

FINAL REPORT

THE STUDY ON MODERNIZATION OF BANGKOK PORT IN THE KINGDOM OF THAILAND

VOL.1 MASTER PLAN

THE STUDY ON MODERNIZATION OF BANGKOK PORT IN THE KINGDOM OF THAILAND



JULY 1994

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN (OCDI)
PACIFIC CONSULTANTS INTERNATIONAL (PCI)

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FINAL REPORT

THE STUDY ON MODERNIZATION OF BANGKOK PORT IN THE KINGDOM OF THAILAND

VOL.1 MASTER PLAN

JULY 1994

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on modernization of Bangkok Port and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team four times between March 1993 and July 1994, which was headed by Mr. Yugo Otsuki and was composed of members from the Overseas Coastal Area Development Institute of Japan (OCDI) and Pacific Consultants International (PCI).

The team held discussions with the officials concerned of the Government of Thailand and conducted field surveys at the port. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Thailand for their close cooperation they extended of the team.

July, 1994

A handwritten signature in black ink, reading "Kensuke Yanagiya". The signature is fluid and cursive, with the first name "Kensuke" and last name "Yanagiya" clearly distinguishable.

Kensuke Yanagiya

President

Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July, 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency

Dear Mr. Yanagiya:

It is my great pleasure to submit herewith the Report for the Study on Modernization of Bangkok Port in the Kingdom of Thailand.

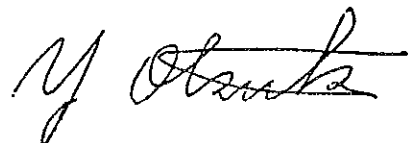
The study team which consists of the Overseas Coastal Area Development Institute of Japan (OCDI) and Pacific Consultants International (PCI), headed by myself, conducted a survey in Thailand from March 1993 to March 1994 as per the contract with the Japan International Cooperation Agency.

The findings of this survey were fully discussed with the officials of the Port Authority of Thailand and other authorities concerned to formulate the Master Plan for the period up to the year 2005 and to formulate and examine the feasibility of the Short-Term Plan for the period up to the year 1997, and were then compiled into this report.

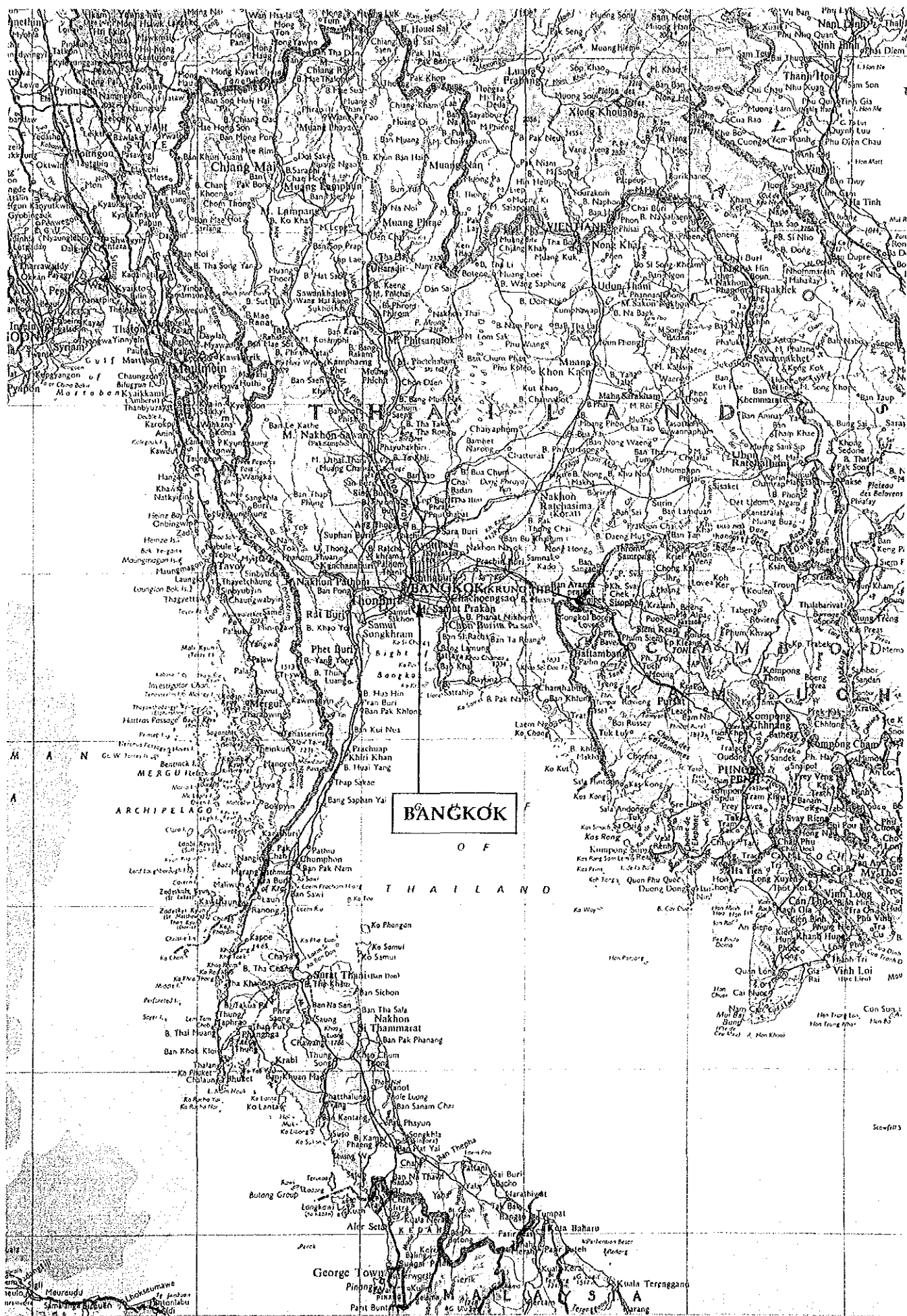
On behalf of the study team, I would like to express my deepest appreciation to the Government of Thailand, the Port Authority of Thailand and other authorities concerned for their brilliant cooperation and assistance and for the heartfelt hospitality which they extended to the study team during our stay in Thailand.

I am also greatly indebted to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Transport and the Embassy of Japan in Thailand for giving us valuable suggestions and assistance during the preparation of this report.

