JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL FOR HUMAN SETTLEMENTS
MINISTRY OF PUBLIC WORKS
REPUBLIC OF INDONESIA

THE DETAILED DESIGN FOR URBAN DRAINAGE PROJECT IN THE CITY OF JAKARTA

FINAL REPORT

IMPLEMENTATION PROGRAM

NIPPON KOEI CO., LTD.
TOKYO, JAPAN

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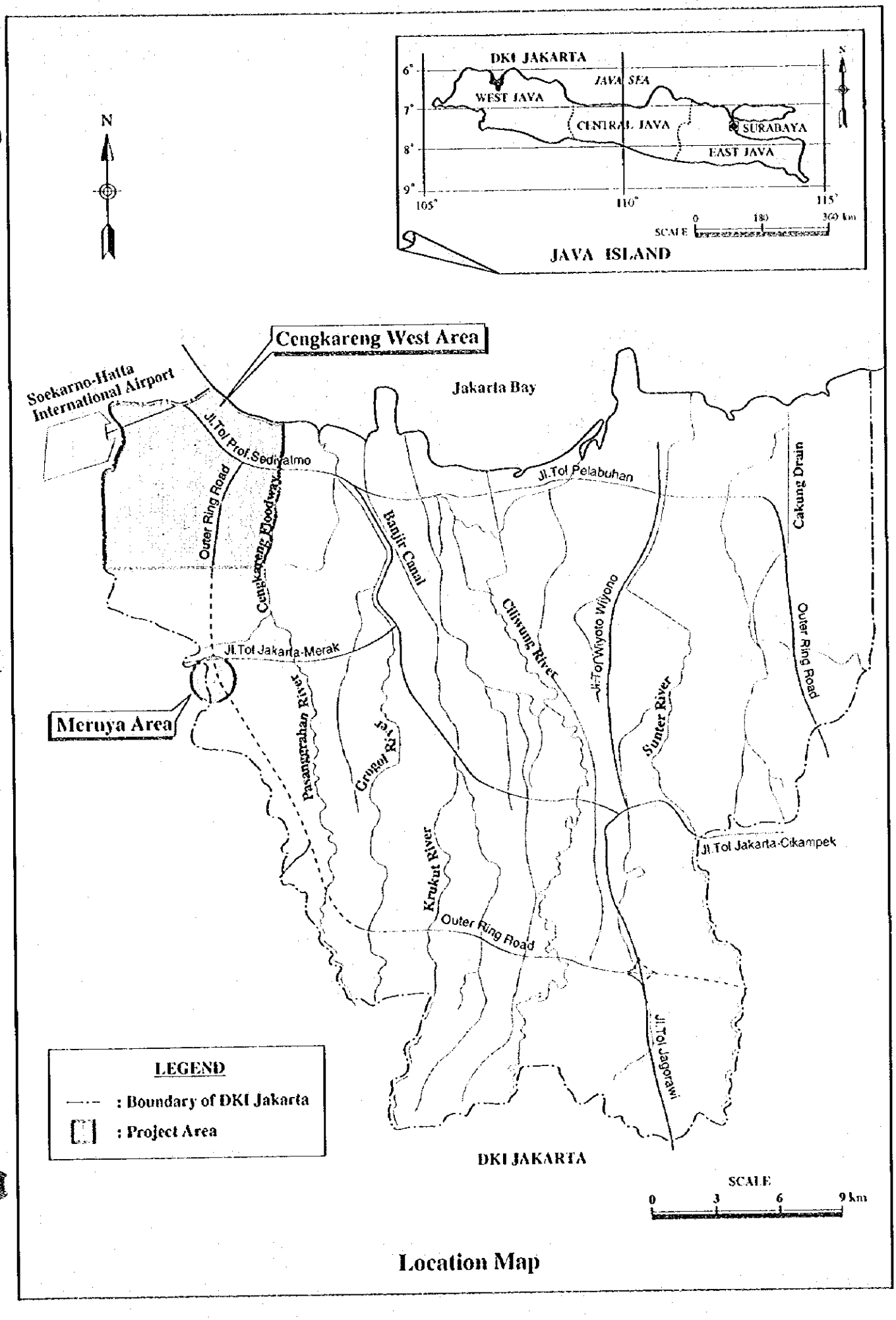


Location Map

SUMMARY

1. EXISTING DRAINAGE SYSTEM

The existing drainage system both for Cengkareng west and Meruya areas is briefly stated as follows:

1.1 Cengkareng west area

The existing drainage networks of the Cengkareng west area is given in Fig 4.1. Drainage water in the Cengkareng west area is discharged through five main drainage channels to three directions, namely, Jakarta bay to northwards, Cengkareng floodway to eastwards and Mokervaat channel to southwards. Present condition of the respective drainage areas and drainage facilities are as follows:

(1) Kamal drainage area

The Kamal drainage area is located in the north-western part of the Cengkareng west area. Drainage area of the Kamal drainage system is about 20.89 km^2 which occupies about 57 % of the Cengkareng west area. About 75 % of the drainage area is occupied by residential area. In center and southern parts of this area, one swampy area and four depression areas are located. These swampy and depression areas had been already acquired by private developers for housing development.

The Kamal main drainage channels have about 11,900 m in total length. Lined channel with wet masonry is 9,700 m and unlined channel is 2,200 m. The channel is about 15 m wide and 2.5~3 m deep at the highway crossing and 10 m wide and 1.5 m deep at the junction portion of the channel extending from eastern direction. The channel bed slope is about 1:3,200 in about 2.3 km from channel mouth and 1:1,700 in its upstream channel stretch. Thirty one bridges and one culvert cross the drainage channels. Majority of the bridges are single span and about 3~8 m in length. Among the related structures, the cross drain crossing the Cengkareng highway is the largest structure with two lanes of 10.8m in total width.

(2) Tanjungan drainage area

The Tanjungan drainage area is located in the northern part of the Cengkareng west area. This drainage area comprises low land with elevation of about EL 0.5 m and large

depression/swampy areas in the center part and eastern part of the drainage area. These depression areas have been already acquired by private sector for house development. Drainage area of the Tanjungan drainage system is about 4.25 km^2. About 40 % of this drainage area is occupied by residential and industrial areas. The Tanjungan drainage channel has about 1,700 m long lined channel with wet masonry and concrete and 200m long unlined channel. The drainage channel is about 5 m wide and 0.8 m deep at the highway crossing. The channel bed slope is so gentle as being about 1:5,000 in all channel stretch. Due to this gentle channel bed slope, drainage water is stagnating even in the dry season. A cross drain with about 3.4 m wide and 1~2 m high has been provided under the Jl. Tol Prof. Sediyatmo (the highway). However, since surface elevation of the highway is almost the same as tidal level due to subsidence of the highway, the culvert crossing the highway functions as siphon at present. Due to this situation, remarkably small drainage water is discharged to downstream through the culvert. Five bridges and one culvert cross the Tanjungan drainage channels.

(3) PIK Junction drainage area

This drainage area is located in the north-eastern part of the Cengkareng west area. Drainage area of the new drainage system is about 2.70 km^2 and all of the area is occupied as residential and industrial areas. The drainage system in this area was drastically changed by construction of the interchange roads of the Jakarta outer ring road and drainage of this area has been interrupted by the interchange road. In this drainage area, 5 culverts with 0.8m in diameter are provided crossing the highway. Length of the new drainage channel is 300m up to the highway. Two bridges and two culverts are crossing the proposed drainage channel.

(4) Gede/Bor and Saluran Cengkareng drainage areas

This drainage area is located in the southern part of the Cengkareng west area. Drainage area of the Gede/Bor and Saluran Cengkareng drainage systems are about 2.41 km^2 and 3.08 km^2 respectively and all of these areas except for 6 % of the paddy field in the Gede/Bor drainage area have been utilized as residential area. The drainage water from the Gede channel is divided into the southern direction to the Mookervaat canal and eastern direction to the Saluran Cengkareng channel. The Bor drainage channel has about 1.5 km in length to the Mookervaat channel and channel bed slope is about 1:1,100. While, the Saluran Cengkareng drainage channel is about 4.2 km in total length to the Cengkareng floodway and channel bed slope is about 1:3,000.

The Saluran Cengkareng drainage channel which drain to the Cengkareng floodway has

4,200 m in total length comprising 3,400 m long lined channel and 800m long unlined channel. Its dimension is 5~8 m wide and 1.5 m deep at upstream end and about 10m wide and 1.8 m deep at the confluence with the Cengkareng floodway. A sluice facility with 2 units of 2.4m wide and 2.6 m high spindle type sluice gate has been provided at the outlet of the Saluran Cengkareng channel to minimize inundation in locally low land areas. Existing sluice gate has been operated under the condition that the gate is closed when the water level of the Cengkareng floodway exceeds 10 cm over the water level in the Saluran Cengkareng drainage channel at its outlet portion. Forty four bridges and two culverts cross these drainage channels.

(5) Pedongkelan drainage area

This drainage area is located in the eastern part of the Cengkareng west area. Drainage area of the Pedongkelan drainage system is about 3.38 km^2 and all of this area has been utilized as residential area. Almost all of center part of this drainage area is already occupied by the National Urban Development Corporation (PERUM PERUMNAS) and a new drainage system with a poundage and pump facilities of its outlet is being constructed to drain the drainage water to the Cengkareng floodway. New drainage is located surrounding the housing complex. The drainage channel comprises about 6,600 m long lined channel with wet masonry.

1.2 Meruya area

Present drainage conditions and flow direction are shown in Fig 4.2. The Meruya drainage area is located at the southern part of the highway connecting Jakarta and Merak harbor. Drainage area of the Meruya drainage system is about 1.27 km^2 and all of this area has been utilized as residential area. The Meruya drainage channel to be studied is secondary level and comprises about 600 m long concrete ditch and 600 m long unlined ditch. Drainage water collected from southern watershed flows towards northern direction and divided into eastern and western directions due to high undulation in the center part of the drainage area. The drainage water flowed down to the eastern direction once stagnates in low land or depression areas in the eastern part of the drainage area and a part of drainage water discharges to existing eastern drainage ditch provided in the recently constructed private housing complex. The drainage water flowed down to the western direction stagnates in depression area in the western part of the drainage area and a part of drainage water discharges to the existing drainage ditch located at northern part of the objective drainage area through the existing cross drains provided under the highway. Along the existing drainage channel, nine bridges cross the

existing drainage networks.

2. DESIGN OF URBAN DRAINAGE PLAN

Design of the urban drainage plan including basic concepts and design works of the drainage facilities for both the Cengkareng west and Meruya areas is briefly presented hereinafter:

2.1 Basic Concepts for Urban Drainage Plan

The basic concept for the urban drainage plan for two objective areas, Cengkareng west area and Meruya area, was established considering rapid urbanization in the objective areas represented by housing development and drastic variation of the existing drainage networks due to (i) construction of interchange structures of Jakarta ring road and (ii) anticipating future land use condition. The established basic concept for the proposed urban drainage plan is as follows:

(a) The future land use plan for the objective areas was established referring to the land use plan set out by DKI Jakarta and anticipating future land use condition from present land use progressing situation, and target year for this drainage plan is set at 2010. Comparison of the land use in the present and the target year 2010 is as follows:

(Unit: km^2)

Category of Area	Present Land Use	Land Use in 2010
- Residential area	22.44	27.98
- Industrial area	2.31	3.48
- Paddy field	5.55	2.27
- Fish pond	3.28	2.98
- Swampy/depression area	3.13	0
Total	36.71	36.71

(b) The drainage channels are designed under protection level of 10-year flood for the Cengkareng west area and 5-year flood for the Meruya area.

(c) Drainage water is drained by gravity flow in principle to minimize operation and maintenance cost for the drainage facilities after construction of the project.

(d) In the Cengkareng west area, only primary (main) drainage channels will be designed. For Meruya area, all of the major drainage channels are the secondary

level. In this design, major secondary drainage channels will be designed.

(e) Special consideration for land subsidence and clean water management was made for planning and designing of the proposed urban drainage project.

(f) There are many swamps and depression areas in the Cengkareng west area and these areas have been already acquired by private housing developer/industrial enterprise. The drainage channels in private owned areas should be constructed by themselves and the constructed drainage facilities will be handed over to DKI Jakarta for routine maintenance works. In the definitive plan, design criteria to be applied to the drainage channel for the private sectors such as design discharge, design channel bed slope and design channel bed elevation will be clarified

(g) Currently, the Jl. Tol. Prof. Sediyatmo is aligned in the swampy area in the northern part of the Cengkareng west area and it has repeatedly suffered from submergence in a rainy season. The cause of this road submergence is attributable mainly to lower elevation of the highway in an about 4 km long stretch in the Cengkareng west area. To cope with this submergence and also to cope with traffic volume increase in a future stage, it has been planned by JASA MARGA that the existing highway is widened to four lanes and heightened in the stretch between the Kamal drainage crossing site and Cengkareng flooway crossing site, and bridges crossing the Kamal and Tanjungan drainage channels are to be designed and constructed by JASA MARGA themselves. Thus, in this design, the bridges for the Kamal and Tanjungan drainage channels, which cross the highway are excluded.

(h) High tension electric lines and water supply pipe lines cross the existing drainage channels. Due to expansion of the drainage channels, treatment of these lines are needed. Besides, it is obliged to shift the existing telephone poles, concrete structure with gates for drainage facilities of highway, road signs, traffic signals, etc. due to expansion of the existing drainage channel. For the treatment, discussion is to be made with authorities concerned. It is proposed that planning, designing and construction of expansion/shifting works of these structures are to be made by authorities themselves under the condition that the cost necessary for expansion/shifting works is born by the project.

2.2 Proposed Drainage Channel Alignment

In accordance with the above concepts, the drainage channel alignment and basic drainage plan were determined. The proposed drainage channels in the Cengkareng west area comprise five, namely, Kamal, Tanjungan, PIK Junction, Gede/Bor and Saluran Cengkareng. Except the PIK Junction drainage channel, all of the proposed drainage

channels were designed by widening the existing drainage channels. For the Kamal and Tanjungan drainage networks, channel alignment for the private owned areas was also studied. For the PIK Junction drainage channel, drainage channel was aligned by avoiding the foundation works of the interchange of the highway. Since it is impossible to drain water perfectly from the locally low land areas, it was contemplated to provide slide/flap gates in the proposed drainage channels along the low land areas. To prevent further expansion of inundation in the low land area along the Saluran Cengkareng drainage channel in case that a large magnitude flood takes place in the Cengkareng floodway and flood flows into the Saluran Cengkareng drainage channel, sluice gate facilities will be provided at the outlet of the Saluran Cengkareng drainage channel. In addition, at upstream end of the Saluran Cengkareng drainage channel, slide gate facilities were provided to release maintenance water in a dry season. In order to prevent dust and garbage from flowing into the drainage channel along the densely populated area in the Saluran Cengkareng drainage channel, open culvert with mesh cover and inlet screen will be provided. For Meruya area, the proposed drainage ditch was aligned so as to drain all of water to the western direction.

2.3 Flood Discharge Distribution

The flood discharge distribution established in the feasibility study was reviewed incorporating the data obtained in this study. The revised design flood discharges are almost the same as those in the feasibility study stage.

2.4 Design Criteria

The design criteria necessary for the design of the drainage channel structures including channels, levees, revetments, bridges, culverts and gate facilities were established referring the standards applied in the Ministry Public Works, DKI Jakarta and standards applied in Japan. In establishment of the design criteria, special considerations were given to the measures against land subsidence, especially for permanent structures such as bridges and culverts.

2.5 Design of the Drainage Facilities

The basic design for the civil works including a series of drainage channel structures and mechanical works such as slide gates and flap gates was carried out based on the topographic map with a scale of 1:1,000 and cross sections with an interval of 100m and

applying the established design criteria.

(1) Longitudinal profile of the drainage channel

The longitudinal profile of the drainage channels was determined under the condition that the newly designed channel bed slope is not remarkably different from the present channel bed slope in principle. The determined channel bed slope is as follows:

- Kamal drainage channel : 1:3,200 and 1:1,800
- Tanjungan drainage channel : 1:5,000
- PIK Junction drainage channel : 1:600
- Saluran Cengkareng drainage channel : 1:3,000
- Gede/Bor drainage channel : 1:1,600
- Meruya drainage channel : 1:2,000, 1:260 and 1:700

(2) Design high water level and cross section of drainage channel

The drainage channels were designed by widening the existing channels and constructing new levees. Single cross section was applied for all of the proposed drainage channels under the condition that design water level should be lower than the ground elevation of the related drainage area in principle.

(3) Design of channel structures

Earth type levees and concrete parapet walls were adopted to meet design water level. The concrete parapet walls were applied in the channel stretches along the densely populated areas. Wet masonry type revetments were applied to stabilize side slopes of the drainage channels, except the channel stretches which will be provided with the earth type levees. Existing roads along the proposed drainage channels will be used as an inspection road for routine operation and maintenance works of the drainage facilities and also for periodical inspection. In case that no existing road is available for the inspection roads along the drainage channels, the inspection roads at least 5 m wide will be provided on the crest of the newly constructed earth type levees or along the drainage channels.

In order to drain water to the drainage channel and to prevent water from entering into the drainage area, slide type gates with 0.7-1.3 m square size were installed for majority of the junction of the secondary drainage channels and several flap type gates were provided for small drainage areas.

