CHAPTER 4

FORMULATION OF DEFINITIVE PLAN

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4.1 River Improvement Plan

4.1.1 Planning Criteria

(1) Objective River Stretch

The flood control works are executed to protect the river stretch of 9.76 km in total length starting from the river mouth up to the confluence with Kreo River. The uppermost point for river improvement is placed on the newly constructed bridge 300 m upstream from the confluence. The project area is administratively covered by Kec. Semarang Barat in Semarang City, Central Java Province.

(2) Target Completion Year

The detailed engineering design for this project is being undertaken under the JICA Development Survey Program. It is expected that the construction of the Project be carried out immediately after this D/D Study. The subsequent works are Pre-qualification of Tenders, Tendering and Construction, requiring about four (4) years in total. The target completion year of the Project, therefore, could be set at 2004.

(3) Flood Control Scale

The river improvement works are designed on the scale of 100-year return period with flood control by Jatibarang Multipurpose Dam for the following reasons. Without dam construction, the design scale is equal to 25-year return period.

(a) According to the Master Plan Study results conducted by JICA in 1993, the optimum flood control plan was formulated by means of river improvement and construction of Jatibarang Multipurpose Dam based on the planning scale of a 100-year return period.

(b) Since the 1990 flood, the river improvement works for Garang River (from Simongan Weir up to the confluence with Kreo River) has been carried out based on a 100-year flood discharge (Q=1,100 m^3/s) without dam construction.

(c) The Flood Control Manual (MPW/CIDA,1993), the guideline for flood control works in Indonesia, requires that the scale of flood control works in medium and big cities should not be smaller than 25-year return period.

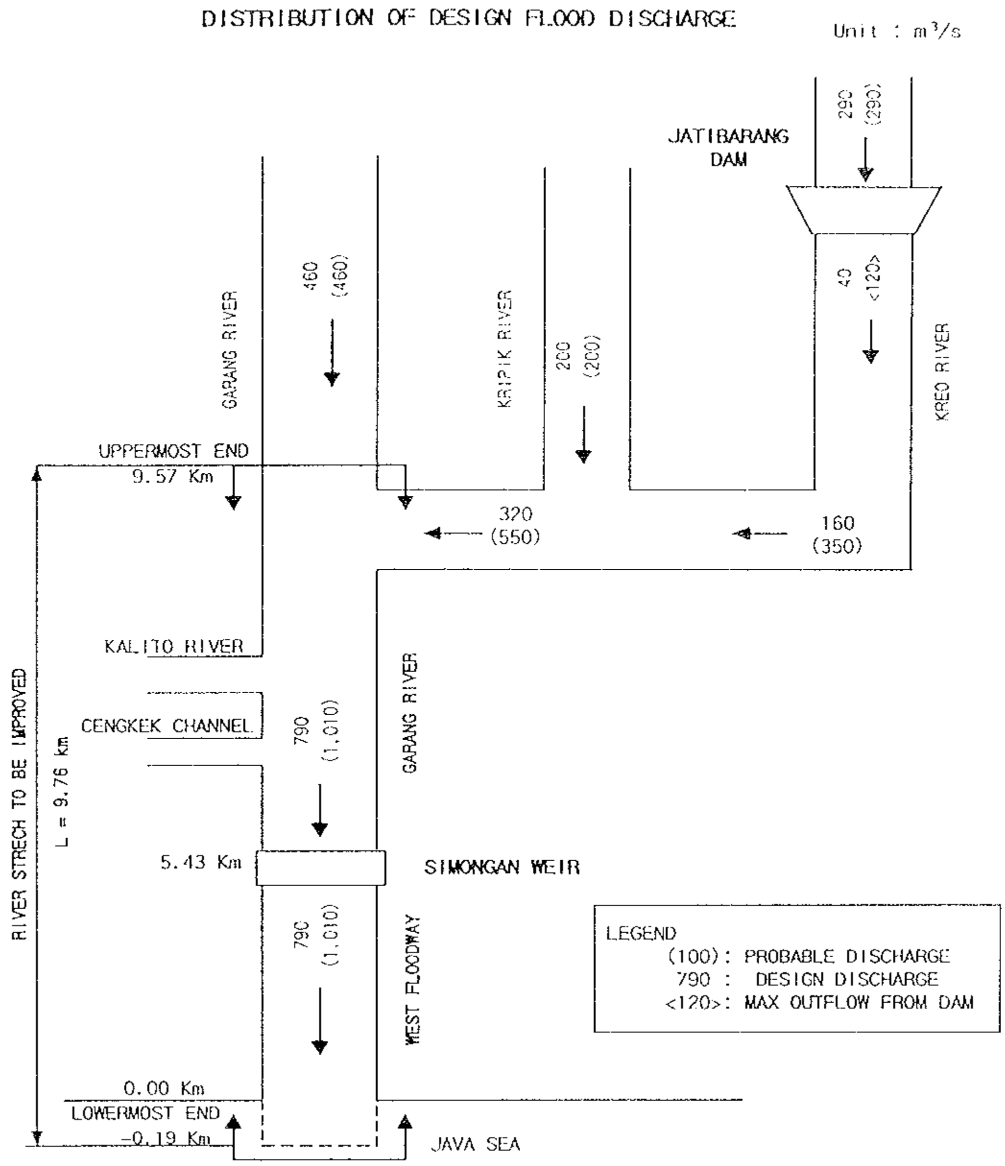
(4) Design Rainfall, Flood Run-off Model and Probable Flood Discharge

To obtain the hydrograph of probable flood in Garang river basin, the hourly rainfall data of Kaligading Station are used after its total daily rainfalls have been adjusted to the basin average daily rainfall. Storage function method is employed for the flood run-off analysis. The rainfall data, flood run-off model and the hydrograph of probable flood are presented in "3.3 Hydrological Analysis of Chapter 3". The probable flood discharges estimated are as follows:

Return Period (year)	Peak Discharge at Dam Site			Peak Discharge at Simongan	
	Inflow (m^3/s)	Outflow (m^3/s)	Out-max (m^3/s)	without Dam (m^3/s)	with Dam (m^3/s)
5	150	20	60	520	400
10	180	30	70	640	500
25	220	30	90	790	620
50	260	40	100	900	700
100	290	40	120	1,010	790

(5) Design Discharge

In accordance with the proposed flood control scale as well as updated probable flood discharges in Garang river system, the design flood discharge for the river improvement has been determined as graphically shown below.



The standard flood discharge of 1,010 m^3/s in the downstream from the confluence is reduced to 790 m^3/s by flood control effect of Jatibarang Multipurpose Dam. The discharge of 790 m^3/s corresponds to 25-year probable flood discharge when Jatibarang Multipurpose Dam is not projected.

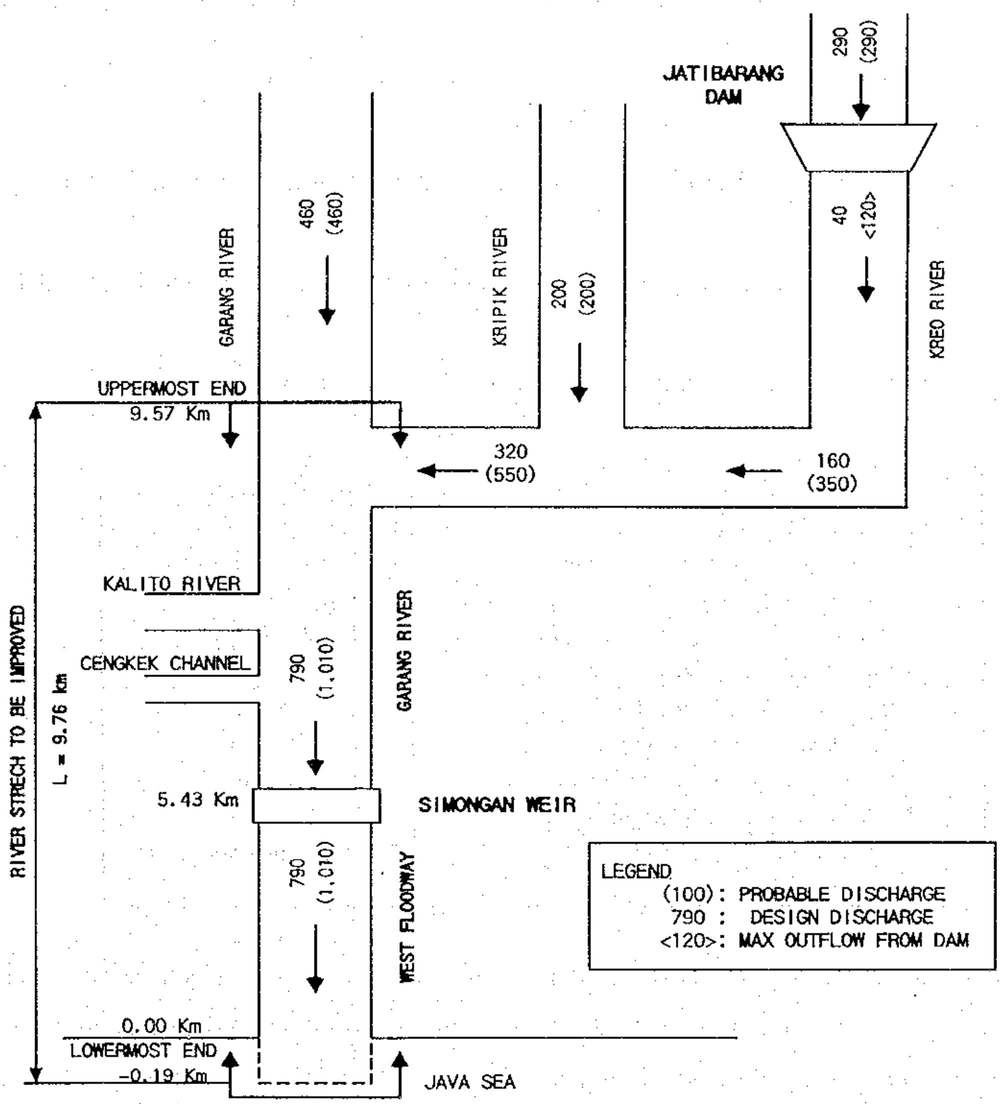
Return Period	Standard Flood Discharge at Simongan Weir	Design Flood Discharge at Simongan Weir *1
100 year	1,010 m^3/s	790 m^3/s
50 year	900 m^3/s	700 m^3/s
25 year	790 m^3/s	620 m^3/s

*1 : Flood control by Jatibarang Dam is considered.

The design discharge of 790 m^3/s is applied to the river improvement of the river stretches from the river mouth up to the confluence with Kreo River.

DISTRIBUTION OF DESIGN FLOOD DISCHARGE

Unit : m³/s



The standard flood discharge of 1,010 m^3/s in the downstream from the confluence is reduced to 790 m^3/s by flood control effect of Jatibarang Multipurpose Dam. The discharge of 790 m^3/s corresponds to 25-year probable flood discharge when Jatibarang Multipurpose Dam is not projected.

Return Period	Standard Flood Discharge at Simongan Weir	Design Flood Discharge at Simongan Weir *1
100 year	1,010 m^3/s	[redacted]
50 year	900 m^3/s	700 m^3/s
25 year	790 m^3/s	620 m^3/s

*1 : Flood control by Jatibarang Dam is considered.

The design discharge of 790 m^3/s is applied to the river improvement of the river stretches from the river mouth up to the confluence with Kreo River.

4.1.2 Project Works

River improvement of West Floodway/Garang River is projected for the following purposes.

(1) To increase the flow capacity of river channel and to prevent flood overflow from river banks/dikes particularly in West Floodway,

(2) To make the flood water level below the hinterland ground level in Garang River, and

(3) To eliminate the dam-up effect of flowing water owing to the existing fixed type Simongan Weir.

To attain these purposes, the following major works have been proposed.

Project Works	River Stretch/Location
1. West Floodway Improvement	L = 5,437 m
- Dredging of downstream channel	L = 1,370 m
- Excavation of existing floodplain	L = 5,250 m
- Raising/Reinforcing of Existing Floodwall	L = 2,510 m
- Embankment for dike in river mouth area	L = 760 m
2. Garang River Improvement	L = 3,907 m
- Riverbed Excavation/Deepening	L = 3,650 m
- Excavation of existing floodplain	L = 3,780 m
3. Reconstruction of Simongan Weir	
- Gated Weir	5.43 km from river mouth
- Intake Structure	

For stabilizing the river channel excavated, river structures such as ground sill, revetment and groin are provided properly as well. As supplementary works, the existing drainage and intake structures, and bridges which may be affected by the river improvement, will be re-constructed or reinforced to maintain their existing functions. Besides, in view of maintenance and use of river channel and structures, and preservation of river environment, waterfront and environmental related facilities are provided as required.

4.1.3 Basic Matters to be Considered

(1) River Survey

The river improvement plan is based on the topographic and river survey results conducted by the JICA Study Team in the phase 1 stage of this project in 1997 for the objective area. The National Bench Mark (TTG), which was determined from the Mean Sea Level of Jakarta Port, is used for the horizontal and vertical reference points. It is noted that the Bench Mark (SPB : Semarang Peil Baru), which was established by JRATUNSELUNA River Development Project, is commonly used for river surveys in this region by the local government. The difference of datum line between TTG and SPB is confirmed by comparing the crest elevation of Simongan Weir as follows:

Bench Mark	Weir Crest
SPB	EL. 5.60 m
TTG	EL. 5.18 m

SPB = TTG + 0.42 m

When adjusting survey results between the existing river improvement plan and that of this project, the above conversion rate will be applied.

In designing the river channel, the following survey results are used for this project.

Kind of Survey	Particular
River Plan	1/2,000
Cross Section	WF0-9 to WF186 (50 m interval) *1 V: 1/100, H: 1/200
Longitudinal Profile	V: 1/100, H: 1/2,000

*1 : Name of river cross section used in this project. The locations of bench marks are shown in the plan for river improvement (refer to Fig. 4.2.1)

(2) Intake from Garang River

The minimum discharges of 0.5 m^3/s for Semarang River and 0.15 m^3/s for the left bank drainage channel are to be diverted from Simongan Weir throughout a year after the completion of Jatibarang Multipurpose Dam. Diverted water is used for the flushing of the downstream channels in densely populated urban area.

In addition, the discharge of 2.04 m^3/s (presently, 0.98 m^3/s) is planed to be taken for the municipal water through the PDAM intake facilities located on the right bank of Garang River at 1.2 km upstream point from Simongan Weir.

The existing Simongan Weir of fixed type enables the water intakes mentioned above. These intake systems are to be maintained in the river channel improvement.

(3) River Maintenance Flow

Should Jatibarang Multipurpose Dam be completed, even if the serious draught with 10-year probability occurs, the minimum flow discharge of 2.69 m^3/s is assured at the confluence of Garang River and Kreo River by Jatibarang Multipurpose Dam. This flow discharge consists of the future municipal water of 2.04 m^3/s and flushing water of 0.65 m^3/s for Semarang River and the left bank downstream drainage channel.

In a serious draught, only a part of the flushing water of 0.15 m^3/s released from the irrigation channel is provided from the left bank channel near National Road Bridge into West Floodway, and no other river water is diverted from the weir. Accordingly, the flow of West Floodway channel is completely affected by tide. Other than the serious draught, river discharge of more than the said amount is expected at the confluence with Kreo River, and the flow discharge into West Floodway is increased.

(4) River Crossing Bridge

There exist six (5) bridges spanning West Floodway/Garang River downstream from the confluence of Garang and Kreo rivers as listed below. Further, one bridge is scheduled to be constructed within a couple of years (in 2000) at about 300 m upstream of Simongan Weir instead of the existing Old Simongan Bridge.

Name of Bridge *1	Location from River Mouth (m)	Structural Type	Span, Total Length (m)	Width of River Channel (m)
North Ring Road Bridge *2	1,175	PC I-Girder	5 spans 160.0	155
Railway Bridge	3,700	Warren Truss	3 spans 97.5	90
National Road Bridge	4,110	PC I-Girder	3 spans 76.1, 78.0	88
Old Simongan Bridge *3	5,160	Plate Girder	8 spans 77.2	90
Toll Road Bridge	8,980	PC I-Girder	7 spans 252	150

*1 Each bridge is named after the name of street or area for this project tentatively.

*2 This bridge is now being expanded in width by constructing abutments and piers with the same structural dimensions as the existing one.

*3 This bridge will be demolished after the New Simongan Bridge was constructed in immediately upstream of the existing Simongan Weir.

Through the study on longitudinal profile of West Floodway channel, it has been proposed that Railway Bridge be raised by 70 cm to have a required freeboard of 1.0 m against the design flood water level established in this project.

(5) Sedimentation

According to the analysis on sediment yield and balance made in Feasibility Study (F/S), it is estimated that sediment deposited in the river channel of downstream from the confluence of Garang and Kreo rivers amounts to about 90,000 m^3/year. It is assumed that most sediment be deposited particularly in the areas of river mouth and immediate upstream portion from Simongan Weir. However, it is expected that a considerable amount of sediment in the upstream of Simongan Weir will be flushed into downstream through the gated weir during big floods. The remaining sediment in the channel could be removed by the periodical maintenance dredging/excavation.

(6) Land Subsidence

It is reported that land subsidence caused by excess groundwater development is being progressed in the central low lying areas in Semarang City. According to the survey results, their annual rates of land subsidence are variable from 2.0 to 10.0 cm/year. The area along the downstream of West Floodway, especially right bank hinterland is being affected as well. It is anticipated that the proposed crown elevation of earth dike/floodwall may be lowered from the original elevation with the progressing land subsidence in the area. Monitoring and repair of dike/floodwall, therefore, will be important task in the maintenance and operation works of river channel and structures.

(7) River Environment and Utilization

West Floodway/Garang River is characterized as an urban river which serves not only for the flood control purpose in the flooding events but also for the purpose of supplying municipal water, channel flushing, industrial use and so on. Besides these purposes, the river serves for daily water use and flood plain use by local residents living in the adjacent area.

As other similar projects in this country indicated, river improvement projects have produced good effects in promoting or developing environmental functions such as realization of sanitary environment, improvement of river water quality, creation of better scenic view and pleasant open space.

Taking the above situations into consideration, structures or facilities which can contribute to the realization of the said functions are provided and designed as much as possible in the river improvement.

4.1.4 Measures of River Improvement

The measures of river improvement for West Floodway/Garang River were studied in the preceding F/S, and are summarized below.

(1) West Floodway

The following two (2) river improvement alternatives are conceivable for this river stretch.

