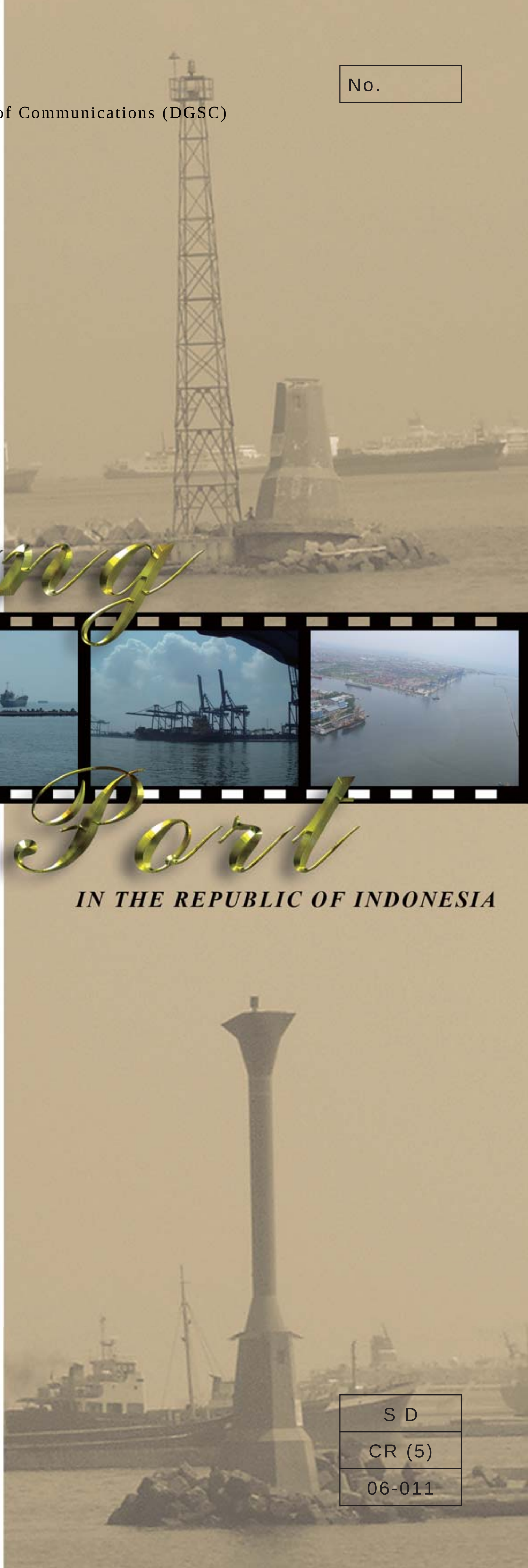
Japan International Cooperation Agency (JICA)
Directorate General of Sea Communication, Ministry of Communications (DGSC)
Indonesian Port Corporation II (IPC II)

No.



Final Report

for the Detailed Design Study
on the Urgent Rehabilitation Project
of

Tanjung Priok Port

IN THE REPUBLIC OF INDONESIA

MAIN REPORT

March 2006

Nippon Koei Co., Ltd.
Japan Port Consultants, Ltd.

Japan International Cooperation Agency (JICA)
Directorate General of Sea Communication, Ministry of Communications (DGSC)
Indonesian Port Corporation II (IPC II)

Final Report

for the Detailed Design Study
on the Urgent Rehabilitation Project
of

Tanjung Priok Port

IN THE REPUBLIC OF INDONESIA

MAIN REPORT

March 2006

Nippon Koei Co., Ltd.
Japan Port Consultants, Ltd.

Conversion Rates under this Study

Yen 1.0 = Rp. 95.00

US$ 1.0 = Rp. 10,900

(October 2005)

PREFACE

In response to the request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Detailed Design Study of the Urgent Rehabilitation Project of the Tanjung Priok Port in the Republic of Indonesia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched a Study Team headed by Mr. Kiyokuni Okubo of Nippon Koei Co., Ltd. to the Republic of Indonesia between February 2005 and February 2006.

The Study Team held discussions with the concerned officials of the Government of the Republic of Indonesia and conducted field surveys and design works in the study area. Upon returning to Japan, the Study Team prepared the Final Report.

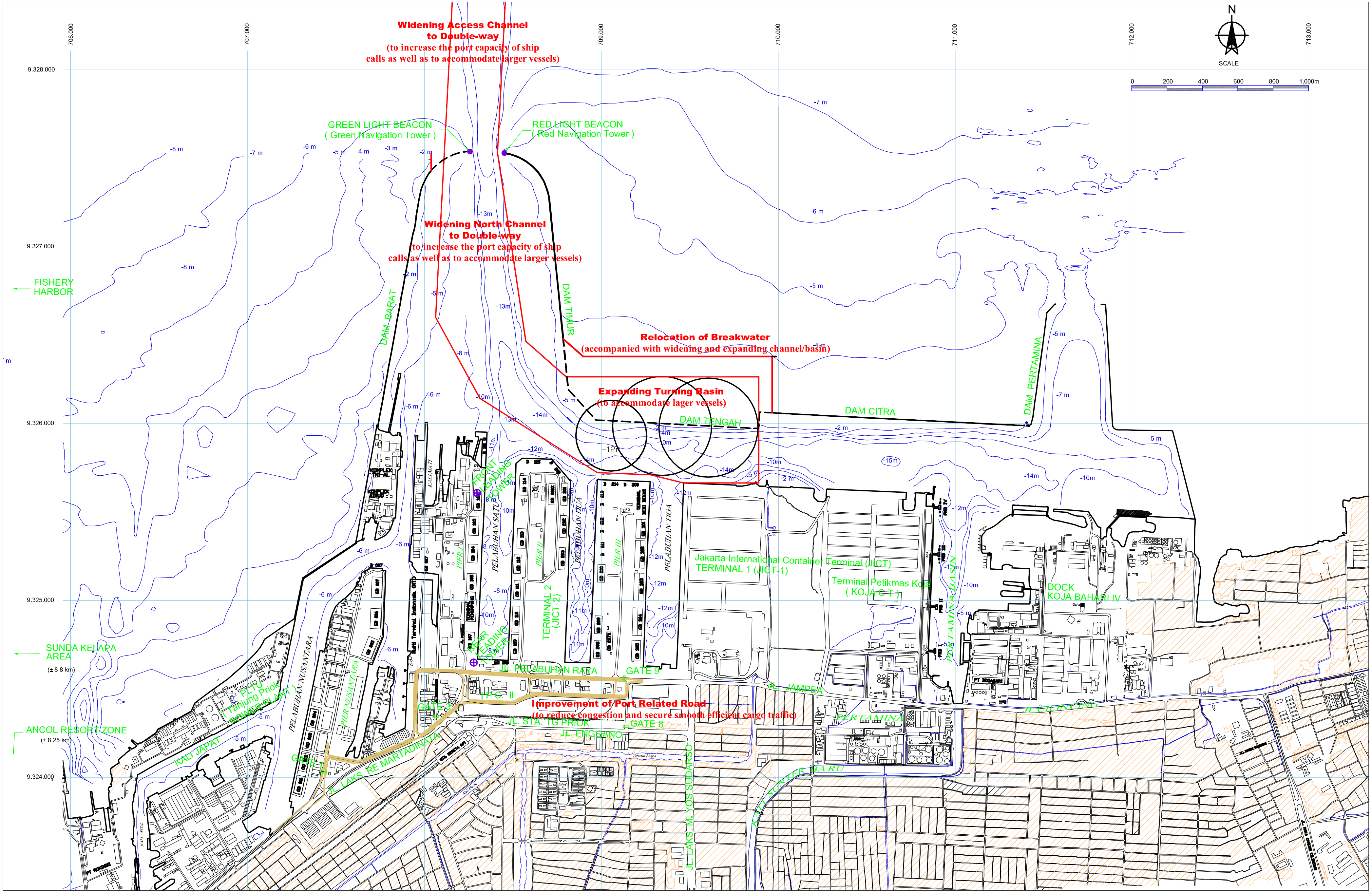
I hope that this report will contribute to the promotion of the Project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the concerned officials of the Government of Indonesia for their close cooperation extended to the Study.

