criteria for assessing coral reefs, only 1.4% of the total study reefs in southern Vietnam were considered to be in excellent condition. In contrast, the number of poor reefs occupied 37.3% and the reefs considered to be in fair and good conditions occupied 48.6% and 31%, respectively. These data indicate that the conditions of the reefs located in offshore islands or at the sites most distant from population centers are significantly better than those located close to populated coastal zones. Moreover, data collected at 30 transects of monitoring done in 2000 or 2001 show the same situation of coral cover in these same reefs. Change in the trends of coral cover and coral reef communities could be assessed based on long-term monitoring in some sites.

(3) Mangrove distribution in the coastal area in the south of Vietnam

The largest concentration of mangroves in the Mekong Delta is located at the coastal provinces of Ca Mau, Kien Giang, Bac Lieu, Soc Trang, Tra Vinh, and Ben Tre. The area that has the most population of mangroves is Ca Mau and mainly Ca Mau Peninsula, where the state was planning to build Mui Ca Mau National Park. Ca Mau Peninsula is a new ground which is constantly being enriched. It encroaches into the sea each year from 50 to 100 m extending to the west and south. The area of mangrove forests near the coast and inland is quite concentrated due to weak waves. In addition, mangroves are distributed in many areas which are just small ones scattered at the coast and deep inland.

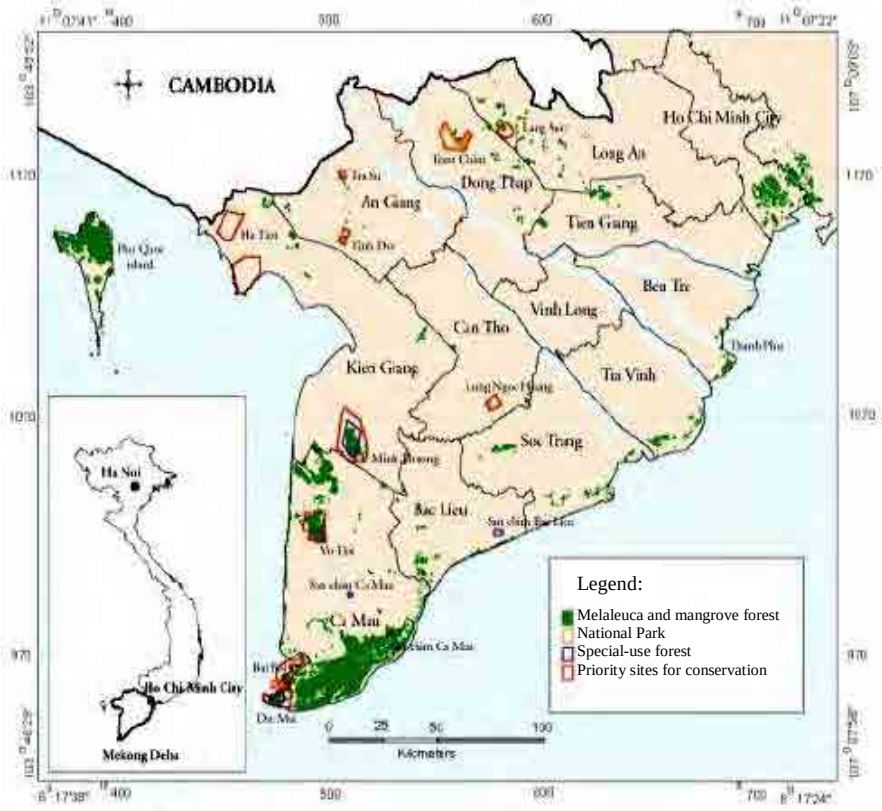
The largest extent of mangroves, with over 191,800 ha, can be found in southern Vietnam associated with Dong Nai and the Mekong River estuaries, while the second largest extent, i.e., 39,400 ha, lies in the northeastern Quang Ninh Province. These are followed by those in the estuaries of Thai Binh and Hong (Red) rivers at 7,000 ha in the northern part of Vietnam.

(4) Mangrove replanting

According to the report of wetlands in the Mekong Delta, natural mangrove forests have been almost entirely lost due to a combination of wartime conflict, especially defoliant spraying, and more recent clearance for aquaculture and exploitation of forest products.

The coastal dynamics of the Mekong Delta are varied, with high erosion rates occurring along parts of the eastern coastline and rapid accretion rates on the Ca Mau Peninsula and at the mouths of the major discharge points of the Mekong River distributaries (see Photos 01 and 02). The highest rates of erosion have occurred where mangroves have been destroyed, often through reduced protection from tropical storms and typhoons, leading to the loss of valuable agricultural land and an increase in saline water intrusion into rice growing areas further inland. This has resulted in the recognition of the important role mangrove plays in maintaining the agricultural system in the delta, at least in part. In order to oppose this, widespread mangrove planting has taken place, often with the assistance of substantial funds from international donors.

Photo 01: Erosion Site Photo 02: Erosion Site



Source: Report No. 12 BirdLife International Vietnam Programme,
"The Conservation of Key Wetland Sites in the Mekong Delta".

Figure 14.3.2.3 Distribution of Special-Use Forest and Ten Priority Sites for Biodiversity Conservation in the Mekong Delta

14.3.3 Typhoon

Typhoons are generated at an average of 26 occurrences per year during the last 30 years (1981-2010) in the South Pacific Ocean. Vietnam is located in Southeast Asia, far from typhoon track routes and has small possibility of direct hit. However, within the last ten years (2000-2011), several typhoons hit the southern area of Vietnam (see Figure 14.3.3.1). In fact, mangroves planted in coastal areas receive damage several times. For the safe operations of the coal transshipment terminal, considerations on the influence caused by typhoons, such as rough seas, tidal waves and storms, are required. Figure 14.3.3.1 shows the tracking chart of typhoons.

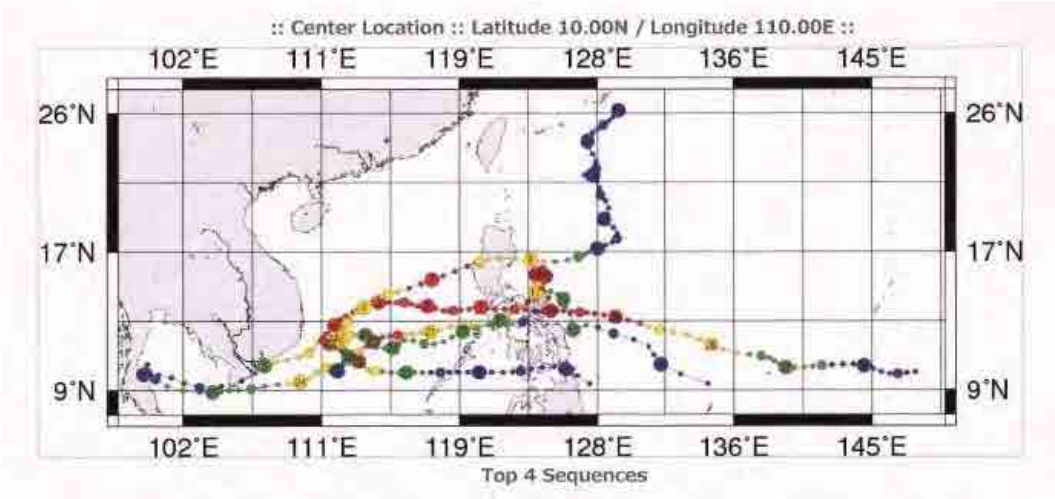


Figure 14.3.3.1 Tracking Chart of Typhoon

Table 14.3.3.1 List of Typhoons that Hit the South of Vietnam

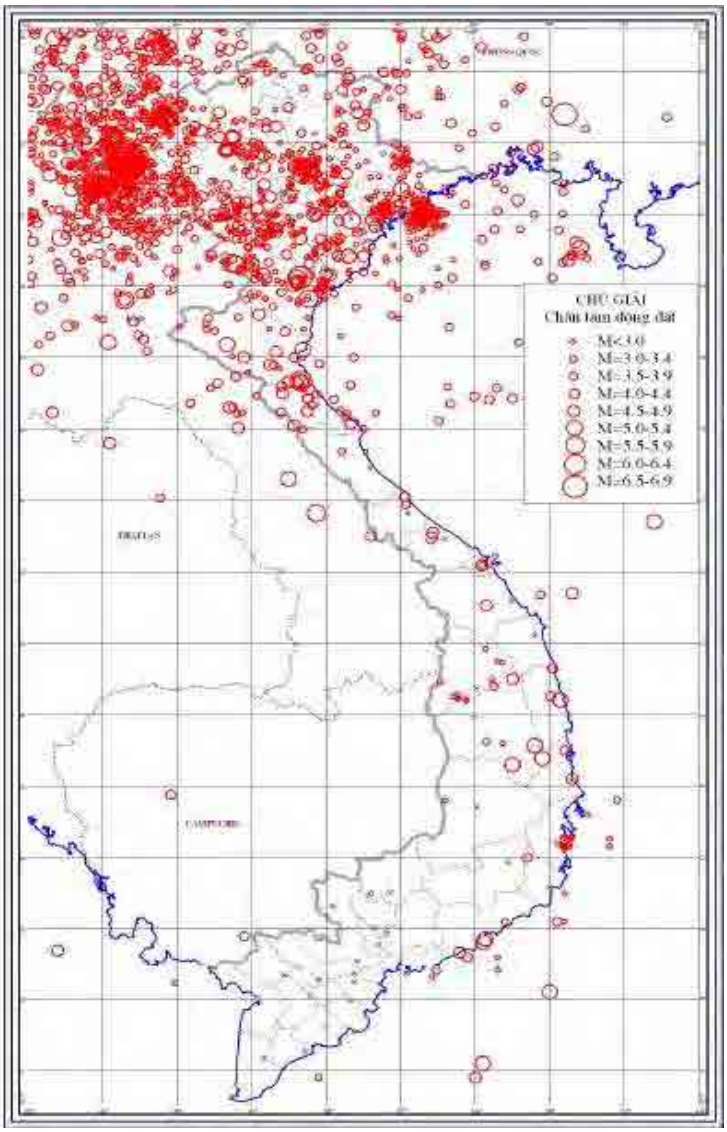
Number	Name	Birth	Death	Duration	Minimum Pressure (hpa)
200425	Muifa	Nov. 14, 2004	Nov. 25, 2004	10 days 18 hr	950
200621	Durian	Nov. 26, 2004	Dec. 05, 2004	8 days 18hr	915
200724	Hagibas	Nov. 20, 2007	Nov. 27, 2007	6 days 18hr	970
200902	Chan-hom	May 3, 2009	May 9, 2009	5days 12hr	975

Source: National Institute Information, Japan

14.3.4 Earthquake

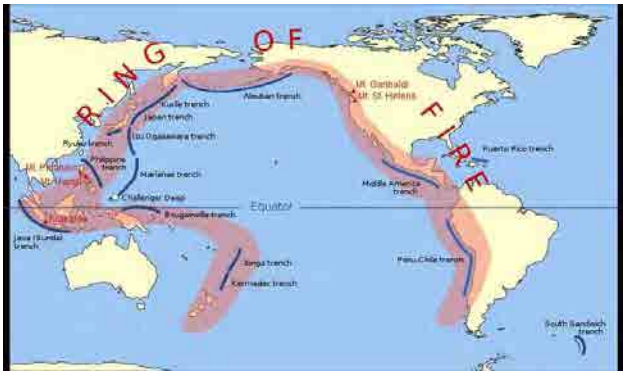
Vietnam is near the “Ring of Fire”, an area around the Pacific Ocean where 90% of the earth’s earthquakes occur. In simple terms, the ring is where huge plates of the earth are colliding against each other. In case of earthquake, the impact on coastal fishing communities and the people living there, who are some of the poorest in the region, will be devastating with high losses of income as well as boats and fishing gears. Fishing fleet and industrial infrastructure in the coastal regions destroyed by wave surges will have adverse economic effects at both local and national levels. In addition, operations of the terminal will be suspended for a long time.

From past records, 90% of earthquakes have taken place in northwestern Vietnam. The largest earthquakes happened in Dien Bien in 1935 (M6.8) and Tuan Giao in 1983 (M6.7). In November 2007, the southern city was also affected when a 4.5-5 magnitude earthquake hit the coast of Binh Thuan and Vung Tau. A map of earthquakes in Vietnam that occurred up to 2005 is shown in Figure 14.3.4.1.



Source: Nguyen Anh Duong, "Earthquake Observation in Vietnam", Institute of Geophysics, 2006

Figure 14.3.4.1 Map of Earthquakes in Vietnam up to 2005



Source: Nguyen Anh Duong, "Earthquake Observation in Vietnam", Institute of Geophysics, 2006

Figure 14.3.4.2 Map of the Ring of Fire

14.4 Study of Environment and Social Considerations

The study of environmental conditions for the site selection on coal transshipment terminal was carried out according to JICA's scoping form and matrix of port development projects. The results of evaluation are shown in the attached Appendix 2.

Six sites were proposed by the Vietnamese side as the site for the proposed coal terminal. However, the locations of the two sites (Nam Du Island and Vinh Tan) are very far from the targeted power plants and thus, not recommended based on an economical point of view for the project because the coal transportation cost will be very high. Therefore, the environmental study did not include Nam Du Island and Vinh Tan sites. Site selection of the coal transshipment terminal was carried out based on the following basic environmental considerations and policies:

- Do not select the site of national park and reserved areas designated by the government
- Select the site which could minimize deforestation of the existing mangrove forest
- Select the site which could minimize involuntary resettlement
- Select the site which could minimize dredging and land reclamation
- Select the site which could minimize construction and operations costs

Table 14.4.1 Results of Evaluation

Site	Main Characteristics of Environmental Conditions	Requirement of mitigation	Evaluation
Con Dau Island	- The entire island area was designated a national park. There are many important ecology areas in this island and surrounding sea area. - From 1995 to 2006, a preservation project for sea turtles was conducted by WWF. - The proposed master plan prohibits the building of factories or exploitation of the marine environment. - Island was developed as a base of tourism by the government.	-	Not recommended
Nam Du Island	- The distance between the power plants and terminal is very far; thus, the transportation cost of coal will be very high. - There are many coral reefs to be protected in the coastal area.	-	Not recommended
Soc Trang	- Large-scale erosion was observed in the coastal zone, which is proposed as the coal storage site. - For countermeasures against erosion, many mangrove plants were forested in the proposed project site by the GIZ project. - The depth of sea in the coastal area is shallow; thus, large volumes of dredging for the access channel and terminal are expected. - The province has many tourism sites such as pagodas; the number of tourists that visited the province was estimated at 620,000 in 2010. - Fishermen conduct fishing operations in the coastal area.	-	Not recommended
Tra Vinh	- There is a mangrove forest but the density is relatively lower than the other sites. - It is required to minimize the deforestation of mangrove forests. - Several families live in small wooden houses in the coastal area. - The construction of Duyen Power Plant project is implemented nearby. - Fishermen conduct fishing operations in the coastal area.	-Replanting of mangroves -Preparation of RAP, if required	Recommended with mitigation
Cai Mep	- There is a mangrove forest in and adjacent to the site and it is required to minimize deforestation of mangrove forest. - Province is a base for tourism; the number of tourists that visited the province was estimated at 696,000 for half of the year in 2010. - Fishermen conduct fishing operations in the coastal area. - A resort/recreational area is located 10 km from the proposed site. - The access channel of vessels was completed by another project and it is possible to minimize dredging works.	-Replanting of mangrove -Preparation of RAP, if required -Pay close attention to resort/recreational area	Recommended with mitigation
Vinh Tan	- The distance between the power plants and terminal is very far; thus, the transportation cost of coal will be very high.	-	Not recommended

14.5 Recommendations of Environment and Social Consideration for EIA

The EIA report for the Project would be prepared after the proposed site for the coal terminal is finalized in the next phase of FS to be executed by the Vietnamese government. The proposed project includes a large-scale land reclamation and dredging as well as construction of structures for port facilities. In addition, large-scale coal handling operations will also be conducted continuously in the future. It is expected that the proposed project will have relatively high potential factors that could affect the environment of the surrounding areas during construction and operations. In order to ensure the adequacy of environmental and social considerations for the preparation of the EIA report, scoping was carried out by using a scoping form drawn out from the new JICA Guidelines on Environmental and Social Considerations. The results of the study are shown in Appendix 2.

The items of the recommendations for the preparation of EIA for the coal transshipment terminal are the following:

(a) Survey of water quality and seabed soils quality at the proposed site
(b) Survey of the disposal area for dredged materials
(c) Survey of ecology in coastal area
(d) Survey of fishery
(e) Survey of resettlement, if available

14.5.1 Survey of Water Quality and Seabed Soil at the Proposed Site

Dredged materials will be disposed in designated sea areas or utilized as materials for land reclamation according to the basic design. In the case that polluted dredging materials are disposed at sea, it will cause serious impact to the existing ecology in the project area. Therefore, the survey of seabed soil quality including analysis of heavy metals and oil is recommended. Dredging works for the port shall be conducted after clarification of the seabed soils.

In addition to the above, the obtained data from the survey will be used as baseline data of seabed and these data will be compared with the monitoring data of seabed taken during the operations of the terminal. Due to the discharged water to the sea even after appropriate treatment, the pollution of sea water is still possible. The items required in the survey for the seabed soils are shown in Tables 14.5.1.1 and 14.5.1.2 as reference.

