3.9 Aqua-culture

3.9.1 Introduction

The study on aqua-culture/fishery has not been included in the original scope of works under this Widas Flood Control and Drainage Project.

The JICA Study Team and GOI agreed in the meeting held on August 6, 1984 that GOI prepares a study report on aqua-culture/fishery and the Study Team reviews it and presents his short comments on it.

In line with the above mutual agreement, the Study Report was prepared by a fishery expert, Dr. Ismudi Muchsin, who was appointed by BRBDEO for the purpose and it was submitted to the Study Team in November 1984.

The Study Report has covered the study of brackish water culture but not fresh water culture since the latter was deemed not so important in the Brantas basin in view of the water resources development programme and water allocation.

The explanation hereunder in sections 3.9.2 to 3.9.4 is a summary of the said study report. The study team's comment is given in the last section of 3.9.5.

The details of this explanation are given in ANNEX-AQ, AQUA-CULTURE STUDY.

3.9.2 Government Policy

Provincial fisheries service of East Java has planned in REPELITA IV, a programme for developing fisheries in the Brantas delta region with emphases on intensification of brackish water culture to increase fishery production aiming at earning foreign trade as well as at domestic supply.

According to REPELITA IV, the Government has projected the increase of the brackish water fishery production from 33,200 tons per annum at the end of REPELITA III (FY 1979-1983) to 52,200 tons per annum at the end of REPELITA IV (FY 1984-1988) which aims at 57% increase during the period.

3.9.3 Present Condition

(1) Brackish water fish pond area and production

Brackish water fish pond area in East Java and Brantas delta region in 1982 was as follows.

Brackish Water Fish Pond Area in 1982 (Unit: ha)

	Gross area	Net cultivated area
East Java	45,900	38,770
Brantas delta region	22,510	19,930
Surabaya	(5,980)	(5,520)
Sidoarjo	(13,150)	(11,150)
Pasuruan	(3,360)	(3,260)

East Java has the brackish water fish pond area of 45,900 ha which shares about 22.5% of the total brackish water fish pond area in Indonesia (about 204,000 ha). The Brantas delta region has 22,510 ha of the brackish water fish ponds which contribute about 49% of that in all East Java. Sidoarjo area occupies 13,150 ha or 58.4% of that in all the Brantas delta region. The brackish water pond area is generally limited within the possible tidal irrigation area and almost all the possible area has been occupied already by fish ponds. Therefore, future expansion of the brackish water fish pond area might be almost impossible.

The total production of the brackish water fisheries in East Java and Brantas delta region is as follows.

Brackish Water Fishery Production

(Unit: tons/yr)

	Year 1980	1981	1982
East Java	22,940	30,780	30,200
Brantas delta Region	12,360	20,060	18,290
Surabaya	(3,280)	(5,150)	(5,700)
Sidoarjo	(7,550)	(8,290)	(9,650)
Pasuruan	(1,530)	(6,620)	(2,940)

As seen above, the Brantas delta region is very important from the viewpoint of brackish water fisheries. In 1982, the Brantas delta contributed about 60.6% of the total production in East Java. Sidoarjo which is the center of the Brantas delta area contributed noticeably about 52.8% of the total production in Brantas delta region.

(2) Present Practice

The fish pond holder in Brantas delta brackish pond was 686, and an average size of pond was 3.6 ha per holder in 1982.

The types of culturing in brackish water pond in Brantas delta region can be roughly classified into three types as follows.

Type of culturing	Kind of fish	Planting time	Harvesting time
Type 1			
1st crop	- Milk fish	Nov. - Dec.	May - June
2nd crop	- Milk fish	June - July	Oct. - Nov.
Type 2			
1st crop	- Mixed milk fish and shrimp	Nov. - Jan.	May - July
2nd crop	- Mixed milk fish and shrimp or Mono milk fish	June - Aug.	Oct. - Dec.
Type 3			
1st crop	- Shrimp	Nov. - Jan.	May - July
2nd crop	- Shrimp	June - July	Oct. - Dec.

The area of brackish water fish pond by type of culture in 1982 was as follows.

Brackish Water Fish Pond Area by Type in 1982

(ha)

	Type 1	Type 2	Type 3	Others	Total
Surabaya	4,688	600	620	76	5,984
Sidoarjo	10,800	1,700	-	653	13,153
Pasuruan	559	2,350	-	453	3,363

Type of fish pond is classified into three in view of the salinity of brackish water.

(a) "Tambak darat" : this type has nearly fresh water pond characteristic in rainy season, when the salinity is about 0 - 5 ppt.
The salinity in dry season is so high as 20 - 40 ppt, sometimes 40 - 60 ppt. This tambak is located the farmost from the sea. Fish farmers cultivates the fresh water fish such as tawes, mujair as well as brackish water fish as milk fish in rainy season, and the brackish water fish as milk fish in dry season.

(b) "Tambak payau" : This type is really brackish water pond. The salinity of pond water is about 5 - 20 ppt in wet season and 20 - 40 ppt in dry season.
The tambak is located in the middle between the first and the third types. Cultivation in this Tambak is milk fish and shrimp.

(c) "Tambak asin" : this type is saline water pond. The salinity of pond water is about 10 - 25 ppt in rainy season and 20 - 40 ppt in dry season. Its location is the nearest to the sea. The fish farmers cultivate both milk fish and shrimp in dry and rainy seasons.

Land and water conditions required for brackish water fishery culture are ;

(a) Land condition : pH 6.5 - 7 and the land not porous

(b) Salinity of brackish water : to be kept between 10 and 25 ppt depending on species

(c) Water temperature : 20°C - 30°C

(d) Dissolved oxygen : more than 3 ppm

Present brackish water fisheries practice has several problems in view of the above requirement since the irrigation system is too primitive to keep the pond in suitable conditions.

3.9.4 Development Plan

The Study Report has proposed a development plan of brackish water fishery for Sidoarjo area of 13,000 ha with the following conditions.

(1) Fresh water requirement

Fresh water requirement is calculated in the following assumptions. (Refer to Section 4.4, APPENDIX of ANNEX-AQ)

(a)	Optimum depth of water	1.0 m
(b)	Optimum salinity	20 ppt
(c)	Salinity of sea water near fish ponds	30 ppt
(d)	Daily change of water	3% of fish pond water volume

Water requirement is calculated dividing into two categories ;

(a) intitial water filling and (b) daily irrigation requirement, as follows.

(a) Initial water filling

1st crop: April to June (3 months)

2nd crop: October to December (3 months)

Water requirement = 3000 m^3/ha

(b) Daily irrigation

Water to be changed: 3% volume (minimum)

Project area : 13,000 ha in Sidoarjo area

Water requirement : 1,170,000 m^3/day on 13.54 m^3/s

(2) Annual Benefit

Based on the fish firm input and output, the annual benefit has been estimated in both cases of with-and without-project as follows. (Refer to Section 2.3 of ANNEX-AQ)

Annual Net Profit per ha

(Rp. 1000)

		Traditional culture		INTAM PROGRAM [1]	
		Mono-culture Milk fish	Mixed-culture Milk fish/shrimp	Mixed-culture Milk fish/Shrimp	Mono-culture Shrimp
I.	Fish Farm Output	1,100.0	2,270.0	5,950.0	11,200.0
II.	Fish Farm Input	595	1,059.2	5,116.0	8,783.4
	Net Profit	504.9	1,210.7	834.0	2,416.5

[1] INTAM : Tambak Intensification, like BIMAS in agriculture

3.9.5 Review of Study Report Prepared by Indonesian Fishery Expert

(1) Fresh water requirement

The Study Report has proposed the fresh water requirement of 13.54 m^3/s for 13,000 ha of brackish water culture in Sidoarjo area. This estimated requirement seems to be too little. The required fresh water is preliminarily reviewed under the following considerations and assumptions which are given from the experimental data.

(a) Two crops, dry season and wet season crops a year are considered.

1st crop (Dry season) : May to November
2nd crop (Wet season) : November to May

(b) First two months in each crop are nursery and planting period. Water requirement is calculated dividing into two stages, initial water filling in fish pond in nursery and planting period and daily irrigation.

(c) Required salinity of brackish water and daily water change are assumed as follows.

	Recommended	(Study Report)
(i) Water depth of fish pond	1.2 m	(1.0 m)
(ii) Optimum salinity of water	20 ppt	(20 ppt)
(iii) Sea water salinity /1	30 ppt	(30 ppt)
(iv) Change of water for daily irrigation	10% of pond water volume a day	(3%)

/1 Sea water salinity is assumed at 30 ppt throughout a year same with that in the Study Report since data on salinity variation by season are not available.

(d) Project area is 11,150 ha in net irrigation area and 13,000 ha in gross area. (Study report proposed 13,000 ha for estimating water requirement)

Fresh water requirement in dry season calculated on the above assumptions is summarized below (Refer to Section 2.1 of ANNEX-AQ)

Dry Season	Fresh Water Requirement (m^3/s)
June	47.3
July	51.6
Aug.	51.6
Sep.	51.6
Oct.	38.7
Nov.	34.4

The above figures are tentative. The precise study is necessary to determine more accurately the water requirement by season based on the seasonal variation of sea water salinity. During rainy season fresh water requirement might be far less than the above values since the salinity of sea water near coastal line would be less in rainy season.

(2) Available Fresh Water

All the fresh water in the K. Brantas during dry season is already allocated to other purposes. There would be no room to allocate newly the fresh water to the fish culture with so much amount of water as more than 50 m^3/s unless otherwise the fresh water is created newly or the fresh water being used for other purposes is transferred for fish culture.

The only possible means to create water for fishery irrigation is to use return flow from Brantas delta irrigation for paddy field.

The irrigation water to the Brantas delta area which was actually diverted from the main Brantas through Porong and Mangetan canals is 24.6 m^3/s which is the monthly minimum irrigation water

on an average from 1980 to 1983. Assuming a rate of return flow at 0.3, the available water at the tail of paddy field irrigation area would be 7.4 m^3/s only.

On the other hand, plenty of water is available during rainy season from December to May next year in excess of requirement for existing water usage.

(3) Proposed Brackish Water Culture

(a) Present culture in Sidoarjo area

Traditional culture for brackish water fisheries in Sidoarjo area is represented as follows.

(i) Fish pond area

Gross area	13,000 ha	
Net area	11,150 ha	
Mono-culture with milk fish	9,750 ha	(87.4%)
Mixed-culture with milk fish and shrimp	1,400 ha	(12.6%)

(ii) Annual benefit from existing brackish water culture (traditional culture)

The benefit from traditional culture is given as follows. (Refer to Section 2.3 of ANNEX-AQ)

Mono-culture (Milk fish)	US$ 5,194 x 10^3/yr	(9,750 ha)
Mixed-culture (Milk fish and shrimp)	US$ 1,802 x 10^3/yr	(1,400 ha)
Total	US$ 6,996 x 10^3/yr	(11,150 ha)

(b) Intensification of brackish water culture

Brackish water culture in Sidoarjo area depends on the availability of fresh water. However, it would be very hard to estimate available water quantity as well as water demand because of shortage of valid data. Therefore, a preliminary study is made to assess if the intensification of brackish water culture is prospective for future development.
The following alternative cases are tentatively considered with assumptions of available water and possibility of improvement in traditional culture (increase of mixed culture area).

Case-1 : Intensive culture for 11,150 ha in both wet and dry seasons (When fresh water required is totally available)

(1-a) : 50% of total area or 5,575 ha for mixed culture with milk fish and shrimp, and the rest 5,575 ha for mono-culture with shrimp

(1-b) : Whole area of 11,150 ha for mono-culture with shrimp

Case-2 : Intensive culture for 11,150 ha in wet season and tradition culture for 11,150 ha in dry season (when the available water in dry season is limited)

(2-a) : Dry season culture - 85% of total area or 9,480 ha for mixed-culture with milk fish and shrimp and the rest 15% or 1,670 ha for mono-culture with milk fish
Wet season culture - 50% of total area or 5,575 ha for mixed-culture with milk fish and shrimp and the rest 5,575 ha for mono-culture with shrimp

(2-b) : Dry season culture - 85% of total area or 9,480 ha for mixed-culture with milk fish and shrimp and the rest 15% or 1,670 ha for mono-culture with milk fish
Wet season culture - Whole area of 11,150 ha for mono-culture with shrimp

Based on the projection of fish farm output and input for INTAM PROGRAM, annual benefit in each alternative case is calculated as follows.

(US$10^3/yr)

	With Project	Without Project	Net Benefit
Case-1			
(1-a)	26,162	6,996	19,166
(1-b)	37,347	6,996	30,351
Case-2			
(2-a)	19,629	6,996	12,633
(2-b)	22,876	6,996	15,880

In implementing the intensive brackish water fishery, rehabilitation and upgrading of the existing irrigation system and fish pond are needed as itemized below.

(i) Fresh water collector canal to be constructed at the upstream end of the fish pond area.
The collector canal functions also as a floodway to drain flood so as not to enter into fish pond.

(ii) Irrigation canals for fresh water supply, and sea water supply

(iii) Water mixing pond to produce suitable brackish water

(iv) Drainage canal

(v) Control gates as required in each canal

(vi) Rehabilitation of existing fish ponds and dikes

(vii) Other miscellaneous works

The construction cost of all the above works is roughly estimated at US$ 64,730 x 10^3 equivalent (Refer to Section 2.3 of ANNEX-AQ)

Economic internal rate of return for the development plan is roughly calculated under the following conditions.

Construction period	5 years
Life time	45 years
Annual O/M cost	2.5% of construction cost
Build-up period	Full benefit upon completion of construction work

Unit: US$1,000

Alternative Cases	Construction Cost	Benefit	EIRR (%)
Case 1-a	64,730	19,166	18.9
1-b	64,730	30,351	30.0
Case 2-a	64,730	12,633	13.2
2-b	64,730	15,880	16.4

Although the above results are just preliminary ones based on several assumptions, the following would be concluded.

(i) The intensification of brackish water culture seems to be economically viable if the fresh water is available sufficiently (Case 1-a/b)

(ii) Even the fresh water is not sufficient in dry season, the intensification seems to be still prospective in economic viewpoint, since the intensive culture in wet season only and improvement of dry season culture could bring about the EIRR of 13.2 to 16.4 (Case 2-a/b)

The above preliminary study implies that intensification of the brackish water culture would be atractive even if fresh water available is so limited that intensive culture can be performed in wet season only.

(4) Conclusion and Recommendation

(a) Fresh water is little available in severe dry season even the return flow from the paddy irrigation is taken into account.

(b) Even if the intensive brackish water culture is adopted for only one crop in a year, the intensification would be still economically viable.

(c) It would be possible to carry out the intensive culture in dry season when the fresh water is plenty in dry season of wet year. The brackish water culture is more attractive when such possibility is taken into consideration.

(d) Intensive culture needs not only the construction of irrigation system and rehabilitation of ponds but also other costly infrastructures such as inland transportation system, storage with freezing facilities, loading and unloading facilities in fish ponds site and markets, etc. The construction cost required therefore is not included in the estimation in this report. More precise study will be needed for the final decision.

(e) It would be very hard because of several restrictions as explained above to implement simultaneously the intensive culture covering all the project area of 11,150 ha. Stagewise development would be recommendable if the intensification is finally proved to be prospective from economical and social viewpoints.

(f) To realize the program of intensive brackish water culture in Siodoarjo area, it is recommended that further detailed study be made of sea water salinity variation throughout a year, water requirement, production rate, etc.

(g) It is recommended to make more detailed study of mechanical aeration system in order to minimize the water requirement.

3.10 Water Allocation

3.10.1 Introduction

The year 1982 was a severe drought year in the recent years. The water supply conditions for irrigation, and domestic and industrial supply was very tight in the year. The Karangkates reservoir continued release of the stored water according to the irrigation water requirement, and the reservoir water level reached EL. 250 m at the end of November, 1982. The Coordination Committee for the water management in the Brantas basin discussed on a emergency water release plan to lower the reservoir water level further to EL. 242 m for securing of the outflow of 24 m^3/sec in December, with complete stoppage of the Karangkates power station. During this critical period, the water in the Surabaya river was very contaminated owing to reduction of the flushing water, and bad smell arising from the contaminated water covered the riparian areas. The water quality at the intake for domestic water exceeded the ability of purification plant, and the domestic water with colour and bad smell was to 70% of the normal level, and cropping over or about 3,000 ha was cancelled.

From the experiences in 1982, the balance of the water demands and the available water in drought years in already becomes tight, even if the existing storage capacities are fully utilized.

As studied in Domestic and Industrial Water section, the present supply level is low, and the potential demands for water are large. In the Irrigation sector, there are still farm lands waiting for irrigation water. Therefore, for the economic development in the basin, much more water will be needed in future. Unless the water resources development in the basin and/or transfer of water from other gasin are not made, severer water shortage in future can be foreseen.

Water allocation study aims to clarify the water balance at present under the present conditions, and the future water balance between future water demands and supply capacities including conceivable water resources development projects. Contents of the study are as follows;

- present and future available water
- present and future water demands
- present and future water balance

Study on the available water is based on the lowflow analysis in Section 3.2 and the dam development study in Section 3.8. Study on the water demands is based on the irrigation study in Section 3.3 and the domestic and industrial water in Section 3.4.

3.10.2 Present and Future Available Water

The available water in the basin consists of the natural flow in the river, ground water, regulated flow by storage facilities and water to be transferred from other basins.

1. Available flow in rivers

In the lowflow analysis, the available run-offs are estimated at Jabon in the main Brantas river and at Perning in the Surabaya river, taking into account the large concentration of the water demands in the downstream area of the basin and based on an assumption that the water use in the tributary areas will not change from the present conditions. The available run-off in the dry season from June to November on dependability basis is estimated as follows;

	Ranking in 20 samples from smallest				
	1st	2nd	3rd	4th	5th
Equivalent year	1977	1982	1967	1965	1972
Volume (MCM)	816.8	833.5	850.0	867.1	911.1

Ref. Table 3.10.1.

Fig. 3.10.1 shows duration curves of the available run-off.

2. Groundwater

According to the East Java Groundwater Irrigation Project and other studies, there are considerable potentials of the groundwater in the basin. A large potential ground water found in the triangular area or by Kediri, Nganjuk, Mojokerto. The potential in terms of yield in this area is estimated at about 30 m^3/sec. However, since the effects of extraction of the ground water to the surface water are not clarified yet with the accuracy on which the water resources development planning is based, it is assumed that the extraction of the groundwater decreases the surface water by the same amount.

For effective use of the groundwater together with the surface water, basin-wide groundwater survey is needed.

3. Regulating facilities

(1) Existing facilities

In the basin, there are three reservoirs having the inter-seasonal flow regulating capacity. The effective storage capasities in 1982 are estimated at 232.5 MCM in the Karangkates, 28.6 MCM in the Lahor, 52.9 MCM in the Selorejo and 33.5 MCM in the Bening. The total existing capacity is 347.5 MCM, the useful capacity to control the run-off in the main

Brantas is 261.1 MCM in the Karangkates and Lahor reservoirs. Due to sedimentation, this total capacity is estimated to decrease to 223.3 MCM in the year 2000.

(2) Facilities under construction

The inter-seasonal flow regulating facility under construction is the Wonorejo dam and reservoir having an effective storage capacity of 106 MCM in the Ngrowo river basin. Half of the capacity is scheduled to be used for irrigation in the Tulungagung area and another half is to be used in the downstream area of the Brantas basin.

(3) Potential facilities

Due to the topographical reason, the potential damsites with large storage capacity are limited. In Dam Study, the following sites are identified;

	Effective storage
Genteng I	70 MCM
Konto II	43.5
Babadan	89.7
Kuncir	47
Semantok	40
Kedungwarak	55.9
B e n g	150

Among the above, the Beng, Konto II and Genteng I dams are considered to be justifiable under the present economic structures.

(4) Reservoir yield

Using the estimated available run-off at Jabon - Perning, and assuming an imaginative reservoir at Jabon - Perning, reservoir yield vs. reservoir capacity is examined as shown on Fig. 3.10.2. From this figure, the reservoir capacity to enable a certain amount water to be used throughout year with the dependability of 100% is as follows;

Reservoir Yield	Required capacity of imaginative reservoir
50 m^3/s	100 MCM
75	440
100	820
125	1,280
150	1,740

4. Transbasin

As possible transbasin from other basins is Umbulan spring, push back from the Ngrowo river basin and the Solo river.

(1) Umbulan Spring

The Umbulan spring locating about 50 km south-east of the Surabaya city and outside of the basin has been studied as a water source for the Surabaya city water supply. According to the plan, constant supply of 2.8 m^3/sec (1st stage; 1.7 m^3/sec and 2nd stage 1.1 m^3/sec) to the Surabaya city is intended.

(2) Push-back from Ngrowo basin

The Ngrowo river basin was originally a part of the Brantas basin, and is now separated from the Brantas basin by the Tulungagung drainage project consisting of Parit Agung and Parit Raya canals and two diversion tunnels leading to the Indonesian Ocean. The Parit Agung canal runs in the lowest part of the basin, and collects return flow from the Lodoyo Tulungagung irrigation project. The rate of the return flow is assumed at 30% of the irrigation intake water. The natural run-off in the Ngrowo basin is estimated at the diversion tunnel site by the Tulungagung Hydro-power project, as shown in Table 3.10.2. Using these data, the available run-off in the Parit Agung canal is estimated as shown below;

Return Flow from Lodoyo-Tulungagung Irrigation Area

(Unit : m^3/s)

	Intake discharge	Return flow
Jun.	10.98	3.29
Jul.	7.93	2.38
Aug.	5.69	1.71
Sep.	6.64	1.99
Oct.	6.73	2.02
Nov.	6.25	1.88

(*) The above intake discharge is the total demand discharge based on the newly proposed cropping patterns.

Return Flow + Natural Flow

(Unit : m^3/s)

Dependability	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
5/20	7.59	4.75	3.35	2.02	1.24	1.10
5/20 (1965)	6.21	4.41	2.98	1.74	1.16	1.74
10/20 (1970)	28.77	7.72	5.21	3.89	2.57	20.00
15/20 (1974)	10.79	7.22	7.93	6.37	58.49	77.62

(3) Solo river

Runoffs in small rivers in the vicinity of Brantas river are already developed or committed for irrigation. The remaining river which has a large potential is Solo river. According to the reports for Surcharge Water Supply, the available water at Bojonegoro for the 1951 - 1972 period is estimated as follows :

Return Period (Years)	2	5	10	20	50
Discharge (m^3/s)	10.28	8.50	7.57	6.83	6.05

Further, it has been reported that the above figures are not representative of future conditions, which will change with increasing development of the river basin, and that on the basis of the historic flows, however, it would appear that about 6.5 m^3/s can be abstracted for water supplies without affecting other users. In this Study, this figure of 6.5 m^3/s is accounted as one of water resources.

5. Total amount of available water

From the above, the total amount of the water available to the Brantas basin in the dry season with the dependability of once in ten years (equivalent to the year 1982) is estimated as follows ;

(Unit : MCM)

Sources	Volume	Accumulative Volume
(1) Available water at Jabon-Perning	833.5	833.5
(2) Karangkates dam	261.1	1,094.6
(3) Return flow	87.2	1,182.3
(4) Wonorejo dam	53.0	1,235.3
(5) Umbulan spring	44.3	1,279.6
(6) Beng dam	150.0	1,429.6
(7) Konto II dam	70.0	1,499.6
(8) Genteng dam	70.0	1,569.6
(9) Bengawan Solo	102.8	1,672.4

3.10.3 Present Water Use and Future Demand

1. Classification of Water Uses

In studying the water balance and allocation in the Brantas river basin, water demands are classified as follows;

(1) Irrigation water

(2) Domestic water

(3) Industrial water

(4) Commercial water

(5) Social water

(6) City water

(7) Fishing water

(8) Hydropower water

Some of the above demand can be divided further into sub-categories according to the status of water allocation to each sub-category.

(1) Irrigation Water Demand

(a) Authorized paddy and polowijo

Required amount of water is allocated by the Irrigation Services according to the cropping plan.

(b) Unauthorized dry season paddy

Unauthorized dry season paddy fields exist outside of the authorized paddy field. Planting of paddy or upland crops is an option of farmers. Farmers select crops according to water availability. Water is not guaranteed by the Irrigation Services.

(c) Future Irrigation water

Future irrigation water is defined as the excess water requirement of new irrigation project beyond the presently allocated amount.

(2) Industrial Water

(a) Licenced industrial water

Industrial water which has a licence to off-take water from Brantas river or its distributaries.

(b) Future industrial water

Water to be used by future industrial establishments. Water allocation for the future industrial water is not made at present.

In hydropower generation in the basin, there is no release specific for hydropower generation, and no net consumption by hydropower generation. Therefore, hydropower water is excluded from the further study.

2. Supply Criteria

Referring to the current practices in Indonesia, the following supply criteria is set for each water demand;

	Dependability
Irrigation water	80 %
Domestic water	90 %
Industrial water	90 %
Commercial water	90 %
Social water	90 %
City water	90 %
Fishery water	80 %

3. Terms and Condition for Water Allocation

To proceed with water allocation study, the following terms and conditions are set forth.

(1) Basic Point

As explained later, the water demands are spreaded widely along Brantas river, and major portion of them concentrates in the area downstream of Jabon gauging station on the Brantas river and Perning gauging station on the Surabaya river. Water taken in the downstreams of Jabon and Perning has no chance to return to the rivers and the excess water flows into the sea. Therefore, for examination of water balance in the entire Brantas river basin, Jabon-Perning site is selected as "Basic Point".

(2) Basic Year

As explained later, the hydrological data in the period from 1964 to 1983 is used for water allocation study, and for examination of water balance with the supply dependability, years representative of specific recurrence are selected as "Basic Year." For example, the basic year 1982 mean the hydrological conditions equivalent to those in 1982.

4. Irrigation Water

(1) Present

Irrigation areas scatter in the whole Brantas river basin and their distribution is as shown on Fig. 3.3.5 The total irrigation area in 1975 was about 312,000 ha and by 1984, it increased to 316,500 ha. In the period from 1975 to 1984, an increase in the irrigation area is seen in the Lodoyo - Tulung-

agung irrigation area. The decrease due to urbanization is found in the Wonokromo section in the Surabaya Delta, as shown in Table 3.10.3.

It is considered that the decrease in the irrigation area around the urban areas will continue. However, it is assumed that the total irrigation area in the basin will be more or less similar to that in 1984.

Of the irrigation systems, the system relying on the mainstream of Brantas river are taken for further study on the water balance. The monthly intake discharge of these system in the 1982 dry season is as shown in Table 4 of Note A1-4

Using the actual cropping data in 1982, the total irrigation demand of the irrigation area relying on the main Brantas is estimated as follows;

	Total water* off-take	Total water* demand	Surplus/Deficit
June	71.26 (m^3/s)	57.36 (m^3/s)	+13.90 (m^3/s)
July	62.81	57.15	+ 5.66
Aug.	52.58	45.51	+ 7.07
Sept.	42.64	38.94	+ 3.70
Oct.	41.18	29.72	+11.46
Nov.	37.41	22.37	+15.04
Total ($\times 10^6 m^3$)	811.03	661.6	149.7

* Except Wonokromo area

According to the figures in the above, it may be said that the irrigation sector took more water than needed.

(2) Future Demand

Future water demand is calculated based on the newly proposed cropping patterns, which intend to introduce concerted planting and harvesting. The water demand of the dry season paddy and polowijo in the areas presently authorized and in the areas under on-going projects such as Warujayeng and Turi-Tunggorono project is treated as authorized demand. On the other hand, the water demand of the dry season paddy and polowijo exceeding the presently authorized demand in the areas under new projects such as Lesti left, Papar-Peterongan, Gottan and groundwater is treated as new demand (not as authorized demand). The above is summarized as shown below.

	Authorized		Unauthorized	New	
	paddy	polowijo + sugarcane	Paddy	paddy	polowijo +sugarcane
Lesti left					o
Molek	o	o	o		
Lodoyo	o	o			
Mrican	o	o			
Papar-Peterongan				o	o
Turi-Tunggorono	o	o			
Jatimlerek-Bunder	o	o	o		
Gottan - etc.	o	o		o	o
Jatikulon	o	o	o		
Wonokromo	o	o	o		
Porong	o	o	o		
Mangetan	o	o	o		
Groundwater develop project				o	o

The future irrigation water demand in dry season is shown in Table 3.10.4.

5. Domestic and Industrial Water

(1) Present

Water for domestic and industrial uses taken directly from Brantas river and it's distributaries are as follows;

Domestic water in SMA; 3.52 m^3/s
(refer to section 3.4)

Industrial water;

	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
SMA	3.57	3.57	3.57	3.21	1.98	1.98
Other areas	2.53	2.53	2.53	2.53	1.66	0.66
Total	6.10	6.10	6.10	5.74	3.64	2.64

(2) Future Demand

Future potential water demand for domestic and industrial use is calculated in Section 3.4. The water demands are classified as follows:

(a) SMA domestic water

(b) SMA commercial water

(c) SMA social water

(d) Other area's domestic water

(e) Other area's social/commercial water

(f) Industry

SMA water demand

The estimated future water demands are as follows.

(Unit : m^3/s)

Year	Domestic		Commercial		Social		Total raw
	net	raw	net	raw	net	raw	
1985	5.15	5.57	0.32	0.35	0.33	0.36	6.28
1990	6.94	7.50	0.44	0.48	0.39	0.43	8.41
2000	12.69	13.71	0.83	0.90	0.57	0.62	15.23
2010	20.79	22.46	1.60	1.73	0.84	0.91	25.10
2020	34.45	37.26	3.00	3.24	1.23	1.33	41.78

Ref. Section 3.4

net: net demand

raw: raw water demand (= net x 1.08) including loss in treatment works.

Demand in Areas other than SMA

The estimated future water demand in other areas is shown in Table MW-12. In the table, each region is divided into large urban, urban and rural areas. Social and commercial water demands are assumed at a certain percentage of the domestic water demand as shown below.

Area	Domestic	Social and Commercial
Large urban	D_1	$D_1 \times 0.30$
Urban	D_2	$D_2 \times 0.20$
Rural	D_3	$D_3 \times 0.05$

Ref. Section 3.4

The total demand is calculated as follows.

Unit : m³/s

Year	Domestic	Social/Commercial	Total
1985	2.54	0.70	3.24
1990	3.45	0.84	4.29
2000	5.41	1.16	6.57
2010	7.52	1.57	9.09
2020	9.60	2.08	11.68

Ref. Section 3.4

The water demand in other areas described here is assumed to be met by springwater and groundwater. Accordingly the loss of treatment works is not taken into account for the above water demand. But the loss in distribution is taken in the above water demand.

Total domestic water demand

Accordingly the future total water demand for domestic use is as follows.

Unit : m³/s

	1985	1990	2000	2010	2020
SMA	6.28	8.41	15.23	25.10	41.78
Other areas	3.24	4.29	6.57	9.09	11.68
Total	9.52	12.70	21.80	34.19	53.46

Industry

Future water demand for industry is calculated in the Section 3.4. The estimated future water demands are as follows.

Year	SMA industry		SMA port		SIER+ TANDES	LICENCE under process	Total
	net	raw	net	raw	raw	raw	raw
1985	0.52	0.56	0.02	0.02	0.50	0.50	1.58
1990	0.71	0.77	0.03	0.04	0.50	0.50	1.81
2000	3.38	3.65	0.04	0.05	0.50	0.50	4.70
2010	6.18	6.68	0.08	0.09	0.50	0.50	7.77
2020	11.27	12.18	0.16	0.18	0.50	0.50	13.36

Ref. Section 3.4

6. City Water

City water is to be used for flushing the stagnant waste water in canals within the Surabaya city and for maintaining the water quality in Surabaya river.

(1) Present flushing water

(a) The Wonokromo canal and the minor canals within the city should be flushed weekly using a discharge of about 2.2 m^3/s for 24 hours.

(b) The Kali Mas, the Kalibokor canal and Jeblokan canal should be flushed for 12 hours every two weeks. A minimum discharge of 14 m^3/sec over Gubeng dam is required for this. The above discharge is equivalent to an average discharge of 0.814 m^3/s in total of (a) and (b).

The water requirement in the Surabaya river is estimated at 12,00 m^3/sec by the Surabaya Irrigation Service for preventing water polution in Surabaya river. Then, presently it is said that the total flushing water is 12.814 m^3/s.

(2) Required city water

From the present water quality in Surabaya river, in the dry seasons as shown in Section 3.2, the discharge of 15 m^3/s is considered to be the minimum requirement to maintain the water quality in Surabaya river at the allowable level.