March 2006

Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

LOCATION MAP



Project Componet for JICA Study

EXECUTIVE SUMMARY

In response to a request from the Government of Indonesia, the Government of Japan dispatched the JICA Study Team, who conducted a Detailed Design Study on the Urgent Rehabilitation Project of Tanjung Priok Port from 2005 to 2006. The major outputs of the Study have been condensed as below.

(Objectives and Scope of the Study)

(01) The Detailed Design Study on the Urgent Rehabilitation Project of the Tanjung Priok Port (the Project) has been conducted for 1) Navigation Channel and Basin Improvement, 2) Relocation of Breakwaters, and 3) Port Inner Road Improvement. All these study targets were clearly identified in the JICA Master Plan Study (2003).

(02) The JICA Detailed Design Study Team (hereinafter referred to as the JICA D/D Team), on the basis of latest site information, has reviewed the Master Plan Study and refined the scope of the Project, and carried out the following studies. On the basis of the detailed design, the Draft Tender Documents for the Project have also been prepared.

* Natural Condition Survey and Numerical Modelling

* Design of Navigation Channel/Basin and Navigation Aids

* Design of Breakwater Relocation

* Design of Breakwater

* Design of Port Inner Road, including Pasoso Flyover

* Implementation Planning (Construction, Cost, Maintenance and Environmental Management Plan)

* Project Evaluation and Recommendations

(Natural Condition Survey and Numerical Modeling)

(03) For the detailed design, the JICA D/D Team has conducted field investigations and surveys, including i) geotechnical investigation and tomography, ii) hydraulic survey, iii) bathymetric, seismic profiling survey and magnetic survey, iv) topographic survey, v) environmental survey and vi) traffic survey. Furthermore, numerical modeling has been carried out to estimate the sedimentation in the new navigation channel and basin, and to project the dispersion level of turbidity from dredging and dumping operations.

(Design of Navigation Channel/Basin and Navigation Aids)

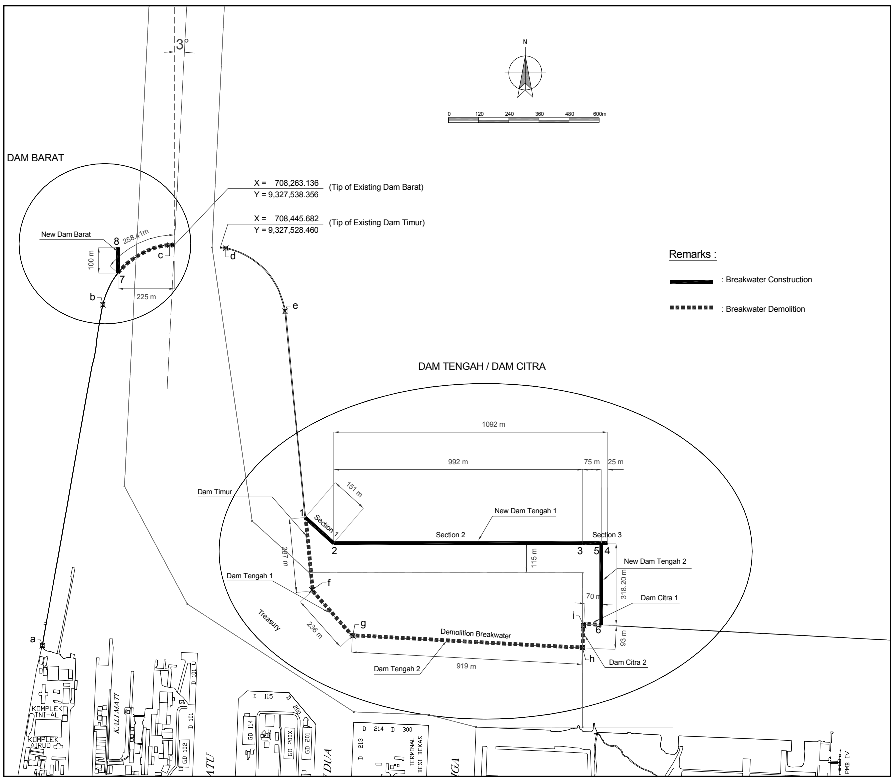
(04) For the design of the channel and basin, the particulars of the maximum size ship of 50,000 GT, which is 280m in LOA, 32.7m in beam and 12.7m in draft, has been confirmed. To allow two-way traffic of 50,000 GT vessels, the navigation channel has been designed with a width of 300m and a depth of 14m. To swing a 50,000 GT vessel with tug assistance, a 560m diameter turning basin should be provided in front of pier III and the container berths. Also considered in the design was the stopping distance of 1000m (3.5@ LOA) straight line inside the breakwater and 2000m (7@ LOA) including the outer channel portion.

(05) The orientation of the new navigation channel has been set at N-03-E, basically following the existing bearing of the outer channel and considering the offshore sight clearance of the new navigation light. The total dredging volume of the navigation channel and basin would be 8.09 million m3 (0.83 million m3 in the outer channel, 2.55 million m3 in the inner channel and 4.71 million m3 in the turning basin).

(06) To mark the new navigation zones, one fairway buoy, two channel buoys, one entrance beacon, two marker beacons and one sector light should be installed with the detailed characteristics designated by DGSC. In addition, 11 sets (10 sets inside the port and 1 set outside the port) of the existing navigation buoys should be relocated.

(Design of Breakwater Relocation)

(07) To protect the new port navigation area, part of the existing breakwaters should be demolished and new breakwaters should be constructed. At the port entrance, the offshore section of Dam Barat should be demolished to make way for the widened navigation channel. Among three alternative breakwater configurations at the tip of Dam Barat, Alternative-3 (demolition of the existing breakwater at the widened channel section and 100m offshore extension parallel to the new navigation channel) has been selected to provide navigational safety and to minimize sedimentation inside the port. (See Figure-00)



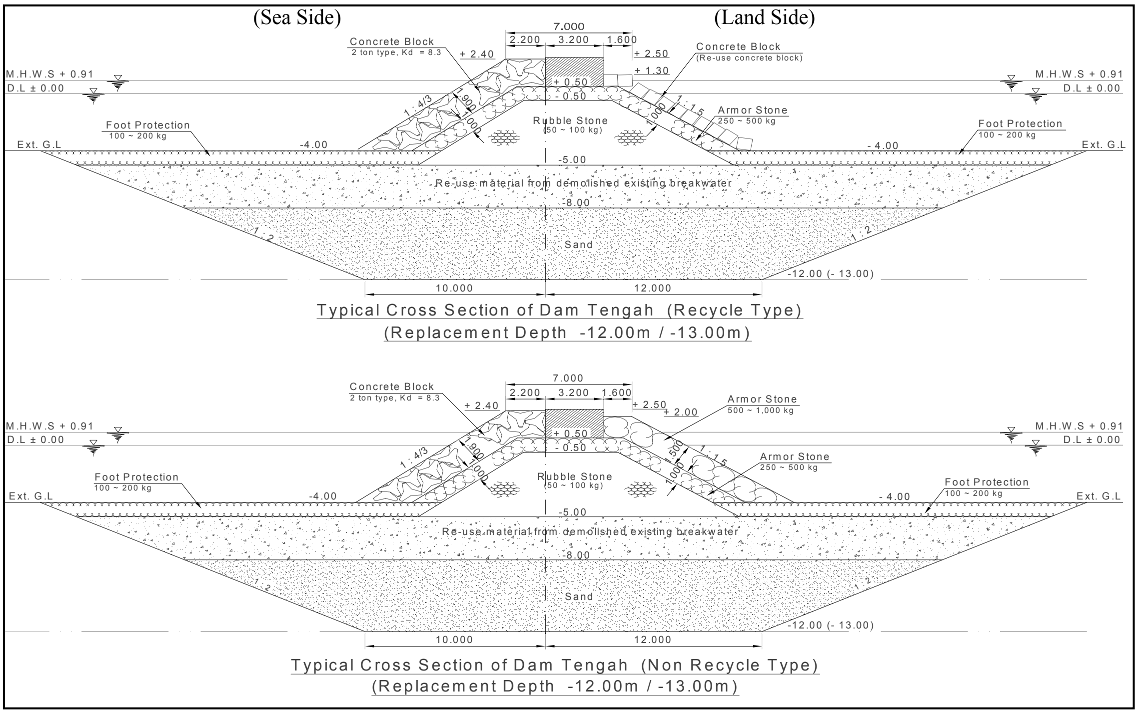
Breakwater relocation Plan

(08) The western part of Dam Tengah (1,605m) should also be demolished, and New Dam Tengah-1 (1,243m) should be constructed about 400m offshore of the existing Dam Tengah. Among two alternative breakwater configurations at the eastern end of New Dam Tengah, A Gap-Close Plan (A temporary breakwater-New Tengah-2 (318m) will be constructed to link New Dam Tengah-1 and the existing Dam Citra) has been selected to minimize the sedimentation inside the port and secure sufficient wave tranquility.