Table 14.5.1.1 Required Data of Seabed Soil Analysis (for reference)

No	Name of Chemical Substance	Symbol of Elements
1	Particle size	-
2	pH	-
3	Chemical Oxygen Demand	COD
4	Normal Hexane Extractive Chemicals	-
5	Total Sulphur	T-S
6	Total Nitrogen	T-N
7	Total Phosphorus	T-P
8	Total Mercury	T-Hg
9	Alkyl Mercury	R-Hg
10	Cadmium	Cd
11	Total Cyanides	CN
12	Organic Phosphorus	Or-P
13	Lead	Pb
14	Chromium	Cr
15	Arsenic	As
16	Polychlorobiphenyl	PCB
17	Copper	Cu
18	Zinc	Zn

Table 14.5.1.2 Required Data of Water Quality Analysis (for reference)

No	Name of Chemical Substance	Symbol of Elements
1	Temperature	-
2	Salts Concentration	-
3	Sampling Depth	-
4	pH	-
5	Total Suspended Solid	TSS
6	Chemical Oxygen Demand	COD
7	Dissolved Oxygen	DO
8	Oil	-
9	Ammonia Nitrogen	NH4(N)
10	Total Nitrogen	T-N
11	Total Phosphorus	T-P
12	Total Mercury	T-Hg
13	Alkyl Mercury	R-Hg
14	Cadmium	Cd
15	Total Cyanides	CN
16	Organic Phosphorus	Or-P
17	Lead	Pb
18	Chromium	Cr^{3+}, Cr^{6+}
19	Arsenic	As
20	Polychlorobiphenyl	PCB
21	Copper	Cu
22	Zinc	Zn

14.5.2 Survey of the Existing Disposal Area of Dredged Materials

Dredging works will be conducted in the access channels and proposed berth area of the port. Approximately 8 million m^3 of dredged materials generated in this Project will be disposed into the new dumping site. Assessment of the environmental impact of pollution requires a thorough study and simulation of the area and period of pollution based on the seabed conditions and tidal current. Also,

monitoring of sea water is required during the construction period according to the details of the monitoring plan which is to be prepared during the design stage.

Large volumes of dredging will be expected in this project. Therefore, the overall impact during the construction phase is expected to be not small. Information of disposal site such as boundary line and receiving capacity for dredged soil is indispensable. Therefore, a site survey of the existing disposal site shall be carried out. In addition, for reducing seawater pollution, it is recommended to study further mitigation measures such as utilization of silt fence, etc., if necessary.

14.5.3 Survey of Ecologies in the Coastal Area

The proposed terminal will be planned in the coastal area which is lined with white sand. Behind the terminal area, there are mangrove forests, small-scale fish ponds and several agricultural fields. There are no data regarding the ecology in the coastal area of this site. Therefore, appropriate site survey should be carried out to properly identify the existing critical habitats of any rare or endangered species or other valuable natural resources such as mangroves and tidal flats in the coastal area. A study of mitigation measures should be prepared based on the results of the survey, if necessary. The items which will be required in the survey of ecologies are the following:

- Data collection of ecology (fauna and flora)
- Field survey of mangrove forest (area, type and species)
- Mitigation measures for deforestation of mangrove
- Field survey of resettlement, if necessary
- Baseline survey of local residents

14.5.4 Survey of Fishing Activities in the Coastal Area

Fishermen living in the coastal area conduct fishing operations in the proposed project area. During the construction and operational phase of the terminal, their fishing activities will be restricted; however, there are no available data on the current fishing activities around the project area. In addition to the above, it is necessary to confirm the presence of fish ponds along the route of access road which requires land acquisition. Therefore, survey of fishing activities being conducted by the local residents is indispensable to ensure that the social impact caused by the project is minimized. The items required in the survey for the fishing activities are the following:

- Information on existing fishing conditions
- Information on fishermen's living conditions

It is recommended to carry out interview survey to examine the socioeconomic impacts of the Project, especially to the fishermen residents of the area.

Table 14.5.4.1 Interview Survey (for reference)

Category	Fishing activities
Number of samples	Households (fishermen) living adjacent to project area
Schedule	2012
Items of survey	Fishing area, Fish catch, Type of fishing, Size of family, Income/expenditure, Occupation, Education level, Area of residence, Ownership of residence, Material of house, Drinking water, Water for other use, Toilet, Electric power supply, Number of ship, Powerboat, Using port, Purpose of using port, Literacy, Health conditions, Medical treatment, Source of information, Living conditions, Concerns/requests about fishing, etc.

14.5.5 Involuntary Resettlement

Coal Terminal facilities will be constructed offshore that Involuntary Resettlement is not anticipated; however the coal storage yard will be constructed at coastal area. Also, with the construction of access road to site, it is expected that several numbers of households and individuals may require involuntary resettlement. Data of necessary numbers of resettlement shall be clarified in the EIA report.

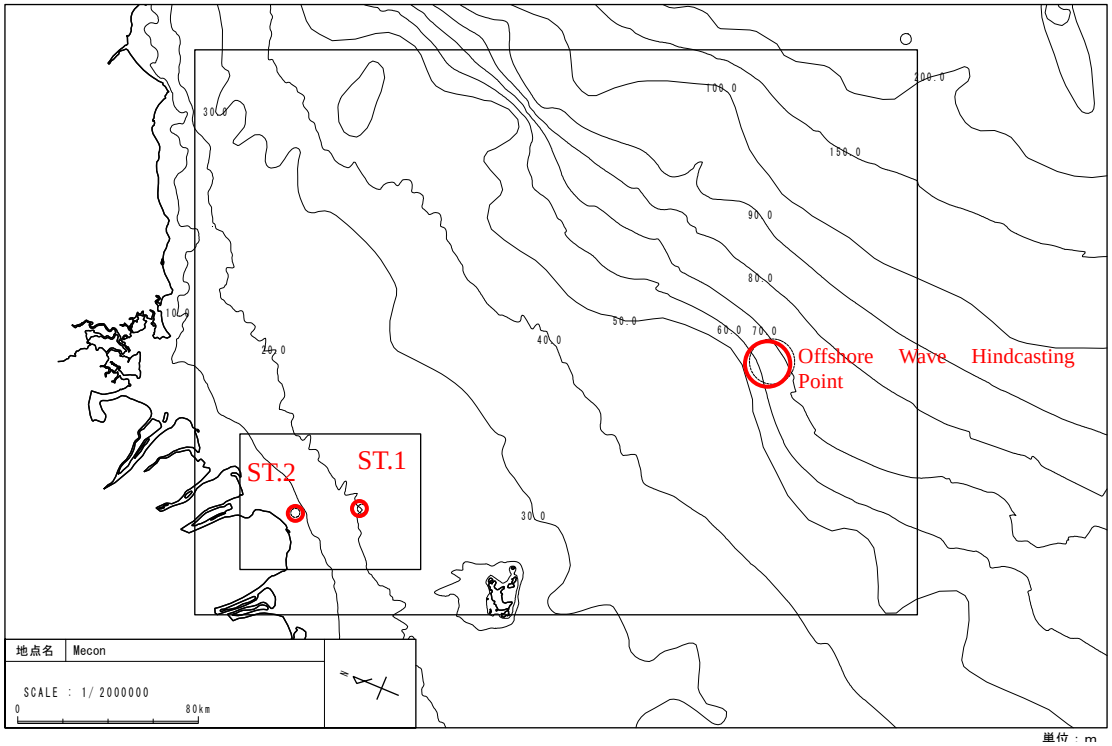
Details of the actual number of households to be affected will be clarified before the final route selection of access road and location of coal storage yard will be completed and finalized. In this selection process, it is necessary that proper consideration be taken in order to minimize the number of involuntary resettlement.

The plan for resettlement needs to be prepared as a part of RAP. The survey for suitable compensation, standard of life based on housings and social economy, and authority for resettlement will be conducted at the stage of RAP. The plan for resettlement will provide the standard for group or individuals based upon meeting with local residents. The framework for resettlement will be mentioned in RAP and it is necessary to consider the budget for resettlement in the report.

Appendix

1. Wave Data

1.1 Offshore Wave Hindcasting Point



Note：”ST.1” means -20m depth point and ”ST.2” means -5m depth point.

Figure A1.1.1 Location Map of Offshore Wave Hindcasting Point and Wave Deformation Calculation

1.2 Offshore Wave Hindcasting Data

Table A1.2.1 Yearly Compound Frequency Table by Wave Height and Direction (2000 ~ 2010)

Mekong ERR : 640

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		0	0	0.0	0	0.0
~ 0.2		0	52	88	99	48	39	11	13	13	33	22	21	0	1	0	0		440	1.4	440	1.4
~ 0.4		6	202	91	8	27	16	20	24	40	81	33	14	5	1	0	1		569	1.8	1009	3.2
~ 0.6		86	1177	476	110	49	17	18	99	148	272	162	47	8	7	5	6		2687	8.6	3696	11.8
~ 0.8		245	1969	474	87	29	10	23	84	220	477	285	100	10	8	7	9		4037	12.9	7733	24.6
~ 1.0		287	1875	347	64	10	4	5	38	250	637	541	156	12	4	0	17		4247	13.5	11980	38.1
~ 1.2		211	1465	356	32	2	0	0	28	144	539	533	141	11	0	0	0		3462	11.0	15442	49.2
~ 1.4		214	1039	253	4	0	0	0	6	112	422	362	139	21	2	2	6		2582	8.2	18024	57.4
~ 1.6		148	1236	190	4	0	0	0	0	82	291	310	114	4	3	0	3		2385	7.6	20409	65.0
~ 1.8		69	974	108	1	0	0	0	0	47	248	268	75	8	0	2	3		1803	5.7	22212	70.7
~ 2.0		96	1111	78	0	0	0	0	0	53	304	244	54	8	0	0	2		1950	6.2	24162	76.9
~ 2.2		54	968	31	1	1	1	0	0	23	141	106	36	12	2	0	1		1377	4.4	25539	81.3
~ 2.4		63	774	12	0	0	0	2	0	17	89	85	42	3	2	0	0		1089	3.5	26628	84.8
~ 2.6		49	780	10	0	0	0	0	0	8	48	42	30	2	5	0	7		981	3.1	27609	87.9
~ 2.8		48	524	8	0	0	0	0	0	8	24	38	11	1	0	0	1		663	2.1	28272	90.0
~ 3.0		65	567	6	0	0	0	0	0	3	22	11	5	1	0	0	1		681	2.2	28953	92.2
~ 3.2		50	480	8	0	0	0	0	0	5	12	11	0	0	0	0	1		567	1.8	29520	94.0
~ 3.4		45	421	3	0	0	0	0	0	0	5	2	0	0	0	0	0		476	1.5	29996	95.5
~ 3.6		19	385	1	0	0	0	0	0	0	0	0	0	0	0	1	0		406	1.3	30402	96.8
~ 3.8		15	209	0	0	0	0	0	0	0	0	0	0	0	0	0	0		224	0.7	30626	97.5
~ 4.0		4	191	0	0	0	0	0	0	0	0	0	0	0	0	0	0		195	0.6	30821	98.1
~ 4.2		0	157	1	0	0	0	0	0	0	0	0	0	0	0	0	0		158	0.5	30979	98.6
~ 4.4		1	124	1	0	0	0	0	0	0	0	0	0	0	0	0	0		126	0.4	31105	99.0
~ 4.6		0	107	1	0	0	0	0	0	0	0	0	0	0	0	0	0		108	0.3	31213	99.4
~ 4.8		0	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0		74	0.2	31287	99.6
~ 5.0		1	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0		56	0.2	31343	99.8
5.0 ~		2	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0		63	0.2	31406	100.0
Frequency	(time)	1778	16977	2543	410	166	87	79	292	1173	3645	3055	985	106	35	17	58	0	31406	100.0		
	(%)	5.7	54.1	8.1	1.3	0.5	0.3	0.3	0.9	3.7	11.6	9.7	3.1	0.3	0.1	0.1	0.2	0.0	100.0			

Source : Met Offcice (UK)

Table A1.2.2 Seasonal Compound Frequency Table by Wave Height and Direction (March ~ May: 2000 ~ 2010)

Mekong ERR : 284

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		0	0	0.0	0	0.0
~ 0.2		0	1	38	1	3	0	0	1	1	8	0	0	0	1	0	0		54	0.7	54	0.7
~ 0.4		2	97	57	0	6	4	4	3	11	13	4	4	0	0	0	1		206	2.7	260	3.4
~ 0.6		43	565	294	85	17	9	2	22	45	40	18	10	0	2	0	0		1152	14.9	1412	18.2
~ 0.8		106	1050	313	52	13	2	0	12	50	82	41	15	0	0	0	0		1736	22.4	3148	40.7
~ 1.0		78	917	182	48	2	2	0	6	58	90	99	22	1	2	0	0		1507	19.5	4655	60.1
~ 1.2		30	485	195	28	2	0	0	0	12	55	57	40	2	0	0	0		906	11.7	5561	71.8
~ 1.4		35	289	126	2	0	0	0	0	7	22	21	22	7	0	0	0		531	6.9	6092	78.7
~ 1.6		21	336	74	2	0	0	0	0	0	12	20	14	3	0	0	0		482	6.2	6574	84.9
~ 1.8		5	162	47	0	0	0	0	0	2	3	18	5	0	0	0	0		242	3.1	6816	88.1
~ 2.0		9	182	24	0	0	0	0	0	3	15	3	1	1	0	0	0		238	3.1	7054	91.1
~ 2.2		5	138	5	1	0	0	0	0	0	8	0	0	1	0	0	0		158	2.0	7212	93.2
~ 2.4		2	101	0	0	0	0	0	0	0	2	1	3	0	0	0	0		109	1.4	7321	94.6
~ 2.6		8	124	1	0	0	0	0	0	0	7	1	2	1	0	0	0		144	1.9	7465	96.4
~ 2.8		4	76	0	0	0	0	0	0	0	1	3	0	1	0	0	0		85	1.1	7550	97.5
~ 3.0		0	52	0	0	0	0	0	0	0	0	0	0	1	0	0	0		53	0.7	7603	98.2
~ 3.2		0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0		35	0.5	7638	98.7
~ 3.4		0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0		28	0.4	7666	99.0
~ 3.6		0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0		23	0.3	7689	99.3
~ 3.8		0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0		9	0.1	7698	99.5
~ 4.0		0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0		9	0.1	7707	99.6
~ 4.2		0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3	0.0	7710	99.6
~ 4.4		0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0		10	0.1	7720	99.7
~ 4.6		0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0		8	0.1	7728	99.8
~ 4.8		0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0		6	0.1	7734	99.9
~ 5.0		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0		2	0.0	7736	99.9
5.0 ~		0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0		4	0.1	7740	100.0
Frequency	(time)	348	4712	1356	219	43	17	6	44	189	358	286	138	18	5	0	1	0	7740	100.0		
	(%)	4.5	60.9	17.5	2.8	0.6	0.2	0.1	0.6	2.4	4.6	3.7	1.8	0.2	0.1	0.0	0.0	0.0	100.0			

Source : Met Offcice (UK)

Table A1.2.3 Seasonal Compound Frequency Table by Wave Height and Direction
(June~August: 2000～2010)

Mekong ERR : 104

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		0	0	0.0	0	0.0
～ 0.2		0	26	19	65	27	27	9	9	12	19	22	21	0	0	0	0		256	3.2	256	3.2
～ 0.4		2	70	23	5	21	6	12	17	22	60	28	9	5	1	0	0		281	3.5	537	6.7
～ 0.6		25	313	96	19	20	8	12	48	87	208	134	24	4	3	4	2		1007	12.6	1544	19.3
～ 0.8		20	211	32	15	6	4	17	42	151	318	184	53	3	1	1	3		1061	13.3	2605	32.6
～ 1.0		16	153	24	9	2	0	1	22	165	457	315	79	0	1	0	6		1250	15.7	3855	48.3
～ 1.2		9	97	19	0	0	0	0	19	119	418	346	49	0	0	0	0		1076	13.5	4931	61.8
～ 1.4		13	31	13	0	0	0	0	5	92	353	266	56	0	0	0	0		829	10.4	5760	72.1
～ 1.6		1	35	10	0	0	0	0	0	75	248	198	52	0	0	0	0		619	7.8	6379	79.9
～ 1.8		0	16	10	0	0	0	0	0	41	205	172	35	1	0	0	0		480	6.0	6859	85.9
～ 2.0		0	15	9	0	0	0	0	0	47	222	188	38	5	0	0	0		524	6.6	7383	92.5
～ 2.2		0	7	14	0	0	0	0	0	21	91	77	15	9	0	0	0		234	2.9	7617	95.4
～ 2.4		0	3	4	0	0	0	0	0	13	54	64	22	3	0	0	0		163	2.0	7780	97.4
～ 2.6		0	1	0	0	0	0	0	0	6	33	31	12	0	2	0	0		85	1.1	7865	98.5
～ 2.8		0	0	0	0	0	0	0	0	8	21	24	6	0	0	0	0		59	0.7	7924	99.2
～ 3.0		0	0	0	0	0	0	0	0	3	20	6	4	0	0	0	0		33	0.4	7957	99.7
～ 3.2		0	0	0	0	0	0	0	0	5	11	6	0	0	0	0	0		22	0.3	7979	99.9
～ 3.4		0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0		5	0.1	7984	100.0
～ 3.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 3.8		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 4.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 4.2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 4.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 4.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 4.8		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
～ 5.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
5.0 ～		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
Frequency	(time)	86	978	273	113	76	45	51	162	867	2743	2061	475	30	8	5	11	0	7984	100.0		
	(%)	1.1	12.2	3.4	1.4	1.0	0.6	0.6	2.0	10.9	34.4	25.8	5.9	0.4	0.1	0.1	0.1	0.0	100.0			