(4) Design of bridge

Due to the expansion of the existing drainage channel, 76 existing bridges and culverts were planned to be reconstructed. Based on the relationship among bridge span, girder height and kind of superstructures, two types of the superstructures, pre-tension girder and in situ slab type bridges are applied. New 76 bridges comprise 54 pre-tension girder bridges, 22 in-situ slab type bridges. In this design, 37 type bridges were designed and designed structural sections were applied to the remaining 39 proposed bridges. Major features of the drainage channels and related structures thus designed are as follows:

Name of Channel	Length (km)	Width* (m)	No. of bridge	No. of gate (Slide/Flap)
a) Cengkareng west area:				
-Kamal(main)	4.5	30 - 35	9	15
-Kamal(branch)	2.8	2 - 13	19	8
-Tanjungan	2.5	15 - 25	5	7
-PIK Junction	0.8	2.2	4	1
-Gede/Bor	1.2	10 - 11	10	5
-Saluran Cengkareng	4.2	6 - 10	13	15
b) Meruya area	2.3	1.2 - 8	16	0
Total	18.3		76	51

Note : * means bottom width

3 COST ESTIMATE

(1) The financial cost for the packages-1 and 2 works was estimated under the following conditions:

(i) The financial cost comprises main construction cost, compensation cost for households and land acquisition, engineering service and administrative costs, physical and price contingencies and interest during construction. The main construction cost was estimated on a unit price basis.

(ii) All the construction works of the project will be executed on a contract basis. The construction equipment, materials and labor to be required for the works will be supplied by the contractors to be selected through an international tendering for each package.

(iii) The cost estimate is made at the price level as of June 1997 because basic costs of labor, material and equipment had been collected at this period.

(iv) The cost estimate is made in terms of US Dollars for both the foreign currency

portion and the local currency portion.

(v) The exchange rate in the cost estimate is US$1.0 = ¥115.00 = Rp. 2,350, on the bases of the TTS (Telegram Transfer Selling) rates of the Bank of Tokyo-Mitsubishi in Japan as of monthly mean rates in June 1997.

(vi)Compensation cost for households and acquisition of lands was estimated based on experienced cost data in city of Jakarta.

(vii)The engineering service cost for assistance of tendering and construction supervision of the project works by consultant was estimated on an actual cost basis. The administration cost necessary for operation expenses of the project management office was estimated at 5 % of the main construction cost.

(viii)The contingency comprises physical and price contingencies. The physical contingency was estimated at 10 % of the sum of main construction cost, land and house compensation, and engineering service and administrative costs. The price contingency to cope with an annual price escalation was estimated at 2 % for both the foreign and local currency portions.

The financial cost estimated based on the above conditions is US$ 61.755 million comprising foreign currency portion of US$ 16.617 million and local currency portion of US$ 45.138 million including tax.

(2) An annual disbursement schedule of the packages-1 and 2 works was estimated based on the proposed construction schedule. The budget to be disbursed annually is summarized as follows:

(Unit:10^3US$

Year	Amount	Year	Amount
1997	995	2001	13,937
1998	812	2002	15,312
1999	4,185	2003	9,271
2000	8,860	2004	6,334
		2005	2,049
Total	14,852		46,903

4 ECONOMIC EVALUATION

(1) The economic cost for the packages-1 and 2 was estimated deducting the transfer payment, compensation cost and costs for price escalation and interest from the financial cost. The estimated economic cost is US$ 46.26 million.

(2) The annual benefit for the packages-1 and 2 was estimated assuming that the annual average flood damage corresponding to less than 10-year probable flood is regarded as the flood control benefit. For estimation of the flood damage, direct flood damages such as damage for general assets, agricultural damage and damage for infrastructures and indirect damage such as damage to economic activities due to its activity stagnation were estimated. The estimated annual flood control benefit is US$ 6.6 million.

(3) Economic viability for the packages-1 and 2 was evaluated by internal rate of return (EIRR) assuming that the project life time is 50 year, annual operation and maintenance cost is 0.5% of the direct construction cost. On the basis of the estimated economic cost and project benefit, EIRR was estimated at 13.8 %.

5 ENVIRONMENTAL IMPACT ASSESSMENT

Environmental impact assessment for the packages-1 and 2 areas is briefly stated as follows:

(1) Noticeable present environmental conditions

There are 196 households with land certificate, generally termed as legal residents, directly affected by the project and that they are subject to relocation. Factories, schools, mosque, market place and government office and public space are also subject to relocation. The squatters directly affected by the project are 977 households. They are subject to evacuation from the present living areas. These make up 1,207 items of relocation within the framework of the project.

The Tanjungan drainage channel is constructed through mangrove plantation area where planting scheme is currently undertaken by the Department of Forestry of DKI Jakarta. The area is designated as "Protected Forest of Angke - Kapuk".

(2) Environmental impacts associated with the project

Relocation of the local residents, both legal residents and the squatters, is the most significant and negative impacts induced by the project. Thus relocation plan is conducted within the framework of the project. Details of the relocation plan are dealt with in the "Social Impact Management Plan".

Construction works taking place within the mangrove plantation area are considered to induce some negative and significant impacts to the mangrove protection area. Dust, noise and general degradation of air quality during the construction period is considered as negative but not significant impacts. Monitoring works will be conducted as a part of general requirement for construction works. Bridge construction works associated with the drainage construction works would induce negative and significant impacts as traffic congestion is inevitable and it would probably cause further negative impacts to the general economic activities in and around the project area.

(3) Environmental management plan

Relocation plan, generally termed as "Social Impact Management Plan", is a kind of environmental management plan. Details of the relocation plan are dealt with in the "Social Impact Management Plan". General precautionary measures of the construction works would be the environmental management plan during the construction implementation period.

The mangrove plantation area that most of the Tanjungan drainage channel is constructed through would have to be designated as the "Area of Biological Management Area" within the framework of the project and intensive effort of plating mangrove species should be conducted upon completion of Tanjungan drainage channel.

(4) Environmental monitoring

Throughout the project area, general air quality, dust, noise and vibration should be monitored during the construction period of all the drainage channels. Mangrove plantation area should be constantly monitored during the construction period of the Tanjungan drainage channel. Upon completion of the all the legal residents, follow-up survey for evaluation of the resettlement conditions should be monitored and evaluated.

6 SOCIAL IMPACT MANAGEMENT PROGRAM

Social impact management program for the packages-1 and 2 is prepared as follows:

(1) No. of households subject to compensation

Number of households and other buildings subject to relocation are as follows:

a. Local Residents with land certificate 196 households;

b. Squatters 977 households; and

c. Factories, schools, market place, etc. 34 places.

(2) Cost of compensation

Summary of the cost of compensation is as follows:

a. Local Residents with land certificate;			
Rp. 42.01 million /household	x	196 households	Rp. 8,232.8 million
b. Squatters;			
Rp. 200,000 /household	x	407 households	Rp. 81.4 million
Rp. 50,000 /household	x	570 households	Rp. 28.6 million
c. Factories and others;			Rp. 7,077.4 million
Total			Rp. 15,420.2 million

(3) Cost of land acquisition

There are open spaces such as the areas being unused in the low lying areas, agricultural land, and fishpond within the project area that are subject to acquisition for drainage channel construction works as follows:

- Overall land area for the project 259,304.2 m^2
- Total cost of land acquisition Rp. 42,785.2 million.

(4) Resettlement areas for the squatters

There is no formally considered resettlement area for the squatters. They are all encouraged to return to the villages of origin. However, because of the fact that some are originally from DKI Jakarta, or living in the present area for considerably long period of time, creating bare land to rent for the squatters is suggested. In order to avoid the squatters moving to other areas for claiming double payment, or not to cause further development of slum, bare land to rent catered for resettlement of the squatters is suggested to prepare over four locations within the project area. Initial investment is necessary but the cost is recovered after the 10-year renting period.

(5) Method of relocation operation

(a) Schedule of budget plan

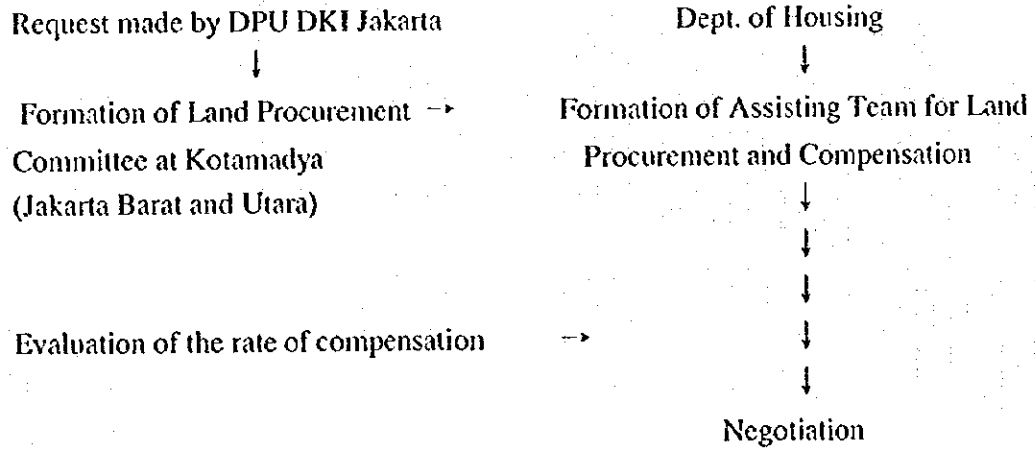
Disbursement plan has been elaborated in order to distribute large sum of budget for compensation and relocation relatively evenly over 7 years as follows:

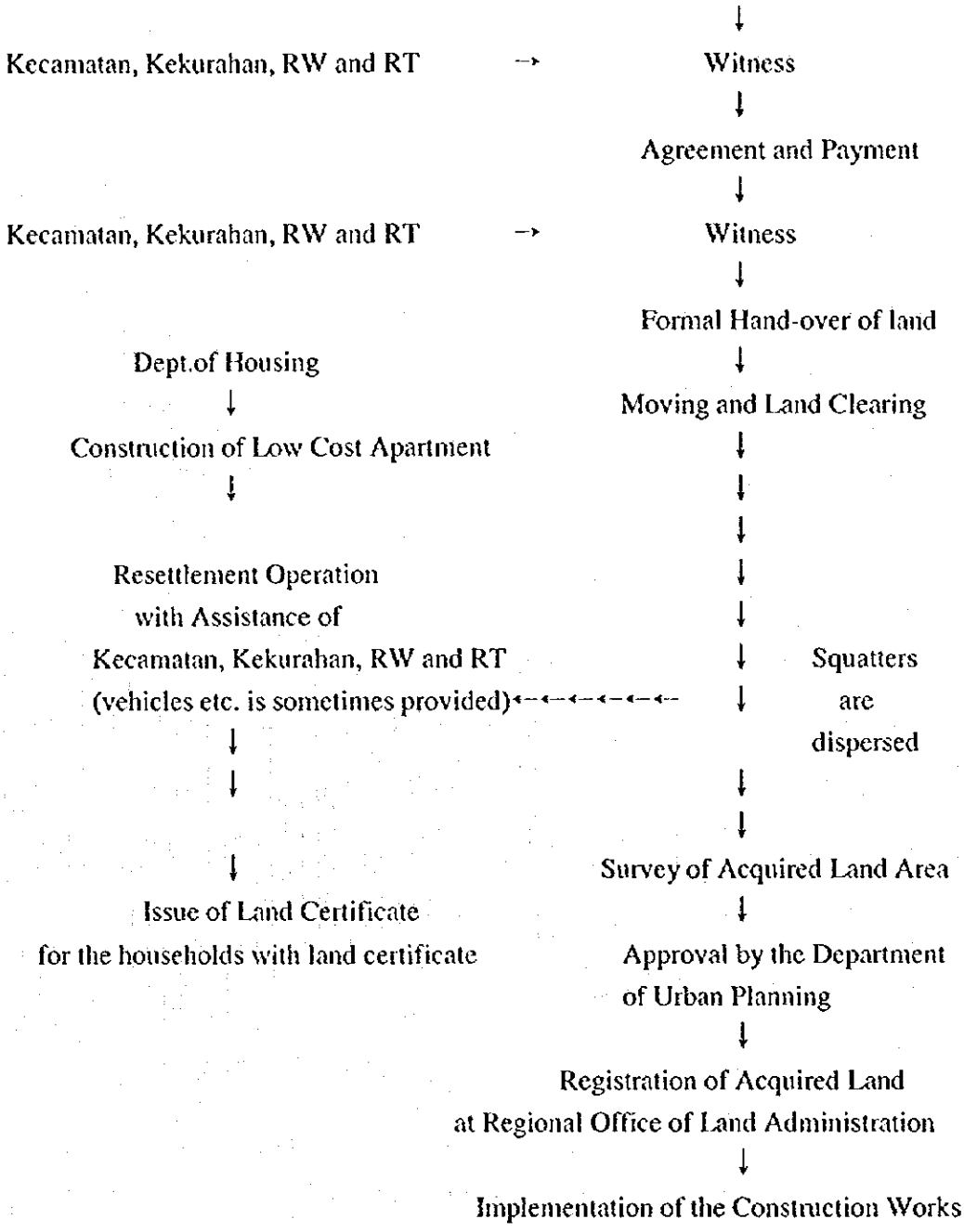
		(Unit : Rp.million)
Fiscal Year 1 (1997/1998)	2,000.0	(3.4 %)
Fiscal Year 2 (1998/1999)	1,473.5	(2.5 %)
Fiscal Year 3 (1999/2000)	5,447.3	(9.4 %)
Fiscal Year 4 (2000/2001)	7,910.1	(13.6 %)
Fiscal Year 5 (2001/2002)	17,669.7	(30.4 %)
Fiscal Year 6 (2002/2003)	19,136.1	(32.9 %)
Fiscal Year 7 (2003/2004)	4,570.8	(7.8 %)
Total	58,207.2	(100 %)

(b) Method of relocation operation

DPU DKI Jakarta is the organization responsible for conducting relocation operation and its method. In general, although there are a number of intricate government procedures to follow when the resettlement operation was conducted, Department of Housing, DKI Jakarta takes over the entire resettlement operation for the development project conducted by DKI Jakarta within the boundaries of DKI Jakarta as considered necessary.

Department of Housing, DKI Jakarta would also construct low cost apartment in order to provide resettlement areas for the low income families subject to relocation. While, Department of Urban Planning determines the appropriateness of the boundaries of drainage channels in relation to the urban planning of DKI Jakarta. Based on the final decision of the Department of Urban Planning, surveyed result of acquired land is registered at the Regional Office of Land Administration. A simplified flow chart of relocation operation for the households with land certificate and the squatters is as follows:





7 CONSTRUCTION PLAN AND IMPLEMENTATION SCHEDULE

(1) The proposed organization for implementation of the packages-1 and 2 is shown in Fig. 10.1. An executing agency of the project will be Directorate General of Human Settlements (CIPTA KARYA), Ministry of Public Works, the Republic of Indonesia, which is responsible for management of the project works including loan appraisal, loan agreement and overall management of the project works. The construction works will be

entrusted and carried out by the Project Management Office, DPU DKI Jakarta.

(2) The foreign currency portion and a part of local currency portion of the construction cost are expected to be financed by an international organization with its soft loan. The remaining local currency portion will be covered by the Indonesian national budget.

(3) It was requested by DKI Jakarta that the first priority should be given to the package-1 and next priority is the package-2, due to the reason that the drainage areas along the Jl. Tol Prof. Sediyatmo (the highway) are quite populated and the highest economic development potential zones, and early implementation of the drainage channels for the packages-1 and 2 was requested. In consideration of this request, it has been proposed to proceed with the construction works of the drainage channels works for the packages-1 and 2 in accordance with the implementation schedule as shown in Fig 10.2.

(4) Construction time schedule was formulated considering the following conditions:

- Drainage channel works shall be executed from downstream part in principle.
- Construction priority is given to the section having the smallest number of households.
- Sluiceway under revetment shall be constructed during revetment construction period.
- Bridge construction in each section shall be made from downstream part in order to follow river structure construction.
- The construction periods of neighboring bridges shall not be overlapped.

The proposed construction time schedule is illustrated in Fig 10.2. The construction works are scheduled to be executed in 5 years from May 2000. The pre-construction activities in 1997 to 2000 consist of financial arrangement, pre-qualification of tender, tendering, tender evaluation and contract award. Besides those activities, land compensation and resettlement will be made timely in advance of commencement of the construction works at each site.