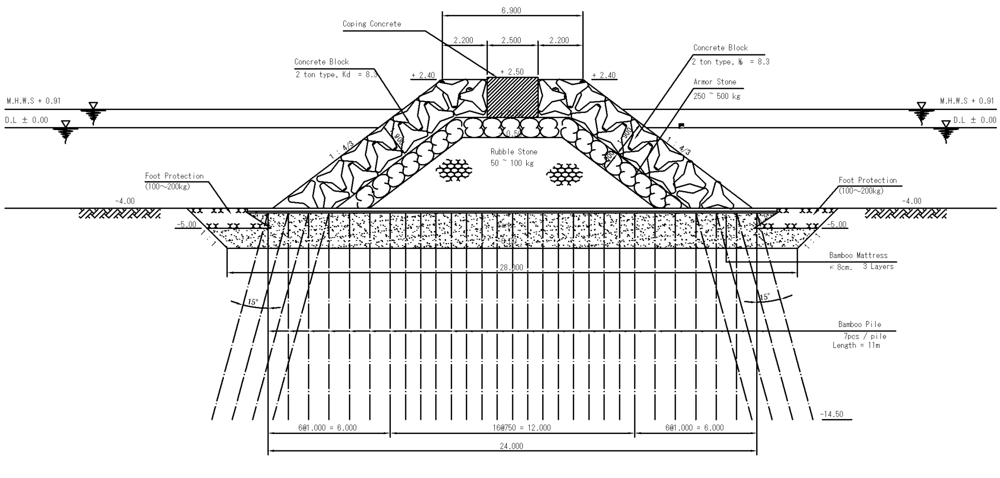
(09) As the result of the combination of the above selected alternative breakwater plans, the total sedimentation in the study port area has been projected at 483,000 m3/year, which is an increase of about 30%, compared to the current sedimentation of 365,000 m3/year.

(Design of Breakwater Structure)

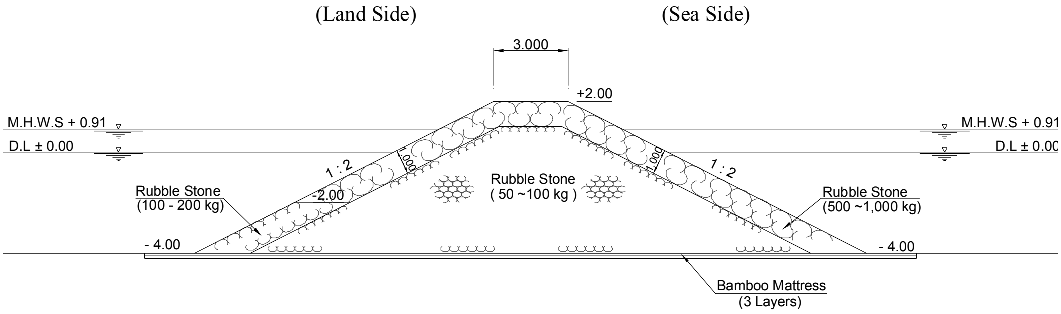
(10) For New Dam Tengah, a rubble-mound structure with sand replacement has been selected because of its advantage in reusability of the demolished breakwater materials (environment-friendly) and less settlement in the future (low-maintenance cost). For New Dam Barat, a combined foundation structure, consisting of shallow sand-replacement and bamboo-piling with bamboo- mattress, has been selected, because of its advantage over the high cost of full-scale sand replacement. For the temporary breakwater-Dam Tengah-2, only bamboo mattress has been considered as foundation, allowing settlement in the future. (See following Figures)



Cross Section of New Dam Tengah-1



Cross Section of New Dam Barat



Cross Section of New Dam Tengah-2

(Design of Port Inner Road and Pasoso Flyover)

(11) To ease serious traffic congestion in the port inner roads, a one-way traffic system has been adopted inside the port. To supplement this system and to cater for the traffic growth in the future, additional lanes and new roads should be constructed. To complete the one-way system, the Pasoso flyover, which serves the outgoing port traffic, should be constructed near Gate-3. The flyover, passing over Jl. Martadinata, will provide clearance height of 5.1m as stipulated in the Indonesian standards, and also provide sufficient clearance height for the elevated highway to be constructed in the near future.

(12) The port inner roads have been designed with cement concrete pavement (30cm) on the overlay portions and asphalt pavement (20cm) on the widened portions. The Pasoso flyover has been designed with a super-structure of PC-I girders (7.0m wide and 40m@8span=320m long) and PC-pile foundation. The total construction time for the port inner road and flyover is 3 years.

(Project Implementation Plan)

(13) The construction and demolition plans for the breakwaters have been prepared, considering i) no interruption to present port operation, ii) maintaining the tranquility of the channel/basin as much as possible, iii) minimizing sedimentation in the stage of construction and iv) reuse of existing breakwater materials. The demolition of the existing breakwater will commence from the southern end of Dam Timur, proceeding eastwards with the new breakwaters partially overlapping the demolished sections. Total construction period for the above work is 15.5 months.

(14) The total dredging volume would be 9.54 million m3, including over-dredging and tolerance for the slopes and bottom. Considering the local conditions of soils and sea traffic, the dredging work will be executed chiefly by trailer suction hopper dredgers (average 4,000m3) and partially supplemented by grab bucket dredgers (average 12m3). The dredging work will proceed from the inner channel to the turning basins, and then to the outer channel areas. The total dredging work period is estimated at 31 months.

(15) The Project is to be implemented in packages. Package-1 consists of the navigation channel/basin improvement and the relocation of the breakwaters. Package-2 consists of the port inner road improvement, including the Pasoso Flyover. The total construction costs for Package-1 and Package-2 are 9,301 million JPY and 1,531 million JPY respectively. The total project costs, including contingencies and engineering fees has been estimated at 11,767 million JPY.

(16) The implementation agency for Environmental Management Plans (EMP) is DGSC in the stage of construction and IPC-II in the stage of operation and maintenance. The environmental surveys disclosed the existence of heavy metal contents (Hg and Cd) in the seabed near the dredging area and the dumping area. Some of the test samples show

contamination levels that might require adequate treatment. As such, it has been concluded that adequate measures should be taken, when dumping such contaminated soil.

(Project Evaluation and Recommendations)

(17) Since the Project has been justified technically, economically and environmentally, and the Draft Tender Documents have been completed, DGSC should proceed to the next process of the Project implementation, including the selection of a supervision consultant.

(18) To minimize the likely obstructions and eliminate accidental damage to the ongoing sea/road traffic during the construction period, the Project implementation body (DGSC/IPC-II) should organize a special safety unit, which should coordinate the construction safety measures jointly with the Supervision Consultant.

(19) DGSC/IPC-II should organize the environmental control unit, who should coordinate and follow the environment management program that has been proposed by the JICA D/D Team. With the assistance of the Supervision Consultant, the monitoring of marine/onshore works should be executed to prevent any environmental problems, including sea pollution in and around the Project area.