Source : Met Offcice (UK)

Table A1.2.4 Seasonal Compound Frequency Table by Wave Height and Direction
(September ~ November: 2000 ~ 2010)

Mekong ERR : 132

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		0	0	0.0	0	0.0
～ 0.2		0	25	31	33	18	12	2	3	0	6	0	0	0	0	0	0		130	1.7	130	1.7
～ 0.4		2	35	11	3	0	6	4	4	7	8	1	1	0	0	0	0		82	1.0	212	2.7
～ 0.6		18	283	35	6	12	0	4	29	16	24	10	13	4	2	1	4		461	5.9	673	8.5
～ 0.8		112	549	89	9	10	4	6	30	19	77	60	32	7	7	6	6		1023	13.0	1696	21.5
～ 1.0		180	567	80	7	6	2	4	10	27	90	127	55	9	1	0	11		1176	14.9	2872	36.5
～ 1.2		162	569	45	2	0	0	0	9	13	66	130	52	9	0	0	0		1057	13.4	3929	49.9
～ 1.4		143	395	22	2	0	0	0	1	13	47	75	61	14	0	2	4		779	9.9	4708	59.8
～ 1.6		104	399	29	2	0	0	0	0	7	31	92	48	1	3	0	3		719	9.1	5427	68.9
～ 1.8		37	367	7	0	0	0	0	0	4	40	78	35	7	0	0	3		578	7.3	6005	76.2
～ 2.0		61	339	9	0	0	0	0	0	3	67	53	15	2	0	0	2		551	7.0	6556	83.2
～ 2.2		28	196	3	0	0	0	0	0	2	41	29	21	2	0	0	0		322	4.1	6878	87.3
～ 2.4		20	130	3	0	0	0	2	0	4	33	20	17	0	2	0	0		231	2.9	7109	90.3
～ 2.6		22	123	0	0	0	0	0	0	2	8	10	16	0	2	0	0		183	2.3	7292	92.6
～ 2.8		12	87	0	0	0	0	0	0	0	2	11	5	0	0	0	0		117	1.5	7409	94.1
～ 3.0		23	83	2	0	0	0	0	0	0	2	5	1	0	0	0	0		116	1.5	7525	95.5
～ 3.2		10	46	0	0	0	0	0	0	0	1	5	0	0	0	0	0		62	0.8	7587	96.3
～ 3.4		13	56	0	0	0	0	0	0	0	0	2	0	0	0	0	0		71	0.9	7658	97.2
～ 3.6		2	59	0	0	0	0	0	0	0	0	0	0	0	0	1	0		62	0.8	7720	98.0
～ 3.8		0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0		17	0.2	7737	98.2
～ 4.0		0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0		21	0.3	7758	98.5
～ 4.2		0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0		26	0.3	7784	98.8
～ 4.4		0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0		27	0.3	7811	99.2
～ 4.6		0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0		32	0.4	7843	99.6
～ 4.8		0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0		12	0.2	7855	99.7
～ 5.0		0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0		15	0.2	7870	99.9
5.0 ～		0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0		6	0.1	7876	100.0
Frequency	(time)	949	4464	366	64	46	24	22	86	117	543	708	372	55	17	10	33	0	7876	100.0		
	(%)	12.0	56.7	4.6	0.8	0.6	0.3	0.3	1.1	1.5	6.9	9.0	4.7	0.7	0.2	0.1	0.4	0.0	100.0			

Source : Met Offcice (UK)

Table A1.2.5 Seasonal Compound Frequency Table by Wave Height and Direction
(December ~ February: 2000 ~ 2010)

Mekong ERR : 120

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		0	0	0.0	0	0.0
~ 0.2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	0	0.0
~ 0.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	0	0.0
~ 0.6		0	16	51	0	0	0	0	0	0	0	0	0	0	0	0	0		67	0.9	67	0.9
~ 0.8		7	159	40	11	0	0	0	0	0	0	0	0	0	0	0	0		217	2.8	284	3.6
~ 1.0		13	238	61	0	0	0	0	0	0	0	0	0	2	0	0	0		314	4.0	598	7.7
~ 1.2		10	314	97	2	0	0	0	0	0	0	0	0	0	0	0	0		423	5.4	1021	13.1
~ 1.4		23	324	92	0	0	0	0	0	0	0	0	0	0	2	0	2		443	5.7	1464	18.8
~ 1.6		22	466	77	0	0	0	0	0	0	0	0	0	0	0	0	0		565	7.2	2029	26.0
~ 1.8		27	429	44	1	0	0	0	0	0	0	0	0	0	0	2	0		503	6.4	2532	32.4
~ 2.0		26	575	36	0	0	0	0	0	0	0	0	0	0	0	0	0		637	8.2	3169	40.6
~ 2.2		21	627	9	0	1	1	0	0	0	1	0	0	0	2	0	1		663	8.5	3832	49.1
~ 2.4		41	540	5	0	0	0	0	0	0	0	0	0	0	0	0	0		586	7.5	4418	56.6
~ 2.6		19	532	9	0	0	0	0	0	0	0	0	0	1	1	0	7		569	7.3	4987	63.9
~ 2.8		32	361	8	0	0	0	0	0	0	0	0	0	0	0	0	1		402	5.1	5389	69.0
~ 3.0		42	432	4	0	0	0	0	0	0	0	0	0	0	0	0	1		479	6.1	5868	75.2
~ 3.2		40	399	8	0	0	0	0	0	0	0	0	0	0	0	0	1		448	5.7	6316	80.9
~ 3.4		32	337	3	0	0	0	0	0	0	0	0	0	0	0	0	0		372	4.8	6688	85.7
~ 3.6		17	303	1	0	0	0	0	0	0	0	0	0	0	0	0	0		321	4.1	7009	89.8
~ 3.8		15	183	0	0	0	0	0	0	0	0	0	0	0	0	0	0		198	2.5	7207	92.3
~ 4.0		4	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0		165	2.1	7372	94.4
~ 4.2		0	128	1	0	0	0	0	0	0	0	0	0	0	0	0	0		129	1.7	7501	96.1
~ 4.4		1	87	1	0	0	0	0	0	0	0	0	0	0	0	0	0		89	1.1	7590	97.2
~ 4.6		0	67	1	0	0	0	0	0	0	0	0	0	0	0	0	0		68	0.9	7658	98.1
~ 4.8		0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0		56	0.7	7714	98.8
~ 5.0		1	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0		39	0.5	7753	99.3
5.0 ~		2	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0		53	0.7	7806	100.0
Frequency	(time)	395	6823	548	14	1	1	0	0	0	1	0	0	3	5	2	13	0	7806	100.0		
	(%)	5.1	87.4	7.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	100.0			

Source : Met Offcice (UK)

1.3 Wave Data at ST.1

Table A1.3.1 Yearly Compound Frequency Table by Wave Height and Direction (2000 ~ 2010)

Mekong ERR : 640

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		1201	1201	3.8	1201	3.8
~ 0.1		0	0	14	20	18	21	2	6	3	4	0	0	0	0	0	0		88	0.3	1289	4.1
~ 0.2		0	30	102	95	30	20	16	21	32	34	17	0	0	0	0	0		397	1.3	1686	5.4
~ 0.3		0	40	72	12	15	9	5	12	40	35	7	0	0	0	0	0		247	0.8	1933	6.2
~ 0.4		4	155	173	8	15	8	8	20	32	85	19	0	0	0	0	0		527	1.7	2460	7.8
~ 0.5		13	370	353	37	22	11	15	118	170	225	52	0	0	0	0	0		1386	4.4	3846	12.2
~ 0.6		17	846	533	114	25	11	16	84	180	279	67	0	0	0	0	0		2172	6.9	6018	19.2
~ 0.7		26	865	427	62	16	2	16	42	224	351	79	0	0	0	0	0		2110	6.7	8128	25.9
~ 0.8		24	1029	518	51	14	4	5	50	190	349	88	0	0	0	0	0		2322	7.4	10450	33.3
~ 0.9		14	836	319	46	9	4	5	34	213	441	174	0	0	0	0	0		2095	6.7	12545	39.9
~ 1.0		17	875	374	50	0	2	0	29	190	524	176	0	0	0	0	0		2237	7.1	14782	47.1
~ 1.1		3	795	383	37	2	0	0	12	150	318	105	0	0	0	0	0		1805	5.7	16587	52.8
~ 1.2		16	624	262	5	0	0	0	6	100	261	98	0	0	0	0	0		1372	4.4	17959	57.2
~ 1.3		11	528	223	6	0	0	0	1	79	143	79	0	0	0	0	0		1070	3.4	19029	60.6
~ 1.4		8	638	267	5	0	0	0	6	65	204	82	0	0	0	0	0		1275	4.1	20304	64.7
~ 1.5		3	465	208	2	0	0	0	5	58	199	68	0	0	0	0	0		1008	3.2	21312	67.9
~ 1.6		7	414	143	2	0	0	0	0	101	281	88	0	0	0	0	0		1036	3.3	22348	71.2
~ 1.8		15	1024	334	1	0	0	0	0	106	243	72	0	0	0	0	0		1795	5.7	24143	76.9
~ 2.0		6	1031	157	2	0	0	1	0	59	151	50	0	0	0	0	0		1457	4.6	25600	81.5
~ 2.2		5	983	92	1	0	1	1	0	26	65	36	0	0	0	0	0		1210	3.9	26810	85.4
~ 2.4		8	792	54	1	0	0	0	0	12	41	18	0	0	0	0	0		926	2.9	27736	88.3
~ 2.5		5	316	14	0	0	0	0	0	7	8	5	0	0	0	0	0		355	1.1	28091	89.4
~ 3.0		21	1490	46	0	0	0	0	0	11	19	11	0	0	0	0	0		1598	5.1	29689	94.5
~ 3.5		0	951	17	0	0	0	0	0	0	0	0	0	0	0	0	0		968	3.1	30657	97.6
~ 4.0		0	415	5	0	0	0	0	0	0	0	0	0	0	0	0	0		420	1.3	31077	99.0
~ 5.0		0	321	3	0	0	0	0	0	0	0	0	0	0	0	0	0		324	1.0	31401	100.0
5.0 ~		0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0		5	0.0	31406	100.0
Frequency	(time)	223	15838	5093	557	166	93	90	446	2048	4260	1391	0	0	0	0	0	1201	31406	100.0		
	(%)	0.7	50.4	16.2	1.8	0.5	0.3	0.3	1.4	6.5	13.6	4.4	0.0	0.0	0.0	0.0	0.0	3.8	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.3.2 Seasonal Compound Frequency Table by Wave Height and Direction (March ~ May: 2000 ~ 2010)

Mekong ERR : 284

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		162	162	2.1	162	2.1
~ 0.1		0	0	5	1	1	0	0	1	1	0	0	0	0	0	0	0		9	0.1	171	2.2
~ 0.2		0	1	45	2	2	1	1	3	3	5	0	0	0	0	0	0		63	0.8	234	3.0
~ 0.3		0	14	47	0	6	3	3	2	15	2	1	0	0	0	0	0		93	1.2	327	4.2
~ 0.4		0	66	69	1	0	0	0	3	9	1	4	0	0	0	0	0		153	2.0	480	6.2
~ 0.5		2	193	160	26	6	6	2	27	53	26	10	0	0	0	0	0		511	6.6	991	12.8
~ 0.6		7	511	315	93	11	5	0	19	31	49	8	0	0	0	0	0		1049	13.6	2040	26.4
~ 0.7		6	470	239	44	8	0	0	7	46	63	12	0	0	0	0	0		895	11.6	2935	37.9
~ 0.8		11	472	246	32	5	0	2	12	36	51	12	0	0	0	0	0		879	11.4	3814	49.3
~ 0.9		5	418	161	37	2	2	0	2	32	67	31	0	0	0	0	0		757	9.8	4571	59.1
~ 1.0		3	320	152	40	0	0	0	0	8	52	22	0	0	0	0	0		597	7.7	5168	66.8
~ 1.1		0	203	171	33	2	0	0	0	8	20	7	0	0	0	0	0		444	5.7	5612	72.5
~ 1.2		0	165	114	5	0	0	0	2	3	13	5	0	0	0	0	0		307	4.0	5919	76.5
~ 1.3		2	115	99	4	0	0	0	0	0	6	14	0	0	0	0	0		240	3.1	6159	79.6
~ 1.4		0	170	97	3	0	0	0	0	0	5	6	0	0	0	0	0		281	3.6	6440	83.2
~ 1.5		0	94	89	2	0	0	0	1	1	5	5	0	0	0	0	0		197	2.5	6637	85.7
~ 1.6		0	38	65	0	0	0	0	0	6	10	3	0	0	0	0	0		122	1.6	6759	87.3
~ 1.8		0	125	109	0	0	0	0	0	3	5	1	0	0	0	0	0		243	3.1	7002	90.5
~ 2.0		0	140	35	1	0	0	0	0	1	7	0	0	0	0	0	0		184	2.4	7186	92.8
~ 2.2		0	125	16	1	0	0	0	0	0	8	2	0	0	0	0	0		152	2.0	7338	94.8
~ 2.4		0	121	13	0	0	0	0	0	0	0	2	0	0	0	0	0		136	1.8	7474	96.6
~ 2.5		0	42	4	0	0	0	0	0	0	0	0	0	0	0	0	0		46	0.6	7520	97.2
~ 3.0		0	126	6	0	0	0	0	0	0	0	0	0	0	0	0	0		132	1.7	7652	98.9
~ 3.5		0	46	1	0	0	0	0	0	0	0	0	0	0	0	0	0		47	0.6	7699	99.5
~ 4.0		0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0		21	0.3	7720	99.7
~ 5.0		0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0		20	0.3	7740	100.0
5.0 ~		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7740	100.0
Frequency	(time)	36	4016	2258	325	43	17	8	79	256	395	145	0	0	0	0	0	162	7740	100.0		
	(%)	0.5	51.9	29.2	4.2	0.6	0.2	0.1	1.0	3.3	5.1	1.9	0.0	0.0	0.0	0.0	0.0	2.1	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.3.3 Seasonal Compound Frequency Table by Wave Height and Direction (June ~ August: 2000 ~ 2010)

Mekong ERR : 104

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		529	529	6.6	529	6.6
~ 0.1		0	0	2	11	11	15	2	5	2	4	0	0	0	0	0	0		52	0.7	581	7.3
~ 0.2		0	26	8	67	16	13	13	13	29	22	17	0	0	0	0	0		224	2.8	805	10.1
~ 0.3		0	15	16	3	9	3	0	7	21	27	6	0	0	0	0	0		107	1.3	912	11.4
~ 0.4		2	66	68	5	13	5	6	13	15	83	15	0	0	0	0	0		291	3.6	1203	15.1
~ 0.5		9	81	124	10	13	5	10	60	103	183	35	0	0	0	0	0		633	7.9	1836	23.0
~ 0.6		6	109	102	15	7	6	12	42	134	174	42	0	0	0	0	0		649	8.1	2485	31.1
~ 0.7		0	66	59	7	4	2	10	21	153	239	47	0	0	0	0	0		608	7.6	3093	38.7
~ 0.8		1	83	43	7	1	2	1	25	144	229	49	0	0	0	0	0		585	7.3	3678	46.1
~ 0.9		2	38	42	5	1	0	0	24	149	301	83	0	0	0	0	0		645	8.1	4323	54.1
~ 1.0		2	53	47	7	0	0	0	29	165	396	106	0	0	0	0	0		805	10.1	5128	64.2
~ 1.1		0	33	26	0	0	0	0	11	127	245	64	0	0	0	0	0		506	6.3	5634	70.6
~ 1.2		0	21	21	0	0	0	0	4	90	210	69	0	0	0	0	0		415	5.2	6049	75.8
~ 1.3		0	7	10	0	0	0	0	1	74	104	44	0	0	0	0	0		240	3.0	6289	78.8
~ 1.4		0	16	21	0	0	0	0	6	59	163	43	0	0	0	0	0		308	3.9	6597	82.6
~ 1.5		0	3	10	0	0	0	0	4	50	147	40	0	0	0	0	0		254	3.2	6851	85.8
~ 1.6		0	4	8	0	0	0	0	0	86	217	70	0	0	0	0	0		385	4.8	7236	90.6
~ 1.8		0	5	20	0	0	0	0	0	81	181	55	0	0	0	0	0		342	4.3	7578	94.9
~ 2.0		0	1	23	0	0	0	0	0	37	99	33	0	0	0	0	0		193	2.4	7771	97.3
~ 2.2		0	0	15	0	0	0	0	0	23	41	29	0	0	0	0	0		108	1.4	7879	98.7
~ 2.4		0	0	1	0	0	0	0	0	12	35	8	0	0	0	0	0		56	0.7	7935	99.4
~ 2.5		0	0	0	0	0	0	0	0	7	7	2	0	0	0	0	0		16	0.2	7951	99.6
~ 3.0		0	0	0	0	0	0	0	0	11	18	4	0	0	0	0	0		33	0.4	7984	100.0
~ 3.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 4.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 5.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
5.0 ~		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
Frequency	(time)	22	627	666	137	75	51	54	265	1572	3125	861	0	0	0	0	0	529	7984	100.0		
	(%)	0.3	7.9	8.3	1.7	0.9	0.6	0.7	3.3	19.7	39.1	10.8	0.0	0.0	0.0	0.0	0.0	6.6	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.3.4 Seasonal Compound Frequency Table by Wave Height and Direction (September ~ November: 2000 ~ 2010)