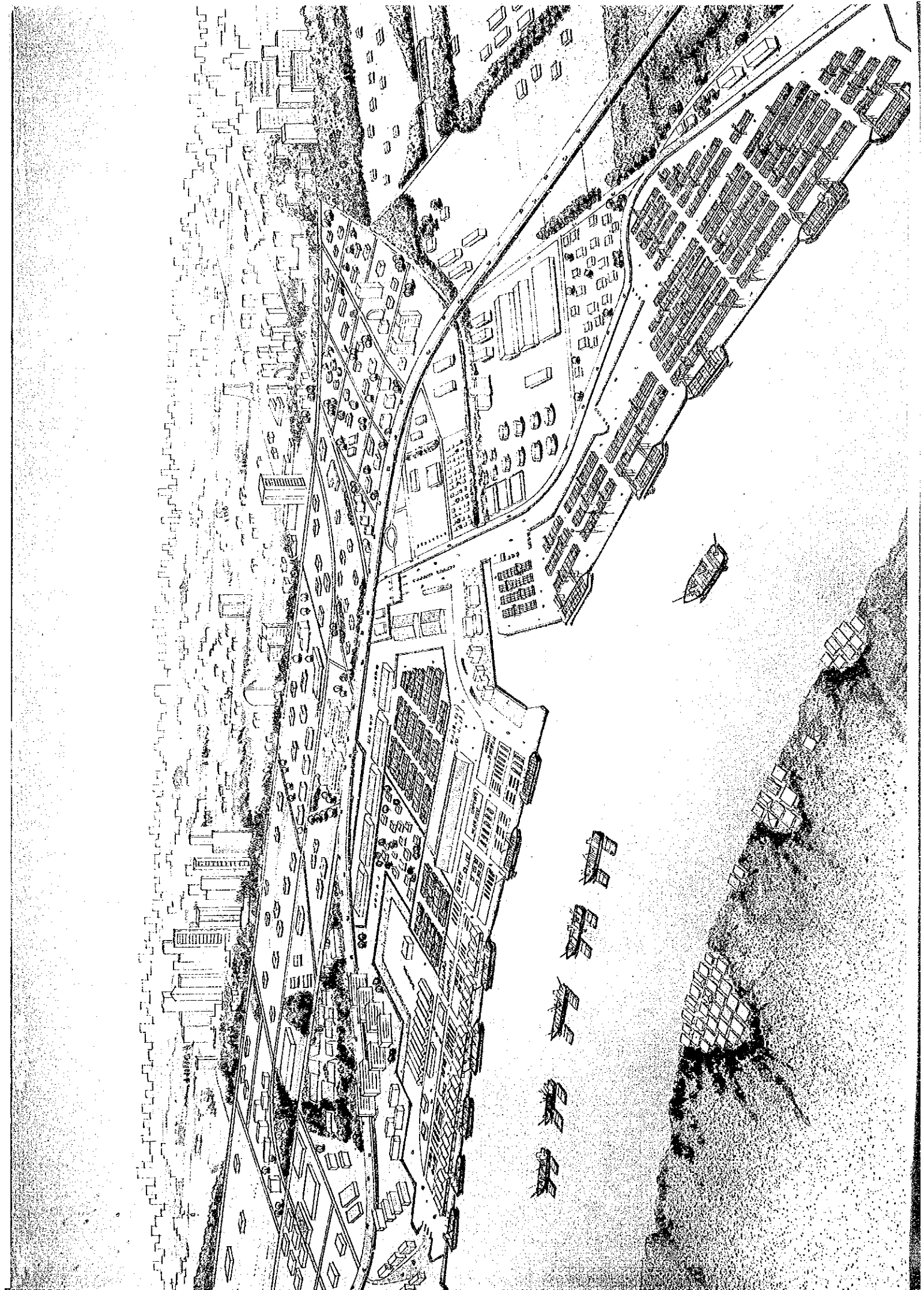
Respectfully,

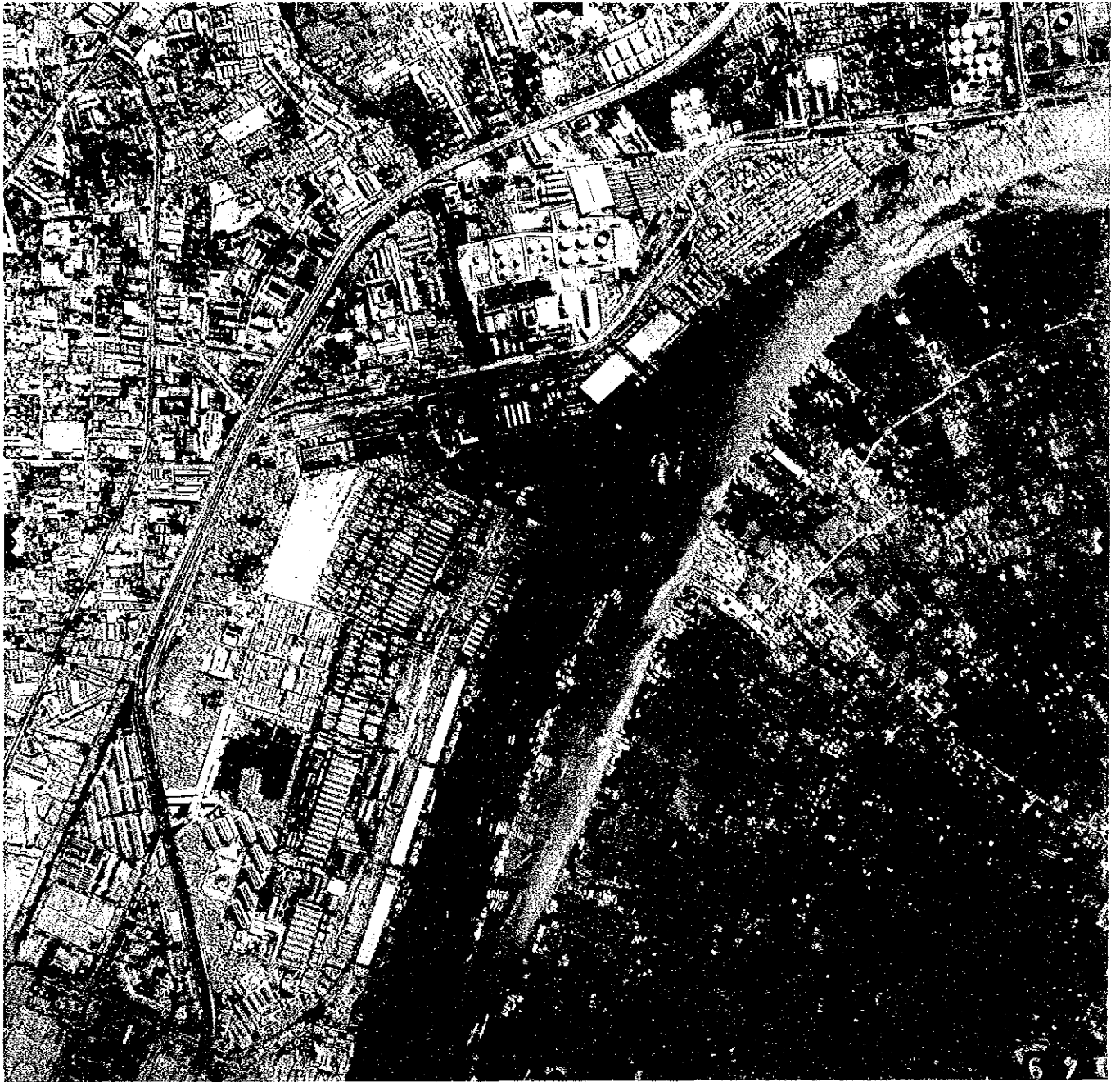


Yugo Otsuki
Leader of the Study Team for
the Study on Modernization of
Bangkok Port



LOCATION MAP (1)





Klong Toei Wharf

ABBREVIATIONS

A

A/N	Arrival Notice
AASHTO	American Association of State Highway and Transportation Office
AC	Alternate Current
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
APL	American President Line
ASTM	American Society for Testing Materials

B

B/N	Boat Note
B/L	Bill of Lading
BHP	Brake Horse Power
BKK	Bangkok
BKP	Bangkok Port
BMA	Bangkok Municipal Administration
BMT	Bangkok Modern Terminal

C

CAT	Communication Authority of Thailand
CFC	Conversion Factor for Consumption
CFS	Container Freight Station
CIF	Cost Insurance Freight
CLP	Container Load Plan
CY	Container Yard

D

D/O	Delivery Order
D/R	Dock Receipt
DBT	Declaration of Bonded Transportation
DC	Direct Current
DOH	Department of Highway
DTS	Data Transmission System
DWT	Dead Weight Tonnage

E

E/D	Export Declaration
-----	--------------------

E

EDI	Electronic Data Interchange
EDO	Equipment Dispatch Order
EIA	Environmental Impact Assessment
EIR	Equipment Interchange Receipt
EIRR	Economic Internal Rate of Return
EIT	Engineering Institute of Thailand
ESCAP	Economic Social Conference Asia and Pacific
ETA	Estimated Time of Arrival
ETA	Expressways and Rapid Transit Authority of Thailand
ETO	Express Transportation Organization of Thailand

F

FCL	Full Container Load
FEU	Forty-foot Equivalent Unit
FIRR	Financial Internal Rate of Return
ft.	foot/feet

G

GDP	Gross Domestic Products
GRT	Gross Registered Tonnage

H

HWL	High Water Level
-----	------------------

I

IALA	International Association of Lighthouse Authorities
IBRD	International Bank for Reconstruction and Development
IC	Integrated Circuit
ICD	Inland Container Depot
IEAT	Industrial Estate Authority of Thailand
IEE	Initial Environmental Examination
IES	Illumination Engineering Society
IMO	International Maritime Organization

J

JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standard

L

LOA	Length Over All
LBP	Length between Perpendiculars
LCL	Less than Container Load
LCP	Laem Chabang Port
LLW	Lowest Low Water
LSI	Large-scale Integration
LT	Long Ton

M

M/F	Manifest
MARPOL	The International Convention of the Prevention of Pollution from Ships of 1973 with Protocol of 1978
MEA	Metropolitan Electricity Authority
MOTC	Ministry of Transport and Communications
MSL	Mean Sea Level
MT	Metric Ton
MWWA	Metropolitan Water Works Authority

N

NEC	National Electric Code
NESDB	National Economic and Social Development Board
NFPA	National Fire Protection Associates
NIDA	National Institute of Development Administration
NPKC	National Peace-keeping Council
NRT	Net Registered Tonnage

O

O/D	Origin and Destination
ODA	Official Development Assistance
OEP	Office of Environmental Policy and Planning

P

PAT	Port Authority of Thailand
PDC	Personnel Development Center
PDS	Position Detection System
PR	Ply Rating
PTT	Petroleum Authority of Thailand

R	
RC	Reinforced Concrete
RPM	Revolution Per Minutes
RTG	Rubber-tired Gantry Crane
S	
S/A	Shipping Application
SCF	Standard Conversion Factor
SHIPNETS	Shipping Cargo Information Network System
SRT	State Railway of Thailand
SSP	Ship Stowage Planning
T	
TEU	Twenty-foot Equivalent Unit
TIS	Thailand Industrial Standard
TMN	Thai Maritime Navigation
TORC	Thai Oil Refinery Company
TOS	Transtainer Operation Supervising System
TOT	Telephone Authority of Thailand
TPT	Thai Prosperity Terminal
U	
Unithai	United Thai Shipping Co.
V	
VAT	Value Added Tax
VVVF	Variable Voltage and Variable Frequency
W	
WCTS	Worldwide Cargo Trace System
Y	
YOCS	Yard Operation Computer System
YPCS	Yard Plan Computer System
YSP	Yard Stowage Planning

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EXECUTIVE SUMMARY

Executive Summary

1. Background of the Study

Bangkok Port is the most important port for international trade in Thailand through which a great portion of cargo destined for or originating from the country passes. Recently, along with the growth of the Thai economy, the volume of cargo handled through the port has shown a sharp increase especially in container cargo, amounting to around 1.3 million TEUs in 1992.

At present, however, the port has many problems; the port area is very narrow and some of the facilities are old and arranged improperly, creating inefficient operations and congestion in the port area. To resolve those problems and support further growth of the trade-oriented industries in Thailand, it is necessary to modernize Bangkok Port by introducing an efficient cargo-handling system and management/operations systems, relocating port facilities and rearranging the land use in the limited port area.

In the meantime, the Port Authority of Thailand constructed Laem Chabang Port and opened it in January 1991. Proper functional allotment of the ports of Bangkok and Laem Chabang should be accomplished through the promotion of the both ports.

Under the above situation, the Government of Thailand requested the Government of Japan to conduct a study on modernization of Bangkok Port. In response to the request, the Government of Japan conducted the preliminary study in October, 1992 which was entrusted to Japan International Cooperation Agency (JICA). The Government of Japan decided to conduct the study and entrusted it to JICA. The study was conducted from March 1993 to July 1994 and the results of the study are incorporated in this report.

2. Objectives of the Study

The objectives of the study are as follows:

- 1) To formulate the Master Plan for modernization of Bangkok Port for the period up to the year 2005,
- 2) To conduct a feasibility study for the Short-Term Plan for modernization of Bangkok Port for the period up to the year 1997.

3. Outline of the Master Plan and the Short-Term Plan

3.1 Port Facilities

The plans of volumes of cargo port facilities and construction costs proposed in this study are outlined as shown in the table below.