(20) The Maintenance and Repair Program for the Project has been prepared, focused on the maintenance dredging operation on the widened channel and basin. IPC-II should execute periodical bathymetric surveys to monitor seasonal trends of sedimentation, thereby refining the maintenance program. Also important is the maintenance for the breakwater structure. The breakwater settlement should be carefully monitored to sustain the planned requirements.

Main Report
for
The Detailed Design Study
on
The Urgent Rehabilitation Project of the Tanjung Priok Port
in
The Republic of Indonesia

CONTENTS

List of Table

List of Figure

List of Photo

List of Abbreviations

ADB	Asian Development Bank
ADPEL	Port Administrator Office
ADT	Average Daily Traffic Volume
AFTA	ASEAN Free Trade Area
AMDAL	Environmental Impact Assessment
ASEAN	Association of South East Asian Nations
B/C	Benefit/Cost
BAKOSURTANAL	National Coordination Agency for Survey and Mapping
BAPEDAL	Environmental Impact Management Agency
BAPEDALDA	Branch Office of BAPEDAL
BAPPEDA	Provincial Development and Planning Board
BAPPENAS	National Development Planning Agency
BCH	Box/Crane/Hour
Bina Marga	Directorate General of Regional Infrastructure, Ministry of Public Works
BKPM	Investment Coordination Board
BOD	Biological Oxygen Demand
BOR	Berth Occupancy Ratio
BOT	Build-Operate-Transfer
BPPN	International Bank of Reconstruction and Development
BPS	Central Bureau of Statistics
BT	Berthing Time
BUMN	State Owned Company
CBR	California Bearing Ratio
CD	Chart Datum
CFS	Container Freight Station
COD	Chemical Oxygen Demand
DCPT	Dynamic Cone Penetration Test
DGH	Directorate General of Highways
DGLC	Directorate General of Land Communication
DGPS	Differential Global Positioning System
DGSC	Directorate General of Sea Communication
DKI	Capital City Area of Indonesia
DO	Dissolved Oxygen
DTV	Daily Traffic Volume
EDI	Electric Data Interchange
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ET	Effective Time (at Berth)
FCL	Full Container Load
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
FTA	Free Trade Area
GBHN	Broad Outlines of the Nation's Direction
GDP	Gross Domestic Product
GOI	Government of Indonesia

GOJ Government of Japan
GRDP Gross Regional Domestic Product
GT Gross Tonnage

HHWL Highest High Water Level
H_s Significant Wave Height
H_{sea} Sea Wave Height
H_{swell} Swell Wave Height

IAPH International Association of Ports and Harbors
IBRD International Bank of Reconstruction and Development
ICB International Competitive Bidding
IDB Islamic Development Bank
IEE Initial Environmental Examination
IMF nternational Monetary Fund
IMTN Indonesia Medium Term Notes
INSA Indonesian National Ship Owner Association
IPC Indonesia Port Corporation

Jabotabek Jakarta, Bogor, Tangerang and Bekasi area
Jasa Marga PT. Jasa Marga (Indonesian Highway Corporation)
JBIC Japan Bank for International Cooperation
JICA Japan International Cooperation Agency
JICT Jakarta International Container Terminal
JICT-1 Jakarta International Container Terminal 1
JIUT Jakarta Intra Urban Transport (Road)
JKT Jakarta
JO Joint Operation
JORR Jakarta Outer Ring Road
JV Joint Venture

KANPEL Port Administration Office (Non-commercial Port)
KANWIL Provincial Office of Central Ministry
Keppres Presidential Decree
Kimpraswil Ministry of Settlements and Regional Development
KM Ministerial Decree
KNMI Royal Dutch Meteorological Institute
$K_{penetration}$ Wave penetration coefficient
KSO Kerja Sama Operasi (Joint Operation)

LA Loan Agreement
LCL Less then Container Load
LCB Local Competitive Bidding
LLWS Lowest Low Water at Springs

M(O)SRD Ministry of Settlements and Regional Development
MARPOL International Conventional for the Prevention of the Polution from Ships
MENEG LH State Ministry for Environment
MHWS Mean High Water at Springs
MLWS Mean Low Water at Springs
MOC Ministry of Communication
MOF Ministry of Finance
MoPW Ministry of Public Works
MOSOE (MOSOC) Ministry of State-Owned Enterprises (Companies)

MSL Mean Sea Level

NGOs Non Government Organizations
NPS National Port System
NPV Net Present Value

OD (Survey) Origin and Destination (Survey)
ODA Official Development Assistance

PAP Project Affected People
PCC Pure Car Carrier
PCU(pcu) Passenger Car Unit
PELINDO Indonesia Port Corporation
PELNI Indonesian National Shipping Company
PERSERO State-Owned Company
PERUM ASDP State-Owned Inland Waterways & Ferry Company
pH Hydrogen ion concentration
PIANC Permanent International Association of Navigation Congress
PJP II The Second Long Term Development Plan
PM10 Particular matter less than 10 μ m
PP Government Regulation
PPKB Permintaan Pelayanan Kapal dan Barang (The Demands of Ship and Good Services)
ppm Parts per million
PPSA One Roof Port Service Center
PROPENAS National Development Policy
PRT Port Related Traffic
PSA PSA Company (changed from Port of Singapore Authority)
PSP Private Sector Participation
PT. Limited Company
PT. RUKINDO Indonesia Dredging State Limited Company

REPELITA National Five-year Development Plan
REPELITADA Local Five-year Development Plan
RKL Environmental Management Plan
ROW Right-Of-Way
Rp. Rupiah
RPL Environmental Monitoring Plan
RTG Rubber Tire mounted Gantry
RTK GPS Real Time Kinematics GPS
RTRW Spatial Use Plan
RUKINDO PT. Pengerukan Indonesia (Dredging Company of Indonesia)

S_{0p} Deep water wave steepness based on peak wave period
SEA Strategic Environmental Assessment
SIMOPPEL Port Operation Management Information System
SMB method Sverdrup-Munk-Bretschneider method
SOLAS International Convention on Safety of Life at Sea
SOR Shed Occupancy Ratio
SPM uspended Particle Matter
SPT Standard Penetration Test
SS Suspended Solid
STEP Special Terms of Economic Partnership

TEU Twenty Foot Equivalent Unit

TGH Ton/Gang/Hour
TgPA Tanjung Priok Access Road Project
THC Terminal Handling Charge
T_m Mean wave period
TOR Term of Reference
T_p Peak wave period
TSHD Trailing Suction Hopper Dredger
TTV Through Traffic Volume

UNCTAD United Nations Conference on Trade and Development
UU Unconsolidated Undrained

WASOP Operational Monitoring System
WB World Bank
WHO World Health Organization

YDT Yard Dwelling Time
YOR Yard Occupancy Ratio

Greek Symbols

φ_{sea} Sea wave direction
φ_{swell} Swell wave direction

CHAPTER 1 OUTLINE OF THE STUDY

1. OUTLINE OF THE STUDY

1.1 Introduction

Tanjung Priok Port (hereinafter referred to as the port) is the largest international port in Indonesia, and handles some 55% of container traffic of the country. Historically, the port has been supporting the economic development of the west Java region centered on the capital city Jakarta, and more broadly the economic growth of the country. In the meantime, the port that was developed back in late 19th century has remained almost intact, suffering various kinds of operational issues. Among others, the traffic congestion in the navigation channel/basin has become a serious problem of the port, with the drastic increase in number and size of calling ships. In addition to ship handling, traffic handling in the port inner road has also become so serious recently.

Without the settlement of these traffic-handling issues, the cargo throughputs of the port will be restricted, and Tanjung Priok Port will not be able to function as a capital port of the country, paralyzing economic activities of Indonesia in the future.

Under these circumstances, JICA conducted in 2003 the M/P and F/S studies on the Port with the target year of 2025 and 2012 respectively, and identified the critical operational areas that should be urgently rehabilitated. This high-priority project was termed as “Urgent Rehabilitation Project”, which consists of three project components 1) Channel and Basin Improvement, 2) Relocation of Breakwater, 3) Road Improvement. After these studies, the Government of the Republic of Indonesia (hereinafter referred to as “GOI”) made a request to the Government of Japan (hereinafter referred to as “GOJ”) to undertake further study to proceed with he Project.