Mekong ERR : 132

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		487	487	6.2	487	6.2
~ 0.1		0	0	7	8	6	6	0	0	0	0	0	0	0	0	0	0		27	0.3	514	6.5
~ 0.2		0	3	49	26	12	6	2	5	0	7	0	0	0	0	0	0		110	1.4	624	7.9
~ 0.3		0	11	9	9	0	3	2	3	4	6	0	0	0	0	0	0		47	0.6	671	8.5
~ 0.4		2	23	36	2	2	3	2	4	8	1	0	0	0	0	0	0		83	1.1	754	9.6
~ 0.5		2	96	49	0	3	0	3	31	14	16	7	0	0	0	0	0		221	2.8	975	12.4
~ 0.6		4	206	70	4	7	0	4	23	15	56	17	0	0	0	0	0		406	5.2	1381	17.5
~ 0.7		20	262	90	7	4	0	6	14	25	49	20	0	0	0	0	0		497	6.3	1878	23.8
~ 0.8		12	360	200	3	8	2	2	13	10	69	27	0	0	0	0	0		706	9.0	2584	32.8
~ 0.9		7	260	68	4	6	2	5	8	32	73	60	0	0	0	0	0		525	6.7	3109	39.5
~ 1.0		12	392	97	3	0	2	0	0	17	76	48	0	0	0	0	0		647	8.2	3756	47.7
~ 1.1		3	376	85	2	0	0	0	1	15	53	34	0	0	0	0	0		569	7.2	4325	54.9
~ 1.2		10	294	39	0	0	0	0	0	7	38	24	0	0	0	0	0		412	5.2	4737	60.1
~ 1.3		8	233	32	2	0	0	0	0	5	33	21	0	0	0	0	0		334	4.2	5071	64.4
~ 1.4		8	234	48	0	0	0	0	0	6	36	33	0	0	0	0	0		365	4.6	5436	69.0
~ 1.5		1	181	33	0	0	0	0	0	7	47	23	0	0	0	0	0		292	3.7	5728	72.7
~ 1.6		2	190	13	2	0	0	0	0	9	54	15	0	0	0	0	0		285	3.6	6013	76.3
~ 1.8		9	410	42	0	0	0	0	0	22	56	16	0	0	0	0	0		555	7.0	6568	83.4
~ 2.0		5	270	16	0	0	0	1	0	21	45	17	0	0	0	0	0		375	4.8	6943	88.2
~ 2.2		1	182	8	0	0	0	1	0	3	16	5	0	0	0	0	0		216	2.7	7159	90.9
~ 2.4		2	136	11	0	0	0	0	0	0	6	8	0	0	0	0	0		163	2.1	7322	93.0
~ 2.5		2	64	3	0	0	0	0	0	0	1	3	0	0	0	0	0		73	0.9	7395	93.9
~ 3.0		5	198	6	0	0	0	0	0	0	1	7	0	0	0	0	0		217	2.8	7612	96.6
~ 3.5		0	124	4	0	0	0	0	0	0	0	0	0	0	0	0	0		128	1.6	7740	98.3
~ 4.0		0	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0		66	0.8	7806	99.1
~ 5.0		0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0		70	0.9	7876	100.0
5.0 ~		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7876	100.0
Frequency	(time)	115	4641	1015	72	48	24	28	102	220	739	385	0	0	0	0	0	487	7876	100.0		
	(%)	1.5	58.9	12.9	0.9	0.6	0.3	0.4	1.3	2.8	9.4	4.9	0.0	0.0	0.0	0.0	0.0	6.2	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.3.5 Seasonal Compound Frequency Table by Wave Height and Direction (December ~ February: 2000 ~ 2010)

Mekong ERR : 120

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		23	23	0.3	23	0.3
~ 0.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.2		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.3		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.5		0	0	20	1	0	0	0	0	0	0	0	0	0	0	0	0		21	0.3	44	0.6
~ 0.6		0	20	46	2	0	0	0	0	0	0	0	0	0	0	0	0		68	0.9	112	1.4
~ 0.7		0	67	39	4	0	0	0	0	0	0	0	0	0	0	0	0		110	1.4	222	2.8
~ 0.8		0	114	29	9	0	0	0	0	0	0	0	0	0	0	0	0		152	1.9	374	4.8
~ 0.9		0	120	48	0	0	0	0	0	0	0	0	0	0	0	0	0		168	2.2	542	6.9
~ 1.0		0	110	78	0	0	0	0	0	0	0	0	0	0	0	0	0		188	2.4	730	9.4
~ 1.1		0	183	101	2	0	0	0	0	0	0	0	0	0	0	0	0		286	3.7	1016	13.0
~ 1.2		6	144	88	0	0	0	0	0	0	0	0	0	0	0	0	0		238	3.0	1254	16.1
~ 1.3		1	173	82	0	0	0	0	0	0	0	0	0	0	0	0	0		256	3.3	1510	19.3
~ 1.4		0	218	101	2	0	0	0	0	0	0	0	0	0	0	0	0		321	4.1	1831	23.5
~ 1.5		2	187	76	0	0	0	0	0	0	0	0	0	0	0	0	0		265	3.4	2096	26.9
~ 1.6		5	182	57	0	0	0	0	0	0	0	0	0	0	0	0	0		244	3.1	2340	30.0
~ 1.8		6	484	163	1	0	0	0	0	0	1	0	0	0	0	0	0		655	8.4	2995	38.4
~ 2.0		1	620	83	1	0	0	0	0	0	0	0	0	0	0	0	0		705	9.0	3700	47.4
~ 2.2		4	676	53	0	0	1	0	0	0	0	0	0	0	0	0	0		734	9.4	4434	56.8
~ 2.4		6	535	29	1	0	0	0	0	0	0	0	0	0	0	0	0		571	7.3	5005	64.1
~ 2.5		3	210	7	0	0	0	0	0	0	0	0	0	0	0	0	0		220	2.8	5225	66.9
~ 3.0		16	1166	34	0	0	0	0	0	0	0	0	0	0	0	0	0		1216	15.6	6441	82.5
~ 3.5		0	781	12	0	0	0	0	0	0	0	0	0	0	0	0	0		793	10.2	7234	92.7
~ 4.0		0	328	5	0	0	0	0	0	0	0	0	0	0	0	0	0		333	4.3	7567	96.9
~ 5.0		0	231	3	0	0	0	0	0	0	0	0	0	0	0	0	0		234	3.0	7801	99.9
5.0 ~		0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0		5	0.1	7806	100.0
Frequency	(time)	50	6554	1154	23	0	1	0	0	0	1	0	0	0	0	0	0	23	7806	100.0		
	(%)	0.6	84.0	14.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

1.4 Wave Data at ST.2

Table A1.4.1 Yearly Compound Frequency Table by Wave Height and Direction (2000 ~ 2010)

Mekong ERR : 640

Deg. / H(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																	1201	1201	3.8	1201	3.8
~ 0.1	0	0	24	52	23	23	2	12	36	1	0	0	0	0	0	0		173	0.6	1374	4.4
~ 0.2	0	0	122	91	57	21	17	56	90	4	0	0	0	0	0	0		458	1.5	1832	5.8
~ 0.3	0	24	322	18	15	11	6	61	264	23	0	0	0	0	0	0		744	2.4	2576	8.2
~ 0.4	0	66	806	96	23	9	17	187	504	41	0	0	0	0	0	0		1749	5.6	4325	13.8
~ 0.5	0	170	1853	205	35	12	21	298	847	46	0	0	0	0	0	0		3487	11.1	7812	24.9
~ 0.6	0	173	1422	144	34	11	27	322	949	71	0	0	0	0	0	0		3153	10.0	10965	34.9
~ 0.7	0	201	1580	122	26	4	11	213	790	57	0	0	0	0	0	0		3004	9.6	13969	44.5
~ 0.8	0	184	1184	143	22	3	3	155	544	40	0	0	0	0	0	0		2278	7.3	16247	51.7
~ 0.9	0	160	1107	101	9	6	5	144	534	34	0	0	0	0	0	0		2100	6.7	18347	58.4
~ 1.0	0	87	918	92	2	2	0	62	380	32	0	0	0	0	0	0		1575	5.0	19922	63.4
~ 1.1	0	66	843	51	0	0	0	84	327	13	0	0	0	0	0	0		1384	4.4	21306	67.8
~ 1.2	0	79	920	42	0	0	0	61	267	13	0	0	0	0	0	0		1382	4.4	22688	72.2
~ 1.3	0	58	715	21	0	0	0	47	147	10	0	0	0	0	0	0		998	3.2	23686	75.4
~ 1.4	0	74	889	10	0	0	0	31	116	6	0	0	0	0	0	0		1126	3.6	24812	79.0
~ 1.5	0	46	688	8	0	0	0	19	45	3	0	0	0	0	0	0		809	2.6	25621	81.6
~ 1.6	0	47	735	7	0	0	0	7	42	1	0	0	0	0	0	0		839	2.7	26460	84.3
~ 1.8	0	103	1062	4	0	0	0	11	40	0	0	0	0	0	0	0		1220	3.9	27680	88.1
~ 2.0	0	86	819	3	1	1	2	5	18	0	0	0	0	0	0	0		935	3.0	28615	91.1
~ 2.2	0	119	669	4	0	0	0	2	5	0	0	0	0	0	0	0		799	2.5	29414	93.7
~ 2.4	0	98	593	3	0	0	0	0	0	0	0	0	0	0	0	0		694	2.2	30108	95.9
~ 2.5	0	40	186	1	0	0	0	0	0	0	0	0	0	0	0	0		227	0.7	30335	96.6
~ 3.0	0	41	663	4	0	0	0	0	0	0	0	0	0	0	0	0		708	2.3	31043	98.8
~ 3.5	0	25	275	1	0	0	0	0	0	0	0	0	0	0	0	0		301	1.0	31344	99.8
~ 4.0	0	12	48	0	0	0	0	0	0	0	0	0	0	0	0	0		60	0.2	31404	100.0
~ 5.0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0		2	0.0	31406	100.0
5.0 ~	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	31406	100.0
Frequency (time)	0	1959	18445	1223	247	103	111	1777	5945	395	0	0	0	0	0	0	1201	31406	100.0		
Frequency (%)	0.0	6.2	58.7	3.9	0.8	0.3	0.4	5.7	18.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0	3.8	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.4.2 Seasonal Compound Frequency Table by Wave Height and Direction (March ~ May: 2000 ~ 2010)

Mekong ERR : 284

Deg. / H(m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																	162	162	2.1	162	2.1
~ 0.1	0	0	12	5	1	0	0	4	5	0	0	0	0	0	0	0		27	0.3	189	2.4
~ 0.2	0	0	31	30	2	1	1	11	6	2	0	0	0	0	0	0		84	1.1	273	3.5
~ 0.3	0	8	134	13	6	3	3	17	25	8	0	0	0	0	0	0		217	2.8	490	6.3
~ 0.4	0	24	363	58	0	0	4	39	72	5	0	0	0	0	0	0		565	7.3	1055	13.6
~ 0.5	0	68	1088	155	14	6	2	69	173	5	0	0	0	0	0	0		1580	20.4	2635	34.0
~ 0.6	0	61	678	118	18	5	0	50	105	16	0	0	0	0	0	0		1051	13.6	3686	47.6
~ 0.7	0	56	757	75	11	0	2	34	85	4	0	0	0	0	0	0		1024	13.2	4710	60.9
~ 0.8	0	34	423	109	8	0	0	11	33	3	0	0	0	0	0	0		621	8.0	5331	68.9
~ 0.9	0	28	338	75	2	2	0	2	32	0	0	0	0	0	0	0		479	6.2	5810	75.1
~ 1.0	0	14	285	63	2	0	0	4	6	0	0	0	0	0	0	0		374	4.8	6184	79.9
~ 1.1	0	3	246	30	0	0	0	2	8	0	0	0	0	0	0	0		289	3.7	6473	83.6
~ 1.2	0	8	204	18	0	0	0	3	7	0	0	0	0	0	0	0		240	3.1	6713	86.7
~ 1.3	0	5	127	8	0	0	0	5	6	1	0	0	0	0	0	0		152	2.0	6865	88.7
~ 1.4	0	6	166	3	0	0	0	0	4	1	0	0	0	0	0	0		180	2.3	7045	91.0
~ 1.5	0	5	109	3	0	0	0	0	6	0	0	0	0	0	0	0		123	1.6	7168	92.6
~ 1.6	0	2	125	1	0	0	0	0	2	0	0	0	0	0	0	0		130	1.7	7298	94.3
~ 1.8	0	2	141	1	0	0	0	0	0	0	0	0	0	0	0	0		144	1.9	7442	96.1
~ 2.0	0	9	113	1	0	0	0	0	0	0	0	0	0	0	0	0		123	1.6	7565	97.7
~ 2.2	0	5	55	0	0	0	0	0	0	0	0	0	0	0	0	0		60	0.8	7625	98.5
~ 2.4	0	5	40	0	0	0	0	0	0	0	0	0	0	0	0	0		45	0.6	7670	99.1
~ 2.5	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0		16	0.2	7686	99.3
~ 3.0	0	1	30	0	0	0	0	0	0	0	0	0	0	0	0	0		31	0.4	7717	99.7
~ 3.5	0	2	17	0	0	0	0	0	0	0	0	0	0	0	0	0		19	0.2	7736	99.9
~ 4.0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0		4	0.1	7740	100.0
~ 5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7740	100.0
5.0 ~	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7740	100.0
Frequency (time)	0	346	5502	766	64	17	12	251	575	45	0	0	0	0	0	0	162	7740	100.0		
Frequency (%)	0.0	4.5	71.1	9.9	0.8	0.2	0.2	3.2	7.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	2.1	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.4.3 Seasonal Compound Frequency Table by Wave Height and Direction (June ~ August: 2000 ~ 2010)

Mekong ERR : 104

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		529	529	6.6	529	6.6
~ 0.1		0	0	0	29	16	16	2	8	27	1	0	0	0	0	0	0		99	1.2	628	7.9
~ 0.2		0	0	45	39	28	15	14	37	74	2	0	0	0	0	0	0		254	3.2	882	11.0
~ 0.3		0	11	130	1	9	3	0	33	228	12	0	0	0	0	0	0		427	5.3	1309	16.4
~ 0.4		0	21	226	26	19	7	13	116	343	25	0	0	0	0	0	0		796	10.0	2105	26.4
~ 0.5		0	14	241	21	11	6	11	195	516	20	0	0	0	0	0	0		1035	13.0	3140	39.3
~ 0.6		0	8	127	3	12	6	16	218	648	38	0	0	0	0	0	0		1076	13.5	4216	52.8
~ 0.7		0	6	127	13	9	4	8	155	586	39	0	0	0	0	0	0		947	11.9	5163	64.7
~ 0.8		0	10	95	12	2	1	1	127	401	23	0	0	0	0	0	0		672	8.4	5835	73.1
~ 0.9		0	1	42	8	3	0	0	134	405	16	0	0	0	0	0	0		609	7.6	6444	80.7
~ 1.0		0	1	37	0	0	0	0	49	307	24	0	0	0	0	0	0		418	5.2	6862	85.9
~ 1.1		0	0	25	0	0	0	0	73	256	7	0	0	0	0	0	0		361	4.5	7223	90.5
~ 1.2		0	0	26	0	0	0	0	49	204	7	0	0	0	0	0	0		286	3.6	7509	94.1
~ 1.3		0	0	14	0	0	0	0	30	101	8	0	0	0	0	0	0		153	1.9	7662	96.0
~ 1.4		0	0	17	0	0	0	0	24	84	0	0	0	0	0	0	0		125	1.6	7787	97.5
~ 1.5		0	0	10	0	0	0	0	18	30	0	0	0	0	0	0	0		58	0.7	7845	98.3
~ 1.6		0	0	8	1	0	0	0	7	31	0	0	0	0	0	0	0		47	0.6	7892	98.8
~ 1.8		0	0	17	0	0	0	0	11	30	0	0	0	0	0	0	0		58	0.7	7950	99.6
~ 2.0		0	0	4	0	0	0	0	5	18	0	0	0	0	0	0	0		27	0.3	7977	99.9
~ 2.2		0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0		7	0.1	7984	100.0
~ 2.4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 2.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 3.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 3.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 4.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
~ 5.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
5.0 ~		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7984	100.0
Frequency	(time)	0	72	1191	153	109	58	65	1291	4294	222	0	0	0	0	0	0	529	7984	100.0		
	(%)	0.0	0.9	14.9	1.9	1.4	0.7	0.8	16.2	53.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	6.6	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.4.4 Seasonal Compound Frequency Table by Wave Height and Direction (September ~ November: 2000 ~ 2010)