<u>Alternative-A :</u> Channel excavation

<u>Alternative-B :</u> Raising of existing floodwalls or new dike embankment

Alternative-B requires a considerably high floodwall or embankment and reconstruction of the existing three (3) bridges to cope with the high flood water level expected. The drainage system along the river channel will be affected as well. On the other hand, the major works of Alternative-A are limited to excavation of the floodplain (high water channel bed) and riverbed, having little impact on the existing bank protection structures and bridge foundations. As a supplementary works for Alternative-A, raising the existing floodwall crest is required, because the existing floodwalls are about 1.0 m lower compared with that in 1991 as shown in Fig. 4.1.1. This is due to the land subsidence in the Semarang City.

According to the project cost comparison of both alternatives under the F/S, Alternative-A has been proved to be more economical (Alternative-A : Rp. 11,158 x 10^6, Alternative-B : Rp. 20,876 x 10^6). In addition to the technical and economical aspects, Alternative-B is planed with much higher design flood level than Alternative-A resulting in higher flood damage potential in the area. In due consideration of these factors, Alternative-A is preferred as the river improvement measures for West Floodway.

(2) Garang River (Simongan Weir to Confluence with Kreo River)

As the case of West Floodway, the same river improvement measures can be applied to Garang River, namely, excavation of the existing low water channel (Alternative-A) and dike embankment/raising of floodwall (Alternative-B).

The higher flood level in Garang River is attributed to dam-up effect by Simongan Weir and the higher back-up water level by the narrow channel of immediately upstream stretch of the weir. Alternative-A is aiming at lowering the high flood level by eliminating the said causes through reconstruction of the existing fixed type weir to a gated weir and excavation of the low water channel. With this measure the design high water level can be kept below the existing ground level of the hinterland, resulting in reduction of the flood damage potential.

In case of Alternative-B, emphasis is placed on raising/reinforcing the existing dikes/floodwalls and construction of new dike/floodwall to accommodate the design flood without any channel excavation. Simongan Weir is also reconstructed as the new fixed weir because of the structural overage.

The design high water level of Alternative-B tends to be much higher than the hinterland ground level (3 m to 4 m). Compared with the design high water level of Alternative-A, that of Alternative-B is estimated at about 1.5 m higher. Accordingly, when an extraordinary flood over the design flood of 25-year return period (without Jatibarang Multipurpose Dam) occurs, the dike may be destroyed by channel overflow, causing disastrous flood damage in the area as experienced in the 1990 flood. On the other hand, Alternative-A could lower the design high water level and minimize the flood damage potential by channel overflow.

According to the cost comparison between two (2) alternatives made in the F/S, the project cost of Alternative-A (Rp. 33,891 x 10^6) is higher than that of Alternative-B (Rp. 31,307 x 10^6). However, the difference in the cost is limited to 2,600 million Rp. which corresponds to only 8 % of the entire project cost of Alternative-B.

In due consideration of disadvantages/advantages, Alternative-A is preferred for the river improvement measure for Garang River.

(3) Reconstruction of Simongan Weir

The existing Simongan Weir of fixed type primarily causes the serious floods in the upstream by its dam-up effect on flood water. Eliminating this adverse effect and lowering the water level in the upstream stretches during flooding time is considered as the most effective river improvement measure for Garang River.

On the other hand, Simongan Weir, at present, plays an important role in supplying both municipal water for Semarng City and flushing water for Semarang River and the irrigation channel throughout a year.

To fulfill both functions of flood control and water supply, the existing fixed type Simongan Weir needs to be reconstructed to a gated weir which has flexible functions of flood control and water supply.

Apart from the flood control aspect, it is considered that the structural stability of the existing weir is remarkably lowered because of structural overage and serious riverbed scouring of up and downstreams. In consideration of these existing conditions, Simongan Weir should be reconstructed to a new weir with a structural safety together with river improvement of Garang River.

4.2 Basic Design

4.2.1 Planning/Design Criteria

(1) General

The planning/design criteria are prepared to serve the hydraulic and structural design of river improvement works and flood control structures for the project. The basic concepts and procedures for the planning and designing are based mainly on the "Flood Control Manual" prepared by the Ministry of Public Works, Government of Indonesia. As well as the "Technical Standard of River and Sabo Works" by the Ministry of Construction, Government of Japan, is used to supplement the said "Flood Control Manual". The other standards/codes pertaining to the specific flood control structures are also used as required.

In this section, the basic planning/design criteria, which serve for determining the dimensions of river channel, location and basic form of river structures, are presented. "Interim Report (4) : Volum III, Design Criteria" are prepared as well for the detailed hydraulic/structural design of channel and structures.

(2) Planning/Design Criteria for River Channel

Taking the existing river morphology and flood control effect on the hinterland of West Floodway/Garang River into account, the following items shall be applied to the design of river channel improvement.

(a) Alignment of Low Water Channel and Dike

In designing the alignment of river course, straight lines or fairy wide curves are used to provide a smooth flood flow. The channel and dike alignments are principally made within the area covered by the existing right-of-way boundary. Land acquisition shall be kept to a minimum if necessary.

(b) Setting of Design High Water Level

In principle, the high water level should not be higher than the predominant elevation of the adjoining ground or the existing dike to minimize the flood damage potential except for the low-lying portions where keeping the high water level lower below the ground height is physically difficult.

(c) Setting of Design Riverbed

The design riverbed profile principally follows the existing average riverbed profile to avoid unbalanced scouring and sedimentation as well as to minimize relocation and modification of existing river structures. The ratio of riverbed gradient between the upper and lower stretches is basically set at less than 1 : 2 to ensure the stability of the river channel. In addition, the design riverbed should be determined in relation with the average velocity and high water level of river channel, considering dike stability and the flood damage potential in the hinterland of the channel.

(d) Cross Sectional Form of River Channel

The existing river channel is composed of low water channel and flood channel (high water channel) forming a compound trapezoidal cross section. This type of channel can accommodate the low flow discharge in the low water channel during ordinary non-flooding time and confine bigger flood discharge within the whole cross sections of channel during flooding event. This is preferable for channel stability, channel maintenance and utilization of the floodplain. Taking these advantages into account, the double trapezoidal cross section (compound cross sectional form) is used in the river improvement plan. As for the side slope, a slope of 1 : 2 (vertical to horizontal) is, as a rule, adopted for the low water channel to ensure bank stability

(e) Freeboard

The freeboard above the design high water level is provided to prevent overtopping of the dikes/floodwalls or river banks. For West Floodway/Garang River, a freeboard of 1.0 m is employed, which corresponds to the design discharge of 500 to 2,000 m^3/s according to the "Flood Control Manual".

(f) Roughness Coefficient of the Channel

For both uniform and non-uniform flow calculation, the following Manning's roughness coefficients are used based on the recommended figures in "Flood

Control Manual".

Low Water Channel (excavated)	0.030
Low Water Channel (existing)	0.033
Floodplain (excavated) *1	0.035
Floodplain (existing)	0.040
Channel with Lining (narrow	0.025

*1 The floodplain here is refereed to the bottom portion of high water channel.

(3) Planning/Design Criteria for Specific Facilities

According to the "Flood Control Manual", standard of design flood and design criteria recommended for flood control facilities are prepared as shown in the following tables.

<u>Minimum Return Period (Years) of Design Flood for River Structures</u>

Item	Return Period (Years)	Objective Structures
River Bank Protection	25	Revetment, Groin
Dike Slope Erosion Protection	50	Revetment
Channelization	varies	Bankfull or regime discharge for natural channel
Bridge	50	-
Weir	50 to 100	-
Sabo Dam	100	-
Pipe Line	50	Elevated line or buried pipeline which convey non-polluting materials.

Design Criteria for Dikes and Floodwalls

Item	Criteria
Design Flood Discharge	790 m^3/s (100-year return period with Jatibarang Dam) The dike height should be selected to convey the discharge mentioned above without over-topping. Side slope erosion protection should accommodate the 50-year flood without damage.
Right-of-Way and Land Use	In accordance with existing law the government acquires and has control over all lands to a distance of 5 meters beyond the outside toe of dike. Permanent residential or industrial type structures should not be allowed within the regulatory flood plain. High crops (e.g. Banana plantations) and crops which leaves soil exposed to potential erosion (e.g. Vegetable crops) should not be permitted. Certain types of agriculture are allowable within the regulatory flood plain. Livestock pasture or low height crops which provide erosion protection for underlying soils are recommended. Land use within the regulatory flood plain should have a negligible impact on flood water level.
Construction Materials and Geotechnical matters	Utilize locally available construction materials including silts, sands and clays where workable. Dikes built of silts and sands should be capped with a 0.3 meter thickness of clay for protection against rapid failure in the event of over topping. Dikes should be compacted to a minimum 90 percent of Standard Proctor Density or greater depending on specific site requirements.
Cross Section Details	Minimum width of dike crown: 4.0 m (500 m^3/s $<Q=790$ m^3/s $<2{,}000$ m^3/s) Minimum Dike/Floodwall freeboard: 1.0 m (500 m^3/s $<Q<2{,}000$ m^3/s) In all cases freeboard should be greater than wave setup and runup. Minimum Dike Sideslopes should be 1:2 (vertical to horizontal). Flatter slopes or berms may be required based on actual soil conditions and the results of stability calculations. Dike slopes should be protected against erosion by vegetation, planting of shrubs or use of armor (e.g. rock riprap) depending on site and soil.
Special Considerations	An additional freeboard is added on the design dike/floodwall crest, when the ground subsidence is anticipated.

Design Criteria for Bank Protection

Item	Criteria
Design Flood	25-year return period flood for river banks -- > 100-year for this project 50-year return period flood for river dikes -- > 100-year for this project
River Engineering	Should withstand hydraulic forces and riverbed scour for design flood conditions. Should be safe from outflanking due to river channel movement during a 25-years project life.
Hydraulic	Should provide a safe factor of 1.25 for stability during the design flood. Adequate underlying filter layer(s) should be provided under the armoring. The alignment of the bank protection should provide a smooth and gradual transition to the upstream and downstream banks.
Miscellaneous	Bank protection works should be designed to minimize damage from vandalism.

Design Criteria for Bridges and River Crossings

Item	Criteria
Design Flood Discharge of the river channel	790 m^3/s (100-year return period with Jatibarang Dam)
Design Flood	At least equal to project flood standard. Any backwater effect during the design flood should not exceed 0.3 m. Higher standards for specific sites may be required by the Department of Road and Bridge..
Freeboard	Department of Public Works "Guideline for Bridge and Highway Loading" requires at less than 1.0 m freeboard between the 50-year flood level and bottom of bridge girder. In this project the high water level is set based on the 100-year design flood. Freeboard of navigable waterways is not considered.
River Engineering	Bridge crossing location and design layout should be selected to suit the river engineering and geomorphologic characteristics of the stream. The ratio between the total pier width and effective river width should be less than 5 %. If the ratio is over 5 %, a study on what extent the bridge piers have an influence on upstream water level shall be carried out.
Bridge Span	Total bridge span should not be less than the natural width of the river channel and should be designed to satisfy pass the design flood.
Bridge Piers	Bridge piers should be located and spaced to insure passage of debris during the flood. Bridge piers should be designed to accommodate potential scour and channel degradation. Sand mining should be prohibited in the vicinity of bridge piers.

Design Criteria for Weir

Item	Criteria
Design Flood	At least equal to project flood standard. --> 100-year for this project Ministry of Public Works Standard SNI 03-2415-1991 requires that weirs be designed for a flood return period between 50- and 100-year. Weirs which are located upstream of major population densities should be designed such that catastrophic do not occur in the event of over-topping or operator error.
River Engineering	The weir should be able to safely pass the design floods without interception of sediment and debris loads. River works should be designed to withstand river bed scour and degradation during design flood event and lateral erosion during project life. The ratio between the total width of pier and effective river channel width should be less than 1/10.
Foundation & Abutment	The foundation and abutment must be stable and should not undergo excessive deformation under any loading condition. Seepage through the foundation and abutment must be controlled to prevent uplift, piping, instability, sloughing, erosion, etc.
Freeboard	Top of structure and wing wall will be at least 1.0 m higher than the design high water level of Garang River.
Span Length of weir *1	The span length (SL) of the movable portion of the weir (the distance between the center lines of adjoining piers of weir should be longer than the values shown in the following: $Q < 500\ m^3/s$ --- SL = 15 m (Q : Design Flood Discharge) $500 < Q < 2{,}000\ m^3/s$ --- SL = 20 m $2{,}000 < Q < 4{,}000\ m^3/s$ --- SL = 30 m $4{,}000\ m^3/s < Q$ --- SL = 40 m

Note *1 : This provision is accordance with Technical Standards for River and Sabo (River Association of Japan)

4.2.2 West Floodway Channel

River improvement of West Floodway is made focusing on the floodplain excavation and raising of the existing floodwall to enlarge the flood flowing area without excessive deepening of the low water channel.

(1) Alignment of River Channel and Dike

The river plan in terms of low water channel and dike is made as shown in Fig. 4.2.1, and the key ideas in designing the channel alignment are described below.

(a) The existing river channel of West Floodway forms an almost straight alignment. Therefore, the design low water channel follows the alignment of existing one using fairly gentle curves.

(b) Floodplain excavation is made on the spacious side of floodplain spreading on the right bank.

(c) Earth dike is proposed along the right bank in the river section between North Ring Road Bridge and the river mouth to protect the land reclamation area from flood damage. Dike alignment is made in parallel with the alignment of low water channel bank keeping a distance of 10 m in order to ensure the dike stability and to lead flood flow smoothly to the sea

(d) In raising the existing floodwalls, there is no change in alignment.

(e) The channel and dike alignments are principally made within the area covered by the existing right-of-way boundary. Land acquisition shall be kept to a minimum if necessary.

(f) Regarding the future land reclamation on the right bank at the river mouth, the river mouth should be widened toward the sea with the angle of 11° as shown in Fig. 4.2.1(1/3) in order to lead flood flow smoothly into the sea.

(2) Longitudinal Profile

Fig. 4.2.2 shows the longitudinal profile of West Floodway channel, including existing river profile and design lines such as design riverbed, design high water level, design dike crown and the elevation of flood plain. The design lines are determined based on the concepts mentioned below.

<u>Design High Water Level</u>

In principle, the design high water level (D.H.W.L.) should not be higher than the predominant elevation of the adjoining ground or the existing dike to minimize the flood damage potential except for the low-lying portions where keeping D.H.W.L. below the ground height is physically difficult.

Technically, the D.H.W.L. is determined based on the water stage calculated. The following conditions are taken into account as well.

(a) At the river mouth, D.H.W.L is set at EL.+0.500 m that is a little higher than the highest high water level of EL.+0.450 m.

(b) In the river stretches between North Ring Road Bridge and Railway Bridge, D.H.W.L is set below the crest level of existing floodwall.

(c) In the upstream from Railway Bridge to Simongan Weir, it is possible to set the D.H.W.L at lower level than the existing riverbank level with the required freeboard of 1.0 m.

(d) The proposed high water level is set lower than the underside elevation of existing bridge girder as much as possible except Railway Bridge, so that bridge raising works are avoided.

<u>Design Riverbed</u>

The design riverbed profile principally follows the existing average riverbed profile to avoid unbalanced scouring and sedimentation as well as to minimize relocation and modification of the existing river structures. The specific considerations are as follows.

(a) Distinctive riverbed aggradation is observed in the river mouth section, resulting in the lowering of the flood flowing capacity of the channel. Therefore, excavation of the riverbed is made in this river section with the adequate excavation depth as shown in Fig. 4.2.2. The riverbed elevation at the river mouth is set at EL.-2.500 m based on the average riverbed elevation in the downstream channel and seabed elevation near the river mouth.

(b) Flat riverbed profile is adopted for the downstream from WF30 to the river mouth because the elevation of existing riverbed is higher in the downstream than that of the upstream, so called the reverse slope of riverbed is presently formed in this stretch.

(c) In the stretch from WF30 to Simongan Weir, the design riverbed slope of 1/2,650 is chosen considering the constraints of D.H.W.L and the stability of structures of which foundation are embedded in the riverbed.

To determine the suitable riverbed profile, comparative study was done for several alternatives in terms of river hydraulics and morphology. The detailed description is presented in "Design Notes, 2.2 Design Riverbed and Channel Hydraulics". Through the comparison the optimum riverbed profile was determined as follows.

	River Mouth WF9		WF30		Simongan WF99+29
Riverbed Elevation	EL -2.500		EL -2.500		EL. -1.184
Riverbed Slope		Level		1/2,650	

(3) Cross Section

In order to accommodate the design discharge of 790 m^3/s, the double trapezoidal cross section (compound cross section) with a side slope of 1:2 (vertical to horizontal) is employed for the cross sectional form of river channel. The cross sections of the river are designed based on the following considerations, and the standard cross sections are shown in Fig. 4.2.3.

(a) The low water channel is widened by excavating the existing flood plain (high water channel bed) with the appropriate excavation width. The width of design channel is determined by comparing calculated water level and D.H.W.L. The proposed widths of river channel are as follows together with existing ones.

River Stretch	River Width (Dike to Dike) (m)	Width of Existing Low Water Channel (m)	Riverbed Width of Design Low Water Channel (m)
WF0-9 ~WF 0	-	-	150
WF 0 ~WF 4	-	130 to 180	150 ~ 115
WF 4 ~WF 15	150 to 160	100 to 130	115
WF 15 ~WF 42	160 to 190	60 to 100	115
WF 42 ~WF 53	120 to 185	50 to 60	115 ~ 58
WF 53 ~WF 69	95 to 120	40 to 55	58
WF 70 ~WF 98	85 to 95	40 to 50	50

(b) In widening the low water channel, the minimum flood plain width of 20 m is provided on both sides for the sake of channel maintenance, riverbank stability and utilization of the waterfront area.

(c) The depth of the low water channel is determined to be 3.0 to 3.5 m depending on the location. With this depth of the channel, the flood plain will be submerged under the flood of about 2-year return period (Q_2=350 m^3/s) for the whole channel stretches except the lowermost portion near the river mouth. This proposed ground elevation is almost the same height as that of existing floodplain. Filling on floodplain is required for the lower portion.

(d) For the narrow channel portion between Railway Bridge and National Road Bridge, retaining wall with a side slope of 1 : 0.5 (vertical to horizontal) is used on the upper portion of channel cross section to confine the design channel cross section within the right of way boundary.

(4) Bridge and Clearance

The clearance of respective bridges against the D.H.W.L is as follows.