IMPLEMENTATION PROGRAM

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ANNEX TERMS OF REFERENCE FOR THE ENGINEERING SERVICES FOR SUPERVISION OF CONSTRUCTION

ABBREVIATIONS

(1) Local Terms

BAKOSURTANAL	Badan Koordinasi Survei dan Penetaan Nasional	:National Mapping Agencies
BAPPENAS	Badan Perencanaan Pembangunan National	:National Planning and Development Board
BPS	Biro Pusat Statistic	:Central Bureau of Statistics
BINA MARGA		:Directorate General of Road Development
CIPTA KARYA		:Directorate General of Human Settlements
DGWRD		:Directorate General of Water Resources Development
DINAS TATA KOTA		:Department of City Planning, DKI Jakarta
DKI Jakarta	Daerah Khusus Ibukota Jakarta	:Special Region of Capital City Jakarta
DPMA	Direktorat Penyelidikan Masalah Air	:Directorate of Hydraulic Engineering
DPU	Departmen Pekerjaan Umum	:Ministry of Public Works
DPU DKI Jakarta	Dinas Pekerjaan Umum DKI Jakarta	:Department of Public Works, DKI Jakarta
DPUP	Dinas Pekerjaan Umum Propinsi	:Provincial Department Office of Public Works
JABOTABEK		:Jakarta-Bogor-Tangerang-Bekasi
JASA MARGA		:Indonesia Highway Corporation
Kabupaten		:Regency
Kecamatan		:Sub-district
Kelurahan		:District
Kotamadya		:Municipal City
PELITA	Pembangunan Lima Tahun	:Five-Year Development
PERUM PERUMNAS		:National Urban Development Corporation

PMG	Pusat Meteorogi dan Geofisika	:Meteorological and Geophysical Center
P.P.	Priok Pile	
P.T.	Perusahaan Terbatas	: Private Estate Enterprise (Company Ltd.)
PWSCC	Proyek Pengembangan Wilayah Sungai Ciliwung-Cisadene	: Ciliwung-Cisadane River Basin Development Project Office
RKL		:Environmental Management Program
RPL		:Environmental Monitoring Program
REPELITA	Rencana Pembangunan Lima Tahun	:Five-Year Development Plan
TTG.	Tanda Tinggi Geodesi	

(2)International or Foreign Organization

GOI	:Government of the Republic of Indonesia
GOJ	:Government of Japan
IBRD	:International Bank for Reconstruction and Development
JICA	:Japan International Cooperation Agency
OECF	:Overseas Economic Cooperation Fund

(3) Foreign Terms

EIRR	:Economic Internal Rate of Return
FIRR	:Financial Internal Rate of Return
GDP	:Gross Domestic Product
GNP	:Gross National Product
GRP	:Gross Regional Product
PMF	:Probable Maximum Flood
NPV	:Net Present Value
O&M	:Operation and Maintenance
IEI	:Initial Environmental Evaluation
B/Q	:Bill of Quantities
TOR	:Terms of Reference

B/C	:Box Culvert
CAD	:Computer-aided Design
EIA	:Environmental Impact Assessment
ICB	:International Competitive Bidding
LCB	:Local Competitive Bidding
JIS	:Japan Industrial Standards
ASTM	:American Society for Testing and Materials

(4) Numerical Units

Length

mm	millimeter
cm	centimeter
m	meter
km	kilometer

Weight

gr	gram
kg	kilogram
ton	metric ton

Area

mm^2	square millimeter
cm^2	square centimeter
m^2	square meter
km^2	square kilometer
ha	hectare

Time

sec	second
min	minute
hr	hour
yr	year

Volume

cm^3	cubic meter
m^3	cubic meter
Ltr	liter

Others

%	percent
℃	degree centigrade
10^3	thousand
10^6	million
10^9	billion

Money

Exchange Rate

Rp.	Indonesian Rupiah	Official rate as of June 1997
¥	Japanese yen	US$ 1= Rp 2,350 = ¥ 115
US$	US dollar	

1 INTRODUCTION

This Implementation Program was prepared for package-1: Kamal drainage channel works and package-2: Tanjungan and PIK Junction drainage channels works in the Cengkareng west area, and presents the project area and the project works for both the Cengkareng west and Meruya areas, and cost estimate, economic evaluation and construction program for implementation for the packages-1 and 2.

1.1 Background of Project

The feasibility study on the urban drainage project for four objective areas, namely, Cengkareng west area, Sepak area, Bojong area and Meruya area was carried out by JICA and completed in 1991, namely, 6 years ago. Since then, land utilization condition has largely changed due to mainly rapid urbanization represented by house development on the land created by land reclamation in the depression areas located in the project areas. The house development has rapidly progressing in many places, especially in the Cengkareng west area, Sepak area and Meruya area. The private developers themselves have constructed the drainage channels for drainage of housing areas in accordance with the Indonesian regulation that the private developers should construct the drainage facilities to drain the housing areas to the main drainage networks. In the Cengkareng west area, many depression areas and swampy areas are located and all of these areas have already acquired by private housing developers or private enterprises. It is anticipated that these depression and swampy areas will be utilized as house development areas by creating the lands by means of land reclamation. In the Sepak and Meruya areas, a large scale houseing complex has completed and further extension is progressing at present. In the Bojong area, rehabilitation works of the existing drainage facilities have completed. In addition to the rapid urbanization in the objective areas, interchange works for Jakarta outer ring road have been progressing at the northern part of the Cengkareng west area and eastern part of the Meruya area. Due to construction of these interchanges, present drainage networks were largely changed compared with the situation investigated in the feasibility study stage.

Discussion meeting on determination of alignment for the proposed drainage channels was carried out and it was determined that detailed design works for the Sepak and Bojong areas were canceled from the scope of works because objected drainage channels in the Sepak area had already constructed and being scheduled to be improved

by private housing developers, and the drainage facilities in the Bojong area had recently rehabilitated and no further drainage works were needed. Due to change of the scope of works, basic study, definitive planning and detailed design for the urban drainage plan were carried out for the Cengkareng west and Meruya areas.

1.2 Outline of Project Works

The project works for the Cengkareng west and Meruya areas comprise mainly widening of the existing drainage channels and construction of levees including earth embankment type and concrete parapet wall type, revetments and bridges and culverts and installation of slide and flap gates. Major features of the project works are as follows:

(1) Drainage works in the Cengkareng west area

(i) Kamal drainage channel (drainage area: 20.89 km^2)

Total length:	7.2 km
Design discharge:	0.9 m^3/sec - 48.1 m^3/sec
Shape of drainage channel:	Trapezoidal section (side slope, 1:2.0 and 1:0.5) and rectangular section
Excavation:	267,000 m^3
Embankment:	39,000 m^3
Concrete parapet:	484 lin.m
Concrete ditch:	452 lin.m
Revetment:	6,675 lin.m
Bridges:	28 bridges comprising 26 girder type bridges, and 2 slab type bridges
Gates:	23 slide / flap gates

(ii) Tanjungan drainage channel (drainage area: 4.25 km^2)

Total length:	2.5 km
Design discharge:	9.6 m^3/sec - 19.0 m^3/sec
Shape of drainage channel:	Trapezoidal section (side slope, 1:3.0, 1:2.0 and 1:0.5) and rectangular section
Excavation:	51,000 m^3
Embankment:	52,000 m^3
Concrete wall:	1,134 lin.m
Revetment:	347 lin.m

Bridges:	5 girder type bridges
Gates:	7 slide/ flap gates

(iii) PIK Junction drainage channel (drainage area: 2.70 km^2)

Total length:	0.8 km
Design discharge:	7.1 m^3/sec - 18.1 m^3/sec
Shape of drainage channel:	Rectangular section
Concrete ditch:	765 lin.m
Bridges:	4 slab type bridges
Gates:	1 slide gate

(iv) Gede/ Bor drainage channel (drainage area: 2.41 km^2)

Total length:	1.2 km
Design discharge:	15.5 m^3/sec - 16.9 m^3/sec
Shape of drainage channel:	Trapezoidal section (side slope, 1:0.5)
Excavation:	29,000 m^3
Embankment:	2,300 m^3
Revetment:	2,300 lin.m
Bridges:	10 girder type bridges
Gates:	5 slide / flap gates

(v) Saluran Cengkareng drainage channel (drainage area: 3.08 km^2)

Total length:	4.2 km
Design discharge:	5.8 m^3/sec - 18.8 m^3/sec
Shape of drainage channel:	Trapezoidal section (side slope, 1:2.0, 1:0.5) and rectangular section
Excavation:	83,000 m^3
Embankment:	41,000 m^3
Concrete parapet:	1,285 lin.m
Revetment:	4,188 lin.m
Concrete culvert:	391 lin.m
Bridges:	13 girder type bridges
Gates:	15 slide/flap gates

(2) Drainage work in the Meruya area (drainage area: 1.27 km^2)

Total length:	2.3 km
Design discharge:	1.6 m^3/sec - 9.4 m^3/sec
Shape of drainage channel:	Rectangular section
Concrete ditch and culvert:	2,798 lin.m
Bridges:	16 slab type bridges

2 PROJECT AREA

Topographical, geological and meteorological conditions of both the Cengkageng west and Meruya areas are presented hereinafter.

2.1 Topography and Geology

2.1.1 Topography

The Cengkareng west area is located in the north-western part of the city of Jakarta and bounded by highway connecting an international airport and city of Jakarta in west, Mookervaat canal in south, Cengkareng floodway in east and Jakarta bay in north. Drainage area is about 36.7 km^2. The Cengkareng west area is characterized by remarkably low land elevation in a range of EL 0 m to EL 5 m, existence of several large scale depression and swampy areas and rapid urbanization represented by housing development on the land created by land reclamation for these depression and swampy areas. Due to these topographic characteristics, habitual inundation takes place in several low land areas. In the northern part of this area, the Jl. Tol Prof. Sediyatmo is located. In its northern part, a large fish pond are extending to the Jakarta bay. Five primary drainage channels are located in this area and majority of drainage water is discharged to the Jakarta bay through the largest Kamal drainage channel, and Tanjungan and PIK Junction drainage channels. The remaining two primary drainage channels are located to direction of southwards and eastwards.

The Meruya drainage area is located in the southern part of the highway connecting Jakarta and Merak harbor and bounded by existing drainage in the west, higher elevated area in the south, and higher elevated street in the east. Drainage area of the Meruya drainage system is about 1.3 km^2 and all of this area has been utilized as residential area. This drainage area is located on the elevation of 8~9m, but ground elevation is complicatedly undulated. Center part of this area is elevated and low land areas are located in its both sides. Due to these topographic characteristics, habitual inundation occurs in these depression areas in every rainy season.

2.1.2 Geology

The sub-surface of the Jakarta plain consists of 250 m thick, Quaternary soils.

Clays represent more than 70% of the soil cover. Thin sand layers are intercalated but laterally they are not continuous. The sands are fine grained and silty. The ground water is distributed over several thin and discontinuous layers and a clear distinction of aquifers is difficult. In general, the ground water level lies 2 m below the ground surface The soils are softer in the coastal area and more consistent from highway to the south and in the Meruya area. Very soft and soft, clayey and silty soils, SPT-value 0 to 3 blows, occur in the lower Kamal and Tanjungan areas, till the level of the highway. Their thickness is 9 to 11 m. Underneath, the soils are more consistent, SPT-values gradually increase to 20 and 30 blows, for an investigation depth of 35 m. South of the highway, towards the Daan Mogot road, mixed or clayey soft soils, where the SPT-value is less than 10 blows, extend from the ground surface to 5 or 7 m of depth. Underneath, 1.5 to 7 m thick, cemented sands, SPT-value more than 50 blows, have been found. This bed is not continuous over the entire area. The sands are underlain by stiff to hard clays, SPT-values 15 to 30 blows.

The Meruya area is covered with red soils. These are mixed type of soils, containing equal amounts of clay, silt and sand, locally with gravel. Such soils are generally stiff to hard. From the sounding data, a hard layer, possibly cemented sands, underlies the soil cover, at an average depth of 5 m.

The project area and the entire Jakarta plain have been affected by land subsidence, due to self-weight consolidation in the deeper soil beds (40-250 m). This process is triggered by groundwater pumping from the deeper, confined aquifer and its impact on the sub-surface is far more important and the counter-measures imply long term decisions on regional scale. At present, ground water has been extracted by more than 3,000 wells with 300 m deep for industrial use in the Cengkareng west area. It has been reported that the maximum land subsidence rate in the project area is about 8cm/year.

2.2 Meteorological Conditions

(1) Air temperature

Annual average of air temperature at the international airport located at southern part of the project area is in the range of 26℃ and 27℃ throughout a year. Extremely maximum and extremely minimum are 35.2℃ and 17.4℃ respectively in November and August.

(2) Relative humidity

Monthly mean relative humidity at the international airport ranges from 75% to 89% throughout a year. Monthly maximum and monthly minimum occur in February and September respectively.

(3) Surface wind

Wind speed is generally calm to 10 knots from 1 a.m. to 10 a.m. The wind speed becomes higher, more than 10 knots at 11 a.m. to 3 p.m. After 3 p.m., the wind speed usually decreasing except in bad weather.

(4) Rainfall

Annual rainfall during the period from 1986 to 1995 at the international airport is around 1,700 mm. The monthly maximum rainfall is 644 mm in January and monthly minimum is 1 mm in October. The highest frequency and lowest frequency of rainy day occur in January and September respectively.

2.3 Flood and Inundation

Location of habitual inundation areas is illustrated in Figs 2.1 and 2.2. On average, approximately 5% of the project area is affected by flood. The inundation tends to occur in lowland areas and the areas along the rivers and drainages. The areas in which the inundation is clustered are the area in the Kamal, Tanjungan and the area along the Saluran Cengkareng drainage channel. The depth of the inundation ranges from 15cm to 100cm depending on the location. The range of duration is 1 to 7 hours. In the Tegal Alur and Kamal along the Kamal drainage channel, the range of depth of inundation is 30cm to 100cm which is the deepest in the project area. In Meruya area, the depth of inundation sometimes reaches 75cm.

The data showing the relationship between acreage of the inundation area and flood damage are not available. Then, the flood damage was estimated assuming the assets in the inundation areas. The estimated annual flood damage is about US$ 7.7 million for the Cengkareng west area and US$ 0.2 million for the Meruya area.

3 SOCIO-ECONOMIC CONDITIONS

Socio-economic conditions of both the Cengkareng west and Meriya areas are as follows:

3.1 Administrative Unit of the Project Area

The project area is located in northwest part of DKI Jakarta which covers 4 Kecamatans and 9 Kelurahans: Kec. Kembangan, Kec. Cengkareng, Kec. Kalideres in Jakarta Barat and Kec. Penjaringan in Jakarta Utara.

The project area is one of the fastest growing regions in DKI Jakarta. This growing trend is caused partly by the Jakarta outer-ring road and the Jl. Tol Prof. Sediyatmo which cut through the project area. The outer-ring road, currently under construction, is going to be built along Kec. Cengkareng and Kec. Kembangan. The Jl. Tol Prof. Sediyatmo, which connects the central city to the international airport, is located in the north part of Kec. Cengkareng and Kec. Kalideres. Because of the existence and construction of the highways, many large scale housing developments are currently underway. In the near future, this area is going to play an important role for economy in the city of Jakarta.

3.2 Population

The population of the project area in 1994 was 261,893 which is 3.5% of the population in DKI Jakarta (7,515,392). The area of Kelurahan which covers the project area is 52.3 km^2 which is about 8% of the area of DKI Jakarta (661.26km^2).

The average population increase in the project area from 1990 to 1994 was 4.03% which is relatively high compared with the rate in 1980's which shows 3.89% increase. The Kelurahan which shows a large population increase is Pegadungan (10.57%) in Kec. Kalideres in which there is a large scale housing development. Several housing developments are also currently underway in Kec. Cengkareng. In Kec. Kalideres, which has more space for housing development, more housing development can be expected, which will trigger a rapid population increase in the future.

Population density in the project area is 5,008 persons/km^2 which is lower than

the population density for DKI Jakarta (10,192 persons/km^2) at present, but due to rapid housing development in the project area, high population density in the project area in near future is anticipated.

3.3 Present Land use

Approximately 61.1% (22.4km^2) of the area has been utilized as a residential area, followed by agricultural area (15.1%, 5.6km^2), fish pond(9%, 3.3km^2), swampy/depression area (8.5%, 3.1km^2) and industrial area(6.3%, 2.3km^2). According to the field survey, most open space has already been acquired by private sector for housing development. Industrial area, commercial area, and office area occupy about 18% of the project area. Industrial area concentrates mainly in Kec. Kamal along the Jl. Tol Prof. Sediyatmo. The commercial area is scattered in all the project area.

3.4 Labor Force

People in the project area are employed in a variety of sectors. The sectors with the largest employment are the industry sectors which employ about 26% of employment, followed by commerce sectors (24%) and the government sectors (13%). The recent trend of economic activities in this area is the decline of agricultural activities, which is caused by a rapid urbanization of the area. Agricultural activities can be seen only in a small area of Kec. Kalideres and Kec. Penjaringan. There is no agricultural activity in Kec. Cengkareng and Kec. Kembangan.

3.5 Social Infrastructure

3.5.1 Water supply

The piped water supply by PAM (Water Supply Enterprise) is available only in the newly developed area. For the majority of households in the project area, the main source of water for domestic use is from wells, either pumped by machine or by hand, and the main source of drinking water is distributed by PAM in large tanks placed in several places in Kelurahan. Even though the water from wells contains salt and not suited for drinking, there are people who use the water from wells for a drinking purpose. The piped water supply is still limited to a small number of households, however, due to the housing development in the area and the effort by PAM, the water service by pipe is expanding and more people will have an access to the PAM service.

3.5.2 Electricity and gas supplies

The electricity is available in most households in the project area. More than 90% of households have an access to electricity. About 6% of households use either lamp or oil, and only a small number of households (0.02%) cannot have any mean of electricity.

Gas is utilized by propane tank for most households. Oil is also used for cooking in some area.