In response to the request of GOI, GOJ decided to conduct the Detailed Design Study for the Urgent Rehabilitation Project of the Tanjung Priok Port in the Republic of Indonesia (hereinafter referred to as “the Study”) in accordance with the relevant laws and regulations in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as “JICA”, the official agency responsible for the implementation of the technical cooperation program of GOJ, has undertaken the Study in close cooperation with the authorities concerned of GOI.

This report has been prepared on the basis of the Minutes of Meeting and the Scope of Works signed on October 19, 2004 by JICA, and the Directorate General of Sea Communication, Ministry of Communications (hereinafter referred to as “DGSC”) and Indonesian Port Corporation II (hereinafter referred to as “IPC-II”).The contents of this report shall be reviewed and confirmed by both sides to ensure its successful implementation in Indonesia.

1.2 Objectives of the Study

The objectives of the Study include the followings:

1) To review the previous studies and plans related to the project, analysis of the most effective and efficient port development of the project,

2) To carry out necessary engineering surveys,

3) To complete a detailed design for execution of the project,

4) To carry out construction planning and cost estimate and

5) To prepare a draft tender documents for execution of the project.

1.3 Scope of the Study

The Scope of the Study is briefed below. The study flow and the detailed work items and schedule are described in the Figure 1.1.

- To conduct the preliminary study, including review of the JICA reports,
- To conduct natural condition surveys, including topographic, bathymetric, geotechnical, hydraulic aspects, etc.,
- To conduct supplementary environmental studies, including environmental surveys,
- To conduct basic design of the project facilities,
- To conduct detailed design of the project facilities,
- To prepare construction plan,
- To prepare Draft Tender Documents,
- To prepare Environmental Management Plan, and
- To conduct overall evaluation and recommendation for the implementation of the project.

1.4 Schedule of the Study

To meet the study requirements stipulated in 1.3, the corresponding works of the Study are carried out in a stage-wise manner as shown in Figure 1.1.

1.5 Composition of the Report

The outputs of the Study have been contained in the following reports and documents. This report is a Main Report, including the major results of design and implementation plan of the Project:

1: Summary in Japanese
2: Summary in English
<u>3: Main Report</u>
4: Appendix for Main Report
5: Design Calculation Report
6: Quantity Calculation Report
7: Cost Estimate Report

(Draft Bid Document for Package 1: Channel and Basin Improvement

8: Prequalification Document
9: Volume I, II, IV and V (Invitation for Bids, Instructions to Bidders; Conditions of Contract Part I, II; Bid Form & Contract Forms; Bill of Quantities)
10: Volume III (Technical Specifications)
11: Volume IV (Drawings)

(Draft Bid Document for Package 2: Inner Road and Flyover Improvement

12: Prequalification Document
13: Volume I, II, IV and V (Invitation for Bids, Instructions to Bidders; Conditions of Contract Part I, II; Bid Form & Contract Forms; Bill of Quantities)
14: Volume III (Technical Specifications)
15: Volume IV (Drawings)

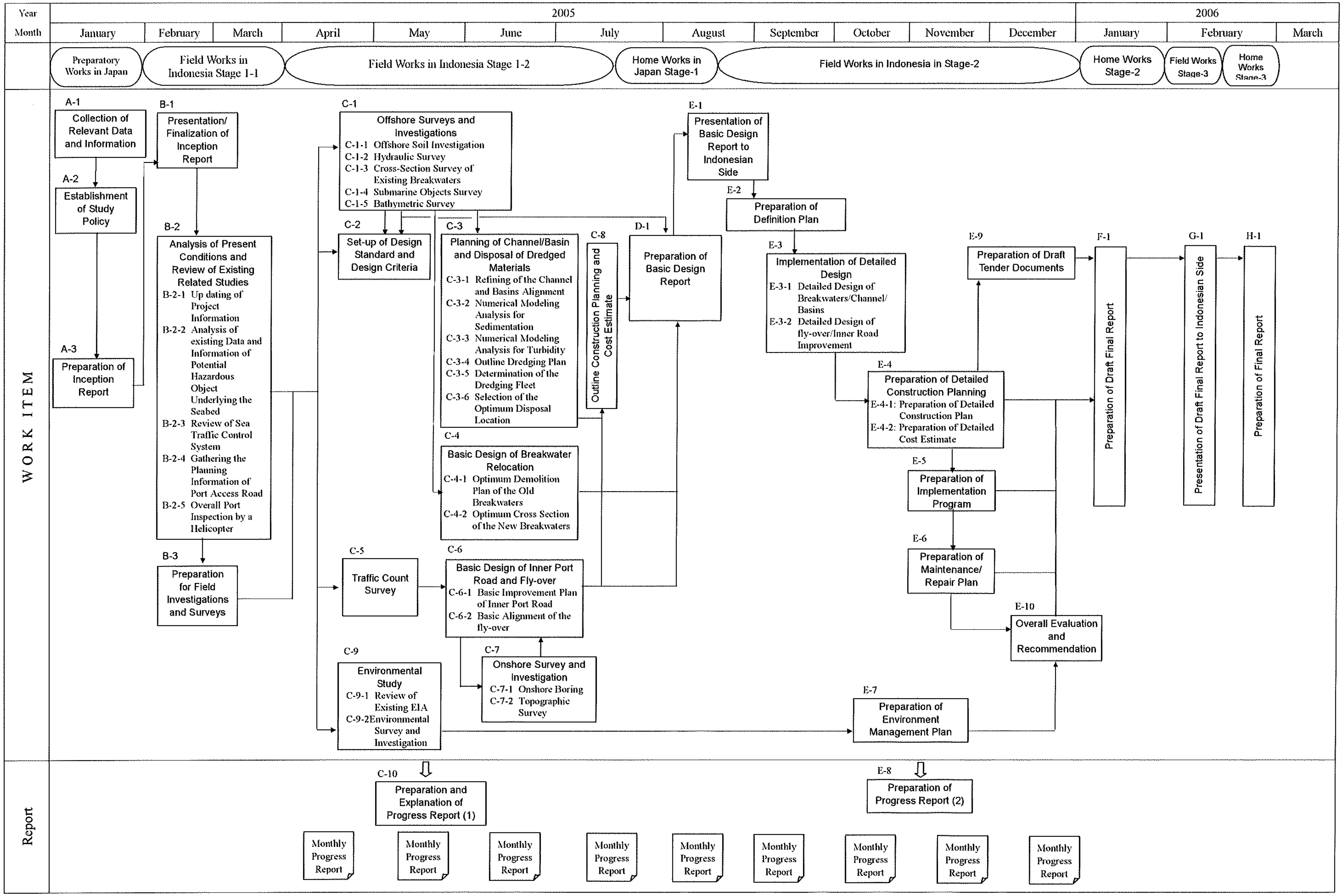


Figure 1.1.1 Study Flow of Detailed Design

CHAPTER 2 NATURAL CONDITIONS

2. NATURAL CONDITIONS

2.1 Field Investigation and Survey

The field investigation and survey carried out in the Study cover the following:

- Geotechnical Investigation, including seismic tomography survey,
- Hydraulic Survey,
- Bathymetric Survey, including seismic profiling survey and positioning/elevation survey and Submarine Objective Survey,
- Topographic Survey,
- Environmental Survey,
- Traffic Count & O/D Interview Survey
- Numerical Modeling Analysis

The above investigations and surveys were commenced in April, 2005 and completed in August 2005 except for the numerical modeling analysis, which has been completed in December, 2005. This chapter describes the valuable information of the natural conditions collected on site and disclosed through the above investigations and surveys. The details of the investigation/survey results are contained in Investigation/ Survey Reports separately prepared, so that essential parts of investigation and survey results are summarized below as an introductory and easy understanding of the succeeding engineering design for various kinds of facilities included in the Study.