Here, the river maintenance flow of the Porong river is deemed to be zero, from the present condition of Porong river in dry season.

Ideally some amount of river maintenance flow in Porong river would be desirable. But from the present condition of the limited water resources in Brantas river, the river maintenance flow of Porong river is set to be zero.

In future, if the social conditions along Porong river is changed and some amount of river maintenance flow is strongly needed for Porong river and some water resources are found available, the river maintenance flow of Porong river would be taken into account in future.

7. Fishery Water

For brackish water fish culture, certain amount of fresh water is needed. At present, there is no allocation specifically for the fishery.

According to ANNEX-AQ, the minimum fresh water requirement for the existing fish ponds of 13,000 ha is estimated at 13.54 m^3/s. This figure is taken as the future water demand.

8. Total Future Water Demand

The total future water demand in the dry season from June to November is estimated as shown in Table 3.10.5 and on Fig. 3.10.3 and summarized hereunder.

(Unit : MCM)

Category	1985	1990	2000	2010	2020
Domestic Water	150.5	200.8	344.7	540.6	845.3
City Water	237.2	237.2	237.2	237.2	237.2
Irrigation	686.3	955.1	955.1	955.1	955.1
Authorized	(636.5)	(636.5)	(636.5)	(636.5)	(636.5)
Future		(271.1)	(271.1)	(271.1)	(271.1)
Unauthorized	(49.9)	(47.4)	(47.4)	(47.4)	(47.4)
Industry	105.0	108.6	154.3	202.9	291.2
Authorized	(80.0)	(80.0)	(80.0)	(80.0)	(80.0)
Future	(25.6)	(28.6)	(74.3)	(122.9)	(211.2)
Fishery	179.0	179.0	179.0	179.0	179.0
Total	1,358.1	1,680.6	1,870.2	2,114.7	2,507.7

3.10.4 Water Balance

1. Water Balance with River flow at Jabon-Perning without regulation

The total future water demand in the dry season is compared with the dry season available river flow at Jabon-Perning estimated from the hydrological data in the period from 1964 to 1983. The comparison results deficit in all years as shown in Table 3.10.6.

The volume of water deficit in the dry season in the year of 2/20 (1982 equiv.), is as follows;

Year of water demand	Volume of deficit (MCM)
1985	474.6
1990	847.0
2000	1,036.6
2010	1,281.0
2020	1,674.1

The 10-day basis balance between the dry season available riverflow at Jabon-Perning and the water demand in 2000 is shown in Table 3.10.7 for the different reccurences of 2/20 (1982), 4/20 (1965), 10/20 (1970) and 15/20 (1974).

2. Water Balance with Available Water at Jabon-Perning including Regulating Facilities

With the flow control facilities and possible transbasin from other basins, the run off at Jabon can be increased by the amount as shown below.

Name	Volume (MCM)
Karangkates dam	261.1
Return flow form K. Ngrowo	87.7
Wonorejo dam	53.0
Umbulan spring	44.3
Beng dam	50.0
Konto II dam	70.0
Genteng I dam	70.0
Bengawan Solo	102.8
Total	838.9

Future water balance with the regulating facilities and transbasin is as shown on Fig. 3.10.4.

In case of the dependability of 2/20 (1982), the additional amount of 838.9 MCM is a little bit larger than the total deficit volume in 1985 but is already smaller than that in 1990.

Taking into account necessary lead time for implementation of water resources development projects, the above additional works are considered as the maximum for the coming decades. Therefore, it is considered that it will be impossible to satisfy all the water demand with the certain dependability like 80% and that it will be necessary to introduce allocation of the limited water among the water users.

3.10.5 Water Allocation Study

1. Priority for Water Allocation

Although there may be other different opinions in terms of the priority order for water allocation, the priority order in this study is considered as follows;

(1) Domestic water

(2) City water

(3) Authorized irrigation water

(4) Authorized industrial water

(5) Future irrigation water

(6) Future industrial water

(7) Unauthorized irrigation water

(8) Fishery water

Domestic water is considred to relate directly to the health conditions of the inhabitants, and supply of it is considered to be a "must".

The city water relates indirectly to the health level of the inhabitants through pushing the waste water to the sea and keeping the river water quality in the dry seasons above the acceptable level. Therefore, the city water is also considered as one of the "must" for protection of the human health.

There are two authorized water demands; irrigation and industry, and allocation for them should be made on the priority basis.

Future irrigation and industrial water demand will be subject to the government's policy. New irrigation project to use the surface water shall prepare necessary water by themselves. Irrigation projects to use the groundwater shall be planned not to give adverse effect to the presently available surface water. Large industrial enterprises will be able to prepare industrial water by themselves. However, the small scale industries will have to rely on the public industrial water supply.

It is recognized that the fishery sector is accorded high priority in the REPELITA IV. The fishery in the Brantas delta has advantageous positions in marketing and transportation. However, the constraint in the water availability in the basin makes it very difficult to allocate any water to this sector. Therefore, it is considered that this sector will use the return flow from the irrigation in the Delta area and the water to be saved due to decrease in the irrigation area. This sector is ranked by the last priority.

2. Water Allocation in Year 2000

If all the conceived flow control facilities and transbasin are implemented by the year 2000, the total available water in the dry season in the dependability of 2 /20 is 1569.6 MCM as shown below. By this amount, the demand up to the future irrigation water can be almost covered, but the future industrial water can not be covered.

Demand side

Unit : MCM

Sector	Demand volume(MCM)	Accumulative Volume
(1) Domestic	345.5	345.5
(2) City water	237.2	582.7
(3) Irrigation (Authorized)	636.5	1,219.2
(4) Industry (Authorized)	80.0	1,299.2
(5) Irrigation (Future)	271.1	1,570.3
(6) Industry (Future)	74.3	1,644.6
(7) Irrigation (Unauthorized)	47.4	1,692.0
(8) Fishery	179.0	1,871.0

Supply Side

Unit : MCM

Sources	Volume	Accumulative Volume
(1) Available water at Jabon-Perning	833.5	833.5
(2) Karangkates dam	261.1	1,094.6
(3) Return flow	87.7	1,182.3
(4) Wonorejo dam	53.0	1,235.3
(5) Umbulan spring	44.3	1,279.6
(6) Beng dam	150.0	1,429.6
(7) Konto II dam	70.0	1,499.6
(8) Genteng dam	70.0	1,569.6

Priority order will change according to the changes in the socio-economic conditions in the basin and national polity. Decision on water allocation belongs the national policy. Therefore, this study presents two alternatives without recommendation.

Alternative 1 ; industrialization oriented
Alternative 2 ; irrigation development oriented

Results of these two alternatives are as shown on Fig. 3.10.5. As shown on these figures, the water resources developments will be needed in the following timings to meet the demands in the year 2000;

	Alternative 1	Alternative 2
Push-back from K.Ngrowo basin	as soon as possible	as soon as possible
Wonorejo dam	1989	1989
Umbulan spring	1992	1991
Beng dam	1995	1992
Konto II	Not needed	1996
Genteng I	Not needed	1997

The sequence in the above is assumed according to the conditions of project preparation and the cost of water to be developed.

It should be noted that the water balance in this study is based on the assumed high efficiency of water use; the future, the overall irrigation efficiency to paddy field is 70%,purification loss of river water for water supply is 8%; etc. If loss increase by 5% of the total demand, an amount of 50 - 75 MCM will be lost. This amount is equivalent to storage capacity of a large dam. Therefore, even if water resources development is implemented according to the growth of water demands, strict lowflow management will be needed.

Besides water resources development, water saving will be necessary. For example,

- improvement of irrigation canal for minimizing losses
- improvement of drainage system for efficient use of the irrigation return flow
- to return waste from domestic use after treatment
- recirculation use of industrial water
- introduction of water saving irrigation

These measures shall be taken up to cope with the water demands beyong the year 2000.

3.11 Water Management System

3.11.1 General

Since the 1960's, the water resources in the Brantas river basin have been developed to the considerable extents. Such developments have brought about stable and prospective production conditions to the agricultures and industries and safe living conditions to the inhabitants in the Basin. Especially, the Surabaya metropolitan area, the second largest city and the economic center of the eastern half of Indonesia, has grown and will grow rapidly. Accordingly, request of safer conditions against flood and demand of water are increasing.

However, owing to dense accumulation of properties along the rivers, it is practically difficult to expand the flood control facilities largely, and owing to hydrological and topographical conditions in the basin, it is also difficult to exploit large amount of water additionally.

Under such circumstances, utilization of the existing facilities to the maximum extent possible is one solution other than construction of new facilities. In order to enable maximum use of the facilities, an integrated water management system will be needed.

In view of the above, overall studies are made of the water management system in this section. The study is made of the existing system in the basin, the programmed system which is going to be implemented by BRBDEO in the near future, and the integrated water management system which is to be proposed in this study.

3.11.2 Existing System

The existing water management system is classified into the high flow management and low flow management. The overall features of them are described hereunder.

1. Highflow Management

Highflow management in the basin has been undertaken through operations of flood control facilities and flood forecasting system as described below.

(1) Flood control facilities

The flood control facilities in the basin consist of storage reservoirs with flood retarding effects, natural flood retarding swamps, and flood diversion canals. Storage reservoirs are Karangkates and Lahor on the main reach, Selorejo on the Konto river and Bening on the Widas river. Natural retarding ponds are in the mainreach upstream of Kediri and in the Widas river basin. Flood diversion canals are Parit Raya and Parit Agung canals with diversion tunnels in the Ngrowo river basin and Porong river in the downstream of the Brantas river.

The locations and general features of these flood control facilities are described in ANNEX - RC.

Operation of these flood control facilities are of the responsibility of BRBDEO. With regard to the reservoirs, operation is princially based on reservoir water level. Reservoir operation based on flood forecasting from rainfall is not yet put in practice.

(2) Flood forecasting and warning sytem (FFWS)

There are two flood forecasting and warning systems in the Brantas river basin. One is the Brantas system and another is Mt. Kelud system.

(a) Brantas flood forecasting and warning system (Brantas system)

Under the management of BRBDEO, there are many kinds of facilities for FFW which can be classified into two systems; one is a communication system and another is a hydrological observation system consisting of rainfall (RF) and water level (WL) gauging stations.

The existing communication system is of the radio telecommunication net works shown in Fig. 3.11.1. The system links the office of BRBDEO in Malang with all the branch offices (19 offices). Details of the existing communication networks are as shown in Table WM-1 in Annex WM.

Hydrological observation system consists of 107 raingauge stations (all automatic recording types) and 67 waterlevel gauging stations (33 automatic and 34 staff gauge types). Locations of this stations are as shown on Fig. 3.2.1. These stations are conventional gauging stations but not of telemetering system.

When flood is observed at the damsites in the upstream reaches (Karangkates, Wlingi or Lodoyo), warning is communicated to the offices in the middle and lower reach and necessary actions are taken.

(b) Mt. Kelud flood warning system (MT. Kelud system)

The Mt. Kelud project office has a special organization with a task of flood warning dissemination and flood fighting in the western and southern area of Mt. Kelud, and has his own flood warning system. The said organization is as illustrated in Fig. 3.11.2.

The flood warning system is a simple radio telecommunication networks to link 11 stations each other including Mt. Kelud project office in Kediri. The system networks are illustrated in Fig. 3.11.1. Details of the networks are as shown in Table WM-2 in ANNEX - WM.

2. Lowflow Management System

(1) Lowflow control facilities

There are so many lowflow control facilities for both water regulation/supply facilities and water intakes for irrigation and municipal water. Major facilities are enumerated below.

(a) Water regulation reservoir

- Karangkates and Lahor reservoir in the main Brantas
- Selorejo reservoir in the Konto river
- Beng reservoir in the Widas river

(b) Water diversion facilities

- Wlingi dam, New Lengkong dam and Mlirip gate in the main Brantas

(c) Water intakes for irrigation

- Molek, Lodoyo, Mrican, Turi-Tunggorono, Bunder-Jatimlerek, Gottan, Porong, Mangetan and Wonokromo irrigation systems located in the main Brantas

(d) Water intakes for domestic and industrial water supply

- Surabaya,Kediri and Mojokerto in the main Brantas

(2) Lowflow management system

There exist no particulater low flow management facilities other than control gates, discharge measuring devices, etc. in each water supply and intake facilities. The telecomunication system described in flood forecasting and warning system has been also utilized for administative communications with regard to the lowflow management.

Lowflow management is made through regulating interests among supply side and various users. The supply side is controlled by BRBDEO through releasing of water stored in the reservoirs. Users consists of hydropower, irrigation, domestic and industrial, and river maintenance.

Water rights are allocated to the existing water users, and at present no additional intake is allowed in the downstream reaches.

Lowflow management is made through Coordination Committee organised among BRBDEO and users consisting of PLN, irrigation offices and Surabaya Water Supply. At the beginning of the dry season, every June, BRBDEO submits water releasing plans to the Coordination Committee, which are made based on an assumption of normal dry season inflow to the reservoirs.

If the inflow condition is equal to or more than the normal, reservoir operation is made according to the plan. If the year is drought, an additional release is requested by irrigation offices, and reservoir operation is changed accordingly. If inflow is too small, restriction of irrigation water intake is made. All the intake facilities are controlled by water users themselves.

According to the experiences in 1982 which was severe drought year, it can be said that the lowflow management in the Brantas river basin is well done. However, there are still rooms to be improved to cope with the future water demand;

- Lowflow management based on lowflow forecasting
- Overall control of water intakes

To make the above possible, it will be necessary to establish a system examined in this report.

3.11.3 Under Implementation Project

The Brantas Middle Reaches River Improvement Project has planned to construct a modernized flood forecasting and warning system. The programmed flood forecasting system is a telemetering system as illustrated in Fig.3.11.3. The warning system is a radio communication networks, which is also illustrated in Fig. 3.11.3.

The system consists of the following component

- A Flood Forecasting Center (FFC) in the BRBDEO in Malang, in order to conduct flood forecasting work quickly and accurately. The FFC will be equiped with the following.

  1-Telemeter supervisory equipment
  1-Operating console for telemeter with printer
  2-150 MHz band radio equipment (one is for telemeter and one is for telephone)
  1-Display equipment for telemetered gauging data
  1-Computer system which is composed of Central Processing Unit (CPU) etc.

- Thirteen (13) branch offices listed below to be linked with FFC in Malang. The branch office is equiped with telephones.

  - Lesti
  - Sengguruh
  - Karangkates
  - Wlingi
  - Lodoyo
  - Tulungagung
  - Kediri
  - Ploso
  - Lengkong

- Porong
- Surabaya
- Selorejo
- Bening

- Telemetering system consisting of;

  19-rainfall gauging stations
  13-water level gauging stations
  150 MHz band radio telemetering communication system
  Rainfall and water level gauging stations are as listed in Table WM-3 and 4 in Annex WM.

- Telephone system consisting of;

  150 MHz band radio telecommunication system which is for exclusive flood warning telephone system.

- To ensure radio communication, two (2) repeater stations will be established in Pujon and Willis.

Existing telecommunication system (telephone) will be utilized for the communications between the branch offices.

Telemetering gauging stations are arranged with special emphasis on the Wlingi dam and Selorejo dam catchment areas aside from the principal gauging station sites along the main Brantas from the consideration of smooth and safe operation of those dams.

Upon the completion of this system, BRBDEO will conduct flood run-off analysis from rainfall and routing calculation of flood in the river channel by the computer system using the data collected through the telemeter system, thus disseminate flood forecasted and flood warning through telephone lines.

3.11.4 Study on Integrated Water Management System

1. Needs of System

As described in the previous sections, the integrated water management system will be necessitated in future to control strictly precious water in the basin since development of new reservoirs will become costly and will be limited from topographical conditions. Further, the system is required to manage flood control works to ensure higher safety against flood in view of social requisite.

2. Basic Scheme of the System

(1) Required functions of system

Basic functions of the system required for effective and efficient water management are;

(a) Aquisition of information at the present condition in the entire stretches of the river at anytime during management

(b) Forecasting of subsequent conditions based on the collected information for proper management of the water resources.

(c) Dissemination of forecasted conditions to the administrator/ operator to ensure the control of related facilities.

(d) Control/operation of facilities.

(e) Recording of information and performance of control.

(2) Information to be collected

The following information is requisite for effective and strict water management.

(a) Rainfall

(b) Water level at gauge site

(c) Reservoir water level

(d) Reservoir outflow through turbine, gate and/or valve

(e) Inflow into irrigation, domestic and industrial water intakes

(f) Water qualities

(g) Power outputs

(3) Composition of the System

Presently, flow control facilities along the Brantas river are operated individually without much knowledge on the flow conditions at other sites at the instant when operation is made. For the efficient and effective water management, flow control shall be unified at one office where all the information on the Brantas river and tributaries are collected in every instant. This office may be named as "Water Control Center".

Since information has to be collected at every instant from the entire basin, on-line real-time system is needed.

In order to realize the above-mentioned functions on real-time on-line basis, three systems will be required under water control center (WCC);

- Telecommunication system

- Computer system

- Telemeter system

Details of the systems are presented in the sub-sequent Chapters.

3. Design of Telecommunication System

Multiplex radio telecommunication system is adopted since many channels are requisite to ensure telephone communication, computer telecommunication and telemeter telecommunication. Individual simplex system to each communication would be costly than the multiplex telecommunication system.

The network of the telecommunication system by multiplex radio equipment will consist of main and branch routes as illustrated in Fig. 3.11.4 which are preliminarily designed as follows.

Main route : - 126.3 km from Malang to Surabaya via Kediri with 7-7.5 GHz, 60-120 CH, FM

- 99.1 km from Kediri to Surabaya, with 400-800 MHz, 24-60 CH, FM

- 225.4 km long entire route with 8 spans with 7 repeater stations

Branch route: - 32.9 km from Malang to Selorejo

- 6.3 km from Wlingi to Lodoyo

- 10.7 km from Tulungagung to Wonorejo

- 28.3 km from New Lengkong dam to Porong

- 4.4 km from Surabaya to Pengairan SBY

Each branch route has 6-12 CH

Priority orders to use the communication CH will be as follows.

Priority	Use for
1	Data transmission line for computer system
2	Data transmission line for telemeter system
3	Exclusive telephone line
4	Facsimile line
5	Administrative telephone line
6	Others

Number of telecommunication CH at each station and the details of equipment to be installed at each station are shown in Table WM-5 in ANNEX - WM.

Exclusive telephone set is to be installed at all the dams and offices and to directly be connected with the exclusive telephone panel in the Water Control Room at WCC. This arrangement will make it possible to communicate WCC's instructions to necessary places instantly through these exclusive telephone lines.

For administrative telephone, a Private Automatic Branch Exchange (PABX) is to be installed at Malang, Kediri and Surabaya offices.

At the dams and other offices Key telephone equipment or automatic telephone sets will be installed as extension of PABX for administrative telephone.

4. Design of Computer System

The information networks of computer system is the same as Fig. 3.11.4.

At WCC in Malang, the CPU including its peripheral equipment and the mimic board etc. are to be arranged as shown on Fig. 3.11.5.

At each dam and office, RTU will be installed properly. The CPU will be connected with the RTU by the data transmission line in the information network, and the data will be transferred at a speed of 1200 bits/sec. between the CPU and the RTU on the basis of on-line real-time system.

Since the CPU (main memory 2 MB) has the Communication Control Unit (CCU) for 14 RTUs, all of the data collected from 14 RTUs will be processed on-line real-time oasis.

As this CPU is connected with four (4) telemeter systems through interface equipment the data from telemeter systems will be put in the CPU automatically, and processed on real-time.

The data processed by the CPU is stored and displayed on the mimic board and dam data display panel in control room, and also sent to each dam and office through CCU. Some data is copied by copier, and if necessary will be sent to offices by facsimile.

Two (2) kinds of RTUs are planned as shown on Fig. 3.11.6. The A type RTU is to be installed at each dam and Kediri, Surabaya office. The B type RTU is to be installed at other offices. Pengairan Surabaya and Cipta Karya are in same precincts, and the distance between the 2 offices is short within 100m, therefore the RTU at Cipta Karya will be connected with the carrier terminal output at Pengairan Surabaya by communication shield cable and the power for RTU at Cipta Karya will be supplied from UPS at Pengairan Surabaya.

The data from the dam to WCC and conversely the data from WCC to dam will be displayed on the display panel and printed out through the A type RTU at the dam.

The Lahor dam reservoir WL will be transmitted to WCC through RTU at Karangkates dam. The information that is needed to calculate the intake discharge into the Lodoyo-Tulungagung irrigation system, will be transmitted to WCC through RTU at Wlingi dam. And also, through the A type RTU at Kediri, New Lengkong and Surabaya the information regarding the turbid waters will be transmitted to WCC. IN this case, the turbid waters data put into RTU at Surabaya will be sent from Jagir dam through the post office telephone line (about 6 km).

The B type RTU has no function to transmit the data, but only has the function to receive the data from WCC and will display the data on the display panel and print out the data as material evidence by typewriter.

Details of the computer system are shown in Table WM-6 in ANNEX WM.

5. Design of Telemeter System

New telemeter network consists of four (4) telemeter systems for up-stream of Karangkates, Ngrowo downstream of Brantas and Widas basin as illustrated on Fig. 3.11.4. Each system has the calling capacity to accommodate thirty (30) stations of RF and WL.

The master station will be installed in the communication apparatus room at WCC in Malang and the base stations will be installed at Tulung-agung, Malang and Selorejo and the repeater stations will be installed at Tjondrogeni, Katoe and Soetadi.

The contents of RF and WL gauging stations to accommodate in every telemeter system is shown in Fig. 3.11.4. and details are shown in Ta - ble WM - 7 and 8 in ANNEX WM.

Gauging stations are determined in accordance with the function requirement. All the principal gauging stations in the main Brantas, reservoirs and water intakes in the Brantas listed in Section 3.11.2 are designated to be the gauging stations to be incorporated in the teleme-tering system.

The telemeter system will be planned in accordance with the standard specification of the Ministry of Construction in Japan, just the same as the telemeter system planned by the Brantas middle reaches river impro-vement project.

The frequency band of this telemeter system is 150 MHz band, simplex, the signal transmission speed is 50 bits/sec and calling method is polling system.

Details of the telemeter system are shown in Table WM - 9 in ANNEX WM.

6. Implementation Plan.

Since the system is big in terms of physical and financial aspects, introduction of stage-wise construction is assumed. Construction of the system is divided into three stages. The first stage will cover the upper half of the basin, the second stage will cover the lower half of the basin and the third stage will increase density of the telemeter system, as follows;

First Stage Construction

- Telecommunication System; Malang, Sengguruh, Karangkates, Wlingi, Lodoyo, Tulungagung, Wonorejo, Pujon, Selorejo
- Computer System ; CPU; Malang
  A type RTU; Sengguruh, Karangkates, Wlingi, Lodoyo, Wonorejo, Selorejo
  B type RTU; Tulungagung

- Telemeter System ; Master station; Malang
  Base station ; Malang, Tulungagung, Selorejo
  Repeater station; Tjondrogeni, Katoe, Soetadi
  Gauging station; 16 stations including all stations for irrigation and for Surabaya city water

Second Stage Construction

- Telecommunication System; Kediri, Ploso, New Lengkong, Porong, Surabaya, Pengairan Surabaya
- Computer System ; A type RTU; Kediri, New Lengkong, Surabaya
  B type RTU; Ploso, Porong, Pengairan Surabaya, Cipta Karya
- Telemeter System ; 20 gauging stations

Third Stage Construction

- Telemeter Station ; 26 gauging stations

Time schedule for implementation is assumed as shown on Fig. WM - 1 in ANNEX WM

The water deficit in the basin is a serious problem even at present in severe drought year, and will become more and more serious in future. It is recommended to establesh the water management system proposed here in early stage.

7. Cost Estimate

The total costs of the water management system are estimated as follows;

I t e m s	Foreign Yen 10^6	Local Rp. 10^6
Electrical works		
Equipment cost (FOB)	2,015	
Spare parts and accessories (FOB)	284	
Freight and insurance	460	
Installation	469	
Sub - total	3,228	
Building		264
Training	121	
Engineering services	1,299	
Grand total	4,648	264

Note : Details of the cost estimate are shown in Table WM-5.6.9 and 10 in ANNEX WM

Assuming the stagewise implementation, the required cost in each stage is estimated as follows.

	Foreign currency Yen 10^3	Local currency Rp. 10^3
1st stage	2,642,000	126,000
2nd stage	1,460,000	104,000
3rd stage	546,000	35,000
T o t a l	4,648,000	265,000

Yearly allocation according to the assumed time schedule is shown in Table WM - 11 in ANNEX WM.

8. Institutional Arrangement

At present, the Coordination Committee is organized for lowflow management and a scheme for flood warning are exist as explained in Section 3.11.2. However, they are limited in functions and scope of works, and they stand on the basis of mutual agreements among authories concerned without institutional supports. For effective operation of the proposed water management system, special arrangements of organizational and institutional improvement are essential. Presented herein is a tentative proposal for organizational and istitutional improvement Fig. 3.11.7.

(1) Organization

All the government agencies concerned with water management shall be involved in this organization. Fig. 3.11.7 shows a tentative proposed organization. Department of CIPTAKARYA in Surabaya, Irrigation service in Surabaya, Mt. Kelud projects office, Brantas river basin Development Execution office, department of PLN for East Java province should be involved in the operation of the system. Duty of each agency is assumed as follows with regard to the water management system operation.

CIPTAKARYA, SBY	:	Domestic water demand/supply and water quality
Irrigation service, SBY	:	Management of water demand, water allocation to irrigation field and administration of water right
Mt. Kelud project	:	Disaster forecasting and warning relating to flood and debris from Mt. Kelud eruption
BRBDEO	:	Operation of water control facilities, and forecasting flood and lowflow
PLN, East Java	:	Power demand,power supply and water

requirement for hydropower generation

It is recommended that more detailed study be made to finalize and fix the organization prior to the establishment of the system.

With members appointed by each agency, it is recommended that water utilization coordination committee and flood disaster coordination council be improved.

The water utilization coordination committee shall have the following function in principle.

(a) To convene committee members to held a meeting on water allocation

(b) To adjust and modify the water demand/supply request from the agencies concerned in line with governmental regulation/ institution

(c) To decide finally the water allocation based on the amount of available water which BRBDEO estimates

(d) To disseminate such decisions to all the officials concerned

(e) To monitor the performance if water is distributed as agreed

Aside from the above it is recommended that national flood disaster coordination council be improved.

The flood disaster coordination council has to have the following duties and responsibility.

(a) To convene committee members to coordinate how to treat flood disaster and debris disaster as needed

(b) To organize a force for flood and disaster fighting as needed

(c) to arrange good/equipment/man power when flood and/or debris disasters are expected

(d) To take the required actions for preventing and minimizing disaster through agencies concerned including local government officials

(e) To report all the activities and/or event relating to the disaster to the higher authorities such as CIPTAKARYA, DGWRD, PLN, etc. as well as the Minister of Ministry of Public Works

More concretely, the flow chart of actions to be taken for low-flow and highflow management are shown in Figs 3.11.7 and 3.11.8.

(2) Institutions

With increasing water demand and limited water supply capacity in the basin, the strict low water management will be necessitated. Higher safety of life and properties against flood and debris disasters will be the desire of all the inhabitants in the basin. Water management, if it is improperly conducted, would bring about confusions, argument among water users and sometime would result in loss of water resources.

To implement the proper water management without such problems, institutional arrangement is essential. The institutions should include the following, some of which have been already established but needed to be improved and/or strengthened.

(a) River law

(b) Water right

(c) Regulations for water allocation

(d) Regulations for water quality

(e) Reservoir operation rule

(f) Establishment of water utilization coordination committee

(g) Establishment of disaster coordination council

(h) Regulations for operation of water management system

It is recommended to establish all the above institutions prior to the water management system operation with careful attentions on impartiality and welfare of all the peoples concerned.

3.12 Environmental Assessment

3.12.1 Introduction

1. Objective of the Study

In the Brantas river basin, a lot of development has been carried out for many years and now the master plan development started in 1973 are still going on. However, it is true that unexpected environmental problems have been arisen along with the rapid progress of development. So there is of necessity for re-examining the overall development to be promoted in the basin.

This Study has two objectives. One is to investigate and examine the effects induced by the existing projects in the whole Brantas river basin, which were mainly implemented based on the comprehensive development plan in 1963 and the master plan in 1973, and on the basis of such examination. The other is to identify the problems to be considered in implementing future projects in view of eliminating unfavourable effects therefore.

2. Scope of the Study

The Study examines the aspects in terms of the natural environment and the social environment and covers the whole Brantas river basin of 12,000 km^2 from the origin to the river mouth. The examination of the study is made qualitatively but not quantitatively.

3.12.2 Present Environmental Problems

1. Basic Strategy

This study investigates the effects induced mainly by the projects which have been implemented under the development plan in 1963 and the master plan in 1973 in the Brantas river basin. Then the Study identifies the problems to be considered in future development projects.

There are many existing projects in the basin, and it would actually be difficult to investigate and asses all of these one by one, with insufficient data and informations on the environmental situations before development.

In this study the following approaches were employed, though they might be different in form from the generally accepted ones in environmental assessments.

(1) To point out the existing environmental problems caused by the existing projects which are dam development, flood control, agriculture and irrigation development, sediment control, water utility and others, and classify them into pertinent environmental sectors.

(2) To clarify the unfavourable effects by the existing projects based on the available data and information.

(3) To present the advice and recommendations for the future projects with related factors to be considered in formulating the development plan in the Brantas river basin in view of environmental aspects.

The study is proceeded in accordance with the flow chart shown in Fig. 3.12.1 which shows the steps to be taken in line with the scope of study.

- To understand the environmental act in Indonesia
- To apprehend the existing environmental condition
- To prepare the study specification
- To apprehend the features of the existing projects
- To clarify the existing environmental problems
- To examine and prepare recommendations of how to solve the problems
- To apprehend the features of the future projects
- To examine the environmental impacts by the principal future projects
- To project the environmental changes qualitatively
- To assess the environmental change
- To prepare recommendation on a way of project formulation in view of environmental impact

2. Present Environmental Problems

Since the 1960's many projects have been implemented in the Brantas river basin. However, with the progress of economic and industrial development and the change of social condition, the whole basin is now facing unfavourable environmental problems caused by the local development. Therefore future development should be promoted taking account of not only political and economic situations but also wider environmental ones.

Field reconnaissances and interviews were employed in this study to indentify the environmental problems caused by development. In order to classify them into factors, the Risk Resultant Matrix (RRM) Analysis is made in response to the condition of Law No. 4/1982.

It is not always conceivable that all the existing problems have been caused by the projects under 1963 master plan and 1973 master plan. Some have been brought about by other factors that were also examined in this study.

Table 3.12.1 shows the existing environmental problems in relation to development projects classified by its nature and related factors. The environmental problems shown in the table shown are discussed hereunder.

(1) Dam developments

(a) Erosion at the quarries around Karangkate dam

The erosion problem exists at the quarries where construction materials were quarried for the Karangkates dam, the largest one in the basin. The Karangkates dam was proposed to be constructed by master plan in 1963 and completed in 1977. Embankment volume is as follows.

Karangkates Multipurpose Dam

Type	:	rock-fill, zoned with center core
Embankment volume		
Main dam	:	6,156,000 m^3
Cover dam	:	448,600 m^3
Total	:	6,644,600 m^3

Since the quarries for embankment materials of about $6.6 \times 10^6 m^3$, are located on steep mountain sides and have been left without any protection measures after completion of quarrying work, the surface erosion has been set up.

As the quarries are located far from residential areas, direct effects on the resident has not been found yet.
However in view of the conservation of the basin, reforesta-

tion or the prevention of erosion must be put on the quarries.

(b) Sedimentations in Karangkates reservoir

A sedimentation is one of the most important and complicated problem in the basin. According to the latest data,the annual sedimentation in the Karangkates reservoir amounts to approximately 2 million m^3, which is still within the designed sediment deposition capacity of the Karangkates reservoir. However, with the passage of generations, the reservoir will be filled up with sediments. Careful attentions should be paid on the progress of sedimentation in view of dam safety and the life time of its operation.

At the same time, the river bed in lower reaches had better be lowered in order to maintain the flood discharge capacity, and many efforts have been made to reduce sediment supply from the upper Brantas area to the lower reaches.

However, excessive sediment control in the upper Brantas area including Karangkates reservoir would bring about excessive lowering of the river bed, which would cause instabilities in river structures. Careful attentions should also be paid on the stability of river structures.