4 EXISTING URBAN DRAINAGE SYSTEM

4.1 Existing Urban Drainage Facilities and Related Structures

4.1.1 Cengkareng west area

The existing drainage networks of the Cengkareng west area is given in Fig 4.1. Drainage water in the Cengkareng west area is discharged through five main drainage channels to three directions, namely, Jakarta bay to northwards, Cengkareng floodway to eastwards and Mookervaat canal to southwards. Existing bridges, high tension electric lines, water supply pipes and telephone lines across the existing drainage channels. Locations of these related structures are shown in Table 4.1. Present condition of the respective drainage areas and drainage facilities are as follows:

(1) Kamal drainage area

The Kamal drainage area is located in the north-western part of the Cengkareng west area and it is bounded by the Jl.Tol Prof. Sediyatmo in the west, main irrigation channel in the south and Jakarta outer ring road in the east. Drainage area of the Kamal drainage system is about 20.89 km^2 which occupies about 57 % of the Cengkareng west area. About 75 % of the drainage area is occupied by residential area. In center and southern parts of this area, one swampy area and four depression areas are located. These swampy and depression areas had been already acquired by private developers for housing development. A part of the depression areas has been developed as housing complex on the land created by land reclamation.

The Kamal main drainage channels have about 11,900 m in total length comprising about 9,700 m long channel constructed and maintained by DKI and 2,200 m long channel constructed by private sectors. Lined channel with wet masonry is 9,700 m and unlined channel is 2,200 m. The channel is about 15 m wide and 2.5~3 m deep at the highway crossing and 10 m wide and 1.5 m deep at the junction portion of the channel extending from eastern direction. The channel bed slope is about 1:3,200 in about 2.3 km from the channel mouth and 1:1,800 in its upstream channel stretch.

No channel related structure such as gates and weirs has been provided along the drainage channels. Thirty one bridges and one culvert cross the drainage channels. Majority of the bridges are single span and about 3~8 m in length. Among the related

structures, the culvert crossing the highway is the largest structure with two lanes of 10.8m in total width.

(2) Tanjungan drainage area

The Tanjungan drainage area is located in the northern part of the Cengkareng west area and bounded by the Kamal drainage in the west and south and outer ring road and interchange of the outer ring road in the east. This drainage area comprises low land with elevation of about EL 0.5 m and large scale depression/swampy areas in the center part and eastern part of the drainage area. These depression areas have been already acquired by private sectors for house development. The downstream part of the Jl. Tol Prof. Sediyatmo (the highway) forms fish pond. Industrial areas are located along the highway. Drainage area of the Tanjungan drainage system is about 4.25 km^2. About 40 % of this drainage area is occupied by residential and industrial areas. The Tanjungan drainage channel has about 1,700 m long lined channel with wet masonry and concrete and 200m long unlined channel. The drainage channel is about 5 m wide and 0.8 m deep at the highway crossing. The channel bed slope is so gentle as being about 1:5,000 in all channel stretch. Due to this gentle channel bed slope, drainage water is stagnating even in a dry season. A culvert with about 3.4 m wide and 1~2 m high has been provided under the highway. However, since road surface elevation of the highway is almost the same as tidal level due to subsidence of the highway, the culvert crossing the highway functions as siphon at present. Due to this situation, remarkably small drainage water is discharged to downstream through the culvert. The drainage water released through this culvert flows into fish pond in its downstream and poured to Jakarta bay through about 900 m long channel provided in the upstream of channel mouth. According to the information concerning subsidence of the highway, the subsidence of the highway has been progressing in the road stretch between the Kamal culvert portion and the Cengkareng floodway bridge in the Cengkareng west drainage area and its extent is the most serious near the Tanjungan culvert crossing portion. Due to inundation caused by subsidence of the highway, access to the international airport has been sometimes disturbed in a rainy season.

No channel related structure has been provided along the drainage channel. Five bridges and one culvert cross the Tanjungan drainage channel.

(3) PIK Junction drainage area

This drainage area is located in the north-eastern part of the Cengkareng west area and surrounded by an interchange of the Jakarta outer ring road in the west, existing street

with slightly higher elevation in the south and the Cengkareng floodway in the east. The downstream of the Jl. Tol Prof. Sediyatmo forms mainly fish pond and a golf yard. Drainage area of the new drainage system is about 2.70 km^2 and all of the area is occupied by residential and industrial areas. The drainage system in this area was drastically changed by construction of the interchange roads of the Jakarta outer ring road and drainage of this area has been interrupted by the interchange road. In this drainage area, 5 culverts with 0.8m in diameter are provided crossing the highway. Length of the new drainage channel is 300m up to the highway. It is reported that these culverts are constructed mainly to stabilize the highway by balancing the water level at the both sides of the highway. The drainage water collected from the densely populated area in the left bank of the Cengkareng floodway is drained along the low elevated fringe of the highway, but, due to obstruction of the interchange roads to the Cengkatreng direction and airport direction, the drainage water is drained through seven culverts with 0.8 m in diameter provided crossing the highway and one culvert with about 0.7m in diameter provided at the interchange road.

No related structure is located in this drainage area. Two bridges and two culverts are crossing the proposed drainage channel.

(4) Gede/Bor and Saluran Cengkareng drainage areas

This drainage area is located in the southern part of the Cengkareng west area and bounded by higher elevated area in the west, boundary area in the south, main irrigation cannel in the north and Cengkareng floodway in the east. Drainage area of the Gede/Bor and Saluran Cengkareng drainage systems are about 2.41 km^2 and 3.08 km^2 respectively and all of these areas except for 6 % of the paddy field in the Gede/Bor drainage area have been utilized as residential area.

The drainage water discharged through the Gede channel which is located inside the newly constructed housing complex is drained to the Bor canal. The drainage water from the Gede channel is divided into the southern direction to the Mookervaat canal and eastern direction to the Saluran Cengkareng channel. The Bor drainage channel has about 1.5 km in length to the Mookervaat canal and channel bed slope is about 1:1,100. While, the Saluran Cengkareng drainage channel is about 4.2 km in total length to the Cengkareng floodway and channel bed slope is about 1:3,000. It is presumed that majority of the drainage water is discharged to the Mookervaat canal through the Bor drainage channel due to steeper river bed slope of the Bor drainage channel.

The Gede/Bor drainage channel which drain to the Mookervaat canal comprises 1,500 m long channel constructed and maintained by DKI and 1,900 m long channel constructed by private sector. The Gede drainage channel which is provided inside the new housing complex is about 8 m wide and 2 m deep. All of these channels are lined channel. About 4 m wide and 2 m deep Citra Garden II channel which drains from the south-western part of the area has been rehabilitated by a private sector. In order to drain water from the Citra Garden II channel to the Mookervaat canal, the private sector already constructed a drainage channel to the Mookervaat canal in the right side of the existing Bor drainage channel.

The Saluran Cengkareng drainage channel which drain to the Cengkareng floodway has 4,200 m in total length comprising 3,400 m long lined channel and 800m long unlined channel. All of these channels were constructed by DKI. Several channel stretch portions of the Saluran Cengkareng channel were rehabilitated by DKI. Its dimension is 5~8 m wide and 1.5 m deep at upstream end and about 10m wide and 1.8 m deep at the confluence with the Cengkareng floodway. The drainage water collected through the Saluran Cengkareng channel flows down through remarkably densely populated area and drained to the Cengkareng floodway. A sluice facility with 2 units of 2.4m wide and 2.6 m high spindle type sluice gate has been provided at the outlet of the Saluran Cengkareng channel to minimize inundation in locally low land area along the Saluran Cengkareng drainage channel at about 1,200m upstream of the channel mouth, due to back water of the Cengkareng floodway. Existing sluice gates has been operated under the condition that the gate is closed when the water level of the Cengkareng floodway exceeds 10 cm over the water level in the Saluran Cengkareng drainage channel at its outlet portion. The Saluran Cengkareng drainage channel in its downstream portion has been filled with dust and garbage at present. To prevent dust and garbage from flowing into the drainage channel, some structural measures will have to be considered for the design works. It has been reported that no inundation due to back water of the Mookervaat canal takes place in the area along the Bor drainage channel. Forty four bridges and two culverts cross these drainage channels.

(5) Pedongkelan drainage area

This drainage area is located in the eastern part of the Cengkareng west area and bounded by Jakarta outer ring road and main irrigation canal in the west, boundary of the PIK Junction drainage area in the north and the Cengkareng floodway in the east. Drainage area of the Pedongkelan drainage system is about 3.38 km^2 and all of this area has been utilized as residential area. Majority of center part of this drainage area is

already occupied by the National Urban Development Corporation (PERUM PERUMNAS) and a new drainage system with poundage and pump facility at its outlet is being constructed to drain the drainage water to the Cengkareng floodway. The new drainage is located surrounding the housing complex. The drainage channel comprises about 6,600 m long lined channel with wet masonry.

4.1.2 Meruya area

Present drainage conditions and flow direction are shown in Fig 4.2. The Meruya drainage area is located at the southern part of the highway connecting Jakarta and Merak harbor and bounded by existing drainage in the west, higher elevated area in the south, and higher elevated street in the east. Drainage area of the Meruya drainage system is about 1.27 km^2 and all of this area has been utilized as residential area. The Meruya drainage channel to be studied is secondary level and comprises about 600 m long concrete ditch and 600 m long unlined ditch. The drainage ditch is about 1~2 m wide and 1 m deep in an average. Nine existing bridges have been provided crossing the drainage ditch. High tension electric lines, telephone lines and electric and telephone poles are located along the drainage ditch. These are listed in Table 4.1. Drainage water collected from southern watershed flows towards northern direction and divided into eastern and western directions due to high undulation in the center part of the drainage area. The drainage water flowed down to the eastern direction once stagnates in low land or depression area in the eastern part of the drainage area and a part of drainage water discharges to existing eastern drainage ditch provided in the recently constructed private house complex. The drainage water flowed down to the western direction stagnates in depression area in the western part of the drainage area and a part of drainage water discharges to the existing drainage ditch located at northern part of the objective drainage area through the existing cross drains provided under the highway. In a rainy season, habitual inundation with long duration takes place in the above mentioned depression areas due to undulation of the ground surface and inadequate drainage channel alignment. Since the capacity of the drainage ditches constructed in the private owned housing areas in eastwards is limited, drainage water flows down in the eastern part of the drainage area will have to be shifted to the western direction. In the north-eastern part of the drainage area, construction works of the interchange are being executed. Due to construction of the interchange facilities, drainage to the existing cross drains will be disturbed and only one outlet of the drainage water in the western part of the drainage area will be limited to a tributary of the Angke river located at about 480m westwards of the drainage area. Along the existing drainage channel, nine bridges cross

the existing drainage networks.

4.2 Flow Capacity of the Existing Drainage Channels

Based on the result of the topographic survey carried out in this time, the flow capacity of the existing drainage channels which were constructed by both the government and private sectors in the Cengkareng west area was estimated by means of non uniform flow. The estimated bankful flow capacity of the existing drainage channels in the Cengkareng west area is illustrated in Fig 4.3. This figure shows that the flow capacity of majority of the existing drainage channels corresponds to less than one-year recurrence. The flow capacity of these drainage channels is insufficient and widening of the channel is needed to discharge the design flood.

The Pedongkelan drainage system has been designed as pumping up method. In order to evaluate this pumping up system, relationship among present width of the constructed drainage channel, flow capacity of the existing drainage channels, ground elevation and necessary width to drain the design flood was studied based on the result of the cross section survey. The result of the study clarifies that the flow capacity of the constructed drainage channels is insufficient to drain the design flood due to low elevation of the drainage area. Since it is not economically feasible to widen the constructed drainage channel up to the required width, it is considered reasonable to employ the pumping up method to drain flood water to the Cengkareng floodway.

In the Meruya area, systematic drainage system has not been yet established and the existing drainage ditches are provided partly and not continued to the downstream existing drainage channel. Due to these conditions, flow capacity of the partly provided drainage ditches is unable to estimate.

5 URBAN DRAINAGE PROJECT

5.1 Basic Concept for Proposed Urban Drainage Project

The basic principle for the urban drainage plan for two objective areas, Cengkareng west area and Meruya area, was established considering rapid urbanization in the objective areas represented by housing development and drastic variation of the existing drainage networks due to (i) construction of interchange structures of Jakarta ring road and (ii) anticipating future land use condition. The established basic concept for the proposed urban drainage plan is as follows:

(1) The future land use plan for the objective areas was established referring to the land use plan set out by DKI Jakarta and anticipating future land use condition from present land use progressing situation, and target year for this drainage plan is set at 2010. Comparison of the land use in the present and the target year 2010 is as follows:

(Unit: km^2)

Category of Area	Present Land Use	Land Use in 2010
- Residential area	22.44	27.98
- Industrial area	2.31	3.48
- Paddy field	5.55	2.27
- Fish pond	3.28	2.98
- Swampy/depression area	3.13	0
Total	36.71	36.71

(2) The drainage channels are designed under protection level of 10-year flood for the Cengkareng west area and 5-year flood for the Meruya area.

(3) Drainage water is drained by gravity flow in principle to minimize operation and maintenance cost for the drainage facilities after construction of the project.

(4) In the Cengkareng west area, only primary (main) drainage channels will be designed. For Meruya area, all of the major drainage channels are secondary level. In this design, these major drainage channels will be designed.

(5) Special consideration for land subsidence and clean water management was made for planning and designing of the proposed urban drainage project.

(6) There are many swampy and depression areas and these areas have been already acquired by private housing developers/industrial enterprises. The drainage channels in these private owned areas should be constructed by themselves and the

constructed drainage facilities will be handed over to DKI Jakarta for routine maintenance works. In the definitive plan, design criteria to be applied to the drainage channels for private sectors such as design discharge, design channel bed slope and design channel bed elevation will be clarified

(7) Currently, the Jl. Tol. Prof. Sediyatmo is aligned in the swampy area in the northern part of the Cengkareng west area and it has repeatedly suffered from submergence in a rainy season. The cause of this road submergence is attributable mainly to lower elevation of the highway in an about 4 km long stretch in the Cengkareng west area. To cope with this submergence and also to cope with traffic volume increase in a future stage, it has been planned by JASA MARGA that the existing highway is widened to four lanes and heightened in the stretch between the Kamal drainage crossing site and Cengkareng flooway crossing site, and bridges crossing the Kamal and Tanjungan drainage channels are to be designed and constructed by JASA MARGA themselves. Thus, in this design, the bridges for the Kamal and Tanjungan drainage channels, which cross the highway are excluded.

(8) High tension electric lines and water supply pipe lines cross the existing drainage channels. Due to expansion of the drainage channels, treatment of these lines are needed. Besides, it is obliged to shift the existing telephone poles, concrete structure with gates for drainage facilities of highway, road signs, traffic signals, etc. due to expansion of the existing drainage channel. For the treatment, discussion is to be made with authorities concerned. It is proposed that planning, designing and construction of expansion/shifting works of these structures are to be made by authorities themselves under the condition that the cost necessary for expansion/shifting works is born by the project.

5.2 Design of Drainage Channels

5.2.1 Design conditions

(1) Alignment of drainage channel

The alignment of the drainage channels is designed, based basically on the present channel alignments, in consideration of the followings:

(i) The existing drainage channels shall be used as much as possible to minimize compensation cost, so far as the widening of the existing channels is economically feasible from the viewpoint of the compensation of lands, houses and other existing facilities, namely electric poles, water pipes and telephone cable ducts.

(ii) The channel structures such as revetments and bridges which are expected to satisfactorily function in future shall be used as much as possible, if necessary with some modification works.

(2) Longitudinal profile of drainage channel

The longitudinal profile of the drainage channels shall be determined based on the following criteria :

(i) The drainage channel bed is designed so as to gradually change from a steeper slope in the upstream stretch to a gentler slope in the downstream one.
(ii) The longitudinal profile of the drainage channel shall be determined under the condition that the newly designed channel bed gradient is not remarkably different from the present one.

(3) Design high water level

In principle, the design high water level of the drainage channel should be equal to or lower than the original ground elevation or the ground elevation for the land reclamation area. The design high water level is determined, through non-uniform flow calculation under the following conditions :

(i) The initial water levels for the Kamal and the Tanjungan drainage channels which discharge to Jakarta Bay are set at the spring tidal level (high water) of TTG System.
(ii) The initial water level for the Saluran Cengkareng drainage channel which discharges to the Cengkareng floodway is set at the 25 year flood water level in the floodway at the drainage channel outlet.
(iii) The initial water levels for other drainage channels are set at the water levels estimated by uniform flow calculation.
(iv) The roughness coefficient is 0.03 in a drainage channel of which the channel slopes will be protected on both sides by masonry revetment and 0.016 for concrete structures.

(4) Cross section of drainage channel

The proposed drainage channels are designed by widening their present channels and constructing new levees. The cross sections of the drainage channels are determined in consideration of effective use of existing structures in and around the drainage channels, such as revetments, bridges, roads, electric poles and telephone cable ducts, in order to

minimize compensation of the structures. The cross sections are determined as follows:

(i) The new levees along the Tanjungan drainage channel will be constructed in the north part of Jalan Tol. Prof. Sediyatmo by dump-fill of earth materials to be obtained from excavation of the channel and in near borrow areas, since the water levels outside the channel are the same as the inside one and the levee is always saturated by water to the upper part. The side slope of the levee shall be 1:3.0.

(ii) The new levees except (i) above shall be of a earth embankment type and their side slopes are to be 1:2.0 .