Name of Bridge	Underside Elevation of Bridge Girder	D.H.W.L	Existing Clearance
North Ring Road (WF15)	E.L. 2.52 m	E.L. 1.21 m	1.31 m
Railway Bridge (WF65)	E.L. 3.37 m	E.L. 3.03 m	0.34 m
National Road Bridge (WF73)	E.L. 4.14 m	E.L. 3.38 m	0.76 m
New Simongan Bridge (WF105+20)	(E.L. 9.25 m) *1	E.L. 8.25 m	1.00 m
Toll Road Bridge (WF174+18)	E.L. 18.17 m	E.L. 11.75 m	6.42 m

*1 : BINAMARGA is, at present, reviewing their original D/D of the bridge, and they agreed that they adjust their bridge design to meet the requirements of the proposed river channel.

Of the five (5) bridges, the clearance of Railway Bridge and National Road Bridge does not meet the required clearance of 1.0 m.

(a) Railway Bridge

The clearance of 0.34 m is a half value of the required clearance of 1.0 m (standard SNI No.1725-1989-F, Department of Public Works). The clearance of 0.34 m does not fulfill the minimum clearance of 0.8 m (applied for design discharge of 200 m^3/s to 500 m^3/s) stipulated in "Flood Control Manual".

As to the bridge sub-structure, the existing bridge piers and footings are rather old structures with more than 60 years history. Besides, the embedding length of existing pier footing is considered very small. Therefore, the piers may be endangered when the excavation around them is made in the channel improvement.

Taking these hydraulic and structural disadvantages into account, it is proposed that the existing super-structure be raised and sub-structures be reconstructed.

(b) National Road Bridge

The estimated high water level at this bridge is 0.76 m lower than underside of bridge girder. This height is a little smaller than the required clearance of 1.0 m. There are no adverse factors affecting water surface profile, because the flood water flows straight and smoothly with a flow width of more than 60 m at this river section. Besides, there is less possibility of debris (including floating logs) jams which may affect water levels. Furthermore, this bridge is quite new constructed in 1993 on the main road of this district. Social difficulty would be accompanied by bridge raising.

In consideration of these conditions, this bridge should be left intact rather than raising.

(c) Other Existing Bridge

The other bridges have enough clearance between the underside of girder and the design high water level.

(d) New Simongan Bridge

According to the bridge construction plan, the bridge girder will be placed on the higher position above the existing floodwall. Therefore, the sufficient clearance more than 1.0 m against the design high water level will be assured, and the bridge length is longer than the proposed river width.

(5) Drainage By-pass Channel at River Mouth

A drainage channel with a channel width of about 10 m joins West Floodway from the right bank at the station WF.12. In connection with dike construction, a bypass channel connecting the existing drainage channel with the river mouth is proposed instead of construction of a water gate at the junction with the main river channel. This is because a bypass channel is advantageous from economical and maintenance aspects compared to construction of a water gate. This channel is excavated behind the proposed earth dike in parallel with dike alignment having a distance of 5.0 m from the dike and a length of 770 m as shown in Fig. 4.2.1(1/3). As a result, some land acquisition is required along the existing riverbank.

The design discharge of channel is determined by estimating the flow capacity of the existing drainage channel. Accordingly, the dimensions of proposed channel are determined as tabulated below.

Channel Section	Right Bank, WF0 to North Ring Road Bridge	
Length	770 m	
Hydraulic Data - Design Discharge - Clearance - Roughness Coefficient	 11.0 m^3/s 0.3 m 0.030	Flow capacity of the existing channel is considered.
Longitudinal Profile - Design High Water Level - Riverbed elevation (lowest end) - Riverbed Slope	 EL +0.50 m (level) EL −1.850 m 1 / 1,650	 H.H.W.L (Tide) +0.05 m 0.6 m higher than the riverbed elevation of Floodway.
Cross Section - Width of Riverbed - Side Slope	 5.00 m 1 : 2	 Same as the existing channel Stable slope
Small Dike	2.5 m wide about 0.5 m high	For inspection

(6) Utilization of River Channel

In downstream from Railway Bridge, a large open space exists on the floodplain. Some areas are utilized as farm land, sports ground, fish pond and so on, but many other areas are so called an utilized land. Riverside activities such as fishing, rowing boats and canoe, and salt loading/unloading are found as well.

With the river improvement, the width of floodplain will be reduced to 20 to 60 m from the original width for the right bank side and 10 to 35 m for the left bank side. The ground elevation of floodplain is set at the position 3.0 m higher than the design riverbed, accordingly, it is estimated that the floodplain will be inundated once in two years. The floodplain with those dimensions is considered usable as sports field, river park and other recreational purposes during non-flooding time.

The walkways/pedestrian paths along the river channel, which connect upstream and downstream areas, are proposed together with approach steps. They will serve for water front activities, strolling and inspection of the river channel and structures.

In addition, mooring facilities are provided for small boats and canoes which have been increasing in number recently.

4.2.3 Garang River Channel

<u>Main River Course</u>

Unlike the channel improvement method in West Floodway, with the purpose of lowering high flood stage, the riverbed excavation and reconstruction of Simongan Weir are employed as the major improvement works for Garang River. The river plan is shown in Fig. 4.2.4.

(1) Alignment of River Channel and Dike

(a) The low water channel excavation is made along the existing river course without any cut-off channels, because the existing low water channel runs quite smoothly.

(b) The river banks adjacent to PDAM Water Intake Structure, which are situated in the concave side of a channel bend, are prone to serious erosion and scouring by flood flow. To ease hydraulic impact on the intake facilities, the course of low water channel is shifted to the other side of the intake with the distance of 10 to 20 m from the existing flow center.

(c) Large open spaces spreading in the river channel (river sections WF115 to WF125, WF136 to WF142 and WF165 to WF172) are to be left intact in consideration of retarding effect of flood.

(d) The new dike is provided on the right bank in the upstream from Toll Road Bridge with the dike crown elevation 1.0 m higher than the D.H.W.L.

(2) Longitudinal Profile

Aiming at lowering the high flood stage of the existing river channel, the longitudinal profile is designed as shown in Fig. 4.2.5, and main points are presented as follows.

<u>Design High Water Level</u>

(a) The design high water level is determined based on the water level calculated by uniform flow calculation. Calculation procedure is presented in Fig. 4.2.6.

(b) In the downstream reaches between Simongan Weir and WF124, the design high water level (D.H.W.L) is set lower than the hinterland ground elevation by lowering the riverbed by about 1.5 m.

(c) In the upstream reaches between WF124 and WF184, D.H.W.L is placed at the position more than 1.0 m below the existing crest of dikes/floodwalls, so that the existing dikes/floodwalls can be effective with a required freeborad.

<u>Design Riverbed</u>

The riverbed profile has been determined through the comparison study regarding the setting of high water level. The detailed study results are presented in "Design Notes, 2.2 Design Riverbed and Channel Hydraulics". Aiming at lowering the high water level of the river channel, the riverbed profile is determined as follows:

	Simongan WF99+29		WF124		WF176	
Riverbed Elevation	EL.-1.184/ EL +1.500	-	EL 2.343/ EL. 3.843	-	EL. 5.910	-
Riverbed Slope	-	1/1,250	-	1/1,250	-	1/500
Elevation Difference	2.684 m	-	1.50 m	-	-	-

(a) The riverbed elevation at Simongan Weir is set at EL.1.500 m by adjusting to the lowered riverbed for the stability of structure. Accordingly, the riverbed difference between upstream and downstream of the weir comes to 2.684 m. The river bed of Simongan Weir and immediately downstream riverbed are connected with a adequate transition section in the form of steps to prevent riverbed degradation.

(b) With the excavation of the riverbed in the downstream, the groundsill with head (hydraulic drop) is required to connect downstream and upstream riverbeds. The height of drop structure is limited to 1.5 m to maintain riverbed stability in the downstream.

(c) The riverbed slope of 1/1,250 is applied to the river stretch up to Toll Road Bridge of which point is located at the lowermost end of the steep stream channel with riverbed material of gravel and cobble stone. The riverbed elevation of this point is set at EL.5.91 m, which is the same as the existing riverbed.

(3) Cross Section

The double trapezoidal cross section (compound cross section) with a side slope of 1:2 (vertical to horizontal) is, in principle, employed for the whole river stretches. The standard cross sections are shown in Fig. 4.2.7.

(a) For the narrow channel in the upstream of Simongan Weir, the channel widening is limited to 35 m at the riverbed position due to the existing narrow channel topography and social constraints. After the riverbed excavation was done, the height of low water channel becomes 5.0 m. The side slope of 1: 0.5 is used for some portions to avoid encroachment of public road.

(b) In the river stretches between the proposed groundsill and Toll Road Bridge, the riverbed width and height of low water channel are 40 m and 3.5 m, respectively.

(c) At the bending section of river channel, a rise in water level and sediment deposit are unavoidable. To cope with them, bending section is widened by about 10 % from the width of standard cross section.

(4) Utilization of River Channel

There are large open spaces on the floodplain in the middle reaches and they are used as farm land (including aquatic plants), sports field, factory yard and so on. Although the channel excavation is made, most part of the existing floodplain is left intact. The future utilization of floodplain, therefore, is basically the same as the present one.

To facilitate waterfront activities and maintenance works for river channel, approach roads/steps, walkways are provided along the low water channel. The frequency of floodplain overflow is approximately once two years.

Tall trees and plants growing thickly on the floodplain, which are hampering smooth flood flow, should be cut or eliminated in the river improvement works.

Tributaries

(1) Existing Condition

There are two (2) tributaries in Garang River, Kalito River (right bank about 1,800 m upstream from Simongan Weir) and Cengkek Channel (right bank about 1,400 m upstream from the weir). Concrete flood walls have been constructed based on the high water stage of 1990-flood for protecting the area with lower ground elevation.

The catchment area, estimated flood discharge and channel dimensions of these tributaries are as follows.

Item	Kalito River	Cengkek Channel
Catchment Area (km^2)	5.20	1.80
10-year Design Discharge (m^3/s)	18	7
5-year Design Discharge (m^3/s)	15	5
Width of Channel in Lower Reaches (m)	15 - 20	10 - 20
Riverbed Gradient	1/300 - 1/400	1/125 - 1/150

(2) Back-Water Effect of Garang River

Figs. 4.2.8 and 4.2.9 show the river channel profiles of Kalito and Cengkek channels at confluence portion with Garang River. After the river improvement and reconstruction of Simongan Weir were completed, the original water level under the 100-year flood in Garang River would be lowered by about 1.1 m at the confluence of Cengkek Channels and 0.8 m at the confluence of Kalito River. As the result, it is confirmed that the surface elevation of probable back water of the main river is lower than the elevation of both right and left river banks and the elevation of underside of the existing bridges as shown in Figs. 4.2.8 and 4.2.9. Therefore, the existing floodwalls become effective as the floodwall of the new improvement plan without raising.

Even though the existing bridges in Cengkek Channel do not have a required clearance of 1.0 m against the probable back water level, raising of bridges will not be adopted. The reason is that the area along Cengkek Channel is so congested with roads and buildings that the bridge raising is not allowed from social and geological constraints. Instead, floodwall with a height of about 0.5 m is provided on the left river bank of which elevation is lower than that of right bank.

For the smooth connection of channel with the main river course, the channel beds of tributaries are excavated with a proper channel bed slope as shown in Figs. 4.2.8 and 4.2.9.

4.2.4 Dike Embankment and Raising of Existing Floodwall

Earth dikes and floodwalls were provided under the Central Java River Improvement Project for the most parts of target river stretches except for the areas of river mouth and confluence with Kreo River. These structures are rather new and are on the whole still functioning as the flood control structures. Therefore, based on the river improvement plan established, the existing dikes/floodwalls are used with necessary reinforcement (including raising works) or repair. New earth dikes are constructed for the said areas where diking system is not provided..

(1) Location and Type of Dike

Earth dikes/floodwalls are constructed or raised for the following places.

Location	Length (m)	Type of Dike
WF0 to WF15 (Right bank)	724	New Earth dike
WF15 to WF65(Right & Left banks)	2,510 m (R) 2,460 m (L)	Raising of existing floodwall
WF74 to WF80 (Left bank)	180	New Floodwall
WF134 to WF136	100	New Floodwall
WF175 to WF179	170	New Earth dike
WF181 to WF185	150	Raising of existing road

(2) Freeboard

Freeboard is provided to prevent overtopping of floods caused by wave run-up, super-elevation of flow at a bend, potential dike settlement, crown deterioration and so on. A freeboard of 1.0 m is employed for the dike and floodwall of West Floodway/Garang River, which corresponds to the discharge between 500 m^3/s and 2,000 m^3/s according to the "Flood Control Manual".

(3) Earth Dike

(a) Existing Earth Dike

In the upstream reaches of Garang River, earth dikes exist on the right bank with a total length of about 1,750 m. These dikes have a crown width of 4.0 m and dike slope of 1:1.5, and lower slopes are protected with concrete revetment. Although minor damages are seen on dike slopes and crown for some portions, their structure is, in general, sound. Therefore, after necessary reinforcement works are provided for the problem portions, these dikes are used as the permanent dikes for Garang River.

(b) Proposed Earth Dike

The river dike should have adequate shape and dimensions to ensure stability against seepage, piping, slope failure and erosion by flood flow, and to serve as maintenance road for periodical inspection, flood fighting activity and so on. The proposed earth dikes are designed with dimensions given below.

Item	Particular
Cross Section	Trapezoid
Crown Width	4.0 m
Side Slopes	1 : 2 (vertical to horizontal)
Freeboard	1.0 m

The proposed dikes are made of earth materials excavated from the river channel. The excavated materials, except those in downstream from North Ring Road, are found suitable for dike embankment from geotechnical survey results.

Extra embankment is required to cope with settlement of dike body and consolidation of subsurface layer after construction. To protect dike slopes from erosion by raindrops and flowing water, soddings are provided on both sides of dike.

Inspection road is provided on the dike crown for river patrol and flood fighting activities as well as river use by local people. The road is 3.0 m wide with gravel or macadam pavement.

Typical cross sections of proposed dikes are presented in Fig. 4.2.10.

(4) Floodwall

In the raising of existing floodwalls in West Floodway, the necessary raising height including a freeboard of 1.0 m, is determined by comparing the proposed design high water level with the existing crest elevation. Raising works are made by connecting reinforced concrete with the existing floodwall body. The structural dimensions of floodwall are basically determined based on the existing ones, but, some reinforcement works are required to ensure the structural stability and to prevent scour around the wall. Namely, they are foundation log piles and covering embankment in front of floodwall as illustrated in Fig. 4.2.11. Since most joints of existing floodwall are deteriorated, repair is required before raising the wall.

Raising of the existing floodwall is made on the river side of flood plain, avoiding an encroachment of boundary area such as roads, drainage ditches and private lands.

The other floodwalls which will be newly constructed, are designed based on the standard structure employed in the previous Garang River Improvement Project.

4.2.5 Reconstruction of Simongan Weir

General

The existing Simongan Weir of fixed type, which was constructed at the end of the 19th century, primarily causes the serious floods in the upstream by its dame-up effect of floodwater. Eliminating this adverse effect and lowering the water level in the upstream stretches during flooding time are considered as the most effective river improvement measures for Garang River.

On the other hand, Simongan Weir, at present plays an important role in supplying municipal water and flushing water for both Semarang River and the irrigation channel on the left bank throughout a year. Also, the weir is regulating flood discharge to the West Floodway.

To fulfill both functions of flood control and water supply, the existing fixed type Simongan Weir needs to be reconstructed to a gated weir that has flexible functions of flood control and water supply.

The existing intake structures on both sides of the weir also have a long history since the construction. The current structures are already overage, at the same time structural stability has been lowered. During the construction of the main weir, these intake structures will surely be affected. As a result, the structural stability will not be assured. Under the conditions, reconstruction of both intake structures is also proposed.

Basic Conditions for Design

Prior to the design of weir, the following basic conditions are confirmed.

(1) Requirements of Weir Design

The weir is designed to satisfy the following requirements.

(a) To have sufficient flow capacity for the design flood discharge of Garang River,

(b) To maintain the proper channel water level for municipal water intake and to divert maintenance flow to Semarang River and the left bank irrigation channel, and

(c) To discharge sediment on upstream riverbed through the gates.

(2) Location of the New Weir

The important factors in determining the location of the new weir are as follows:

- The river flow can be diverted easily and smoothly into both Semarang River and the left bank irrigation channel through the diversion/intake gates.
- The river portion that is less affected by river impacts such as flood flowing force, scouring and sedimentation should be selected for the location of weir in consideration of operation and maintenance of the facilities.
- Total construction cost for the necessary facilities can be minimized.
- The current river environment such as water quality, river flow volume, water surface area, water front utilization etc., should not be worsened.

Taking these factors into account, the following two alternatives are drawn up and compared.

[Alternative-1] : Same location as the existing fixed weir (WF99+29 m),
Shell type steel roller gate for flood diversion portion, and
Girder type steel roller gate for flushing portion.
(Refer to Fig. 4.2.12)

[Altternative-2] : 550 m upstream section from the existing fixed weir (WF110+30m)
Inflatable rubber type gate for flood diversion portion, and
Girder type steel roller gate for flushing portion.
(Refer to Figs. 4.2.13 to 4.2.15)

A comparative study was made as presented in Table 4.2.1, and Alternative-1 was selected as a suitable location of the new weir from the following reasons.

(a) This alternative is advantageous in reducing the total construction cost for weir structures, steel gates, intake structures and protection works around structures.

(b) Since the weir is placed close to the existing diversion/intake gates, a reliable and precise diversion can be performed.

(c) This alternative shows a high flood control ability due to the bigger river channel width and the current river environment can be improved for the better.

(3) River Channel Dimensions

The gate of weir is placed at the channel section of WF99+18.5 m and data on the channel section are shown in the following table.

Design Flood Discharge	790 m^3/s
Design River Bed - Upstream - Downstream	 EL + 1.500 m EL. -1.184 m
Design High Water Level	EL + 8.000 m
Design Dike Crown	EL + 9.000 m
Low Water Channel (Upstream) - Width of Riverbed - Height - Side Slope Gradient	 35.0 m 5.00 m 1 : 2 (Vertical :Horizontal)
Low Water Channel (Downstream) - Width of Riverbed - Height - Side Slope Gradient	 50.0 m 3.50 m 1 : 2 (Vertical :Horizontal)

(4) River Discharge

The proposed weir is primarily designed to let the design flood (790 m^3/s) pass safely to the downstream channel at the rate of once every 100 years (after Jatibarang Dam is completed). Simultaneously, the weir has to cope with the daily river flows throughout a year. Before the design of weir/gate is done, the river flow is well studied to set the necessary conditions on discharge and water level of the channel as described below.