(c) Water hyacinth in Wlingi reservoir

Luxuariant growth of water hyacinth in Wlingi reservoir is a serious problem for dam operation. The cause of growth and the obstruction to normal dam operation must be studied in order to make a suitable counter plan for the situations.

(d) Forest reduction due to the emergence of reservoirs and quarries

Forest has been reduced due to the emergence of reservoirs and quarries. For example, in case of Bening dam, it is said that the most part of teak forest around Bening dam reseroir had decreased. And in case of Wonorejo dam, forest was also inundated in reservoir and decreased by quarries, however it is reported that the reduction of forest made by inundation forest area is actually mixed with cultivated areas and scrubs. Under the present environmental situation in which forest reductions has progressed, reforestations as large as disappeared forest should be recommended around the inundation area quarries, from the standpoint of preservation of the river basin.

(2) Flood control

(a) Blockings of inland drainage by the diking

It is pointed out that the diking for flood control has blocked the inland drainage to the river. The problem has mainly occurred in the middle reach. Although heavy damages have not been generated, blockings of inland drainage by the diking is serious problem for the peoples around there in view of the public hygiene. Thus pertinent counter measures have to be undertaken to improve inland drainages without reducing the structural stability of embankments.

(3) Agriculture and irrigation

(a) Soil devastation due to multiple paddy harvests and deficiency of nutritious elements

In the Brantas river basin, the irrigation development has been implemented for many years. Although dam constructions enabling some areas to farm all the year round, soil devastation problems have come on the scene instead. The excessive use of fertilizers and agricultural chemicals may be harmful to soil devastation, that might have unfavourable effects on future environment.

As mentioned above, soil devastation means the deficiency of nutritious elements that are fundamental to the growth of crops. Straw burning on paddy fields would be one of the simplest and effective methods to restore the elements to soil.

(b) Erosion due to cultivation at the slope of the mountain side

This problem may not be directly related to agriculture and irrigation projects. However, slope cultivations enchance the erosion induced by rainfall, resulting in an increase of sediment inflow into the downstream and the sediment increase causes the sedimentation on the Brantas river bed.

One of the reasons why slope cultivations have developed so far would be that with the increase of agricultural population the second or third generations suffered the shortage of available farmlands in the basin.

Reforestation has been promoted for this problem, though they were not enough. Slope cultivations must be limited and reforestations should take the place of them for the river basin environments.

(c) Water shortage induced by developments

As mentioned above, the agriculture and irrigation development has made it possible to farm all the year round. However, this is one of the reason to cause water shortage in the river

basin in dry season.

In the river basin, despite of present water shortage, further agriculture and irrigation development are requested to produce more crops. They may give an impetus to present water shortage. This problem must be considered in a new development project of the whole river basin. At present, new dams are planned to be constructed in order to supply sufficient water.

(d) Effect of fertilizers and agricultural chemicals

With the progress of agriculture and irrigation developments the consumption of fertilizers and agricultural chemicals went up, especially at paddy fields where harvests can be done several times a year.

The increase of fertilizers and agricultural chemicals has not become a serious problem yet, however, it is feared that excessive consumption would affect the water quality and ecological system in the basin. Routine inspections of river water quality are necessary to protect the environments.

(e) Over cultivation at the slope of the mountain side

As previously mentioned, slope cultivations has decreased forest areas and might have affected native flora there. Slope cultivations must be limited, and reforestations are recommended for the surrounding area of slope cultivation.

(4) Sediment control (Watershed management)

The present sediment volume in lahar pockets and other structures reached 14.55 x $10^6 m^3$, 75% of the designed capacity (19.41 x $10^6 m^3$), and more sand control works are to be executed semipermanently.

As for sediment control structures, it might not cause serious environmental problems because the locations of control works are limited to sparsely populated and devastating volcanic areas and the scales of development are comparatively small.

(a) Decrease of available water by reforestation

It is generally said that reforestations decrease the total amount of river water since a part of rain water is assimilated by trees. Although the exact quantitative relation between the total amount of river water and reforestations is hard to establish, it is suggested to study the details of the relation and to select the location for actual reforestation and trees to be planted there.

(5) Water utility

As for water utility, no development has been identified so far in view of affecting the environtments. Worsening of water quality in Surabaya area is a serious problem for water supply. This problem is mentioned in the next section.

(6) The others

(a) Air pollution in Surabaya area

In Surabaya area, air pollution is an emerging problem. In this case, the pollution is not due to the project implementations but to the traffic increase brought about by urbanizations and industrialization.

Very few data on air pollution are available so that it is necessary to measure the amount of pollutants such as Nox and Sox in order to grasp the present situations.

(b) Worsening of water quality in Surabaya area

The water quality has become worse with the progress of urbanization. It is said that serious degradation of water quality has occurred during dry season. The shortage of water in the whole river basin is one of the important factors to cause the degradation of water quality.

Water worsening in Surabaya area has been reported from the 1970's. Camp Dresser & McKee studied the water quality in Surabaya city canals in 1976, and analysis of DO, COD, and BOD indicated that very poor conditions existed in the north of the town, particularly in the Pegirian canal and the Morokrembangan Boezem. The Lower Brantas Pollution Study in 1977 and the report by Astron Polaris indicated that the unfavourable conditions existed in the Surabaya river and canal systems.

Further the Lower Brantas Pollution Study indicated that unfavourable water quality condition appeared in August when the mean monthly discharge became less than about 30 m^3/s.

Recent water quality analysis made at K. Surabaya in 1982 showed continuing degradation of water quality in this area (Location map is shown in Fig. 3.12.2). Above study also showed relations between fatories drainage and water quality. Big factories are concentrated around St.B-7 and high DO values were recorded there, COD and BOD values at that point decreased. It implies that the effect of factory drainage upon the water quality around St. B-7 was not evident. The drainage from households and small factories might contribute

to the worsening of water quality in K. Surabaya.

(c) Effect of degraded water quality on the health

The same arguments may be applied to the above.

(d) Bad smell due to the worsening of water quality

Surabaya city has the problem of bad smell caused by worsening of water quality. Near the Surabaya river the situation has changed for the worse, especially during dry season in which the river flow decreases considerably. From the sanitary view point, regulations must be put on drainage and dumpings, and disposal facilities are to be constructed.

(e) Dumpings to the river

The same arguments may be applied to the above.

3. Recommendations

(1) Recommendations

In the previous section, the problems caused by the preceding development were pointed out and discussed project-wise and it was revealed that a lot of development so far executed have affected the environment to produce several problems. In some cases, the causes of prblems are so interrelated that it would be impossible to find out a settlement without considering all the environmental elements and their mutual relations established in the river basin. However, not all the problems may be attributed to the master plan in 1973. Development before that and some other factors may not be ignored in considering the problems.

The followings are the recommendations for environmental problems pointed out in the previous section.

(a) Dam development

(i) As to the problem of quarry, reforestation is encouraged in order to prevent landslide for protecting the surroundings.

(ii) Quarries must be chosen so as to minimize their effect on the eco-system.

(iii) The amount of sedimentation in reservoir must be carefully checked.

(b) Flood control

(i) Inland drainage system must be introduced without reducing the structural strength of banks and sanitary conditions in the surroundings must be improved.

(c) Agriculture and irrigation

(i) Excessive cultivations at slopes must be restricted and reforestation are recommended instead in order to conserve the environments. Furthermore, in cultivated area adjacent to slopes, those farm products with low CP factor, such as coffee (CP factor = 0,01), corn + peanuts (CP factor = 0.15), or corn + cassava (CP factor = 0.25) which can sieze the ground are highly recommended to plant.

(ii) The amount and safety of fertilizer used in the basin must be supervised and excessive use must be avoided.

(iii) In rice fields, straw burning is encouraged in order to restore nutricious elements.

(d) Watershed management

(i) Based on the examination of absorbtion efficiency of rain-water, the area and kind of trees for reforestation must be selected.

(e) Water utility

To keep sufficient water in the upper reach area in order to provide flushing water even in the dry season and further more consider water allocation in the whole basin.

(f) The others

(i) Present air pollution in Surabaya city must be studied. Improvement of water quality will be attained through the constructions of sewerage systems and disposal facilities.

(ii) Control the discharge of industrial wastes to improve water quality.

In each sector, the above-mentioned recommendations should be examined further on the details of measures to be employed on their possibilities.

Nontheless, it is considered that many environmental problems in Brantas river basin are related to such factors as "water shortage in dry season", "over cultivation at the slope of the mountain side or decrease of forest", and "increase of rubbish

and insufficient drainage or worsening of water quality".

And it also means that they are closely related to land reclamation started long before, the progress of urbanization and industrialization and population increase in the Brantas river basin. To cope with such environmental problems mentioned above, the idea should be established how to develop the Brantas river basin in future. The idea is in harmony with the desirable form of natural and social conditions in this district.

(2) The development and conservation of the environment in the Brantas river basin.

In the previous sections, solutions to each problem existing in the Brantas river basin were propounded. However, they are only temporary measures for the special problems in certain areas. The fundamental approach to the given environmental problems comprising the problems of water balance, preservation of the natural resources, exessive cultivation at mountain sides, remains to be examined carefully. In other words, the problem of the management of environment and how to harmonize the development with conservation has not yet been discussed enough. To cope with this difficult problem would require higher point of view in terms of development and environmental conservation. To clarify the nature of environmental problems already existed in the basin must be the prerequisite for the solution to this problem. Bearing these in mind, described is an idealized environment which may provide guiding principles in making future plans for development.

The idea :

"It must be realized in the Brantas river basin that natural disasters seldom occur, the basin must be free from environmental pollutions (no noise, vibration, bad smell or land subsidence in residential areas), the resident can enjoy well-provided water supply, drainage and waste disposal systems in addition to good sanitary environments, sufficient medical and cultural facilities such as play grounds, public halls, libraries, museum etc. are available, precious natural resources and environment in the basin must be preserved, while available lands are made best use of, and high living standard brought about through sound economic activities makes it possible for people in the basin to have confortable lives, and harmonies environments must be developed." (In fact, the time schedule for realization of such idea must also be set up.)

The details of the idea mentioned above are to be put in orders as follows.

(a) Project in the basin have to be carried out taking the political and economic situations in the Republic of Indonesia and Java Island into consideration. For the propose of setting up the future ideal conditions in the Brantas river basin, well organized development must be implemented. The effect of development upon the environments in the Brantas river basin must be examined carefully in order to develop a harmonious environment.

(b) The protection of human life and property should be considered the matter of primary importance.

(c) Environmental problems threatening human life and health must be exterminated in taking necessary steps to meet the situation.

(d) The endeavour to improve or maintain hygienic environments must be given high priority.

(e) Enchanging economic and living standard must also be given high priority.

(f) Pleasant and safe natural environments for human being must be conserved and developed carefully.

Based on these ideas, concrete schemes can be shown as follows

As to the development and environmental conservation in the Brantas river basin, comprehensive guides must be set up aiming at the prevention of natural disasters and environmental pollutions. They are the elevation of economic and living standard and the conservation of natural environments etc. In order to perform this objective the desirable form of nature, society and living conditions must be clarified.

According to its special characteristics of natural condition and present land use, the Brantas river basin should be divided into three areas: an upper reach area around volcano (Mt.Bromo, Semeru, Arjuno, Kelud) from the origin to Tulungagung, a middle reach area from Tulungagung to Mojokerto including the Widas river basin, and a lower reach area from Mojokerto to the river mouth.

Natures and roles of each area in the river basin must be clarified. The natural environments and resources such as water in the upper reach area must be preserved, while the middle reach and lower reach area are reserved for agricultural activities and for industrial, commercial and residential areas respectively. Development and conservation of the environment must be implemented, considering their own characteristics of areas.

Furthermore, the river basin may be divided into three districts. The first district is the one where development must not or cannot be carried out. In the second district, development must be restricted and they are strongly encouraged in the the third one.

In the first district, natural environments should be preserved and reservations may be set up for that purpose. Efficient and intensive development is to be carried out in the third district while the second one is expected to be something between the first and third districts. The establishment of effective administration systems and through enforcement of adopted policies are expected.

In setting up guide, it is desirable to investigate other developments of the basin in advanced countries as well as Indonesia. And all kinds of data of present environmental condition in Brantas river basin are to be collected and filled.

In dealing with the future condition of the basin, it would be helpful to grasp the potential of the Brantas river basin divinding the area into meshes and, in each mesh, evaluating the natural and social environments such as the topography, the distribution of natural resources (minerals, soils, water, etc.), plants and animals, population, land use and agricultural production, industrial and economic structure and transportation etc.

The following subjects are to be suggested as a conclusion.

- To collect and file the data on the environmental condition of the whole Brantas river basin.

- To organize a commitee to lead the development in the Brantas river basin, consisting of political personnels, men of learning and experience, representation of each local governments, engineers, etc.

In order to file the data and evaluate the environmental conditions in the Brantas river basin, the following 'mesh evaluation method' that measures a land potential is set up.

- To divide the entire basin into numbered meshes

- To analyse and itemize the present environmental situations to be studied (Refer to RRM)

- Under the present environmental situations, quantitative evaluations have to be made on each mesh. (For instance, the evaluations of each item are made quantitatively with the ranks of 0 - 5).

- To compare the above evaluation with the present phases of environmental developments

- To grasp the environmental capacity in each area

- To arrange the conditions imposed on development

- To compare given evaluation results with development plan and examine the plans and potentials of development based on this comparison.

The evaluations of potentials in the Brantas river basin gives loacal and entire capacities of the basin.

The result of this evaluation and development guides or policies will clarify the roles of each area and the outlines of definite development projects on population, agricultural, industrial, commercial, economic and city-planning problems and so on without difficulty.

However, what we have to think over is a fact that the negative effects of human activities on our living environments and eco-system will innevitably come into existence as long as we try to develop a confortable and economically advanced city or artificial environment. And independent efforts to solve the local environmental problems are insufficient to save the whole situation. We must realize that sound human activities are also allowed to exist on the subtle balances in the natural eco-system. That is to say, we have to develop surroundings in which humanity as a member of living creatures can sustain their lives safely and continuously. And within the framework of this policy, what should be established are the idealistic guides or definite plans of how to create cultures that enable further developments.

Our development should not be restricted to a mere environmental preservation, but to an active creation of stable and diversified living environment.

The environmental preservations are not the problems of our contemporaries only. The problem consists in securing precious living environments.

Foreseeing a desirable relations between man and the nature in the Brantas river basin, efforts are actively made to develop a excellent environment that secures our existence and promises human prosperity.

4. Master Plan

4.1 Conclusion of Sector Study

Conclusion of each sector study is summarized hereunder.

(1) Agriculture and Irrigation

In this sector, there are five projects under construction. They are Waru-Turi Irrigation, East Java Irrigation Rehabilitation, Lodoyo-Tulungagung Irrigation, P2AT Kediri-Nganjuk and East Java Groundwater Irrigation. Wonorejo dam and irrigation project has completed its detailed design. These projects are to be implemented as scheduled.

Irrigation development is studied from the viewpoint of regional equity. Comparing the cropping intensity of main staple food - rice, the Lesti Left area, Trenggalek area, Widas North area and Beng-Gottan-Losari area are found below the average of the basin. For the Trenggalek area, Tugu dam and irrigation project has been proposed by BRBDEO. The Widas North (Widas extension area) and Beng areas are planned with storage reservoirs. The Lesti Left and Gottan-Losari are planned to take water from the Brantas river.

According to the water balance in future, very tight supply condition is foreseen. Therefore, it is considered that implementation of new irrigation projects and rehabilitation projects should depend on the availability of water resources.

Projects with low EIRR based on the present price structure will be postponed after the year 2000.

(2) Domestic and Industrial Water

Supply of safe water is a vital need of all the inhabitants in the basin and domestic water supply is given the highest priority among various water uses. Potential domestic water demand in future is estimated taking into account growth of the basin population, urbanization and increase in the unit water demand per capita.

Location of industries, in principle, is adjustable according to availability of resources, including natural resources and economic infrastructures. Since the economic infrastructures in the Surabaya area are comparatively well developed and seem to be attractive to industries, industrial water is taken into account with priority basis.

As for water sources for the domestic and industrial water supply, trans-basin plan from the Solo river is one alternative. However, as far as cost of development of storage reservoir in the basin is cheaper than or comparative to the trans-basin plan, development of dam and reservoir within the basin is preferable.

In order to secure water resources for domestic and industrial water use up to the year 2000, development of push-back water from the Ngrowo river basin, Wonorejo dam, Umbulan spring and Beng dam is conceived together with full utilization of the existing reservoirs.

(3) Flood Control

(a) Flood control in Main Reaches

Flood flow analysis is made under the condition that future development in the tributaries will not increase the peak discharge in the main stream, and the retarding basins will be kept as they are. Results of analysis including the recent large floods reveals the newly estimated larger than the probable floods planned in the present flood distribution for the Middle Reaches River Improvement project. The present design floods which are regarded as 50 years floods are assessed to be 20 - 40 years floods in the newly estimated probable floods.

In case Mt. Kelud erupts, it would be inevitable that the riverbed in the main Brantas will rise by 1 to 2 m transitionally for several years after the eruption, even necessary sabo works are carried out. The riverbed rise will result in the discharge capacity decreases below the capacity equivalent to 10 years probable flood in the present design flood distribution, and the safety against flood will become very low.

For discharging the newly estimated 50 years probable floods safely even after the eruption of Mt. Kelud two alternatives are conceivable; one is improvement of the main stream channel up to the rivermouth, and the other is flood diversion to the Indonesian Ocean through a diversion canal and tunnel. The former will need not only huge construction cost but also will bring sociological problems to the riparian area. In this context, the flood diversion plan to the Indonesia Ocean is recommended.

(b) Flood control in the Widas basin

In case the retarding effect in the Widas basin is decreased, flood discharge in the lower Brantas will increase accordingly. Hence, flood control works in the Widas basin are obliged to wait for improvement of the lower main reaches or diversion plan. Since the Widas basin has suffered from habitual inundation for long years, urgent improvement is desired. Therefore, the flood control plan in the Widas basin is contemplated in such that it will not bring about increase of outflow from the Widas to the main Brantas (allowable maximum outflow of 270 m^3/sec).

As for measures of flood control, following works are planned;

- river channel improvement
- modification of the present natural retarding basin into controllable retarding basin

- construction of new flood diversion channel

- combination of the above three

Feasibility study on the flood control plan will be made in Part-II Study.

(c) Tributaries in the Mt. Kelud area

Presently, river channel improvement works have been carried out by Mt. Kelud project. Basic criteria for planning of flood control in the area is not to increase flood inflow to the main stream from the flood inflow under the present conditions.

The present conditions are assessed by the regime theory based on the present wide riverbed. In case there is a sand pocket with retarding effect in the upstream area, the river width of such river can be reduced by a width equivalent to the retarding effect in the sand pocket. Otherwise, the river width shall be kept as the width determined by the regime theory.

(4) Watershed management

Within the Brantas river basin, three areas are examined.

(a) Lesti river/Upper Brantas

In this area, there are erodible areas. High concentration of sediment flow is observed in Lesti river. The important Karangkates reservoir exists and Segguruh dam is under construction in this basin. For elongation of life time of the Karangkates and the Segguruh reservoirs, Sabo dams and reforestation with terracing in the critical area are recommended.

(b) Upstream of Selorejo reservoir

In case the sediment inflow is kept at the present level, life time of the Selorejo reservoir will be more than 50 years, and there will be no immediate problem. From the general view of watershed conservation, reforestation in the critical parts is recommended.

(c) Mt. Kelud area

Debris control works have been carried out by the Mt. Kelud project based on a plan established by the Government. This plan seems to have been established in well conservative view from Sabo plan. It is recommended that the Debris control works be continued in accordance with the present plan. An alternative plan of balance of the erupted materials is presented in this study from the view of dynamic stability of the main Brantas river channel. Based on the new balance, the remaining sediment control capacity of the existing sabo facilities is deemed insufficient to control large inflow of sediment to the deposit zone in several years after eruption. Preparation of additional control capacity is recommended.

(5) Electric Power

According to power demand forecast by PLN, rapid and large increase in both capacity and energy requirement is foreseen. PLN plans to cope with such requirement mainly by large scale thermal plants and by hydropower in the Central and West Java. However, since the EHV interconnection will remain as single line for the planning period, and it will be risky for peak power supply to rely on hydropower in the Central and West Java. At least 10% of hydropower plant capacity will be needed for the East Java system in order to cope with peak power demand and keep the reliability level of the East Java system.

Hydropower development is recommended as one component of dam developmetn.

(6) Dam Development

Total surface water in the basin on the yearly basis is quite a lot. However, the seasonal variation is also very large. The existing storage capacity in the basin is only 3% of the total amount of surface water in the basin. In order to cope with the future water demand, dam and reservoir development is of vital necessity. Due to the topographic conditions, there are very few sites suitable for conventional development of dam. Therefore, it will be necessary to consider development of trans-basin reservoir, inter-seasonal pumped storage reservoir, and inter-yearly reservoir. To cope with the water demands of domestic, city and licenced irrigation and industries and future industries up to the year 2000, development of Beng dam (inter-seasonal pumped storage) and K. Konto II dam (with trans-basin) is recommended.

Relating to the existing dams, the following are recommended;

- revision of reservoir operation rule of the Karangkates - Lahor reservoir with emphasis of effective utilization of reservoirs for water supply

- examination of heightening of HWL of the Karangkates reservoir by 2 m or so

- examination of spillway capacities of the existing dams (Karangkates, Lahor, Wlingi and Selorejo) based on the current design standard of spillway and recent hydrological data.

(7) Aqua-Culture

The coastal areas of the Brantas Delta has large potential of brackish water fishery. Presently, milk fish and shrimp are cultured but unit yields are not so high.

The Government intends to promote the shrimp culture widely over the nation and the Sidoarjo area is one of the candidates.

According to the report on the brackish water culture in the Sidoarjo area with an area of 13,000 ha prepared by the Government, the minimum fishery water requirement for this areas is estimated at 13.5 m^3/sec. However, from the water balance in the basin, there is little dry season discharge allocatable to brackish water fishery development. As a trial case, one cropping of shrimp in the rainy season is examined, and found economically feasible. Detailed investigation and study on brackish water fishery development is recommended.

(8) Water Allocation Study

According to the water balance study, the available water in the dry season with the storage capacities of the existing and proposed reservoirs can meet the water demands of domestic, city and licenced irrigation and industry, and a part of future irrigation and industry in the year 2000.

There are alternatives of water allocation; irrigation oriented, industry oriented, or other. However, decision on water allocation belongs to the national policy. Then the study presents possible menue without recommendation.

Water balance study so far made assumes high efficiency of water use. If the actual efficiency of water use is lower than the assumed, water demand and supply conditions will become much severer. Therefore, strict management of water demand, supply and use will be a requisite for future water balance.

(9) Water Management System

In order to make efficient and effective use of water and to secure safety against floods, introduction of extensive and intensive water management system to be supported by computer, communication and telemeter systems is recommended.

The system is considered in line with the flood forecasting system to be constructed by the Middle Reaches Project, and recommendation is made to the FF system for collection of hydrological data for supporting the future water management system.

By the time of introduction of the hardware of the system, establishment of organization and institutional arrangement for the system operation is of vital necessity. Recommendation on these matters is made.

4.2 Inter-sectoral Priority

The priority order for implementing the proposed project is considered in accordance with the following principle from the viewpoints of present project status, needs of projects, and economical values.

(1) Priority order in view of the project status

(a) There are many on-going project under construction, completed detailed design and completed feasibility study. As far as the projects have been verified to have technical, economical viability and needs for implementation, such projects are accorded highest priority.

(2) Priority order in view of needs for project realization

(a) A big constraint to the economic and social development in the Brantas river basin is found to be water availability in the dry season. Since water has no alternative, increase of water availability or saving of water use is only a measure to solve this constraint. Therefore, priority of inter-sectoral projects is given to these to develop water resources.

(b) One of the most important strategies of the basin development is recognized to be a regional equity. The projects to realize the economic development in less-developed area are accorded the higher priority.

(3) Priority order among the sectors

(a) Projects concerning water resources development (to create water newly, to minimize water loss, etc.) are given higher priority as above mentioned.

(b) Flood control projects are accorded higher priority since the flood damage potentials have been increasing with the economic development in the basin. The flood control is vital need for safety of human lives as well as the protection of properties.

(c) Projects of agriculture and irrigation are selected as priority ones in view of regional equity development. As far as water availability is confirmed or required water may be extracted from the basin unless it would affect the present water balance, the agriculture and irrigation projects taken up.

(d) The hydropower development project ought to be selected in conjunction with water resource and dam development. Priority given to single purpose hydropower project could be low.

Taking the above basic priority principle, project-base priority is given below.

1st Priority Group

Completion of the on-going projects is given the first priority, provided that the projects will not affect the present water balance.

This group includes the following projects;

- Waru-Turi Irrigation Project Stage 1
- East Java Irrigation Rehabilitation
  It is considered that the water requirement of the areas to be rehabilitated will be the same level of the present
- Lodoyo-Tulungagung Irrigation
- P2AT Kediri-Nganjuk Irrigation
- East Java Groundwater Irrigation
  Since extraction of the groundwater in a large scale may affect the balance between the surface water and groundwater, implementation of this project shall be made with careful monitoring of the balance and should not decrease the available surface water
- Middle Reaches River Improvement 2nd Stage
  This project shall be implemented according to the present design flood distribution
- Tulungagung Drainage Project
- Mt. Kelud Debris Disaster Prevention Project
  Construction of additional control capacity for the next eruption is necessary
- Flood Forecasting System
- Sengguruh Hydropower Project

2nd Priority Group

Project for which feasibility study and/or detailed designs are already completed are given the second priority.

This group includes the following projects;

- Wonorejo Dam and Irrigation Project
- Karangpilan Treatment Works Stage 1 (to continue to Stages 2 and 3)
- Umbulan Spring Development
- Push-back from the Ngrowo Basin
- K. Surabaya River Improvement
- South Tulungagung Hydropower

3rd Priority Group

- Beng Dam and Irrigation
- Widas Flood Control
- Widas Extension Project (Kedungwarak Dam and Irrigation)
- Tugu Dam and irrigation

4th Priority Group

The 4th priority group includes the following projects;

- Water Management System
  Following up the flood forecasting system, introduction of the water management system for lowflow management as well as for highflow management is recommended.
- Water Supply for SMA, other urban and rural

5th Priority Group

The 5th priority group includes the following projects;

- Lodoyo Diversion Schemes
- K. Konto II Dam

The watershed management projects are to be implemented steadily.

Agriculture and irrigation development projects which are not included in the above groups are to be implemented depending on the water availability. Hydropower development projects are to be implemented in association with the dam development.

4.3 Implementation Program

In formulation of the implementation program for the Master Plan, the following guidelines are set force;

(1) On-going Projects
The construction schedule intended for each project is kept.

(2) Projects under detailed design
For the projects which are under detailed design or waiting for financial arrangement upon completion of detailed design, implementation schedule of each project is established in due consideration to the present progress of financial arrangement.

(3) Newly proposed projects
For the project newly proposed in this study or proposed in other preliminary study the following time allocation is taken into account;

- feasibility study	one year
- arrangement for detailed design finance	one year
- detailed design	one or two years
- arrangement of construction finance	one year
- procurement	one year

As seen in the above, at least 5 years will be needed before commencement of construction works.
In case project needs supply of equipment such as turbine and generator, necessary time for manufacturing and transportation of one to one and a half years are taken into account.

Besides the above conditions, projects which have to cover wide area and long distance such as rehabilitation of irrigation system, reclamation of fish pond and river channel improvement, capacity of implementation and economical speed of construction are taken into account.

Based on the above conditions and taking into account the priority of each project as explained in the previous section, implementation schedule of the Master Plan is prepared as shown on Fig. 4.1.

According to the fund requirement study, there may be a possibility to adjust implementation schedule of some projects; slow down or postpone. The projects which can be slowed down or postponed are as explained in the following section.

4.4 Fund Requirement

Fund requirement of each project is based on the following sources of information;

(1) From REPELITA IV

- AI- 1 Warujayeng-Turi-Tunggrono Irrigation
- AI- 2 East Java Irrigation Rehabilitation
  After 1980, same level of fund requirement of Rp.18,000 million is assumed to continue up to 1999 for covering the entire scheduled area of about 25,000 ha.
- AI- 3 Lodoyo-Tulungagung Irrigation
- AI- 4 P2AT Kediri-Nganjuk Irrigation
- AI- 5 East Java Groundwater Irrigation
  Fund requirement after 1988 is based on the unit construction cost of Rp.2.4 million per ha and the annual progress of 3,000 ha.
- AI- 6 Mrican Barrage
  It is assumed that after completion of the barrage, it will become necessary to remove sediment deposit upstream of the barrage of about 600,000 m^3 annually with the cost of Rp.1,200 million.
- FC- 3 K. Surabaya River Improvement
  Disbursement is shifted by one year to the future taking into account the present progress of loan arrangement.
- WS- 1 G. Kelud
  It is assumed that after 1989, same level of fund requirement will continue since the work is ever lasting one.

(2) From project's rep ort (pre-F/S, F/S, D/D, or I/P)

- AI- 7 Wonorejo Irrigation - D/D
- AI- 8 Tugu Irrigation - pre-F/S
- MW- 1 Push-Back from Ngrowo River Basin - pre-F/S
- MW- 2 Karangpilang Treatment Works Stage 1 - F/S
- FC- 1 Middle Reaches River Improvement Stage 2 - I/P
- FC- 2 Tulungagung Drainage - I/P
- EP- 1 Sengguruh Hydropower - I/P
- EP- 2 Wonorejo Hydropower - D/D
- EP- 3 South Tulungagung Hydropower - F/S
- EP- 4 Lesti III Hydropower - F/S
- EP- 5 Tugu Hydropower - pre-F/S
- MP- 1 Wonorejo Dam - D/D

- MP- 6 Tugu Dam - pre F/S
- WM- 1 Flood Forecasting System - I/P

Fund of other projects are estimated in this Master Plan Study.

Annual fund requirement of each project is accorded to the relevant report or estimated based on simplified percentage taking into account scale of project and normal speed of construction.

Total fund requirement of the water resources development in the K. Brantas basin is as shown in Table 4.1. Fund requirement of project with greater uncertainty of implementation is shown with parenthesis.

Contingency of 15% of the total fund requirement is assumed for covering the fund requirement of projects such as increase of spillway capacity of the existing dams, for which cost estimate is difficult at this moment but necessity is confirmed in this study, and the fund requirement for operation and maintenance of the completed projects.

The fund requirement in each year on the 1984 constant price basis including uncertainty project is as follows;

Unit: Rp. billion

Year	Total	Contin-gency	Total
1985	91.8	13.7	105.5
1986	126.7	19.0	145.7
1987	99.9	15.0	114.9
1988	111.8	16.8	128.6
1989	146.9	22.0	168.9
1990	144.4	21.7	166.1
1991	138.1	20.7	158.8
1992	122.5	18.4	140.9
1993	167.8	25.1	192.9
1994	151.8	22.8	174.6
1995	138.1	20.7	158.8
1996	149.9	22.5	172.4
1997	148.1	22.2	170.3
1998	108.5	16.3	124.8
1999	86.8	13.0	99.8
2000	53.2	8.0	61.2
Total	1,986.3	297.9	2,284.2

According to the Government budget in the 1985/86 fiscal year, the development fund is Rp.12,849 billion. The sectoral allocation of the Government development budget in REPELITA IV considered to relate the water resources development is as follows;

- Agriculture and irrigation	12.74%
- Regional, rural and urban development	0.65%
- Housing and human settlement	3.79%
- Natural resources and environment	2.49%
Total	19.67%

If a half of the above is allocatable purely to the water resources development, the amount in a year can be calculated as Rp.1,264 billion. Ratio of the population in the basin to the population in the entire Indonesia in the year 2000 is estimated at 7.6%. If equal distribution of development budget is assumed, the allocatable amount to water resources development in the basin is Rp.96 billion in a year on the present price level.

The estimated annual fund requirement is 1.5 to 2.5 times of the above figure. However, the basin has the second largest city in Indonesia which will generate large amount of water demand due to economic development associating large scale urbanization. From the viewpoint of the national economy, it is considered that economic development in the Surabaya area is highly desirable since basic infrastructures to be needed for economic development except water is already available in the Surabaya area.

If the annual fund for the water resources development in the K. Brantas basin is to be restricted by the national policy, it is obliged to postpone some projects and also to slow down implementation of some projects. Table 4.2 shows the alternative fund requirement obtained on the assumption that the annual fund requirement is to be within 1.5 times of the 1985 level at the maximum.