(iii) A trapezoid shape channel protected by a wet masonry revetment is applied to the channels except for the stretches designated in (i) and (ii) above, in consideration of land and house compensation, maintenance of side slopes of the channel and convenience in water use for inhabitants. The side slopes of the revetment shall be 1:0.5

(iv) Freeboard shall be provided above the design high water level, as follows:

Drainage channel	Freeboard(cm)
1) Cengkareng west area	
- Kamal	50 (20 - 30)
- Tanjungan	40
- PIK Junction	30
- Gede/Bor	40
- Saluran Cengkareng	30-40
2) Meruya area	20-40

Note: Figure in brackets shows freeboard for branch channel

5.2.2 Special Consideration of land subsidence and clean water management

(1) Land subsidence

Land subsidence is a serious problem in the Cengkareng west area. The extent of the land subsidence for 20 years since 1974 has been estimated at the rate of 6cm/year to 8cm/year by DKI Jakarta by means of levelling survey of existing bench marks in PP System. In due consideration of the extent of the land subsidence rate per year, basic concept and criteria for this urban drainage project against land subsidence was set as follows:

(i) The drainage channels and related structures are designed so as to cope with land subsidence up to target year, 2010.

(ii) The drainage channels and related structures shall be designed under the condition that all of the riparian areas along the drainage channels are settled down at the rate of the above extent of subsidence per year and the tidal water level in Jakarta bay is unchanged. The drainage channels and related structures are designed by gravity flow up to the target year. If the design flood water levels of the Kamal, the Tanjungan and the Saluran Cengkareng drainage channels become higher than the elevation in riparian areas along the drainage channels due to land subsidence after the target year, pumping up facilities will have to be considered. To cope with such situations, a pump drainage plan with a regulation pond is examined at a preliminary level.

(iii) It has been presumed that subsidence takes place due to two parameters, namely settlement due to heavy burden in a shallow zone and self consolidation due to pumping up of ground water in a deep zone. In case of the design of permanent structures such as bridges and culvert structures, it is proposed to apply supporting or friction piles and to provide the height to meet a subsidence depth during the selected period above the freeboard of the design flood water level to cope with settlement in the shallow zone. However, it is impossible to cope with self consolidation in the deep zone, the type of a bridge and a culvert which can be technically heightened when land subsidence in the deep zone takes place will be adopted.

(iv) No allowance for the land subsidence is provided for the levees on condition that the levees shall be heightened after occurrence of detrimental subsidence in future, for the following reasons:

(a) Extra embankment 20 cm thick is provided for the levees against (i) future settlement in levee bodies and (ii) subsidence in the shallow zone under the levee bodies due to their heavy burden.

(b) It is difficult to quantitatively specify the extent of self-consolidation due to pumping up of ground water in the deep zone.

(c) Rather high safety against the protection level of a 10 year flood inheres in the designed high water levels of the drainage channels, because the high water levels correspond to respective 10 year floods calculated by the Rational Method.

(d) Future heightening works of the levees are able to be easily executed, as required.

(2) Clean water management

Drainage water containing contaminated water in the existing drainage channels in the Cengkareng west area stagnates in most of the channel stretches in the dry season due mainly to very gentle channel slope caused by the remarkably low land area and also reduction of flow capacity caused by throwing dust and garbage into the drainage channels. In particular, this phenomenon is conspicuous in the outlet of the Saluran Cengkareng drainage channel. Consciousness of inhabitants for improvement to clean water in the drainage channels is remarkably low at present. In order to keep and maintain drainage channels in clean condition, following structural and non-structural measures will have to be adopted.

(i) Along the downstream part of the Saluran Cengkareng drainage channel, many houses are densely located and the drainage channel has been filled with dust and garbage. To prevent dust and garbage from flowing into the drainage channel and to keep clean water, a structural measure of provision of a 400m long culvert with mesh cover and inlet screen is introduced in this densely populated drainage stretch. In addition, to prevent stagnation of drainage water, the drainage channel is designed so as to have so high velocity as the topographic condition allows

(ii) In order to flush out the contaminated water in the drainage channels in a dry season, a part of the irrigation water from the main irrigation canal provided at the southern part of the Cengkareng west area will be utilized as maintenance flow of the proposed drainage channels. To meet this requirement, connection of the drainage channels and the secondary irrigation canal is contemplated in this design.

(iii) In order to facilitate clean water management as non structural measures, the proposed operation and management plan including (a) technical aspects such as routine operation and maintenance methods and works and equipment to be needed, and (b) institutional aspects such as the proposed organization and system, annual budget to be disbursed and participation of inhabitants to operation and maintenance works is studied.

5.2.3 Proposed flood discharge distribution

The design flood discharge prepared in the feasibility stage was reviewed by incorporating the data obtained in this study. It has been determined to apply a 10-year probable flood for the Cengkareng west area and a 5-year probable flood for the Meruya area. The flood peak discharges of the objective urban drainage channels were

calculated by using the Rational formula. In this formula, the basin average rainfall intensity was estimated using point rainfall intensity-duration relationship which was prepared based on the available rainfall data. Flood concentration in the objective drainage channels was estimated using the assumed flow velocity-channel gradient relationship.

The flood peak discharges at several points for respective channels were estimated adopting the run-off coefficient, basin average rainfall intensity and respective catchment areas to the rational formula. Based on the estimated flood peak discharge, the flood peak discharge at the selected points for respective drainage channels were estimated by applying a specific discharge- catchment area relationship. The flood discharge distribution based on this estimation for the Cengkareng west area and Meruya area is given in Figs 5.1 and 5.2 respectively.

5.2.4 Alignment of drainage channels

In accordance with the above basic concept, the drainage channel alignments and basic drainage plan were determined as follows and these are illustrated in Fig 5.3 for the Cengkareng west area and Fig 5.4 for the Meruya area.

(1) Cengkareng west area

1) Kamal drainage channel

The drainage channels in the depression areas and swampy areas which had been acquired by the private sectors have already been constructed, and it is presumed that the drainage channels in the remaining depression and swampy areas, which have been acquired by private sectors, will be constructed by private sectors themselves by reclaiming the lands up to EL 4~6 m, under the condition that the drainage water is discharged by gravity flow. To drain the water from the upstream drainage areas to Jakarta bay, the drainage channel is aligned by expanding the existing drainage channel and reconstructing a bridge at Jl. Tol. Prof. Sediyatmo (the Highway). The gate facilities will be provided along the Kamal drainage channel in locally low land areas in southern part of the Highway.

2) Tanjungan drainage channel

The drainage channel in the depression area in the center part of the drainage area, which has been acquired by the private sector, will be constructed by a private sector

under the condition that the depression area is reclaimed up to 2 m and the drainage water is drained by gravity flow. A low land is located at the southern part of the Highway. In order to drain water in this low land by gravity flow and to cope with land subsidence, it is necessary to heighten this low land up to EL 2 m. The drainage water in this low land will be discharged through sluiceways until completion of land reclamation in this low land. In order to drain water from the upstream depression areas and other drainage area to Jakarta bay, the Tanjungan drainage channel is aligned straightway to Jakarta bay by providing a bridge at the Highway and constructing the drainage channel in the fish pond.

3) PIK Junction drainage channel

The drainage condition in this area was drastically changed from that stated in the feasibility study (1991): drainage in this area is interrupted by a newly constructed interchange road which divides the drainage area into two zones. The drainage channel in the depression area, which is located along the ring road and already acquired by a private sector, will be constructed in the land to be reclaimed up to EL 2 m. Since the interchange road network crosses the proposed drainage channel, the proposed drainage channel will be aligned by avoiding this interchange road. The northern part of this drainage area is acquired by a private housing developer. The drainage water collected along the Highway is planned to be discharged to Jakarta bay through the existing 6 culverts with diameters of 0.80m~1m under the condition that the land already acquired by the private sector is heightened up to EL 1~2 m.

4) Gede and Bor drainage channels

Since majority of the Gede drainage channel was already constructed by a private house developer and also majority of the Citra Garden II drainage channel was constructed by a private sector, the remaining stretches of the Gede primary channel and the Citra Garden II drainage channel and all of the Bor drainage channel will be expanded to discharge the design flood to the Mookervaat canal. The Bor drainage channel will be designed by gravity flow without any gate facilities.

5) Saluran Cengkareng drainage channel

The Saluran Cengkareng drainage channel is connected with the Bor drainage channel at its upstream end and drainage water flowing in the Bor drainage channel is discharged to two directions at the connection point; namely the southern direction to the Mookervaat canal and the eastern direction to the Saluran Cengkareng channel. In order to minimize the width of the Saluran Cengkareng drainage channel in the downstream

stretch in the densely populated area, the Saluran Cengkareng drainage channel is separated from the Bor channel. However, at the upstream end portion of the Saluran Cengkareng drainage channel, sluice gate facilities are provided to release the Bor water to the Saluran Cengkareng drainage channel as maintenance flow in a dry season. The Saluran Cengkareng drainage channel is designed by gravity flow without any pumping facility. To prevent further expansion of inundation in the locally low land area along the Saluran Cengkareng drainage channel in case that a large magnitude flood takes place in the Cengkareng floodway and the flood flows into the Saluran Cengkareng drainage channel, sluice gate facilities will be provided at the outlet of the Saluran Cengkareng drainage channel by modification of the existing gate facilities. Both banks of the present Saluran Cengkareng drainage channel along the low land area 1.5 km upstream of the outlet will be heightened to prevent drainage water from flowing into the low land area and sluiceways will be provided.

6) Pedongkelan drainage channel

In the center part of this drainage area, a large scale house complex is located and drainage channels surrounding this house complex and extending to the eastern direction to drain water to the Cengkareng floodway are being constructed by the National Urban Development Corporation (PERUM PERUMNAS) at present. It is planned in this drainage channel to provide a regulation pond and pump facilities to discharge drainage water to the Cengkareng floodway. Since construction of this drainage channel belongs to this house supply cooperation, design of this drainage channel was deleted.

(2) Meruya area

Since the ground elevation of Meruya area is lower than the surrounding area topographically, the habitual inundation areas are formed in the center part of the drainage area. A part of the drainage water from Meruya area flows into the existing drainage ditch located in the private housing complex in the eastwards of Meruya area. Since the capacity of the existing drainage ditch in the private owned housing area is limited, the drainage water caused by future development of Meruya area could not be drained to eastern direction. In addition, due to the construction of the new junction of Jl. Tol Jakarta-Merak (Kebon Jeruk Junction) in the north east part of the project area, the drainage to the existing culverts under the embankment of Jl. Tol Jakarta-Merak will be interrupted. Because of these reasons mentioned above, it is considered that the only outlet of the drainage from Meruya area is a tributary of Angke river located at about 480m west from the drainage area. The new drainage channel is aligned across the

inundation areas in upstream and middle stream stretch, along Jl Tol Jakarta-Merak in downstream stretch, and connected to the tributary of the Angke river. The proposed channel alignment in Meruya area is shown in Fig 5.4.

5.2.5 Longitudinal profile of drainage channels

(1) Cengkareng west area

1) Drainage channel to be drained to Jakarta bay

Drainage water in the Kamal, the Tanjungan and the PIK Junction drainage channels is discharged to Jakarta bay. In order to drain as much discharge as possible within the limited channel width, a steeper channel bed slope should be applied. If this method is applied, channel excavation to off shore is needed and jetty will have to be provided to protect the excavated channel from scouring and depositing of sand. However, design of the jetty such as its direction and scale will not be made with no result of the coastal investigation. In addition, it is anticipated that the deepened channel bed alters to the original channel bed due to sea sand and sedimentation from upstream side. In view of the above, the design channel beds in the existing drainage channel portions are set at the original bed elevation for the Kamal and the Tanjungan drainage channels. The design channel beds for the depression and swampy area portions, which have been acquired by private sectors, are set in consideration of channels bed slope in the existing channels and the assumed ground elevations of the land reclamation areas. The design channel bed slope for the PIK Junction drainage channel is set in consideration of the existing channel bed slope along Jakarta Outer Ring Road and the ground elevation of the upstream drainage area. The determined channel bed slope is as follows:

-Kamal drainage channel	: 1:3,200	and 1:1,800
-Tanjungan drainage channel	: 1:5,000	
-PIK Junction drainage channel	: 1:600	

2) Drainage channel to be drained to Cengkareng floodway

The Saluran Cengkareng drainage channel discharges to the Cengkareng flooway. The Saluran Cengkareng channel is affected in its downstream portion by the water level of the Cengkareng floodway. Even if the channel bed at outlet portion of the Saluran Cengkareng drainage channel is lowered, the flood capacity hardly changes. Thus, the design channel bed is set at the original channel bed elevation. The determined channel bed slope is 1:3,000.

3) Drainage channel to be drained to Mookervaat canal

The Gede/Bor drainage channel discharges to the Mookervaat canal. Since the Gede/Bor drainage channel is not affected by the water level of the Mookervaat canal, the channel bed at the outlet portion is slightly lowered and the steeper channel bed slope than that of the existing channel is adopted to minimize the channel width. The determined channel bed slope is 1:1,600.

(2) Meruya area

In order to drain water from the drainage area by gravity flow to the tributary of the Angke river, following conditions were contemplated:

(i) In the partly high elevated areas in the drainage area, box culverts are designed under the existing roads to drain water to the westward of the drainage area.

(ii) All of the objective drainage area was already acquired by residents and provision of a new drainage channel in this acquired area is rather difficult because of compensation problem with residents. To avoid this compensation problem, the proposed drainage channel is to be aligned along the existing roads.

(iii) The proposed drainage channel is to have alignment crossing the city road along the west fringe of the drainage area, so as not to cross a pier portion of the road bridge across the Jakarta-Merak highway.

(iv) Foundation of the existing houses located along the proposed drainage channel in the center part area has been heightened by 0.5~0.7 m to avoid inundation. Since the ground elevation of the center part area is about 2m lower than those of neighboring areas, the design water level corresponding to a 5-year flood becomes about 0.5m higher than the foundation of the existing houses. Under such drainage conditions, it was contemplated to proceed with the drainage works by two stages. In the initial stage, a drainage channel with the same design water level as the foundation of the existing houses is designed considering convenience of inhabitants, on condition that inundation is allowed at a part of the center part area against a 5-year probable flood. In the final stage when substantial land reclamation will be carried out, the drainage channel will be heightened to discharge a 5-year probable flood.

Comparative study on the relationship among channel width, ground elevation along the drainage channel and channel bed slope was made. Among several alternatives, drainage plan with the lowest design water level was selected. The determined channel bed slope is 1:2,000, 1:260 and 1:700.

The design longitudinal profiles determined in accordance with the above concepts are given in Fig 5.5.

5.2.6 Design cross sections of drainage channels

A single cross section is applied for all of the drainage channels. The cross section was designed considering the following conditions:

a) The design water level should be lower than the ground elevation of the drainage area in principle,
b) In the drainage area of the Tanjungan drainage channel, it is necessary to heighten the low land in the southern part of Jl. Tol. Prof. Sediyatmo up to EL 2 m to discharge water by gravity flow and to cope with land subsidence.
c) Compensation for lands and houses due to widening the drainage channel should be minimized.
d) The freeboard as specified in the design criteria is applied.

Comparative study on alternatives of the channel cross sections was made for respective drainage channels by means of non-uniform flow calculation. Among several alternatives, the cross section with the maximum channel depth to satisfy the above condition and the minimum width was selected for each channel stretch, except for locally low land areas. The designed cross sections thus selected are given in Fig 5.6.

5.3 Design of Channel Structures

5.3.1 Design conditions

(1) Levee

It is required to construct new levees along the drainage channels in some low land areas. An earth type levee is adopted, if there is no special restriction in land for levee construction. However, a parapet wall is adopted if there is constraint in land acquisition in a densely populated area. The design criteria of these levees are as stated below.

(a) Earth type levee

(i) Clayey and silty earth materials which will be obtained from excavation for drainage channel widening and in near borrow areas shall be used as embankment material. Accordingly, a homogeneous type levee is constructed.

(ii) The earth type levee shall be of a trapezoid shape with 3 m in crest width and its side slopes shall be 1: 2.0 in principle. However, the crest shall be 5 m wide, in case that the crest is used as an inspection road.

(iii) A two(2) m wide berm shall be provided 3 m below the levee crest on the land side slope.

(iv) The foundation area of the levee shall be stripped up to 20 cm in principle.

(v) Extra embankment is necessary for levee construction to cope with future settlement of levee body and foundation, and the following values shall be applied:

Height of levee(m)	Extra embankment(cm)
Less than 3	20
3 to 5	30

(vi) The side slope surfaces of the earth type levee are protected by gabion mattress and sod facing on the channel and land sides, respectively, against local erosion due to rainfall and stream flow.

(vii) The levee constructed in fishponds is provided by dump fill of earth materials. The side slope of the levee is 1:3.0 and is protected with riprap only on the channel side.

(b) Parapet wall

The parapet wall is designed in the following stretches having difficulty in construction of an earth type levee due to constraint in land acquisition:

i) Stretches facing difficulty in land acquisition in densely populated areas, and

ii) Stretches having no space for earth type levee construction because of narrow space between channel bank and existing road.

The parapet wall is an inverted T-type of reinforced concrete. The height of the wall is designed based on the design water level and necessary freeboard above the design water level. Other dimensions such as the width and thickness of the wall take into consideration the loading conditions after heightening the wall due to future land subsidence.