Item	Master Plan	Short-Term Plan
1. Target Year	2005	1997
2. Volume of Cargo		
2.1 Containers (TEUs)	1,000,000	1,000,000
2.2 Conventional Cargo(MT)	3,910,000	3,810,000
3. Facility Plan		
3.1 Facilities for Containers		
1) Expansion of the marshaling yard of the east quay	*	*
2) Introduction of 9 large RTGs	*	*
3) Construction of a concentrated reefer yard	*	*
4) Addition of one lane to the bridge connecting the east and west quays	*	*
5) Construction of 2 Import CFSs at Area II	*	*
6) Construction of 3 Export CFSs at Zone 1	*	*
7) Improvement of sheds Nos.13 and 14 as Import CFSs	*	*
8) Preparation of a yard specialized for stuffing export container cargo	*	*
9) Preparation of empty container yards west and behind sheds Nos.15-17	*	*
10) Introduction of modernized information system using computers	*	*
3.2 Facilities for Conventional Cargo		
1) Demolition of sheds Nos.7-9 to provide open storage yards	*	*
2) Relocation of the yard for import steel to inside the port from outside	*	*
3) Relocation of the existing bonded warehouse to inside the port from outside	*	*
4) Demolition of the existing supplementary sheds Nos.1,4-7,9, the bonded warehouse	*	*
5) Realignment and expansion of the existing port roads	*	*
6) Modification of sheds Nos.1-9 to create additional port roads	*	*
7) Dismantlement of the existing dockside cranes at the west quay	*	*
8) Relocation of the existing warehouses and yards for dangerous cargoes	*	*
9) Relocation of railway operations to the west quay from the east quay	*	*
10) Relocation of parking lots for port-related vehicles	*	*
11) Relocation of some of the existing offices from inside the port to outside	*	*
12) Relocation of the Vehicle Section to near Parking Lot No.3	*	*
4. Construction Cost (Billion Bhat)	3.5	1.2

3.2 Management/Operations and Institutional Matters

- 1) Introduction of the Closed Terminal System
- 2) In the stage of the Master Plan, it is proposed to create a new organization established and funded by PAT responsible for cargo-handling operations both for containers and conventional cargo at the port in order to conduct cargo handling operations in a commercial manner and simultaneously avoid the possible social problems of relocation of workers. Prior to the establishment of the above organization, in the Short-Term Plan, it is proposed that PAT take full responsibility of container-handling at a part of the marshaling yard of the east quay as a terminal operator in cooperation with shipping lines/agents under the closed terminal system so as to get operational knowhow which is expected to be transferred to the new organization proposed in the Master Plan.
- 3) In order to achieve quick decision-making and efficient management, it is proposed that PAT rearrange its organization including the Headquarters and Bangkok Port Office.
- 4) Improvement of the statistical system etc.

4. Evaluation of Feasibility of the Short-Term Plan

4.1 Economic Feasibility

Two kinds of economic benefits shown below are evaluated as benefits from the Short-Term Plan for modernization of Bangkok Port.

- 1) Savings in ships staying costs
- 2) Savings in administration and operation costs

The economic internal rate of return (EIRR) of the project is calculated as 12.4%. It exceeds the criterion of 10% which is generally adopted to assess the economic justifiability of a project. Accordingly, the Short-Term Plan is considered economically feasible.

4.2 Financial Viability

Four kinds of revenues shown below are evaluated as revenues that PAT receives from the Short-Term Plan.

- 1) Reduction of revenues of berth hire through less berthing time of container vessels
- 2) Increase of revenues from the land rent
- 3) Increase of revenues from container repair and cleaning
- 4) Increase of revenues by increase of the port tariff related to containers

Costs of investment, reinvestment, management and operation are taken into account. The personnel cost is calculated based on the assumption that PAT would recruit a smaller number of personnel than that of retirees by 50 persons per year as an effect of the Short-Term Plan.

The financial internal rate of return (FIRR) of the project is calculated as 9.3%. This figure keeps a favorable level judging from the range of the interest rates of the bank deposits. Accordingly, the Short-Term Plan is considered financially viable.

5. Outline of Recommendations

It is recommended that the project proposed in the above modernization plan of Bangkok Port be implemented to achieve economical, efficient, safe and reliable operations for port users. When implementing the project, it is proposed to take the following measures:

- 1) Both restructuring of management and operations systems and investment in necessary physical facilities in Bangkok Port shall be given emphasis and be implemented simultaneously.
- 2) The purpose of modernization of Bangkok Port is not to increase cargo throughput but to upgrade service levels of port services for its port users. The required amount of the investment is moderate judging from an average income level of PAT. Those points shall be made clear to the authorities concerned.
- 3) The port tariff is proposed to be raised slightly to cover some portion of the capital investment. In other words, the proposed increase rate is considered to be conservative compared with the benefits for the port users generated from the project. That point shall be understood by the port users.
- 4) Knowhow to control the container terminal under the closed terminal system shall be obtained by PAT through employment of competent yard planners along with cooperation with private companies as port users. Even in the transitional period when PAT will operate a part of the marshaling yard, it is essential that PAT take full responsibility of container-handling at that terminal.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Necessity of Modernization of Bangkok Port

(1) Container-Handling

The number of containers through Bangkok Port has sharply increased recently.

1. Since the start of containerization in Thailand in 1977, along with the development of the Thai economy, especially in the export-oriented industries, the number of containers through Bangkok Port has continuously increased. In the last five years, from 1988 to 1992, the number shows a sharp increase, indicating an average growth rate of 14% per annum. In 1992, the number of containers handled at Klong Toei Wharf of Bangkok Port reached around 1.3 million TEUs. In 1991/1992, the average berth occupancy rate of seven berths of the east quay where over 90% of containers are handled reached a high value of 75%.

Present system of terminal operations at Bangkok Port remains as an open type.

2. Although machines specialized for container-handling were introduced and containers of more than one million TEUs per annum are already passing through the port, the container terminal at Klong Toei Wharf of Bangkok Port remains as an open type terminal as of old where operations are performed by an individual shipping line/agent independently with the permission of PAT by each operation. The modernized system is not yet adopted in which container-handling operations are wholly controlled by a terminal operator that takes full responsibility for handling and storing containers after receipt or before delivery at its terminal gates by conducting yard planning and inventory control of containers based on data/information interchanged with customers or the authorities concerned (hereinafter referred to as "the closed terminal system").

Shortage of the marshaling yard space and incomplete yard planning cause long berthing hours of container vessels at Bangkok Port.

3. In addition to the above fact, the marshaling yard in the east quay can only rarely afford to prepare necessary stacking space for outbound containers before ship arrivals

due to shortage of yard area. Consequently, the marshaling yard in the east quay is left in a chaotic condition, and the shipping lines/agents are often forced to do costly direct loading of containers onto ships from the open yard at the west quay or off-dock CYs outside the port. When conducting the direct loading, traffic jams in and around the port cause unpredictability of boxes' arrivals to ships, and even in the port, it sometimes takes a long time to get from the west quay to the east quay.

4. In addition to the direct loading, long hauls of outbound boxes once stacked within the marshaling yard from stacking places to dockside are often found due to lack of proper yard planning. Thus, the actual gross container-handling productivity per dockside gantry crane is small, with the result that costly container ships are forced to berth for a long period, 33 hours per vessel on average.

Chaotic conditions are found in handling LCL and empty containers at Bangkok Port.

5. As to handling export LCL cargoes, stuffing operations of export cargoes and stacking operations of empty containers are conducted in mixture at the open yards of the west quay without Export CFSs, creating a dangerous situation for the people working on ground, cargoes and cargo-handling equipment within the yards. On the other hand, import LCL cargoes are stored in Import CFSs scattered within the port area, forcing tractor-chassis units and ordinary trucks to engage in intricate movements, which has led to serious traffic congestion in the port.

It is necessary to modernize container-handling at Bangkok Port through the introduction of the closed terminal system together with increase in container storage capacity at the marshaling yard.

6. Thus, to resolve the present problems mentioned above and achieve economical, efficient, safe and reliable operations for the port users, it is necessary to modernize container-handling at Klong Toei Wharf of Bangkok Port through the introduction of the closed terminal system and the preparation of the required infrastructures, upper-structures and container-handling machines including an increase of container storage capacity at the marshaling yard. By realizing the modernization of the marshaling yard, berthing times of container vessels are expected to be reduced remarkably; that results in economical container transportation and consequently generates benefits for the Thai economy.

After introducing the closed terminal system, container-handling capacity at Bangkok Port is estimated as one million TEUs per annum, reduced from the present level despite the increase in the container storage capacity, and the figure matches the ceiling number of containers decided by the government.

7. To ensure the above mentioned modernized services for the port users, by adopting the closed terminal system, a terminal with the system needs a more spacious marshaling yard than the present open type terminal to handle the same number of containers, in other words, the terminal with the closed system can handle less containers than the present open type terminal given the same storage capacity of marshaling yard. This is because it is necessary for the terminal with the closed system to receive export containers and stack them within its marshaling yard before an arrival of a container vessel without allowing the direct loading from outside and also to stack import containers once after discharging within the yard.

8. After introducing the closed terminal system at Bangkok Port, the container-handling capacity of the container terminal is estimated to be reduced to approximately one million TEUs per annum from the present level despite the increase in the container storage capacity, though it may sound paradoxical.

9. The estimated figure of approximately one million TEUs per annum in container-handling capacity almost matches the figure of one million TEUs which was determined by the Government of Thailand to restrict the total number of containers through Bangkok Port and thereby reduce the road traffic burden generated by port cargoes in Bangkok Metropolis.

Owing to the modernization of Bangkok Port, traffic volume generated from port activities at Bangkok Port is expected to be remarkably reduced.

10. The total traffic volume from/to Bangkok Port in the stage of the Master Plan is forecast to decrease about 50% from the present traffic volume due to the reduction in the number of containers through the port mentioned above, the percentage of 20ft. containers and LCL containers, though the traffic volume of the conventional cargo is forecast to increase slightly at that stage.

Proper functional allotment between the ports of Bangkok and Laem Chabang is expected to be accomplished through the market mechanism.

11. In the meantime, since a great portion of containers originate from or are destined for in and around Bangkok Metropolis, and the container-handling capacity of Bangkok Port is restricted due to the limitation of available space and necessity of reducing road traffic generated from its port activities, a considerable portion of containers must be diverted to Laem Chabang Port, a deep sea port that has recently opened.

12. Although presently most containers are transported through Bangkok Port and the portion through Laem Chabang Port is still small, the number of containers through Laem Chabang Port is expected to steadily increase in the future on routes where the cost of land transport from Bangkok area to Laem Chabang Port can be compensated or covered by the savings on maritime transport costs derived through the introduction of bigger container vessels. Some eastbound routes including routes for East Asia are considered to be such routes where Laem Chabang Port has an advantage or potential advantage over Bangkok Port.

13. Consequently, proper functional allotment between the ports of Bangkok and Laem Chabang is expected to be achieved. That will be beneficial to both ports and also for port users; the moderate amount of containers that will be handled at Bangkok Port will enable services for port users to be upgraded, and Laem Chabang Port will be promoted at the same time.

(2) Handling Conventional Cargo

All ten berths of the west quay at Bangkok Port will be exclusively used to receive the forecast volume of conventional cargo in the stage of the Master Plan.