Slow down of implementation

- East Java Irrigation Rehabilitation Project
- East Java Groundwater Project
- Karangpilang Treatment Works 2nd Stage
- Water Supply to SMA, Urban and Rural
- K. Surabaya River Improvement 2nd Stage
- Widas Flood Control and Drainage
- Watershed Management System

Postpone after year 2000

- Lesti Left Irrigation
- Gottan-Losari Irrigation
- Lodoyo Diversion Scheme
- Genteng I Dam
- Lumbansari Hydropower
- Kepanjen Hydropower

Selection of the original plan or the reduced plan will be subject to the national policy.

4.5 Action Plan for Master Plan

For evolving the Master Plan toward its implementation, the feasibility study and detailed design of the proposed projects are to be carried out according to the project status. In this regard, it is recommended that the following actions are to be taken especially for the newly proposed projects in this study.

(1) Agriculture and irrigation project

- Widas irrigation extension project
  The F/S of this project will be conducted in the Part II study of this study. Action Plan will be clarified in the stage of F/S;

(2) Water supply project

- Push back from Ngrowo river basin
  Hydrological observation in order to get more correct data on available return flow from irrigation field (Lodoyo and Tulungagung irrigation project);

(3) Flood Control Project

- Surabaya river Improvement Project
  Detailed survey of present network of drainage channel system and water quality observation;

- Widas Flood Control Project
  The F/S of this Project will be conducted in Part II of this study. Action Plan will be clarified in the stage of F/S.

(4) Dam Development Plan

- Beng Dam and Konto II Dam Projects
  Hydrological observation to get the more collect data on available water
  The other survey concerning the geological investigation of dam sites and the investigation of land use within the reservoir area;

- Kedungwarak Dam for Widas Irrigation Extension Project
  Part II study of this study will clarify the action plan for this Project;

(5) Watershed management

- Upper Brantas and Lesti area
  More precise investigation on erodibility in the proposed basin area
  Hydrological observation including sediment and discharge at the proposed Sabo dam sites
  Monitoring of experimental terrace for the prevention of landslide and land erosion.

- Upper K. Konto area
  Monitoring of experimental terrace for the prevention of landslides and land erosion

- Mt. Kelud area
  More precise investigation on eruption material distribution especially at the time of next eruption when it occurs.
  Monitoring sediment deposition in the existing sand pockets and sabo facilities including river profile changes in the deposition area

- Ngrowo river basin
  Precise investigation on erodibility in the said basin
  Sediment deposition in the Parit Raya and Parit Agun canals to clarify the real sediment problem in the basin

(6) Water management system

Detailed investigation of organization and institution relating to water management system

During this study for reviewing Brantas river basin development master plan, it was found out that some basic data are incomplete or inaccurate. More accurate survey and investigation would be needed as a whole. The master plan in nature should be updated as needed and be reviewed again after 10 years or so. The survey and investigations recommended below will be very important to give the fundamental data for updating master plan in future.

(1) Socio-economic conditions

* Up-dating of socio-economic conditions
  The socio-economic conditions are the basis of the Master Plan. Continous efforts to up-dating of the socio-economic conditions are needed. Among others, population, production and regional income data is needed.

(2) Land resources

* Up-dating of land use data
  The land use in the basin will change from time to time due to urbanization, industrialization and others. Changes in the land use will bring effects to the hydrological settings in the basin, increase in flood peaks and decrease of lowflow. Therefore, continuous monitoring of the land use condition is needed.

(3) Water resources

* Simultaneous discharge measurement at the gauging stations along the main Brantas river and major tributaries
  Although discharge measurements have been continued, there still remain questionable data. For example, large discharge at Jongbiru than Jobon. Simultaneous and continuous discharge measurement is needed to clarify these point.

* Basin-wide groundwater survey
  At present, the groundwater potential in the basin is investigated in the limited locations by irrigation and water supply projects. In order to utilize the groundwater together with the surface water to the maximum extent, basin-wide groundwater survey is needed.

(4) Project benefit monitoring and evaluation

For all the projects to be implemented, project monitoring and evaluation is needed.

(5) The survey of water quality

- Long-term survey of water quality in the downstream of the Brantas river, Surabaya river and their tributaries to clarify the water polution problem

(6) The survey of aqua-culture

- Survey of present aqua-culture industry in other areas

- Survey of seasonal fluctuation of salinity of brackish water in the area of Sidoarjo

- Study on possibility of aqua-culture planning

TABLES

Table 1.1 THE MEMBERS OF THE ADVISORY COMMITTEE, THE STUDY TEAM AND THE COUNTERPART

THE MEMBER OF ADVISORY COMMITTEE

1.	T. IWAKIRI	CHAIRMAN	Water Resources Development Public Corporation
2.	T. YAMAZAKI	RIVER	Ministry of Construction
3.	K. OKAYAMA	HYDROLOGY	National Land Agency
4.	M. WATANABE	AGRICULTURE/IRRIGATION	Ministry of Agriculture, Forestry and Fisheries
5.	M. HAYASHIDA	AGRICULTURE/IRRIGATION	Ministry of Agriculture, Forestry and Fisheries
6.	H. KOBAYASHI	SABO	Ministry of Construction

COORDINATOR

1.	M. FUWA	JAPAN INTERNATIONAL COOPERATION AGENCY

THE MEMBER OF STUDY TEAM AND COUNTERPARTS

No.	Sector	Name	
		The Study Team	Counterparts
1.	Team leader	H. Sato	Ir. SOENARNO Dipl. HE.
2.	Co-leader and Dam	S. Ohtsuki	Ir. Sukistiyono Dipl. HE. Ir. Mulyadi
3.	Water Resource	T. Imai	Ir. Kusmartini,
4.	River	T. Nobe	Ir. Widiastuti, Ir. Idham, L.O.
5.	Agriculture	K. Onaka	Ir. Sunu Suprapto, Ir. Puguh Saktiono
6.	Irrigation	H. Matsuura	Ir. Rudy Suwarto, Ismi Farida, Achron, Ir. Agus Surwanto, Moh, Sahid
7.	Hydrology	S. Sakamoto	Drs. Nugroho
8.	Soil Mechanics	Y. Nakano	Ruskandi, BE
9.	Water Supply	M. Kawaguchi	Waskito. BE, Fathony
10.	Sabo	T. Nishiguchi	Wagiyo. BE, A. Djunaidi, Soemorto
11.	Aqua-culture	-	Dr. Ismudi, Rustidya
12.	Electricity	H. Ebisawa	Ir. Moh. Anwar, Syamsudin
13.	Water Management	H. Ueda	Ir. Sri Astuti, Sutadi. BE
14.	Environment	T. Ohhashi	Ir. Danu Wijay Ir. Sugeng Bahagia
15.	Surveyor	-	Syamsul Bakri
16.	Project Economy	M. Tada	Drs. Choirun Najib.

Tab.e 2.3.1 GROSS DOMESTIC PRODUCT AND INVESTMENT
1983/84 - 1988/89 (CURRENT PRICE)

Unit: 19^9 Rp.

	1983/84	1984/85	1985/86	1985/86	1987/88	1988/89	REPELITA IV
1. GDP	73691.6	84465.3	96578.5	109624.3	123514.6	138126.6	552309.5
2. Investment	16678.0	19116.3	23533.0	28337.4	34221.1	40026.1	145224.5
a) Government Development Expenditure	9195.8	10459.3	12849.0	15415.2	21343.4	21342.6	78609.5
b) Others	7482.2	8657.0	10684.0	12922.2	15667.7	18684.1	66615.0
3. Investment GDP Ratio	22.6%	22.6%	24.4%	25.8%	27.7%	29.0%	26.3%

Source : REPELITA IV (A Summary)

Table 2.3.2 SECTORAL ALLOCATION OF GOVERNMENT DEVELOPMENT BUDGET 1984/85 AND REPELITA IV

Unit : (10^9) Rp. Current Price

	1984/85	REPELITA IV	PERCENTAGE
1. Agriculture and Irrigation	1,401.7	10,014.3	12.74
2. Industry	650.0	4,281.9	5.45
3. Mining and Energy	1,300.9	12,125.9	15.43
4. Communication and Torism	1,392.1	9,923.1	12.62
5. Trade and Cooperation	127.1	969.2	1.23
6. Manpower and Transmigration	675.1	4,551.8	5.80
7. Regional, Rural and Urban Development	809.9	5,379.1	6.84
8. Religion	62.9	507.2	0.65
9. Education, Youth, Culture and Sipiritual Development	1,501.9	11,539.5	14.68
10. Health, Social Welfare Role of Women, Population and Family Planning	408.0	3,516.5	4.47
11. Housing and Human Settlement	432.7	2,980.6	3.79
12. Law	80.4	629.2	0.80
13. National Defense and Security	697.8	5,238.9	6.66
14. Information, Press and Social Communication	67.1	498.6	0.63
15. Sience, Research and Technology	205.9	1,757.7	2.24
16. State Apparatus	162.0	1,047.4	1.33
17. Business Enterprise Development	226.9	1,689.7	2.15
18. Natural Resources and Environment	256.9	1,958.8	2.49
T o t a l	10,459.3	78,609.5	100.0

Source : REPELITA IV

Table 2.3.3 SELECTED TARGETS : AGRICULTURE GROWTH RATE BY SUBSECTOR 1983/84 - 1988/89

	Annual Growth Rate (%)
1. Food Production	3%
(of which is Rice)	(4%)
2. Annual Husbandary	2.1%
3. Fishery	2.4%
5. Plantation	3.7%
6. Forestly - logs	7.1%
- Forest Product	6.6%
Total Agriculture	3.0%

Source : REPELITA IV

	1983	1988
A. Food		
Rice Production (10^3) ton	23,462	28,624
Harvested Area (10^3) ton	9,043	9,726
(of which : Intensification)	7,000	9,240
Average Production (tons of rice)	2.60	2.94
B. Plantation Area		
Rubber (10^3) ha	2,466.1	3,113.1
Oil palm (10^3) ha	494.8	975.8
Sugar cane (10^3) ha	382.3	397.3

Source : REPELITA IV

Table 2.3.4 Economically Active Population by Type of Main Occupation East Java, in 1980

Occupation	Persons	%
Professional, technical and related workers	263,863	2.3
Managers and administrator	15,719	0.1
Clerical and related workers	378,053	3.3
Sales workers	1,570,923	13.6
Service workers	615,910	5.3
Farmers	6,428,279	55.6
Production, Transport equipment operators	2,052,648	17.8
Others	232,648	2.0
Total	11,557,704	100.0

Source : Jawa Timur Dalam Angka, 1982

Table 2.3.5 ECONOMICALLY ACTIVE POPULATION BY EDUCATIONAL ATTAINTMENT, EAST JAVA IN 1980

Educational Attaintment	Person	%	
Never attended school	3,371,845	29.2	
Not yet finished primary school	4,307,094	37.2	66.4
Primary school	2,531,368	21.9	
Junior high school (general)	456,529	3.9	
Junior high school (vocational)	136,959	1.2	
Senior high school (general)	375,857	3.3	
Academy	55,708	0.5	
University	43,688	0.4	
Not stated	4,854	-	
Total	11,557,704	100.0	

Source Dalam Angka, 1982

Table 2.3.6 GRDP IN EAST JAVA

	GRDP			Sectoral share in 1975 const.		Annual Growth Rate 1975-82
	1975	1982	1982	1975	1982	
	Current Rp.10^9	Current Rp.10^9	1975 const. Rp.10^9	%	%	%
1. Agriculture	808.2	2,915.1	1,057.3	42.9	32.5	3.9
(1) Form food crop	659.0	2,234.3	818.2	35.0	25.2	3.1
(2) Small holder estate crop	44.0	257.1	115.5	2.3	3.5	14/3
(3) Estate crop	33.5	47.7	18.5	1.8	0.6	-8.1
(4) Livestock	50.3	266.8	77.4	2.7	2.4	6.4
(5) Forestry	7.1	20.8	6.8	0.4	0.2	-0.7
(6) Fishery	14.3	88.4	23.9	0.8	0.7	7.6
2. Mining & quarrying	3.7	17.4	7.9	0.2	0.3	11.1
3. Industry	21.1	1,284.8	500.3	11.7	15.4	12.4
4. Electricity, gas & water	8.3	56.3	27.2	0.4	0.8	18.4
5. Construction	13.5	78.7	37.1	0.7	1.1	15.6
6. Trade, hotel, restourant	389.4	2,140.9	822.5	20.7	25.3	11.3
7. Transport and communication	119.6	633.5	238.8	6.3	7.4	10.4
8. Band & Others	25.1	141.9	49.9	1.3	1.5	10.3
9. Ownership by dwelling	43.9	165.0	76.0	2.3	2.3	8.2
10. Public administration	209.1	910.1	364.2	11.1	11.2	8.3
11. Services	43.4	183.9	68.0	2.3	2.1	
GRDP	1,885.2	8,527.6	3,249.3	100.0	100.0	

Source : Dalam Angka, 1982

Table 2.3.7 PRODUCTION OF AGRICULTURE SECTOR IN 1982

Items	Harvested Area (ha)	Unit Yield ton/ha	Production ton
Food Crop			
Paddy	1,506,941	4.82	7,261,842
Maize	882,125	1.77	1,557,340
Cassava	408,146	10.67	4,365,535
Sweet potato	33,078	7.44	246,214
Peanuts	137,704	1.01	137,811
Soybeans	308,232	1.01	311,337
Vegetables	163,028	-	353,984
Fruits	-	-	*
Cash/Estate Crops			
Rubber			19,967
Coffee			29,510
Cocoa			5,973
Tea			3,239
Clove			2,243
Coconut			145,260
Capok			23,877
Abaca			251
Cassiavera			22
Anacarclium Occidentate			4,947
Nut-meg			3
Areca Palm			8,421
Sugarcane			1,035,654
Tobacco			66,442
Cotton			2,229
Roselle			4,975
Forestry			
Building wood (m^3)			374,803
Fire wood (m^2)			193,436
Livestock			
Meet (ton)			143,278
Milk 1000 ℓ			46,496
Egg ton			66,498
Fishery			
Catch in the sea			154,424
Brackish fish pond			49,187
Others			11,192

* Unknown

Source : Dalam Angka, 1982

Table 2.3.8 MANUFACTURING INDUSTRY IN EAST JAVA, 1982

Size Class of Industry	Number of Establish-ment	Total Employee	Output Value	Input Value	Value Added	Percent %
Industry of Foods, Drink & Tobacco	776	166,144	1,639,923	912,575	727,349	71.9
Industry of Textile, Ready Clothes, Leather	234	32,011	166,205	77,957	38,248	3.8
Industry of Woods and products of woods Furniture	69	9,064	79,070	50,892	28,179	2.8
Industry of Paper Printing, Publishing	62	7,239	49,515	36,943	12,572	1.2
Industry of Chemicals, Oils, Coals, Rubbers, Plastics	187	22,789	335,082	233,900	101,182	10.0
Industry of Mineral non Metal except Oils and Coals	160	13,369	102,987	62,155	40,831	4.0
Industry of Metal Nature	4	1,651	20,131	17,601	2,530	0.3
Industry of Products Metal, Machine and applian	184	26,602	155,021	95,205	59,816	5.9
Industry of others Manufecture	14	616	725	476	249	0.1
Total	1,690	279,485			1,010,956	100.0

Source : Central Bureau of Statistic Jakarta

Table 2.3.9 EXPORT AND IMPORT, EAST JAVA, 1982

Unit ; Volume : ton Value : US$ 1000

	Volume	Value
A. EXPORT		
Principle Goods		
1. Rubber	19,812	15,344
2. Coffee	23,807	39,657
3. Tobacco	15,076	25,326
4. Dried Cassava	118,635	9,170
5. Coprah	133,078	14,017
6. Mollases	253,035	8,417
7. Maize	541	111
Total	563,984	112,042
Kind of Leather		
1. Goat	1,475	7,203
2. Cow	480	1,587
3. Sheeps	181	2,308
Total	2,136	11,097
Kind of Industry		
1. Woods	462	675
2. Textile	33	96
3. Tungkwan Lamp	236	1,217
4. Rattan	143	904
5. Garment	1,534	4,467
6. Ceramics	9	4
7. Oven	5	149
Total	2,426	7,512
Other Industry		
1. Cocoa	3,187	4,793
2. Rice Bran	53,398	4,622
3. Wheat Bran	115,339	8,906
4. Shrimps Crisply	*	5,507
5. Frog Foot	979	3,153
6. Birds Nest	25	120
7. Edible Sea-Cucumber	99	15
8. Transfusion drops	1,214	2,567
9. Animals Bone	1,850	103
10. Sandal	12	11
11. Wrist watch	100	26
12. Lola	36	4
Total	176,240	29,917

B. IMPORT

Kind of goods	Value	%	Kind of goods	Value	%
1. Foods/Drinks	15,910	2.82	6. Textile, Strap	18,712	3.32
2. Mineral	23,597	4.18	7. Machines and Electricity	94,112	16.68
3. Chemistry	214,084	37.95	8. Metals	95,062	16.68
4. Fuel	2,624	0.46	9. Transport Material	6,813	1.21
5. Papers, Books, other Printers	29,679	5.56	10. Others	63,597	11.27
Totals				564,189	100.00

Source : Trading Office Department.

Table 2.3.10 BUDGET OF EAST JAVA, 1982

Unit : Million Rp.

Description	Realization	
A. OPERATING RECEIPT		
1. Previous Yearsurplus	6,713	
2. Receipt from Government	204,932	
3. Provincial internal revenue service	54,494	
a. Local tax	35,766	
b. Local retribution	2,641	
c. Profit distribution from Region Interpice	342	
d. Income service	1,877	
e. Others revenue	13,869	
Totals of operating receipt	266,140	(95.5%)
B. DEVELOPMENT RECEIPT		
1. Previous year surplus	100	
2. Income which is comes from the higher constitution	12,363	
3. Authentic Region income	-	
4, Loan receipt	-	
Totals of Development receipt	12,463	(4.5%)
Totals of Receipt (A + B)	278,603	(100.0%)
C. OPERATING EXPENDITURES		
1. Personnel Expenditures	151,083	
2. Material Expenditures	12,653	
3. Maintenance Cost	1,642	
4. Official Selling expenditures	583	
5. Others expenditures	6,025	
6. Pensioner Expenditures	6,205	
7. Subsidies for under of region	44,838	
8. Other Expenditures	4,550	
9. Unexpected Expenditures	92	
10. Wessel duty	133	
Total of Operating expenditures	227,804	(83.2%)
D. DEVELOPMENT EXPENDITURES		
1. Economic Field	13,340	
2. Social Field	9,863	
3. General Field	15,867	
4. Capital Transfer to Lower level regions	7,058	
Total of Development expenditure	46,128	((16.8%)
Totals (C + D)	273,932	(100.0%)

Source : Govenor's Office

Table 2.3.11 FOOD PRODUCTION TARGETS IN EAST JAVA

Food	1984	1985	1986	1987	1988
Paddy	7.24	7.62	7.87	8.12	8.38
(Rice)	(4.92)	(5.18)	(5.35)	(5.52)	(5.70)
Maize	2.29	2.40	2.52	2.64	2.77
Cassava	3.94	3.99	4.05	4.12	4.18
Sweet Potatoes	0.28	0.28	0.29	0.30	0.30
Peanuts	0.15	0.15	0.15	0.16	0.16
Soybeans	0.41	0.43	0.49	0.49	0.53

Source : Repelita IV (East Java) Statistik Indonesia 1983
Production of rice converted from paddy at 68 %.

Table 2.3.12 PERCENTAGE OF INDUSTRIAL CONTRIBUTION TO EAST JAVA GRDP

	1984	1985	1986	1987	1988	1989
Percentage (%)	19.18	20.72	22.40	24.15	25.99	27.89

Source : Repelita IV (1984/85/89)

Table 2.3.13 POPULATION IN 1961, 1971 AND 1980 BY REGENCY
POPULATION DENSITY IN 1980 BY REGENCY

Kab/Kodya	1961	1971	1980	Annual Growth Rate of Population (%) 1961 - 1971	1971 - 1980	Density person/ km^2
Kab						
Trenggalek	438,857	521,279	564,542	1.74	0.89	468
Tulungagung	675,349	759,850	833,323	1.19	1.03	790
Blitar	839,952	950,802	1,037,258	1.25	0.97	622
Kediri	918,036	1,080,695	1,235,265	1.64	1.50	1,283
Malang	1,464,106	1,767,055	2,045,939	1.90	1.64	428
Sidoarjo	541,051	667,639	854,298	2.12	2.78	1,445
Mojokerto	494,492	596,185	705,596	1.89	1.89	844
Jombang	686,362	812,485	941,988	1.70	1.66	813
Nganjuk	675,906	774,590	882,282	1.37	1.46	746
Kod						
Surabaya	1,007,945	1,550,255	2,027,913	4.40	3.03	7,401
Blitar	62,972	67,856	78,503	0.75	1.63	4,906
Malang	341,452	422,428	511,780	2.15	2.15	7,417
Mojokerto	51,732	60,013	68,849	1.50	1.54	9,496
Kediri	158,918	178,865	221,830	1.19	2.42	3,498
Total	8,367,131	10,209,997	12,009,366	2.01	1.82	865
East Java	21,823,021	25,526,714	29,188,852	1.58	1.50	603

Source : Population Census of East Java 1980

Table 2.3.14 URBAN AND RURAL POPULATION IN THE BASIN, 1980

	Urban	Rural	Total	Urban Ratio %
Kabupaten				
Trenggalek	29,318	535,207	564,525	5.2
Tulungagung	141,094	692,078	833,172	16.9
Blitar	74,245	962,930	1,037,175	7.2
Kediri	79,576	1,155,450	1,235,026	6.4
Malang	194,069	1,851,635	2,045,704	9.5
Sidoarjo	185,354	668,331	853,685	21.7
Mojokerto	47,848	657,699	705,547	6.8
Jombang	109,442	832,347	941,789	11.6
Nganjuk	87,332	794,775	882,607	9.9
Kotamadya				
Kediri	173,433	48,203	221,636	78.3
Blitar	75,509	2,872	78,381	96.3
Malang	469,660	41,246	510,906	91.9
Mojokerto	68,507	-	68,507	100.0
Surabaya	1,767,721	249,806	2,017,527	87.6
Total Mean	3,503,608	8,492,579	11,996,187	29.2
	29.2 %	70.8%		

Source : 1980 Census

Table 2.3.15 POPULATION BY AGE GROUP, 1980

Kab./Kod.	Age group						
	0 - 4	5 - 9	10 - 14	15 - 24	24 - 49	over 50	Total
Kabupaten							
1. Trenggalek	61,650	76,820	74,681	105,821	167,502	78,051	564,525
2. Tulungagung	92,532	110,021	103,902	155,880	247,386	123,451	833,172
3. Blitar	111,051	135,366	132,194	192,439	313,049	153,076	1,037,175
4. Kediri	145,516	165,339	155,058	235,259	358,517	175,337	1,235,026
5. Malang	241,172	267,068	244,663	387,298	624,464	281,039	2,045,704
6. Sidoarjo	103,284	110,725	107,323	188,060	247,262	97,031	353,685
7. Mojokerto	79,922	95,370	90,443	143,296	209,413	87,103	705,547
8. Jombang	112,657	125,903	120,046	183,114	271,760	128,309	941,789
9. Nganjuk	106,887	119,249	108,708	159,565	259,694	128,504	882,607
Kotamadya							
10. Kediri	26,056	26,696	25.642	52,700	61,934	28,608	221,636
11. Blitar	8,555	9,099	,433	17,613	22,170	11,511	78,381
12. Malang	58,965	59,004	56,833	124,065	149,248	62,791	510,906
13. Mojokerto	7,737	7,966	8,038	15,814	19,734	9,218	68,507
14. Surabaya	241,655	234,916	216,003	478,555	639,982	206,416	2,017,527
Total	1,397,639	1,543,542	1,452,967	2,439,479	3,592,115	1,570,445	11,996,187
%	1.7	12.9	12.1	20.3	29.9	13.1	100.0

Source : Dalam Angka 1981

Table 2.3.16 PERCENTAGE OF ECONOMICALLY ACTIVE POPULATION BY SECTOR

Unit : %

Kab./Kod.	Agri-culture	Indu-try	Const-ruction	Trade	Transport	Service	Others
Kabupaten							
Trenggalek	57.67	2.51	-	4.08	-	2.89	32.85
Tulungagung	85.85	2.76	0.17	3.16	0.29	7.57	0.20
Blitar	61.14	2.34	1.26	14.18	1.86	13.77	5.45
Kediri	86.00	1.33	2.02	9.68	0.65	0.14	0.18
Malang	56.0	8.32	4.70	13.70	4.44	5.66	7.18
Sidoarjo	33.8	8.3	4.6	7.0	1.3	9.1	35.3
Mojokerto	80	5	3	3	2	5	2
Jombang	59.46	4.01	6.47	12.26	0.41	7.88	9.51
Nganjuk	43.64	2.51	0.17	3.16	0.29	7.57	42.66
Kotamadya							
Kediri	6.5	6.1	2.5	6.1	5.2	12.3	61.3
Blitar	16.8	52.13	1.26	14.18	1.86	13.77	
Malang	23.93	37.53	0.81	17.74	13.66	6.20	0.13
Mojokerto	8.38	9.57	5.21	14.10	1.70	52.50	8.54
Surabaya	6.26	14.92	4.06	21.19	13.28	32.15	8.19

Source : Man Power Census 1983

Note : data on Sidoarjo are based on 1980 figures

Above figures show tendency only

Table 2.3.17 ECONOMICAL ACTIVE POPULATION BY SECTOR IN THE BASIN
1980

Unit : Person

Kab./Kod.	Economic Active	Agri-culture	Manufac-ture	Cost-ruction	Trade	Trans-portion	Services	Others
Kabupaten								
1. Trenggalek	273,321	157,625	6,960	-	11,151	-	7,899	89,786
2. Tulungagung	403,268	346,203	11,130	685	12,743	1,169	30,527	806
3. Blitar	505,488	309,055	11,828	6,369	71,678	9,402	69,605	27,549
4. Kediri	593,776	510,647	7,897	11,994	57,477	3,859	831	1,068
5. Malang	1,011,758	566,586	84,178	47,552	138,611	44,922	57,265	72,644
6. Sidoarjo	435,322	147,138	36,131	20,025	30,472	5,560	42,226	153,668
7. Mojokerto	352,709	282,167	17,635	10,581	10,581	7,054	17,635	7,054
8. Jombang	454,874	270,468	18,240	29,430	55,767	1,864	35,844	43,258
9. Nganjuk	419,259	182,964	10,523	0,712	13,248	1,215	31,737	178,855
Kotamadya								
10. Kediri	114,634	7,451	6,992	2,865	6,992	5,960	14,099	70,270
11. Blitar	39,783	6,683	20,738	501	5,641	739	5,478	-
12. Malang	273,313	65,403	102,574	2,213	48,485	37,334	16,945	0,355
13. Mojokerto	35,548	2,978	3,401	1,852	5,012	0,604	18,662	3,035
14. Surabay	1,118,537	70,020	166,885	45,412	237,017	148,541	359,609	91,608
Total	6,031594	2,295,388	505,012	180,191	704,875	268,223	708,362	739,953
%	100	48.5	8.4	3.0	11.7	4.4	11.7	12.3
KABUPATEN	4,449,775	2,772,853.	204,422	127,348	401,728	75,045	293,569	574,688
%	100	62.3	4.6	2.9	9.0	1.7	6.6	12.9
KOTAMADYA	1,581,815	152,535	300,590	52,843	303,147	193,178	414,793	165,268
%	100	9.6	19.0	3.3	19.2	12.2	26.2	11.5

Note: only indicative estimated by the study team
from Table 2.3.16 and 2.3.17

Table 2.3.18 TRANSMIGRATION 1982 - 1983

Kab./Kod.	Sponteneous w/cost support		Sponteneous w/o support		General		Total	
	House-hold	Person	House-hold	Person	House-hold	Person	House-hold	Person
Kabupaten								
1. Trenggalek	-	-	168	286	681	2,873	849	3,159
2. Tulungagung	-	-	313	609	1,048	4,110	1,361	4,719
3. Blitar	75	298	414	637	1,681	6,687	2,170	7,622
4. Kediri	140	565	237	416	1,707	6,538	2,084	7,519
5. Malang	-	-	82	271	1,916	8,736	1,998	9,007
6. Sidoarjo	-	-	88	174	226	892	314	1,066
7. Mojokerto	-	-	35	105	388	1,595	423	1,700
8. Jombang	80	335	124	371	997	4,416	1,201	5,122
9. Nganjuk	119	506	278	393	1,077	4,449	1,474	5,348
Kotamadya								
10. Kediri	-	-	-	-	- -	-	-	-
11. Blitar	-	-	-	-	-	-	-	-
12. Malang	-	-	-	-	-	-	-	-
13. Mojokerto	-	-	-	-	-	-	-	-
14. Surabaya	-	-	311	891	609	2,070	920	2,961
Total	414	1,704	1,739	3,262	9,721	40,296	12,794	48,223

Source : Directorate of Transmigration

Note : w/o ..... without
w/..... with

Table 2.3.19 KABUPATEN - WISE LAND USE

Land Use	Kab. T'gulek	Kab. T'Agung	Kab. Blitar	Kod. Blitar	Kab. Kediri	Kod. Kediri	Kab. Malang	Kod. Malang	Kab. Sidoarjo	Kab. M'Kerto	Kab. N'Kerto	Kab Jombang	Kab. Nganjuk	Kod. Surabaya
Soil Area														
Land Area	117,240	104,614	158,879	3,237	138,605	6,340		7,842	68,109	82,660	1,647	115,950	121,511	29,178
a. Fully Technical	6,936	21,786	23,269	1,096	15,732	1,490	53,06	1,550	30,770	17,165	345	38,886	33,265	3,328
b. Non Technical	7,560	3,606	10,195	-	3 304	1,263		1,103	1,056	9,156	-	9,278	4,965	2,640
c. Upland	14,499	20,930	51,259	28	-	640	136,106	706	849	13,036	136	8,325	10,462	2,914
d. Residence	15,424	19,996	23,311	1,284	36,881	2,063	37,124	2,324	1,588	12,548	311	32,721	20,586	11,706
e. Plantation	721	2,452	13,689	-	-	294	25,451	1,053	14,284	-	-	872	-	-
f. Mixed plantation	-	-	-	-	-	-	2,938	-	-	—	-	-	5,209	-
g. Horticulture	-	-	-	-	-	-	-	-	-	-	-	-	-	-
h. Forest Production	45,030	28,083	34,879	-	-	128	-	—	-	11,584	-	20,443	45,468	-
i. " Conservation	15,003	3,213	-	-	21,898	-	91,845	-	-	-	-	4,347	-	-
j. Wildlife Reserve	-	-	-	-	-	-		-	-	-	-	-	-	-
k. Pond	-	120	89	2	-	2	-	3	-	52	1	-	51	-
l. Reservoir	-	438	9,591	-	-	-	1,780	-	-	70	1	-	95	-
m. Lake	-	6	-	-	-	-	-	-	-	-	-	58	-	-
n. Swamp	-	50	-	-	-	-	-	-	787	14	5	23	-	3,254
o. Salt Field	-	-	-	-	-	-	-	-	-	-	-	750	-	3,254
p. Fish Pond	-	-	-	-	-	-	-	-	13,438	-	-	-	3	5,636
q. Others	12,066	2,929	-	827	-	470	1,586	113	1,337	-	-	246	1,402	-
	Rainfed													
r. Population in 1980(x10³)	564.5	833.3	1,037.3	78.5	1,235.3	221.8	2045.9	511.8	854.3	705.6	68.8	942.0	882.7	2.027.9
s. Fully F./Pop m²	260	300	320	139	154	124	260	52	370	370	50	560	430	29
t. Agri.Land/Pop m²	530	560	830	143	154	153	910	66	380	560	70	590	560	44
u. Residencial/Pop m²	270	240	220	160	298	90	180	50	19	180	50	350	230	60

Table 2.3.20 GRDP POPULATION AND PER CAPITA IN THE BASIN IN 1980

(Current Price)

Kab./Kod.	GRDP (10^6Rp)	Population 1980	Per Capita GRDP (Rp)	Index Indonesia = 100
Kabupaten				
1. Trenggalek	106,688.29	564,542	188,982	62
2. Tulungagung	174,620.01	833,323	209,546	68
3. Blitar	190,675.53	1,037,258	188,826	62
4. Kediri	218,030.01	1,235,265	176,504	57
5. Malang	347,094.94	2,045,939	169,650	55
6. Sidoarjo	173,450.79	854,298	203,033	66
7. Mojokerto	111,666.25	705,596	158,258	52
8. Jombang	155,128.92	941,988	164,682	54
9. Nganjuk	122,507.07	882,832	138,766	45
Kotamadya				
10. Kediri	47,167.26	221,830	212,628	69
11. Blitar	21,641.94	78,503	275,683	90
12. Malang	118,718.22	511,780	232,362	76
13. Mojokerto	18,786.89	68,849	272,870	89
14. Surabaya	792,887.60	2,027,913	381,124	124
Total	$2,547 \times 10^9$	$12,010 \times 10^3$	214,762	70
East Java	$5,958.2 \times 10^9$	$29,189 \times 10^3$	204,124	66
Indonesia(GDP)	$45,446 \times 10^9$	$148,040 \times 10^3$	306,985	100

Source : East Java Developing in Repelita III.