2.2 Meteorology

The port is located in the tropical monsoon climatic zone. Southeast monsoons prevail between May to September, and northwest monsoons between November to March. Southeast monsoon seasons are relatively dry, and the precipitation is concentrated in the northwest season, which has 65% of the annual rainfall of 1,800mm. Throughout the year, wind climate is rather mild. Some gusts occur in the wet season, but no tropical cyclone is experienced. The annual average temperatures are between 23 degree-C and 33degree-C.

2.3 Topography

The port opens to the sea in the north, and extends from west to east along the narrow coastal strip of the Jakarta Bay. Historically, Jakarta has been developed as a port city, so that residential/business zone and port zone have been developed in close proximity. Currently, the port area is flanked by densely populated city zone in the south, having no more expansion space shoreward (southward). To the west of the port there is the Ancol resort zone, and a fishery harbor to the east.

The port area is situated in a low land. Part of the port roads are occasionally inundated by seasonal floods. Some of the flood water flow through several canals/ditches aligned in the city zone, and discharge into the port area. One of the major canals is Kali Sunterbaru, which has the outlet at the Pertamina Oil Basin, next to the Koja Container Terminal.

Between the port area and the city zone run city roads, namely, from west to east, Jl. Martadinata, Jl. Engano, Jl. Jampea and Jl. Cilincing. At the intersection of Jl. Pelabuhan Raya (port road), Jl.Laks, Yos Sudarso runs to the central Jakarta area.

The port inner roads are distributed inside the port area to feed/receive the port cargoes from/to the terminals, backup port areas and city zones. The port inner road for the Study is located inshore of the Nusantra Pier, Pier I, Pier II and Pier III. The Study roads are linked to the above city roads through the port gates. There are three major port gates, named Gate-9 and Gate-3/Gate1. The former one receives the port traffic chiefly to/from the eastern and the northern part of Jakarta and the latter one to/from the western Jakarta. Near the Gate-3, stand a mosque inside the port and a bus terminal in front of the Gate-3 across Jl. Laks. RE. Martadinata.

The topographic survey has been executed in the Study, covering the port inner road of the Study and part of Jl. Laks. RE. Martadinata, where Pasoso Flyover will be landed. The detailed survey data and maps are contained in the Investigation and Survey Report.

2.4 Bathymetry

The seabed of the coastal zone near the port lies in a gentle slope of 1 to 1,000. The isobathic water depth contour of -20m is situated about 15 km offshore the port area. The dredged channel of -14m extends about 3.5km from the port entrance to offshore. A 0.5 to 1km wide strip of shallow zone (-3 to -4m deep) stretches immediately seaward of the breakwaters.

The water depth inside the port is maintained to certain operational levels, depending on the navigation requirements. The inner channel inside the breakwater is maintained to -14m, and the adjoining anchoring basins to -5-7m. The basin in front of the Jakarta International Container Terminal is maintained to -14m, and the basin in front of Pier III to -12m. The remaining zones have the water depth of less than -10m.

The bathymetric survey, seismic profiling survey, positioning/elevation survey and submarine objective survey have been executed in the Study, covering the improvement channel/basin areas and breakwater relocation areas. The detailed survey data and maps contained in the Investigation and Survey Reports.

2.5 Hydraulics

(1) Water level

A detailed analysis of the water levels is included in Appendix 2-A. The tidal elevation data are presented in Table 2.5.1.

Tidal elevations have been related to CD which is 0.60 m below MSL.

Table 2.5.1 Tidal Elevations at Tanjung Priok Port

Tidal levels	Level (m CD)
HHWL (Highest High Water Level) :	1.18
MHWS (Mean High Water Spring) :	1.03
MSL (Mean Sea Level) :	0.60
MLWS (Mean Low Water Spring) :	0.21
LLWS (Lowest Low Water Spring)	0.12

To account for the combined effects of tides and storm surges, 15 years of observed tidal elevations have been collected from IPC-II. Of these data, the annual maximum and minimum water level have been analysed using a three parameter Weibull distribution (see Appendix 2-A). Based on this analysis, the 1:50 year design minimum and maximum water level inside Tanjung Priok port are presented in Table 2.5.2.

Table 2.5.2 1:50 Year Maximum and Minimum Water Level inside Tanjung Priok Port, by Combined Tide and Storm Surge

Water level	Level (m CD)
Maximum	1.82
Minimum	-0.15

Sea level rise in Indonesia has been analysed by Safwan (see Appendix 2-A), based on tide gauge records at different marine monitoring centers along the western Indonesian coast. The analysis shows that the sea level in Jakarta rises 4.38 mm/year. Within 50 years, the increase in water level thus would be about 0.22 m.

Based on the analysis above it is assessed that the 1:50 year highest and lowest water level to be expected are:

Table 2.5.3 Maximum and Minimum 1:50 Year Water Level, Due to Tide, Storm Surge and Sea Level Rise

Water level	Maximum	Minimum
Combined tide and surge	1.82	-0.15
Future sea level rise	0.22	0
Total water level	*2.05* [1]	-0.15

[1] Rounded upward

(2) Wave Conditions

To define the wave climate at Tanjung Priok, visual observations on voluntary ships in an area between 4°- 6° S and 106° - 108° E have been obtained from the Royal Dutch Meteorological Institute (KNMI). The data have been collected from 1950 to 1979 and comprises a raw data set of 3858 observations of which 295 records of an “undetermined” character for either wave height, wave period or wave direction. The statistical analysis of the wave data is presented in Appendix 2-B. Based on this analysis the annual offshore wave rose is presented in Figure 2.5.1. The wave rose clearly indicates the prevailing NW and SE monsoons.

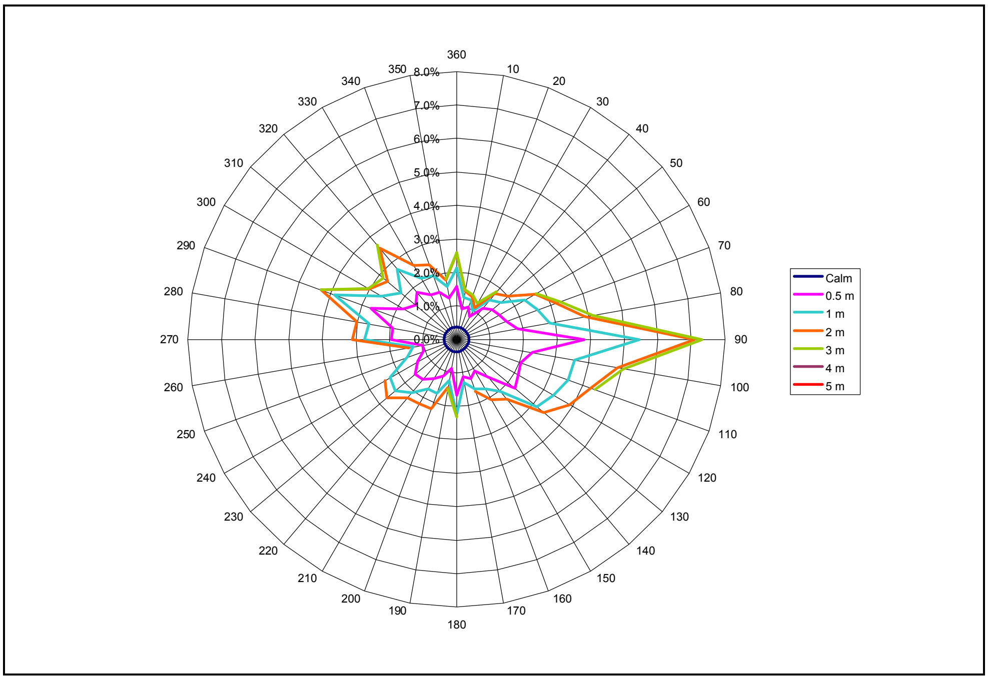


Figure 2.5.1 Annual Deep Water Wave Rose and Wave Height (Hs) Arriving from Direction

Taking into account the location of Tanjung Priok within Jakarta Bay, the offshore, directional deep water 1:50 year design waves have been established (Appendix 2-B) to be:

Table 2.5.4 Offshore 1:50 Year Wave Conditions from Relevant Directions

Direction (° N)	H_s (m)	T_m (s)
310 – 330	6.90	7.5
340 – 360	7.10	7.6
10 – 30	6.60	7.4

Based on these wave conditions and a design water level of +2.05 m CD (Table 2.5.3), the near shore wave conditions in front of Dam Tengah have been calculated. This results in the following design wave conditions:

Table 2.5.5 Near Shore Design Wave 350 m in front of Existing Breakwater Local Depth -3.6 m CD, Water Level +2.05 m CD

Direction (° N, offshore)	H_s (m)
310 – 330	2.5
340 – 360	2.5
10 – 30	2.5

Further it has been established that (in combination with a water level of +2.05 m CD) the wave height over water depth ratio (Hs/d) is more or less constant up to 900 m in front of the old breakwater being Hs/d ≈ 0.44.