14. In 1991/1992, the berth occupancy rate of ten berths at the west quay of Klong Toei Wharf of Bangkok Port which received mainly conventional vessels (87% of the total number at the west quay) reached a high value of 78%. In recent years the volume of conventional cargoes handled at the west quay has shown a downward trend, and the volume of conventional cargo handled in the stage of the Master Plan is projected to remain almost at the same level as at present. On the other hand, container vessels, some of which are presently received at the west quay, are planned to be received only

at the east quay in the stage of the Master Plan as a result of the modernization of container-handling at Klong Toei Wharf of Bangkok Port and the subsequent reduction in the total container number from the present level. This means all ten berths will be exclusively used for conventional vessels. Thus, the usage conditions of the west quay are expected to remain almost the same as at present and the preparation of additional berths for conventional cargo in the Master Plan is not required.

Mixing use of the sheds and open storage yards behind the conventional berths for both conventional and container cargoes induces the shortage of space for storing conventional cargo and serious traffic congestion in the port.

15. The sheds and open storage yards behind the conventional berths of the west quay are presently used for not only conventional cargo but container cargo, resulting in shortage of space for storing conventional cargo, especially in open storage yards for steel products. Consequently, import steel products are forced to be stored at the yard outside the custom fences, resulting in inefficient discharging of the cargo from conventional vessels.

16. Moreover, mixing use of the sheds and open storage yards behind the conventional berths for both conventional and container cargoes induces serious traffic congestion on the roads behind the berths due to intricate movements of various kinds of vehicles such as ordinary trucks and tractor-chassis units. Also, passenger cars and trucks/tractor-chassis units parking along the existing roads narrow the effective widths of the roads and exacerbate the traffic congestion.

The modernization of the container-handling at Bangkok Port makes it possible to withdraw container storage from the area behind the conventional berths, and consequently storage for steel products can be transferred to yards inside the port from outside.

17. Such congestion in cargo storage or traffic behind the conventional berths of the west quay can be resolved by the withdrawal of container storage at the area behind the conventional berths of the west quay and subsequent rearrangement of usage of the existing sheds, warehouses, open storage yards and offices, and realignment of the existing port roads. The above withdrawal of container storage is linked to the proposed modernization of the container-handling at Bangkok Port. In such rearrangement of the

existing storages, storage for steel products can be transferred to yards inside the port from outside.

18. It is also effective for the reduction of traffic congestion to prepare new parking lots for passenger cars and trucks/tractor-chassis units near the port gates and transfer the existing various offices inside the port having no direct linkage with cargo-handling operations to outside the customs fences.

2. Master Plan (Target Year: 2005)

The Master Plan includes both modernization of management, operations and institutional matters, and that of physical facilities in Bangkok Port. Both of these are indispensable for the modernization of the port and should be realized simultaneously.

(1) Container-Handling

Containers of one million TEUs per annum are planned to be handled.

19. The Master Plan is formulated with a target year of 2005. In that year, the number of containers to be handled at Bangkok Port (Klong Toei Wharf and private terminals) and Laem Chabang Port is estimated as 3.47 million TEUs as a total. Out of the total, one million TEUs and 2.19 million TEUs are allocated to Klong Toei Wharf of Bangkok Port and Laem Chabang Port, respectively. The remaining 280,000 TEUs are allocated to the private terminals within the limits of Bangkok Port.

It is proposed to introduce the closed terminal system along with an increase in container storage capacity at the marshaling yard.

20. To accommodate the above containers of one million TEUs at Klong Toei Wharf of Bangkok Port with economical, efficient, safe and reliable terminal operations for the port users, it is proposed to introduce the closed terminal system. To enable the introduction of the closed terminal system, it is essential to increase the storage capacity of the marshaling yard at the east quay by converting the site of the two existing sheds into the container-stacking yard. At the newly expanded stacking yard, RTGs which are larger than those presently used are proposed to be procured so as to increase the

container storage capacity as much as possible (which would result in a total capacity of approximately 10,000 TEUs).

21. In addition, it is proposed to introduce information systems using computers which is prerequisite to handle containers of one million TEUs per annum in the closed terminal system.

It is proposed to rationalize LCL-handling operations at the west quay by installing new Export CFSs in Zone 1 and Import CFSs in Area II.

22. To back up container-handling operations at the marshaling yard of the east quay which will be modernized as mentioned above, it is proposed to rationalize LCL-handling operations at the west quay and thereby LCL containers can be delivered to the marshaling yard of the east quay swiftly before a closing time from the west quay or be delivered to the west quay from the marshaling yard just after the completion of the necessary procedure at the marshaling yard. For that purpose, it is proposed to install new Export CFSs in Zone 1 and Import CFSs in Area II facing Ajnarong Road running along the port area.

23. Thus, areas for stuffing operations for exported container cargoes will be separated from the empty container stacking yards. Furthermore, the movements of ordinary trucks from outside to CFSs will be separated from the movements of tractor-chassis units. The yards for storing empty containers with a total storage capacity of around 12,000 TEUs are allocated behind and west of the sheds Nos.15-17.

(2) Handling Conventional Cargo

The existing ten berths at the west quay are allocated exclusively for conventional vessels.

24. In the target year of the Master Plan, the volume of conventional cargo to be discharged at Klong Toei Wharf of Bangkok Port is estimated as 3.91 million tons. To accommodate the above amount of conventional cargo, the existing ten berths at the west quay are allocated exclusively for conventional vessels.

It is proposed to rearrange the usage of the existing sheds, warehouses, open storage

yards and offices, and realign the existing port roads.

25. The sheds and open storage yards behind the conventional berths will be used exclusively for storing the cargo discharged from conventional vessels. Some of the existing sheds will be converted into open storage yards, and thereby import steel products which are presently stored outside the port will be stored at the yards just behind the berths. The usage of the existing warehouses will be rearranged, and thereby bonded cargoes for Laos which are presently stored outside the customs fences will also be stored inside the port.

26. Corresponding to the above rearrangement, it is proposed to realign and expand the existing port roads, and prepare parking lots near the port gates.

27. In addition, it is also proposed to relocate the existing warehouses for dangerous cargo to a place with a sufficient buffer zone by expanding the present area for the storage.

(3) Necessity of Land for New Port Facilities

The areas containing Area II, Zone 1, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be indispensable for port activities in the stage of the Master Plan.

28. It is difficult to prepare lands for installing new Export CFSs, Import CFSs and parking lots for port-related vehicles within the present customs fences because of the limitation of space. Therefore, they should be located outside of existing customs fences. The areas containing Area II, Zone 1, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be the most suitable places for the above new port facilities judging from their location and are indispensable in the stage of the Master Plan.

(4) Navigational Safety

It is proposed to widen the breadth of the stretches of the Bar Channel and institute special new rules to improve navigational safety.

29. It is proposed to widen the breadth of the stretches of the Bar Channel to 150 meters to improve navigational safety from the present level especially for large vessels whose lengths and breadths are close to the maximum permissible ones. In addition, it is also proposed to institute special new rules for the port including certain restrictions/controls on overtaking, anchoring, maximum speed and reciprocal meeting of large vessels within the fairway to prevent accidents.

(5) Construction Costs

30. The total construction cost of the Master Plan is roughly estimated as 3.5 billion Baht.

(6) Management, Operations and Institutional Matters

It is proposed to create a new organization established by PAT responsible for cargo-handling operations and rearrange the remaining PAT organization including the Headquarters and Bangkok Port Office.

31. It is advisable that the cargo-handling operations at Bangkok Port be carried out in a commercial manner where business is run efficiently with a flexible management system especially in container-handling operations where the closed terminal system will be newly introduced and the existing facilities will be redeveloped to back up the new system. As to container-handling operations, all-out operations by private companies are not realistic taking account of the situation of Bangkok Port: more than fifteen shipping lines/agents are using the terminal with limited space and social problems of relocation of workers would arise if cargo-handling operations were privatized.

32. To conduct cargo-handling operations in a commercial manner and simultaneously avoid the possible social problems, it is proposed to create a new organization established and funded by PAT responsible for cargo-handling operations both for containers and conventional cargo at the port.

33. Prior to the establishment of a new organization for cargo-handling operations, it is proposed to rearrange the remaining PAT organization including the Headquarters and Bangkok Port Office to achieve quick decision-making and efficient management.

(7) Environmental Consideration

Estimated annual throughput at the port and the total traffic volume to be generated from the port activities in the stage of the Master Plan are less than the present level and the project has positive environmental effects.

34. Bangkok Port is already an operating port with an annual throughput of 16 million tons. Estimated annual throughput in 2005, when the modernization project is completed, is less than the present levels, and therefore the total traffic volume to be generated from the port activities will decrease from the present level. Moreover, the maximum size of calling vessels will not be changed. Consequently, the project has positive environmental effects reducing number of calling ships and induced road traffic.

35. A comprehensive system to satisfy requirements of MARPOL 73/78 convention should be studied by the Government of Thailand.

3. Short-Term Plan (Target Year: 1997)

The Short-Term Plan includes both modernization of management, operations and institutional matters, and that of physical facilities in Bangkok Port. Both of these are indispensable for the modernization of the port and should be realized simultaneously.

(1) Container-Handling

Containers of one million TEUs per annum are planned to be handled.

36. The Short-Term Plan is prepared as a first-stage plan for the modernization of Bangkok Port with a target year of 1997. In that year, the number of containers to be handled at Bangkok Port (Klong Toei Wharf and private terminals) and Laem Chabang Port is estimated as 2.12 million TEUs as a total. Out of the total, one million TEUs and 840,000 TEUs are allocated to Klong Toei Wharf of Bangkok Port and Laem Chabang Port, respectively. The remaining 280,000 TEUs are allocated to the private terminals within the limits of Bangkok Port.

It is proposed to introduce the closed terminal system along with an increase in

container storage capacity at the marshaling yard.

37. To accommodate the above containers of one million TEUs at Klong Toei Wharf of Bangkok Port, it is proposed to introduce the closed terminal system in the stage of the Short-Term Plan with an increase in storage capacity of the marshaling yard at the east quay by the same way proposed in the Master Plan.

It is proposed to rationalize LCL-handling operations at the west quay by installing new Import CFSs in Area II and separating stuffing yard for exported container cargoes from the stacking yards for empty containers.

38. To back up container-handling operations at the marshaling yard of the east quay which will be modernized as mentioned above, it is proposed to rationalize LCL-handling operations at the west quay by installing new Import CFSs in Area II and separating stuffing yard for exported container cargoes from the stacking yards for empty containers. The yards for stuffing export container cargoes or storing empty containers neighboring with each other are allocated behind or west of the sheds Nos.15-17.

(2) Handling Conventional Cargo

The existing ten berths at the west quay are allocated exclusively for conventional vessels.

39. In the target year of the Short-Term Plan, the volume of conventional cargo to be discharged at Klong Toei Wharf of Bangkok Port is estimated as 3.81 million tons. To accommodate the above amount of conventional cargo, the existing ten berths at the west quay are allocated exclusively for conventional vessels.