Table 2.3.21(1) PRODUCTION OF SELECTED CROPS, 1983

Unit : Ton

Kab./Kod.	Paddy Area ha	Paddy Yield t/ha	Paddy Product t	Maize Area ha	Maize Yield t/ha	Maize Product t
1. Trenggalek	15,889	5.10	81,034	7,309	2.21	16,153
2. Tulungagung	25,362	4.91	124,036	14,363	2.06	30,618
3. Blitar	47,091	5.79	272,657	21,364	1.48	31,619
4. Kediri	60,797	5.97	360,958	49,110	3.23	158,625
5. Malang	66,205	5.72	378,693	89,513	1.96	175,445
6. Sidoarjo	36,098	5.74	207,203	1,830	1.31	2,697
7. Mojokerto	43,556	5.56	242,171	15,216	1.47	22,368
8. Jombang	54,470	5.95	324,097	19,194	2.24	42,995
9. Nganjuk	54,128	5.61	303,658	21,089	3.08	64,954
10. Surabaya	7,430	4.26	31,652	708	0.67	474
Total	411,026	5.66	2,326,159	239,696	2.28	545,948

	Cassava Area ha	Cassava Yield t/ha	Cassava Product t	Soybeans Area ha	Soybeans Yield t/ha	Soybeans Product t
1. Trenggalek	19,313	9.80	189,267	4,835	0.73	1,220
2. Tulungagung	7,438	8.98	66,793	1,648	0.74	3,530
3. Blitar	12,698	8.47	107,552	7,256	0.58	4,208
4. Kediri	14,738	21.06	310,382	6,295	0.83	5,225
5. Malang	23,791	15.29	363,810	3,175	0.72	2,286
6. Sidoarjo	430	9.05	3,892	1,071	0.89	953
7. Mojokerto	2,842	12.71	36,122	10,198	0.94	9,586
8. Jombang	3,285	14.51	47,665	15,728	0.84	13,212
9. Nganjuk	6,729	9.15	61,570	22,805	0.85	19,384
10. Surabaya	169	5.00	845	2	0.60	1
Total	91,433	12.99	1,187,898	73,013	0.82	59,605

Source : Dalam Angka, 1982

Table 2.3.21 (2) PRODUCTION AND Ha OF SELECTED ESTATE CROPS IN THE BRANTAS BASIN IN 1983

Unit : Ha, ton

Small Holders	Sugarcane		Coconut		Coffee		Tobacco		Capok	
Kab.	Ha	P	Ha	P	Ha	P	Ha	P	Ha	P
Trenggalek	1,407	9,710	13,947	4,852	633	167	94	53	774	64
Tulungagung	1,744	11,534	14,262	5,588	119	7	1,050	590	3,445	634
Blitar	6,724	45,734	15,841	4,812	2,751	710	1,976	1,308	6,310	2,186
Kediri	12,814	88,415	9,098	4,789	2,007	620	226	104	2,822	644
Malang	21,480	103,615	11,469	2,690	15,095	5,599	-	-	19,172	2,401
Sidoarjo	5,014	65,208	3,189	594	-	-	-	-	518	33
Mojokerto	5,405	34,588	2,658	579	6	2	-	-	3,032	453
Jombang	9,881	72,630	7,255	1,396	448	46	3,951	2,562	5,466	314
Nganjuk	4,670	31,291	5,299	1,316	22	3	1,052	317	1,890	100
Sub-total	71,159	462,725	83,018	26,616	21,081	7,154	8,394	4,934	43,429	6,849
	(100)	(100)	(98)	(99)	(70)	(56)	(100)	(100)	(95)	(91)
G.E.	-	-	-	-	3,613	2,427	-	-	-	-
P.E.	-	-	2,105	202	5,363	3,105	-	-	2,177	715
G. Total	71,159	462,725	85,123	26,818	30,057	12,686	8,394	4,934	45,605	7,564
	(42)	(4)	(31)	(34)	(38)	(43)	(7)	(7)	(32)	(35)
East Java	171,235	1,049,037	278,827	80,029	79,714	29,594	119,867	69,900	140,835	21,856

Note : P ... Production G.E ... Government-owned estate
P.E.. Privately owned estate

The figure is the parentheses shows the share of small house holders to total areas and production in the Brantas basin. The other parentheses shows the share of the basin area to East Java in terms of area and production.

Source : Data Statistik Perkebunan, Region Crops Estate Service East Java 1983.

Table 2.3.22 POPULATION OF SELECTED LIVESTOCK IN 1982

Kab. & Kod.	Horse	Cow	Milking Cow	Buffalo	Coat	Sheep
Kabupaten						
1. Trenggalek	490	32,740	27	6,356	89,429	13,160
2. Tulungagung	500	58,327	188	2,603	84,166	7,096
3. Blitar	752	67,373	535	6,681	77,947	23,743
4. Kediri	2,183	80,146	741	9,088	88,579	22,665
5. Malang	4,415	137,381	18,803	3,033	119,714	39,235
6. Sidoarjo	458	13,671	1,252	7,068	34,471	26,753
7. Mojokerto	396	50,454	1,172	5,633	52,641	4,772
8. Jombang	116	49,755	1,743	11,573	53,514	21,841
9. Nganjuk	705	79,821	191	7,444	63,696	37,843
Kotamadya						
10. Kediri	103	4,532	340	710	4,862	2,703
11. Blitar	14	721	188	31	881	631
12. Malang	165	5,708	264	280	1,921	1,182
13. Mojokerto	9	65	136	158	383	472
14. Surabaya	15	4,667	2,872	1,944	5,251	8,309
Total	10,321	58,361	28,452	62,602	667,454	310,405

Source : Dalam Angka, 1982

Table 2.3.23 DATA ON FORESTRY IN 1982

Ground Administration	Forest Teak ha ha	Cutting Jungle ha ha	Area Total ha ha	Wood Build W. m^3 m^3	Production Fire W. m^2	Reforestation 1981 ha	Reforestation 1982 ha	Balance ha
Nganjuk	311	169	480	8,735	5,030	420	217	-263
Jombang	537	-	537	20,416	3,899	294	293	-244
Mojokerto	281	-	281	8,286	1,648	189	653	372
Kediri	135	1,351	1,486	36,801	29,414	588	2,859	1,373
Blitar	1,214	262	1,476	6,859	5,913	468	806	-670
Malang	289	90	379	10,427	2,235	504	470	91
Total	2,767	1,872	4,639	91,254	48,139	2,463	5,298	659

Source : Dalam Angka, 1982

Table 2.3.24 PRODUCTION OF INLAND FISHERY IN 1982

Unit : ton

Kab & Kod.	Open Water	Brackish water Pond	Fresh water Pond	Brackish Paddy Field	Paddy Field	Total
Kabupaten						
1. Trenggalek	21	-	18	-	-	39
2. Tulungagung	664	-	36	-	41	741
3. Blitar	445	-	727	-	38	1,210
4. Kediri	70	-	10	-	-	80
5. Malang	402	-	46	-	13	461
6. Sidoarjo	180	9,655	28	-	-	9,863
7. Mojokerto	91	-	69	-	-	160
8. Jombang	157	-	179	-	-	336
9. Nganjuk	317	-	103	161	-	581
Kotamadya						
10. Kediri	-	-	-	-	-	-
11. Blitar	-	-	-	-	-	-
12. Malang	4	-	-	-	4	8
13. Mojokerto	-	-	-	-	-	-
14. Surabaya	332	5,702	101	-	-	6,135
Total	2,543	15,357	1,317	161	96	19,614

Source : Dalam Angka, 1982

Table 2.3.25 ESTABLISHMENTS AND MANPOWER BY INDUSTRY AND KAB/KODYA RELATED TO THE BRANTAS BASIN IN 1982

Kab./Kod.	Metal		Chemical		Varied Industry		Sub-total		Household cottage	
	Unit	M	Unit	M	Unit	M	Unit	M	Unit	M
Kab.										
Trenggalek	1	50	-	-	215	2,055	216	2,105	16,488	49,051
Tulungagung	1	32	1	99	508	6,579	510	6,710	8,718	27,556
Sidoarjo	34	5,827	8	1,492	492	15,899	534	23,218	10,344	38,963
Jombang	-	-	-	-	293	1,586	293	1,586	10,286	20,882
Nganjuk	-	-	-	-	277	13,617	277	13,617	9,041	22,452
Kab./Kodya										
Blitar	-	-	-	-	428	5,701	428	5,701	19,900	51,001
Kediri	6	162	1	245	692	41,713	699	42,120	7,744	15,652
Malang	19	904	1	295	956	52,518	976	53,717	20,043	47,271
Mojokerto	2	48	2	479	358	7,207	362	7,734	11,371	40,563
Kodya										
Surabaya	94	11,491	16	2,362	2,946	89,963	3,056	103,816	2,720	9,196
	157	18,514	29	4,927	7,165	236,838	7,351	260,324	116,637	322,587
%		7.1		1.9		91		100%		

Note : M ..... Man power
According to the definitation of Ministry of Industry, the condition of varied industry (Aneka Industri) is that investment on production facilities is over 70 million Rp. If the corresponding investment is less than 70 million Rp, such industrial establishment is regarded small or household cottage industry.

Source: Dalam Angka, 1983

Table 2.3.26 BUILDING NOS, ACCORDING TO USE OBJECTIVES

	Residence	Store	Factory	Restourant	Others
Urban Area					
Kecamatan					
Trenggalek	5,569	164	33	6	432
Tulungagung	25,955	1,555	794	84	2,261
Blitar	15,372	959	277	82	1,028
Kediri	15,001	940	114	59	963
Malang	37,583	2,194	347	80	2,981
Sidoarjo	32,815	1,784	555	66	3,064
Mojokerto	9,240	499	64	10	657
Jombang	19,740	1,397	159	114	2,606
Nganjuk	16,259	1,110	208	385	1,678
Kotamadya					
Kediri	30,400	1,703	352	82	2,377
Blitar	14,002	808	123	140	1,225
Malang	86,772	4,297	1,186	271	7,621
Mojokerto	12,535	994	206	46	1,343
Surabaya	331,451	15,577	3,778	987	26,819
Sub-total	652,694	33,981	8,196	2,412	55,055
Rural					
Kecamatan					
Trenggalek	113,241	1,023	1,695	9	4,561
Tulungagung	146,288	2,372	2,746	55	4,934
Blitar	204,000	4,913	4,339	380	8,140
Kediri	239,068	5,910	1,016	165	8,893
Malang	397,244	6,878	2,659	320	17,369
Sidoarjo	129,845	3,322	827	58	9,414
Mojokerto	143,653	2,846	1,174	82	7,564
Jombang	174,670	4,433	1,477	67	9,913
Nganjuk	164,379	3,682	907	3,222	11,407
Kotamadya					
Kediri	8,916	228	83	2	377
Blitar	540	3	1	-	32
Malang	8,757	104	93	-	576
Mojokerto	-	-	-	-	-
Surabaya	52,357	1,533	452	194	6,715
Sub-total	1,782,958	37,247	17,469	4,554	89,895
TOTAL	2,435,652	71,228	25,665	6,966	144,950

Source : 1980 Census

Table 2.3.27 HOUSEHOLD BY KAB/KODYA AND FLOOR AREA IN 1980 (Percentage Distribution)

Unit : %

Kab./Kodya	Floor Area (m^2)					
	-19	20 - 39	40 - 69	70 - 99	100 -	Total
Kab.						
Trenggalek	3	13	32	24	28	100
Tulungagung	2	15	44	21	18	100
Blitar	4	16	41	20	19	100
Kediri	3	16	43	22	16	100
Malang	4	19	43	20	14	100
Sidoarjo	5	30	43	14	8	100
Mojokerto	2	18	38	25	17	100
Jombang	3	24	45	18	10	100
Nganjuk	4	14	38	23	21	100
Kodya						
Kediri	13	22	38	17	10	100
Blitar	9	17	36	16	22	100
Malang	16	29	29	12	14	100
Mojokerto	10	25	37	13	15	100
Surabaya	26	25	25	11	13	100
East Java	6	26	36	17	15	100

Source: Jawa Timur Dalam Angka 1983

Table 2.3.28 LIGHTING BY TYPE OF FUEL IN URBAN AND RURAL AREAS OF THE BRANTAS BASIN IN 1980 (Percentage Distribution)

Unit : %

Kab./Kodya	Electric		Lamp		Kerosene		Others		Total	
	V	R	V	R	V	R	V	R	V	R
Kab.										
Trenggalek	27	2	24	32	49	65	0	1	100	100
Tulungagung	16	1	48	36	35	63	1	0	100	100
Blitar	6	2	57	48	36	50	1	0	100	100
Kediri	17	3	32	48	51	48	0	1	100	100
Malang	36	6	44	46	20	47	0	1	100	100
Sidoarjo	48	7	27	49	25	43	0	1	100	100
Mojokerto	27	5	46	44	27	50	0	1	100	100
Jombang	36	3	39	38	25	59	0	0	100	100
Nganjuk	24	1	42	42	34	56	0	1	100	100
Kodya										
Surabaya	72	7	10	56	18	36	0	1	100	100
Blitar	44	0	33	66	22	34	1	0	100	100
Malang	61	10	19	42	19	48	1	0	100	100
Mojokerto	64	-	14	-	22	-	0	1	100	-
Kediri	47	27	25	47	26	25	2	1	100	100

Note : V ... Urban R ... Rural

Aource: Population Census of East Java, 1980

Table 2.3.29 PRIMARY SOURCE OF WATER FOR DRINKING IN URBAN AND RURAL AREAS OF THE BRANTAS BASIN IN 1980

(Percentage Distribution)

Unit : %

Kab./Kodya	Pipe		Pump		Well		Spring		Others		Total	
	V	R	V	R	V	R	V	R	V	R	V	R
Kab.												
Trenggalek	1	0	1	0	97	60	0	37	1	3	100	100
Tulungagung	0	0	1	0	94	79	0	13	5	8	100	100
Blitar	0	2	1	0	98	72	1	25	0	1	100	100
Kediri	0	0	6	1	77	90	17	17	0	0	100	100
Malang	16	5	2	1	67	96	16	38	5	12	100	100
Sidoarjo	28	1	4	1	67	96	1	0	0	2	100	100
Mojokerto	3	3	3	2	92	83	0	2	2	10	100	100
Jombang	1	1	6	1	93	94	0	3	0	1	100	100
Nganjuk	0	1	9	1	91	88	0	7	0	3	100	100
Kodya												
Surabaya	88	45	2	4	9	48	0	0	1	3	100	100
Blitar	0	0	15	0	85	100	0	0	0	0	100	100
Malang	19	4	5	9	71	52	3	22	2	22	100	100
Mojokerto	4	0	23	0	73	0	0	0	0	0	100	100
Kediri	2	0	10	1	86	98	0	1	2	0	100	100

	Pipe		Pump		Well		Others		Total	
Indonesia	V	R	V	R	V	R	V	R	V	R
	26	2	12	2	53	59	9	37	100	100

Note : V ... Urban R... Rural

Source: Population Census of East Java, 1980

Indonesia : Urban Service Sector Report, 1984

Table 3.2.1 RAINFALL GAUGING STATION FOR FLOOD ANALYSIS

No.	Name of Station	Available Period		No.	Name of Station	Available Period	
		Daily	Hourly			Daily	Hourly
1	Batu	1950-1983	1979-1983	27	Besuki	1950-1983	1980-1983
2	Singosari	1950-1983	1979-1983	28	Kampak	1950-1983	1974-1983
3	Kajutangan	1950-1983	1982-1983	29	Karangan	1951-1983	1980-1983
4	Wagir	1950-1983	1979-1983	30	Bendungan	1952-1983	1981-1983
5	Janung	1950-1983	1979-1983	31	Jaejam	1951-1983	1980-1983
6	Tumpang	1950-1983	1929-1983	32	Besuki	1951-1983	1980-1983
7	Poncokusmo	1950-1963	1979-1983	33	Kandat	1951-1983	1980-1983
8	Tangkil	1950-1983	1979-1983	34	Wates	1955-1983	1980-1983
9	Dampit	1951-1983	1979-1983	35	Kediri (Mrican)	1955-1983	1977-1983
10	Gondanglegi	1951-1983	1979-1983	36	P.G. Menang	1951-1983	1980-1983
11	Kepanjeng	1951-1983	1980-1983	37	Jati	1950-1983	1981-1983
12	Kesamben	1950-1983	1977-1983	38	Sawahan	1950-1983	1979-1983
13	Birowo	1950-1983	1980-1983	39	Nganjuk	1950-1983	1974-1983
14	Doko	1950-1983	- -	40	Kertosono	1950-1983	1977-1983
15	Semen	1953-1983	1980-1983	41	Pare	1958-1983	1982-1983
16	Wlingi	1950-1983	1972-1983	42	Siman	1951-1958, 1960-1983	1980-1983
17	Lodoyo	1950-1983	1980-1983	43	Sekar	1950-1983	- -
18	Garum	1950-1983	1980-1983	44	Pujon	1950-1983	1978-1983
19	Badak	1952-1983	1980-1983	45	Kandangan	1950-1983	1980-1983
20	Blitar	1950-1983	1980-1983	46	Jombang	1951-1983	1980-1983
21	Kademangan	1950-1983	1980-1983	47	Blimbing	1951-1983	1980-1983
22	Srengat	1950-1983	- -	48	Kabuh	1951-1983	1978-1983
23	Gandekan	1950-1982	1980-1983	49	Tapen	1950-1983	- -
24	Tulungagung	1951-1983	1984	50	Mojoagung	1950-1983	1977-1983
25	Boyolangu	1951-1983	1982-1983	51	Tampung	1950-1983	1980-1983
26	Campundanat	1950-1983	1981-1983	52	Mojokerto	1951-1983	1978-1983

Table 3.2.2 CALCULATION OF NATURALIZED FLOW

Unit : m^3/sec

		Karangkates			Jabon		
		1981	1982	1983	1981	1982	1983
Jan.	1-10	149.8	153.98	105.94	518.58	545.77	466.25
	11-20	73.6	128.21	115.06	445.84	599.22	438.37
	21-31	63.7	86.60	64.11	494.21	516.40	266.75
Feb.	1-10	72.0	122.31	113.1	474.41	677.12	487.94
	11-20	68.1	129.05	96.23	365.99	601.67	443.92
	21-28	85.1	101.72	102.99	572.85	476.83	422.23
Mar.	1-10	74.0	127.22	103.73	527.55	601.75	463.25
	11-20	64.3	123.86	85.32	396.25	632.58	439.49
	21-31	67.3	78.37	87.02	342.09	363.01	487.30
Apr.	1-10	65.8	90.23	94.58	375.19	395.41	422.06
	11-20	47.9	90.51	77.71	207.05	434.67	343.58
	21-30	75.3	87.61	112.94	275.88	293.03	366.96
May	1-10	64.1	55.05	134.31	420.51	224.19	561.49
	11-20	85.3	47.78	110.59	426.17	97.53	469.69
	21-31	55.0	46.20	116.71	180.88	89.15	454.22
Jun.	1-10	48.9	43.43	79.9	105.04	96.07	260.81
	11-20	55.7	39.97	67.1	88.88	77.59	202.39
	21-30	65.2	38.74	51.5	312.82	63.15	99.72
Jul.	1-10	69.1	36.20	52.3	46.05	56.83	93.68
	11-20	133.4	35.7	45.1	54.80	51.94	104.78
	21-31	56.0	37.1	39.8	8.89	55.65	73.38
Aug.	1-10	43.6	37.1	37.3	71.57	47.24	56.11
	11-20	40.4	31.6	34.3	67.85	42.64	53.88
	21-31	40.5	29.7	32.6	52.91	44.54	42.26
Sep.	1-10	34.4	25.8	29.6	46.49	36.64	48.33
	11-20	30.96	27.0	26.5	33.19	39.24	42.74
	21-30	60.89	23.2	27.0	133.15	35.24	37.25
Oct.	1-10	54.18	22.16	26.1	177.84	39.00	40.39
	11-20	40.96	20.59	57.4	79.55	33.43	83.08
	21-31	47.72	22.75	74.2	81.73	40.39	165.01
Nov.	1-10	39.87	22.14	63.3	63.15	31.18	211.14
	11-20	72.38	27.29	70.3	216.84	40.23	253.61
	21-30	137.15	23.28	90.2	376.90	43.62	337.87
Dec.	1-10	106.39	42.17	61.2	392.01	64.11	182.32
	11-20	120.78	66.80	57.3	491.80	168.34	176.52
	21-31	107.9	87.29	114.21	345.24	297.13	368.15

Table 3.2.3 TANK MODEL COEFFICIENTS

Item		Location						
		Blobo	Clumprit	Metro	Selorejo	Vonorejo	Bening	Ngudikan
Catchment area (km^2)		916.1	441.0	270.2	239.0	43.6	89.5	212.0
Top tanks								
Hole No.3	Height (mm)	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Coefficient	0.15	0.10	0.10	0.09	0.23	0.15	0.00
Hole No.2	Height (mm)	15.0	15.0	15.0	15.0	15.0	15.0	15.0
	Coefficient	0.100	0.100	0.048	0.060	0.100	0.100	0.350
Hole No.1	Height (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coefficient	0.100	0.050	0.048	0.020	0.050	0.100	0.300
Bottom	Coefficient	0.60	0.70	0.80	0.80	0.60	0.60	0.30
Maximum depth (mm)		70.0	70.0	70.0	70.0	70.0	70.0	30.0
Lower tanks								
No. 2	Height (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coefficient	0.05	0.10	0.10	0.10	0.05	0.05	0.05
	Bottom coef.	0.10	0.30	0.75	0.75	0.08	0.10	0.30
No. 3	Height (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coefficient	0.01	0.10	0.10	0.10	0.02	0.02	0.02
	Bottom coef.	0.07	0.20	0.55	0.45	0.10	0.07	0.30
No. 4	Height (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coefficient	0.002	0.100	0.100	0.100	0.002	0.003	0.003
	Bottom coef.	0.005	-	-	-	0.003	0.005	-
River channel								
Hole No.1	Height (mm)	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Coefficient	0.20	0.35	0.35	0.35	0.35	0.35	0.35
Hole No.2	Height (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coefficient	0.05	0.35	0.10	0.10	0.35	0.35	0.35
Others								
Evaporation rate		0.70	0.70	0.70	0.70	0.70	0.70	0.70
Zoning ratio		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Rainfall ratio		1.00	1.35	1.30	1.20	1.00	1.00	1.00

Note : hyphen means no bottom-orifice.

Table 3.2.4 APPLICATION OF TANK MODEL COEFFICIENTS

Sub-basin No.	Catchment area (km^2)	Application	Remarks
1	760.2	Blobo	
2	156.5	Blobo	
3	24.5	Blobo	
4	271.1	Clumprit	
5	381.1	Clumprit	
6	221.0	Clumprit	
7	236.1	Metro	
8	159.5	Metro	
9	211.7	Metro	
10	244.5	Metro	
11	83.5	Metro	
12	116.0	Metro	
13	24.3	Clumprit	
14	127.0	Metro	
15	393.0	Metro	
16	69.9	Blobo	
17	163.7	Blobo	
18	59.4	Metro	
19	109.5	Wonorejo	
20	435.7	Blobo	
21	61.8	Blobo	
22	138.2	Blobo	
23	115.1	Selorejo	
24	330.7	Blobo	
25	114.4	Blobo	
26	336.2	Selorejo	
27	236.0	Selorejo	Selorejo Dam basin
28	133.0	Bening	Beng Dam basin
29	88.8	Bening	
30	230.1	Bening	
31	69.5	Blobo	
32	664.4	Blobo	
33	468.2	Blobo	
34	676.8	Wonorejo	
35	82.8	Wonorejo	Segawe basin
36	53.6	Wonorejo	
37	43.6	Wonorejo	Wonorejo basin
38	77.5	Wonorejo	
39	225.9	Wonorejo	
40	159.4	Wonorejo	
41	122.8	Wonorejo	
42	18.3	Wonorejo	Kampak basin
43	53.5	Wonorejo	Tawing basin
44	81.2	Wonorejo	
45	53.8	Wonorejo	Bagong basin
46	58.7	Wonorejo	
47	212.2	Wonorejo	
48	91.6	Wonorejo	
49	88.3	Wonorejo	Tugu basin
50	234.7	Bening	
51	43.4	Bening	
52	143.0	Bening	
53	112.0	Bening	
54	275.3	Wonorejo	
55	56.3	Wonorejo	
56	85.0	Wonorejo	Kuncir basin
57	42.5	Bening	
58	27.0	Bening	Kedungwarak basin
59	76.3	Bening	
60	61.0	Bening	Semantok basin
61	109.6	Bening	
62	183.1	Wonorejo	
63	89.5	Bening	Bening basin

Table 3.2.5 ESTIMATED RUNOFF VOLUME

(Unit: MCM)

Year	Karangkates Dam Site			K. Ngrowo River			K. Konto River		
	Annual	Dec-May	Jun-Nov	Annual	Dec-May	Jun-Nov	Annual	Dec-May	Jun-Nov
1963/64	1,952.9	1,091.2	861.6	1,677.4	905.2	772.2	970.1	560.3	409.8
64/65	1,794.0	1,261.0	533.1	748.2	608.8	139.4	817.0	553.0	264.0
65/66	2,210.3	1,605.2	605.1	1,189.9	907.9	282.0	714.4	467.2	247.2
66/67	1,811.0	1,336.6	474.4	1,021.5	883.5	137.9	933.0	668.7	264.3
67/68	2,797.5	1,669.8	1,127.7	1,658.3	1,030.6	627.7	1,043.6	653.5	390.2
68/69	2,851.9	2,130.3	721.7	1,004.1	826.1	178.0	860.0	579.6	280.4
69/70	2,106.7	1,460.1	646.7	1,078.1	832.0	246.1	810.9	532.3	278.6
70/71	2,097.1	1,405.9	691.2	1,453.4	921.9	531.5	1,132.5	762.5	370.1
71/72	2,043.9	1,521.3	522.7	1,021.2	874.6	146.6	969.4	679.7	289.7
72/73	2,470.2	1,435.4	1,034.8	1,465.6	929.7	535.9	883.1	532.4	350.8
73/74	1,983.8	1,239.3	744.4	1,137.0	689.6	447.3	1,187.3	818.2	369.2
74/75	3,054.9	1,862.6	1,192.3	1,481.5	934.5	547.0	1,269.0	816.5	452.5
75/76	2,480.6	1,818.1	662.5	857.7	629.3	228.4	1,239.0	903.9	335.1
76/77	1,720.6	1,235.3	485.3	680.9	531.0	149.9	903.8	620.7	283.2
77/78	2,861.7	1,761.8	1,099.9	1,656.1	731.7	924.4	871.5	556.1	315.4
78/79	2,604.4	1,709.5	894.3	1,364.0	973.9	390.1	832.5	518.8	313.8
79/80	1,462.8	971.7	491.1	743.9	501.5	242.5	814.2	552.5	261.7
80/81	2,172.3	1,375.9	796.4	1,342.1	707.5	634.3	1,091.3	737.1	354.1
81/82	2,215.9	1,680.7	535.2	687.8	559.7	128.1	1,093.5	815.7	277.8
82/83	2,550.4	1,753.5	796.9	1,368.5	1,001.9	366.6	963.6	627.4	336.2
Ave.	2,251.1	1,516.3	744.9	1,178.4	799.1	379.3	970.0	647.8	332.2
Max.	3,054.9	2,130.3	1,192.3	1,677.4	1,030.6	924.4	1,269.0	903.9	452.5
Min.	1,462.8	971.7	474.4	680.9	501.5	128.1	714.4	467.2	247.2

Year	K. Widas River			Jabon			Total in the basin		
	Annual	Dec-May	Jun-Nov	Annual	Dec-May	Jun-Nov	Annual	Dec-May	Jun-Nov
1963/64	1,332.7	1,043.6	289.1	9,462.3	5,733.2	3,729.1	10,562.5	6,532.0	4,030.5
64/65	595.4	505.6	89.8	6,531.0	4,786.4	1,744.6	7,453.6	5,572.2	1,881.3
65/66	958.3	858.2	100.1	7,997.6	6,003.5	1,994.1	9,178.8	7,018.7	2,160.1
66/67	1,187.4	1,095.7	91.7	8,209.4	6,510.3	1,699.1	9,691.0	7,815.8	1,875.2
67/68	1,444.7	1,201.6	241.1	10,923.4	7,011.5	3,911.9	12,652.2	8,380.4	4,271.8
68/69	1,231.2	1,133.6	97.5	9,083.8	6,939.4	2,144.4	10,063.2	7,779.3	2,284.0
69/70	1,410.3	1,283.7	127.1	8,142.1	6,213.2	2,225.9	9,909.4	7,479.8	2,429.6
70/71	1,357.8	1,022.9	334.8	9,447.6	6,373.3	3,074.3	11,039.0	7,630.1	3,408.9
71/72	1,004.0	901.6	102.4	7,643.5	5,352.4	1,793.1	8,532.4	6,611.2	1,921.2
72/73	1,314.2	1,511.1	203.1	9,995.9	6,614.4	3,381.5	11,686.5	8,040.5	3,646.0
73/74	1,073.1	893.9	179.2	8,545.2	5,703.8	2,841.5	9,664.2	6,623.1	3,041.2
74/75	1,981.8	1,657.6	324.2	12,258.4	8,212.1	4,046.3	14,113.7	9,633.8	4,480.0
75/76	1,131.9	973.6	158.2	8,321.9	6,646.4	2,175.6	10,046.5	7,689.5	2,357.1
76/77	936.4	821.4	115.1	6,300.2	4,678.5	1,621.7	7,494.0	5,669.8	1,824.2
77/78	1,436.5	1,216.3	220.3	9,309.5	6,044.9	3,264.6	11,333.3	7,375.0	3,958.3
78/79	1,884.9	1,662.4	222.5	10,132.9	7,167.1	2,965.8	11,899.1	8,657.3	3,241.8
79/80	933.3	732.8	200.5	6,730.4	4,538.2	2,032.2	7,499.6	5,311.9	2,187.7
80/81	1,429.8	1,222.3	207.5	9,320.5	6,367.1	2,953.5	10,271.0	7,139.3	3,131.7
81/82	1,072.5	982.0	90.5	7,759.7	6,095.6	1,663.2	9,022.6	7,208.8	1,813.9
82/83	1,640.9	1,412.5	228.4	9,756.5	6,951.3	2,795.2	11,088.7	8,033.2	3,055.5
Ave.	1,293.4	1,111.7	181.7	8,353.7	5,220.7	2,623.0	10,160.1	7,310.1	2,850.0
Max.	1,981.8	1,662.4	334.8	12,258.4	8,212.1	4,046.3	14,113.7	9,633.8	4,480.0
Min.	595.4	505.6	89.8	6,300.2	4,678.5	1,621.7	7,453.6	5,311.9	1,813.9

Note, Annual : December to November.