Flow regime of Garang River has been obtained as shown in Table 3.3.23, which are based on the observed discharge in the past 10 years and the discharge given by the run-off simulation. Moreover, the relation between discharge and frequency of its occurrence is given as follows.

Discharge (m^3/s)	Frequency of Occurrence (times/year)	
	By observed Data	By estimated Data
30	18.9	24.6
40	10.5	14.5
50	5.2	8.8
60	3.4	5.3
70	1.9	3.5
80	1.5	2.0
90	1.4	1.4
100	1.2	1.0

The above flow regime is used in establishing gate operation rule. In addition to the flow regime, the relation between discharge and water level of the channel was estimated at the channel sections of weir and immediate downstream point as shown in Fig. 4.2.16. These H-Q curves are obtained based on critical flow calculation and non-uniform flow calculation, respectively, and used for hydraulic analysis for the weir.

(5) Basic Operation for Gate and Reservoir

Aiming at achieving an easy and effective operation of gate and reservoir, the gate operation rules shall be basically the same as those of the existing fixed weir, namely:

- The channel water level is kept at EL. +5.200 m (hereinafter referred to as normal water level), which is equivalent to the crest elevation of existing fixed weir, by closing operation of both flood discharge gates and sediment flush gates.
- If the inflow to the weir increases and the water level reaches a certain elevation over the gate crest, flood discharge gates and flush gates are to be fully open. This level of flood corresponds to big floods with a discharge more than 200 m^3/s. In case that the flood is small or middle scale, a partial gate operation will be performed to control the water level.
- Sediment flush gates are pulled up with a certain opening over the riverbed in order to discharge sediment deposit of the upstream riverbed as required for the maintenance of river channel. This gate operation is made in the wet season when the river flow is affluent.

The detailed gate operation rules are discussed in "CHAPTER 9. Operation and Maintenance".

(6) Intake from the River Channel

For the design of the intake structures located at both sides of weir, the following design discharges are to be considered. These are determined based on the current gate operation and diversion practice taken by the flood control sector of Provincial Government of Central Java.

Right bank Intake Structure (for Semarang River)	0.50 m^3/s in dry season (for future plan 1.00 m^3/s) 0.70 m^3/s in rainy season
Left bank Intake Structure (for downstream drainage channel)	0.15 m^3/s

(7) Foundation Work for Weir

The pier footing is placed on the alluvium layer of sandy soil which contains a lot of gravel. The layer has medium hardness with the N-value of 20 to 50, and the thickness varies 3.0 to 5 .0 m. This layer is not suitable for a bearing layer of structure because both thickness and N-value of layer are variable, and not stable. There exists a 8 m to 10 m thick soft layer of sandy silt beneath the said hard sandy layer. Further, a diluvial cemented sand layer with the N-value of more than 50 spreads under the soft layer.

Judging from the above ground and soil conditions, the diluvial cemented sand layer is selected as the bearing layer to ensure the structural stability of the weir. This layer is situated at the position about 12 m below the pier footing, so the pile foundation is employed. Concrete sheet piles are also provided for the purpose of seepage control.

Study on Basic Matters

The basic matters that have to be considered in designing the weir are discussed hereinafter.

(1) Height of Gate

The proposed flood diversion gates are designed as an overflow type gate. When the gates are totally closed, the top elevation of gates is set at the same height of the crown elevation of existing fixed weir, so that the normal water level of reservoir (EL.+5.20 m) can be maintained.

On the other hand, the sediment flush gates are designed considering only underflow. Flow over the gate is not allowed to avoid clogging with floating trees or other flowing objects during flooding event. The top elevation of flush gates, when fully closed, is set 0.65 m higher than the normal water level of EL. +5.200 m.

(2) Elevation of Weir Floor and Transition of Upstream and Downstream Channels

The design riverbed elevation at the weir has been set at EL.+1.500 m, which was given as the proper riverbed elevation through the study on river channel profile of Garang River. The floor elevation of weir, therefore, conforms to the design riverbed elevation of EL.+1.500 m. It is noted that a part of the existing riverbed of the immediate upstream channel is heavily lowered due to the serious scouring phenomenon. If the riverbed elevation of the area is lower than the design riverbed, then filling works in the lower portion of riverbed will be carried out up to the elevation of design riverbed.

There is a elevation difference of 2.684 m between the floor level of weir and the downstream riverbed. This elevation difference may induce scouring on the downstream riverbed resulting in riverbed degradation. To prevent/reduce this adverse effect, both riverbeds are connected with the long transition section in the form of steps.

(3) River Width and Span of Gate

(a) Cross Section of River Weir

Dimensions of the proposed river channels in upstream and downstream of Simongan Weir are shown in the table below together with the width of existing weir.

Item	Downstream Channel	Upstream Channel	Existing Weir
Width of Existing Weir - Flood Diversion Section - Sediment Flushing Section	 - -	 - -	 64.6 m 5.9 m x 2
Width of Riverbed (Design River Channel)	50.0 m	35.0 m	-
Width of Low Water Channel (Design River Channel)	64.0 m	55.0 m	-
Distance between Right and Left River Banks	100 m	83 m	about 97 m
Flow Area Under Design Flood	360 m^2 or more	324 m^2	about 181 m^2

In designing the cross sectional form of weir, the width of flood diversion section should be bigger than that of low water channel in the immediate upstream stretch (w=55.0 m). Further, the flow area of the flood diversion section is to be bigger than that of the upstream channel (A=324 m^2).

(b) Span Length of Weir Piers in Flood Discharge Section

The weir piers are built across the river channel, becoming an obstruction to the smooth flood flow. In view of river hydraulics, the larger the span length is, less influence the weir has on the flood flow. On top of that, construction cost, technical aspects of gate manufacturing and maintenance should be taken into consideration for deciding the span length of weir piers.

From the viewpoint of effective flood control, the following span length of weir piers are recommended depending on the design discharge of river channel.

Class	1	2	3	4
Design Discharge (m^3/s)	Less than 500	500 to 2,000	2,000 to 4,000	More than 4,000
Span Length (m)	15	20	30	40

Source : Technical Standard for River and Sabo, Ministry of Construction Japan.

Applying the above criteria to the reconstruction of Simongan Weir (Q=790 m^3/s), the span length of 20 m is given as a proper span length of the weir pier.

Referring to the span length obtained above, four (4) alternatives (refer to Fig. 4.2.17) in terms of the span of weir pier are set as follows;

	Span Length (m)	Number of Gate
Alternative (I)	28.0	2
Alternative (II)	18.5	3
Alternative (III)	14.0	4
Alternative (IV)	11.0	5

Comparative study regarding flood control ability, operation and maintenance and construction cost was done as presented in Table 4.2.2. As a result, the Alternative (II) (a span length of 18.5 m) has been justified as a sound span length for Simongan Weir.

(c) Width of Sediment Flush Gate

The sediment flush gate is installed at both right and left sides of weir. The width of sediment flush gate is determined to be 5.0 m based on the following considerations.

(i) The existing gate structure is composed of two wooden slide gates and the total gate width is 5.0 m. The proposed gate width should be 5.0 m or more than this width to have enough space for sedimentation discharge.

(ii) The width of gate should be wide enough to enable floating trees to pass smoothly without being trapped.

(iii) The flow velocity under the gate should be high enough to flush sediment such as soil, sand and gravel to the downstream.

(4) Type of Gate

The following four (4) gate type were compared in F/S from technical and economical aspects, and roller gate has been selected as the best alternative.

(a) Steel roller gate	(Alternative-1)
(b) Inflatable rubber gate	(Alternative-2)
(c) Steel radial gate	(Alternative-3)
(d) Steel tilting gate	(Not adopted for Alternative *1)

*1 :In general, this type of gate is employed only for the gate of which height is less than 3.0 m from the reliability of gate and flood control ability. The gate height of proposed Simongan Weir is 3.7 m. Therefore, this type will not be adopted for alternatives.

Based on the newly obtained river survey results and geotechnical data, and the detailed channel data, comparative study on gate type said above was carried out.

For each alternative plan the preliminary design was made as shown in Figs. 4.2.18 to 4.2.20. To select the suitable type of gate, a comparative study focusing on operation, maintenance and construction cost was made (refer to Table 4.2.3) and the Alternative –1 (steel roller gate) has been selected for the following reasons.

(a) Safe and precise gate operation (opening and closing) can be performed and high flood control ability can be maintained for a long period of time compared with the other alternatives.

(b) Gate operation will not be affected by riverbed sediment or stones transported from the upstream.

(c) The steel gates can withstand any vandalism that might happen in the congested urban area, and has a long durability. In regard to the gate type, rubber type gate should not be employed because the safety against heavy vandalism is not ensured in a urban area.

(d) Repair/replacement and maintenance of the gates can be made easily by using temporary lifting gate without providing cofferdams around the gates.

(5) Underside Elevation of Gates When Fully Opened

When the gates are lifted up to the highest level, the underside elevation of the gates must be set at the level higher than the top of dike crown, so that the design flood discharge can pass safely under the gates without causing obstruct to the flood flow.

The design dike crown elevation is EL.+9.00 m at the point of weir, so the same elevation is applied to the underside elevation of gates at full opening.

(6) Location of Intake Structures and Conditions of Intake Structures and Channel

The proposed intake structures are placed at the same location of existing ones, because there are no other proper locations which provide suitable area and ensure smooth intake for Semarang River and left irrigation channel. During the construction, the current intakes have to be maintained by using other means of measures.

Existing Facilities	Dimensions of Intake Structure and Downstream Channel	
	Right Bank	Left Bank
Size of Existing Gate	1.30 m x 1.80 m x 7 gates	1.50 m x 2.20 m x 2 gates
Floor Elevation of Box Culvert	EL. 3.80 m	EL. 3.50 m
Riverbed Elevation	EL. 3.80 m	EL. 4.40 m

(7) Discharge Rating for Gate

In developing the gate operation rule for the flood discharge gate and sediment flush gate, discharge versus overflow and discharge versus gate opening were calculated based on the calculation formulas presented in "Hydraulic Design Criteria". The results are shown in Fig. 4.2.21. In this figure, discharges are obtained using the total width of gates.

(8) Discussion on Fishway

Considerations were made as to whether fish ladders should be provided at the weir or not. According to the biological study carried out by the Study Team so far, fish species found in the upstream and downstream of Simongan Weir are obviously different. The number of species is limited to five (5) or six (6), and rare species are not observed in West Floodway/Garang River. Neither migratory fishes nor benthos are found except a few fishes that move toward upstream during flooding event. Assuming that fish ladders are provided, it is considered that there is no change in ecology such as kinds of fish and benthos, habitats of fish, spawning pattern of fish and so on.

Under such river ecology in West Floodway/Garang River, the necessity of fish ladder can not be seen. Therefore, fish ladder will not be provided for the reconstruction of Simongan Weir.

Preliminary Design of the Weir

(1) Structural Component

To fulfill the requirements of weir mentioned before, the existing Simongan Weir is reconstructed as the gated weir with the structural components mentioned below.

① Flood discharge portion,

② Sediment flush portion,

③ Intake structures for Semarang River and left bank irrigation channel,

④ Retaining walls and protection works for riverbed and riverbank,

⑤ Maintenance and approach bridges, and

⑥ Operation/Management Compound.

Each component comprises the following structures/facilities.

Component	Structures
Flood discharge portion	Shell type steel roller gates (3 gates) Gate piers, Gate floor slabs, Stilling basin, Control house on the pier., Hoisting systems.
Sediment discharge portion	Girder type steel roller gates (2 gates) Gate piers, Gate floor slabs, Control house on the pier., Hoisting systems.
Intake structure	Steel slide gates (4 gates for right bank, 2 for left bank) Box culvert, Concrete walls and deck, Control house and Hoisting system.
Maintenance bridge	I-shape girder type
Protection works for river bank and riverbed	Concrete apron and foundation piles, Retaining walls, Revetment, Riverbed protection (Concrete block and gabion mattress)
Control/Management compound	Management office building, Electrical building, Warehouse, Guard house, Access road, Parking lot, Flower bed, Tree planting.

(2) Layout Plan of Facilities

Both flood diversion gates and sediment flush gates are placed perpendicular to the flow direction and the center line of gates is located at 12 m downstream point from the uppermost end of existing weir body. The layout plan for the proposed weir is presented in Fig. 4.2.12.

(3) Preliminary Design

Based on the study results mentioned in the previous section, the preliminary design of weir was carried out. The table below shows the dimensions of major structures and materials.

Name of Component	Material	Dimensions
Main Flood Diversion Gate	Steel Roller Gate	
- Width of Gate		18.50 m x 3 gates
- Height of Gate		3.70 m
Flushing Gate	Steel Roller Gate	
- Width of Gate		5.50 m x 2 gates
- Height of Gate		4.35 m
Gate Pier	Reinforced Concrete	
- Height from Riverbed		12.00 m
- Length		17.50 m
- Thickness		2.50 m
- Footing	Reinforced Concrete	8.0 m x 17.5 m x 1.6 m
- Foundation Works	PC Pile	Dia. 500 mm x 12.0 m
Floor Slab and Apron	Reinforced Concrete	
- Length , Width (Slab)		17.5 m x 13.0 m
- Length (Up/Down streams)		15.0 m / 7.50 m
- Foundation Works	PC Pile	Dia. 400 & 350 , L=12.0 m
Intake Gate	Steel Slide Gate	
- Right Bank		2.25 m x 2.0 m x 4 gates
- Left Bank		2.00 m x 2.0 m x 2 gates
Maintenance Bridge		
- Main Bridge	PC Girder Type	21.0 m x 3 span
Riverbed Protection		
- Downstream, Length	Concrete Block and	10.0 m x 3 + 15.0 m
- Upstream, Length	Gabion Mattress	7.5 m + 10.0 m
Control House		
- Main Office Building		18.0 m x 7.0 m
- Warehouse		12.0 m x 5.0 m
- Mechanical/Electrical		10.0 m x 7.0 m

4.2.6 River Structures

Revetment

(1) General

Revetments are mainly provided for protection of river banks or dikes from erosion and scouring due to water flow and wave wash. The locations of the proposed revetments are as follows:

(a) Along the concave sides of meander bends of channel;

(b) At the downstream and upstream sides of hydraulic structures including bridges;

(c) At the water colliding front of river bank which is prone to erosion by flow water;

(d) At the river mouth where flushing flood flow arises; and

(e) At confluence of tributaries and main river channel..

Revetments are provided on the river bank slopes or dike slopes below the design high water level.

To protect the toe of side slope from scouring and lowering of the channel bed, foot protection is provided. The elevation of the top of foot protection is placed at the design riverbed height. In case the existing channel bed is lower than the design bed, the position of footing is placed at the existing channel bed. The width of the foot protection is to be more than 3.0 m.

(2) Type of Revetment

In general, the following types of revetment are applicable for the protection of river banks and dike slopes.

Type of Revetment	Standard Slope	Application
(1) Wet Stone Masonry (Gravity type)	Vertical to 1:0.5	River bank, Dike slope Height of 3 m to 7 m
(2) Wet Stone Pitching with Concrete Frame	1:1.0 or gentler	Height of 3 m to 5 m
(3) Wet Stone Pitching	1:1.0 or gentler	Ditto
(4) Dry Stone Pitching (Riprap)	1:2.0 or gentler	Height of up to 3 m
(5) Precast Concrete Block	1:1.0 or gentler	Height of 3 m to 5 m
(6) Sheet-pile Wall	Vertical	Water front structures Height : 3 m to 4 m
(7) Sheet-pile Wall with Anchorage	Vertical	Water front structures Height: 4 m to 8 m
(8) Gabion Mattress/Cylinder	1:1.0 or gentler	Transition of channel

Of these revetment types, the wet stone masonry type and wet stone pitching type are considered suitable for West Floodway/Garang River from the aspects such as availability of material, reasonable construction cost and preferable scenic view in urban area. In principle, these two types are mainly used in this project. In addition, the sheet-pile wall type and gabion type are also employed depending on the site conditions.

Based on the river characteristics, channel cross section and soil mechanical conditions of sub soil layer, features of revetments are determined as shown in Fig. 4.2.22.

Ground Sill

(1) Location and River Channel Dimensions

The following two (2) ground sills are proposed in the river improvement plan.

(a) Ground sill with Head (Hydraulic Drop) (WF124)

Being located at 1,055 m upstream portion from Simongan Weir, this ground sill is placed at the point in which the riverbed elevation changes in the form of step. The requirements that the ground sill must meet are i) to prevent riverbed degradation ii) to stabilize the upstream and downstream riverbeds and, iii) to maintain longitudinal and cross sectional forms of river channel.

The dimensions of river channel at the ground sill is as follows:

Location	1,055 m upstream from Simongan Weir
Riverbed Width	35 m for downstream, 40 m for upstream
Drop Height	1.50 m
Elevation of Riverbed	EL.2.343 m / EL.3.843 m
Height of Low Water Channel (Riverbed to flood plain)	3.5 m for downstream, 5.0 m for upstream
Maximum Water Depth	6.5 m / 5.9 m

(b) Ground Sill (WF173)

It is anticipated that riverbed degradation of Garang River channel downstream from the confluence with Kreo River arises after the completion of Jatibarang Dam. Accordingly, the existing structures constructed in the channel may be affected. For this reason, a ground sill aiming at protecting the pier foundation of Toll Road Bridge from riverbed/river bank encroachment is proposed at the immediate downstream portion from the bridge. The following are the dimensions of river channel at the structure site.

Location	1,100 m upstream from Simongan Weir
Riverbed Width	45.0 m
Drop Height	None
Elevation of Riverbed	EL. 5.793 m
Height of Low Water Channel	3.5 m
Maximum Water Depth	5.9 m

(2) Structural Type

The ground sill (WF124) is of concrete gravity type connected with an apron to safeguard its own body from hydraulic force during floods. The concrete body is constructed on the hard clayey layer without using foundation piles. Flexible gabion mattresses are placed on upstream and downstream riverbeds of the ground sill with an appropriate length to protect riverbed. Fig. 4.2.23 shows the general feature of the ground sill (WF124).

On the other hand, the ground sill (WF173) consists of main sill body made of wet masonry and mounded gabion mattress placed on the upstream and downstream riverbeds. This type of ground sill is flexible to conform the riverbed variations. The general feature of structure is presented in Fig. 4.2.24.