(2) Revetment

For slope protection of the drainage channels, revetment works with wet masonry are employed in this design, except the channel stretches for the earth type levee.

The revetment of wet masonry consists of slope protection, toe protection and foot protection. Their structural design conforms to the following criteria.

(i) Slope protection

The slope protection shall be provided at least up to the design high water level. However, the protection shall be raised up to the top of the drainage channel or levee, depending on the local flow condition.

A transition of 3 m in length is provided at the upstream and downstream ends of the revetment, to avoid abrupt change in roughness and hardness between the wet masonry and levee slope, which may cause unfavorable flow turbulence. For this transition, gabion mattress is to be placed.

(ii) Toe protection and foot protection

In order to protect the toe potion of the slope protection from the damage due to local scouring or degradation at the channel bed, the toe protection by foot concrete will be provided. The depth of the foot concrete is 0.5 m. The foot concrete shall be provided 1.0 m below the design channel bed in the drainage channel and 0.5 m below the original ground surface for the levee revetment.

In order to avoid destruction of the wet masonry after uneven settlement of foundation due to durability of foundation material and future local subsidence, wooden piles are provided at the foot concrete.

The toe portion of the slope protection will be also protected against the scouring and degradation of the channel bed, and gabion mattress will be provided for foot protection in front of the toe protection.

(3) Sluiceway

The existing sluiceway with 2 slide gates (approx. 2.3 m x 2.3 m) at the outlet of the Saluran Cengkareng drainage channel shall be modified due to improvement of the drainage channel. In addition, a new sluiceway will be designed at the upstream end of the Saluran Cengkareng drainage channel.

As some inland rain water will be confined in low land areas along the drainage channels after construction of levees, revetments and other structures, the inland rain

water will be drained to the drainage channels through sluiceways.

(a) Location of sluiceway

The location of sluiceway is determined based on the following consideration:

(i) The location is to be the same as the site of the major present drainage canal in principle. However, the location shall be determined so as no to impair the function of the existing and/or new drainage facilities

(ii) The number of sluiceway shall be minimized through integration of drainage areas to realize effective and efficient drainage.

(iii) The longitudinal direction of sluiceway shall be aligned perpendicular to the axis of the levee to minimize sluiceway length and to simplify sluiceway structure.

(b) Hydraulic design

(i) The sluiceway is designed under the hydraulic condition of the drainage channel which has a 10-year flood capacity.

(ii) A ten (10) year runoff discharge in the drainage area of the sluiceway is used as a conduit capacity. The probable runoff discharge is estimated under future land use condition by use of the Rational formula.

(c) Structural design

(i) Conduit

1) A box culvert type is applied because of its high drainage capacity.
2) A maximum size of a box culvert type conduit is limited to 2.3 m x 2.3 m at the outlet in consideration of manual gate operation.
3) The number of conduits is determined so as not to remarkably reduce the original flow area of the secondary drainage channel to be connected.

(ii) A contraction joint shall be provided in the conduit, if its length exceeds 20m in terms of uneven settlement of foundation

(iii) The foundation of sluiceway is designed so as to safely transmit upper loads to subsoil. To avoid leakage through the foundation, base concrete of 10 cm is provided instead of gravel bedding.

(iv) The outlet sill elevation of the conduit is determined based on the design elevation of the drainage channel bed and topographic conditions of the inland area.

(v) The sluiceway is provided with a slide gate or a flap gate to prevent drainage channel water from inundating in the inland area during floods, in case that the inland surface is lower than the design high water level of the drainage channel at the sluiceway site.

1) The slide gate is designed so as to allow manual operation.
2) The flap gate is applied in case that the required conduit capacity is less than 0.2 m^3/sec/ and no serious inundation damage is presumed in the inland area even in the case of malfunction of the gate.

(4) Inspection road

An inspection road is required on one side of each drainage channel not only for routine operation and maintenance works of such channel facilities as a drainage channel, levees, revetments and sluiceways, but also for periodical inspection of the facilities. The existing roads along the proposed drainage channels will be used as inspection roads. However, in the channel stretches where no existing road is available, inspection roads of at least 5 m wide will be newly provided along the stretches.

5.3.2 Channel structures

(1) Levee

(a) Earth type levee

The earth type levee is adopted for the channel stretches in rarely populated areas along the Kamal, the Tanjungan and the Saluran Cengkareng drainage channels. This earth type levee is of a trapezoid shape with a side slope of 1:2.0. An inspection road of 5 m wide will be provided on the top of the levee, in case that no existing road is available for an inspection road of the drainage channel. The levee along the Tanjungan drainage channel is provided by dump fill of earth materials in the north part of Jl. Tol. Prof. Sediyatmo, because the channel is aligned in fishponds. The side slope of the levee is 1:3.0 and is protected with rip rap only on the channel side.

(b) Concrete parapet wall

The concrete parapet walls were aligned along the channel stretches in densely populated areas along the Kamal, the Tanjungan and the Saluran Cengkareng drainage channels. The footing concrete is provided with friction piles of 250 mm x 250 mm because of insufficiency in bearing capacity of foundation soil. In the upstream stretch of the Tanjungan drainage channel, a concrete L-type wall is employed, in consideration of (i) needlessness in construction of masonry revetment (ii) shortening of foundation pile length and (iii) future land reclamation in the inland area.

(2) Revetment

The side slopes of the drainage channels are protected by revetment works with wet masonry, excluding the channel stretches where concrete lined stretches, namely

stretches of an open culvert, concrete ditches and concrete L-type walls, are provided. The slope of the wet masonry is 1:0.5.

(3) Open culvert with mesh cover and screen

The open culvert is applied to the 390 m long channel stretch from the outlet of the Saluran Cengkareng drainage channel. The open culvert is divided cross-sectionally into 3 lanes and is provided with mesh cover at the top over the whole stretch in order to prevent dust and garbage from being thrown into the drainage channel. A screen made of I-type steel members is provided at the upstream end of the open culvert to prevent dust and garbage from flowing into the culvert.

(4) Open U- type concrete ditch

The open U-type concrete ditch was adopted for the Kamal (branch) and the Tanjungan drainage channels and the Meruya area.

5.3.3 Gate and related structures

(1) Kind of gates and location to be adopted

Two types of gate; namely, slide gate and flap gate types are adopted in this design. Characteristics of these two types of gate are as follows:

a) The flap gate tends to malfunction due to clogging by water drift and trash.
b) The slide gate has higher reliability of operation performance, though it is operated manually.

In view of the above, each type of gate was applied to the following locations:

Gate Type		Location
(a) Slide gate	-	at inlet and outlet of the Saluran Cengkareng drainage channel
	-	at sluiceways having design discharges of more than 0.2 m^3/s
(b) Flap gate	-	at sluiceways having design discharges of equal to or less than 0.2 m^3/s

(2) Design of gate and related structure

1) Type of gates and related structures

The following metal equipment are proposed to provide at the each drainage channel:

Type of Gate	Dimension		Type of Gate	Dimension	
	Width(m)	Height(m)	or Metal Works	Width(m)	Height(m)
1.Slide Gate			2.Flap Gate		
Type-1	2.3	2.3	Type-1	0.4	0.4
Type-2	1.5	1.5			
Type-3	1.4	1.4			
Type-4	1.3	1.3			
Type-5	1.2	1.2			
Type-6	1.1	1.1			
Type-7	1	1			
Type-8	0.9	0.9	3.Stop log		
Type-9	0.8	0.8	Type-1	2.3	2.7
Type-10	0.7	0.7	Type-2	2.3	3.4
Type-11	0.6	0.6	4.Trashrack	10	2.403
Type-12	0.5	0.5	5.Mesh Cover	10	400(length)

Typical section of the slide and flap gates is shown in Fig 5.7.

2) Standard to be applied

The design and fabrication of gates, in principle, conform to the applicable provisions of the Technical Standards for Gates and Penstocks published by the Hydraulic Gate and Penstock Association of Japan. The Japanese Industrial Standards (JIS) and the American Society for Testing and Materials (ASTM) are mainly adopted for the materials to be used and workmanship of the works. In addition, the Indonesian National Standards are applied as much as possible.

3) Gate

Twelve (12) sizes of steel-made slide gates and one (1) size of steel-made flap gate are designed at the inlet or outlets of the drainage channels for draining the water from inland area and for preventing the adverse flow of flood water from the river or main drainage.

(i) Slide gates

Type of gate shall be determined from the view points of the required purpose, functions,

frequency of operation, safety, convenience of operation and maintenance, installed location and circumstances, civil structure, etc., and also from the economical view point. Slide gate or roller (fixed wheel) gate is generally adopted to the inlet or outlet gates in vertical lift type gate. Out of them, lift slide gate is selected as the inlet or outlet gate in due consideration of simply manufacturing procedure, easy maintenance and operation load condition.

The power source will not be supplied for the gate operation in principle. Accordingly, the gate should be operated by the man power within the limited operating force which a operator can operate the hoist continuously. A manually driven single stem screwed spindle hoist was selected as the operation device for each slide gate.

Each hoist consists of screwed spindle with its supports and cover, gear reducer unit with gear cover, bearings manual operating device and other necessary components for safe, proper and efficient operation. The hoist should be established on the concrete deck or structural steel base frame works. The spindle is made of corrosion-resisting steel.

(ii) Flap gates

The flap gates are provided at the outlets having the small size culverts (0.4 m width by 0.4 m) which are located at the junction of tributary. The flap gate can be operated automatically by a water head difference between upstream and downstream sides of the gate without operator. The square type flap gate having rubber seal was applied from the viewpoint of perfect water tightness and high durability.

4) Design of stoplog

To maintain the gate leaf, guide slots and piers, stoplog are installed at the upside and downside of the Saluran Cengkareng drainage channel. Since the H.W.L. is +1.30 and elevation of the drain is EL. -2.1, the design head of 3.4 m was applied for the structural calculation of the stoplog.

5) Design of trashrack

To prevent the garbage which shall obstruct the smooth flow in the drain, fixed type trashrack is installed at the each drain separated by concrete partition of Saluran Cengkareng drainage channel. Each trashrack having 3.333m, 3.334m width by 2.402m vertical height is inclined at an angle of 16.7° to the vertical plane. The above dimension and inclination are decided so as to keep the water velocity of 0.9 m/sec

under the maximum discharge of 18.8 m^3/sec, considering head losses at the trashracks and convenience of cleaning on their surface by manual.

Each trashrack comprises screen panels, top and bottom embedded beams etc. The screen panels consist of rectangular bar elements, tie rods with nuts and spacing pipes, and they are fixed to the embedded beams.

The trashracks are designed to have a sufficient strength and suitable structure against the impact force, static and all other loads, and vibration phenomena which would likely occur due to the inflow of water.

6) Design of mesh cover

The mesh cover is provided at the part of the open culvert of the Saluran Cengkareng drainage channel to prevent thrown away the garbage. Expanded metals (JIS G 3351 XS-type) should be used as the mesh cover because of lightness and comparative strength. The mesh size is determined to be 50 mm square so as the relatively large garbage not to be dumped. The panel size of mesh cover is determined to be 2.0 m width x3.5 m length for easy handling. The edge of mesh cover should be fixed with angle steel by welding. The angle steel is designed to consider the self weight of mesh cover panel and the garbage load of 10 kg/m^2. The mesh cover panel should be fixed with anchor bolts on the concrete of the drain.

5.3.4 Shifting of related structures

High tension electric lines, water supply pipe lines and telephone lines crossing the existing drainage channels and several structures such as concrete structures with gates, road signs, signals, etc. were planned to be shifted due to expansion of the existing drainage channels. For these treatments, only cost necessary for shifting works was estimated under the condition that planning, designing, land and house compensation and shifting works are performed by the authorities concerned.

5.4 Design of Bridge, Culvert and Access Road

5.4.1 Design conditions

Due to expansion of the existing drainage channels, 76 existing bridges were planned to be reconstructed. Design of these bridges was made in accordance with

Indonesian Codes and Standards. For the design criteria which have not been covered by these Codes and Standard, Japanese Standard or AASHTO for highway bridges were applied.

(1) Loading condition for the bridges to be designed

The existing bridges have been provided on the national roads and other small roads. The loading condition for the bridges to be designed was specified as follows:

(i) The bridges on the national road are designed by applying 100 % of live load according to the Load Specification Standard.
(ii) Other bridges except for the national road is designed by applying 80 % instead of 70 % for T-load. assuming entering of heavy cars into rural road.

(2) Type of bridge superstructure

Based on the study on the relationship among bridge span, girder height and kind of superstructures, two types of the superstructures, pre-tension girder and in-situ slab type bridges are applied. Width of the bridge was determined under the following concepts:

(i) Width of the bridge is checked in accordance with Road Geometric Design Standard and decided after comparison with the bridge inventory data.
(ii) Width of the bridge shall coincide with width of the existing road for which there is heavy traffic volume. The width of the bridges for which there are less traffic volume does not always coincides with width of the existing road from economical viewpoint, but in any cases, width of new bridge shall be larger than that of the existing bridge.

(3) Type of bridge foundation

Considering the geological condition of the bridge foundation, pile type was selected.

(4) Type of bridge pier

Pile trestle type was selected considering relatively small reaction from small spanned superstructure, horizontal reaction due to load, height of pier and economical view points according to Indonesian standard drawings.

(5) Type of bridge abutment

Pile trestle abutment was selected due to the same reason as the pier and considering foundation condition of the height of the abutment provided on the existing ground.

(6) Elevation of bridge

Elevation of the girder bottom of the proposed bridges shall be set above the vertical clearance restricted by freeboard and allowance of land subsidence. These criteria were applied for the bridge with length more than 6m. For in-situ slab bridge of which span length is less than 6m, allowance against land subsidence is not applied because side protection for access road to be constructed in front of the densely populated area disturbs visual amenity, besides, it is easily possible to heighten the substructure by jack method even if the ground elevation is settled down due to land subsidence.

(7) Design condition of culvert

It is defined that the culvert is a crossing structure with the size of less than 2 m x 2 m. Open culvert with cover at the top of the culvert shall be applied to cope with land subsidence. For design of the culvert, Indonesian Code and Japan Bridge Design Manual were applied.

5.4.2 Design of bridge

(1) Kind of bridge, their number and dimension

Location of the bridges and their dimension were determined based on the following concepts:

- Location of the bridges is the same sites as those of the existing bridges.
- Maximum length of the pre-tension girders is limited to less than 17.5 m and its height is limited as low as possible taking into account the severe constriction conditions to be executed in narrow space at residential area and the transportation restraints on the national road.

Based on the above concepts, number of the bridges for respective drainage channels was estimated as follows and their location is shown in Fig 5.8.

Drainage Channel	Girder Bridge	Slab Bridge	Total
-Kamal(main)	9	-	9
-Kamal(branch)	17	2	19
-Tanjungan	5	-	5
-PIK Junction	-	4	4
-Gede/Bor	10	-	10
-S. Cengkareng	13	-	13
-Meruya	-	16	16
Total	54	22	76

Among these, 54 are normal sized bridges with pre-tension girders, while, 22 bridges are in-situ slab type. Type of bridges is shown in Fig 5.9. In this design work, structure with the span length of more than 2m is defined as the bridge. In order to standardize the bridges and culverts, these 76 proposed bridges were classified by bridge width and girder length and following standardized type of bridge were selected:

Type of Bridge	Number of Standardized Type
- Girder type bridge	31
- In-situ slab type bridge	6
Total	37

In this design work, 37 type bridges were designed and designed structural sections were applied to the remaining 39 proposed bridges. Relationship among name of the bridges, the bridges with different size and total number of bridges for each drainage channel is as follows:

(1) Girder Type Bridge								
BKM 1	BKE 1	BTM 1		BGM 1,2	BCM 2		5	6
BKM 3	BKE 2,6,9	BTM 3		BGM 3	BCM 3		5	7
BKM 4	BKE 3,4,5,7	BTM 4,5		BGM 4,8,9	BCM 4		5	11
BKM 5	BKE 8	BTM 6		BGM 5,6,7	BCM 5		5	7
BKM6, 7					BCM 7		2	3
BKM 8	BKE 10			BGM 10	BCM 6		4	4
	BKE 11,18				BCM 8,9		2	4
					BCM 10		1	1
BKM 10,11	BKE 13				BCM 11,12,		3	5
	BKE 14,15				BCM 13		2	3
	BKE 16,17				BCM 14		2	3
7(9)	9(17)	4(5)		5(10)	11(13)	-	36	54
(2) In-situ Slab Type Bridge								
-	BKE 19,20	-	BNK1-4	-	-	BMM1-8,	2	7
						BMM9-12	1	3
						BMM15,16		
						BMM 13,14		
	1(2)		1(4)			4(16)	6	22
7(9)	10(19)	4(5)	1(4)	5(10)	11(13)	4(16)	42	76

Note: Figures in brackets show total number of the proposed bridges.