Table 3.2.6 ESTIMATES OF NET CONSUMPTION INCLUDING TRIBUTARY AREA, 1982

		Streamflow at Jabon	Naturalized flow at Jabon	Net Consumption of Water		
				Area fed by BTS [1]	Lodoyo	Including Tributaries
M	I	220.4	224.19	18.50	9.0	
	II	188.3	97.53	19.16	9.0	84.5
	III	153.1	89.15	18.28	9.0	70.9
J	I	154.5	96.07	14.92	9.0	69.6
	II	143.7	77.59	16.73	9.0	65.8
	III	134.9	63.15	17.06	9.0	66.9
J	I	127.3	56.83	17.49	9.0	67.8
	II	120.7	51.94	17.11	7.6	65.8
	III	104.3	55.65	15.82	6.0	59.1
A	I	109.2	47.24	16.23	6.0	60.5
	II	104.1	42.64	13.54	6.0	51.8
	III	90.3	44.54	11.90	6.0	45.8
S	I	94.8	36.64	11.58	6.0	45.7
	II	90.4	39.24	10.86	6.0	41.8
	III	86.3	35.24	10.97	6.0	43.1
O	I	82.3	39.00	12.02	6.0	46.7
	II	78.4	33.43	3.71	6.0	47.3
	III	67.9	40.39	5.35	6.0	24.1
N	I	71.2	31.18	3.05	6.0	16.0
	II	68.0	40.23	6.51	7.6	29.5
	III	65.0	43.62	3.92	9.0	22.4
D	I	72.9	64.11	7.50	9.0	
	II	187.6	168.34	10.44	9.0	
	III	276.8	297.13	13.61	9.0	

Note [1] Ref. Table HY 1.14

Table 3.2.7 THE ESTIMATED RUN-OFF ADJUSTED BY TANK MODEL

Unit : m^3/s

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
JAN - 1	360.70	331.40	319.05	434.00	363.10	321.70	330.21	390.70	430.65	364.10
- 2	297.53	303.10	293.30	452.05	326.50	317.60	341.93	359.70	464.93	392.03
- 3	285.74	314.20	296.10	487.00	392.20	515.10	307.70	314.10	371.60	368.53
MEAN	314.03	316.35	302.81	478.54	334.01	348.74	264.32	357.35	420.73	371.31
FEB - 1	354.10	409.60	259.30	914.00	358.00	491.50	307.30	471.45	348.78	359.33
- 2	321.30	454.40	369.70	921.93	340.70	541.50	492.63	540.00	369.70	410.03
- 3	287.62	433.20	374.60	891.90	356.33	632.30	311.60	637.90	331.10	374.00
MEAN	322.04	419.06	314.53	910.01	318.48	552.04	341.34	542.45	354.00	433.41
MAR - 1	499.70	305.60	470.20	474.15	471.43	410.74	319.60	425.30	336.10	429.13
- 2	493.70	359.40	333.30	407.03	341.00	410.00	314.30	400.00	359.20	349.90
- 3	434.03	372.05	494.03	368.03	340.00	301.00	433.70	436.30	353.90	407.53
MEAN	440.09	319.14	500.60	415.44	332.67	447.74	300.74	422.91	348.31	412.38
APR - 1	433.10	355.00	321.60	303.53	781.40	910.70	403.30	481.40	309.90	469.20
- 2	417.60	374.70	456.90	342.00	356.00	520.30	393.35	333.45	343.03	410.00
- 3	327.10	321.40	401.40	304.10	439.74	430.00	343.00	317.10	312.93	401.60
MEAN	392.60	337.03	459.77	343.20	565.70	515.87	414.30	334.37	333.07	406.93
MAY - 1	296.90	132.97	322.70	371.50	434.74	323.40	313.93	249.10	329.10	513.20
- 2	249.55	106.02	155.30	630.84	433.90	318.60	282.50	269.50	265.00	520.50
- 3	231.00	81.31	127.33	88.17	350.30	287.50	214.60	279.03	115.43	444.70
MEAN	254.04	104.33	191.54	344.17	400.49	262.02	252.72	262.17	332.07	492.47
JUN - 1	133.50	85.14	124.70	88.27	323.03	204.00	206.50	252.70	102.34	319.60
- 2	210.90	27.02	99.26	77.84	314.02	119.15	114.08	219.90	83.17	307.30
- 3	111.03	20.44	40.04	20.09	345.40	141.74	95.74	124.16	74.15	251.62
MEAN	192.04	77.49	102.71	78.32	315.40	148.49	139.49	212.72	84.35	321.01
JUL - 1	95.91	45.41	73.02	60.14	249.30	97.30	83.32	95.44	59.74	224.90
- 2	82.05	61.00	66.31	53.42	325.00	83.34	73.25	82.41	63.69	134.53
- 3	65.96	50.21	53.33	60.84	260.10	67.49	82.39	65.31	52.06	91.70
MEAN	79.45	38.51	64.20	57.20	285.10	79.90	73.34	29.97	61.45	141.81
AUG - 1	60.23	53.72	56.50	51.84	227.50	70.09	84.95	47.12	51.83	91.80
- 2	63.36	50.64	52.42	40.96	133.60	64.37	59.91	61.95	37.25	80.86
- 3	31.40	42.78	40.23	41.35	37.20	32.76	49.84	50.31	43.91	53.21
MEAN	60.04	48.03	50.44	47.20	131.50	42.76	57.70	59.34	50.34	70.13
SEP - 1	57.31	45.40	48.09	43.91	90.15	34.37	32.97	53.85	40.81	67.30
- 2	53.20	43.14	44.44	43.84	86.27	32.02	49.91	51.01	44.20	19.34
- 3	61.34	41.07	42.20	29.19	80.39	49.41	47.63	48.03	42.09	96.95
MEAN	57.32	43.20	44.94	43.14	69.27	32.93	50.04	50.91	40.32	79.42
OCT - 1	167.30	37.21	43.55	39.42	84.98	44.83	44.91	43.43	40.12	81.53
- 2	311.50	37.41	44.44	37.35	15.37	44.25	47.75	45.55	38.34	31.48
- 3	243.40	35.37	36.58	33.07	41.31	40.08	30.34	210.13	33.19	60.47
MEAN	208.04	36.58	41.36	36.93	37.08	43.61	41.69	108.04	37.38	73.74
NOV - 1	343.00	35.83	36.73	37.03	189.12	38.36	31.41	324.70	35.33	87.68
- 2	315.93	34.31	46.62	34.63	126.35	90.70	76.41	299.50	34.67	87.78
- 3	244.03	44.06	33.26	35.00	254.70	48.28	125.45	350.10	35.79	139.21
MEAN	300.93	38.07	33.34	34.63	160.06	58.44	82.40	261.43	35.76	104.20
DEC - 1	201.43	41.43	292.60	314.70	247.10	65.11	104.40	272.40	49.41	250.40
- 2	110.64	137.39	365.10	335.27	334.70	275.00	131.13	421.40	176.86	267.60
- 3	351.10	224.99	342.10	210.50	340.90	210.42	242.90	317.90	214.40	216.29
MEAN	191.70	140.00	333.55	215.63	315.09	177.41	166.00	340.61	149.34	263.01

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
JAN - 1	276.90	331.00	497.10	533.49	433.50	424.30	203.93	446.50	415.00	417.00
- 2	288.00	402.30	498.20	342.70	437.30	427.35	211.00	430.00	424.90	488.30
- 3	275.00	403.10	337.10	270.10	422.60	433.00	307.70	470.03	397.40	401.30
MEAN	279.91	319.91	454.91	317.03	437.85	429.64	246.83	431.11	415.46	434.04
FEB - 1	365.20	563.53	341.90	310.10	472.30	519.80	320.60	461.50	301.30	467.40
- 2	378.10	591.10	360.50	393.40	459.30	514.00	334.10	444.23	447.63	418.10
- 3	333.70	667.20	463.40	353.90	540.10	508.90	480.60	528.40	372.40	683.20
MEAN	433.66	610.13	400.43	317.94	507.03	520.47	340.70	474.44	316.05	537.04
MAR - 1	440.70	530.06	347.70	320.50	427.60	434.03	372.20	439.20	465.00	949.10
- 2	434.40	326.00	333.60	394.30	430.40	396.00	337.40	368.49	473.29	989.40
- 3	326.90	537.50	437.10	409.95	372.40	375.76	302.10	342.50	359.50	437.60
MEAN	411.03	327.69	322.84	353.93	400.92	400.60	347.35	348.36	433.53	483.89
APR - 1	368.30	344.10	403.09	410.70	354.40	404.50	500.90	333.30	342.30	412.60
- 2	380.10	628.63	327.80	341.80	297.30	438.70	337.10	335.00	363.99	374.70
- 3	293.50	600.90	268.60	293.70	262.49	430.40	306.70	391.20	217.30	367.40
MEAN	347.93	604.93	333.40	347.90	305.37	439.20	314.01	300.57	304.53	344.97
MAY - 1	318.14	330.70	251.50	232.50	244.70	493.40	250.30	293.10	329.40	340.49
- 2	303.10	494.39	204.95	115.04	257.60	404.10	205.60	283.20	183.00	400.30
- 3	223.10	353.60	100.93	78.46	250.20	339.00	93.50	213.30	85.78	376.30
MEAN	278.43	458.76	179.60	136.37	244.55	410.60	180.24	263.14	191.47	367.94
JUN - 1	203.00	298.63	183.09	89.55	368.70	421.90	95.11	335.79	87.11	319.00
- 2	114.83	244.70	91.21	70.66	304.20	315.85	78.34	109.89	77.78	262.49
- 3	100.21	213.10	83.25	40.42	291.30	249.30	69.60	337.29	69.76	133.91
MEAN	139.34	252.13	92.34	75.00	301.48	329.05	79.41	327.40	70.02	232.38
JUL - 1	88.15	128.06	73.11	50.37	310.43	209.30	63.21	181.71	63.41	107.39
- 2	80.50	116.34	69.70	53.72	256.85	132.35	58.29	209.13	50.99	88.27
- 3	69.37	88.59	55.10	46.60	336.95	88.34	48.38	92.30	48.43	68.69
MEAN	77.65	106.36	66.38	52.05	332.98	238.49	58.34	130.47	54.03	80.02
AUG - 1	76.41	87.60	59.77	47.17	119.75	40.43	50.03	81.95	51.38	69.04
- 2	66.26	79.61	55.19	44.65	102.23	46.73	47.04	70.35	49.52	62.91
- 3	55.09	63.06	46.55	38.51	74.34	67.60	40.69	55.83	41.02	51.01
MEAN	65.51	74.27	53.41	43.24	97.98	43.71	46.31	61.45	48.71	60.46
SEP - 1	67.24	70.17	49.45	45.54	82.23	72.48	42.88	38.06	45.24	34.67
- 2	41.00	125.02	47.65	38.77	27.01	67.70	40.03	34.17	41.03	30.92
- 3	38.01	119.01	44.49	37.15	30.66	62.69	36.99	67.05	39.17	47.91
MEAN	60.64	104.75	47.24	38.02	26.90	67.46	40.90	59.77	41.16	30.91
OCT - 1	92.40	232.00	47.60	35.71	69.95	50.71	37.32	47.46	37.44	45.40
- 2	86.35	137.70	41.89	34.45	64.72	55.03	35.93	35.49	35.47	32.95
- 3	85.98	304.38	37.45	32.26	56.10	49.25	33.27	67.11	32.21	45.03
MEAN	90.13	227.73	40.83	33.73	63.30	54.13	35.46	39.83	35.04	36.10
NOV - 1	89.80	312.40	45.64	32.74	77.09	35.56	35.37	49.75	32.27	110.25
- 2	221.10	345.20	70.48	31.32	115.37	36.37	34.03	100.32	32.24	176.37
- 3	293.90	409.90	241.30	41.50	188.01	33.03	313.29	240.10	31.30	253.10
MEAN	188.30	342.57	129.01	35.02	100.02	35.15	134.35	143.30	38.78	147.51
DEC - 1	370.40	182.70	264.70	87.59	264.50	81.13	424.90	347.95	33.13	224.93
- 2	345.05	463.45	116.66	118.99	284.50	83.32	373.70	345.85	122.96	133.44
- 3	278.05	312.40	72.43	155.44	311.10	145.06	348.10	319.05	174.63	168.50
MEAN	333.12	434.37	162.41	179.74	304.45	88.97	393.39	337.22	148.03	112.48

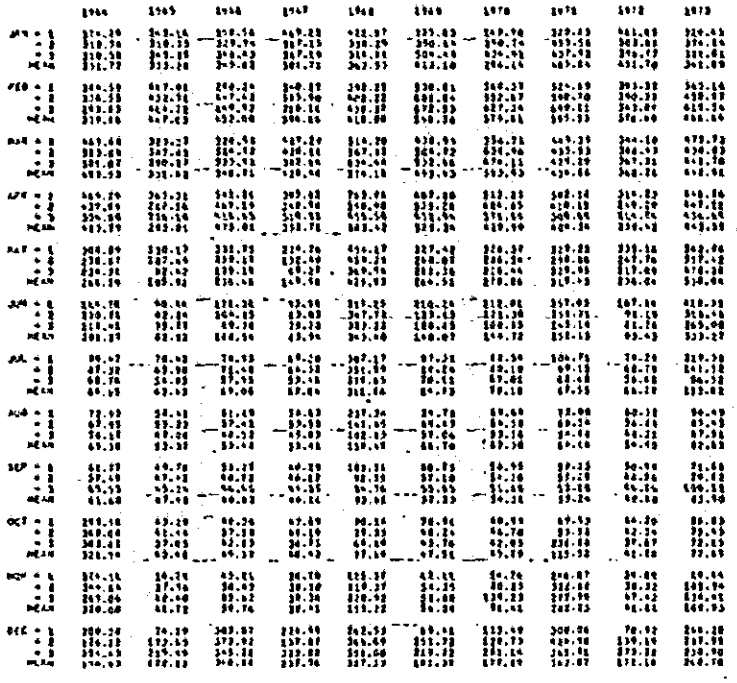
Table 3.2.8 BALANCE BETWEEN STREAMFLOW RECORD AT PERNING AND DISCHARGE RECORD THROUGH MLIRIP SLUICE

(Unit: m^3/s)

Year		1980	1981	1982	1983
Jan.	-1	27.54	42.85	54.9	21.1
	-2	48.17	22.62	53.3	20.3
	-3	66.02	33.81	34.7	11.5
Feb.	-1	34.64	33.26	61.1	27.8
	-2	55.58	27.99	38.8	17.4
	-3	91.42	16.29	38.3	38.9
Mar.	-1	40.05	60.27	48.8	41.5
	-2	32.45	33.26	54.0	20.3
	-3	27.42	13.81	25.8	28.7
Apr.	-1	15.45	11.99	38.4	30.9
	-2	33.54	19.73	40.7	18.2
	-3	29.82	19.93	31.4	18.6
May	-1	24.94	30.17	21.5	30.8
	-2	16.25	26.27	8.0	10.9
	-3	11.05	19.47	7.0	18.3
Jun.	-1	5.72	17.11	6.3	4.8
	-2	4.37	16.19	5.9	5.9
	-3	5.40	24.33	9.6	6.0
Jul.	-1	-	9.06	8.7	7.1
	-2	-	16.13	5.7	5.5
	-3	-	11.15	5.1	3.2
Aug.	-1	3.08	14.81	3.7	3.8
	-2	6.35	7.46	5.7	5.0
	-3	-	10.77	2.9	5.9
Sep.	-1	4.46	9.74	3.5	4.6
	-2	4.70	7.99	3.0	3.5
	-3	3.20	12.49	5.3	4.9
Oct.	-1	-	5.99	4.4	5.5
	-2	-	3.72	3.7	5.0
	-3	-	4.40	2.4	5.5
Nov.	-1	-	5.10	1.9	6.2
	-2	-	8.95	1.7	14.5
	-3	-	13.97	3.8	26.6
Dec.	-1	-	30.80	6.4	12.2
	-2	-	51.36	10.2	13.6
	-3	-	29.46	11.8	23.6

Table 3.2.9 AVAILABLE WATER AT JABON-PERNING SITE

Unit : m^3/s



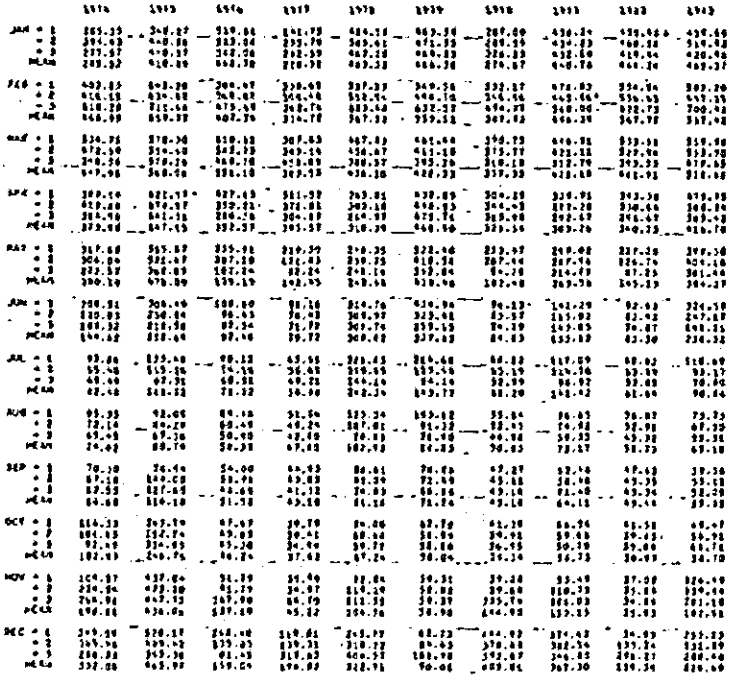


Table 3.2.10 AVAILABLE WATER AT JABON-PERNING SITE

(Unit: MCM)

Year	Annual (Dec - Nov)	Wet Season (Dec - May)	Dry Season (Jun - Nov)
1963/64	8,176.3	5,380.6	2,795.7
64/65	5,305.9	4,438.8	867.1
65/66	6,841.7	5,813.1	1,028.6
66/67	7,011.2	6,161.2	850.0
67/68	9,883.9	6,881.0	3,002.9
68/69	8,028.3	6,817.7	1,210.6
69/70	7,275.8	6,024.1	1,251.7
70/71	8,367.5	6,126.1	2,241.4
71/72	6,360.2	5,449.1	911.1
72/73	8,482.4	6,274.8	2,207.7
73/74	7,270.2	5,512.2	1,758.0
74/75	11,336.8	8,059.8	3,277.0
75/76	7,607.5	6,394.9	1,212.6
76/77	5,098.8	4,282.0	816.8
77/78	8,217.9	5,831.1	2,386.7
78/79	8,942.2	6,951.1	1,991.1
79/80	5,345.5	4,227.5	1,118.0
80/81	7,724.1	6,091.6	1,632.5
81/82	6,942.3	6,108.8	833.5
82/83	8,383.1	6,574.0	1,809.2
Ave.	7,630.1	5,970.0	1,660.1
Max.	11,336.8	8,059.8	3,277.0
Min.	5,098.8	4,227.5	816.8

Table 3.2.11 PROBABLE 1-DAY/3-DAY RAINFALL

NAME	C.A	2-YEAR		5-YEAR		10-YEAR		25-YEAR		50-YEAR		100-YEAR	
	(SQ.KM)	1-D	3-D	1-D	3-D	1-D	3-D	1-D	3-D	1-D	3-D	1-D	3-D
P. 8	2050.	49.	83.	68.	108.	81.	125.	98.	147.	110.	162.	122.	178.
C.14	2890.	47.	82.	65.	107.	77.	124.	91.	146.	102.	162.	113.	176.
C.15	3017.	46.	88.	63.	111.	76.	127.	90.	146.	101.	161.	112.	176.
C.16	3407.	45.	84.	62.	106.	73.	121.	87.	141.	97.	153.	107.	167.
C.17	3485.	45.	82.	61.	102.	72.	115.	85.	131.	95.	144.	105.	156.
C.18	3662.	45.	82.	60.	103.	71.	117.	84.	133.	94.	148.	104.	161.
C.21	4020.	43.	81.	57.	102.	66.	117.	78.	134.	87.	147.	96.	160.
C.22	4488.	45.	86.	59.	106.	69.	119.	81.	135.	89.	147.	98.	160.
C.23	4554.	41.	80.	55.	99.	65.	112.	76.	128.	85.	140.	93.	152.
C.26	4779.	42.	81.	54.	98.	63.	109.	73.	123.	81.	134.	88.	144.
C.27	5072.	41.	78.	53.	96.	61.	108.	71.	123.	78.	135.	86.	146.
C.31	5758.	40.	77.	52.	92.	60.	103.	70.	115.	77.	125.	84.	134.
C.32	7297.	39.	77.	49.	91.	55.	100.	63.	111.	69.	119.	75.	128.
C.35	7519.	38.	75.	48.	88.	54.	97.	62.	107.	68.	116.	74.	124.
C.36	7749.	38.	75.	47.	88.	53.	97.	60.	108.	66.	117.	71.	125.
C.38	8727.	38.	76.	46.	88.	52.	96.	59.	106.	64.	114.	69.	121.
C.39	9195.	36.	71.	44.	83.	50.	90.	56.	100.	62.	107.	67.	114.
C.28	236.	69.	118.	90.	148.	103.	169.	121.	192.	133.	213.	146.	232.
C.30	686.	50.	92.	63.	110.	72.	122.	83.	140.	91.	147.	99.	158.
C.25	225.	66.	104.	81.	123.	90.	136.	103.	155.	112.	164.	121.	175.
C.13	200.	67.	113.	82.	145.	93.	167.	106.	192.	115.	212.	125.	232.
C.20	240.	59.	105.	79.	133.	92.	151.	108.	175.	120.	192.	132.	209.
P.81	1538.	55.	89.	64.	115.	72.	131.	79.	153.	88.	168.	95.	184.
C.63	1304.	56.	95.	69.	119.	78.	134.	89.	154.	97.	168.	105.	183.
C.64	1261.	56.	96.	69.	121.	77.	137.	88.	158.	96.	173.	104.	189.
C.72	590.	60.	100.	74.	130.	83.	149.	94.	170.	102.	191.	110.	209.
C.75	520.	58.	98.	71.	127.	80.	147.	92.	172.	101.	190.	109.	208.
P.76	444.	61.	101.	75.	134.	85.	156.	97.	183.	106.	204.	114.	224.
C.66	528.	61.	104.	74.	128.	83.	144.	94.	164.	103.	179.	111.	193.
C.67	112.	83.	124.	99.	164.	110.	191.	123.	226.	133.	251.	143.	276.
C.68	416.	68.	105.	85.	127.	97.	142.	112.	160.	122.	174.	133.	187.
C.69	275.	62.	108.	77.	139.	87.	159.	100.	184.	110.	203.	119.	222.
C.70	141.	83.	132.	105.	164.	120.	185.	138.	211.	152.	232.	165.	251.
C.71	73.	111.	133.	140.	206.	159.	236.	184.	273.	202.	300.	220.	328.
C.40	177.	77.	121.	103.	153.	120.	174.	141.	201.	157.	221.	172.	240.

REMARKS : 1-D --- 1-DAY PROBABLE RAINFALL (MM)
3-D --- 3-DAY PROBABLE RAINFALL (MM)
C.A.--- CATCHMENT AREA
P.8 --- KARANGKATES DAM
C.16--- PAKEL
C.22--- KEDERI
C.35--- PLOSO
C.38--- LENGKONG DAM
C.39--- PORONG

Table 3.2.12 STORAGE FUNCTION OF SUB-BASIN

Basin No.	Catchment Area (km^2)	K	P	T_l	Basin No.	Catchment Area (km^2)	K	P	T_l
1.	760.2	15		0	33.	468.2	40		1
2.	156.5	20		0	34.	176.8	40		1
3.	24.5	20		0	35.	82.8	43		1
4.	271.1	20		0	36.	53.6	43		1
5.	381.1	20		1	37.	43.6	32		0
6.	221.0	20		0	38.	77.5	40		0
7.	236.1	20		1	39.	225.9	66		1
8.	159.5	20		1	40.	159.4	55		0
9.	211.7	25		1	41.	122.8	54		1
10.	244.5	25	0.33	1	42.	18.3	24	0.33	0
11.	83.5	25		0	43.	53.5	38		0
12.	116.0	25		0	44.	81.2	38		0
13.	24.3	25		0	45.	53.8	36		0
14.	127.0	30		1	46.	58.7	30		0
15.	393.0	40		2	47.	212.2	40		1
16.	69.9	30		1	48.	91.6	38		0
17.	163.7	30		0	49.	88.3	38		0
18.	59.4	30		0	50.	234.7	60		3
19.	109.5	30		0	51.	43.4	35		0
20.	435.7	35		1	52.	143.0	25		1
21.	61.8	35		0	53.	112.0	25		1
22.	138.2	35		0	54	275.3	40		2
23.	115.1	40		0	55.	68.3	40		1
24.	330.7	45		1	56.	73.0	30		1
25.	114.4	45		0	57.	42.5	35		0
26.	336.2	40		0	58.	27.0	20		0
27.	236.0	29		0	59.	76.3	20		0
28.	133.0	30		0	60.	61.0	20		0
29.	88.8	40		1	61.	109.6	25		0
30.	230.1	40		0	62.	183.1	20		0
31.	314.3	45		2	63.	89.5	20		0
32.	664.4	40		1					

Saturated rainfall : Rsa (= 200 mm)

Preliminary run-off coefficient : f_l (= 0.3)

Table 3.2.13 STORAGE FUNCTION FO CHANNEL

Channel No.	K	P		T_l
13.	10	0.60		1
14.	6.9	0.73		1
15.	5.2	0.73		2
16.	9.7	0.73		1
17.	25	0.74		1
20.	35	0.60		1
21.	13	0.65	($Q \leq 500$)	1
	0.019	1.70	($Q \leq 500$)	
22.	37	0.58	($Q \leq 500$)	
	0.504	1.63	($Q > 500$)	
23.	7.4	0.71		0
25.	40	0.60		1
26.	18	0.67	($Q \leq 700$)	1
	15	0.70	($Q > 700$)	
27.	39	0.70	($Q \leq 800$)	1
	15	0.84	($Q > 800$)	
30.	45	0.60		1
31.	21	0.72		
32.	0.009	1.78		0
35.	31	0.65	($Q \leq 800$)	0
	16	0.75	($Q > 800$)	
36.	80	0.52	($Q \leq 1000$)	1
	14	0.77	($Q > 1000$)	
39.	50	0.60	($Q \leq 1000$)	1
	22	0.72	($Q \geq 1000$)	
40.	7.5	0.76		1
44.	1.3	0.69		0
47.	4.7	0.68		1
49.	24	0.72		1
51.	14	0.69		1

Channel No.	K	P		T_l
63.	44	0.63	($Q \leq 200$)	1
	3.8	1.09	($Q > 200$)	
64.	15	0.63	($Q \leq 200$)	1
	1.3	1.20	($Q > 299$)	
66.	1.6	0.62	($Q \leq 80$)	0
	5×10^{-5}	2.98	($Q > 80$)	
67.	10	0.54	($Q \leq 20$)	1
	3.4	0.90	($Q > 20$)	
68.	3.4	0.56	($Q \leq 80$)	0
	2×10^{-4}	2.84	($Q > 80$)	
69.	7.1	0.60	($Q \leq 100$)	1
	0.8	1.07	($Q > 100$)	
70.	13	0.63	($Q \leq 20$)	1
	5.4	0.92	($Q > 20$)	
72.	5.1	0.65	($Q \leq 300$)	0
	1.4	0.89	($Q > 300$)	
75.	4.1	0.64	($Q \leq 300$)	0
	7.1	0.88	($Q > 300$)	

Inflow coefficient : f (= 1.0)

Table 3.2.14 PROBABLE 50-YEAR FLOOD PEAK DISCHARGE OF K. BRANTAS FOR THE PRESENT CONDITION

Base Point		Return Period in Year 2	5	10	25	50	100
K. Kates	Inflow	760	1,250	1,460	1,880	2,180	2,480
		580	910	1,160	1,500	1,740	1,990
	Outflow	380	470	540	640	740	870
		330	390	450	520	570	630
Pakel		640	760	880	1,020	1,100	1,210
		980	1,120	1,220	1,430	1,620	1,830
Kediri		670	780	850	950	1,020	1,090
		670	720	760	820	910	1,090
Before the confluence of K. Konto		670	780	850	940	1,020	1,090
		640	700	740	830	900	1,010
After the confluence of K. Konto		870	970	1,050	1,130	1,200	1,260
		820	930	1,020	1,120	1,210	1,280
Before the confluence of K. Widas		860	960	1,050	1,120	1,190	1,250
		810	920	1,010	1,100	1,190	1,260
After the confluence of K. Widas		1,060	1,190	1,280	1,370	1,440	1,510
		1,020	1,170	1,250	1,370	1,460	1,550
Ploso		1,060	1,190	1,270	1,360	1,440	1,500
		1,020	1,150	1,230	1,330	1,420	1,500
Before the confluence of K. Brangkal		1,080	1,210	1,300	1,400	1,480	1,540
		1,050	1,170	1,260	1,370	1,460	1,540
Lengkong		1,200	1,340	1,420	1,520	1,600	1,660
		1,180	1,300	1,380	1,490	1,580	1,660
Porong		1,190	1,340	1,410	1,510	1,570	1,640
		1,200	1,300	1,380	1,490	1,570	1,650

Upper ... JAN. 1981

Lower ... MAR. 1984

Table 3.2.15 PROBABLE 25-YEAR FLOOD PEAK DISCHARGE OF K. WIDAS FOR THE PRESENT CONDITION

Jan. 6 - 8, 1981

Base Point	2	5	10	25	50	100/1
K. Widas						
Before the confluence of K. Kedungsoko	220	290	350	410	440	470
Before the confluence of K. Brantas	310	370	400	450	480	510
K. Kedungsoko	170	250	300	390	460	530
Kuncir Retarding Basin	105	110	115	120	125	130
Ulo Retarding Basin	150	165	170	170	175	180
K. Kuncir	90	110	130	150	170	180
K. Ulo	90	120	150	210	350	470

Mar. 2 - 4, 1984

Base Point	2	5	10	25	50	100
K. Widas						
Before the confluence of K. Kedungsoko	260	340	400	440	470	510
Before the confluence of K. Brantas	270	310	350	390	450	510
K. Kedungsoko	110	160	190	240	270	300
Kuncir Retarding Basin	105	110	110	110	115	120
Ulo Retarding Basin	120	140	150	160	165	170
K. Kuncir	120	170	210	260	300	340
K. Ulo	110	150	180	220	250	280

/1 - Return Period in Year

TABLE 3.2.16 DISCHARGE AND B.O.D. VALUE ON K. SURABAYA

	B.O.D. (mg/l)		Discharge (m^3/s)	
	Perning	G. Sari	Mrilip	Jabon
July	15.9 17.4	1.8 3.7	11.1	49.5
August	7.4 1.9	7.1 2.0	13.8	43.8
September	1.5 1.1	1.0 1.8	14.0	35.8
October	2.1 1.4	1.0 1.8	11.3	34.7
Mean	6.1	2.5	12.6	41.0

Source : HY-53

Table 3.3.1 MEAN MONTHLY RAINFALL

(Unit : mm)

Name of station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Malang/Kayutangan	318	271	261	160	106	61	39	15	31	82	211	294	1,849
Blitar/Lodoyo	311	278	257	140	108	51	34	15	20	91	177	299	1,781
T.Agung/Campur Darat	216	221	201	103	101	56	61	19	39	108	121	180	1,207
Kediri/Kandat	266	246	277	169	149	43	39	17	25	62	146	270	1,709
Nganjuk/Nganjuk	250	273	266	175	134	43	27	12	8	52	166	289	1,795
Pare/Kantor Seksi	304	297	271	173	118	51	23	10	37	66	132	195	1,677
Jombang/Jombang	267	316	272	179	91	29	39	19	18	43	135	292	1,700
Mojokerto/Kantor Seksi	347	325	303	158	100	30	30	9	16	39	119	267	1,743

Malang	34 years from 1950 to 1983
Blitar	34 years from 1950 to 1983
T.Agung	34 years from 1950 to 1983
Kediri	29 years from 1955 to 1983
Nganjuk	34 years from 1950 to 1983
Pare	22 years from 1962 to 1983
Jombang	33 years from 1951 to 1983
Mojokerto	32 years from 1952 to 1983

Table 3.3.2 LAND CAPABILITY CLASSIFICATION IN THE BRANTAS BASIN

Class	Definition	Soil type	Land use at present	Acreage Ha	Acreage (%)
I	Very suitable for irrigated farming	Alluvial	Two crops of paddy, one crop of paddy and one upland crop of sugar cane	289,000	24.5
II	Suitable for irrigation farming, drainage is indespensable	Alluvials Grumsols Humus Gley Soils	Two crops of paddy or one crop of paddy and one upland crop	94,000	8.0
IIb	Suitable for irrigated farming of upland crops with irrigation	Latosols Mediterranean Regosols	One crop of paddy or upland crops	49,000	4.1
III	Usable for crop cultivation	Latosols Mediterranean Brown Forest soils Andosols Regosol	Upland crops, forest or waste land	192,000	16.3
IV	Unusable for crop cultivation	Mediterranean Soils Lithosols Latosols Regosols Andosols	Waste land	556,000	47.1
				1,180,000	100.0

Source : 1973 Master Plan Report

Table 3.3.3 PAST TREND OF IRRIGATED PADDY FIELD

(Unit : ha)

Name of Irrigation Section	1970	1975	1980	1984
Malang	18,044	18,051	18,022	16,712
Kepanjen	27,361	27,359	27,429	28,294
Blitar	30,129	31,667	35,792	34,986
Tulungagung	30,426	30,202	30,182	34,268
Kediri	29,141	29,140	29,211	29,660
Nganjuk	38,827	38,801	38,728	39,069
Jombang	24,381	23,199	24,314	24,269
Pare	19,621	19,367	19,300	19,298
Mojoagung	23,199	23,199	23,222	23,389
Mojokerto	32,431	32,324	32,217	32,024
Sidoarjo	33,417	33,077	32,609	31,601
Wonokromo (Surabaya area)	6,724	5,356	4,976	2,979
T o t a l	313,706	311,742	316,002	316,544

Source : AI62

Table 3.3.4 BENEFIT AND EIRR. OF FUTURE IRRIGATION PROJECT

	Unit	Widas Extension		Bang	Cottan Losari	Widas South	Lesti Left
		K.Warak Scheme	Semantok Scheme				
1. Irrigation Area	ha	950 (720)	1,300 (1,530)	3,200	4,180	6,270	2,300
2. Irrigation Benefit	x10^{6}Rp/Y	1,163	1,591	3,698	3,935	5,112	2,650
3. Negative Benefit	x10^{6}Rp/Y	290	100	234	-	64	-
4. Capital Cost							
Dam	x10^{6}Rp/Y	5,100	45,000	5,089	22,170/1	75,000	7,096/1
Irrigation facilities	x10^{6}Rp/Y	1,285	1,759	5,175	5,683	5,560	4,213
5. O & M Cost							
Dam	x10^{6}Rp/Y	51	450	51	222/2	750	71/2
Irrigation facilities	x10^{6}Rp/Y	32	44	129	142	139	105
Pump energy	x10^{6}Rp/Y	-	-	-	28	-	227
6. B-C at DF = 12%	x10^{6}Rp	- 682	-27,760	9,514	271	-39,188	4,135
7. EIRR	%	10.5 (10.8)	0.5 (0.3)	22.9	12.2	4.1	17.9

Note: Figures in parenthesis are in the case of cropping pattern of paddy-paddy-polowijo. Irrigation benefit and cost of irrigation facilities of Widas Extension Project is divided into Kdeungwarek scheme and Semantok scheme in the proportion of their irrigation areas.