Mekong ERR : 132

H(m) \ Deg.		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																		487	487	6.2	487	6.2
~ 0.1		0	0	12	18	6	7	0	0	4	0	0	0	0	0	0	0		47	0.6	534	6.8
~ 0.2		0	0	46	22	27	5	2	8	10	0	0	0	0	0	0	0		120	1.5	654	8.3
~ 0.3		0	5	58	4	0	5	3	11	11	3	0	0	0	0	0	0		100	1.3	754	9.6
~ 0.4		0	21	207	5	4	2	0	32	89	11	0	0	0	0	0	0		371	4.7	1125	14.3
~ 0.5		0	84	420	5	10	0	8	34	158	21	0	0	0	0	0	0		740	9.4	1865	23.7
~ 0.6		0	96	470	12	4	0	11	54	196	17	0	0	0	0	0	0		860	10.9	2725	34.6
~ 0.7		0	122	496	22	4	0	1	24	119	14	0	0	0	0	0	0		802	10.2	3527	44.8
~ 0.8		0	122	456	10	12	2	2	17	110	14	0	0	0	0	0	0		745	9.5	4272	54.2
~ 0.9		0	100	393	5	4	4	5	8	97	18	0	0	0	0	0	0		634	8.0	4906	62.3
~ 1.0		0	60	302	2	0	2	0	9	67	8	0	0	0	0	0	0		450	5.7	5356	68.0
~ 1.1		0	37	263	1	0	0	0	9	63	6	0	0	0	0	0	0		379	4.8	5735	72.8
~ 1.2		0	36	303	3	0	0	0	9	56	6	0	0	0	0	0	0		413	5.2	6148	78.1
~ 1.3		0	33	250	0	0	0	0	12	39	1	0	0	0	0	0	0		335	4.3	6483	82.3
~ 1.4		0	36	239	0	0	0	0	7	28	5	0	0	0	0	0	0		315	4.0	6798	86.3
~ 1.5		0	17	136	2	0	0	0	1	9	3	0	0	0	0	0	0		168	2.1	6966	88.4
~ 1.6		0	15	134	0	0	0	0	0	9	1	0	0	0	0	0	0		159	2.0	7125	90.5
~ 1.8		0	30	175	1	0	0	0	0	10	0	0	0	0	0	0	0		216	2.7	7341	93.2
~ 2.0		0	17	124	0	0	0	2	0	0	0	0	0	0	0	0	0		143	1.8	7484	95.0
~ 2.2		0	16	92	0	0	0	0	0	0	0	0	0	0	0	0	0		108	1.4	7592	96.4
~ 2.4		0	11	67	0	0	0	0	0	0	0	0	0	0	0	0	0		78	1.0	7670	97.4
~ 2.5		0	3	27	0	0	0	0	0	0	0	0	0	0	0	0	0		30	0.4	7700	97.8
~ 3.0		0	3	92	0	0	0	0	0	0	0	0	0	0	0	0	0		95	1.2	7795	99.0
~ 3.5		0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0		75	1.0	7870	99.9
~ 4.0		0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0		6	0.1	7876	100.0
~ 5.0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7876	100.0
5.0 ~		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7876	100.0
Frequency	(time)	0	864	4843	112	71	27	34	235	1075	128	0	0	0	0	0	0	487	7876	100.0		
	(%)	0.0	11.0	61.5	1.4	0.9	0.3	0.4	3.0	13.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0	6.2	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

Table A1.4.5 Seasonal Compound Frequency Table by Wave Height and Direction
(December ~ February: 2000 ~ 2010)

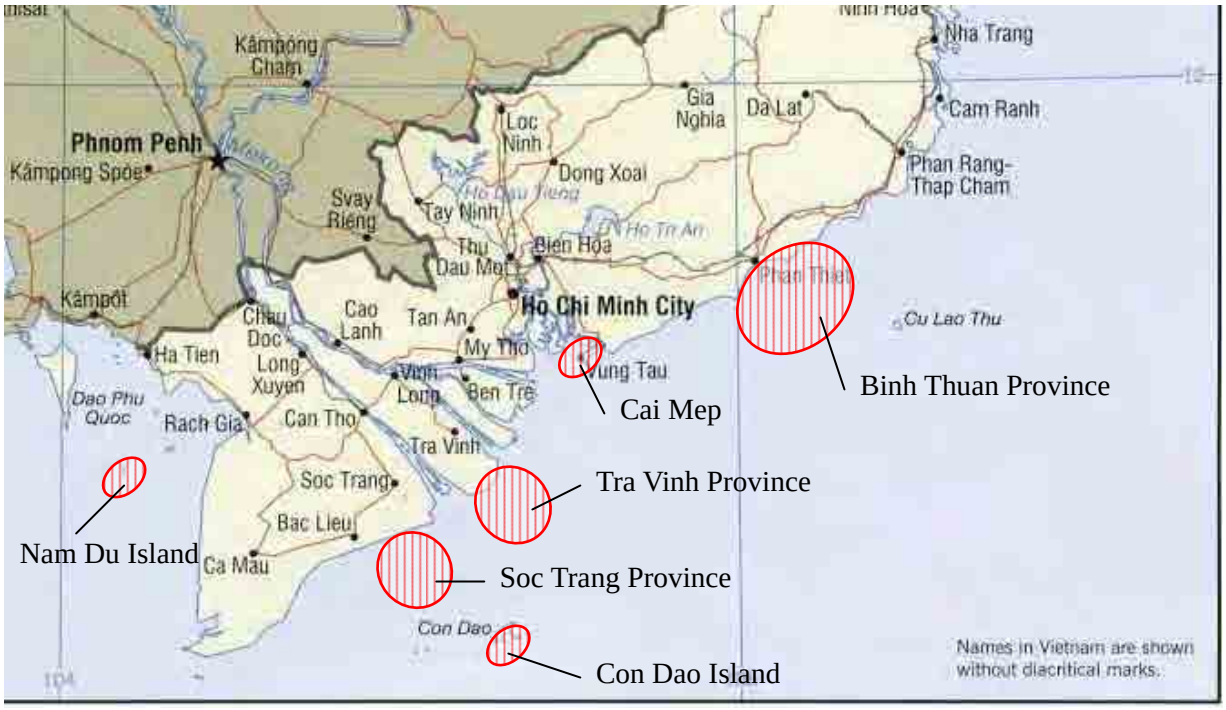
Mekong ERR : 120

H(m) \ Deg.	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM	Frequency (time)	Frequency (%)	over Frequency (time)	over Frequency (%)
CALM																	23	23	0.3	23	0.3
~ 0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	23	0.3
~ 0.4	0	0	10	7	0	0	0	0	0	0	0	0	0	0	0	0		17	0.2	40	0.5
~ 0.5	0	4	104	24	0	0	0	0	0	0	0	0	0	0	0	0		132	1.7	172	2.2
~ 0.6	0	8	147	11	0	0	0	0	0	0	0	0	0	0	0	0		166	2.1	338	4.3
~ 0.7	0	17	200	12	2	0	0	0	0	0	0	0	0	0	0	0		231	3.0	569	7.3
~ 0.8	0	18	210	12	0	0	0	0	0	0	0	0	0	0	0	0		240	3.1	809	10.4
~ 0.9	0	31	334	13	0	0	0	0	0	0	0	0	0	0	0	0		378	4.8	1187	15.2
~ 1.0	0	12	294	27	0	0	0	0	0	0	0	0	0	0	0	0		333	4.3	1520	19.5
~ 1.1	0	26	309	20	0	0	0	0	0	0	0	0	0	0	0	0		355	4.5	1875	24.0
~ 1.2	0	35	387	21	0	0	0	0	0	0	0	0	0	0	0	0		443	5.7	2318	29.7
~ 1.3	0	20	324	13	0	0	0	0	1	0	0	0	0	0	0	0		358	4.6	2676	34.3
~ 1.4	0	32	467	7	0	0	0	0	0	0	0	0	0	0	0	0		506	6.5	3182	40.8
~ 1.5	0	24	433	3	0	0	0	0	0	0	0	0	0	0	0	0		460	5.9	3642	46.7
~ 1.6	0	30	468	5	0	0	0	0	0	0	0	0	0	0	0	0		503	6.4	4145	53.1
~ 1.8	0	71	729	2	0	0	0	0	0	0	0	0	0	0	0	0		802	10.3	4947	63.4
~ 2.0	0	60	578	2	1	1	0	0	0	0	0	0	0	0	0	0		642	8.2	5589	71.6
~ 2.2	0	98	522	4	0	0	0	0	0	0	0	0	0	0	0	0		624	8.0	6213	79.6
~ 2.4	0	82	486	3	0	0	0	0	0	0	0	0	0	0	0	0		571	7.3	6784	86.9
~ 2.5	0	37	143	1	0	0	0	0	0	0	0	0	0	0	0	0		181	2.3	6965	89.2
~ 3.0	0	37	541	4	0	0	0	0	0	0	0	0	0	0	0	0		582	7.5	7547	96.7
~ 3.5	0	23	183	1	0	0	0	0	0	0	0	0	0	0	0	0		207	2.7	7754	99.3
~ 4.0	0	12	38	0	0	0	0	0	0	0	0	0	0	0	0	0		50	0.6	7804	100.0
~ 5.0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0		2	0.0	7806	100.0
5.0 ~	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0	7806	100.0
Frequency (time)	0	677	6909	192	3	1	0	0	1	0	0	0	0	0	0	0	23	7806	100.0		
Frequency (%)	0.0	8.7	88.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	100.0			

Source : Wave deformation calculation was conducted by subletting contract based on Met Offcice data.

2. Environmental Consideration

2.1 Project Site



2.2 Photo

Con Dau Island

	
Beach of Sea Tutle Laying Eggs	Hatch of Sea Turtle
	
Coastal area of Island	Seaside Street in Tourism Area
	
Existing Jetty	Swallow’s Cave

Soc Trang

	
Planted Mangrove by GIZ	Planted Mangrove by GIZ
	
Existing Mangrove Forest	View of Coastal Area
	
Rice Field (Hinterland)	Fishpond for Cultivation (Hinterland)

Tra Vinh

	
Coastal Area of Proposed Site	Coastal Area of Proposed Site
	
Existing Jetty at Branch of Mekong River	Fixed Shore Net
	
Farmer's House at Inland	Fish Pond for Cultivation

Cai Mep

	
View of Proposed Site	View of Proposed Site
	
Existing Jetty at River	Existing Jetty at River
	
Fixed Shore Net in the River	Tourism Area in Bay

2.3 Matrix for Scoping

Site: Con Dao

Name of Cooperation Project			Imported Coal Transshipemt Terminal Project												
				Planning Phase		Construction Phase					Operation Phase				
	No.	Likely Impacts	Overall Rating	Land acquisition	Change of fishing zones, Land use, Restriction of activities	Reclamation of coastlines	Deforestation in coastlines	Alteration to ground by cut land, filling, drilling, etc.	Construction of Moorings, Seawalls, Water facilities, etc.	Operation of Construction Equipment and Vehicles	Drainage	Sailing/ Arrival & Departure of Ship	Operation of Port Facilities	Increase of Traffic Volume	Appearance/ Occupancy of Building Structure
Social Environment * the impacts on "Gender" and "Children's Right" might be related to all criteria of Social Environment.	1	Involuntary Resettlement	C	C	-	-	-	-	-	-	-	-	-	-	-
	2	Local economy such as employment and livelihood, etc.	A	-	-	-	-	A	B	B	-	B	+B	B	-
	3	Land use and utilization of local resources	A	B	-	B	-	A	B	B	-	-	B	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	Existing social infrastructures and services	B	-	-	-	-	-	-	C	-	-	-	B	-
	6	The poor, indigenous and ethnic people	C	C	-	-	-	-	-	-	-	-	-	-	-
	7	Misdistribution of benefit and damage	-	-	-	-	-	-	-	-	-	-	-	-	-
	8	Cultural heritage	B	-	-	-	-	-	-	-	-	-	-	-	B
	9	Local conflict of interests	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	Water Usage or Water Rights and Rights of Common	B	-	-	-	-	-	B	-	-	-	B	-	-
	11	Sanitation	-	-	-	-	-	-	-	-	-	-	-	-	-
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	-	-	-	-	-	B	-	-	-	-	-	-
Natural Environment	13	Topography and Geographical features	C	-	-	C	-	C	C	-	-	-	-	-	-
	14	Soil Erosion	C	-	-	C	-	C	C	-	-	-	-	-	-
	15	Groundwater	-	-	-	-	-	-	-	-	-	-	-	-	-
	16	Hydrological Situation	-	-	-	-	-	-	-	-	-	-	-	-	-
	17	Coastal Zone	B	-	-	B	B	B	B	B	-	B	-	-	-
	18	Flora, Fauna and Biodiversity	A	-	-	A	A	A	A	A	-	B	-	-	-
	19	Meteorology	B	-	-	-	-	-	-	-	-	-	B	-	-
	20	Landscape	A	-	-	A	A	A	A	A	-	-	-	-	-
	21	Global Warming	-	-	-	C	C	C	C	-	-	-	C	-	-
Pollution	22	Air Pollution	C	-	-	-	-	-	C	C	-	-	B	-	-
	23	Water Pollution	B	-	-	C	-	-	B	C	-	-	-	-	-
	24	Soil Contamination	B	-	-	B	-	-	-	-	-	-	-	-	-
	25	Waste	C	-	-	-	-	-	C	-	-	-	C		-
	26	Noise and Vibration	B	-	-	-	-	-	C	-	-	-	C	B	-

	27	Ground Subsidence	C	-	-	C	-	-	-	-	-	-	-	-	-
	28	Offensive Odor	-	-	-	-	-	-	-	-	-	-	-	-	-
	29	Bottom sediment	C	-	-	-	-	-	C	-	-	-	-	-	-
	30	Accidents	B	-	-	-	-	-	B	-	-	C	B	B	-

Rating:

A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses)

+ : Positive impact

No mark: No impact is expected.

Reference:

1) Japan International Cooperation Agency (1992) "I Ports and Harbors: Environmental Guidelines for Infrastructure Projects", Tokyo, Japan.

2) Norman Lee and Clive George (2002) "Environmental Assessment in Developing and Transitional Countries", JOHN WILEY & SONS, LTD., London, England.

Site: Soc Trang

Name of Cooperation Project			Imported Coal Transshipemt Terminal Project												
				Planning Phase		Construction Phase					Operation Phase				
	No.	Likely Impacts	Overall Rating	Land acquisition	Change of fishing zones, Land use, Restriction of activities	Reclamation of coastlines	Deforestation in coastlines	Alteration to ground by cut land, filling, drilling, etc.	Construction of Moorings, Seawalls, Water facilities, etc.	Operation of Construction Equipment and Vehicles	Drainage	Sailing/ Arrival & Departure of Ship	Operation of Port Facilities	Increase of Traffic Volume	Appearance/ Occupancy of Building Structure
Social Environment * the impacts on "Gender" and "Children's Right" might be related to all criteria of Social Environment.	1	Involuntary Resettlement	C	C	-	-	-	-	-	-	-	-	-	-	-
	2	Local economy such as employment and livelihood, etc.	B	-	-	-	-	C	B	B	-	B	+B	B	-
	3	Land use and utilization of local resources	A	A	B	B	-	B	B	B	-	-	B	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	Existing social infrastructures and services	B	-	-	-	-	-	-	B	-	-	-	B	-
	6	The poor, indigenous and ethnic people	C	C	-	-	-	-	-	-	-	-	-	-	-
	7	Misdistribution of benefit and damage	-	-	-	-	-	-	-	-	-	-	-	-	-
	8	Cultural heritage	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	Local conflict of interests	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	Water Usage or Water Rights and Rights of Common	B	-	-	-	-	-	-	-	-	B	-	-	-
	11	Sanitation	-	-	-	-	-	-	-	-	-	-	-	-	-
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	-	-	-	-	-	B	-	-	-	-	-	-
Natural Environment	13	Topography and Geographical features	C	-	-	C	-	C	C	-	-	-	-	-	-
	14	Soil Erosion	B	-	-	B	-	B	C	-	-	-	-	-	-
	15	Groundwater	C	-	-	C	-	-	-	-	-	-	C	-	-
	16	Hydrological Situation	C	-	-	-	-	-	C	-	-	-	-	-	-
	17	Coastal Zone	A	-	-	A	A	B	B	-	-	-	-	-	-
	18	Flora, Fauna and Biodiversity	A	-	-	B	A	C	C	-	-	-	-	-	-
	19	Meteorology	-	-	-	-	-	-	-	-	-	-	-	-	-
	20	Landscape	B	-	-	C	C	C	C		-	-	B	-	-
	21	Global Warming	C	-	-	-	-	-	-	-	-	-	C	-	-
Pollution	22	Air Pollution	B	-	-	-	-	-	C	C	-	-	B	-	-
	23	Water Pollution	B	-	-	C	-	-	B	C	-	-	-	-	-
	24	Soil Contamination	B	-	-	B	-	-	-	-	-	-	-	-	-
	25	Waste	C	-	-	-	-	-	C	-	-	-	C	-	-
	26	Noise and Vibration	C	-	-	-	-	-	C	-	-	-	C	-	-
	27	Ground Subsidence	C	-	-	C	-	-	-	-	-	-	-	-	-
	28	Offensive Odor	-	-	-	-	-	-	-	-	-	-	-	-	-

	29	Bottom sediment	C	-	-	-	-	-	C	-	-	-	-	-	-
	30	Accidents	B	-	-	-	-	-	B	-	-	C	B	B	-

Rating:

A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses)

+ : Positive impact

No mark: No impact is expected.

Reference:

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2) Norman Lee and Clive George (2002) “Environmental Assessment in Developing and Transitional Countries”, JOHN WILEY & SONS, LTD., London, England.