Groin

Groins are provided at the concave side of large bending portions and at the water colliding fronts of river banks in the midstream reaches of Garang River in order to control river bank erosion by reducing the flow velocity along the river bank and by inducing sediment deposit in and around the groins.

(1) Location

Groins are planed for the following locations.

No.	River Section	Right/Left	Length (m)	Condition of river bank
1	WF115 toWF117	Right Bank	100	Bending portion
2	WF127 toWF129	Left Bank	100	Straight riverbank with cliff
3	WF130 toWF132	Left Bank	100	Bending portion
4	WF144 toWF147	Left Bank	150	Straight riverbank with cliff

(2) Structural Type

Since the proposed groins are placed in the river stretches with a gentle riverbed gradient of 1 : 1,250, permeable groins made of reinforced concrete piles and beams are employed. Reinforced concrete piles are more reliable than timber structures in terms of stability and durability. Fig. 4.2.25 shows a typical features of proposed groins.

The general dimensions of groins are determined based on the empirical formula as follow:

Item	Particular
Height	about 0.3 times of highest water depth
Length	Less than 10 % of low water channel width
Angle to downstream bank	Right angle to river bank
Spacing	Two (2) to four (4) times of length of groin

Groin root should be embedded in the bank to resist the lateral force on the groin and to prevent flow outflanking the groin. Further, the area around groin root will be well protected against local scouring of flow.

Protection for Bridge Abutment and Pier

The abutments and piers of the existing bridges may be affected to some extend by river improvement works such as deepening and widening of river channel. The channel cross sections at the existing bridges are designed to maintain structural stability of bridge sub-structures. However, further erosion or scouring around abutments and piers are an avoidable phenomenon, then the protection works for abutment and piers are provided.

The wet masonry type revetment is used as the erosion protection around the abutments. While, mounded gabions shown in Fig. 4.2.26 is adopted for preventing local scouring of riverbed around the piers. The protection will be made with an adequate area.

Drainage Outlet

(1) Flap Gate

According to the inventory survey of the existing drainage outlet, 47 drainage ditches/culverts/pipes with a channel width of 0.4 m or more have been confirmed. Some of the drainage outlets are equipped with wooden or steel flap gates, but many others are without gates. Comparing the top elevation of the drainage channels/ditches and the D.H.W.L, the impact of the back water from the main river on the existing drainage channels/ditches is assessed and the necessity of gate is judged as presented in Table. 4.2.4.

Although wooden or steel plate flap gates are widely used in West Floodway/Garang River, almost all gates are in trouble with corrosion, sedimentation at outlet portion and structural overage. In due consideration of the existing conditions, suitable gate type is decided together with the modification of existing outlet structure.

Steel flap gates are basically employed for the whole drainage outlets, because of its easy operation without operator and reasonable cost. Features of typical drainage outlet is shown in Fig. 4.2.27.

(2) Sluice Gate

There exists four (4) drainage culverts on the right bank of Garang river stretch between WF.172 and WF.173. They are placed close to each other within a 60 m distance. Wooden gates are provided at the outlet portions. These drainage structures are not well functioning because of structural overage and clogged culvert. Moreover, erosion around the outlets is also a serious problem in the event of flooding.

Taking these problems into account, the above four (4) drainage culverts are integrated into one drainage structure and reconstructed as a concrete sluiceway with steel gate. the structural features are as follows:

Item	Particular
Location	Garang River WF.172+6 m Right bank
Type of Gate	Steel Slide Gate
Size	1.6 m x 1.6 m x 1 box
Lifting System	Spindle Type, Manual Operation
Design High Water Level	EL. +11.643 m
Elevation of Floor	EL. +9.700 m
Foundation Structure	Spread Foundation

Waterfront and Environmental Related Facilities

(1) Facilities and Location

As proposed in Channel Utilization Plan, waterfront and environmental related facilities are provided in the following areas :

- Mooring facilities at river banks in downstream of West Floodway (3 places),

- Riverside walkways along the low water channel of West Floodway/Garang River (Total length : 8,460 m for West Floodway, and 6,500 m for Garang River),
- Approach steps on river banks and dike/floodwalls of West Floodway/Garang River (Total number : 40 places for West Floodway, and 37 places for Garang River), and
- Planting and railing alongside the river bank in upstream of West Floodway (Total Length : 2,000 m for West Floodway, 600 m for Garang River).

(2) Riverside Walkway/Inspection Road

Riverside walkway is provided along both banks of the low water channel, which is used for maintenance of the channel and strolling along river. This pedestrian road is paved by gravel with a width of 3.0 m and thickness of 15 cm.

(3) Approach Steps

The river channel is used by inhabitants near the river for various domestic purposes. Therefore, approach steps to the waterfront are provided on the dikes and river banks with the interval of 300 to 400 m. The waterfront steps are made of concrete or wet masonry and riprap is provided at both sides of step. Features of the waterfront steps are presented in Fig. 4.2.28.

(4) Mooring Facilities

The facilities are designed for small size boats and canoes. The size of the facility is 10 m long and 7 m wide, and the height is 3.0 m from design riverbed to the top of deck. The facilities are composed of concrete steps, walls, concrete posts, paved road and revetment as shown in Fig. 4.2.28(2/2).

(5) Planting (Tree and Flower)

Low height trees and flowers are proposed to be planted on the floodplain terrace in the upstream of West Floodway. Tall trees and railing , on the other hand, are proposed on the top portion of river bank.

4.2.7 Raising of the Existing Railway Bridge

General

The railway across the West Floodway is one of the most important railway lines connecting Jakarta and Surabaya, which is operated and maintained by the National Railway Corporation (PERUMKA). See Fig. 4.2.29.

The existing railway bridge across the West Floodway has steel truss structure with three spans, on piers and abutments made of wet stone masonry. Fig. 4.2.30 shows the existing railway bridge.

According to PERUMKA, the substructures were constructed during the period of Dutch Colony and no design drawings are available now. The superstructures are maintained and periodically renewed by PERUMKA and their design drawings are available.

According to the survey results of the existing bridge, the elevation of the girder is EL.+3.520 m on the right bank and EL.+3.370 m on the left bank. On the other hand, the design high water level of West Floodway is set at EL.+3.026 m at Railway Bridge. There is only a little clearance of 0.34 m between the design high water level and bridge girder. In the river improvement plan of West Floodway, the river crossing structures are required to have a clearance of 1.0 m over the design high water level. The required bottom elevation of the girder is EL.+4.026 m.

It is, therefore, necessary to raise the railway bridge girder by 0.406 m on the right bank and 0.656 m on the left bank as a part of the West Floodway Improvement Work.

Design Concept

(1) Superstructure

Since the existing superstructure of the railway bridge has enough structure quality for further utilization, it should be used after raising the bridge.

(2) Substructure

(a) Basic Concept

By raising the bridge with the amount of 0.7 m, load acting on the substructure increases. As the substructures were constructed more than 70 years ago and no design drawings nor design calculation are available, it is not possible to confirm the stability of the existing substructure after raising. In addition, digging around the exiting substructure leads the structure to structural instability.

Thus, all substructures, two abutments and two piers, shall be newly designed and reconstructed in this project.

(b) Structure Type

After studying several alternatives of structural design of the substructure, an alternative of concrete pier and abutment constructed on a concrete beam supported by a group of concrete piles driven on upstream and downstream sides of the existing structures was selected as an optimum type. (Case 5 in Table 4.2.5).

For foundation pile PC pile with diameters of 450mm was selected as the most economical and structural reasons.

(3) Approach Tracks

It is necessary to raise the approach tracks on both sides of the bridge in order to attain the smooth transition of slope. According to the discussion with PERUMKA, the design slope and the range of approach tracks were determined as shown in Fig. 4.2.31. The length of the approach track to be raised is about 800 m each on both sides.

(4) Scope of the work

Based on the planed profile of the approach track, the scope of the work is proposed as follows, which were determined among JRATUNSELUNA, PERUMKA and JICA Study Team. (refer to Fig. 4.2.5.)

- Abutment (Cirebon Side)
- Abutment (Semarang Side)
- Pier No.1
- Pier No.2
- Raising of Track (Cirebon Side) 1+627～2+251 (L=894m)

- Raising of Track (Semarang Side) 1+528～0+677 (L=851m)
- Related Structure with Raising of Approach Tracks

Road Crossing 8 places

No.	Name of Road	Location	Width	Raising Height
		(km+m)	(m)	(m)
1	Brontojoyo	00+711	7.22	0.03
2	Noroyono	00+987	5.48	0.21
3	Poncowolo Timur Raya	01+333	3.60	0.45
4	Kokrosono	01+524	5.70	0.70
5	Madukoro	01+633	12.60	0.70
6	Wiroto	01+875	3.60	0.64
7	Sawojajar II	02+094	3.60	0.93
8	Kencono Wungu Raya	02+342	3.60	0.80

Small Bridges 3 places

No.	Structure	Location	Span	Raising Height
		(km+m)	(m)	(m)
1	steel bridge	00+816	1.03	0.16
2	steel bridge	01+177	1.62	0.44
3	steel bridge	02+331	8.00	0.83

General Construction Plan

After the discussion with PERUMKA, the following general construction plan was agreed by PERUMUKA.

(1) Alternatives on Construction Method

Two alternatives were compared, in Case 1, the existing bridge is raised at the same position while in Case 2, an temporary bridge is constructed upstream or downstream of the existing bridge during the construction period and a new bridge is constructed at the exact location of the existing one. (refer to Table. 4.2.6)

After comparison of two alternatives, Case 1 was selected by economical reason and to avoid social impacts of numbers of house evacuation on both sides of the river bank.

(2) Shift of Alignment in Left Bank Direction

There exist municipal roads on both side of the river crossing the railway. The road width of the right bank is 7.0 m and that of the left bank is 12.6 m. For the reconstruction of the abutments, it is necessary to excavate a part of the roads.

Considering the narrow width of the road on the right bank and a number of vehicles passing, it is difficult to construct a new right abutment at the same position of the existing one with the road traffic keep open.

Two alternatives are compared for abutment construction. Alternative A is to construct a new abutment on the same position as the existing one with right bank road traffic closed for several months, while Alternative B is shift the whole abutments and two piers towards west by 5 m and keep the both road traffic keep open during construction.

From the view point of river improvement, 5 m shifting of the bridge causes no problem as the width of the channel is wide enough at the section. Even though the road width on the left bank will be narrower than the present width , it was agreed by the road administrator, the Public Works Department of Semarang City.

Above two alternatives were proposed to both PERUMKA and Semarang City, who is the road administrator, and The alternative B was selected.

4.3 Project Evaluation

General

In general, a project for public works concerning flooding and/or inundation will be evaluated taking engineering and economic aspects into consideration. The engineering aspects are studied on the technical feasibility of the project from the viewpoint of construction, operation and maintenance.

Economic analysis appraises a project under study in terms of a national and/or a regional social economy by comparing and measuring its economic costs and benefits. In other words, economic analysis evaluates a degree of economic impacts on a project under study that would bring about in the national and/or regional social economy.

Methodology

The Project Evaluation this time is a review of the evaluation executed in the Feasibility Study made by JICA Study Team in 1993, so the way of the project evaluation from the viewpoint of economic aspects in this stage of the Project is made by the same manner applied for the evaluation in the Feasibility Study at that time, namely, the mesh method, reviewing the unit damageable value based on a price index for housing for determining of value of general assets in the flood prone area.

Value of assets and/or damageable value of assets depend surely on a current price level because that they are usually re-evaluated for estimation of amount of damages by using the current price level when they are damaged and/or lost caused by flood and/or inundation. For estimation of existing damages and updated damageable value of properties consisting of buildings and indoor movables, an annual average increase ratio of price index of 6.74 % for the period from 1992 to 1997 in Semarang City as shown in Table 4.3.1 is applied to the standard construction prices of building with the same assumptions used in the said Feasibility Study.

Table 4.3.2 shows a result of estimation of a damages increasing rate using 10-year probable flood. As shown in this table, the increasing rate of damages might be 1.495 comparing the damages in 1992 as a base. This rate can be applied for other scale of floods because of no any changes of such assumptions as standard construction price for residence, industrial and commercial buildings, depreciation rate, rate of tax, building density and so forth as mentioned above.

The economic internal rate of return (EIRR) is calculated and used as an index of economic feasibility. This EIRR is defined by the following formula:

$$\sum_{t=1}^{t=T} \frac{C_t}{(1+R)^t} = \sum_{t=1}^{t=T} \frac{B_t}{(1+R)^t}$$

where, T = the last year of the project life,

C_t = an annual economic cost flow of the project under study in year t,

B_t = an annual benefit flow derived from the project in year t, and

R = the Economic Internal Rate of Return (EIRR).

The project life is assumed at 50 years after completion of the said flood control works.

Flood Damages

Table 4.3.3 shows a result of estimation of probable flood damages by flood scale of each return period by using the said damages increasing rate of 1.495 for general assets consisting of buildings and their indoor movables of residence, industrial and business buildings , and for public facilities and business suspension losses. In this case, rates for applying for estimation of damages of public facilities and business suspension losses are 46.8 % and

6.0 % to the said damages of general assets respectively which are the same rates applied in the Feasibility Study.

Total probable flood damages are Rp. 176,669 million for 10-year flood, Rp. 360,264 million for 25-year, Rp. 545,983 million for 50-year flood, and Rp. 805,102 million for 100-year flood.

Annual average flood damages are estimated based on the said flood damages by each flood scale at Rp. 8,833 million for 10-year flood, Rp. 24,941 million for 25-year flood, Rp. 34,004 million for 50-year flood and Rp. 40,759 million for 100-year flood as shown in Table 4.3.4.

Identification of Economic Benefit

River improvement works for West Floodway/Garang River as Flood Control Works this time is designed to relieve such general assets, industrial and business buildings and their indoor movables, and public facilities and business suspension losses from the damages caused by 25-year flood. Therefore, the above mentioned annual average probable damages caused by 25-year flood, namely the amount of Rp. 24,941 million, are only converted into the benefit due to the said river improvement works when there is no any dam construction works.

A dam constructed in the upper streams of the flood prone area has usually a function of flood control, and the Jatibarang Dam located in the upper streams of flood prone area is one of main components of the Project. According to the design criteria, damages caused by 100-year flood can be eliminated in combination of river improvement and the said dam construction works.

Accordingly, the damages caused by 100-year flood, namely Rp. 40,759 million, can be converted into benefit due to completion of both the said two works.

Identification of Economic Cost

Economic cost of a project is identified as opportunity cost of the project. In this case, if goods and services would be invested in the project under study, they could no longer be utilized for other projects. This implies that the benefits of the other projects could have been created would be sacrificed. These sacrificed benefits of the other projects are called opportunity cost of the project. A project cost consists of foreign currency portion and local currency portion.

Firstly, gross construction costs are separately estimated on river improvement works and dam construction works based on unit prices and work volume as mentioned in previous CHAPTER, and these gross construction costs includes construction base cost, engineering service cost for supervision, cost for administration, value added tax, cost for compensation, physical contingency and price contingency. In this case, the total dam construction cost is allocated to river improvement works based principally on water utility with a rate of 35.40 % according to the design criteria of the dam construction works.

(1) Foreign currency portion

Using the said gross construction cost, an economic cost of the Project is estimated. In this study, the construction base cost includes labour cost, cost for materials, and cost for equipment. For the foreign currency portion, these costs for materials and equipment are estimated in either Cost Insurance Freight (CIF) price or Free on Board (FOB) price. These international prices are assumed to reflect economic cost directly.

Value added tax is not included in the foreign currency portion because that the said tax should be paid by local currency based on the taxation regulation in Indonesia.

For economic evaluation of the Project, such transfer cost as contractor's overhead and profit should be deducted, and price contingency should be excluded because that comparison of cost and benefit is made by net present value.

(2) Local currency portion

Because it is presumed that local markets in developing countries are distorted by price controls and other regulations, prices in the domestic markets do not reflect economic scarcity of goods and services. This means that the prices can not be used to identify economic costs of local procurement and have to be converted into economic prices.

In economic analysis of a project, conversion factors are used to convert the costs in domestic markets into economic costs of a project.

Using export and import statistics, a standard conversion factor (SCF) is estimated. The SCF converts the domestic commodity prices into the economic prices that can be assumed to reflect the economic scarcity of the local costs (refer to Table 4.3.5).

However, the SCF is applied to only tradable goods. The economic cost of non-tradable goods and services have to be separately evaluated. Conversion factors of land, skilled and non-skilled labours are respectively estimated.

Economic wage of unskilled laborers to be employed for the construction works is assumed to be 90 % of the actual market wage, taking of the employment opportunity of laborers in the study area into consideration.

Economic cost of land compensation including other compensation cost such as the cost for removal of houses is assumed to be 100 % of the financial cost, taking account of the opportunity cost of land use.

(3) Total Economic Cost

The estimated economic cost is shown in Table 4.3.6, and summarized as follows:

Economic Cost for River Improvement Works

(Rp.10^6)

Year	FC portion	LC portion	Total
2000/01	2,889	3,422	6,311
2001/02	17,134	17,984	35,118
2002/03	14,207	24,576	38,783
2003/04	16,839	12,457	29,296
Total	51,069	58,440	109,508

Economic Cost for Jaibarang Dam Construction Works to be Allocated for Flood Control

(Rp.10^6)

Year	FC portion	LC portion	Total
2000/01	644	702	1,346
2001/02	3,156	4,182	7,339
2002/03	4,395	5,362	9,757
2003/04	10,062	9,039	19,101
2004/05	6,816	4,353	11,169
Total	25,074	23,638	48,712

(4) Cost for Operation/Maintenance and Replacement

Financial costs for operation/maintenance (OM cost) and annualized replacement cost (cost for R) are estimated by work items at Rp.480 million per annum for river improvement works and at Rp.570 million for Jatibarang dam construction works. From these financial costs, an economic cost in total is estimated at Rp.457 million per annum for river improvement works and at Rp.176 million for Jatibarang dam construction works to be allocated for flood control by the same manner for estimation of the said economic construction cost. These costs for OM and R will be a burden to the Project until the end of the project life of 50 years after completion of the river improvement works. Detail of calculation process is also shown in Table 4.3.6.

Economic Evaluation of Flood Control Works

The evaluation of the flood control works as a component of the Project is made by using cash flows of the said costs and benefits as shown in Table 4.3.7. The results are also shown in the table and summarized below.

EIRR (%)	19.77%
B/C	1.78
NPV (Rp.10^6)	72,201

In this case, B/C rate is a comparison result of benefit and cost in present value of them, and NPV means net cash balance between benefits and costs also expressed by their present value. For calculation of present value, a discount rate of 12 % is applied as same as that in similar projects in Indonesia.