It is proposed to rearrange the usage of the existing sheds, warehouses, open storage yards and offices, and realign the existing port roads.

40. The sheds and open storage yards behind the conventional berths will be used exclusively for storing the cargo discharged from conventional vessels. Some of the existing supplementary sheds and Bonded Warehouse will be converted into open storage yards, and thereby import steel products which are presently stored outside the port will be stored at the yards just behind the berths.

41. Corresponding to the above rearrangement, it is proposed to realign and expand the existing port roads, and prepare parking lots near the port gates.

42. In addition, it is also proposed to relocate the existing warehouses for dangerous cargo to a place with a sufficient buffer zone by expanding the present area for the storage.

(3) Necessity of Land for New Port Facilities

The areas containing Area II, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be indispensable for port activities in the stage of the Short-Term Plan.

43. The areas containing Area II, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be the most suitable places for installing new Import CFSs and the parking lots for port-related vehicles and are indispensable in the stage of the Short-Term Plan.

(4) Construction Costs

44. The total construction cost of the Short-Term Plan is estimated as 1.2 billion Baht.

(5) Management, Operations and Institutional Matters

It is proposed that PAT take full responsibility of container-handling operations at a part of the marshaling yard cooperating with shipping lines/agents, and rearrange PAT's organization including the Headquarter and Bangkok Port Office.

45. It is proposed that PAT take full responsibility of container-handling at a part of the marshaling yard of the east quay in cooperation with shipping lines/agents under the closed terminal system to be newly introduced so as to get operational know-how which is expected to be transferred to the new organization proposed in the Master Plan.

46. Prior to the establishment of the new organization mentioned above, it is advisable to rearrange PAT organization including the Headquarters and Bangkok Port Office so as to achieve quick decision-making and efficient management in the stage of

Short-Term Plan.

(6) Economic Analysis

The proposed modernization project with the EIRR of 12.4% is considered to be economically justifiable.

47. A comparison between the "Without Modernization" case and the "With Modernization" case was carried out to evaluate the feasibility of the project for modernization of Bangkok Port proposed in the Short-Term Plan from the viewpoint of the national economy of Thailand. In the comparison, the economic rate of return (EIRR) is used to evaluate the measurable economic benefits compared with the economic costs. The main economic benefits of the project are the savings on staying costs of container vessels at the port and the costs of port administration and operations generated from the modernization project. The resulting EIRR is estimated as 12.4% exceeding the general criterion to assess the economic justifiability.

(7) Financial Analysis

The proposed modernization project with the FIRR of 9.3% is considered to be financially feasible.

48. The main financial benefits of the project are increases of revenues from the new business of container repair/cleaning, tariff raised slightly to cover some portion of the capital investment and reduction of administration and operation costs generated from the project. The resulting financial rate of return (FIRR) is estimated as 9.3% keeping a favorable level judging from the range of the interest rates of bank deposit.

(8) Environmental Consideration

The modernization project proposed in the Short-Term Plan has positive environmental effects and EIA as an administration procedure will not be needed.

49. The Short-Term Plan has positive environmental effects, reducing number of calling ships and induced road traffic. Consequently, EIA as an administration procedure will not be needed.

50. In the stage of the construction works, contractors of the works should take heed of regulations in Thailand regarding environmental consideration such as disposition of waste materials from demolition sites.

RECOMMENDATIONS

In accordance with the results of the study, it is recommended that the Government of Thailand implement the modernization project of Bangkok Port to achieve economical, efficient, safe and reliable operations for port users. The project is divided into two phases: the first phase project is that proposed in the Short-Term Plan with the target year 1997 and the second phase project is that to be completed by the target year 2005 of the Master Plan.

1. The First Phase Project

The main components of the first phase project are summarized as follows:

1.1 Container-Handling

- (1) Introduction of a closed container terminal system
- (2) Expansion of the marshaling yard of the east quay:
 - Total storage capacity: 9,942 TEUs (4,128 ground slots)
 - Demolition of sheds Nos.11 and 12 to provide an open yard
- (3) Introduction of 9 large RTGs (6 rows + 1 lane) to be used partly at the marshaling yard
- (4) Construction of a concentrated reefer yard at the west end of the marshaling yard:
 - Number of plugs: 352 units
 - Reefer-handling equipment: RTGs of small size
- (5) Adding one traffic lane to the bridge connecting the east and west quays
- (6) Construction of 2 Import CFSs with the total floor space of 15,000 sq.m at Area II
- (7) Improvement of sheds Nos.13 and 14 as Import CFSs
- (8) Preparation of a yard specialized for stuffing export container cargo:
 - Ground slots of 912 TEUs
 - Container-handling equipment: toplifters
- (9) Preparation of yards for storing empty containers west and behind sheds Nos.15-17:
 - Total storage capacity: 7,272 TEUs (2,424 ground slots)
 - Container-handling equipment: toplifters

(10) Preparation of other main facilities:

- Marshaling yard:
 - Terminal office near gate No.3
 - Repair yards for RTGs (No.1 ~ No.3)
 - 3 terminal gates
- West quay:
 - Maintenance shop for container boxes
 - Cleaning area for container boxes
 - Parking lot for tractors/chassis
 - Area for container-handling equipment

(11) Introduction of Modernized Information System Using Computer:

- Review and modification of the current documentation forms to meet the requirements of the new terminal operation system
- Development of required software through purchase of package software and improvement of it by trained PAT staffs to minimize a lead time

1.2 Handling Conventional Cargo

(1) Transference of the storage yard for import steel products to inside the port from outside:

- Preparation of storage yards behind the conventional berths
- Conversion of the site of existing Import Steel Open Yard located outside the port into commercial use

(2) Demolition of the existing supplementary sheds Nos.1,4-7,9 and the Bonded Warehouse to provide open yards

(3) Realignment and expansion of the existing port roads

(4) Modification of sheds Nos.1-9 to create additional port roads

(5) Dismantlement of the existing dockside cranes at the west quay

(6) Relocation of the existing warehouses and yards for dangerous cargoes including cotton to an area with a sufficient buffer zone

(7) Transference of railway operations to the yard west of the west quay from the east quay

(8) Preparation of parking lots for passenger cars and trucks/tractor-chassis units:

- Parking Lot No.1 near Checking Post 1 for passenger cars
- Parking Lot No.3 behind the planned dangerous cargo area for trucks
- Parking Lot No.2 near Checking Post 2 for trucks/tractor-chassis units

- (9) Transference of offices having no direct linkage with cargo-handling operations from inside the port to outside

1.3 Navigational Safety

To improve safety in the navigational waterways of Bangkok Port, special new rules including certain restrictions/controls on overtaking, anchoring, maximum speed and reciprocal meeting of large vessels within the fairway should be instituted.

1.4 Management, Operations and Institutional Matters

PAT should start container-handling operations at a part of the marshaling yard and take full responsibility for the container-handling there to get operational know-how which could be transferred to the new organization controlling the entire terminal proposed to be established in the next phase. In the early stage, it is advisable to employ competent yard planners who are indispensable in controlling the terminal under the closed terminal system.

Moreover, PAT should rearrange its organization including the Headquarters and Bangkok Port Office to achieve quick decision-making and efficient management. PAT should also improve the statistical system.

1.5 Environmental Consideration

A study on which sector should be responsible for receiving and treating oily wastes and a study on the location of treatment plant should be made by the government in preparing to ratify MARPOL 73/78 convention. PAT will not be primarily responsible for the system, but it will have to share responsibility for backing up the system to some extent.

2. The Second Phase Project

The main components of the second phase project are summarized as follows:

2.1 Container-Handling

- (1) Construction of 3 Export CFSs with the total floor space of 27,000 sq.m at Zone 1
- (2) Expansion of yards for storing empty containers west and behind sheds Nos.15-17:
 - Total storage capacity: 11,832 TEUs (3,944 ground slots)
 - Container-handling equipment: toplifters
- (3) Upgrading Information System Using Electronic Computer:
 - Participation to computer network system connecting port users and authorities concerned internationally

2.2 Handling Conventional Cargo

- (1) Demolition of sheds Nos.7-9 to provide open storage yards
- (2) Transferring the warehouse for bonded cargo for Laos to inside the port from outside:
 - Preparation of sheds Nos.15-17 to store the bonded cargo
 - Conversion of the site of existing In-Transit Warehouse located outside the port into commercial use
- (3) Expansion of parking lots
 - Parking Lot No.1 for passenger cars
 - Parking Lot No.2 for passenger cars and trucks
- (4) Transference of the Vehicle Section to the area adjacent to Parking Lot No.4

2.3 Navigational Safety

It is advisable to widen the breadth of the stretches of the Bar Channel to 150 m.

2.4 Management, Operations and Institutional Matters

To conduct cargo-handling in a commercial manner and simultaneously avoid the possible social problems arising from the relocation of workers, it is advisable to create a new organization established and funded by PAT responsible for cargo-handling operations at the port.