Site: Tra Vinh

Name of Cooperation Project			Imported Coal Transshipemt Terminal Project												
				Planning Phase		Construction Phase					Operation Phase				
	No.	Likely Impacts	Overall Rating	Land acquisition	Change of fishing zones, Land use, Restriction of activities	Reclamation of coastlines	Deforestation in coastlines	Alteration to ground by cut land, filling, drilling, etc.	Construction of Moorings, Seawalls, Water facilities, etc.	Operation of Construction Equipment and Vehicles	Drainage	Sailing/ Arrival & Departure of Ship	Operation of Port Facilities	Increase of Traffic Volume	Appearance/ Occupancy of Building Structure
Social Environment * the impacts on "Gender" and "Children's Right" might be related to all criteria of Social Environment.	1	Involuntary Resettlement	B	B	-	-	-	-	-	-	-	-	-	-	-
	2	Local economy such as employment and livelihood, etc.	B	-	-	-	-	C	B	B	-	B	+B	B	-
	3	Land use and utilization of local resources	A	A	C	B	B	B	B	B	-	-	B	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	Existing social infrastructures and services	B	-	-	-	-	-	-	B	-	-	-	B	-
	6	The poor, indigenous and ethnic people	C	C	-	-	-	-	-	-	-	-	-	-	-
	7	Misdistribution of benefit and damage	-	-	-	-	-	-	-	-	-	-	-	-	-
	8	Cultural heritage	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	Local conflict of interests	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	Water Usage or Water Rights and Rights of Common	B	-	-	-	-	-	-	-	-	B	-	-	-
	11	Sanitation	-	-	-	-	-	-	-	-	-	-	-	-	-
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	-	-	-	-	-	B	-	-	-	-	-	-
Natural Environment	13	Topography and Geographical features	C	-	-	C	-	C	C	-	-	-	-	-	-
	14	Soil Erosion	B	-	-	B	-	B	C	-	-	-	-	-	-
	15	Groundwater	C	-	-	C	-	-	-	-	-	-	C	-	-
	16	Hydrological Situation	C	-	-	-	-	-	C	-	-	-	-	-	-
	17	Coastal Zone	B	-	-	B	B	B	B	-	-	-	-	-	-
	18	Flora, Fauna and Biodiversity	A	-	-	B	A	C	C	-	-	-	-	-	-
	19	Meteorology	-	-	-	-	-	-	-	-	-	-	-	-	-
	20	Landscape	B	-	-	C	C	C	C	-	-	-	B	-	-
	21	Global Warming	C	-	-	-	-	-	-	-	-	-	C	-	-
Pollution	22	Air Pollution	B	-	-	-	-	-	C	C	-	-	B	-	-
	23	Water Pollution	B	-	-	C	-	-	B	C	-	-	-	-	-
	24	Soil Contamination	B	-	-	B	-	-	-	-	-	-	-	-	-
	25	Waste	C	-	-	-	-	-	C	-	-	-	C	-	-
	26	Noise and Vibration	C	-	-	-	-	-	C	-	-	-	C	-	-
	27	Ground Subsidence	C	-	-	C	-	-	-	-	-	-	-	-	-
	28	Offensive Odor	-	-	-	-	-	-	-	-	-	-	-	-	-

	29	Bottom sediment	C	-	-	-	-	-	C	-	-	-	-	-	-
	30	Accidents	B	-	-	-	-	-	B	-	-	C	B	B	-

Rating:

A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses)

+ : Positive impact

No mark: No impact is expected.

Reference:

1) Japan International Cooperation Agency (1992) “I Ports and Harbors: Environmental Guidelines for Infrastructure Projects”, Tokyo, Japan.

2) Norman Lee and Clive George (2002) “Environmental Assessment in Developing and Transitional Countries”, JOHN WILEY & SONS, LTD., London, England.

Site: Cai Mep

Name of Cooperation Project			Imported Coal Transshipemt Terminal Project												
				Planning Phase		Construction Phase					Operation Phase				
	No.	Likely Impacts	Overall Rating	Land acquisition	Change of fishing zones, Land use, Restriction of activities	Reclamation of coastlines	Deforestation in coastlines	Alteration to ground by cut land, filling, drilling, etc.	Construction of Moorings, Seawalls, Water facilities, etc.	Operation of Construction Equipment and Vehicles	Drainage	Sailing/ Arrival & Departure of Ship	Operation of Port Facilities	Increase of Traffic Volume	Appearance/ Occupancy of Building Structure
Social Environment * the impacts on "Gender" and "Children's Right" might be related to all criteria of Social Environment.	1	Involuntary Resettlement	B	B	-	-	-	-	-	-	-	-	-	-	-
	2	Local economy such as employment and livelihood, etc.	B	-	-	-	-	C	B	B	-	B	+B	B	-
	3	Land use and utilization of local resources	A	A	C	B	A	B	B	B	-	-	B	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	Existing social infrastructures and services	B	-	-	-	-	-	-	B	-	-	-	B	-
	6	The poor, indigenous and ethnic people	C	C	-	-	-	-	-	-	-	-	-	-	-
	7	Misdistribution of benefit and damage	-	-	-	-	-	-	-	-	-	-	-	-	-
	8	Cultural heritage	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	Local conflict of interests	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	Water Usage or Water Rights and Rights of Common	B	-	-	-	-	-	-	-	-	B	-	-	-
	11	Sanitation	-	-	-	-	-	-	-	-	-	-	-	-	-
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	-	-	-	-	-	B	-	-	-	-	-	-
Natural Environment	13	Topography and Geographical features	C	-	-	C	-	C	C	-	-	-	-	-	-
	14	Soil Erosion	B	-	-	B	-	B	C	-	-	-	-	-	-
	15	Groundwater	C	-	-	C	-	-	-	-	-	-	C	-	-
	16	Hydrological Situation	C	-	-	-	-	-	C	-	-	-	-	-	-
	17	Coastal Zone	B	-	-	B	B	B	B	-	-	-	-	-	-
	18	Flora, Fauna and Biodiversity	A	-	-	B	A	C	C	-	-	-	-	-	-
	19	Meteorology	-	-	-	-	-	-	-	-	-	-	-	-	-
	20	Landscape	B	-	-	C	C	C	C	-	-	-	B	-	-
	21	Global Warming	C	-	-	-	-	-	-	-	-	-	C	-	-
Pollution	22	Air Pollution	B	-	-	-	-	-	C	C	-	-	B	-	-
	23	Water Pollution	B	-	-	C	-	-	B	C	-	-	-	-	-
	24	Soil Contamination	B	-	-	B	-	-	-	-	-	-	-	-	-
	25	Waste	C	-	-	-	-	-	C	-	-		C	-	-
	26	Noise and Vibration	C	-	-	-	-	-	C	-	-	-	C	-	-
	27	Ground Subsidence	C	-	-	C	-	-	-	-	-	-	-	-	-
	28	Offensive Odor	-	-	-	-	-	-	-	-	-	-	-	-	-

	29	Bottom sediment	C	-	-	-	-	-	B	-	-	-	-	-	-
	30	Accidents	B	-	-	-	-	-	B	-	-	C	B	B	-

Rating:

A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses)

+ : Positive impact

No mark: No impact is expected.

Reference:

1) Japan International Cooperation Agency (1992) “I Ports and Harbors: Environmental Guidelines for Infrastructure Projects”, Tokyo, Japan.

2) Norman Lee and Clive George (2002) “Environmental Assessment in Developing and Transitional Countries”, JOHN WILEY & SONS, LTD., London, England.

2.4 Survey Result of Site Conditions

Con Dao Island

Item			Evaluation	Comments
Social Environment: *Impacts on "Gender" and "Children's Right" may be related to all social environment criteria.	1	Involuntary Resettlement	C	The port facilities (Jetty) will be constructed in the bay area, and large scale Involuntary Resettlement is not anticipated by the project implementation.
	2	Local Economy such as Employment and Livelihood, etc	A	Main economy of this island is tourism because the island was developed as a base of tourism by the Government. The project scale is very big, and the local people will be employed as worker in this port project. The port project will result in the improvement of the local economy including of those people living around the project area. However, the project will be causing serious impact to the tourism.
	3	Land Use and Utilization of Local Resources	A	Basically, the construction project will be conducted in the existing coastal area. Coal storage area required approx. 72 ha. There is a limitation of land use, and it is very difficult to find enough space for coal stock yard in the island. The proposed master plan prohibits the building of factories or exploitation of the marine environment.
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	-	Environmental impact is not anticipated by the project implementation.
	5	Existing Social Infrastructures and Services	B	Environmental impact is anticipated by the project implementation.
	6	The Poor, Indigenous and Ethnic people	C	There are no data of the poor, indigenous and ethnic people.
	7	Misdistribution of Benefit and Damage	-	No misdistribution of benefit and damage was expected.
	8	Cultural heritage	B	There are local archaeological, historical, cultural and religious heritage site in the island.
	9	Local Conflicts of Interest	-	There are no local residents who live in the project area. No significant impact on the living conditions of inhabitants is anticipated and there are no local conflicts of interest.
	10	Water Usage or Water Rights and Communal Rights	B	There are fishermen living in the island and they carry out their fishing operation by small boats in the coastal area. No fishing village is observed in the vicinity of the proposed project site.
	11	Sanitation	-	Project will not cause sanitation problems.
	12	Hazards (risk) Infectious Diseases such as HIV/AIDS	B	There might be some possibility for disease to be introduced at the site and surrounding area, because of the expected migration of many workers and local entrepreneurs during the construction period.
Natural Environment	13	Topography and Geographical Features	C	There are no data of topography and geographical features.
	14	Soil Erosion	C	There are no data of soil erosion.
	15	Groundwater	-	There are no data of groundwater.
	16	Hydrological Situation	-	There are no data of hydrological situation
	17	Coastal zone	B	Almost all of the coastal zones are covered with rocks, and only few places are available with white sand beach. Island coastal zone provide rich resources for ecology.

Item			Evaluation	Comments
	18	Flora, Fauna and Biodiversity	A	There are many protected animals and birds that live in this island (sea turtle, dugong, coral, petrel etc.). The park has a total area of about 15,043 ha including 9,000ha of marine and 6,043 ha of green forest. Serious impact will be expected during the construction and operation of the terminal and coal storage yard.
	19	Meteorology	B	West side of the island is expected to experience high tidal waves and the operation of vessel has a high risk for accidents, therefore special attentions for shipping in this area is necessary.
	20	Landscape	A	All area of the island is designated as a national park and the construction is expected to impact the landscape. Approx. 10 m height of coal piling is expected and create special scenery at site.
	21	Global Warming	C	There are no data of global warming
Pollution	22	Air Pollution	B	Huge volume of coal will be imported monthly from Indonesia/Australia. After the coal unloading, it is stored into the coal stock yards. Then, all of the coals are transported to the small vessel by belt conveyer. In dry season, the handling of coal is expected to have impact of air pollution.
	23	Water Pollution	B	Due to the resulting disturbance of seabed soil during construction, it is anticipated that a part of the seabed soil will become suspended soils by the construction of jetty. There are no data of seabed soil quality presently.
	24	Soil Contamination	B	In the case of large scale land reclamation, soil contamination is anticipated.
	25	Waste	C	In the absence of oil treatment and oil disposal facilities in the port, it is anticipated that all of the effluent (bilge) from ships are treated at the dock yard.
	26	Noise and Vibration	B	The expected noise sources during the construction are the piling work equipment and transportation vehicles
	27	Ground Subsidence	C	There are no data of ground subsidence
	28	Offensive Odor	-	No odor source is anticipated
	29	Bottom Sediment	C	There are no data of bottom sediment
	30	Accidents	B	Operation of the port will potentially increase the overall traffic density in nearby areas, which may cause some traffic safety problems to the nearby residents, workers and visitors.

Grade	Number	Notes
A	4	
B	11	
C	8	
No Mark	7	

Evaluation;
A: Serious impact is expected,
B: Some impact is expected,
C: Extent of impact is unknown,
No Mark: No impact is expected.

Tra Vinh

Item			Evaluation	Comments
Social Environment: *Impacts on "Gender" and "Children's Right" may be related to all social environment criteria.	1	Involuntary Resettlement	B	The port facilities (Jetty and coal stock yard) will be constructed in the coastal area, and large scale Involuntary Resettlement is not anticipated by the project implementation.
	2	Local Economy such as Employment and Livelihood, etc	B	Main economy at the project area is farming and fishing. The project scale is very big, and the local people will be employed as worker in this port project. The port project will result in the improvement of local economy including of those people living around the project area.
	3	Land Use and Utilization of Local Resources	A	Basically, the construction project will be conducted in the existing coastal area. Coal storage area required approx. 72 ha, and the existing site is covered with mangrove and miscellaneous trees, and a part of the proposed site is utilized for farming by local residents.
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	-	Environmental impact is not anticipated by the project implementation.
	5	Existing Social Infrastructures and Services	B	Environmental impact is anticipated by the project implementation.
	6	The Poor, Indigenous and Ethnic people	C	There are no data of the poor, indigenous and ethnic people.
	7	Misdistribution of Benefit and Damage	-	No misdistribution of benefit and damage was expected.
	8	Cultural heritage	-	Impact for local archaeological, historical, cultural and religious heritage is not anticipated in the proposed site.
	9	Local Conflicts of Interest	-	No significant impact on the living conditions of inhabitants is anticipated and there are no local conflicts of interest.
	10	Water Usage or Water Rights and Communal Rights	B	There are several fishermen living in the coastal area adjacent to project area and they carry out their fishing operation by small boats and fixed shore net in the coastal area.
	11	Sanitation	-	Project will not cause sanitation problems
	12	Hazards (risk) Infectious Diseases such as HIV/AIDS	B	There might be some possibility for disease to be introduced at the site and surrounding area, because of the expected migration of workers and local entrepreneurs during the construction period.
Natural Environment	13	Topography and Geographical Features	C	There are no data of topography and geographical features.
	14	Soil Erosion	B	Soil erosion was observed in the coastal area. In the case of required land reclamation, have possibility of soil contamination.
	15	Groundwater	C	There are no data of groundwater.
	16	Hydrological Situation	C	Due to muddy conditions of the seawater, the water has low transparency, and there is very low visibility in the sea water at the expected project area.
	17	Coastal zone	B	Coastal zone have sandy beach. In the hinterland of the project site, several farmers cultivate crops. There are many fish ponds and fishermen conduct aquaculture in the area.
	18	Flora, Fauna and Biodiversity	A	The proposed project site is not located within an area of protected habitats of endangered species designed by the country's law and international treaties and conventions. There is a mangrove forest but the density is small relatively compared with other sites. Required minimization of deforestation area of mangrove
	19	Meteorology	-	No impact is anticipated

Item			Evaluation	Comments
	20	Landscape	B	Proposed area is not designated as a national park and reserved area. Approx. 10 m height of coal piling is expected and create special scenery at site.
	21	Global Warming	C	There are no data of global warming
Pollution	22	Air Pollution	B	Huge volume of coal will be imported monthly from Indonesia/Australia. After the coal unloading, it is stored into the coal stock yards. Then, all of the coals are transported to the small vessel by belt conveyer. In dry season, the handling of coal is expected to have impact of air pollution.
	23	Water Pollution	B	Due to the resulting disturbance of seabed soil during construction, it is anticipated that a part of the seabed soil will become suspended soils by the construction of jetty. There are no data of seabed soil quality presently.
	24	Soil Contamination	B	In the case of large scale land reclamation, soil contamination is anticipated.
	25	Waste	C	In the absence of oil treatment and oil disposal facilities in the port, it is anticipated that all of the effluent (bilge) from ships are treated at the dock yard.
	26	Noise and Vibration	B	The expected noise sources during the construction are the piling work equipment and transportation vehicles
	27	Ground Subsidence	C	There are no data of ground subsidence
	28	Offensive Odor	-	No odor source is anticipated
	29	Bottom Sediment	C	There are no data of bottom sediment
	30	Accidents	B	Operation of the port will potentially increase the overall traffic density in nearby areas, which may cause some traffic safety problems to the nearby residents, workers and visitors.

Grade	Number	Notes
A	2	
B	13	+B=1, -B=12
C	8	
No Mark	7	

Evaluation;
A: Serious impact is expected,
B: Some impact is expected,
C: Extent of impact is unknown,
No Mark: No impact is expected.

Cai Mep

Item			Evaluation	Comments
Social Environment: *Impacts on "Gender" and "Children's Right" may be related to all social environment criteria.	1	Involuntary Resettlement	B	The port facilities (Jetty and coal stock yard) will be constructed in the coastal area, but large scale Involuntary Resettlement is not anticipated by the project implementation.
	2	Local Economy such as Employment and Livelihood, etc	B	Project scale is very big, and the local people will be employed as worker in this port project. The port project will result in the improvement of the local economy including of those people living around the project area. Resort area is located 10 km away from the site.
	3	Land Use and Utilization of Local Resources	A	Basically, the construction project will be conducted in the existing coastal area. Coal storage area required approx 72 ha, and the existing site is covered with mangroves and miscellaneous trees,
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	-	Environmental impact is not anticipated by the project implementation.
	5	Existing Social Infrastructures and Services	B	Environmental impact is anticipated by the project implementation.
	6	The Poor, Indigenous and Ethnic people	C	There are no data of the poor, indigenous and ethnic people.
	7	Misdistribution of Benefit and Damage	-	No misdistribution of benefit and damage was expected.
	8	Cultural heritage	-	Impact for local archaeological, historical, cultural and religious heritage is not anticipated in the proposed site.
	9	Local Conflicts of Interest	-	No significant impact on the living conditions of inhabitants is anticipated and there are no local conflicts of interest.
	10	Water Usage or Water Rights and Communal Rights	B	There are fishermen living in the mouth of the river adjacent to the project area and they carry out their fishing operation by small boats and fixed shore net in the coastal area.
	11	Sanitation	-	Project will not cause sanitation problems
	12	Hazards (risk) Infectious Diseases such as HIV/AIDS	B	There might be some possibility for disease to be introduced at the site and surrounding area, because of the expected migration of workers and local entrepreneurs during the construction period.
Natural Environment	13	Topography and Geographical Features	C	There are no data of topography and geographical features.
	14	Soil Erosion	B	In case of land reclamation is required, there is a possibility of soil contamination to occur.
	15	Groundwater	C	There are no data of groundwater.
	16	Hydrological Situation	C	Due to muddy conditions of the seawater, the water has low transparency, and there is very low visibility in the sea water at the expected project area.
	17	Coastal zone	**B**	There are many mangroves forest at the proposed project area and at the vicinity of the project area. Fishermen conduct their fishing operation in the river. There are many fish ponds and the fishermen conduct aquaculture in the area.
	18	Flora, Fauna and Biodiversity	A	The proposed project site is not located within an area of protected habitats of endangered species designed by the country's law and international treaties and conventions. For the construction of coal storage yard, the existing mangrove forest will be subjected to deforestation.
	19	Meteorology	-	No impact is anticipated
	20	Landscape	B	Proposed area is not designated as a national park and reserved area. Approx. 10 m height of coal piling is expected and create special scenery at site.