From the viewpoint of EIRR, the rate is increased from 16.2 % in the Feasibility Study stage to 19.8 % as indicated above, while the rate of B/C has decreased from 1.90 to 1.78. On the other hand, the amount of net cash balance has also increased from Rp.51,626 million in the Feasibility Study stage to Rp.72,201 million as shown in the above table. The annual average benefit has increased from Rp.27,264 million in the Feasibility Study stage to Rp.40,759 million as shown in Table 2.8.7 in combined case of the river improvement works and the dam construction works.

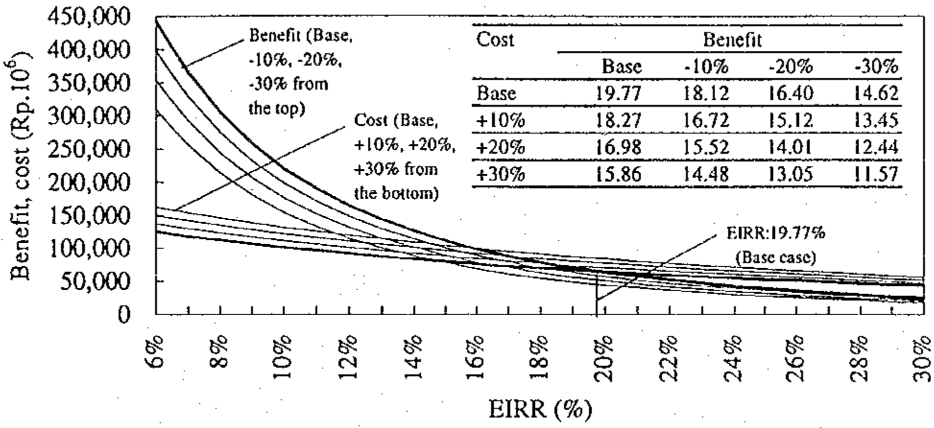
Sensitivity Analysis for Flood Control Works

The economic internal rate of return changes its value depending on the parameters employed for the calculation. Out of these parameters, the construction cost of the Project and its benefit are the most important determinants of the economic analysis.

Therefore, a sensitivity analysis is made for 16 combined cases including base case under the benefit of -10 %, -20 % and -30 %, and the cost of +10, +20 % and +30 % taking into account of fluctuation of the benefit and the cost to be likely to come at present economic situation in Indonesia.

A figure and a table hereunder show the results of sensitivity analysis for economic features.

Sensitivity of EIRR



Cost	Benefit			
	Base	-10%	-20%	-30%
Base	19.77	18.12	16.40	14.62
+10%	18.27	16.72	15.12	13.45
+20%	16.98	15.52	14.01	12.44
+30%	15.86	14.48	13.05	11.57

The EIRR under both the benefit and the cost in base case is calculated as 19.77 % as mentioned above. And, nevertheless under the case of the benefit of 30 % decrease and the cost of 20 % increase , the EIRR is calculated as 12.44 % which is higher rate than the used discount rate of 12 % that is suggested by such international financing institutions as the World Bank. Also in the case under the benefit is decreased by 20 % and the cost is increased by 30 %, the EIRR is still keeping more than 12 % as 13.05 % as indicated in the above table. It means that the said flood control works as a component of the Project is economically sound.

Project Justification for Flood Control Works

The EIRR of Flood Control Works indicates 19.8 %, and in the case of (1) 30 % increase in cost with the 20 % decrease in benefit, and/or (2) 20 % increase in cost with 30 % decrease in benefit, it is still keeping more than and/or the same level of the used discount rate as 12 %.

Accordingly, it may say that the said Flood Control Works as a component of the Project has high economic viability, and the above mentioned results indicates that the Flood Control Works surely keeps its viability even if the cost would be increased by 30 % or the benefit would be decreased by 30 %.

TABLES

CHAPTER 4

FORMULATION OF DEFINITIVE PLAN

Table 4.2.1 COMPARISON ON WEIR LOCATION

Item	Alternative-1	Alternative-2
General View	See drawings in Fig. 4.2.12	See drawings in Figs.4.2.13 to 4.2.15
Diversion to Semarang River & Left bank Irrigation Channel	- Diversion can be made at the same position as the existing one.	The intake points would be located about 550 m upstream from the existing Semarang River and irrigation channel, so the flushing water have to be conveyed by connecting channels provided along the both river banks.
Flood Control, River Hydraulics and River Environment	- Flood control ability will be highly improved. - Riverbed fluctuation will be eased. - Same condition as the existing one.	- The riverbed degradation caused by scouring is anticipated in the downstream river channel from the weir, so the protection measures will be provided to maintain the design riverbed profile. - The river environment along the downstream channel from the proposed weir will be worsen because the channel will be dried during the dry season.
Required Structures	- Gated weir consisting of flood diversion gates and flushing gates. - Intake structures at both right and left river banks.	- Gated weir consisting of flood diversion gates and flushing gates. - Intake structures at both right and left river banks. - Connecting channels from the weir reservoir to Semarang River and the irrigation channel. - Countermeasure for riverbed degradation in the downstream channel. - Cutting existing weir and Reinforcement of existing structures.
Operation & Maintenance	- It is considerably easy to control the water level and discharge of the river by gate operation. - Since the intake points are cross to the weir, effective gate operation can be done for intake.	- It is difficult to control the water level and discharge of the river - Replacement will be required every 25 years. This is very costly. - Periodical painting is not necessary for the rubber gate. - Rubber gate is not irresistible against heavy vandalism, therefore, special caution about gate body is necessary.
Construction Cost	- Earth work and temporary works 2,443,000,000 - Weir body & Gate (steel roller gates) 24,043,000,000 - Maintenance and repair cost in the whole working life 4,808,600,000 - Intake structures 1,835,000,000 - Protection works for river bank and riverbed 3,156,000,000 - Maintenance bridge and Control house 2,703,000,000 Total Rp 38,988,600,000	- Earth work and temporary works 2,239,000,000 - Weir body & Gate (Rubber gates and Flushing gates) 18,218,000,000 - Replacement of rubber gates 16,396,200,000 - Intake structures 1,682,000,000 - Protection works for river bank and riverbed 2,787,000,000 - Maintenance bridge and Control house 2,183,000,000 - Connecting channel 4,610,000,000 - Countermeasure for riverbed degradation 3,541,000,000 - Cutting existing weir and Reinforcement 1,825,000,000 Total Rp 53,481,200,000
Evaluation	Adopted	Not adopted

Table 4.2.2 COMPARATIVE STUDY ON SPAN LENGTH OF SIMONGAN WEIR

	Alternative (I)	Alternative (II)	Alternative (III)	Alternative (IV)
Front View	Refer to Fig. 2.1.24	Refer to Fig. 2.1.24	Refer to Fig. 2.1.24	Refer to Fig. 2.1.24
- Distance between right and left banks(1) - Total width of piers(2) - (2) / (1)	76.0 m 3.0 m X 3 = 9.0 m 12%	76.7 m 2.5 m X 4 = 10.0 m 13%	78.0 m 2.2 m X 5 = 11.0 m 14%	78.0 m 2.0 m x 6 = 12.0 m 15%
- Number of Gate (Main Flood Gates) - Span Length x Height - Recommendable Length in Design Criteria	2 L=28.0 m x H=3.7 m L=20.0 m (500<Q<2,000 m^3/s)	3 L=18.5 m x H=3.7 m L=20.0 m (500<Q<2,000 m^3/s)	4 L=14.0 m x H=3.7 m L=20.0 m (500<Q<2,000 m^3/s)	5 L=11.0 m x H=3.7 m L=20.0 m (500<Q<2,000 m^3/s)
- Production of Gate in Indonesia - Actual Cases Applied to Projects	Difficult No cases in Indonesia	Possible Several cases 20.0m x 3.9m (Komering Irrigation P) 18.0m x 2.4 m (Kota Panjang Hydro P) 18.0m x 7.5m (Dumpil Diversion Dam	Possible Many cases	Possible Quite a lot of cases
Initial Cost (Mechanical and Electrical works) - Gate & Hoisting System	¥425,920,000 (US$ 3,160,000)	¥417,120,000 (US$ 3,090,000)	¥436,480,000 (US$ 3,240,000)	¥457,600,000 (US$ 3,390,000)
Flood Control Ability	Very high The center pier will not affect flood flow.	Fairly high The center piers will not affect flood flow.	Low The center piers may be obstructive to the smooth flood flow.	Very low The center piers could be obstructive to the smooth flood flow.
Operation and Maintenance of Gate	O & M works may be a little troublesome, because the gate length is far bigger than those of other cases.	O & M works could be easier.	O & M works may be a little troublesome.	O & M works will be troublesome because of too many gates.
Evaluation	Not adopted	Adopted	Not adopted	Not adopted

Table 4.2.3 COMPARISON OF GATE TYPE

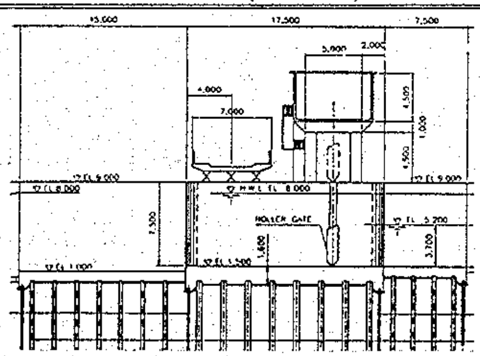
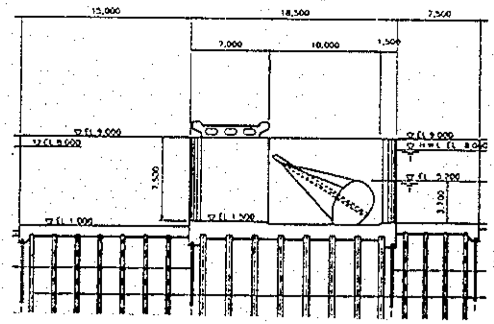
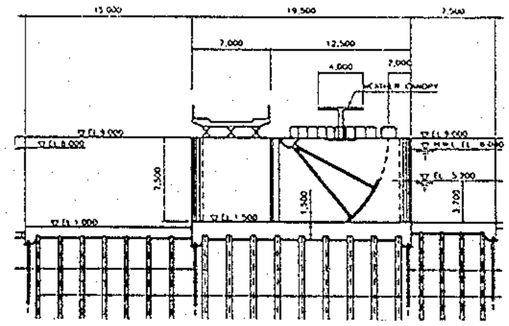
Item	Steel Roller Gate (Alternative-1)	Rubber Gate (Alternative-2)	Steel Radial Gate (Alternative-3)
General View			
Mechanical/Structural Characteristics	- Gate body is lifted vertically by hoisting devices. - Gate is lifted higher than the dike height. - Both superstructure and substructure will be rather big in structural scale.	- Gate body is inflated by air or water. - Gate body is made of strong synthetic rubber coated with ceramic, which has 20 to25 years durability. - Mechanical system is simple. - Substructure will be small in structural scale.	- Gate body lifted by hoisting devices and turn round trunnion axis. Mechanical system is rather complicated. - Both superstructure and substructure will be rather big in structural scale.
Flood Control Ability	- As the gate body can be lifted up to the safety position during floods, flood control ability is better than others.	- Rubber gates may be affected by sedimentation on immediate upstream riverbed when they are deflated.	- Gate piers may obstruct smooth flood flow, and flood water interferes with trunnion pin.
Gate Operation	- Gate operation is done by the operator from both gate house and control office. - It is easy to control the water level and discharge of the river by gate operation. - Operation facilities are a little complicated in structure.	- Automatic operation for the gate deflation can be performed without any power in flooding time. - It is difficult to control the water level and discharge of the river. - Operating devices are simple and easy to handle.	- Gate operation is done by the operator from both gate house and control office. - It is easy to control the water level and discharge of the river by gate operation. - Operating devices are rather complicated.
Maintenance	- Working life is more than 50 years. - Periodical (every 7 years) painting is necessary. - Inspection of the operating devices is easy but it should be done frequently. - Steel gate can resist any vandalism.	- Replacement will be required every 25 years. - Periodical painting is not necessary for rubber gate. - Rubber gate is not irresistible against heavy vandalism, therefore, special caution about gate body is necessary.	- Working life is more than 50 years. - Periodical (every 7 years) painting is necessary. - Inspection of the operating devices is not easy because of complex system. - Steel gate can resist any vandalism.
Components of Gate Structure	[Gate] Roller gate : L=18.50 m, H=370 m x 3 Roller gate : L= 5.50 m, H=3.70 m x 2 Hoisting device and Operating system. . . .5 sets [Pier, Footing, Apron, etc.] 6 places, Concrete V=5,900 m^3 PC Pile Dia.500, L=2,120 m PC Pile Dia. 400 L=1,440 m, Dia.350 L= 5,280 m	[Gate] Rubber gate : L=29.5 m, H=3.7 m x 2 Roller gate : L= 5.50 m, H=3.70 m x 2 Hoisting device and Operating system. . . .2 sets [Pier, Footing, Apron, etc.] 4 places, Concrete V=6,400 m^3 PC Pile Dia.500, L=1,730 m PC Pile Dia. 400 L=1,160 m, Dia.350 L= 5,600 m	[Gate] Radial gate : L=13.50 m, H=370 m x 4 Radial gate : L= 6.00 m, H=3.70 m x 2 Hoisting device and Operating system. . . .6 sets [Pier, Footing, Apron, etc.] 6 places, Concrete V=5,900 m^3 PC Pile Dia.500, L=2,810 m PC Pile Dia. 400 L=1,160 m, Dia.350 L= 5,500 m
Construction Cost (Main body & Gate)	Rp 17,570 x 10^6 (Initial direct cost only) Rp 18,930 x 10^6 (including gate maintenance cost)	Rp 17,500 x 10^6 (Initial direct cost only) Rp 20,330 x 10^6 (including gate maintenance cost)	Rp 18,800 x 10^6 (Initial direct cost only) Rp 22,040 x 10^6 (including replacement & maintenance costs)
Evaluation	- High flood control ability and reliability of steel gate can be expected for a long time. Cost performance is better than others. **Adequate**	- Advantageous with regard to O & M and initial cost, however problems are left in long term reliability of gate body. **Inadequate**	- This type is more costly than other alternatives and O&M is not easy. **Inadequate**