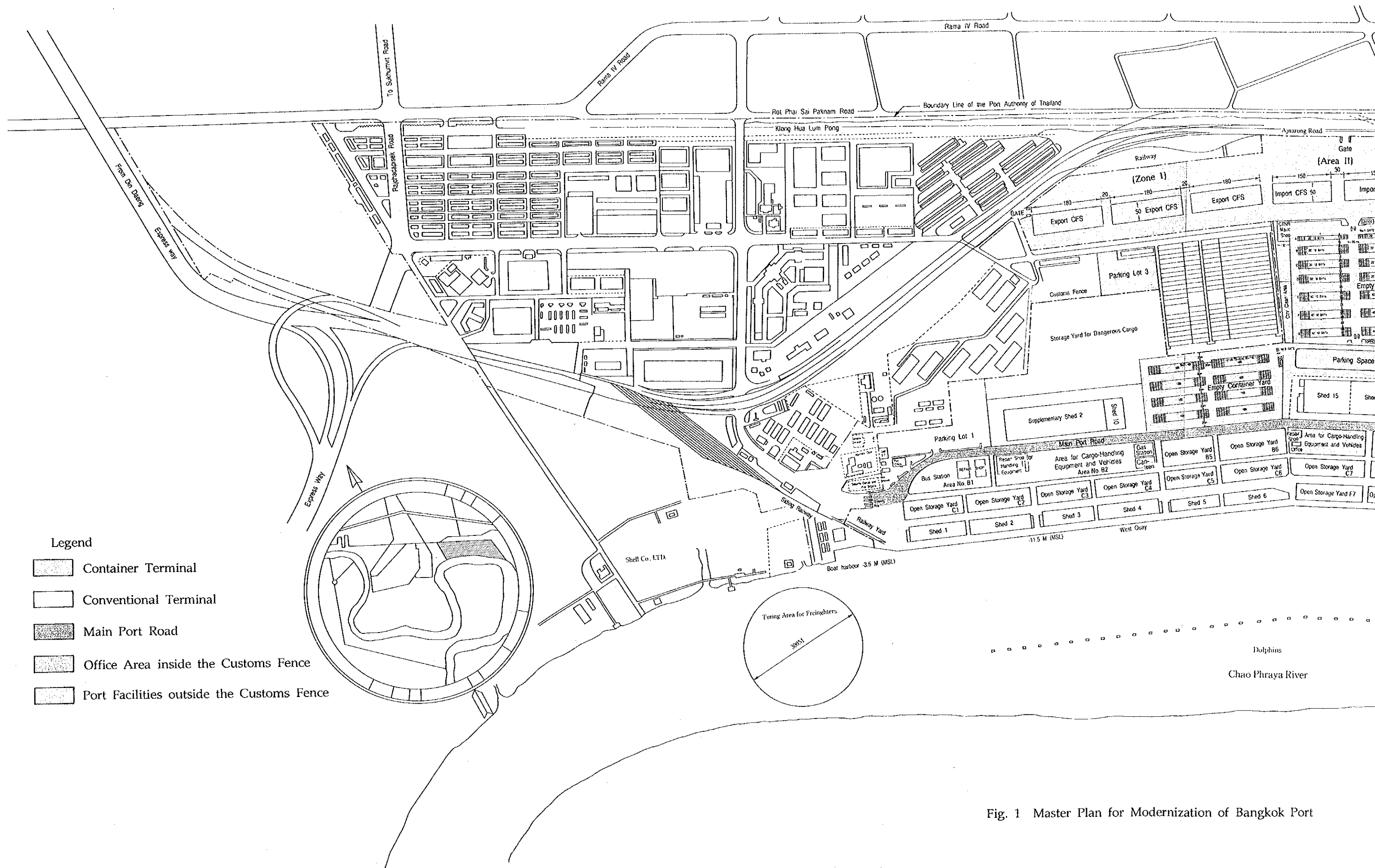


Fig. 1 Master Plan for Modernization of Bangkok Port

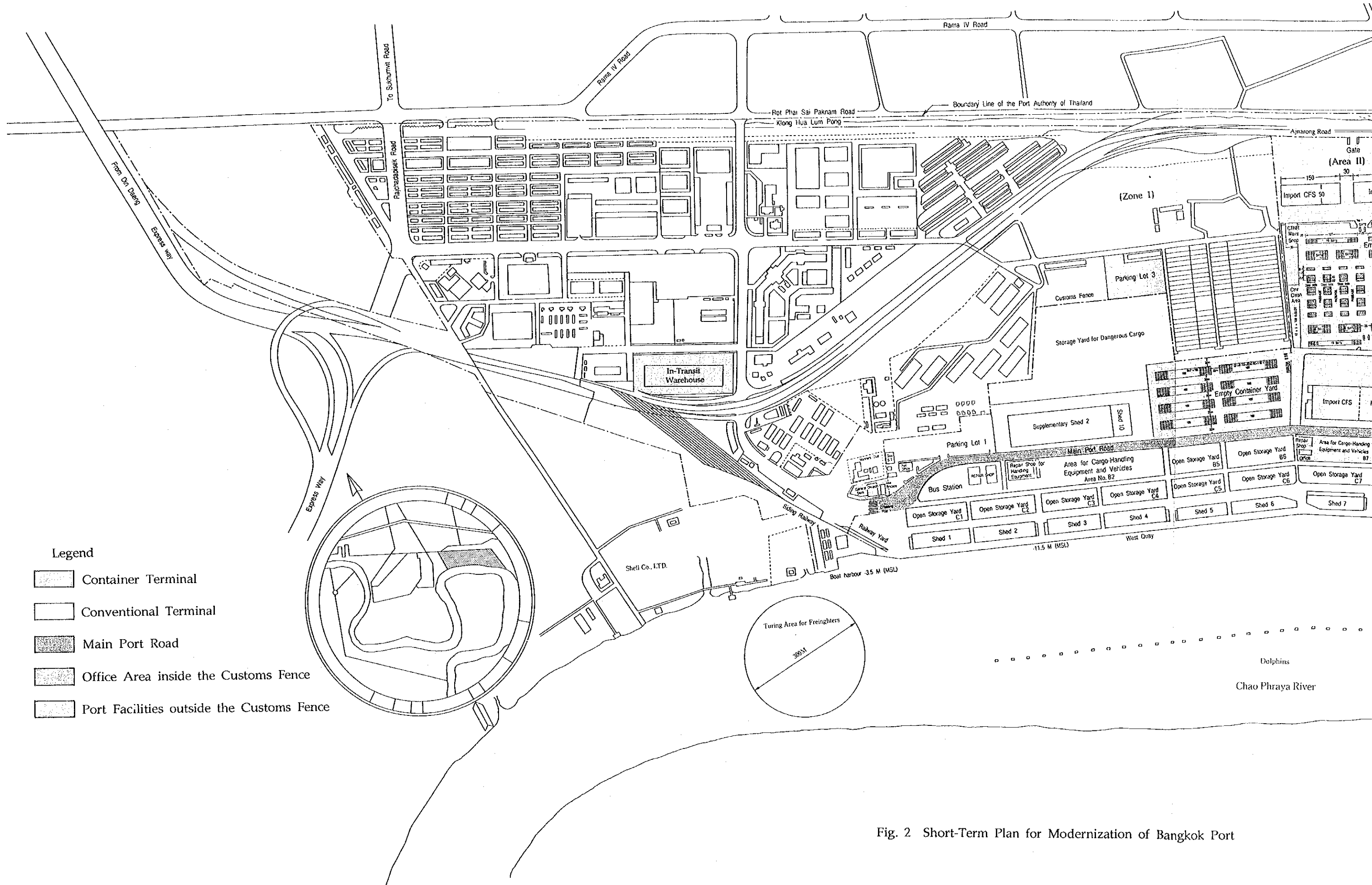
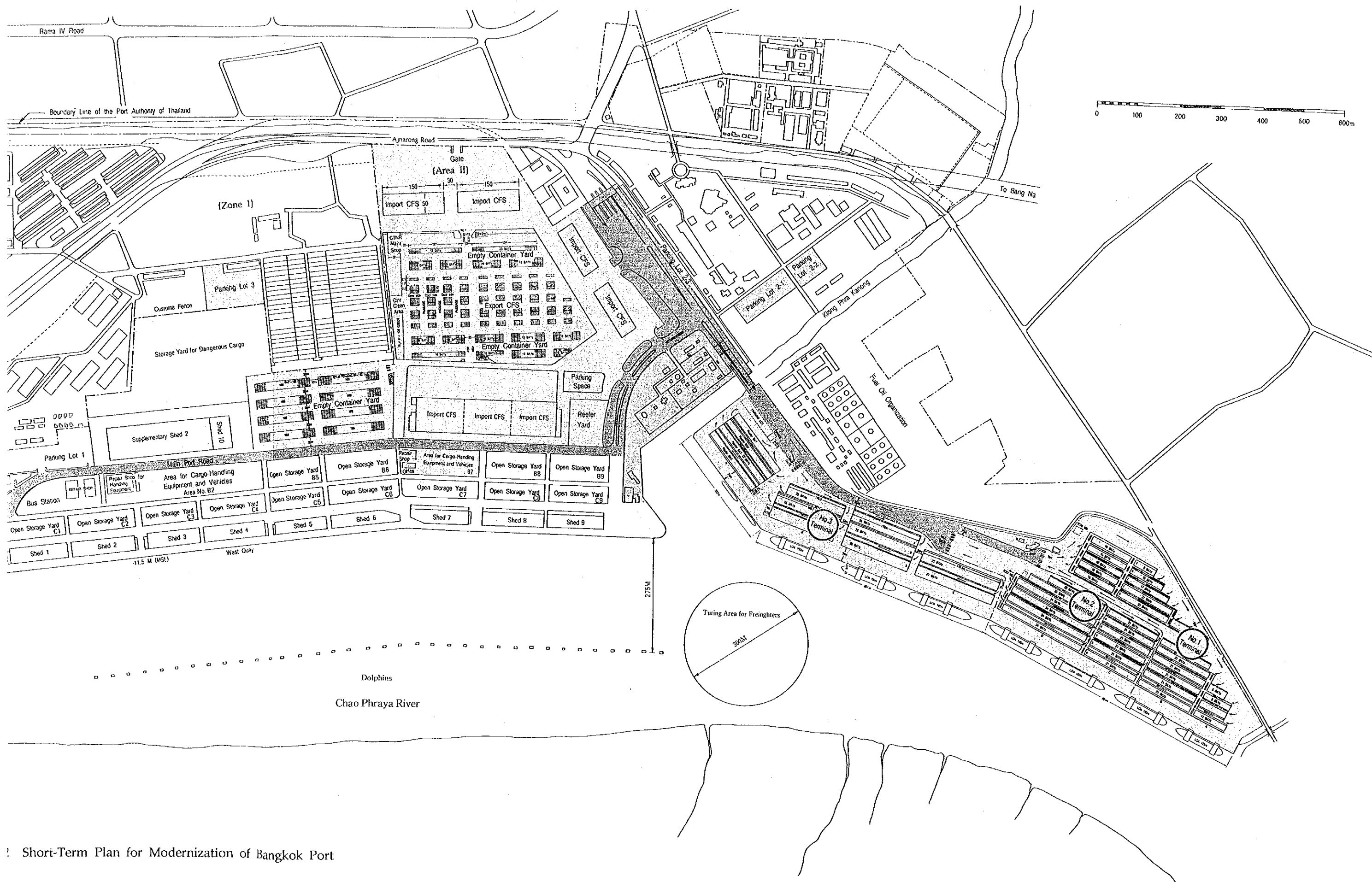


Fig. 2 Short-Term Plan for Modernization of Bangkok Port



2 Short-Term Plan for Modernization of Bangkok Port

PART I

MASTER PLAN

Chapter 1 Outline of the Kingdom of Thailand

1.1 General

1.1.1 General Condition

The population of Thailand increased to 56.933 million in 1991 from 48.709 million in 1982 with an average annual growth rate of 1.7%. Presently, population density is 111 persons/km².