(3) Hydraulic Survey

The hydraulic survey has been set-up to provide a coherent set of data to calibrate the flow, sediment transport and turbidity modeling to be carried out for the Tanjung Priok Urgent Rehabilitation Project. The hydraulic survey has been carried out from 29 May, 2005 to 2 July, 2005. The results of the hydraulic survey are reported extensively in the Investigation Report and for this reason not repeated here. Still, based on these results the findings can be characterized as follows:

1) Current

Outside Tanjung Priok Port

Currents in front of Tanjung Priok port are highly influenced by wind. During the survey, tide induced mid-depth currents and near bottom currents showed to be weak (less than 0.20 m/s) whereas wind induced currents near the surface are weak to moderate (up to 0.70 m/s). The tidal currents also indicated to be vary between West and East, whereas surface current for a major part of time remained between 225° N and 360° N (going to).

Tidal currents at the existing disposal site appear to be low and highly influenced by winds. Maximum currents are up to about 0.8 to 1.0 m/s at the surface and reduce with depth.

At the day of measurement at the proposed (new) disposal site the wind showed to be very weak, which is reflected by the current measurement. The currents vary between 0.10 and 0.50 m/s and also show a distinct difference in direction. Thus the currents appear to indicate a clear picture of the tidal currents at these locations.

Currents near Pulau Rambut appear to be irregular. Velocities vary between 0.10 and 0.60 m/s and again are assessed to reflect the effect of the wind, although the moment of high wind velocity and larger current velocities are a out of phase.

Inside Tanjung Priok Port

Currents inside Tanjung Port are in a number of stations surprisingly high. Currents measured at the outlet of the Kali Japat show nearly constant currents of 0.75 to 1.0 m/s and running in directions 200 to 250, nearly constant into the outlet (rather then out of the outlet). This current is even higher than the current at the Kali Sunter Baru outlet, where currents are measured to vary between 0.10 and 0.60 m/s. Since this high current was not expected, an explanation was sought for and (likely) found by the presence of a powerplant located at close distance inside the Kali Japat outlet. This powerplant takes water from inside the Kali Japat and discharges this on open sea (see Photo 2.5.1).

Photo 2.5.1 Cooling Water Inlet of Tanjung Priok Power Plant, Located Approx. 500 m West of the Measurement Point

Another location with high currents is located at the east side of the port, close to the (disappeared) breakwater. Currents are here in the order of 0.60 to 0.80 m/s and nearly constantly running in 315° to 360° direction at surface, mid-depth and bottom. There is no clear explanation for this. It may be that currents generated by the discharge of the Kali Sunter Baru generate a local eddy, but in such case the currents are strong. However, in view of the fact that the currents are the same at surface, mid-depth and bottom, it appears that the (submerged) breakwater at this location is still so high (under water) that all currents run in the same direction.

Only in front of the Jakarta International Container Terminal 1, the currents are week. In general, it is less than 0.10 m/s. The measurement being taken close to the corner with Harbour Basin 3, the current direction varies a lot.

2) Bottom sediment

Bottom sediments in front of Tanjung Priok port typically consists of either silt and clay or sand (depending on the location). At the existing disposal site 1 silt is found, but at the new disposal site 2 sand is found (D50 = 0.400 mm). Also at Pulau Rambat sand is found. Inside the port the bottom material typically consists of silt and clay.

3) Suspended sediment

Suspended sediments in front of Tanjung Priok varied between 23.62 mg/l and 43.84 mg/l, with the majority of the measurements between 27 mg/l and 40 mg/l. Similar type of concentrations are found at disposal sites 1 and 2 and near Pulau Rambat.

Inside the port the sediment concentrations are more or less the same, apart from the entrance of the Kali Sunter Baru where concentrations between 60 and 70 mg/l are measured. At the Kali Japat concentrations between 38 and 45 mg/l are found.

4) Water density

Water density has been measured inside the port. At the Jakarta International Container Terminal 1 the surface density is about 1018 mg/l and near the bottom nearly 1020 mg/l. Close to the east breakwater at the east side of the port, about the same densities are found. At the outfall of the Kali Japat surface the density reduces to about 1016.5 to 1017.5 mg/l, whereas the bottom density is about 1019 mg/l. At the outlet of the Kali Sunter Baru, the surface density is about 1017 mg/l, whereas the bottom density is about 1018 mg/l.

2.6 Geology

2.6.1 Regional Geology

Jakarta is located near the southern margin of a geological area known as the Sunda area. The Sunda area forms the south-eastern extension of the Asiatic continent to which it is connected by the Malay Peninsula. The central part of the Sunda area was submerged during the Quaternary by a general rise in sea level due to the melting of the Pleistosene ice caps and by a gradual subsidence of the land.

The peripheral parts of the Sunda area were not stable during the Plio-pleistocene and considerable vertical oscillations occurred. A corresponding subsidence of the southern part of the Sunda area occurred and considerable thickness of sediment were laid down on the pre-tertiary basement complex.

The marginal zones of the Sunda area have shown a strong coastal accretion during recent and historical times. The large amount of sediment supplied by the rivers and shallow depth of the sea have resulted in the coastlines moving rapidly outward.

In addition to the sedimentary deposits, layers of volcanic breccia are found on the coastal plains of Java. The name lahar has been given to these volcanic breccias which have been reworked and transported by water. A lahar is a mud flow, containing debris and angular blocks of generally volcanic rocks, and may attain a thickness of tens of meters.

The subsurface conditions underlying Jakarta are a result of a number of relatively recent and overlapping geological processes. A tectonic subsidence related to the ongoing mountain building in Java has resulted in a large thickness of young sedimentary deposits. Additionally the Sunda area has been submerged during the Quaternary. Occasional layers of volcanic breccia have been placed within the sedimentary deposits. Rapid coastal accretion is occurring due to the heavy sediment load in the rivers of northern Java. Active volcanoes and seismic activity are known to occur in the area due to the ongoing mountain building in southern Java.

2.6.2 Site Geology

2.6.3 Stratum Classification

As a result of previous investigation review, the following stratum classification was proposed for drawing the geological profile based on the soil classification and N-value.

Proposed Stratum Classification

Layer	Soil	N-value
Fs	Reclaimed / Fill Sand	
Ac1	Clay / Silt	N value < 8
Ac2	Clay / Silt	8 ≤ N value < 30
Ac3	Clay / Silt	N value ≥ 30
As1	Sand	N value < 10
As2	Sand	10 ≤ N value < 30
As3	Sand	N value ≥ 30

(1) Dredging Area

Geological profiles of three sections in the dredging area (Section A-A’, B-B’ and C-C’) are shown in Appendix 2-C.

1) Section A-A’ (Outside the port)

- Up to -14.0 m to be dredged Ac1 is deposited. Ac1 is classified into a silty clay layer, dark grey to greenish grey. The N-value ranges from 0 to 5 and the average is 0.4. Therefore it is evaluated to be a very soft clay layer.

- Below around -16.0m As1 and Ac2 are deposited. As1 is classified into a sandy silt layer, grey to brownish grey with N-value of 2 to 15, while Ac2 is classified into a silty clay layer, brownish grey to greyish brown with N-value of 8 to 15.