/1 : Water exploitation cost is estimated based on Wonorejo dam construction cost
/2 : 1 % of water exploitation cost is taken into account

Table 3.3.5 BENEFIT AND EIRR. OF ON-GOING PROJECT

	Unit	Wonorejo	Tugu	Waru-Turi		Waru-Turi
				Waru-jayeng	Turi-Tunggorono	Pepar-Peterongan (Zone A + B)
1. Irrigation Benefit	x10^{6}Rp/Y	14,758	5,744	12,161	7,072	24,967
2. Negative Benefit	x10^{6}Rp/Y	40	112	-	-	-
3. Capital Cost	x10^{6}Rp/Y	62,921	33,702	26,813	11,531	85,341 /1
4. Recurrent Cost	x10^{6}Rp/Y	264	141	523	195	925
5. Construction Period	Year	6	5	4	5	8
6. B-C at DF = 12%	x10^{6}Rp	25,175	961	33,576	16,802	37,164
7. EIRR. %	%	18	12	25	27	18

/1 : Water cost, Rp.15,030 x 10^6 is included for Pepar-Peterongan area

Table 3.3.6 (1) COMPARISON BETWEEN INTAKE DISCHARGE AND POTENTIAL WATER REQUIREMENT IN DRY SEASON, 1982

Intake Area (ha)		Molek 3991			Lodoyo 10,000			Mrican/1 12,827			Turi-Tunggorono 9.587		
		1	2	3	1	2	3	1	2	3	1	2	3
	1	5.40	2.34	3.06	9.00	7.81	1.19	9.93	12.76	-4.16	6.70	5.92	0.78
June	2	5.30	1.80	3.50	9.00	7.83	1.17	10.11	12.76	-3.86	6.00	9.03	-3.03
	3	5.30	2.25	3.05	9.00	7.78	1.22	9.30	12.64	-4.54	5.70	9.19	-3.49
	1	5.50	2.31	3.19	9.00	7.07	1.93	7.62	12.34	-5.64	6.50	9.82	-3.32
July	2	5.50	1.84	3.66	7.60	6.13	1.47	7.42	12.40	-5.50	5.20	9.73	-4.53
	3	5.60	2.51	3.09	6.00	5.22	0.78	8.02	11.12	-3.62	8.20	8.68	-0.48
	1	5.20	3.37	1.83	6.00	4.90	1.10	7.52	11.73	-4.73	5.80	7.83	-2.03
Aug.	2	4.60	3.44	1.16	6.00	4.23	1.17	7.32	9.30	2.47	5.70	6.39	-0.69
	3	4.30	3.45	0.85	6.00	2.70	3.30	7.42	8.53	-1.63	5.20	5.17	0.03
	1	3.90	2.71	1.19	6.00	3.73	2.27	7.42	9.98	-3.08	4.30	4.44	-0.14
Sept.	2	3.90	2.64	1.26	6.00	4.04	1.96	7.32	9.99	-3.19	5.10	3.84	1.26
	3	4.20	2.78	1.42	6.00	4.40	1.60	7.32	9.91	-3.11	3.70	4.12	-0.42
	1	3.70	2.72	0.98	6.00	2.89	3.11	7.42	9.86	-2.96	0	4.47	-4.47
Oct.	2	3.40	1.26	2.14	6.00	3.98	2.02	7.52	9.46	-2.46	1.40	4.16	-2.76
	3	3.30	2.45	0.85	6.00	3.60	2.40	7.12	0.42	6.18	3.40	3.91	-0.51
	1	3.60	2.15	1.45	6.00	3.26	2.74	6.92	7.73	-0.81	3.10	3.35	-0.25
Nov.	2	4.00	3.74	0.26	6.00	0.22	5.78	7.12	2.35	4.77	3.50	2.85	0.65
	3	3.80	2.20	1.60	6.00	2.81	3.19	6.62	0.45	6.17	3.70	2.51	1.19
Total		80.50	45.96	34.54	121.60	82.60	39.0	139.44	163.73	-24.29	83.20	105.41	-22.81

Intake Area (ha)		Jatikulon 619			Mangetan 18,203			Porong 12,339			Cottan - Etc. 4,238		
		1	2	3	1	2	3	1	2	3	1	2	3
	1	0.30	0.94	-0.64	23.26	13.52	9.74	17.71	8.67	9.04	0.40	1.45	-1.05
June	2	0.30	0.72	-0.42	23.76	14.65	9.11	14.41	8.78	5.63	0.20	1.18	-0.98
	3	0.30	0.73	-0.43	21.66	15.57	6.09	12.81	8.86	3.95	0.30	1.23	-9.93
	1	0.30	0.80	-0.50	19.86	15.45	4.41	10.91	8.71	2.20	0.30	1.41	-1.11
July	2	0.30	0.82	-0.52	16.86	15.48	-1.38	10.53	8.73	1.78	0.20	1.38	-1.18
	3	0.30	0.80	-0.50	23.76	13.56	10.20	17.71	8.09	9.62	0.10	1.21	-1.11
	1	-	-	-	16.16	11.95	4.21	10.21	7.30	2.91	0.20	1.55	-1.35
Aug.	2	0.20	0.93	-0.73	16.16	11.10	5.06	10.41	6.44	3.97	0.20	1.60	-1.40
	3	0.30	0.91	-0.61	15.96	10.17	5.79	10.01	5.64	4.37	0.20	1.61	-1.41
	1	0.30	0.82	-0.52	11.26	10.69	0.57	9.81	5.66	1.15	0.20	1.82	-1.62
Sept.	2	0.30	0.58	-0.28	10.56	9.87	0.69	7.11	4.91	2.20	0.20	1.86	-1.66
	3	0.30	0.36	-0.06	11.16	9.09	2.07	6.31	4.77	2.54	0.20	1.93	-1.73
	1	0.30	0.16	0.14	11.06	9.42	1.64	7.81	5.96	1.85	0.20	2.06	-1.86
Oct.	2	0.30	0.07	0.23	11.26	8.16	3.10	7.71	6.00	1.71	0.20	2.05	-1.85
	3	0.30	0.08	0.22	11.26	0.35	10.91	7.01	2.81	4.20	0.20	2.04	-1.84
	1	0.30	0.08	0.22	10.56	5.79	4.77	7.50	5.17	2.33	0.70	1.87	-1.17
Nov.	2	0.30	0.10	0.20	11.36	1.88	9.48	8.10	3.23	4.87	0.70	1.75	-1.05
	3	0.10	0.10	0.00	6.66	6.23	0.43	4.10	4.94	-0.84	0.70	1.34	-0.64
Total		4.80	8.98	-4.20	272.58	182.93	89.65	178.15	114.67	63.48	5.40	29.31	-23.91

1 : Intake discharge
2 : Potential water requirement
3 : Difference

Note: Intake discharge in Mangetan and Porong are values deducted the amounts of industrial water requirements of 1.14 m^3/sec and 1.29 m^3/sec, respectively.

/1 : Intake Mrican plus Banjarsari.

Table 3.3.6(2) COMPARISON BETWEEN INTAKE DISCHARGE AND POTENTIAL WATER REQUIREMENT IN DRY SEASON, 1983

Intake Area (ha)		Molek 3,991			Lodoyo 10,000			Mrican/1 12,827			Turi-Tunggorono 9,587		
		1	2	3	1	2	3	1	2	3	1	2	3
	1	6.10	2.63	3.47	9.00	9.47	-0.47	9.90	14.23	-4.33	8.30	8.36	-0.06
June	2	5.80	2.92	2.88	9.00	9.29	0.21	10.80	14.32	-3.52	8.30	8.56	-0.26
	3	5.40	3.28	2.12	9.00	8.70	0.30	10.90	14.23	-3.33	8.60	8.87	-0.27
	1	5.50	3.54	1.96	9.00	8.64	0.36	10.30	13.68	-3.38	9.70	9.81	-0.11
July	2	5.50	3.02	2.48	9.00	8.77	0.23	8.20	12.35	-4.15	7.90	9.80	-1.90
	3	4.90	3.79	1.11	9.00	8.89	0.11	7.00	11.86	-4.86	5.60	9.68	-4.08
	1	3.80	3.99	-0.19	8.40	9.40	-1.00	10.60	12.03	-1.43	4.60	10.59	-5.99
Avg.	2	3.90	3.84	0.06	8.00	8.48	-0.48	8.30	10.83	-2.53	4.00	9.72	-5.72
	3	3.60	3.53	0.07	8.00	6.30	1.70	7.50	9.07	-1.57	3.50	8.20	-4.70
	1	3.20	3.74	-0.54	8.00	6.95	1.05	8.10	9.95	-1.85	3.30	7.32	-4.02
Sep.	2	3.30	3.73	-0.43	8.00	6.18	1.82	7.20	9.88	-2.68	2.30	6.03	-3.73
	3	3.50	3.49	0.01	8.00	5.45	2.55	6.60	9.82	-3.22	2.60	4.96	-2.36
	1	3.40	2.77	0.63	8.00	3.07	4.93	7.60	9.70	-2.10	2.30	4.74	-2.44
Oct.	2	5.00	1.05	3.95	7.50	3.61	3.89	7.50	8.93	-1.43	1.10	4.54	-3.44
	3	4.10	0.81	3.29	6.50	3.29	3.21	7.60	0.44	7.16	0.30	4.37	-4.07
Total		67.00	46.13	20.87	124.40	105.89	18.91	128.1	161.32	-33.22	72.4	115.55	- 43.15

Intake Area (ha)		Jatikulon 619			Mangetan 18,203			Porong 12,339			Cottan - Etc 4,238		
		1	2	3	1	2	3	1	2	3	1	2	3
	1	0.10	0.23	-0.63	24.36	13.04	11.32	17.61	6.17	11.44	0.60	1.74	-1.14
June	2	0.60	0.74	-0.14	25.46	12.52	12.94	18.01	7.00	11.01	0.70	1.59	-0.89
	3	0.50	0.77	-27	25.85	13.09	12.77	17.91	9.32	8.59	0.80	1.57	-0.77
	1	0.50	0.84	-0.34	25.86	14.85	11.01	17.91	9.96	7.95	0.50	1.74	-1.24
July	2	-	-	-	24.46	13.94	10.52	17.11	8.57	8.54	0.70	1.68	-0.98
	3	0.40	0.81	-0.41	18.76	14.86	3.90	11.91	8.87	3.04	0.50	1.44	-0.94
	1	0.30	0.95		15.56	14.44	1.12	9.31	9.51	-0.20	0.20	1.84	-1.64
Avg.	2	0.30	0.94	-0.64	15.66	14.79	0.87	10.01	9.73	0.28	0.50	1.86	-1.36
	3	0.30	0.89	-0.59	14.36	15.53	-1.17	9.41	9.84	-0.43	0.30	1.83	-1.53
	1	0.40	0.78	-0.38	14.36	17.30	-2.94	8.61	10.88	-2.27	0.40	2.00	-1.60
Sep.	2	0.20	0.48	-0.28	10.86	16.42	-5.56	8.31	10.31	-2.00	0.20	1.94	-1.74
	3	0.40	0.20	0.20	10.26	14.79	-4.53	7.81	9.32	-1.51	0.50	1.89	-1.39
	1	0.20	0.06	0.14	11.46	14.81	-3.35	9.01	9.36	-0.35	0.50	1.88	-1.38
Oct.	2	0.10	0.07	0.03	14.66	12.68	1.98	11.51	7.74	3.77	0.20	1.89	-1.69
	3	0.30	0.07	0.23	19.26	2.06	17.20	15.21	2.99	12.22	0.10	1.92	-1.82
Total		4.60	8.33	- 3.73	271.20	205.12	66.08	189.65	129.37	60.08	6.50	26.81	-20.31

1 : Intake discharge
2 : Potential water requirement
3 : Difference

Note : Intake discharges in Mangetan and Porong are values deducted the amount of industrial water requirement of 1.14 m3/sec and 1.29 m3/sec, respectively.

/1) Mrican plus Banjarsari.

Table 3.3.7 SUMMARY OF FUTURE WATER DEMAND OF IRRIGATION AREA FED FROM K. BRANTAS

(Unit: m^3/sec)

		Lesti Left	/1 Mulek	Lodoyo	Melcan	Papar-Peteron-gan /2	Turi-Tunggo-rono	Jatim-lerek-Bunder	Gottan-Losari /1	Jatiku-lon	Wonok-rono	Porong	Manges-tan	Total
Jan.	1	0	9	10.53	5.21	3.43	13.46	1.34	1.44	0	0.54	3.81	5.04	44.80
	2	0	1.29	3.65	0.96	1.51	15.51	1.37	0.97	0.20	0.20	5.22	6.90	37.98
	3	0	0	13.33	9.50	0.02	13.23	1.42	0	0	0.72	0.04	0.05	38.31
Feb.	1	0	0.09	8.58	13.08	0	13.83	1.48	0	0	0	0	0	37.06
	2	0	1.47	23.56	8.30	0.16	0	0	4.19	0.73	0.07	10.66	14.00	63.14
	3	0.73	5.45	22.35	3.30	0.26	0.25	0	4.71	0.80	0.94	12.26	16.09	67.14
Mar.	1	1.07	5.33	1.76	5.32	3.60	4.67	0.65	1.08	0.22	0.59	2.65	3.51	30.45
	2	0.26	3.74	6.60	8.10	3.05	3.65	0.05	0.05	0.03	0.39	0.20	0.26	26.38
	3	1.03	4.47	6.61	11.20	3.01	3.66	0.63	2.57	0.71	1.15	8.40	11.13	54.57
Apr.	1	0.93	4.19	10.31	15.81	3.54	8.65	1.22	3.99	0.98	1.23	12.37	16.34	79.56
	2	1.76	5.89	15.91	18.29	5.34	11.58	1.57	3.64	0.97	0.84	11.67	15.44	92.90
	3	0	1.64	14.89	15.49	3.14	12.34	1.54	3.42	0.95	0.86	11.11	14.74	80.12
May	1	0.23	3.76	13.72	16.02	4.89	13.22	1.17	2.52	0.70	1.13	10.25	13.65	81.26
	2	0	2.11	12.71	18.23	6.50	10.94	1.19	2.73	0.72	0.53	10.70	14.31	80.71
	3	0.10	4.19	12.76	18.25	8.41	11.02	1.20	2.91	0.73	1.01	9.22	12.36	82.16
Jun.	1	0.14	4.06	11.39	16.04	6.86	7.60	0.85	2.89	0.72	1.05	9.41	12.65	73.66
	2	0.21	3.44	11.15	13.11	6.97	9.58	1.19	2.90	0.71	1.09	9.67	13.00	73.02
	3	1.10	3.55	10.41	10.35	5.18	7.84	1.17	2.78	0.71	1.09	9.74	13.12	67.04
Jul.	1	1.43	2.84	9.03	8.08	1.83	6.65	1.22	2.58	0.76	1.01	9.23	12.42	57.09
	2	1.10	1.65	7.92	5.74	0	5.07	1.04	1.94	0.66	0.86	8.19	11.00	45.17
	3	1.60	1.56	6.93	3.85	0	3.66	0.78	1.16	0.47	0.64	6.19	8.32	35.16
Aug.	1	1.70	1.20	6.76	4.21	0	2.90	0.64	1.05	0.44	0.47	5.63	7.54	32.54
	2	1.59	1.20	6.05	5.61	0	2.85	0.43	0.91	0.37	0.33	4.52	6.08	29.52
	3	0.63	1.64	4.38	7.04	0	3.78	0.42	1.01	0.35	0.23	3.66	4.96	28.10
Sep.	1	0.26	2.23	6.09	9.08	0	5.21	0.63	1.60	0.46	0.31	3.84	5.26	34.97
	2	0.10	2.55	6.50	9.66	0	5.69	0.77	2.17	0.49	0.47	4.51	6.25	39.36
	3	0.14	2.71	7.33	8.69	0	6.30	0.86	2.60	0.49	0.64	5.85	8.14	43.74
Oct.	1	0.24	2.29	5.47	8.06	0	5.84	0.91	3.13	0.40	0.87	8.20	11.45	46.86
	2	0.07	0.77	7.69	5.72	0	4.96	0.87	3.35	0.29	0.98	9.17	12.84	46.70
	3	0.07	2.33	7.00	0.27	0	4.00	0.66	3.32	0.18	0.13	9.75	13.64	41.35
Nov.	1	0	2.14	10.60	2.98	0	2.99	0.44	2.69	0.11	0.67	9.23	12.86	44.71
	2	0.80	3.53	4.07	7.01	0	2.20	0.30	2.19	0.09	0.22	8.19	11.32	39.92
	3	0	2.65	4.07	6.78	2.23	6.16	0.93	3.17	0.51	1.04	10.50	14.15	52.14
Dec.	1	0	2.55	16.79	11.49	4.54	4.93	0.73	3.65	0.68	0.84	11.13	14.86	72.25
	2	0	1.54	15.67	16.06	1.45	3.99	0.56	1.56	0.35	0.58	4.03	5.32	51.11
	3	0	0.02	17.44	20.29	7.82	5.65	0.79	2.35	0.56	1.08	5.81	7.68	69.49

Note : /1; The breakdown of water requirement of Lesti and Gottan-Losari is compiled in Note AI-12 & 13.

/2; Water demand of Papar-Peterongan area is increasing amount from the present demand estimated (see Note AI-17)

TABLE 3.4.1 WATER PRODUCTION, SUPPLY AND NUMBER OF CUSTOMER IN PDAM SURABAYA, 1982

Month	Production 10^3 m^3	Supply 10^3 m^3	Nos. of Customer
Jan.	6,564	4,982	86,919
Feb.	5,947	4,592	87,220
Mar.	6,753	4,706	87,628
Apr.	6,543	4,658	83,030
May	6,846	4,900	88,311
Jun.	7,418	4,736	88,605
Jul.	8,112	5,225	89,049
Aug.	8,094	5,234	89,406
Sept.	8,340	5,554	89,846
Oct.	8,564	5,230	90,303
Nov.	8,103	5,201	90,903
Dec.	8,549	5,518	91,587
Yearly Total	89,833	60,536	

TABLE 3.4.2 WATER SUPPLY BY CATEGORIES IN PDAM SURABAYA

Customer Classification	Total Supplied m^3/month	Total Supplied m^3/day	Total Supplied %	No. of Connection	Av. demand per Connection (m^3/day)
Domestic					
Residential	2,566,656	85,555	49.0	73,611	1.16
Vendors	399,904	13,330	7.6	4,164	3.20
Industrial	320,517	10,684	6.1	1,711	6.24
Port Authority	14,272	475	0.3	3	158.33
Commercial	591,660	19,723	11.3	10,747	1.83
Government	991,794	33,060	18.9	2,155	15.34
Social institutions	61,911	2,063	1.2	558	3.69
Other enterprises (Sidoarjo Gempol Supply)	288,146	9,605	5.5	42	288.66
Total	5,234,860	174,495	-	92,991	-

Table MW-3.4.3 DESIGN STANDARD FOR BNA AND IKK PROJECT

BNA Project

Town Category	Medium	Small
Population in 1990 (x 1,000)	100 - 500	20 - 100
Percent of 1990 population to be served	75 %	75 %
Domestic demand (l / c / d)		
- House connection to 1/4 of served population	200	120
- Yard connection to 1/4 of served population	100	60
- Public stand pipes, each serving 200 persons to 1/2 of served population	30	30
Total average domestic demand	90	60
Non-domestic demand % of domestic demand)	30 %	20 %
Allowance for unaccounted water (% of total demand)	20 %	20 %

Note : according to REPELITA IV

IKK Project

Design Population	Source Capacity (l/c)	No. of House Connection	No. of Public Tap	Population Served
For IKK using river water treatment plants as source				
3,600 - 7,200	2.5	180	9	3,600
7,201 - 12,000	5	360	18	7,200
12,001 - 16,000	7.5	540	27	10,800
16,001 - 20,000	10	720	36	14,400
For IKK using spring or deep well as water source				
3,600 - 7,200	2.5	180	9	3,600
7,201 - 14,400	5	360	18	7,200
14,401 - 20,000	10	720	36	14,400

Items	Criteria
1. Supply level of public taps	30 litres/capita/day
2. Supply level of house connections	60 litres/capita/day
3. Population served	50 % - 100 %
4. Ratio of population served by public taps and population served by house connection	50 % - 50 %
5. Water allocation for non domestic demand	5 % of domestic demand
6. Water allocation for leakage in the system and production losses	15 % of total demand
7. Maximum day factor	1.1
8. Peak factor for maximum - hour	None
9. Design group for public tap	200 capita/unit
10. Design group for house connections	10 capita/unit
11. Minimum pressure in distribution system	10 meter head
12. Design horizon distribtuion	5 years population
13. Design horizon transmission	10 years population

Table 3.4.4 ESTIMATED CONSTRUCTION COST FOR BNA PROJECT

Town	Construction Cost Estimate Rp.10^6	Population Served in	Cost per Capita. Rp.10^3/C	Supply Capacity L^1 m^3/day	Unit Cost Rp.$10^3/m^3$/day
1st Stage		1985			
Singojari	1,211	40,800	30	4,049	299
Batu	1,016	43,700	23	4,395	231
Kepanjen	920	31,550	29	3,253	283
Tulungagung	2,271	68,000	33	6,730	337
Ngunut	893	23,000	33	3,692	346
Mojosari	637	22,850	28	2,298	277
Sidoarjo	1,865	46,200	40	4,582	407
Krian	1,277	37,200	33	2,350	374
2nd Stage		1990			
Wlingi	880	23,800	37	2,350	374
Trenggalek	830	29,200	28	2,875	289
Pare	1,590	48,450	33	4,830	329
Kertosono	1,170	32,600	36	2,070	565
	14,560			43,474	335

IKK PROJECT

Town	Construction Cost Estimate Rp.10^6	Population Served in	Cost per Capita. Rp.10^3/C	Source Capacity (L/S)	Unit Cost Rp.$10^3/m^3$/day
1st Stage		1985			
Malang-9 Ikks	1,100	43,200	25	30.0	467
Mojokento-6 Ikks	546	21,600	25	15.0	463
Sidoarjo-4 Ikks	543	32,400	17	22.5	307
Tulungagung-4 Ikks	534	18,000	30	12.5	544
2nd Stage					
Nganjuk-7 Ikks	1,080	44,600	24	32.5	423
Kediri-7 Ikks	1,254	54,000	23	37.5	426
Blitar-6 Ikks	1,083	46,800	23	32.5	424
Trenggalek-7 Ikks	1,113	33,630	33	22.5	629
Total/Average	7,253			205.0	450

Table 3.4.5 POPULATION PROJECTION FOR ENTIRE INDONESIA

Year	Population 10^3	Annual Growth Rate %
1971	119,232	
1980	148,040.0	2.43
1985	165,153.6	2.21
1990	183,456.8	2.12
1995	202,746.3	2.02
2000	222,753.0	1.90

Source: Statistik, Indonesia, 1983

Table 3.4.6 ASSUMED POPULATION GROWTH RATES

Unit: % per annum

Region including respective Kotamadya	Year								
	1971	1980	1985	1990	1995	2000	2005	2010	2015
	1980	1985	1990	1995	2000	2005	2010	2015	2020
All Indonesia /1	2.43	2.21	2.12	2.02	1.90	1.83	1.65	1.52	1.38
East Java /2	1.50	1.36	1.31	1.25	1.17	1.13	1.02	0.94	0.85
Trenggalek	0.89	0.81	0.78	0.74	0.70	0.67	0.60	0.56	0.51
Tulungagung	1.03	0.94	0.94	0.86	0.81	0.78	0.70	0.64	0.58
Blitar	1.02	0.92	0.89	0.85	0.80	0.77	0.69	0.64	0.58
Kediri	1.63	1.48	1.42	1.35	1.27	1.23	1.11	1.02	0.93
Malang	1.74	1.58	1.52	1.45	1.36	1.31	1.18	1.09	0.99
Sidoarjo	2.78	2.53	2.43	2.31	2.17	2.09	1.89	1.74	1.58
Mojokerto	1.86	1.69	1.62	1.55	1.45	1.40	1.26	1.16	1.06
Jomban	1.66	1.51	1.45	1.38	1.30	1.25	1.13	1.04	0.94
Ngenjuk	1.46	1.33	1.27	1.21	1.14	1.10	0.99	0.91	0.83

Note: /1 Based on Fig. 3.4.3

/2 For example, the rate of East Java in 1980-85

1.58% x 2.21%/2.43% = 1.36%

Table 3.4.7 POPULATION PROJECTION

	1980	1985	1990	1995	2000	2005	2010	2015	2020
East Java	29,188,852	31,228,400	33,328,200	35,463,900	37,587,700	39,759,900	41,829,500	43,832,800	45,727,600
1 Excl. SMA 1	26,321,375	28,160,600	30,054,100	31,980,000	33,895,100	35,854,000	37,720,200	39,526,700	41,235,400
2 SMA 2	2,867,477	3,465,000	4,187,000	5,060,400	6,119,000	7,395,400	8,938,100	10,802,600	13,056,000
3 East Java 1 + 2									
Balance 3 - 1	0	-397,200	912,900	1,576,500	2,426,400	3,489,500	4,828,800	6,496,500	8,563,800
Trenggalek	564,542	587,800	611,100	634,000	656,500	678,800	699,400	719,200	737,700
- SMA		-8,300	-18,600	-31,300	-47,000	-66,100	-89,500	-118,200	-153,200
- Urban	29,318	33,200	37,500	42,500	48,000	54,400	61,500	69,600	78,700
Rural	535,224	546,300	555,000	569,200	561,500	558,300	548,400	531,400	505,800
Tulungagung	833,323	873,200	913,200	953,200	992,400	1,031,700	1,068,400	1,103,000	1,135,300
- SMA		-12,300	-27,700	-47,000	-71,000	-100,400	-136,800	-181,300	-235,800
- Urban	178,094	201,500	228,000	257,900	291,800	330,200	373,600	422,700	478,200
Rural	655,229	659,400	657,500	648,300	629,600	601,100	558,000	499,000	421,300
Blitar	1,115,761	1,168,000	1,221,000	1,273,700	1,325,500	1,377,300	1,425,500	1,471,700	1,514,900
- SMA		-16,500	-37,100	-62,800	-94,900	-134,000	-182,500	-241,900	-314,600
- Urban	141,913	160,600	181,700	205,500	232,500	263,100	297,700	336,800	381,000
Rural	973,800	990,900	1,002,200	1,005,400	998,100	980,200	945,300	893,000	819,300
Kediri	1,457,095	1,568,200	1,682,700	1,799,400	1,916,600	2,037,400	2,153,000	2,265,100	2,372,400
- SMA		-22,100	-51,100	-88,700	-137,200	-198,300	-275,600	-372,300	-492,700
- Urban	248,009	280,600	317,500	359,200	406,400	459,800	520,200	588,500	665,900
Rural	1,209,086	1,265,500	1,314,100	1,351,500	1,373,000	1,379,300	1,357,200	1,304,300	1,213,800
Malang	2,557,719	2,766,300	2,983,000	3,205,600	3,429,600	3,660,200	3,881,300	4,097,500	4,304,400
- SMA		-39,000	-90,600	-158,000	-245,500	-356,200	-496,900	-673,500	-893,900
- Urban	663,729	750,900	849,600	961,300	1,087,600	1,230,500	1,392,200	1,573,200	1,782,200
Rural	1,893,990	1,976,400	2,042,800	2,086,300	2,096,500	2,073,500	1,992,200	1,850,800	1,628,300
Sidearjo	351,181	397,900	448,700	502,900	559,900	620,900	681,900	743,300	803,900
- SMA		-5,600	-13,600	-24,800	-40,100	-60,400	-87,300	-122,200	-167,000
- Urban	55,273	62,500	70,800	80,100	90,600	102,500	115,900	131,200	148,400
Rural	295,908	329,600	364,300	398,000	429,200	458,000	478,700	489,900	488,500
Mojokerto	774,445	842,100	912,600	985,500	1,059,100	1,135,300	1,208,700	1,280,500	1,349,800
- SMA		-11,900	-27,700	-48,600	-75,800	-110,500	-154,700	-210,500	-280,300
- Urban	116,355	131,600	148,900	168,500	190,700	215,700	244,100	276,100	312,400
Rural	658,090	698,600	736,000	768,400	792,600	809,100	809,900	793,900	757,100
Jombang	941,988	1,015,300	1,091,100	1,168,500	1,246,400	1,326,300	1,402,900	1,477,400	1,548,200
- SMA		-14,300	-33,100	-57,600	-89,200	-129,100	-179,600	242,800	321,500
- Urban	87,832	99,400	112,400	127,200	143,900	162,800	184,200	208,400	235,800
Rural	854,156	901,600	945,600	983,700	1,013,300	1,034,400	1,039,100	1,026,200	990,900
Nganjuk	882,832	943,100	1,004,600	1,066,800	1,129,000	1,192,500	1,252,700	1,310,800	1,366,100
- SMA		-13,300	-30,500	-52,600	-80,800	-116,100	-160,400	215,400	283,700
- Urban	87,832	99,400	112,400	127,200	143,900	162,800	184,200	208,400	235,800
Rural	795,000	830,400	861,700	887,000	904,300	913,600	908,100	887,000	846,600
SMA	2,867,477	3,465,000	4,187,000	5,060,400	6,119,000	7,395,400	8,938,100	10,802,600	13,056,000
Urban	1,608,355	1,819,700	2,058,800	2,329,100	2,635,400	2,981,800	3,373,600	3,814,900	4,318,400
Rural	7,870,483	8,198,700	8,479,200	8,697,800	8,798,100	8,807,500	8,636,900	8,225,500	7,671,600
Total	12,346,315	13,481,400	14,250,000	16,087,600	17,552,500	19,184,700	20,948,600	22,843,000	25,046,000

Table 3.4.8 INTERNATIONAL COMPARISON OF PER CAPITA DOMESTIC WATER CONSUMPTION

(Unit: l/day)