Item			Evaluation	Comments
	21	Global Warming	C	There are no data of global warming
Pollution	22	Air Pollution	B	Huge volume of coal will be imported monthly from Indonesia/Australia. After the coal unloading, it is stored into the coal stock yards. Then, all of the coals are transported to the small vessel by belt conveyer. In dry season, the handling of coal is expected to have impact of air pollution.
	23	Water Pollution	B	Construction project will include dredging for port and access channels. Due to the resulting disturbance of seabed soil during construction, it is anticipated that a part of the seabed soil will become suspended soils by the construction of jetty. There are no data of seabed soil quality presently. Access channel of vessels was already completed by other project, therefore it is possible that the dredging work in this project will just be minimal.
	24	Soil Contamination	B	In the case of large scale land reclamation, soil contamination is anticipated.
	25	Waste	C	In the absence of oil treatment and oil disposal facilities in the port, it is anticipated that all of the effluent (bilge) from ships are treated at the dock yard.
	26	Noise and Vibration	B	The expected noise sources during the construction are the piling work equipment and transportation vehicles
	27	Ground Subsidence	C	There are no data of ground subsidence
	28	Offensive Odor	-	No odor source is anticipated
	29	Bottom Sediment	C	There are no data of bottom sediment
	30	Accidents	B	Operation of the port will potentially increase the overall traffic density in nearby areas, which may cause some traffic safety problems to the nearby residents, workers and visitors.

Grade	Number	Notes
A	2	
B	13	
C	8	
No Mark	7	

Evaluation;
A: Serious impact is expected,
B: Some impact is expected,
C: Extent of impact is unknown,
No Mark: No impact is expected.

Soc Trang

Item			Evaluation	Comments
Social Environment: *Impacts on "Gender" and "Children's Right" may be related to all social environment criteria.	1	Involuntary Resettlement	C	The port facilities (Jetty and coal stock yard) will be constructed in the coastal area, and large scale Involuntary Resettlement is not anticipated by the project implementation.
	2	Local Economy such as Employment and Livelihood, etc	B	Project scale is very big, and the local people will be employed as worker in this port project. The port project will result in the improvement of the local economy including of those people living around the project area. Soc Trang provinces has many pagodas, the number of tourist visiting the province was estimated at 620,000 in 2010.
	3	Land Use and Utilization of Local Resources	A	Basically, the construction project will be conducted in the existing coastal area. Coal storage area required approx 72 ha, and the existing site is covered with mangroves and miscellaneous trees.
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	-	Environmental impact is not anticipated by the project implementation.
	5	Existing Social Infrastructures and Services	B	Environmental impact is not anticipated by the project implementation.
	6	The Poor, Indigenous and Ethnic people	C	There are no data of the poor, indigenous and ethnic people.
	7	Misdistribution of Benefit and Damage	-	No misdistribution of benefit and damage was expected.
	8	Cultural heritage	-	Impact for local archaeological, historical, cultural and religious heritage is not anticipated in the proposed site.
	9	Local Conflicts of Interest	-	No significant impact on the living conditions of inhabitants is anticipated and there are no local conflicts of interest.
	10	Water Usage or Water Rights and Communal Rights	B	There are fishermen living in the mouth of the river adjacent to project area and they carry out their fishing operation by small boats and fixed shore net in the coastal area.
	11	Sanitation	-	Project will not cause sanitation problems
	12	Hazards (risk) Infectious Diseases such as HIV/AIDS	B	There might be some possibility for disease to be introduced at the site and surrounding area, because of the expected migration of workers and local entrepreneurs during the construction period.
Natural Environment	13	Topography and Geographical Features	B	Accretion of river silt and impact of strong sea waves and wind have created a large mound of sand along the coast.
	14	Soil Erosion	B	Large scale erosion was observed in the coastal area proposed for coal storage site. Erosion of the flood plains in front of the dyke is clearly visible.
	15	Groundwater	C	There are no data of groundwater.
	16	Hydrological Situation	C	Due to the muddy conditions of the seawater, the water has low transparency, and there is very low visibility in the sea water at the expected project area.
	17	Coastal zone	A	As a countermeasure for erosion, many mangrove plants were forested in the proposed site by GIZ project (Environmental preservation project of shoreline in Soc Trang). This project started in 2007 and will be continued up to 2013 by GIZ. There are many fish ponds and fishermen conduct aquaculture in the area. Depth of the sea in the coastal area is shallow, that a large volume of dredging is expected for access channel of vessels.
	18	Flora, Fauna and Biodiversity	A	The proposed project site is not located within an area of protected habitats of endangered species designed by the country's law and international treaties and conventions. However, for the construction of coal storage yard, existing mangrove forest will be subjected for deforestation. About 3,000 ha of mangroves have been rehabilitated in the coastal area since 1990 (GIZ report)

Item			Evaluation	Comments
	19	Meteorology	-	No impact is anticipated
	20	Landscape	B	Proposed area is not designated as a national park. Approx. 10 m height of coal piling is expected and create special scenery at site.
	21	Global Warming	C	There are no data of global warming
Pollution	22	Air Pollution	B	Huge volume of coal will be imported monthly from Indonesia/Australia. After the coal unloading, it is stored into the coal stock yards. Then, all of the coals are transported to the small vessel by belt conveyer. In dry season, the handling of coal is expected to have impact of air pollution.
	23	Water Pollution	B	Construction project will include dredging for port and access channels. Due to the resulting disturbance of seabed soil during construction, it is anticipated that a part of the seabed soil will become suspended soils by the construction of jetty. There are no data of seabed soil quality presently. Access channel of vessels was completed by other project and it is possible to minimize dredging work in this project.
	24	Soil Contamination	B	In the case of large scale land reclamation, soil contamination is anticipated.
	25	Waste	C	In the case absence of oil treatment and oil disposal facilities in the port, it is anticipated that all of the effluent (bilge) from ships are treated at the dock yard.
	26	Noise and Vibration	B	The expected noise sources during the construction are the piling work equipment and transportation vehicles
	27	Ground Subsidence	C	There are no data of ground subsidence
	28	Offensive Odor	-	No odor source is anticipated
	29	Bottom Sediment	C	There are no data of bottom sediment
	30	Accidents	B	Operation of the port will potentially increase the overall traffic density in nearby areas, which may cause some traffic safety problems to the nearby residents, workers and visitors.

Grade	Number	Notes
A	3	
B	12	
C	8	
No Mark	7	

Evaluation;
A: Serious impact is expected,
B: Some impact is expected,
C: Extent of impact is unknown,
No Mark: No impact is expected.

2.5 Data of Con Dao National Park

(1) Location:

Ba Ria – Vung Tau Province

(2) Type of national park:

There are two types : Tropical rain closed evergreen forest and tropical rain closed semi-deciduous forest

(3) Area

The park has the total area of about 15,043 ha including 9,000ha marine and6,043 ha forest

(4) Protected animals, birds:

Forests in Con Dao are mainly proteozic, belonging to the tropical island ecosystem with 882 species of fauna, nearly 150 species of animal, among which there are some rare species only found in Con Dao such as Con Dao black squirrel, winged house gecko, and some species of birds just existing in Con Dao like Masked booby, Red-billed tropicbird, Nicba pigeon and Rock pigeon. Distribution of animals in Con Dao island is shown in Figure 3.5.1.

Con Dao has various marine ecosystems with 285 species of hard coral, 84 species of sea weed, 202 species of fish, 153 species of mollusc, etc. What is more, aquiherbosa ecosystem, geophyte in sea estimate about 200ha, comprising of 9 species among 16 ones in the world. Con Dao's sea is a home of tortoise-shell, turtle, Black whale, and especially Dugong, one of the extremely rare species in the world.

(5) Characteristics:

Con Dao National Park is one of two national parks in Viet Nam owing both forest and marine protected area

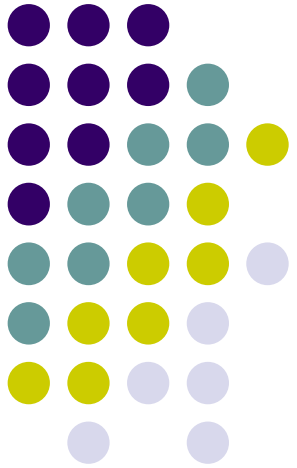
(6) Others

There is great potential to further develop ecotourism at the national park, in the form of hiking, birdwatching, snorkeling, diving and watching nesting turtles. Controlled and environmentally sensitive ecotourism development has the potential to raise awareness of conservation issues and generate revenue for management of the national park.

The waters off the Con Dao archipelago are an important fishery. Several marine products of high economic value, such as groupers and giant clams, occur in the area. The islands' mangroves are an important nursery area for the fishery.

Japan International Cooperation Agency (JICA)
Preparatory Survey on Son Hau Coal Fired Power Plant and related Infrastructures

Imported Coal Transship Terminal (Phase1)



MOIT Presentation (2nd)

February 2012

Sumitomo Corporation

Contents of Presentation

1. Study Case

	Short-Term	Long-Term
1	Vinh Tan	Tra Vinh
2	Vinh Tan	Cai Mep
3	Tra Vinh	Tra Vinh
4	Cai Mep	Cai Mep
5	Cai Mep	Tra Vinh

2. Secondary Freight

The secondary freight from imported coal transshipment terminal to the Mekong River estuary is calculated preliminary as shown below.

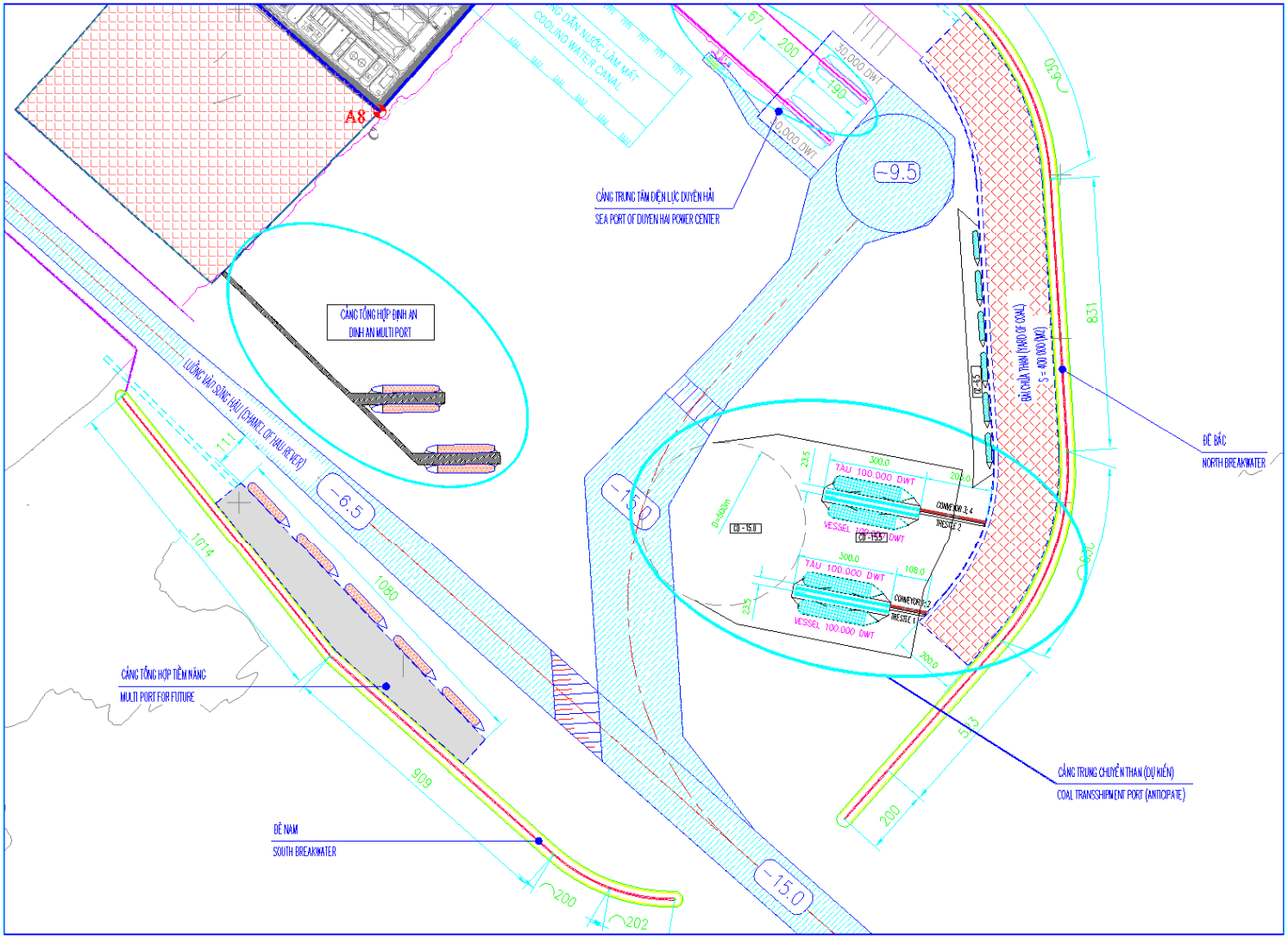
Location of Terminal	Cai Mep	Tra Vinh	Vinh Tan
Transport time (one way) + spare time 1hour	12hrs	1.2hrs	36hrs
Loading port stay 5,000DWT	5.5hrs	5.5hrs	5.5hrs
Unloading port stay 5,000DWT	9.1hrs	9.1hrs	9.1hrs
Cycle time 5,000DWT	38.6hrs (1.6d)	17.0hrs (0.7d)	86.6hrs (3.6d)
Charterage 5,000DWT	US$3,120	US$1,365	US$7,020
Freight rate 5,000DWT	US$0.70/MT	US$0.30/MT	US$1.60/MT
Operation risk factor	1.5	1.0	3.0
Freight rate 5,000DWT for Study	US$1.05/MT	US$0.30/MT	US$4.80/MT

Transport distance (Nm=1,852KM): Cai Mep – Mekong River estuary approx. 65Nm
Tra Vinh – Mekong River estuary approx. 1Nm
Vinh Tan – Mekong River estuary approx. 190Nm