Table.4.2.4 EXISTING DRAINAGE OUTLET AND INSTALLATION OF FLAP GATE

No	Location	Type of Drainage	Dimension n@ W x H / Dia.	Type of Gate	Channel bed	Top Elevatio	D.H.W.L. (m)	U/S ground elevation (m)	Remarks	Recommendation	Proposed Dimension
Right Bank											
R-1	WF. 5 +5m	Open Channel	W = about 10 m	-	-1.42		0.91		Realigned to river mouth	No work	-
R-2	WF. 53 +12m	Box Culvert	2@W1.00 x H1.00	Flap Gate	-0.88	0.12	2.29	+0.30	Tanah Mas R.E. Good	No work	-
R-3	WF. 68 +21m	Trapezoid	2@W(1.4-1.8) x H2.20	Flap Gate	0.01	0.23	3.17	+3.00		To be modified w/new gate	2@ 2 x 2
R-4	WF. 74 +3m	Pipe Culvert	Dia. 1.100	Flap Gate	0.16	1.26	3.42		New Str., Good	No work	-
	WF. 74 +4m	Box Culvert	W 1.20 x H 1.20	Flap Gate	0.27	1.47	3.42		New Str., Good	No work	-
R-5	WF. 98 +7m	Box Culvert	2@ W 2.50 x H 2.90	-	0.24	3.14	4.38	+7.11		No work	-
R-6	WF. 115 +00m	Box Culvert	2@ W 1.40 x H 1.50	Log Gate	5.54	7.04	8.58	+10.00		To be modified w/new gate	2@ 1.5 x 1.5
R-7	WF. 121 +20m	Open Channel	W 1.50 x H 5.40	Slide Gate	5.70	11.10	8.78		Small Garang River	No work	-
R-8	WF. 138 +00m	Box Culvert	W 1.20 x H 1.20	-	7.39	8.59	10.29		Outlet at Kalito River	To be modified w/new gate	1.2 x 1.2
R-9	WF. 157 +00m	Box Culvert	W 1.00 x H 1.20	Flap Gate	9.65	10.85	11.08	+10.60		To be modified w/new gate	1.2 x 1.2
R-10	WF. 160 +21m	Box Culvert	W 1.10 x H 1.20	Flap Gate	9.52	10.72	11.22	+10.80	Under Constr. On Oct`97 (site visit). Good	No work	-
R-11	WF. 162 +41m	Box Culvert	W 1.10 x H 0.60	Flap Gate	9.80	10.40	11.31	+11.40		To be modified w/new gate	1.0 x 1.0
R-12	WF. 165 +9m	Box Culvert	W 1.10 x H 0.90	-	8.52	9.42	11.39	+11.00		To be modified w/new gate	1.0 x 1.0
R-13	WF. 172 +16m	Box Culvert	W 1.10 x H 1.10	Flap Gate	10.87	11.97	11.66	+11.70	Broken	To be modified w/new gate	1.2 x 1.2
R-14	WF. 172 +20m	Box Culvert	W 0.90 x H 0.70	Flap Gate	11.22	11.92	11.66	+12.30	Broken	To be modified w/new gate	1.0 x 1.0
R-15	WF. 172 +58m	Box Culvert	W 0.90 x H 0.80	Flap Gate	11.15	11.95	11.69	+12.30	Broken	To be modified w/new gate	1.0 x 1.0
R-16	WF. 172 +61m	Box Culvert	W 0.90 x H 1.00	Flap Gate	11.21	12.21	11.69	+12.30	Broken	To be modified w/new gate	1.0 x 1.0
R-17	WF. 173 +30m	Open Channel	W 3.0 x H 1.0	-	8.92	9.92	11.72	+12.50	Inside wall +10.42, outside +12.5	No work	
R-18	WF. 176 +27m	Open Channel	W 3.0 x H 1.0	-	7.03	8.03	11.83	+12.60		New concrete outlet	3.0 x 1.0
R-19	WF. 176 +46m	Open Channel	W 3.0 x H 1.0	-	7.75	8.75	11.85	+12.60		New concrete outlet	3.0 x 1.0
Left Bank											
L-1	WF. 0-7 - 41m	Open Channel	W 1.70 x H 1.10	-	-0.45	0.65	0.51	+0.90	Grand Marina	No work	-
L-2	WF. 2 +33m	Box Culvert	W 1.70 x H 1.80	-	-0.95	0.85	0.83	+2.00	Grand Marina	No work	-
L-3	WF. 4 +28m	Pipe Culvert	Dia. 800	-	0.15	0.95	0.89	+2.00	Grand Marina	No work	-
L-4	WF. 8 +17m	Pipe Culvert	Dia. 800	-	0.46	1.26	0.95	+2.00	Grand Marina	No work	-
L-5	WF. 10 +20m	Pipe Culvert	Dia. 800	-	0.32	1.12	1.07	+2.00	Grand Marina	No work	-
L-6	WF. 11 +8m	Pipe Culvert	Dia. 800	-	0.45	1.25	1.09	+2.00	Grand Marina	No work	-
L-7	WF. 14 +10m	Open Channel	W = about 4 m	-	-0.91		1.18	+2.00	Grand Marina	Filling	-
L-8	WF. 15 +20m	Box Culvert	W 1.20 x H 1.50	Stop Log	-0.36	1.14	1.22	+0.60		To be modified w/new gate	1.5 x 1.5
L-9	WF. 22 +37m	Box Culvert	W 1.40 x H 0.80	-	-0.71	0.09	1.42	+0.50		To be modified w/new gate	1.2 x 1.2
L-10	WF. 29 +12m	Pipe Culvert	3@ Dia. 1700	Flap Gate	-1.25	0.45	1.58	-	Kotamadya	To be modified w/new gate	3@ Dia. 1.800
L-11	WF. 36 +20m	Box Culvert	8@ W 1.9 x H 1.8	Flap Gate	-1.47	0.33	1.77	-	Kotamadya	To be modified w/new gate	8@ 2.0 x 2.0
L-12	WF. 74 +9m	Box Culvert	W 1.50 x H 1.50	Slide Gate	0.22	1.72	3.42	-	Slide gate U/S, only 1 Nos W1.0xH0.70, while the other culvert W1.0 H2.0 w/o gate	To be modified w/new gate	1.5 x 1.5
L-13	WF. 96 +37m	Open Channel	W 2.70 x H 2.00	-	5.25	7.25	4.49	-	Good, Higher than DHWL	No work	
L-14	WF. 98 +42m	Open Channel	W 2.70 x H 2.00	-	5.46	7.48	4.50	-	Good, Higher than DHWL	No work	
L-15	WF. 129 +10m	Box Culvert	2@ W 1.0 x H 1.6	-	8.59	10.19	9.92	+10.60		To be modified w/new gate	2@ 1.5 x 1.5
L-16	WF. 134 +00m	Pipe Culvert	2@ Dia. 800	-	6.80	7.8	10.06	+9.00	New Str: too small	Reconstruction w/new gate	2.0 x 2.0
L-17	WF. 150 +10m	Box Culvert	W 1.20 x H 1.00	-	7.94	8.94	10.84	+11.30			
L-18	WF. 152 +16m	Box Culvert	W 1.50 x H 1.00	-	9.03	10.03	10.89	+11.60			
L-19	WF. 154 +00m	Pipe Culvert	Dia. 800	-	9.69	10.49	10.95	+11.70			
L-20	WF. 155 +05m	Pipe Culvert	Dia. 800	-	9.97	10.77	11.00	+11.80			
L-21	WF. 156 +20m	Pipe Culvert	Dia. 800	-	10.03	10.83	11.05	+11.20			
L-22	WF. 158 +1m	Pipe Culvert	Dia. 800	-	9.42	10.22	11.12	+12.00	Panjangan River		
	WF. 158 +3m	Box Culvert	W 1.20 x H 1.60	-	9.70	11.3	11.12	+12.00	Panjangan River	No Work	
L-23	WF. 158 +18m	Box Culvert	W 0.90 x H 2.00	-	10.21	12.21	11.13	+12.00			
L-24	WF. 160 +7m	Pipe Culvert	2@ Dia. 500	-	11.91	12.41	11.21	-	Higher than DHWL		
L-25	WF. 161 +1m	Box Culvert	W 0.80 x H 0.70	-	13.62	14.32	11.27	-	Higher than DHWL		
L-26	WF. 167 +1m	Open Channel	W 1.50 x H 1.70	-	6.69	8.39	11.44	+10.50	Retarding basin		
L-27	WF. 174 +34m	Open Channel	W 3.0 x H 1.90	-	5.72	7.62	11.76	+11.71	-		
L-28	WF. 177 +37m	Box Culvert	W 0.40 x H 0.50	-	12.21	12.71	11.88		Higher than DHWL		

Table 4.2.5 COMPARISON OF STRUCTURE TYPES FOR RAILWAY BRIDGE PIERS

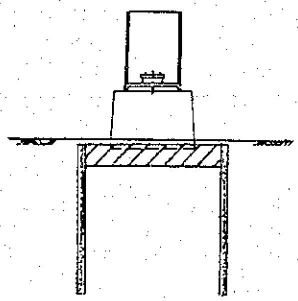
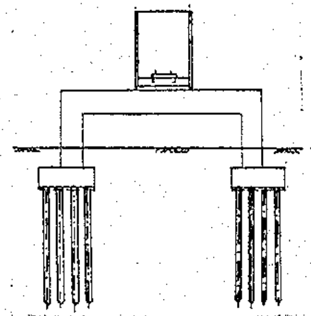
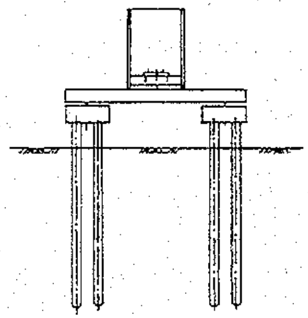
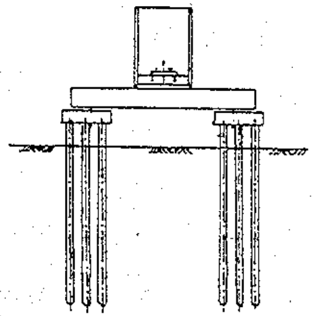
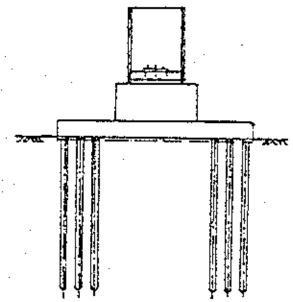
	CASE 1 steel sheet pile foundation	CASE 2 RC rigid frame (PC pile foundation)	CASE 3 pile foundation with steel beam (steel pile foundation)	CASE 4 pile foundation with RC beam (PC pile foundation)	CASE 5 RC long footing (PC pile foundation)
FRONT VIEW					
CONSTRUCTION BASE COST (× 10^9 Rp)	6.1	5.1	4.4	3.8	4.3
COMMENT	- construction work is most complex - maintenance free	- construction work is comparatively complex - maintenance free	- construction work is simple - painting necessary once in 7 to 10 years	- construction work is most simple - deflection is large at the top of pile	- construction work is comparatively complex - maintenance free

Table 4.2.6 COMPARISON OF CONSTRUCTION METHOD IN RAILROAD BRIDGE

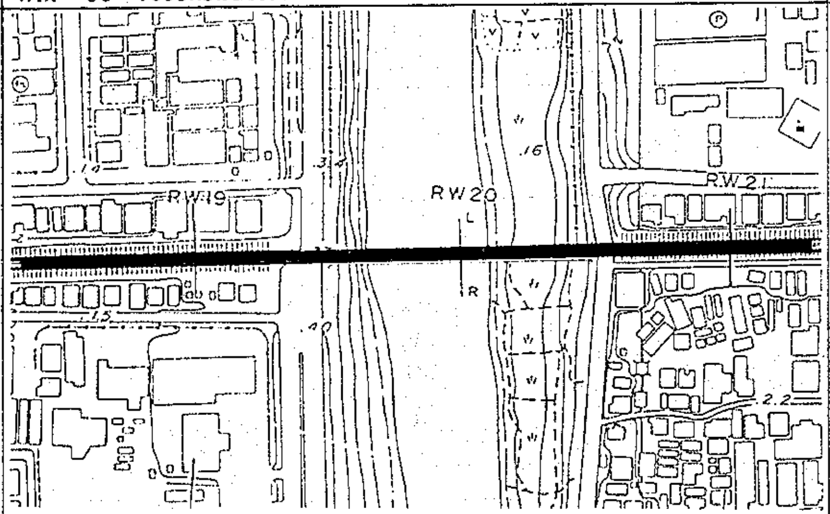
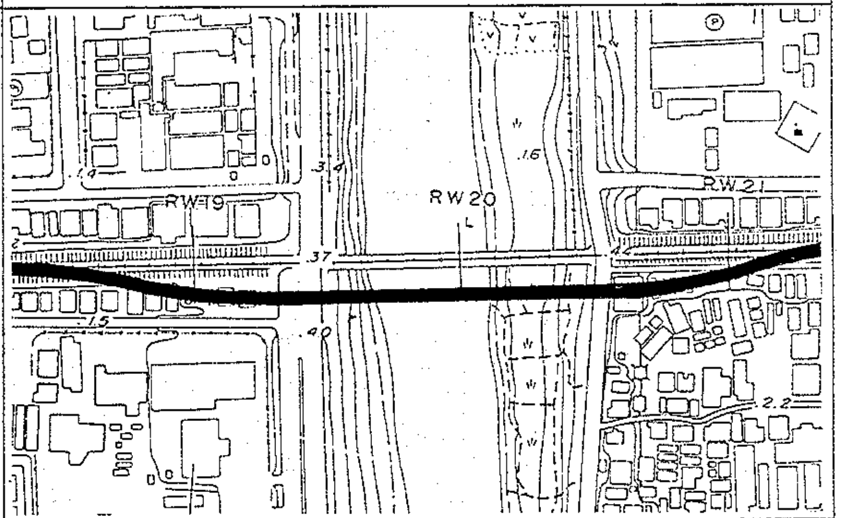
	CASE1	CASE2
	The existing superstructure will be raised by jacks and the existing superstructures are used while the new substructure will be reconstructed	A temporary bridge is constructed beside the existing bridge. A new bridge will be constructed at the existing location.
PLAN		
CONSTRUCTION COST TOTAL	superstructure $117000 substructure $111000 $228000	superstructure $174000 substructure $111000 $285000
CONSTRUCTION PERIOD TOTAL	superstructure 210DAY substructure 200DAY 410DAY	superstructure 250DAY substructure 200DAY 450DAY
COMMENT	· The same alignment will bring about suspension of train operation about 6 hours in one day, several times in construction period.	· relocation of alignment will bring about resettlement of a lot of houses near the railroad.
EVALUATION	ADOPTED	NOT ADOPTED

Table 4.3.1 CONSUMERS'S PRICE INDEX IN INDONESIA AND IN SEMARANG CITY

(Fiscal year 1988/89 = 100)

Group/Sub group	Composite consumer price indexes of 27 municipalities in whole Indonesia at the end of each calendar year				Average annual increasing	Consumer price indexes of Semarang Municipality at the end of each calendar year						Average annual increasing
	1993[1]	1994[2]	1995[2]	1996[2]	ratio(%)*	1992[3]	1993[4]	1994[2]	1995[2]	1996[2]	1997[5]	ratio(%)**
General	145.07	157.42	172.27	185.92	8.62%	134.46	147.52	157.38	171.21	178.82	194.12	7.62%
Food	136.27	151.08	171.06	187.38	11.20%	139.08	147.40	164.52	183.93	188.42	218.58	9.46%
Cereals, cassava and their products	120.56	139.97	167.89	179.67	14.22%	125.73	132.28				214.13	11.24%
Meat and its products	161.56	180.34	205.96	225.92	11.83%	169.60	174.07				250.21	8.09%
Fresh fish	142.35	159.99	173.97	202.09	12.39%	140.74	158.71				280.41	14.78%
Preserved fish	134.12	148.80	162.10	188.63	12.04%	129.14	141.63				177.17	6.53%
Eggs, milk and their products	148.56	154.01	161.12	178.56	6.32%	148.40	151.20				196.16	5.74%
Vegetables	137.20	165.16	179.34	204.91	14.31%	122.26	151.53				302.99	19.90%
Beans and nuts	135.26	147.51	155.27	173.20	8.59%	157.02	177.38				197.76	4.72%
Fruits	146.14	160.47	192.67	211.17	13.05%	154.25	186.26				308.16	14.84%
Spices	141.97	150.05	158.25	191.41	10.47%	125.53	125.22				214.11	11.27%
Fats and oils	126.61	140.41	179.49	187.04	13.89%	116.49	120.72				166.16	7.36%
Soft drinks	144.12	154.64	176.53	182.01	8.09%	150.21	157.55				229.90	8.88%
Prepared food and other food items	131.93	141.17	157.03	167.49	8.28%	140.08	142.68				188.06	6.07%
Housing	154.88	170.09	185.12	194.81	7.95%	133.19	147.91	154.93	162.98	171.04	181.40	6.37%
Costs for housing	165.58	188.30	208.59	220.75	10.06%	131.91	151.03				182.79	6.74%
Fuel, electricity and water	152.80	160.14	169.21	175.01	4.63%	134.17	153.24				174.29	5.37%
Household equipment	131.33	136.41	143.29	148.17	4.10%	122.48	124.49				170.39	6.83%
Household operation	131.04	136.64	145.96	154.86	5.73%	137.52	143.47				190.12	6.69%
Clothing	135.74	144.53	153.81	164.04	6.52%	124.41	133.57	139.99	148.26	152.02	157.13	4.78%
Clothing for men	139.24	147.89	156.05	167.09	6.27%	138.09	145.33				167.72	3.96%
Clothing for women	136.46	143.41	151.51	159.12	5.25%	122.40	131.09				149.19	4.04%
Clothing for children	151.52	163.31	179.21	193.95	8.58%	122.80	134.62				157.63	5.12%
Personal effects	111.61	120.45	126.38	134.52	6.42%	107.59	116.87				152.60	7.24%
Miscellaneous	150.71	158.31	168.40	184.60	6.99%	133.81	152.19	157.45	171.90	183.99	190.20	7.29%
Medical care	137.59	157.28	173.67	191.02	11.56%	127.43	142.64				189.60	8.27%
Personal care and cosmetics	136.60	145.86	156.43	165.43	6.59%	133.96	138.20				164.78	4.23%
Education	144.95	159.65	177.49	196.25	10.63%	125.76	143.74				180.93	7.55%
Recreation and sports	137.27	142.88	158.29	169.72	7.33%	129.96	147.61				185.11	7.33%
Transportation	160.20	162.02	165.66	182.64	4.47%	139.13	163.58				200.18	7.55%
Tobacco and alcoholic drinks	171.74	174.91	184.00	202.70	5.68%	149.78	157.99				203.59	6.33%

Source :
1) Statistical Year Book of Indonesia 1995, Biro Pusat Statistik Indonesia.
2) Statistical Year Book of Indonesia 1996, Biro Pusat Statistic Indonesia.
3) Economic Indicator of Semarang City (Indikator Ekonomi Kotamadya Semarang) 1992, Kantor Statistik Kotamadya Semarang.
4) Economic Indicator (Indikator Ekonomi) November 1993, Kantor Statistik Kotamadya Semarang.
4) Economic Indicator (Indikator Ekonomi) November 1997, Kantor Statistik Kotamadya Semarang.

(Note)
* : Annual average increasing ratio from 1993 to 1996.
**: Annual average increasing ratio from the end of 1992 to November 1997.

Table 4.3.2 ESTIMATION OF DAMAGES INCREASING RATE FOR FLOOD CONTROL WORKS BASED ON 10-YEAR FLOOD

No.	X	Y	Land Use			Inund-ation(m)	Damageable Value ($Rp.10^6$)						Damage Rate						Damaged Value ($Rp.10^6$)						Total
							Buildings			Indoor movables			Buildings			Indoor movables			Buildings			Indoor movables			
			RS	ID	BZ		RS	ID	BZ	RSIm	IDIm	BZIm	RS	ID	BZ	RSIm	IDIm	BZIm	RS	ID	BZ	RSIm	IDIm	BZIm	
28	10	8	0	4	0	0.10	0	10,094	0	0	8,378	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	535	0	0	3,443	0	3,978
36	10	9	0	4	0	0.07	0	10,094	0	0	8,378	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	535	0	0	3,443	0	3,978
45	10	10	0	4	0	0.06	0	10,094	0	0	8,378	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	535	0	0	3,443	0	3,978
54	10	11	0	4	0	0.06	0	10,094	0	0	8,378	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	535	0	0	3,443	0	3,978
61	8	12	0	0	4	0.04	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
62	9	12	0	4	0	0.09	0	10,094	0	0	8,378	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	535	0	0	3,443	0	3,978
63	10	12	0	4	0	0.09	0	10,094	0	0	8,378	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	535	0	0	3,443	0	3,978
68	6	13	0	0	4	0.01	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
69	7	13	0	0	4	0.02	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
70	8	13	0	0	4	0.07	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
71	9	13	0	0	4	0.15	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
76	5	14	0	0	4	0.02	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
77	6	14	0	0	4	0.02	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
78	7	14	0	0	4	0.06	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
79	8	14	0	0	4	0.11	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
80	9	14	0	0	4	0.21	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
81	10	14	0	0	4	0.24	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
87	7	15	0	0	4	0.02	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
88	8	15	0	0	4	0.06	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
89	9	15	0	0	4	0.14	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
90	10	15	0	0	4	0.10	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
96	7	16	0	0	4	0.04	0	0	10,951	0	0	15,058	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	0	0	580	0	0	3,779	4,360
97	8	16	4	0	0	0.07	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
98	9	16	4	0	0	0.04	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
105	7	17	4	0	0	0.07	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
106	8	17	4	0	0	0.01	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
114	7	18	4	0	0	0.05	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
208	4	36	4	0	0	0.03	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
209	5	36	4	0	0	0.12	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
211	2	37	4	0	0	0.04	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
212	3	37	4	0	0	0.03	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
213	4	37	4	0	0	0.04	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
214	5	37	4	0	0	0.04	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
216	2	38	4	0	0	0.06	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
217	3	38	4	0	0	0.03	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
218	4	38	4	0	0	0.02	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
221	2	39	4	0	0	0.24	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
222	3	39	4	0	0	0.06	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
223	4	39	4	0	0	0.01	4,353	0	0	2,612	0	0	0.0530	0.0530	0.0530	0.4070	0.4110	0.2510	231	0	0	1,063	0	0	1,294
Total																			3,922	3,210	9,287	18,070	20,660	60,472	115,619

Remarks

1. Damage Rates by inundation depth

Inundation depth (m)	Damage rates					
	Buildings			Indoor movables		
	RS	ID	BZ	RSIm	IDIm	BZIm
0.00	0	0	0	0	0	0
0.01	0.053	0.053	0.053	0.407	0.411	0.251
0.50	0.072	0.072	0.072	0.600	0.575	0.448
1.00	0.109	0.109	0.109	0.642	0.613	0.543
1.50	0.109	0.109	0.109	0.622	0.626	0.561
2.00	0.152	0.152	0.152	0.683	0.632	0.579
2.50	0.152	0.152	0.152	0.690	0.632	0.597

(Note) Refer to the Feasibility Study Report made by JICA in 1993.