As for the national population distribution, northeastern region accounts for 34.4% of the national total.

Urbanization has proceeded along with the progress of the industrialization of the Thai economy. However, only 17 cities have a population of more than 50,000, all of which are connected by the major transport network. Cities having more than 100 thousand inhabitants are Chiang Mai and Nakhon Sawan in the north region, Khon Kaen, Nakhon Ratchasima in the northeastern region, Hat Yai in the southern region and Bangkok.

Table 1-1-1 Population by Region 1982 to 1991

Region	Unit: thousand									
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BMA	5,139	5,273	5,412	5,557	5,681	5,802	5,924	6,040	6,162	6,267
Vicinity	2,180	2,257	2,333	2,416	2,499	2,581	2,659	2,733	2,808	2,888
Central	2,528	2,553	2,584	2,608	2,635	2,662	2,690	2,726	2,755	2,780
North	9,724	9,870	10,012	10,154	10,285	10,417	10,548	10,677	10,804	10,921
Northeastern	17,098	17,411	17,708	17,982	18,264	18,540	18,810	19,068	19,321	19,564
Eastern	2,941	3,005	3,074	3,144	3,213	3,278	3,348	3,417	3,491	3,558
Western	2,911	2,958	3,006	3,055	3,097	3,139	3,175	3,217	3,254	3,290
Southern	6,188	6,354	6,508	6,663	6,837	7,006	7,171	7,335	7,488	7,665
Total	48,709	49,681	50,637	51,579	52,511	53,425	54,325	55,213	56,083	56,933

Source: Human Resources Planning Division, National Economic and Social Development Board

Table 1-1-2 GDP Volume 1982-1991 at 1988 prices

	Millions of Baht									
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Agriculture	198,825	208,312	217,518	227,324	228,191	228,346	252,346	276,729	265,414	278,063
Manufacture	230,235	255,995	271,856	288,133	294,521	341,750	403,034	467,686	542,169	606,763
Construction	48,008	53,772	59,390	59,289	60,138	65,060	74,449	95,554	114,420	135,240
Others	542,433	558,353	589,590	636,529	674,327	740,691	829,975	911,566	1,032,226	1,086,183
Total	1,019,501	1,076,432	1,138,353	1,191,255	1,257,177	1,376,847	1,559,804	1,751,515	1,954,229	2,108,249

Source: Office of the National Economic and Social Development Board

The structure of the Thai economy remained virtually unchanged up to the late 1950s. Since the early 1960s, the industrial and service sectors have been increasing their shares of the total GDP and the total employment, respectively. Agricultural sector, however is still the major sector in generating income and employment in Thai economy; about two thirds of the working population are engaged in agriculture and 13.2% of the national income is derived from agriculture.

Significant structural changes in the Thai economy have taken place since the early 1960s. The agricultural sector's share of the national income declined steadily from about 40% in 1960 to 13.2% in 1991. At the same time, the manufacturing sector expanded very rapidly, increasing its share of the national income from 13% in 1960 to 28.8% in 1991. Such a structural change does not, however, imply that agricultural output failed to rise during the period. On the contrary it increased by about 5% per year.

The industrialization process initiated during the 1960s was geared toward import substitution. It was succeeded in the 1970s by a drive to produce export-oriented items. By the mid 1970s, Thailand was exporting manufactured goods ranging from cement to watch parts, and including canned fruits, garments, chemical products, transport equipment and television sets. In 1991, manufactured exports accounted for about 76% of total export earnings.

International trade is vital to the Thai economy. Thailand's entry into foreign markets has enabled its economy to expand rapidly. Today the economic structure has become more outward-oriented and internationalized, as indicated by the increase in the proportion of international trade to GDP from 60% in 1986 to 80% in 1991. Although there were annual deficits, the balance of payments recorded a continuous surplus throughout the 1960s and the early 1970s. A sharp increase in oil prices since 1973, though, has affected the balance of payment position severely.

The public sector supports the growth process by providing basic infrastructures and by creating a positive environment for private sector development. The ratio of capital formation by the public sector to that of the private sector is rising sharply from 0.43 in 1977 to 0.74 in 1981.

In short, the performance of the Thai economy over the 25 years ranks high among developing countries. Some basic economic problems such as income disparity, the need to conserve natural resources, the high dependence on energy consumption and the need for improving administrative efficiency remain to be solved, but judging from the past performance as well as from the present economic outlook, it is clear that Thailand has the potential to greatly expand its economy.

1.1.2 Industrialization

Industrialization in Thailand began in the early 1960s. Although the Industrial Promotion Act was enacted in 1954, it was actually implemented in 1960 through the establishment of the Board of Investment. The Act was revised in 1962 to include the promotion of investment through such incentives as exemption from customs duties and other taxes on imported materials, equipment and machinery, and was revised again in 1972 together with the change in policy emphasis from import substitution toward export promotion.

Since the formation of IEAT in 1972 the establishment of industrial estate has branched out from the Bangkok Metropolitan area to other provinces of the country. The total area of the industrial estate now covers 35,000 rais and is prepared to meet the increasing demand. To cope with the rapidly growing number of industries resulting from the implementation of the National Economic and Social Development Plan, more industrial estate are planned for in three regions, North, Northeast and South, in conjunction with the strong support provided by the government and private sector.

Major industries in Thailand are cement, textiles, electric appliances, sugar, paper and iron and steel. Light industries producing consumer goods are dominant. Almost all the major industries are concentrated in the Bangkok Metropolitan Area except for sugar mills and gunny bag producers which are located in the northeastern region, and tin smelting in the southern region.

Major mining products in Thailand are tin, fluorite, manganese, antimony, lead, lignite, gypsum and rock salt. Almost all of these mining products are exported to neighboring countries in South Asia, Japan, England, Germany and the Netherlands as raw materials. Among these, smelted tin is exported through Phuket port.

1.1.3 Foreign Trade

The amount of foreign trade cargo increased from 36,846 thousand tons in 1982 to 76,051 thousand tons in 1991, at an average annual rate of 8.6%. Total imports fluctuated between 15 million tons and 20 million tons during the period from 1982 through 1986, but after 1987 rapidly increased and reached 45 million tons in 1991. Total exports fluctuated between 17 million tons and 23 million tons during the period from 1982 to 1987, but after 1988 rapidly increased and reached 31 million tons in 1991.

Table 1-1-3 Foreign Trade Cargo of Thailand by Maritime Transportation

Cargo	Unit: 1,000 Tons									
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Import	15,736	20,032	18,908	18,092	18,820	22,688	26,144	32,577	39,867	45,402
Export	21,110	17,101	20,266	21,737	23,368	22,506	27,204	32,009	29,565	30,649
Total	36,846	37,133	39,174	39,829	42,188	45,194	53,348	64,586	69,432	76,051

Source: MOTC Statistics

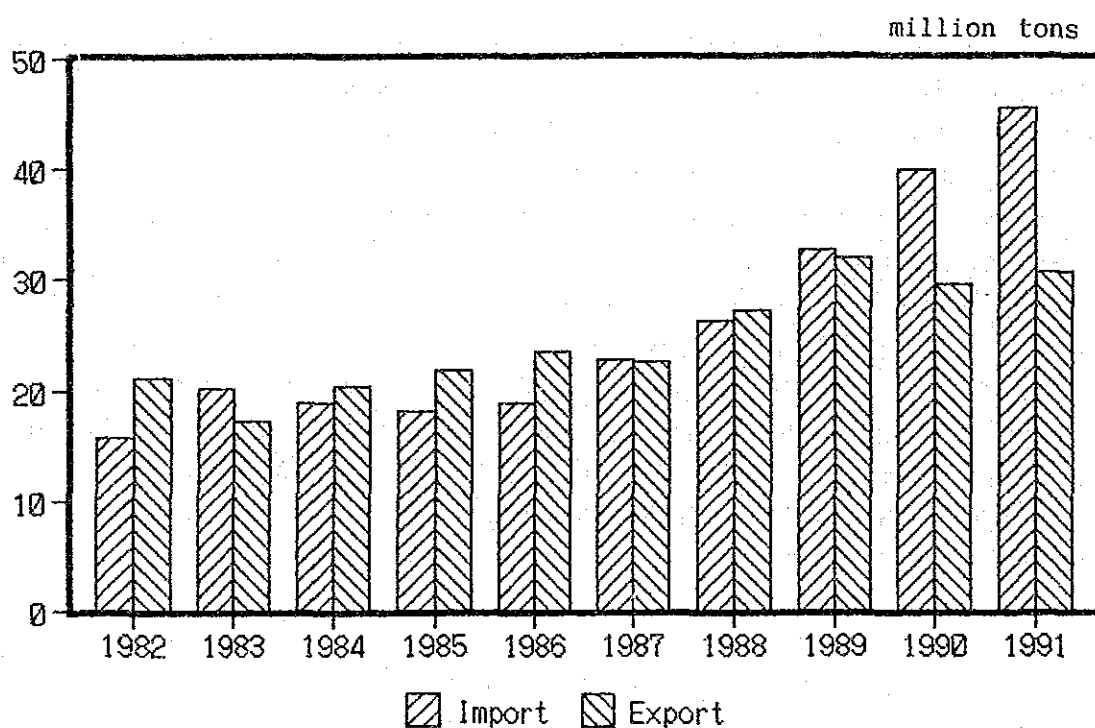


Fig. 1-1-1 Foreign Trade Cargo of Thailand

1.2 Socioeconomic Development Plans

1.2.1 First Plan(1961-1966)

In 1959, Thailand established the National Economic Development Board following the recommendations of the International Bank for Reconstruction and Development (IBRD) and the first National Economic Development Plan was formulated by the Board in 1961.

The first plan mainly concerned public works, and the major objectives were as follows:

- i) To raise the standard of living;
- ii) To encourage economic growth in the private sector;
- iii) To promote increased agricultural production and improve quality;
- iv) To promote industrial expansion; and
- v) To promote commercial competition in the private sector.

During the first planning period (1961-1966), the Investment Promotion Act was enacted and import substitution industries such as the textile industry were promoted.

1.2.2 Second Plan(1967-1971)

From the second development plan, the name of the plan was changed to the National Economic and Social Development Plan considering the importance of social development in Thailand.

The second plan aimed to achieve: i) mobilization of human and natural resources for optimum utilization in expanding the productive capacity and national income of the country so that the benefits of the development could be shared equitably by all classes of people, ii) promotion and maintenance of social justice; preservation of social stability, national institutions, customs and culture; and provision of relief to people in isolated areas who cannot effectively help themselves, iii) maintenance of economic and financial stability to enable the development process to continue on the basis of sound values and productive investments for long-term growth, and iv) preservation of national security, which depends in the final analysis upon the economic strength and social unity of the country.