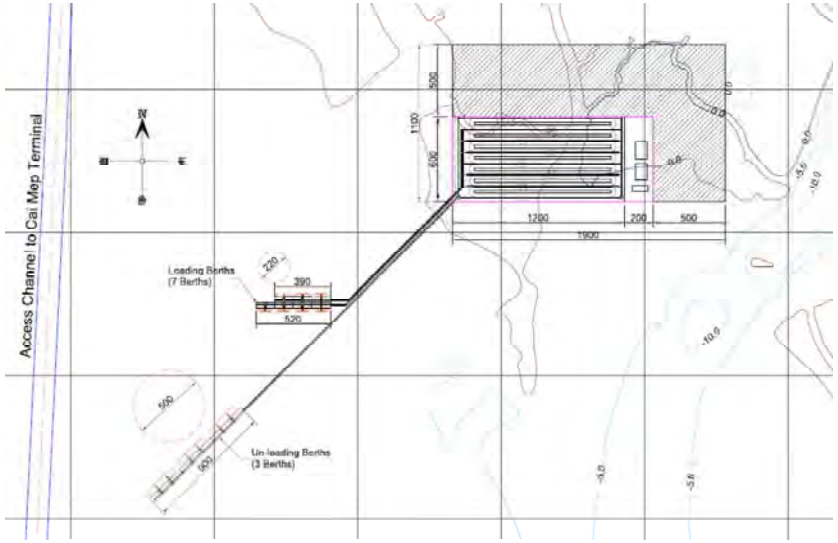
Speed of coaster vessel: 5.5Knot/hr

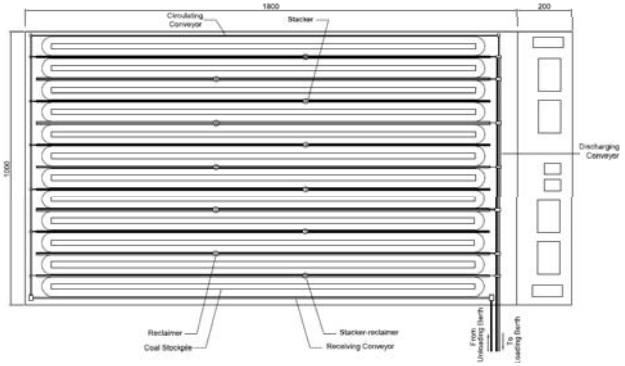
3. Terminal Layout
3.1 Vinh Tan

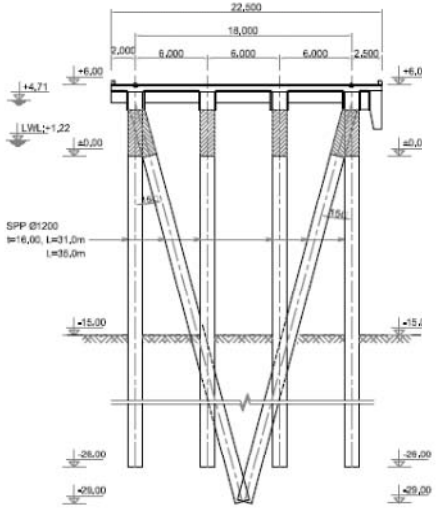
3. Terminal Layout
3.2 Tra Vinh

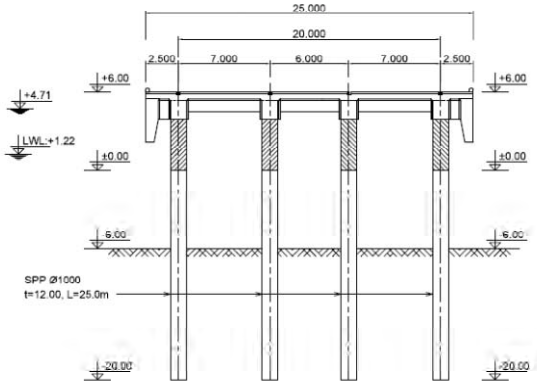


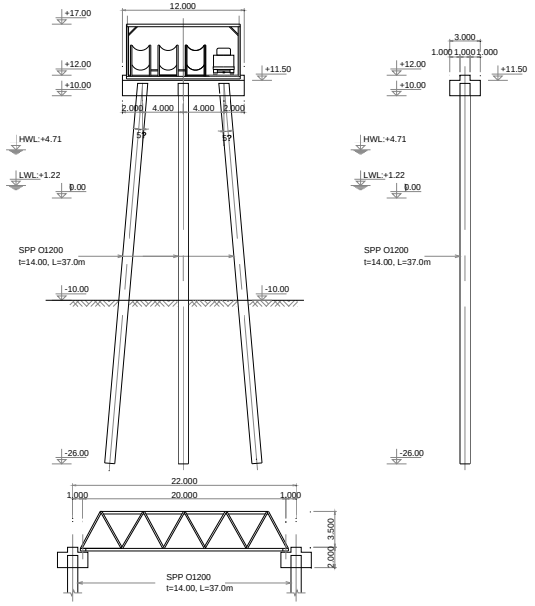
3. Terminal Layout
3.2 Cai Mep











4. Project Cost (Long-Term)
4.1 Summary

Unit: Million USD

Item	1. Vinh Tan + Tra Vinh	2. Vinh Tan + Cai Mep	3. Tra Vinh + Tra Vinh	4. Cai Mep + Cai Mep	5. Cai Mep + Tra Vinh
Initial Cost					
Terminal construction cost	741.0	656.0	523.0	438.0	778.0
Annual Cost (total in 30 years)					
Operations and maintenance cost	1,236.0	640.0	1,425.0	647.0	1,243.0
Secondary transport cost	377.6	752.2	164.1	574.4	199.7
Total Cost					
	2,354.6	2,048.2	2,112.1	1,659.4	2,220.7

4. Project Cost (Long-Term)
4.2 Breakdown

	1. Vinh Tan + Tra Vinh					2. Vinh Tan + Cai Mep					3. TraVinh + Tra Vinh				
	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 4.8/0.3 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 4.8/1.05 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 0.3 US$/t	OM cost mil.US$	Ammount mil.US$
0															
1	50.0				50.0	50.0				50.0	80.0				80.0
2	100.0				100.0	100.0				100.0	160.0				160.0
3	68.0				68.0	68.0				68.0	98.0				98.0
4		5.0	24.0	16.0	40.0		5.0	24.0	16.0	40.0		5.0	1.5	43.0	44.5
5		5.5	26.4	16.0	42.4		5.5	26.4	16.0	42.4		5.5	1.7	43.0	44.7
6		6.1	29.0	16.0	45.0		6.1	29.0	16.0	45.0		6.1	1.8	43.0	44.8
7		6.7	31.9	16.0	47.9		6.7	31.9	16.0	47.9		6.7	2.0	43.0	45.0
8	120.0	7.3	35.1	16.0	171.1	100.0	7.3	35.1	16.0	151.1	35.0	7.3	2.2	43.0	80.2
9	250.0	8.1	38.7	16.0	304.7	200.0	8.1	38.7	16.0	254.7	100.0	8.1	2.4	43.0	145.4
10	153.0	8.9	42.5	16.0	211.5	138.0	8.9	42.5	16.0	196.5	50.0	8.9	2.7	43.0	95.7
11		9.7	2.9	56.2	59.1		9.7	10.2	26.4	36.6		9.7	2.9	56.2	59.1
12		10.7	3.2	56.2	59.4		10.7	11.3	26.4	37.7		10.7	3.2	56.2	59.4
13		11.8	3.5	56.2	59.7		11.8	12.4	26.4	38.8		11.8	3.5	56.2	59.7
14		13.0	3.9	56.2	60.1		13.0	13.6	26.4	40.0		13.0	3.9	56.2	60.1
15		14.3	4.3	56.2	60.5		14.3	15.0	26.4	41.4		14.3	4.3	56.2	60.5
16		15.7	4.7	56.2	60.9		15.7	16.5	26.4	42.9		15.7	4.7	56.2	60.9
17		17.3	5.2	56.2	61.4		17.3	18.1	26.4	44.5		17.3	5.2	56.2	61.4
18		19.0	5.7	56.2	61.9		19.0	19.9	26.4	46.3		19.0	5.7	56.2	61.9
19		20.9	6.3	56.2	62.5		20.9	21.9	26.4	48.3		20.9	6.3	56.2	62.5
20		23.0	6.9	56.2	63.1		23.0	24.1	26.4	50.5		23.0	6.9	56.2	63.1
21		25.3	7.6	56.2	63.8		25.3	26.5	26.4	52.9		25.3	7.6	56.2	63.8
22		27.8	8.3	56.2	64.5		27.8	29.2	26.4	55.6		27.8	8.3	56.2	64.5
23		30.6	9.2	56.2	65.4		30.6	32.1	26.4	58.5		30.6	9.2	56.2	65.4
24		33.6	10.1	56.2	66.3		33.6	35.3	26.4	61.7		33.6	10.1	56.2	66.3
25		37.0	11.1	56.2	67.3		37.0	38.9	26.4	65.3		37.0	11.1	56.2	67.3
26		38.0	11.4	56.2	67.6		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
27		38.0	11.4	56.2	67.6		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
28		38.0	11.4	56.2	67.6		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
29		38.0	11.4	56.2	67.6		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
30		38.0	11.4	56.2	67.6		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
Total	741.0		377.6	1,236.0	2,354.6	656.0		752.2	640.0	2,048.2	523.0		164.1	1,425.0	2,112.1
			Present value		1,019.8			Present value		898.0			Present value		929.3

Note1: Capital investment includes only construction/purchase cost of terminal facility.

Note2: Environmental countermeasure cost will be required additionally around the range of US$ 100-200 mil based on the Vietnamese Gov's requirement.

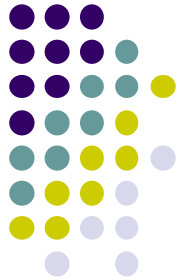
4. Project Cost (Long-Term)
4.2 Breakdown

	4. Cai Mep + Cai Mep					5. Cai Mep + Tra Vinh				
	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 1.05 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 1.05/0.3 US$/t	OM cost mil.US$	Ammount mil.US$
0										
1	50.0				50.0	50.0				50.0
2	120.0				120.0	130.0				130.0
3	85.0				85.0	75.0				75.0
4		5.0	5.3	17.0	22.3		5.0	5.3	17.0	22.3
5		5.5	5.8	17.0	22.8		5.5	5.8	17.0	22.8
6		6.1	6.4	17.0	23.4		6.1	6.4	17.0	23.4
7		6.7	7.0	17.0	24.0		6.7	7.0	17.0	24.0
8	30.0	7.3	7.7	17.0	54.7	120.0	7.3	7.7	17.0	144.7
9	90.0	8.1	8.5	17.0	115.5	250.0	8.1	8.5	17.0	275.5
10	63.0	8.9	9.3	17.0	89.3	153.0	8.9	9.3	17.0	179.3
11		9.7	10.2	26.4	36.6		9.7	2.9	56.2	59.1
12		10.7	11.3	26.4	37.7		10.7	3.2	56.2	59.4
13		11.8	12.4	26.4	38.8		11.8	3.5	56.2	59.7
14		13.0	13.6	26.4	40.0		13.0	3.9	56.2	60.1
15		14.3	15.0	26.4	41.4		14.3	4.3	56.2	60.5
16		15.7	16.5	26.4	42.9		15.7	4.7	56.2	60.9
17		17.3	18.1	26.4	44.5		17.3	5.2	56.2	61.4
18		19.0	19.9	26.4	46.3		19.0	5.7	56.2	61.9
19		20.9	21.9	26.4	48.3		20.9	6.3	56.2	62.5
20		23.0	24.1	26.4	50.5		23.0	6.9	56.2	63.1
21		25.3	26.5	26.4	52.9		25.3	7.6	56.2	63.8
22		27.8	29.2	26.4	55.6		27.8	8.3	56.2	64.5
23		30.6	32.1	26.4	58.5		30.6	9.2	56.2	65.4
24		33.6	35.3	26.4	61.7		33.6	10.1	56.2	66.3
25		37.0	38.9	26.4	65.3		37.0	11.1	56.2	67.3
26		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
27		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
28		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
29		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
30		38.0	39.9	26.4	66.3		38.0	11.4	56.2	67.6
Total	438.0		574.4	647.0	1,659.4	778.0		199.7	1,243.0	2,220.7
			Present value		686.1			Present value		947.1

Note1: Capital investment includes only construction/purchase cost of terminal facility.

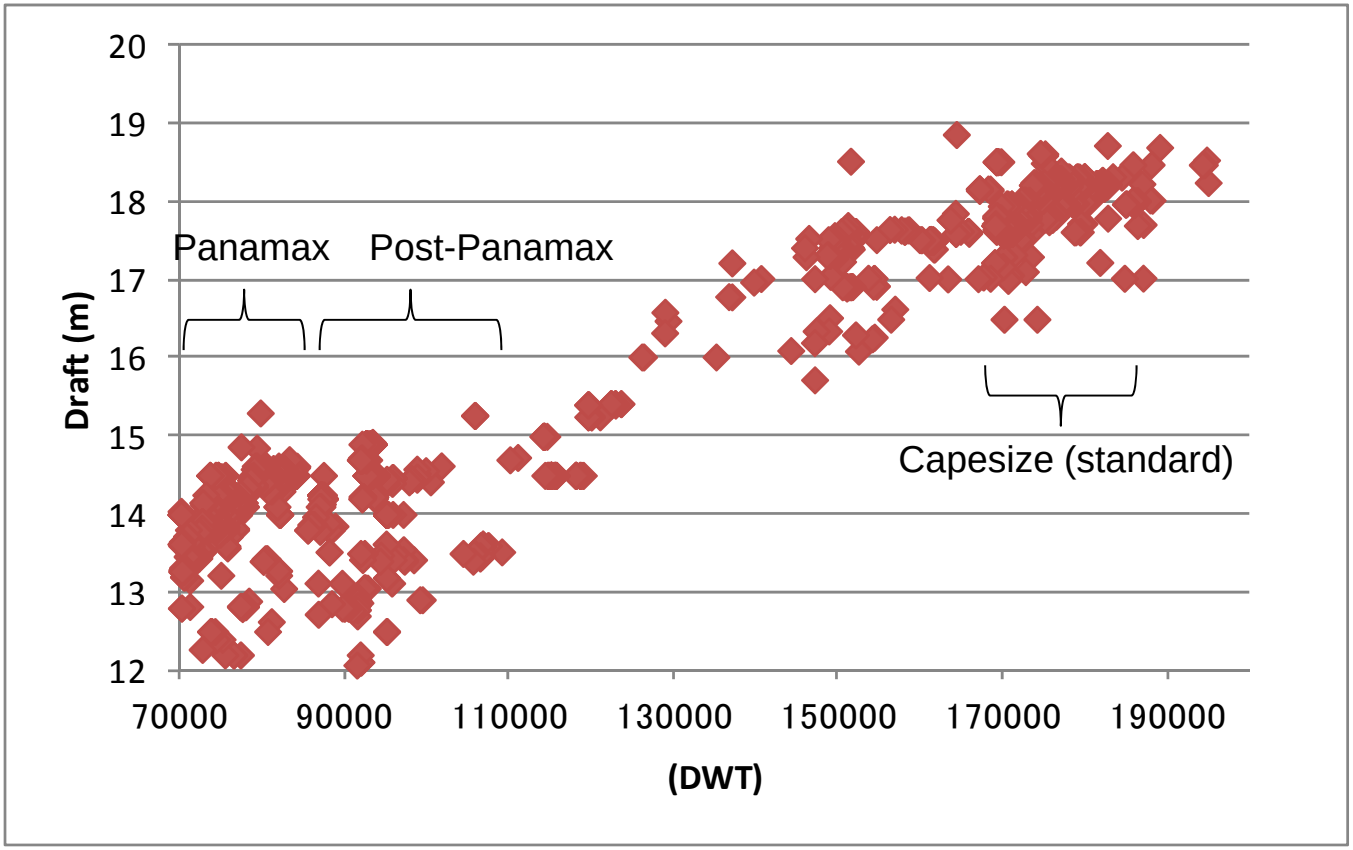
Note2: Environmental countermeasure cost will be required additionally around the range of US$ 100-200 mil based on the Vietnamese Gov's requirement.

4. Project Cost (Long-Term)
4.3 Examination Result 1



- The examination result for long-term is as follows.
  - 1st rank (686.1): Cai Mep + Cai Mep
  - 2nd rank (898.0): Vinh Tan + Cai Mep
  - 3rd rank (929.3): Tra Vinh + Tra Vinh
  - 4th rank (947.1): Cai Mep + Tra Vinh
  - 5th rank (1,019.8): Vinh Tan + Tra Vinh

5. Ship Size
5.1 Statistical Ship Data



Source: Fairplay (UK)

5. Ship Size
5.2 Situation of Coal Loading Ports

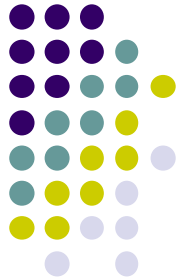
(1) Indonesia
Taboneo Port and Satui Port (South Kalimantan)
Operation with floating facility or ship gear.
Taboneo can recive Capesize and Post-Panamax.
Satui can receive up to Panamax.

(2) Australia
Both Capesize and Post-Panamax are available.

According to JICA team's survey, coal price in Australia is higher than that in Indonesia. Also, transportation cost from Australia is more expensive than that from Indonesia.

Coal import from Indonesia would be realistic.

5. Ship Size
5.3 Ship Size and Berth Occupancy



(1) Coal demand: 10 mil ton / year (short-term)

100,000DWT – 105 ship calls / year
(Post-Panamax) (2 times / week)

150,000DWT – 70 ship calls / year
(1.3 times / week)
180,000DWT – 58 ship calls / year
(Capesize) (1.1 time / week)

(2) 1 berth will be enough for operation in all cases.

6. Project Cost (Short-Term)
6.1 Summary

Unit: Million USD

Item	1. Vinh Tan	3. Tra Vinh	4. Cai Mep
Initial Cost			
Terminal construction cost	218.0	338.0	255.0
Annual Cost (total in 10 years)			
Operations and maintenance cost	112.0	301.0	119.0
Secondary transport cost	227.7	14.2	49.8
Total Cost			
	557.7	653.2	304.8

6. Project Cost (Short-Term)
6.2 Breakdown

	Vinh Tan					Tra Vinh					Cai Mep				
	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 4.8 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 0.3 US$/t	OM cost mil.US$	Ammount mil.US$	Capital investment mil.USD	Coal handling volume mil.ton	Transport cost 1.05 US$/t	OM cost mil.US$	Ammount mil.US$
0															
1	50.0				50.0	80.0				80.0	50.0				50.0
2	100.0				100.0	160.0				160.0	120.0				120.0
3	68.0				68.0	98.0				98.0	85.0				85.0
4		5.0	24.0	16.0	40.0		5.0	1.5	43.0	44.5		5.0	5.3	17.0	22.3
5		5.5	26.4	16.0	42.4		5.5	1.7	43.0	44.7		5.5	5.8	17.0	22.8
6		6.1	29.0	16.0	45.0		6.1	1.8	43.0	44.8		6.1	6.4	17.0	23.4
7		6.7	31.9	16.0	47.9		6.7	2.0	43.0	45.0		6.7	7.0	17.0	24.0
8		7.3	35.1	16.0	51.1		7.3	2.2	43.0	45.2		7.3	7.7	17.0	24.7
9		8.1	38.7	16.0	54.7		8.1	2.4	43.0	45.4		8.1	8.5	17.0	25.5
10		8.9	42.5	16.0	58.5		8.9	2.7	43.0	45.7		8.9	9.3	17.0	26.3
Total	218.0		227.7	112.0	557.7	338.0		14.2	301.0	653.2	255.0		49.8	119.0	304.8
			Present value		399.4			Present value		492.4			Present value		326.2

Note1: Capital investment includes only construction/purchase cost of terminal facility.
Note2: Environmental countermeasure cost will be required additionally around the range of US$ 100-200 mil based on the Vietnamese Gov's requirement.

6. Project Cost (Short-Term)
6.3 Examination Result 2

- The examination result for short-term is as follows.
  - 1st rank (326.2): Cai Mep
  - 2nd rank (399.4): Vinh Tan
  - 3rd rank (492.4): Tra Vinh