Relationship between above bridge number and bridge dimension is as follows:

No of Bridge	Bridge Dimension(m)			No of Bridge	Bridge Dimension(m)		
	Length	Width	Unit span length		Length	Width	Unit span length
BKM 1	44.79	4.6	14.9	BKE 8	16.86	2.5	8.4
BKM 3	40.14	9.6	13.35	BKE 10	14.66	6.6	7.3
BKM 4	39.96	2.5	13.1	BKE 11,18	14.66	4.6	7.3
BKM 5	56.72	9.6	14.15	BKE 13	14.66	8.2	7.3
BKM 6,7	36.54	2.5	12.15	BKE 14,15	14.66	3	7.3
BKM 8	38.79	4.6	12.9	BKE 16,17	14.66	2.5	7.3
BKM 10,11	35.79	9.6	11.9	BTM 1	40.59	6.6	13.5
BKE 1	16.86	3	8.4	BTM 3	23.86	10.6	11.9
BKE 2,6,9	16.86	4.6	8.4	BTM 4,5	19.26	12.2	9.6
BKE 3,4,5,7	16.86	6.6	8.4	BTM 6	18.46	2.5	9.2

No of Bridge	Bridge Dimension(m)			No of Bridge	Bridge Dimension(m)		
	Length	Width	Unit span length		Length	Width	Unit span length
BGM 1,2	15.83	9.6	15.8	BCM 4	14.63	2.5	14.6
BGM 3	15.83	2.5	15.8	BCM 5	15.83	6.6	15.8
BGM 4,8,9	15.83	6.6	15.8	BCM 6	14.13	6.6	14.1
BCM 5,6,7	15.83	4.6	15.8	BCM 8,9	12.63	2.5	12.6
BGM 10	15.83	3.5	15.8	BCM 11,12	13.53	12.2	13.5
BCM 2	15.83	9.6	15.8	BCM 13	11.33	8.2	11.3
BCM 3	15.83	4.6	15.8	BCM 14	10.53	9.6	10.5
BCM 7	15.83	2.5	15.8	BKE 19,20	2.33	4.6	2.3
BCM10	14.93	6.6	14.9				

The bridge category will be divided into several groups since there are many bridges of which unit span length is slightly different though the bridge width is the same size. The bridges with slightly different length were classified into several groups to set out standardized type of bridge.

Following table shows bridge category divided by classifying the bridges with slightly different unit span length as one bridge group in respect of width and number of the bridges to be designed.

Kamal(main)	Kamal(branch)	Tanjungan	PIK Junction	Gede/Bor	S,Cengkareng	Meruya	Total of Bridge Number	No of Bridge to be designed
(1) Girder Type Bridge								
				(road class;	I-3) BCM 11,12(13.5)(2)		1(2)	1
		W= 10.6m BTM 3(11.9(1)	(road class:	I-2)			1(1)	1
		W= 12.2m BTM 4,5(9.6)(2)	(road class:	II-3)			1(2)	1
	W= 8.2m BKE 13(7.3)(1)	(road class:			BCM 13(11.3)(1)		2(2)	1
W= 4.6m BKM 1(14.9(1)) BKM 8(12.9)(1)	(road class: BKE 2,6,9(8.4)(3) BKE 11,18(7.3)(2)	IV-1)		BGM 5,6,7(15.8)(3)	BCM 3(15.8)(1)		6(11)	6
W= 9.6m BKM 3(13.35)(2) BKM 10,11(11.9)(1), BKM5(14.15)(1	(road class:	III-2)		BGM 1,2(15.8)(2)	BCM 2(15.8)(1) BCM 14(10.5)(1)		6(8)	5
W= 2.5m BKM 6,7(12.15)(2),BKM4(13.1)(1) BKM 9(11.5)(2)	(road class: BKE 8(8.4)(1) BKE 16,17(7.3)(2)	P.B) BTM6(9.2)(1)		BGM 3(15.8)(1)	BCM 4(14.6)(1) BCM 8,9(12.6)(2,BC 11,17(15.8)(1))		7(12)	7
	W= 6.6m BKE 3,4,5,7(8.4)(BKE 10(7.3)(1)	(road class: BTM 1(13.5)(1)	III-3)	BGM 4,8,9(15.8)(3)	BCM 5(15.8)(1) BCM 6(13.5)(2),BC 10,(14.9)(1)		9(12)	8
				W= 3.5m BGK	(road class:	IV-S)	1(1)	1
	W= 3m BKE BKE 14,15(7.3)(2)	(road class:	IV-S)				2(3)	2
Total for(1) 7(9)	9(17)	4(5)		5(10)	11(13)		36(54)	31
(2) Slab Type Bridge								
	BKE 19,20(2)		BNM1-4((4)			BMM1-8,BMM9-12,BMM13,14, BMM15,16	3(10)	6
Total for(2)	1(2)		1(4)			4(16)	6(22)	6
Total ((1)+(2)) 7(9)	10(19)	4(5)	1(4)	5(10)	11(13)	4(16)	42(76)	37

(2) Superstructure

The girder type bridge with an uniform rectangular section was designed. The relation between the stress by service load and allowable stress at girder center was calculated to determine the dimension of the girder section.

(3) Substructure

Pile trestle type comprising pile and hammer head was selected. Typical section of the hammer head is composed of 2 m x 0.65 m for the pier and 1.8 m x 0.65 m for the abutment. For calculation of number of the piles, 41 t has been selected as the allowable bearing capacity. The number of pile to support superstructure and hammer head was calculated by dividing the total load acting on the piles by the allowable bearing capacity. The number to be actually used was finally decided with consideration of suitable arrangement of the piles.

To determine pile length, geological data are fully used to presume the bearing layer penetrated with pile tips. In the geological survey result, the geological cross section connecting the bore data of 6 points and geological profiles of Dutch Cone Sounding along the channels are depicted, which can be effectively used to point out the tip location of pile with the insert method of putting bridge location between sounding positions of the profiles. The layers with more than 20 blows of N value have been read on the profiles as a bearing stratum, in which the following depth are roughly assessed in each channel.

Drainage channel	D(N:20)(m)
- Kamal(main)	10.0-16
- Kamal(branch)	7.0-19
- Tanjungan	9.0-17
- PIK Junction	8.8-11
- S, Cengkareng	5.0-9
- Gede/Bor	9.0-10

The seismic design of substructure has been carried out properly according to Indonesian Standards, "Procedure of Designing Earthquake Proof for Highway Bridges, SNI 03-2833-1992.

5.4.3 Design of culvert

1) Small bridge and culvert

Definition of border line between bridge and culvert is set at the span length of 2 m, however, this definition is not necessarily known internationally. But, the classification by span length is generally accepted in Indonesia because it is stipulated in two standard, i.e. that of in-situ bridge with 2 to 6 m long span and culvert for spanning 2 m.

According to the above definition in-situ bridges are estimated at 22, i.e. 2 in the Kamal (branch), 4 in the PIK Junction and 16 in the Meruya respectively. Besides, two types of box culverts are planned under ground for the Meruya area. These are 2.2 m x 1.6m size and 288m long, and 3m x 2.2 m size and 504m long.

2) Typical section

Typical section of in-situ slab bridge and culvert are illustrated in Fig 5.9, according to Indonesian standard. The detail design is being carried out.

5.4.4 Design of access road

The elevation of new bridges is positioned over the vertical clearance restricted by the height of freeboard and the allowance of land subsidence, therefore the elevation gap between bridge surface and existing ground line shall be smoothly connected with each other by the access road with transition curve.

1) Gradient and transition curve

Maximum gradient transition curve and their length are stipulated in the standard for Geometric Design of Urban Road.

2) Bridge elevation

The elevation of deck surface has been calculated as the following equation:

Bridge Elevation = H.W.L + Free Board + Land Subsidence + Girder Height + Pavement Depth + Cross-fall

3) Classification of mound up height

In line with the elevation gap between bridge surface and ground line, the classification of mound up height for the access road is as follows:

	Mound up height(m)						Total
	0<h<0.5 and h=0	0.5<h<1.0 and h=0.5	1.0<h<1.5 and h=1.0	1.5<h<2.0 and h=1.5	2.0<h<2.5 and h=2.0	2.5<h<3.0 and h=2.5	
Number of bridge	18	4	10	21	19	4	76

This table shows that the number of the bridge between 1m to 2.5m is 54, amounting to 67 % of the total number. Twenty three bridges with less than 0.5m are in-situ slab bridges with small span less than 6m are planned without allowance for land subsidence due to easy works of heightening of deck slab of bridges with relatively light weight.

4) Classification of side protection

The side protection works of the access road will be classified into following types, namely, sod facing-6, retaining wall-43, stairs for pedestrian-12 and no need of embankment -23. It shows that the retaining wall type occupies 71 % of all of the access roads because the bridge is remarkably approached to the residential areas.

5) Access road length

The total length of access road can be computed mechanically according to the standard as follows ;

	Road length(one side)(m)	
Drainage channel	Carriageway	Pedestrian
- Kamal(main)	30.5-60.5	15.7-21.3
- Kamal(branch)	31.2-50.1	18.7-21.6
- Tanjungan	49.2-68.8(83.5*)	
- S, Cengkareng	27.6-57(84*)	13.8-26
- Gede/bor	43.9-79	19.1

* : National road (Class 1st)

Above table indicates that the approach length is 50 to 70 m for local road, about 85 m for National Highway and about. 25 m for pedestrian bridges.

6) Typical section of access road

The typical section of access road is planned in two different types, whether the bridges are situated at field area or residential area. The embankment in field can be provided with gentle slope for side protection while in resident area, retaining wall of concrete or concrete blocks shall be built to minimize the total width of access road and furthermore the installation of guard-rail and storm drainage shall be provided on the retaining walls for improving the comfortable life of residents.

6 COST ESTIMATE

6.1 General

It has been proposed to execute the construction works of the drainage channels by dividing into the following three packages:

Package-1:	Kamal drainage channel
Package-2:	Tanjungan drainage channel
	PIK Junction drainage channel
Package-3:	Gede/Bor drainage channel
	Saluran Cengkareng drainage channel
	Meruya drainage channel

Among these three packages, it was proposed to request project loan for the packages-1 and 2. Thus, the cost estimate was made only for these two packages.

6.2 Basic Condition of Cost Estimate

The financial cost for the packages-1 and 2 was estimated under the following conditions:

(1) Financial cost

The financial cost comprises main construction cost, compensation cost for households and land acquisition, engineering service and administrative costs, physical and price contingencies and interest during construction. The main construction cost was estimated on a unit price basis.

(2) Project execution method

All the project works will be executed on contract basis. The contractors will be selected through an international tendering.

(3) Classification of Foreign and Local Currencies

The financial cost is divided into foreign currency portion and local currency portion. The following conditions for the classification of foreign currency portion and local currency portion are applied in the cost estimate:

Local currency portion:

- All labor costs;
- Net local portion of construction material costs;
- Annual management and part of maintenance costs of construction equipment;
- Cost of local portion of engineering services.
- All costs of administration expense for the government staff,
- Land acquisition and compensation costs;
- Value Added Tax;
- Local portion of contingencies, and
- Local portion of interest during construction.

Foreign currency portion:

- Part of maintenance and full amount of depreciation costs of equipment;
- Net and indirect portions of construction material costs,
- Cost of foreign engineering services.
- Foreign portion of contingencies, and
- Foreign portion of interest during construction.

The proportions of foreign and local currency components of the major construction materials and other unit price components are assumed as follows:

Description		Foreign Portion (%)	Local Portion (%)
1.	Labor	0	100
2.	Construction Equipment	80	20
3.	Construction Materials		
	(1) Cement	70	30
	(2) Re-bar	70	30
	(3) Fuel, Oil and Lubricant	80	20
	(4) Aggregate and stone materials	70	30
	(5) Cobble, Gravel and Sand	40	60
	(6) Lumber, Plywood & Wooden Materials	40	60
	(7) R.C. Products	70	30
	(8) Asphalt Bituminous	60	40
	(9) Steel Sheet Pile	90	10
	(10) Structural Steel	90	10
	(11) PVC Waterstop	80	20

(4) Price level and exchange rate

The cost estimate was made at the price level of June 1997. The foreign exchange rate for cost estimate is US$ 1.00 = Rp. 2,350 = Yen 115.

(5) Unit prices

Unit prices of local materials were estimated based on the prices of local markets or local suppliers. The labor rates are based on the prevailing rates.

(6) Unit work cost

The unit work cost was estimated based on the unit prices of materials, labor and equipment. It consists of direct cost, indirect cost including contractor' profit, office expense, contractor risk insurance, unforeseen contingency, miscellaneous expenses and income tax for local portion.

(7) Compensation of households and acquisition of land

Compensation cost for households and acquisition of lands was estimated based on experienced cost data in Jakarta City.

(8) Engineering service and administrative costs

The engineering service cost for assistance of tendering and construction supervision of the project works by consultant was estimated on an actual cost basis. The administration cost necessary for operation expenses of the governmental staff was estimated at 5 % of the sum of main construction cost and land and house compensation cost.

(9) Contingency

The contingency comprises physical and price contingencies. The physical contingency was estimated at 10 % of the sum of main construction cost, land and house compensation, and engineering service and administrative costs. The price contingency to cope with an annual price escalation was estimated at 2 % for both the foreign and local currency portions.

(10) Tax

The income tax was estimated at 10 % of the construction cost and engineering services.

(11) Interest during construction

The annual interest amount during construction period was estimated by applying fixed

rate of 3 % against the accumulated financed amount in each year.

6.3 Financial Cost and Annual Disbursement Schedule

The financial cost estimated based on the above conditions is US$ 61.755 million comprising foreign currency portion of US$ 16.617 million and local currency portion of US$ 45.138 million including tax. Table 6.1 shows the summary of the financial cost. Breakdown of cost for the packages-1 and 2 is shown in Tables 6.2 and 6.3 respectively.

An annual disbursement schedule for the packages-1 and 2 works was estimated as shown in Table 6.4 based on the proposed construction schedule. The annual budget to be disbursed is summarized as follows:

Year	Amount (1,000 US$)	Year	Amount (1,000 US$)
1997	1,145	2002	17,321
1998	3,369	2003	17,969
1999	5,091	2004	14,398
2000	8,236	2005	9,471
2001	14,503	2006	5,367
Total	32,344	Total	64,526

7 ECONOMIC EVALUATION

7.1 General

The economic viability of the packages-1 and 2 works was examined incorporating the estimated project cost and flood damage. The economic cost was estimated deducting the transfer payment from the financial cost. The project benefit was estimated assuming that the annual average flood damage corresponding to less than 10-year probable flood is regarded as the flood control benefit. The economic evaluation was made by means of internal rate of return (EIRR).

7.2 Economic Cost

The economic cost of the packages-1 and 2 was estimated under the following conditions and assumptions:

(1) Costs are estimated on the price level of June 1997.

(2) The exchange rate from June to August 1996, US$ 1.00 = Rp. 2,350 = Yen 115 was applied.

(3) Costs for the following items are excluded:
- Income tax: 10 % of material, equipment and labor cost
- Corporate tax: 30 % of contractor profit
- Price escalation: 2 % of direct cost

(4) Shadow price is applied to the common labor cost. It is estimated at 60 % of common labor cost.

Based on the above conditions and assumptions, the economic cost was estimated to be US$ 46.26 million as shown in Table 7.1.

It is presumed that a pumping facilities may be needed in the following years at downstream of the Tanjungan and Kamal drainage channels if land subsidence at a rate of 6cm/year occurs and tidal level is unchanged:

- Tanjungan drainage channel 2016
- Kamal drainage channel 2018

The economic cost necessary for pumping facilities including regulation ponds

and pump facilities was approximately estimated at US$17.4 million in total.

7.3 Project Benefit

Project benefit expected by implementation of the packages-1 and 2 works was estimated under the following procedures.

(1) Estimation of inundation area
(2) Category of damage
(3) Estimation of unit value of assets
(4) Estimation of damage by inundation depth
(5) Estimation of probable flood damage
(6) Estimation of project benefit

7.3.1 Estimation of inundation area

Based on the available data, the inundation area was estimated at about 176 ha for the Cengkareng west area. The inundation takes place in lowland and the area along the river or channel. Approximately 7% of residential area and 4 % of industrial area with the inundation depth ranging from 20cm to 100cm are considered as a flood prone area.

7.3.2 Category of damage

The flood damages are divided into two types: direct damage and indirect damage. The direct damage is defined as damage to the general assets such as assets for residence, shops, offices, factories, public services, household goods, facilities in the buildings, and agricultural properties (paddy) in the flood prone area. Indirect damage includes the damage to economic activities, such as income loss due to its activities stagnation. Other possible damages, such as a forgone development in the flood prone area and cost of emergency measures made by local government, are also estimated.

7.3.3 Estimation of unit value of assets

In order to estimate the flood damage, the value of assets in the flood prone area was calculated. The value of general assets such as houses, shops, factories, and public offices have been estimated by the survey conducted for the study on comprehensive

river management plan in JABOTABEK. The basic data for assets was utilized for this study. In order to find the appropriate value of the assets for the project area, additional data was collected from Kecamatan offices and other related agencies.

The general assets are categorized into three types of land use: residential area, industrial area, swamp(paddy). Shops, offices, public buildings are included in the residential area.

(1) Assets in the residential area

The value of assets for residential area was calculated in the following manner.

- Estimate the unit value (US$/ha) of assets for houses, shops, offices, and public buildings, and
- Find the average value in the residential area by taking the ratios of the number of houses, shops, offices, and public buildings.