During the second planning period (1967-1971), modern manufacturing industry grew with increased foreign investment and a high degree of diversification took place, enabling Thailand to boost its export items from only three major commodities, namely, rice, teak and rubber in the early 1950's to more than 10 agricultural products including

maize, tapioca and sugar.

1.2.3 Third Plan(1972-1976)

The third plan started in 1972 and its major objectives were as follows:

- i) To restructure the economic system and to promote economic growth
- ii) To maintain economic stability
- iii) To promote economic growth in rural areas and to reduce the income disparity gap
- iv) To improve social justice
- v) To develop manpower resources and to create employment
- vi) To promote the private sector's role in economic development

During this planning period (1972-1976), the major objectives could not be achieved due to the unfavorable economic situation caused by the oil crisis. However, foreign trade grew rapidly beyond the targeted volume. Imports increased at an average annual rate of 11.5% and exports increased at an average annual rate of 14% mainly through the diversification of agricultural products for export.

1.2.4 Fourth Plan(1977-1981)

The fourth plan was formulated under various political and socioeconomic changes in Thailand including the revolution of October 1976. However, the major objectives of the plan were inherited from the third plan, since the objectives in the third plan addressed the basic structural problems of the country. These were i) acceleration of economy recovery, ii) reduction of income disparity, iii) reduction of the population growth rate, iv) improvement of the management of critical resources and rehabilitation of environmental conditions and v) strengthening of national security management.

During the planning period (1977-1981), Thailand achieved a high economic growth rate of around 7.1% per year. However, inflation and trade imbalances caused by the rapid industrialization and the increase in imported raw materials including oil, imported intermediate manufactured products and imported capital goods became a serious burden on the country's finances.

1.2.5 Fifth Plan(1982-1986)

The fifth plan aimed at the restoration of the country's economic and financial position intending to make the country one of the newly industrialized countries in the long run,

as well as at the decentralization of economic activities away from the Bangkok Metropolitan Area.

Major objectives of the fifth national economic and social development plan were as follows.

- i) Restoration of the country's economic and financial position
- ii) Adjust economic structure and raise economic efficiency
- iii) Development of social structure and distribution of social services
- iv) Poverty alleviation in backward areas
- v) Coordination of economic development activities with national security management
- vi) Reformation of the national development administration system and deconcentration of the ownership pattern

During the fifth planning period (1982-1986), the average economic growth was 4.4% per year, which was below the target of 6.6%. This was caused by low growth of international trade, trade barriers, high real interest rates and falling prices for agricultural commodities.

1.2.6 Sixth Plan(1987-1991)

In view of the problems and limitations on the one hand and the development opportunities in Thailand in the near future on the other, the sixth plan defines its major objectives as follows:

Economic: To maintain an average rate of growth at a level not below 5% in order to absorb the minimum of 3.9 million persons who will be entering the labor market. Growth should be accomplished in such a way that economic stability is strengthened and the economic problems that arose during the fifth plan period are solved.

Social: To develop the quality of life so that social development can progress, peace and justice be attained and development of the country as a whole supported. The national identity, culture and system of values will be maintained and the quality of life of the Thai people will be raised in both rural and urban areas.

1.2.7 Seventh Plan(1992-1996)

Evaluation of past development efforts suggests that the development objectives of the Seventh Plan will have to carefully balanced in terms of quantitative and qualitative

development dimensions, as well as social equity aspect in order to bring about more sustainable development for the country. Therefore, the three main development objectives of the Seventh Plan have been set out as follows.

- i) Maintain economic growth rates at appropriate Levels to ensure sustainability and stability.
- ii) Redistribute income and decentralize development to the regions and rural areas more widely.
- iii) Accelerate the development of human resources, and upgrade quality of life, the environment and natural resource management.

In order to bring about the pattern of more sustainable development mentioned earlier, it is essential to accord equal priority to the three main development objectives.

Table 1-2-1 shows the overall economic targets in the Seventh Plan.

Table 1-2-1 Overall Economic Targets in the Seventh Plan

Category	Sixth Plan Actual trends (1987-1991)	Seventh Plan Targets (1992-1996)
1. Economic growth (% per year at constant prices)	10.5	8.2
1.1 Agriculture sector	3.4	3.4
1.2 Non-agriculture sector	12.1	8.6
- Industry	13.7	9.5
- Construction	18.7	8.9
- Services and others	11.0	8.1
2. Per capita income (baht/year) *1	41,000	71,000
3. Export of goods		
3.1 Average value (billion bath)	496	1,063
3.2 Average growth rate per year (%)	24.5	14.7
4. Import of goods		
4.1 Average value (billion bath)	664.3	1358.0
4.2 Average growth rate per year (%)	32.6	11.4
5. Inflation (%)	4.7	5.6
6. Number of population (million)	56.9	61.0
Population growth rate (%)	1.4	1.2

*1 Figures of the last year (1991 and 1996) of the Sixth and Seventh Plans respectively

Source: The Seventh National Economic and Social Development Plan (NESDB)

Chapter 2 Natural and Environmental Conditions

2.1 Natural Conditions

2.1.1 Geography

Thailand is located in the western part of the Indochinese Peninsula, bordered by Myanmar to the west, the Lao People's Democratic Republic to the north and northeast, Cambodia to the east, and Malaysia to the south. The country's total area covers 513,115 square kilometers and its longest north to south distance is approximately 1,650 kilometers from 5°37' to 20°27' north latitude.

The country can be divided into four geographical regions: the fertile central region dominated by the Chao Phraya River, the cool and mountainous north region, the semi-arid north-east plateau, which is the country's poorest region, and the southern peninsular region extending to the border of Malaysia. There are 73 Changwats (Provinces) in Thailand and each Changwat houses a local government. Bangkok, the capital of the country, is located at 14 degrees north latitude in the central plains.

2.1.2 Climate

The following three seasons can be distinguished in the country:

- The rainy season is generally from late May to mid October. The average annual rainfall of the country is about 1,800 mm and the region of heaviest rainfall extends along the west coast of the southern part and along the east coast of the Gulf of Thailand where the annual rainfall is more than 4,000 mm.
- The cold season, from mid October to mid February, is the mildest season of the year.
- The hot season begins in late February and lasts to mid May and the average temperature is above 30 °C.

A summary of meteorological data in Thailand is shown in Table 2-1-1.

Table 2-1-1 Climate for Selected Meteorological Station

(1989 ~ 1991)

Meteorological Station	Latitude	Longitude	Year	Temperature		Rainfall Total (mm)	Humidity Mean (%)
				Mean Max (°C)	Mean Min (°C)		
Bangkok	13° 44' N	100° 30' E	1989	32.9	24.4	1496.4	73
			1990	33.2	24.7	1362.9	72
			1991	33.3	24.9	1358.5	73
Chiang Mai	18° 47' N	98° 59' E	1989	32.1	19.9	1190.4	70
			1990	32.2	20.3	1161.0	70
			1991	32.4	20.9	1006.8	69
Phuket	07° 53' N	98° 24' E	1989	32.2	25.0	1899.0	75
			1990	32.7	25.3	1984.9	76
			1991	32.8	25.0	1967.0	76

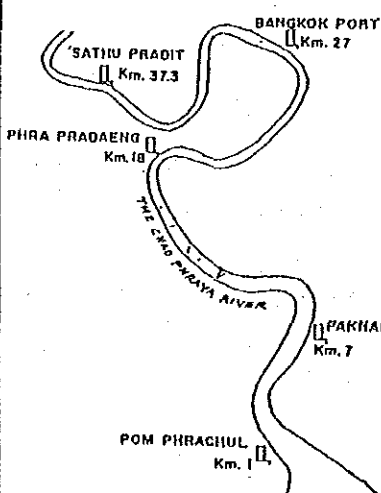
Source : Thailand, Meteorological Station

Note : Not including the data of December, 1991.

2.1.3 Tidal conditions in Bangkok port

There are five tidal observation stations from the estuary of the Chao Phraya river to Bangkok port. The tidal information from each station is shown in Table 2-1-2.

Table 2-1-2 Tidal Information

Tides	Sathu Pradit	Bangkok Port	Phra Pradaeng	Paknam	Pom Phrachul	Site of The Tidal Guages
Highest High Water	+2.01m (1983)	+2.11m (1988)	+2.19m (1990)	+2.20m (1991)	+2.28m (1988)	
Mean High Water Spring		+1.28	+1.31	+1.35	+1.39	
Mean High Water		+0.89	+0.94	+0.91	+0.95	
Mean High Water Neap		+0.95	+0.95	+0.97	+0.94	
Mean Sea Level (Kohs Lak Standard)	0.00	0.00	0.00	0.00	0.00	
Mean Low Water Neap		-0.17	-0.72	-0.75	-0.83	
Mean Low Water		-0.48	-0.54	-0.65	-0.63	
Mean Low Water Spring		-1.04	-1.15	-1.22	-1.29	
Lowest Low Water						
Low Water	-1.79	-1.72	-1.78	-1.90	-1.79	

Source : Marine Department, P.A.T

2.1.4 Waves in Bangkok Bay

Bangkok bay is well sheltered from the south-western or north-eastern monsoons by the peninsula and the main land respectively. Thus, waves come from the south only.

Significant wave heights:	1.50m	2.00m	2.50m
Duration(hours per year):	30	1	0.05

(source: Nedeco)

2.1.5 Subsoil condition in Bangkok port

Boring works and laboratory tests were carried out by JICA Study Team from the end of April to the beginning of June 1993 to confirm the subsoil condition in Bangkok port. Three borings were done on the line between shed 7 and shed 8 in the west quay, and one boring was done on land between shed 11 and shed 12 in the east quay.

The borings have been done up to the depth of maximum -35m below ground surface. It shows three different layers as shown below.

- 1st layer: Ground level to about -12m
 Soft, Dark gray clay
 N value=0 (penetrated by the weight of hammer)
- 2nd layer: Between around -12m to -20m
 Stiff to very stiff, Grayish brown silty clay
 N value=10 to 20
- 3rd layer: Below around -20m
 Very stiff to hard, Grayish brown silty clay
 N value=20 to 30

The location of boreholes and the soil profile are shown in Fig. A-1-1, 2, 3 of Appendix 1. The boring log and laboratory test results of each boring are also presented in Fig. A-1-4, 5, 6, 7 and Table A-1-1, 2, 3, 4 of Appenrdix 1 respectively.