2. Calculation of Damages Increasing Rate:
- Damages as of 1992 for residence, industry and business areas: $Rp.10^9$ 77
- Damages as of 1997 taking price index for housing into account: $Rp.10^9$ 116
- Damages increasing rate: 1.495

(Note) 1. Standard construction price of building (in 1992) / 2. Share rate / 3. Area value ($Rp.10^6$/ha):

1. Standard construction price of building (in 1992)				2. Share rate	3. Area value ($Rp.10^6$/ha)		
Residence					Residence:		1,088
Permanent -	Rp.	300	(thousand/m^2)	0.48	Permanent -	Rp.	664
Semi P. -	Rp.	225	(thousand/m^2)	0.28	Semi P. -	Rp.	293
Temporary -	Rp.	120	(thousand/m^2)	0.24	Temporary -	Rp.	131
Industry	Rp.	548	(thousand/m^2)		Industry:	Rp.	2,523
Comercial	Rp.	594	(thousand/m^2)		Commercial :	Rp.	2,738
Public	Rp.	594	(thousand/m^2)		Public :	Rp.	2,738

Annual increase (%): 6.74%

4. Depreciation: 56%
5. Tax : 10%
6. Building densit 66%
7. Indoor movables to buildings (%):
Residence - 60.0%
Industry - 83.0%
Commercial - 137.5%

8. Abbribiation:
RS : Residence
ID : Industry
BZ : Business (commercial)
RSIm : Residence - indoor movables
IDIm : Industry - inddor movables
BZIm : Business - indoor movables

Table 4.3.3 PROBABLE FLOOD DAMAGES BY FLOOD SCALE

(Rp.10^6)

Flood scale (return perio	5-year	10-year	25-year	50-year	100-year
Building					
Residence*	0	3,922	11,217	17,146	30,413
Industrial*	0	3,210	8,025	14,445	21,824
Business*	0	9,287	15,091	20,894	25,252
Inddor movable					
Residence*	0	18,070	51,527	75,804	132,527
Industrial*	0	20,660	51,652	92,974	141,167
Business*	0	60,472	98,263	136,055	175,716
Sub-total (damages to general assets		115,621	235,775	357,318	526,899
Public facilities**	0	54,111	110,343	167,225	246,589
Business suspension***	0	6,937	14,146	21,439	31,614
Total probable damage	0	176,669	360,264	545,983	805,102

(Note) * : For 10-year flood damages, refer to Table 3.6.1.
For 25-, 50- and 100-year flood damages, estimated based on the flood damages used in the Feasibility Study in 1993 multiplying an damages increase rate of 1.495 calculated in the said table.

**: Estimated by a rate of 46.8 % of damages to public facilities to the total of general assets above as same manner in the said Feasibility Study.

***:Estimated by a rate of 6.0 % of damages to business suspension to the total of general assets.

Table 4.3.4 ANNUAL AVERAGE PROBABLE FLOOD DAMAGES

(Rp.10^6)

Return period	Annual average probability of exceedance	Probability of occurrence	Flood damages by return period	Average amount of assumed damages	Average annual amount of probable damages	Accumu-lated amount of probable damages
5-year	0.2000	0.0000	0	0	0	0
10-year	0.1000	0.1000	176,669	88,334	8,833	8,833
25-year	0.0400	0.0600	360,264	268,467	16,108	24,941
50-year	0.0200	0.0200	545,983	453,123	9,062	34,004
100-year	0.0100	0.0100	805,102	675,542	6,755	40,759

Table 4.3.5 ESTIMATION OF STANDARD CONVERSION FACTOR

(Note)
Equaition for calculation of standard conversion factor (SCF):

$$SCF = \frac{\text{Import amount} + \text{Export amount}}{(\text{Import amount} + \text{Import customs}) + (\text{Export amount} - \text{Export tax} + \text{Excise duties})}$$

(Rp.10^6)

Year	Import amount	Export amount	Import customes	Export taxes	Excise duties
1992/93	36,016	33,967	3,223	9	2,242
1993/94	37,961	36,823	3,555	14	2,626
1994/95	46,129	40,053	3,218	120	3,001
1995/96	55,360	45,418	3,248	201	3,668
Total	175,466	156,261	13,244	344	11,537
				SCF=	0.93139

(Note) Refer to Tables 2.3.5 and 2.3.9.

Table 4.3.6 ANNUAL DISBURSEMENT OF CONSTRUCTION COST AND ESTIMATION OF ITS ECONOMIC COST
(Flood Control Works)

A. River Improvement Works (Rp.10^6)

Cost item	2000/01 FC	2000/01 LC	2000/01 Sub-total	2001/02 FC	2001/02 LC	2001/02 Sub-total	2002/03 FC	2002/03 LC	2002/03 Sub-total	2003/04 FC	2003/04 LC	2003/04 Sub-total	2004/05 FC	2004/05 LC	2004/05 Sub-total	Total FC	Total LC	Total
Construction works	2,582	2,789	5,371	15,738	15,559	31,297	12,893	22,320	35,213	16,112	10,471	26,583	0	0	0	47,325	51,139	98,464
Preparatory works	2,582	2,789	5,371	430	465	895	430	465	895	860	930	1,790	0	0	0	4,302	4,649	8,951
West Floodway improvement	0	0	0	11,009	6,786	17,795	4,626	8,879	13,505	0	0	0	0	0	0	15,635	15,665	31,300
Reconstruction of Simongan	0	0	0	4,299	8,308	12,607	5,418	8,898	14,316	12,450	4,926	17,376	0	0	0	22,167	22,132	44,299
Garang river improvement	0	0	0	0	0	0	2,419	4,078	6,497	2,802	4,615	7,417	0	0	0	5,221	8,693	13,914
Engineering cost for supervision	336	181	517	1,569	845	2,414	1,457	785	2,242	897	483	1,380	0	0	0	4,259	2,294	6,553
Tax	0	589	589	0	3,371	3,371	0	3,746	3,746	0	2,796	2,796	0	0	0	0	10,502	10,502
Compensation cost	0	162	162	0	0	0	0	0	0	0	0	0	0	0	0	0	162	162
Sub total	2,918	3,721	6,639	17,307	19,775	37,082	14,350	26,851	41,201	17,009	13,750	30,759	0	0	0	51,584	64,097	115,681
Administration	0	387	387	0	2,191	2,191	0	2,465	2,465	0	1,861	1,861	0	0	0	0	6,904	6,904
Sub-total	2,918	4,108	7,026	17,307	21,966	39,273	14,350	29,316	43,666	17,009	15,611	32,620	0	0	0	51,584	71,001	122,585
Phisical contingency	292	372	664	1,731	1,978	3,709	1,435	2,685	4,120	1,701	1,375	3,076	0	0	0	5,159	6,410	11,569
Sub-total	3,210	4,480	7,690	19,038	23,944	42,982	15,785	32,001	47,786	18,710	16,986	35,696	0	0	0	56,743	77,411	134,154
Price contingency	298	1,164	1,462	2,389	8,632	11,021	2,514	15,019	17,533	3,631	9,969	13,600	0	0	0	8,832	34,784	43,616
Total	3,508	5,644	9,152	21,427	32,576	54,003	18,299	47,020	65,319	22,341	26,955	49,296	0	0	0	65,575	112,195	177,770
Financial cost (Total-Price conti.)	3,210	4,480	7,690	19,038	23,944	42,982	15,785	32,001	47,786	18,710	16,986	35,696	0	0	0	56,743	77,411	134,154
Economic cost	2,889	3,422	6,311	17,134	17,984	35,118	14,207	24,576	38,783	16,839	12,457	29,296	0	0	0	51,069	58,440	109,508

Remarks:

1. Price share rates of construction:

	2000/01 FC	2000/01 LC	2001/02 FC	2001/02 LC	2002/03 FC	2002/03 LC	2003/04 FC	2003/04 LC
- Labour	0%	15%	0%	15%	0%	14%	0%	16%
- Equipment and Material	100%	85%	100%	85%	100%	86%	100%	84%

2. Tax : 10 % for construction and engineering services.
3. Contractor's overhead & profit: 10%
4. Standard conversion factor: 0.9314 (Refer to Table 2.8.5)
5. Shadow wage rate (economic wage rate): 90%
6. Price : As of October 1997.
7. Conversion rate : US$ 1.00 = Rp.2,971 and Yen100 = Rp.2,437.

8. Operation/maintenance and replacement cost:

Annualized work item	F.C.	L.C.	Total
Power consumption:	0	25	25
Periodical inspection:	0	5	5
Pump replacement cost:	60	15	75
Maintenance for civil:	0	295	295
Administration:	0	80	80
Financial cost	60	420	480
Economic cost	60	397	457

B. Jatibarang Dam Construction Works (Rp.10^6)

Cost item	2000/01 FC	2000/01 LC	2000/01 Sub-total	2001/02 FC	2001/02 LC	2001/02 Sub-total	2002/03 FC	2002/03 LC	2002/03 Sub-total	2003/04 FC	2003/04 LC	2003/04 Sub-total	2004/05 FC	2004/05 LC	2004/05 Sub-total	Total FC	Total LC	Total
Jatibarang Dam Construction Works	1,834	1,625	3,459	8,942	10,684	19,626	12,232	13,381	25,613	28,642	22,800	51,442	19,165	11,143	30,308	70,815	59,633	130,448
35.4% allocated for river improvement	649	575	1,224	3,165	3,782	6,948	4,330	4,737	9,067	10,139	8,071	18,210	6,784	3,945	10,729	25,069	21,110	46,179
Engineering cost for supervision	336	181	517	1,738	936	2,674	2,859	1,539	4,398	2,859	1,539	4,398	1,962	1,056	3,018	9,754	5,251	15,005
Tax	0	398	398	0	2,282	2,282	0	3,379	3,379	0	6,268	6,268	0	4,130	4,130	0	16,457	16,457
Compensation cost	0	1,350	1,350	0	2,700	2,700	0	4,050	4,050	0	5,400	5,400	0	0	0	0	13,500	13,500
Administration	0	337	337	0	1,599	1,599	0	2,341	2,341	0	4,458	4,458	0	2,679	2,679	0	11,414	11,414
Sub-total	336	2,266	2,602	1,738	7,517	9,255	2,859	11,309	14,168	2,859	17,665	20,524	1,962	7,865	9,827	9,754	46,622	56,376
Allocated for river improvement	11	97	108	56	350	406	92	522	614	92	866	958	63	427	490	315	2,262	2,576
Sub-total	660	672	1,332	3,222	4,132	7,353	4,422	5,259	9,681	10,232	8,937	19,169	6,848	4,372	11,219	25,383	23,372	48,755
Phisical contingency	217	355	572	1,111	1,669	2,780	1,794	2,328	4,122	3,688	3,747	7,435	2,822	1,721	4,543	9,632	9,820	19,452
25.7% allocated for river improvement	56	91	147	286	429	715	461	599	1,060	948	963	1,911	726	442	1,168	2,476	2,525	5,001
Sub-total	716	763	1,479	3,507	4,561	8,068	4,884	5,857	10,741	11,180	9,900	21,080	7,573	4,814	12,387	27,860	25,896	53,756
Price contingency	221	1,103	1,324	1,534	7,196	8,730	3,143	13,116	16,259	7,872	26,807	34,679	7,135	15,426	22,561	19,905	63,648	83,553
25.7% allocated for river improvement	57	284	340	394	1,850	2,244	808	3,372	4,180	2,024	6,892	8,916	1,834	3,966	5,800	5,117	16,363	21,481
Total	773	1,047	1,820	3,902	6,411	10,313	5,692	9,229	14,921	13,204	16,792	29,996	9,408	8,780	18,188	32,977	42,260	75,237
Financial cost (Total-Price conti.)	716	763	1,479	3,507	4,561	8,068	4,884	5,857	10,741	11,180	9,900	21,080	7,573	4,814	12,387	27,860	25,896	53,756
Economic cost	644	702	1,346	3,156	4,182	7,339	4,395	5,362	9,757	10,062	9,039	19,101	6,816	4,353	11,169	25,074	23,638	48,712

Remarks:

1. Price share rates of construction:

	2000/01 FC	2000/01 LC	2001/02 FC	2001/02 LC	2002/03 FC	2002/03 LC	2003/04 FC	2003/04 LC	2004/05 FC	2004/05 LC
- Labour	0.0%	13.2%	0.0%	11.2%	0.0%	10.2%	0.0%	13.6%	0.0%	18.8%
- Equipment and Material	100.0%	86.8%	100.0%	88.8%	100.0%	89.8%	100.0%	86.4%	100.0%	81.2%

2. Tax : 10 % for construction and engineering services.
3. Contractor's overhead & profit: 10%
4. Standard conversion factor: 0.9314 (Refer to Table 2.8.5)
5. Shadow wage rate (economic wage rate): 90%
6. Price : As of October 1997.
7. Conversion rate : US$ 1.00 = Rp.2,971 and Yen100 = Rp.2,437.
8. Share rate of cost for engineering services, tax, compensation and administration of dam to total dam construction cost: 27.4%
9. Share rate of cost for engineering services of dam to total dam construction cost: 9.1%
10. Share rate of cost for compensation for dam to total dam construction cost: 9.5%

11. Operation/maintenance and replacement cost:

Annualized work item	F.C.	L.C.	Total
Power consumption:	0	25	25
Periodical inspection:	0	5	5
Replacement cost per yea	70	20	90
Maintenance for civil:	0	270	270
Administration:	0	180	180
Financial cost	70	500	570
Economic cost	70	478	548
Allocated economic cost	25	151	176

Table 4.3.7 CALCULATION OF ECONOMIC INTERNAL RATE OF RETURN
(Flood Control Works)

(Rp.10^6)

Year in order	Year	Flood control works				Cost allocated from dam				Cost grand total	Benefit	Cash balan
		Construction cost		Cost for	Total	Construction cost		Cost for	Total			
		F/C	L/C	O/M & R		F/C	L/C	O/M & R				
1	1998/99	0	0	0	0	0	0	0	0	0	0	0
2	1999/00	0	0	0	0	0	0	0	0	0	0	0
3	2000/01	2,889	3,422	0	6,311	644	702	0	1,346	7,657	0	-7,657
4	2001/02	17,134	17,984	0	35,118	3,156	4,182	0	7,338	42,456	0	-42,456
5	2002/03	14,207	24,576	0	38,783	4,395	5,362	0	9,757	48,540	0	-48,540
6	2003/04	16,839	12,457	0	29,296	10,062	9,039	0	19,101	48,397	0	-48,397
7	2004/05			457	457	6,816	4,353	0	11,169	11,626	24,941	13,315
8	2005/06			457	457	0	0	176	176	633	40,759	40,126
9	2006/07			457	457	0	0	176	176	633	40,759	40,126
10	2007/08			457	457			176	176	633	40,759	40,126
11	2008/09			457	457			176	176	633	40,759	40,126
12	2009/10			457	457			176	176	633	40,759	40,126
13	2010/11			457	457			176	176	633	40,759	40,126
14	2011/12			457	457			176	176	633	40,759	40,126
15	2012/13			457	457			176	176	633	40,759	40,126
16	2013/14			457	457			176	176	633	40,759	40,126
17	2014/15			457	457			176	176	633	40,759	40,126
18	2015/16			457	457			176	176	633	40,759	40,126
19	2016/17			457	457			176	176	633	40,759	40,126
20	2017/18			457	457			176	176	633	40,759	40,126
21	2018/19			457	457			176	176	633	40,759	40,126
22	2019/20			457	457			176	176	633	40,759	40,126
23	2020/21			457	457			176	176	633	40,759	40,126
24	2021/22			457	457			176	176	633	40,759	40,126
25	2022/23			457	457			176	176	633	40,759	40,126
26	2023/24			457	457			176	176	633	40,759	40,126
27	2024/25			457	457			176	176	633	40,759	40,126
28	2025/26			457	457			176	176	633	40,759	40,126
29	2026/27			457	457			176	176	633	40,759	40,126
30	2027/28			457	457			176	176	633	40,759	40,126
31	2028/29			457	457			176	176	633	40,759	40,126
32	2029/30			457	457			176	176	633	40,759	40,126
33	2030/31			457	457			176	176	633	40,759	40,126
34	2031/32			457	457			176	176	633	40,759	40,126
35	2032/33			457	457			176	176	633	40,759	40,126
36	2033/34			457	457			176	176	633	40,759	40,126
37	2034/35			457	457			176	176	633	40,759	40,126
38	2035/36			457	457			176	176	633	40,759	40,126
39	2036/37			457	457			176	176	633	40,759	40,126
40	2037/38			457	457			176	176	633	40,759	40,126
41	2038/39			457	457			176	176	633	40,759	40,126
42	2039/40			457	457			176	176	633	40,759	40,126
43	2040/41			457	457			176	176	633	40,759	40,126
44	2041/42			457	457			176	176	633	40,759	40,126
45	2042/43			457	457			176	176	633	40,759	40,126
46	2043/44			457	457			176	176	633	40,759	40,126
47	2044/45			457	457			176	176	633	40,759	40,126
48	2045/46			457	457			176	176	633	40,759	40,126
49	2046/47			457	457			176	176	633	40,759	40,126
50	2047/48			457	457			176	176	633	40,759	40,126
51	2048/49			457	457			176	176	633	40,759	40,126
52	2049/50			457	457			176	176	633	40,759	40,126
53	2050/51			457	457			176	176	633	40,759	40,126
54	2051/52			457	457			176	176	633	40,759	40,126
55	2053/54			457	457			176	176	633	40,759	40,126
56	2054/55			457	457			176	176	633	40,759	40,126
Total		51,069	58,439	22,850	132,358	25,073	23,638	8,624	57,335	189,693	2,022,132	1,832,439
In the condition of discount rate at 12 %:												
Net Present value (NPV):										92,130	164,331	72,201
Internal rate of return (EIRR):												19.77%
B/C												1.78