2) Section B-B’ (Inside the port)

- In BS-9 Borehole, up to -14 m, Ac1 is deposited with N-value of 0 to 1 and classified into a very soft clay layer. Below Ac1, As2 with N-value of 13 to 23 and Ac3 with N-value of 24 to 60 are deposited.

- In BS-10 Borehole, up to -14 m, Ac1, As1 and Ac2 are deposited. Ac1 is classified into a very soft organic clay layer with N-value of 0 to 2, while As1 is classified into a loose sand layer with N-value of 2 to 6. On the other hand, Ac2 is classified into a stiff silty clay layer with N-value of 18 to 20. Below -14 m, Ac3 is deposited and classified into a very stiff clay/silt with N-value of 30 to 45.

- In BS-11 Borehole, up to -14 m, As1 and Ac2 are deposited. As1 is classified into a very loose sand layer with N-value of 1 to 2, while Ac2 is classified into a stiff silty clay layer with N-value of 12. Below -14 m, As2 and Ac3 are deposited to be stiff.

3) Section C-C' (Basin Area)

- In BS-12 Borehole, up to -12m, Ac1 is deposited with N-value of 0 to 6 and classified into a very soft clay layer. From -12 m to -16 m, Ac2 is deposited with N-value of 13 to 16 and classified into a stiff silty clay. Below Ac2, Ac3 with N-value of over 45 is deposited.

- In BS-13 Borehole, up to -13m, Ac1 is deposited with N-value of 0 and classified into a very soft sandy clay. From -13 m to -14.5 m, Ac2 is deposited with N-value of 12 to 17, a stiff clayey silt. As2 intervenes in Ac2 and is classified into a clayey sand layer.

- In BS-14 Borehole, up to -5m, As1 is deposited and is classified into a very loose clayey sand layer with N-value of 0. From -5 m to -13 m, Ac1 is deposited with N-value of 0 to 5, a very soft clay. Below -13 m, Ac2 is deposited with N-value of 4 to 9.

(2) New Breakwater Area

Geological profiles of two sections in the new breakwater area (Section E-E' and D-D') are shown in Appendix 2-C.

1) Section E-E' (Dam Tengah)

In the area along Section E-E', Ac1, Ac2 and Ac3 are mainly deposited. The thickness and N-value of each layer is characterized as follows.

- Ac1 is classified into a clay layer, grey to greenish grey. The thickness varies from 8.0 m to 12.4 m and N-value ranges from 0 to 8. Ac1 layer is evaluated to be very soft and is not stiff enough for the foundation of new breakwater regarding the shear strength and settlement.

- Ac2 is deposited below Ac1 and is classified into a silty clay layer, brownish grey to greyish brown. The thickness varies from 2.0 m to 7.0 m and N-value ranges from 8 to 20.

- Ac3 is classified into a silty clay layer, greyish brown to brown. The N-value is 50 in average. Therefore Ac3 layer is evaluated to be very stiff and has no problems for the foundation of new breakwater regarding the shear strength and settlement.

Based on N-value and laboratory test results, the design values of subsoil for new breakwater design along Section E-E' (Dam Tengah) are proposed as shown in Table 2.6.1.

Table 2.6.1 Design Values of Subsoil for New Breakwater of Dam Tengah

Layer	N-value	Density γt (t/m^3)	Strength Parameters		Consolidation Parameters	
			c (kg/cm^2)	ϕ (degree)	Cc	Cv (cm^2/sec)
Ac1	1	1.45	0.1	0	1.12	0.01
Ac2	12	1.69	0.38	0	0.42	0.03
Ac3	50	1.8 *1	1.5 *1	0	Unconsolidated Layer	
As1	-	-	-	-	-	
As2	21	2.0 *1	0	35	Unconsolidated Layer (Only Immediate Settlement)	
As3	50	2.1 *1	0	40	Unconsolidated Layer	

Note: *1) Assumed value

2) Section D-D' (Dam Barat)

In the area along Section D-D', Ac1 and Ac3 are mainly deposited. The thickness and N-value of each layer is characterized as follows.

- Ac1 is classified into a clay layer, grey to greenish grey. The thickness varies from 10.0 m to 10.7 m and N-value ranges from 0 to 6. Ac1 layer is evaluated to be very soft and is not stiff enough for the foundation of new breakwater regarding the shear strength and settlement.

- Ac3 is classified into a silty clay layer, dark grey to brown. The N-value is 45 in average. Therefore Ac3 layer is evaluated to be very stiff and has no problems for the foundation of new breakwater regarding the shear strength and settlement.

- In BS-26 Borehole, As1 is deposited above Ac1. As1 is classified into a very loose sand layer with N-value of 2. Therefore, it is a problem layer for the foundation of new breakwater regarding the shear strength and settlement.

Based on N-value and laboratory test results, the design values of subsoil for new breakwater design along Section D-D' (Dam Barat) are proposed as shown in Table 2.6.2.

Table 2.6.2 Design Values of Subsoil for New Breakwater of Dam Barat

Layer	N-value	Density γt (t/m^3)	Strength Parameters		Consolidation Parameters	
			c (kg/cm^2)	ϕ (degree)	Cc	Cv (cm^2/sec)
Ac1	2	1.43	0.06	0	0.98	0.006
Ac2	-	-	-	-	-	
Ac3	45	1.8 *1	1.5 *1	0	Unconsolidated Layer	
As1	2	1.8 *1	0	25 *1	Unconsolidated Layer (Only Immediate Settlement)	
As2	-	-	-	-	-	
As3	-	-	-	-	-	

Note: *1) Assumed value

(3) Existing Breakwater Area

The formations of materials composing the existing breakwater could be clarified by the geotechnical investigation including core drillings and seismic tomography.

The results of core drillings and seismic tomography for each section are shown in Appendix 2-C.

Furthermore, it could be confirmed that there is no problem for reusing sand/gravel materials as replaced sand of new breakwater because almost all the materials of Sand/Gravel contain less than 15 % of fines content (less than 0.075mm).

The quantities of reusable sand/gravel material as replaced sand for new breakwater are estimated as shown in Table 2.6.3.

Table 2.6.3 Quantities of Reusable Materials

Section	Section Area (m^2)		
	Concrete Structure	Gravel	Sand/Gravel
T-A	10.3	61.4	233.0
T-B	10.1	-	125.3
T-C	8.4	-	199.8
T-D	3.6	-	183.2
T-E	4.6	-	143.2
T-F	2.4	-	150.3

(4) Flyover Area

Geological profile along the proposed flyover is shown in Appendix 2-G.

In the area along the proposed flyover, Fs, Ac1 and As3 are mainly deposited.

- Fs is classified into a silty sand layer of reclaimed land, grey. The thickness varies from 0.8 m to 6.0 m and N-value ranges from 0 to 7. Therefore it is evaluated to be a soft layer.

- Ac1 is deposited below Fs and is classified into a clay layer, grey to blueish grey. The thickness varies from 8.0 m to 15.0 m and N-value ranges from 0 to 4. Ac1 layer is evaluated to be softer than Fs layer.

- As3 is classified into a silty sand layer, grey to brown. The N-value ranges from 32 to over 60. Therefore As3 layer is evaluated to be stiff enough for the bearing stratum of pile foundation for flyover.

Based on N-value and laboratory test results, the design values of subsoil for flyover design are proposed as shown in Table 2.6.4.

Table 2.6.4 Design Values of Subsoil for Flyover

Layer	N-value	Density γt (t/m^3)	Strength Parameters		Consolidation Parameters	
			c (kg/cm^2)	φ (degree)	Cc	Cv (cm^2/sec)
Fs	2	1.61	0.1	0	0.40	0.01
Ac1	1	1.47	0.1	0	0.73	0.01
Ac2	23	1.7 *1	1.0 *1	0	0.30 *1	0.01 *1
Ac3	53	1.8 *1	1.5 *1	0	Unconsolidated Layer	
As1	5 *1	1.8 *1	0	25 *1	Unconsolidated Layer (Only Immediate Settlement)	
As2	21	2.0 *1	0	35	Unconsolidated Layer (Only Immediate Settlement)	
As3	61	2.1 *1	0	40	Unconsolidated Layer	

Note: *1) Assumed value