The estimated value for each parameter in the residential area is shown in Table 7.2. Based on the value estimated for each parameter, total unit value in the residential area was calculated assuming following ratios of the number of houses, shops, offices, and public buildings in the residential area:

The ratio in the residential area	
House	95.2 %
Shop	2.4 %
Office	1.8 %
Public building	0.6 %
Total	100 %

The value in a residential area was estimated from the value of assets and the assumed ratio. The estimated unit value in the residential area was calculated to be 680,183 US$/ha as shown in Table 7.3.

(2) Assets in the industrial area

The assets in the industry area was calculated from the value of the buildings and the property(stocks of products, raw material and machine and equipment). The estimated value of assets in the industry area is 4,546,060 US$/ha as shown in Table 7.4.

(3) The damage to the paddy

Since the average duration of flood is less than a day, and the paddy area in the project area is relatively small, the damage to the paddy is considered to be small. Then, the damage to the paddy was deleted from estimation.

(4) Damages to infrastructure

The damages to infrastructure such as roads, railway were estimated to be 20 % of damage to general assets based on the survey at the Kecamatan office.

(5) Indirect damage

The damage to the net income loss for goods and loss of services to the nation due to the interruption of economic actives in the project area was regarded as indirect damage. Indirect damage is assumed to be 6% of damage to general assets.

(6) Other damages

The other possible damages were estimated for the items listed below. The item that is the largest in other damages is the forgone development in the project area in which the value of land will go up as much as five times the current value after the area is free from flood. The other damages were estimated to be 20% of the sum of direct damage, damage to infrastructure, and indirect damage

- Forgone development in the flood prone area
- Cost of emergency measures made by local government
- Fears, misgiving and inconvenience people experience
- Insanitary and danger of infectious diseases
- Injury to human lives

7.3.4 Estimation of damage by inundation depth

The flood damage rate prepared by the Ministry of Construction, Japan was utilized for estimating the unit flood damage. The unit flood damage for one hectare for a residential area and an industrial area was calculated from the unit value of assets and the flood damage rate. The result is shown in Table 7.5.

The direct damage for different inundation depth in the project area was estimated by multiplying the unit flood damage for one hectare and the inundation area for a different level of inundation depth. Since an accurate inundation map is not

available, field investigations and interviews were conducted to estimate the relationship between inundation area and inundation depth. The estimated direct damage for a different inundation depth is summarized in Table 7.6.

7.3.5 Estimation probable flood damage

Probable flood damage, which includes direct damage, indirect damage, damage to infrastructure, and other damages was calculated under various magnitude of flood events. Conditions for the relationship between the inundation area and the flood probability of 2 years, 5 years, and 10 years were assumed as follows:

- Two-year probable flood will inundate 7% of residential area and 4 % of industrial area with an inundation depth up to 20cm.
- Five year probable flood will inundate the area approximately 10 % more area than the rain with the return period of 2 years and will cause inundation depth up to 50cm.
- Ten-year probable flood will inundate the area approximately 30 % more area than the inundation area with the rain with 2year period and will cause the inundation depth up to 100cm.

Based on the above assumptions, the probable flood damage was calculated as shown in Table 7.7.

7.3.6 Estimation of project benefit

The difference of annual average flood damage without the project and with the project is regarded as economic benefit of the project. Annual average flood damage was estimated by applying average occurrence probability to the corresponding probable flood damage.

Based on the probable flood damage, the annual average flood damage was calculated. After the drainage project works are completed, the project area will be free from 10-year probable flood for the Cengkareng west area. Thus, it was assumed that the annual average flood damage corresponding to less than 10-year probable flood for the Cengkareng west would be regarded as the flood control benefit. The estimated annual benefit for the packages-1 and 2 is US$ 6.6 million as shown in Table 7.8.

7.4 Economic Evaluation

Economic viability of the project was examined on the following assumptions:

(1) Base year: 1997

(2) Project life time: 50 years after completion of the project works

(3) Annual operation and maintenance cost (O/M cost):0.5% of the main construction cost. The O/M cost is assumed to incur from the following year of completion of the project works through the entire project time.

(4) Benefit: 100 % of the benefit is attained from the following year of completion of the whole project works. The benefit during the construction period is assumed to occur in accordance with the ratio of the project cost disbursed by preceding year.

(5) The cost necessary for provision of pumping facility may occur in the years as stated in Section 7.2.

Based on the cost and benefit flow as shown in Table 7.9, the economic internal rate of return(EIRR) was estimated at 13.8 %.

To check the sensitivity of the project due to variation of project conditions, EIRR was calculated on the following assumptions.

Case 1 : Construction costs increase by 15%
Case 2 : Economic benefits decrease by 15%
Case 3 : Case 1 plus Case 2

The result of sensitivity analysis is as follows:

(Unit : %)

Case	EIRR
1	11.8
2	11.4
3	9.7

8 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Introduction

Physico-chemical environment in both the Cengkareng west and Meruya areas including water quality, air quality and noise, biological environment including flora and fauna in the project area and socio-economic environment were studied based on the collected data in this stage. Major positive and negative impacts were identified in this study. Measures to mitigate the negative impacts are studied in the environmental management and monitoring plans.

8.2 Present Environmental Conditions

8.2.1 Physico-chemical environment

(a) Air quality and noise level

Air quality and Noise Level in the project area has been measured during the EIA study period. Lead (Pb) concentrations throughout the project area are slightly above (30-31 μ / m^3), or at the limit of standard concentration for DKI Jakarta (29 μ / m^3), indicating the level of air pollution derived from vehicular traffic in the project area.

Result of the noise measurement shows that the average daily noise level in all of the sampling locations exceeds the maximum standard for human settlement of DKI Jakarta(60 dB), ranging from 78 dB to 66 dB and the highest place is downstream of the Saluran Cengkareng drainage channel.

(b) Water quality

Water pollution in the project area has been progressing mainly due to garbage and filthy water from residential areas and drainage from industrial zones. The extent of organic pollution within the drainage channels of the project area is considered relatively high, especially in the entire length of the Saluran Cengkareng drainage channel, the upstream area of the Kamal and Tanjungan drainage channels. The most significant values deviating from the standard are those measured for Ammonia Nitrogen (NH_3-N), Hydrogen Sulphide (H_2S), Nitrites (NO_2-N), and Dissolved Oxygen (DO), indicating evidence of organic pollution, probably derived from the disposal of raw sewerage coming from the adjacent human settlements. This condition is enhanced by the low

oxygenation capacity of the channels, and thus generating high H_2S, and low DO readings, along with offensive odors. These results are in accord with the low biodiversity index found during the aquatic biota (Benthos) survey. Other values reported to be above the official standards are Zinc (Zn), which is probably derived from the leaching of metal components such as car parts, junk etc. It is disposed off directly into the drainage channels and rivers of the project area at present.

8.2.2 Biological environment

(a) Mangrove forest and plantation area

The Tanjungan drainage channel is constructed through the middle of mangrove plantation area. Thus greater care has to be taken during the construction period as the area is designated as "Protection Forest" and that the area contains seedlings of mangrove. This is the area that cutting trees, maintaining pet or domestic animals in the area, or constructing any structures within the area. However, this is the area possible to open for development project conducted by a government agency as it is considered necessary.

(b) Fauna

There is no fauna of scientific, economic or recreational importance in the project area. Some small populations of nesting birds have been reported to exist in the remaining mangrove forest in Jakarta Bay.

8.2.3 Socio-economic environment

(a) Relocation of the local residents

There are a large number of local residents living in the areas along the drainage channels within the project area subject to relocation. There are three different types of local residents as follows:

i) Legal residents with land certificate
   Those who own land, or rent land and/or house. These lands are registered at the Office of Regional Land Administration. Therefore these land owners are considered as legal residents. There are 196 households in the project area.

ii) Squatters with RW/RT numbers
   Those who have established themselves as members of the local neighborhood association of Rukun Warga (RW) and Rukun Tattanga (RT). Their RW/RT numbers

are mailing address and therefore electricity and telephone as they can afford to pay can be distributed. Their residential areas are generally belonging to the Department of Public Works and they recognize the risk of their residential status. Some have been living in their present area for more than 20 years as there was no development project took place in the past. There are 407 households of this type in the project area.

iii) Squatters without RW/RT numbers

Those who have not established themselves as members of the neighborhood association. Thus there is no recognition of their residential status. As they establish themselves in the present area, they will be recognized as members of the neighborhood association. They might stay in the place for a few decades if no development project would took place. There are 570 households of this type in the project area.

(b) Public health

Air born diseases, waterborne diseases and the diseases generated by solid waste are noticeable among the population within the project area. Cholera have their origin in water puddles and in the inadequate solid waste disposal area. Pollution of surface and groundwater, the blockage of drainage, including flooding and the proliferation of pests and disease vectors induced by air pollution caused by garbage burning and gaseous contamination are all causing substandard of public health within the project area.

(c) Economic activities

The project area is one of the fastest growing region in DKI Jakarta, supported by the road system of Outer Ring Road, Jl. Tol Prof. Sediyatmo, and Jl Tol Jakarta-Merak. Ranging from family-run shops such as grocery stores to eating places and to the commerce and industry of various scales such as the cottage industry run by a family to large scale shopping centers, economic activity within the project area shows virtually no consistency but diversification.

There are some people living along the mouth of Kamal drainage channel that are heavily depending their income on fishing in Jakarta Bay. On the other hand, there are still relatively wide area of agriculture fields producing up-land crops and rice and that there are relatively large number of farmers within the project area.

(d) Land use

Present land use within the project area is summarized as follows:

Land use	Area (km^2)	%
Residential area	23.71	62.4
Industrial/commercial area	2.31	6.1
Agricultural land	5.55	14.6
Fish pond	3.28	8.6
Swampy/depression(open space)	3.13	8.3
Total	37.98	100.0

Most of the open spaces within the project area are in possession of the private developers for housing and commercial development. Agricultural area is still left in the project area further inland from the coast line while industrial/commercial area concentrates along the road linking, Tangerang and DKI Jakarta.

8.3 Environmental Impacts Associated with Project

8.3.1 Physico-chemical environment

(a) Air quality and noise level

With a regular procedure for the contractor of the construction works such as to install silencer in exhaust pipes on the construction equipment, constant spraying of water during dry season for dust suppression, most of the ambient air quality degradation and noise emanation during the construction period could be reduced. Close monitoring works by the authority concerned should be conducted in order to meet the requirement of air quality standard adapted by DKI Jakarta.

(b) Water quality

Degradation of water quality for all the drainage channels, especially the turbidity, is inevitable during the construction period. However, it will not affect water use or the aquatic life in most cases as regular construction procedure is exercised.

The Tanjungan drainage channel is constructed in the middle of mangrove growth area as well as the fish pond area. Thus great care is necessary when access road and dike construction works are conducted.

Upon completion of the project, amount of water flowing through the drainage channels would be increased. Thus dilution effect should improve present level of water pollution in the drainage channels to a limited extent.

8.3.2 Biological environment

(a) Mangrove plantation area

During the construction period, seedlings of mangrove plantation area might be affected by the construction works to some extent. Thus excessive turbidity in the water caused by the construction works should be monitored during the construction period. Any sign of significant impact on the seedlings should be monitored and any necessary mitigation measures of avoiding turbidity in the water should be implemented by the contractor.

(b) Fauna

Bird species known to flock in the mangrove growth area will stay away from the coastal area of the project area as construction works for the Tanjungan drainage channel is conducted. Since there are similar area of mangrove growth along the coast of Jakarta Bay and/or beyond, they will move to these areas at large. To some extent, this is the only and probably light impact induced by the project to the wildlife within the project area.

8.3.3 Socio-economic environment

(a) Relocation of the local residents

i) Local residents with land certificate

Relocation of the local residents would be the most significant and negative impacts associated with the implementation of the project. With the relocation program, details of which are described in the "Social Impact Assessment", most of the significant impact are canceled out.

ii) Squatters

Relocation of the squatters with conventional method and policy will probably cause further negative impacts as the squatters removed from the current residential areas would move into other riverside areas. Thus, it would be sensible to prepare resettlement areas specifically designated for relocation of the squatters.

(b) Traffic congestion during construction period

There are a number of bridges reconstructed during the construction period. Some of them are foot bridges that may not cause any traffic congestion. However, the reconstruction of the vehicular bridges on the major route of transportation would probably cause very significant traffic congestion despite the fact that precautionary and preventive measures as well as the construction of temporary bridges are planned to conduct by the contractor during the construction period.

(c) Public health

Public health conditions would be slightly improved upon completion of the project as water quality in the river is improved. Moreover, as stricter use of water in the river is imposed as fences are erected on the side of drainage channels upon completion, public health hazard should be reduced to a very limited extent.

(d) Improvement of the traffic conditions upon completion of the project

Condition of the traffic within the project area will be improved to some extent as inspection road constructed on either side of drainage channels constructed within the framework of the project is made available for public use. This will subsequently change ways of land use in and around the project area over time.

8.4 Environmental Management Plan (RKL)

8.4.1 Physico-chemical environment

Muffler, silencer and anti-vibration devices installed on heavy construction equipment should be closely monitored in reference to the data on air quality and noise level measured during the period of EIA Study. Any devices installed on the construction equipment substandard to the regulations adapted by DKI Jakarta should not be allowed to use. Proper tuning up of this equipment has to be conducted regularly by the contractor of the construction works. Spraying water on the exposed earth surface has to be conducted as a part of environmental management on construction site during the construction period.

8.4.2 Biological environment

During the construction works for the Tanjungan drainage channel, mangrove plantation area would be disturbed to some extent. Depending on the turbidity, greater

care has to be taken. Upon completion of the construction works, mangrove plantation works should resume as planned. This is the area within the jurisdiction of PANTURA in the future while the area is under the command of the Department of Forestry of the Government of Indonesia for mangrove plantation.

8.4.3 Socio-economic environment

(1) Relocation of the local residents

Relocation of the local residents to the designated resettlement areas selected at their own discretion would be the only way to manage environmental impact of the relocation of the local residents. Thus monetary compensation is the option conducted for compensation made to the local residents subject to relocation. Rate of compensation per unit of land, building and improvements are subject to determination by land procurement committee, which will be established upon final approval of the project was made. It is established at the Kotamadya level of Jakarta Barat and Jakarta Utara.

Based on the past experiences of the Department of Housing, DKI Jakarta, approximately 75 % of the local residents subject to relocation would select low cost housing built by DKI Jakarta if low income families are involved in the relocation program. Other families whose income is higher, or who own shops, or who run small factory would select to resettle in the area they selected themselves. Details of the relocation program are elaborated in the "Social Impact Management Plan".

(2) Air quality and noise level

There is a condition imposed on the contractor of the construction works that they are requested to install muffler and silencer on the construction equipment used on site. These devices will be the only way to reduce contamination of the air, emanating noise and vibration. Close monitoring on the performance of the contractor using heavy equipment is the responsibility of the Engineer of the project.

(3) Traffic diversion

During the construction period, traffic diversion is necessary as bridges are reconstructed. With a coordination of the Department of Traffic, DKI Jakarta, the contractor of the construction works is required to divert traffic with proper road sign, signal and attendants. Traffic police will also assist the traffic diversion.

Depending on the scale of bridge construction works, the size of road, and the volume of traffic, one whole street may have to be blocked for through traffic. Period of road blockage will be as long as the period of bridge construction works. All these arrangement should be conducted with the Department of Traffic, DKI Jakarta and the Traffic Section of the Police Department of DKI Jakarta. There is no other way to manage traffic congestion during the bridge construction works of the project, i.e. precautionary measures is the only way to deal with the traffic during the construction period.

8.5 Environmental Monitoring Plan (RPL)

8.5.1 Physico-chemical environment

(1) Air quality and noise level

Periodic check-up of once every week on the performance of heavy equipment used on site is suggested to conduct by the Engineer of the project. Standard monitoring equipment for gas analysis and audiometer should be used in routine check-ups for vehicle emissions has to be used. It would be ideal to maintain the sampling locations the same as those selected for the EIA Study. Data obtained during the EIA Study should be used as reference data as well as the standard adapted by DKI Jakarta. Monitoring air quality and noise level is conducted during the construction period. Present conditions of air quality, noise level and dust are required to use as reference data during the construction period.

(2) Water quality

The present data on water quality and the Standard of Water in DKI Jakarta are to be used as reference data when water quality analysis was conducted during and after the construction works. However, no plan of water quality analysis has been elaborated as changes of water quality in the drainage channels of the project area induce any significant environmental impacts.

8.5.2 Biological environment

(1) Mangrove plantation area

During the construction preparation period as well as the construction period of the Tanjungan drainage channel, turbidity in the water where mangrove planting activity is on-going should be monitored in relation to the growth of mangrove. If necessary, preventive measures to minimize turbidity in the water should be taken.

(2) Fish pond

The Tanjungan drainage channel is constructed through mangrove plantation area. Among the planted area is fish pond operated for commercial purpose. It is therefore necessary to monitor turbidity of the water in the area during the dike construction period. No specific monitoring device is necessary but visual observation as well as the fish pond keeper's complaints should be taken as necessary precaution. Based on the observation and the complaints further actions as environmental management of this particular area should be taken.

8.5.3 Socio-economic environment

Resettlement areas receiving local residents moving from the project area should be monitored for the level of infrastructure constructed for them, the level of the development of socio-economic program, and the accessibility to public facility. The period conducting the monitoring program is approximately 6 months after all of the local residents are moved out and settled in the designated resettlement areas. Result of the evaluation should be compiled and produce a report to the owner of the project as appropriate.