	1970						Future						GDP per Capita 1981 US$
	Urban				Rural		Urban				Rural		
	With House Connections		With Public Standposts		Min.	Max.	With House Connections		With Public Standposts		Min.	Max.	
	Min.	Max.	Min.	Max.			Min.	Max.	Min.	Max.			
Bangladish	45	70	15	25	10	20	70	135	25	45	25	45	140
Burma	100	180	45	100	22	60	150	220	70	120	50	100	190
India	50	270	-	-	25	100	90	270	-	-	45	130	260
Indonesia	50	150	5	20	-	-	86	150	-	100	30	60	530
Sri Lanka	170	220	30	50	20	70	170	220	30	50	20	70	300
Thailand	120	180	-	-	50	100	150	200	-	-	50	80	770
Fuji	140	260	-	-	-	-	-	270	-	-	9	90	
Korea	150	250	-	-	40	80	200	350	-	-	80	120	1,700
Malaysia	18	410	-	-	14	230	250	250	-	-	23	110	1,840
Philippines	110	540	-	-	40	110	360	1,100	-	-	180	360	790
Singapore	-	220	-	-	-	-	-	315	-	-	-	-	5,240

Table 3.4.9 NUMBER OF HOUSEHOLD BY MONTHLY EXPENDITURE CLASS

(1975 Constant Price)

Monthly Expenditure Class (Rp./Family)	1980 House-hold (100)	Share (%)	1990 House-hold (1000)	Share (%)	2000 House-hold (1000)	Share (%)
(1) Under 5,000	5.3	0.89	3.2	0.37	1.7	0.14
(2) 15,000- 10,000	33.8	5.66	24.9	2.92	16.9	1.36
(3) 10,000- 20,000	114.8	19.24	105.3	12.34	89.4	7.19
(4) 20,000- 30,000	109.0	18.25	124.0	14.52	124.1	9.98
(5) 30,000- 40,000	85.3	14.28	111.8	13.10	125.6	10.10
(6) 40,000- 50,000	62.5	10.47	88.3	10.34	122.1	9.82
(7) 50,000- 60,000	45.6	7.63	73.2	8.58	102.2	8.22
(8) 60,000- 70,000	32.5	5.44	59.6	6.08	89.1	7.17
(9) 70,000- 80,000	23.4	3.91	46.0	5.39	78.1	6.28
(10) 80,000- 90,000	18.6	3.11	36.4	4.27	65.6	5.28
(11) 90,000-100,000	13.6	2.27	30.5	3.57	53.7	4.31
(12) 100,000-120,000	18.1	3.03	43.6	5.11	85.5	6.88
(13) 120,000-140,000	11.8	1.98	28.4	3.33	63.8	5.13
(14) 140,000-160,000	6.9	1.16	20.2	2.37	48.6	3.91
(15) 160,000-180,000	4.8	0.80	15.0	1.76	36.3	2.92
(16) 180,000-200,000	3.2	0.53	9.6	1.13	26.4	2.13
(17) 200,000-250,000	4.1	0.69	15.4	1.80	44.6	3.59
(18) 250,000 and over	3.9	0.66	18.1	2.12	69.4	5.59
Total	597.2	100.00	853.5	100.00	1,243.1	100.00

Source; Surabaya Urban Development Planning Study

Table 3.4.10 WATER DEMAND

Item No.	Kind of Industries	Unit Water Demand m^3/employees/d	Number of Employees* (Capita)	Water Demand (m^3/d)	(m^3/s)
31-(A)	Foodstuff drink, beverage, and cigarettes	1,47	165,261	242,934	2.81
32-(B)	Textiles, ready-made clothing and leathers	0.82	31,690	25,986	0.30
33-(C)	Wooden wares and furnitures	0.19	8,993	1,709	0.02
34-(D)	Paper industry, printing and publishing	6.79	7,195	48,854	0.57
35-(E)	Chemical industry and chemical goods, oil, coal, rubber goods & plastics	4.27	22,659	96,754	1.12
36-(F)	Mineral industries excluding metal goods, oil and coal	1.52	13,238	20,122	0.23
37-(G)	Basic Metal Industry	2.71	1,651	4,474	0.05
38-(H)	Metal goods, machine & tools	0.27	26,491	7,153	0.08
39-(L)	Other industries	0.46	594	273	0.01
	T o t a l	-	277,772	448,263	4.92
	Average Unit Water Demand per Employee			1.61 m^3/c/d	

* : Ref. MW 24

Table 3.5.1 ESTIMATED WATER DEPTH IN THE INUNDATION AREA

(Unit: m)

	Return Period in Year					
	2	5	10	25	50	100
K. Brantas						
10 km	2.36	2.41	2.43	2.46	2.48	2.51
20 km	2.23	2.30	2.34	2.40	2.45	2.49
30 km	1.95	2.02	2.66	2.12	2.17	2.22
40 km	2.46	2.53	2.58	2.65	2.70	2.74
50 km	2.27	2.35	2.40	2.47	2.54	2.59
60 km	1.94	2.02	2.08	2.15	2.21	2.27
70 km	2.43	2.51	2.58	2.65	2.72	2.78
80 km	2.18	2.23	2.27	2.32	2.36	2.41
90 km	1.24	1.31	1.36	1.44	1.50	1.57
100 km	1.54	1.63	1.69	1.78	1.86	1.93
110 km	1.04	1.12	1.17	1.26	1.33	1.40
120 km	2.25	2.50	2.65	2.87	3.04	3.24
130 km	1.75	1.96	2.10	2.27	2.41	2.55
140 km	0.55	0.74	0.87	1.02	1.13	1.26
K. Widas						
5 km	1.60	1.76	1.86	1.98	2.07	2.19
10 km	1.29	1.45	1.55	1.67	1.74	1.86
15 km	1.85	2.09	2.24	2.41	2.53	2.64
20 km	0.52	0.83	1.04	2.11	1.49	1.65

Table 3.5.2 THE NUMBER OF MESHES BY LAND USE AND KAB/KODYA

Kab / Kodya	A	B	C	D	E	Total
Kab						
Sidoarjo	487	0	67	237	1	786
Mojokerto	261	3	0	105	0	369
Jombang	627	25	29	161	26	868
Nganjuk	788	87	39	381	12	1,307
Kediri	340	59	0	260	2	661
Tulungagung	519	159	6	503	40	1,227
Blitar	5	1	0	1	0	7
Trenggalek	37	73	7	118	26	461
Kodya						
Surabaya	106	9	16	59	0	190
Mojokerto	19	8	0	25	0	52
Kediri	44	2	0	67	0	13
Total	3,43	426	164	1,911	107	6,041

Note : A ..... Pady field
B ..... Upland field
C ..... Fish pond
D ..... Residential area
E ..... Others

1 mesh = 25 ha

Table 3.5.3 THE NUMBER OF BUILDINGS BY KAB/KODYA AND TYPE OF BUILDINGS

Kab/Kodya	House		Factory	Commercial building	Store/hotel /restaurant	Total
	Urban	Rural				
Kab						
Sidoarjo	3150	11,502	125	1,124	471	16,327
Mojokerto	257	4,004	35	231	96	4,653
Jombang	824	6,405	61	465	224	7,989
Nganjuk	1,569	13,513	130	1,177	863	17,552
Kediri	740	10,471	49	434	309	12,003
Tulungagung	3,734	18,866	466	1,164	736	24,966
Blitar	2	31	1	1	1	36
Trenggalek	141	2,594	153	126	73	3,087
Kodya						
Surabaya	15,440	2,369	196	1,556	1,342	20,903
Mojokerto	3,839	-	63	413	319	4,634
Kediri	7,030	1,869	98	623	455	10,075
Total	36,756	71,924	1,377	7,314	4,889	122,260

Table 3.5.4 - DAMAGE RATE

Damage Rate of Buildings

Unit: %

	Below Floor Level	Above Floor Level			
		0-50cm	50-99	100-199	200-299	300-
House & Buildings	0.03	0.053	0.072	0.109	0.152	0.220
Household Effects		0.086	0.191	0.331	0.499	0.690
Properties of Buildings		0.180	0.314	0.419	0.539	0.632

Damage Rate of Agricultural Crops

Unit: %

	Less than 0.5m deep Inundation days				0.5-0.9m deep Inundation days				More than 1.0m deep Inundation days			
	1-2	3-4	5-6	7-	1-2	3-4	5-6	7-	1-2	3-4	5-6	7-
Paddy	21	30	36	50	24	44	50	71	37	54	64	74
Soybean Peanut	23	41	54	67	30	44	60	73	40	50	68	81
Maize	27	42	54	67	35	48	67	74	51	67	81	91

Source: Criteria for the Engineering of River and Sabo Project, Ministry of Construction, Japan

Table 3.5.5 PHYSICAL INUNDATION AREA

Unit : ha

Item	Inundation Depth	Flood Return Period 2	5	10	25	50	100
Paddy	0 - 0.5	4875	4300	3875	3400	3300	3140
	0.5 - 1.0	8525	7725	7450	6950	6200	5775
	more than 1.0	27475	29325	30475	32000	33125	34050
Upland	0 - 0.5	100	100	75	75	75	50
	0.5 - 1.0	675	425	350	325	225	200
	more than 1.0	2275	2575	2650	2675	2775	2525
Fish pond		2250	2250	2400	2400	2525	2525
Building	0 - 0.5	7900	7050	6475	5750	5675	5325
	0.5 - 1.0	14075	12450	12075	11325	10025	9700
	1.0 - 2.0	30050	30200	30050	30000	29875	29650
	2.0 - 3.0	12825	15650	17325	19625	21425	22850
	more than 3.0	-	-	100	250	350	425

Table 3.5.6 VALUATION OF FLOOD DAMAGES BY EACH PROBABLE FLOOD

Present basin development level (as of year 1984)

(Rp. 10^6)

Return period	Brantas river		Widas river
	Up to 139 K	Up to 159 K	
2	155,099	163,888	9,528
5	159,970	169,745	11,612
10	163,997	174,354	13,652
25	169,325	181,004	15,437
50	173,440	185,600	17,513
100	178,734	191,171	19,252

Future basin development level (as of year 2000)

(Rp. 10^6)

Return period	Brantas river		Widas river
	Up to 139 K	Up to 159 K	
2	304,671	321,543	18,902
5	314,023	332,773	22,935
10	321,703	341,570	26,923
25	332,049	354,459	30,399
50	339,986	363,306	34,421
100	350,267	373,672	37,783

Table 3.5.7 ANNUAL AVERAGE FLOOD DAMAGE UP TO CERTAIN RETURN PERIOD

Present basin development level (as of year 1984)

(Rp. 10^6)

Return period	Brantas river		Widas river
	Up to 139 K	Up to 159 K	
2	38,775	40,972	2,382
5	86,035	91,017	5,553
10	102,233	108,222	6,816
25	112,233	118,883	7,689
50	115,661	122,549	8,018
100	117,422	124,433	8,202

Future basin development level (as of year 2000)

(Rp. 10^6)

Return period	Brantas river		Widas river
	Up to 139 K	Up to 159 K	
2	76,168	80,386	4,725
5	163,972	178,533	11,001
10	200,758	212,250	13,494
25	220,371	233,131	15,213
50	227,091	240,309	15,862
100	230,542	243,994	16,223

Table 3.5.8 DESIGN DISCHARGE AND ITS SCALE OF RIVERS IN INDONESIA

No.	Name of River	Province	Catchment Area (km^2)	Deisgn Flood (m^3/s)	Specific Discharge ($m^3/s/km^2$)	Return Period (yr)
1.	Cimanuk	West Java	3,006	1,440	0.48	25
2.	Serang	Central Java	937	900	0.96	25
3.	Citanduy	West Java	3,680	1,900	0.52	25
4.	Ular	North Sumatra	1,080	800	0.74	25
5.	Pemali	Central Java	1,228	1,300	1.06	25
6.	Cipanas	West Java	220	385	1.75	25
7.	Solo	Central/East Java	3,400	1,500 2,000	0.44 0.59	10 *1 40 *2
8.	Madiun	East Java	2,400	1,100 2,300	0.46 0.96	10 *1 40 *2
9.	Wampu	North Sumatra	3,840	1,320	0.34	20
10.	Arakundo	Aceh	5,495	1,800	0.33	20
11.	Kring Aceh	Aceh	1,775	1,300	0.73	20
12.	Brantas	East Java	10,000	1,350 1,500	0.135 0.15	10 *1 50 *2
13.	Bah Bolon	North Sumatra	2,776	1,220	0.44	20
14.	Walanae	South Sulawesi	3,190	2,900	0.91	20
15.	Biba	South Sulawesi	1,368	1,900	1.39	20
16.	Jenebarang	South Sulawesi	729	3,700	5.08	50
17.	Ciujung	North Banten	1,850	1,100 1,600	0.59 0.86	10 *1 50 *2
18.	Kuranji	West Sumatra	213	870 1,000	4.08 4.69	25 *1 50 *2
19.	Air Dingin	West Sumatra	131	600 700	4.58 5.34	25 *1 50 *2
20.	Marmoyo	East Java	290	230	0.79	20
21.	Surabaya	East Java	631	370	0.59	50

Table 3.5.9 PROBABLE FLOOD PEAK DISCHARGE OF K. BRANTAS FOR COMPARATIVE STUDY

Base Point		Case No. of Scheme 1							
		1-1	1-2	2-1-1	2-1-2	2-1-3	2-2-1	2-2-2	2-2-3
K. Kates	Inflow	2,180	2,180	2,180	2,180	2,180	2,180	2,180	2,180
	Outflow	740	740	740	740	740	740	740	740
Pakel		1,620	1,620	1,330	1,430	1,530	1,330	1,430	1,530
K.Ngrowo - K.Konto		1,020	1,020	820	860	920	820	860	920
K.Kongo - K.Widas		1,210	1,210	960	1,020	1,100	960	1,020	1,100
K.Widas - K.Brangkal		1,620	1,480	1,340	1,430	1,520	1,230	1,290	1,370
Lengkong		1,730	1,600	1,460	1,550	1,640	1,350	1,410	1,490
Porong		1,700	1,570	1,430	1,510	1,610	1,320	1,370	1,460

Base Point		Case No. of Scheme 2							
		1-1	1-2	2-1-1	2-1-2	2-1-3	2-2-1	2-2-2	2-2-3
K. Kates	Inflow	2,180	2,180	2,180	2,180	2,180	2,180	2,180	2,180
	Outflow	740	740	740	740	740	740	740	740
Pakel		1,620	1,620	830	1,030	1,230	830	1,030	1,230
K.Ngrowo - K.Konto		1,500	1,500	900	910	1,100	900	910	1,100
K.Konto - K.Widas		1,310	1,310	860	860	910	860	860	910
K.Widas - K.Brangkal		1,740	1,580	1,240	1,240	1,330	970	970	1,060
Lengkong		1,870	1,710	1,380	1,380	1,470	1,110	1,110	1,200
Porong		1,830	1,670	1,390	1,390	1,420	1,120	1,120	1,150

Table 3.5.10 PROBABLE 25-YEAR FLOOD PEAK DISCHARGE OF K. WIDAS FOR COMPARATIVE STUDY

Base Point	Case No. 1	2		3
K. Widas				
Before K. Pelengkeng	450	450		450
K. Pelangkeng - K. Narembek	520	520		520
K. Ngrembek - K. Kedungsoko	590	590	(300)	590
K. Kedungsoko - K. Brantas	850	500	(270)	830
K. Kedungsoko				
Before K. Kancir	550	200		510
K. Kuncir - K. Ulo	460	150		400
K. Ulo - K. Widas	390	390		390
K. Kuncir				
K. Kuncir Dam	180	180		0
Before Kedungsoko	260	260		170
K. Ulo	220	220	(50)	130

Retarded Volume

Kedungsoko	8×10^6 m^3
Ulo	7×10^6 m^3
Widas	12×10^6 m^3

Remarks: Case 1 ... Without controled retarding pond

Case 2 ... With controled retarding pond

Case 3 ... With Kuncir Flood Control Scheme on the condition of Case 1.

( ) ... Outflow from controled retarding pond.

Table 3.5.11 SUMMARY OF CONSTRUCTION COST FOR COMPARATIVE CASE STUDY

(Unit: Rp. 10^6)

Scheme/Case	Mainstream			K. Widas			Grand Total
	Main	Flood diversion c.	Total	K. Widas	Retarding basin	Total	
Scheme 1 (unleveed reach upstream from 139 K : present)							
Case 1: without flood diversion channel							
Case 1-1	43,000	0	43,000	64,000	0	64,000	107,000
Case 1-2	28,400	0	28,400	49,800	10,300	60,100	88,500
Case 2: with flood diversion channel (Q = 100 m^3/s)							
Case 2-1	14,700	12,100	26,800	64,000	0	64,000	90,800
Case 2-2	800	12,100	12,900	49,800	10,300	60,100	73,000
Scheme 2 (unleveed reach upstream from 139 K : confined by dikes)							
Case 1: without flood diversion channel							
Case 1-1	88,300	0	88,300	64,000	0	64,000	152,300
Case 1-2	78,500	0	78,500	49,800	10,300	60,100	138,600
Case 2: with flood diversion channel (Q = 400 m^3/s)							
Case 2-1	20,400	41,200	61,600	64,000	0	64,000	125,600
Case 2-2	20,400	41,200	61,600	49,800	10,300	60,100	121,700

Remarks: 1. Construction cost is estimated for direct construction cost for civil works, and land and building compensation.

2. Price level in Sept. 1984 is adopted. US$ 1 = Rp. 1030.

3. Proposed dimensions of the flood diversion channel are as follows:

- Total length: 10.2 km (Tunnel 5.5 km + Open channel 4.7 km)

Table 3.5.12 NET PRESENT VALUE AND EIRR

(Unit: Rp. 10^6)

Scheme/Case	Present development level					Future development level				
	Net present value (at 12 %)				EIRR (%)	Net present value (at 12 %)				EIRR (%)
	Cost	Benefit	B-C	B/C		Cost	Benefit	B-C	B/C	
Scheme 1 (unleveed reach upstream from 139 K : present)										
Case 1: without flood diversion channel										
Case 1-1	65,500	34,100	-31,400	0.52	6.2	65,500	70,000	4,500	1.07	12.7
Case 1-2	54,700	30,700	-24,000	0.56	7.0	54,700	63,300	8,600	1.16	13.4
Case 2:with flood diversion channel (Q = 100 m^3/s)										
Case 2-1	58,100	34,100	-24,000	0.59	7.3	58,100	70,000	11,900	1.20	13.7
Case 2-2	47,800	30,700	-17,000	0.64	8.2	47,800	63,300	15,500	1.32	14.5
Scheme 2 (unleveed reach upstream from 139 K : confined by dikes)										
Case 1: without flood diversion channel										
Case 1-1	85,500	36,200	-49,300	0.43	3.8	85,500	74,700	-10,800	0.88	11.1
Case 1-2	77,000	32,800	-44,200	0.43	4.0	77,000	68,000	-9,000	0.89	11.2
Case 2: with flood diversion channel (Q = 400 m^3/s)										
Case 2-1	73,400	36,200	-37,200	0.49	5.7	73,400	74,700	1,300	1.01	12.2
Case 2-2	69,300	32,800	-36,500	0.48	5.3	69,300	68,000	-1,300	0.98	11.9

Remarks: 1. Construction period: 10 years

2. Project life : 50 years after completion

3. Discount rate : 12 %

4. O/M cost : 1 % of the construction cost per annum after completion

5. Net incremental beneficial area (Unit: ha):

Scheme 1,	Case 1-1 :	2,100	Scheme 2, Case 1-1 :	3,500
	Case 1-2 :	700	Case 1-2 :	2,100
	Case 2-1 :	2,100	Case 2-1 :	3,500
	Case 2-2 :	700	Case 2-2 :	2,100

6. Net benefit (Negative cost): Rp. 721,000/ha per annum after completion

Table 3.5.13 PROJECT COST OF THE PROPOSED PLAN

(Rp. 10^6)

Item	K. Brantas (Flood diversion channel)	K. Widas	Total
I. Civil works	60,197	40,365	100,562
II. Land acquisition and building compensation	684	19,694	20,378
III. Sub total	60,881	60,059	120,940
IV. Engineering including administration			
Detailed design	6,020	4,037	10,057
Construction supervision	6,020	4,037	10,057
V. Contingency (physical)	12,040	8,073	20,113
VI. Total	84,961	76,206	161,167

Remarks: 1. Price level in Sept. 1984 is adopted. US$ 1 = Rp. 1030.

2. The following lump sum costs are adopted to project cost estimates.
   Engineering cost (incl. administration cost)
   - Detailed design : 10 % of the civil works cost
   - Construction supervision: 10 % of the civil works cost
   Physical contingency : 20 % of the civil works cost

3. The following construction schedules are applied.
   K. Widas incl. detailed design : 7 years (1986 to 1992)
   K. Brantas incl. detailed design: 7 years (1991 to 1997)

4. O/M cost for the facilities after completion of the project is assumed to be annually 1 % of the civil works cost.
   Flood diversion channel: Rp. 30,100 × 10^6
   K. Widas : Rp. 20,200 × 10^6

Table 3.5.14 SUMMARY OF CONSTRUCTION COST FOR WITH AND WITHOUT KUNCIR DAM SCHEME

Item	Construction cost (Rp. 10^6) Scheme 1	Scheme 2
I. K. Widas	60,726	63,939
K. Widas	34,906	35,364
K. Kedungsoko	8,539	8,875
K. Ulo	8,520	10,055
K. Kuncir	8,012	8,896
Backwater levee	749	749
II. Kuncir dam	25,738	0
III. Total	86,464	63,939

Note 1. Construction cost for each scheme is estimated for direct construction cost of civil works, and land and building compensation.

2. Price level in Sept. '84 is adopted
US$ 1 = Rp. 1030

3. The following are considered to dam scheme
Dam height : 44 m
Dam type : concrete gravity
Dam concrete volume : 310,000 m^3
Reservoir capacity : 9×10^6 m^3

Table 3.5.15 PROJECT COST OF THE PROPOSED PLAN

(Rp. 10^6)

Item	K. Brantas (Flood diversion channel)	K. Widas	Total
I. Civil works	60,197	40,365	100,562
II. Land acquisition and building compensation	684	19,694	20,378
III. Sub total	60,881	60,059	120,940
IV. Engineering including administration			
Detailed design	6,020	4,037	10,057
Construction supervision	6,020	4,037	10,057
V. Contingency (physical)	12,040	8,073	20,113
VI. Total	84,961	76,206	161,167

Remarks: 1. Price level in Sept. 1984 is adopted. US$ 1 = Rp. 1030

2. The following lump sum costs are adopted to project cost estimates.
Engineering cost (incl. administration cost)
- Detailed design : 10 % of the civil works cost
- Construction supervision: 10 % of the civil works cost

Physical contingency : 20 % of the civil works cost

3. The following construction schedules are applied.
K. Widas incl. detailed design : 7 years (1986 to 1992)
K. Brantas incl. detailed design: 7 years (1991 to 1997)

4. O/M cost for the facilities after completion of the project is assumed to be annually 1 % of the civil works cost.
Flood diversion channel: Rp. 30,100 × 10^6
K. Widas : Rp. 20,200 × 10^6

Table 3.6.1 SEDIMENT VOLUME OF PROPOSED SABO DAMS AND LESTI III DAM IN THE SENGGURUH DAM CATCHMENT

No.	Name of river	without of dam (m)	Gradient	Area (m^2)	Mean width (m)	Sediment volume (10^6 m^3)
		(1)	(2)	(3)	(4)	(5) = (3)x(4)x2/3
1.	Upper K. Brantas basin					
1	Brantas	70	1/222	78,000	70	3.60
2	Brantas	75	1/216	74,250	45	2.21
3	Brantas	88	1/196	64,500	60	2.55
	Amprong		1/300	77,350	50	2.55
	Bango		1/200	29,500	20	0.39
	Juli		1/193	13,650	20	0.18
3	Sub-total					5.67
	Sub-total					11.48
2.	K. Lesti basin					
4	Lesti	150	1/269	83,250	80	4.40
5	Lesti	150	1/149	49,875	90	2.96
6	Lesti	70	1/84	27,750	60	1.10
	Bamban,					0.27
6	Sub-total					1.37
7	Genteng (south)	100	1/84	59,250	68	2.36
	Genteng (north)		1/84	59,250	60	2.35
7	Sub-total					4.71
8	Genteng	80	1/120	42,750	44	1.24
9	Juwak	60	1/149	48,750	35	1.13
	Sub-total					15.81
3.	Lesti III dam					
	Dead storage					6.00
	Sub-total					6.00
	Total					33.29

Table 3.6.2 COST ESTIMATION OF SABO DAM

No.	Name of River	Dam Width (m) (1)	Construction cost (10^6 Rp) (2)	Sediment volume ($10^6 m^3$) (3)	Cost sediment volume (Rp/m^6) (4) = (2)/(3)
1.	Brantas	70	3,142	3.60	873
2.	Brantas	70	3,327	2.21	1,505
3.	Brantas	88	3,790	5.67	669
4.	Lesti	150	5,923	4.40	1,346
5	lesti	150	5,923	2.96	2,001
6.	Lesti	70	3,142	1.37	2,293
7.	Genteng	100	4,186	4.71	889
8.	Genteng	80	3,502	1.24	2,824
9	Juwok	60	2,807	1.13	2,484
	Total		35,742	27.29	1,310

Table 3.6.3 CATCHMENT AREA AROUND G.KELUD

(Unit : Km^2)

Basin No.	River	Plain Area	Mountainous Area	Total	Percentage
I	Lekso	66.00	27.50	93.50	4.67
II	Jari	46.35	13.25	59.60	2.98
III	Putih	68.74	8.86	77.60	3.87
IV	Abab	96.98	9.02	106.00	5.22
V	Badak	476.20	29.00	505.20	25.22
VI	Petungkobong	102.20	10.20	112.40	5.61
VII	-	174.00	-	174.00	8.69
VIII	Sukorejo	142.26	12.94	155.20	7.75
IX	Ngobo	185.55	19.25	204.80	10.22
XII	Serinjing	241.70	5.50	247.20	123.4
XI	Konto	213.20	54.38	267.58	13.36
	Total	1,813.18	189.90	2,003.08	100.00

Remarks : Presented figures are the acreage of the basin area that belongs to lahar area originating from G. Kelud.

Source : WS - 04

Table 3.6.4 GRADIENT OF RIVER BED IN THE LAHAR AREA

Elevation (m)	K.Lekso	K.Semut	K.Putih	K.Badak	G.Gedok	K.Petung-Kobong	K. Suko-rejo	K.Ngobo	K. Se-rinjing	K.Konto
0 -100	-	-	-	1/480 (75~100m)	1/390 (75~100m)	1/200 (75~100m)	1/188 (55~100m)	1/215 (55~100m)	1/300 (40~100m)	1/381
100 - 200	1/137.5 (160~200m)		1/60 (150~200m)	1/136	1/117.5	1/100	1/99	1/97.5	1/102.5	1/106
201 - 300	1/16	1/55.9 (215 ~300m)	1/55	1/56.5	1/50	1/50	1/41	1/43	1/42.5	1/51.5
301 - 400	1/50	1/42.5	1/40	1/42.5	1/42.5	1/37.5	1/30	1/34.5	1/29	1/45
401 - 500	1/36.5	1/32.5	1/30	1/30	1/32.5	1/27.5	1/30	1/22.5	1/21	1/30.5
501 - 600	1/31.5	1/17.5	1/22.5	1/28.5	1/25.5	1/22.5	1/15	1/18.5	1/15.5	1/6*
601 - 700	1/18.5	1/20.5	1/17	1/15.5	1/11.95	1/17	1/18.5	1/12.5	1/16.5	1/10.5
701 - 800	1/15.5	1/13	1/13	1/10.5	1/7.5	-	1/17	1/8	1/13	1/10
801 - 900	1/14	1/6	1/9.5	1/9	-	-	1/13	1/8.5	1/7.5	1/7
901 - 1000	1/8	1/8.5	1/8	1/9	-	-	1/4.5	1/10	1/2.5	1/4
1001 - 1100	1/8	-	1/4	1/8	-	-	-	1/6	1/4	1/8
1101 - 1200	1/5	-	1/4	1/3.5	-	-	-	1/4.5	1/4	1/8
1201 - 1300	1/3.5	-	-	-	-	-	-	-	-	-

* Remarks : Gradient above the EL 500 m is that for one of the Tributaries of K. Konto which originates G. Kelud.

Source : WS 04

Table 3.6.5 MEAN MONTHLY RAINFALL IN THE LAHAR AREA

(mm)

Basin No.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
(I)	352	329	326	248	170	78	79	32	46	136	295	418	2,509
(II)	352	322	332	259	177	89	87	38	55	156	338	440	2,645
(III)	326	319	330	236	172	92	72	38	41	132	279	398	2,435
(IV)	319	318	323	233	175	91	66	35	32	120	250	371	2,333
(V)	319	303	326	219	167	74	56	27	23	99	199	319	2,131
(VI)	277	267	328	202	169	73	54	30	28	88	173	281	1,970
(VII)	282	275	325	210	160	67	51	26	22	73	153	259	1,903
(VIII)	304	289	387	275	185	86	65	33	26	99	246	425	2,420
(IX)	313	303	319	219	157	78	58	30	26	89	178	303	2,073
(X)	301	317	293	183	137	67	51	26	22	72	146	274	1,889
(XI)	376	364	323	190	130	62	55	25	21	88	195	322	2,151
Mean	320	310	328	225	164	78	63	31	31	105	223	346	2,224

Source : WS 04

Table 3.6.6 AMOUNT OF VOLCANIC DEBRIS TO MAIN 5 RIVERS

($10^6 m^3$)

River	Catchment Basin area (Km^2)	Flow distance (km)	Amount of volcanic debris				
			Ladu	Primary Lahar	Secondary lahar	Total	Percentage (%)
K. Semut	93.5	19.30	1.5	2.35	6.13	9.98	17.5
K. Putih	77.6	23.7	3.0	3.70	7.50	14.20	24.9
K. Badak	505.2	47.2	2.7	11.50	4.0	18.20	31.9
K. Ngobo	204.8	37.0	0.35	3.60	5.30	9.25	16.2
K. Konto	267.6	53.0	0.2	0.7	4.50	5.40	9.5
Total	1,148.7		7.75	21.85	27.43	57.03	100.0

Source : WS 04

Remarks ; (1) The amounts show those derived from G. Kelud eruption in 1966 until the end of 1966, investigated by GOI.

Table 3.6.7 SEDIMENT BALANCE IN THE LAHAR AREA

Name of Rivers area	Catchment area (Km^2)	Lahar & Lahars	Falling Materials	Total volcanic	Sediment yield during 15 years (B+S)*	(W)**	Sub-total	Remaining sediment volume in lahar area
Semut (I-II)	153.1	22.7	4.9	27.6	4.9	2.7(2.0)	7.6	20.0(73%)
Putih (III)	77.6	32.4	1.8	34.2	6.9	1.0(1.0)	7.9	26.3(77%)
Badak (VI-VII)	897.6	41.5	11.6	53.1	8.8	8.4(8.4)	17.2	35.9(68%)
Ngobo (VII-X)	607.2	21.1	9.4	30.5	6.1	6.1(6.1)	12.2	18.3(60%)
Konto (XI)	267.6	12.3	9.1	21.4	6.8	7.4(4.7)	14.2	7.2(34%)
Sub total	2,003.1	130.0	36.8	166.8	33.5	25.6(22.2)	59.1	107.7(65%)
Other area	5,850.9	-	33.2	33.2	-	-	33.2	-
Total	7,854.0	130.0	70.0	200.0	33.5	25.6(22.2)	92.3	107.7

Remarks : ( ) : Sediment from lahar area
* : Bed and suspended load
** : Wash load

Source : WS - 04

Table 3.6.8 SEDIMENT BALANCE DURING 15 YEARS

BY BERDEB (10^6 m^3)

Basin	(1) Total volcanic product	(2) Sediment carried off to the Brantas	(3) Controllable sediment retained in tributaries	(4)=(2)+(3) Sub total	(5) Sediment to be carried off to the Brantas under proposed condition	(6)=(4)+(5) Excess over proposed amount to be arrested
Semut	27.6	4.9	7.5	12.4	0.9	11.5
Putih	34.2	6.9	10.6	17.5	0.9	16.6
Badak	53.1	8.8	13.6	22.4	4.5	17.9
Ngobo	30.5	6.1	6.9	13.0	3.0	10.0
Konto	21.4	6.8	4.1	10.9	2.3	8.6
Total	166.8	33.5	42.9	76.2	11.6	64.6

Remarks : * Bed and suspended load
Source : WS - 04

BY G. KELUD PROJECT

Name of river	Length (km)	Excess (10^6 m^3)	Sediment (%)
K. Konto	40	6.54	9.90
K. Serinjing	39	0.84	1.27
K. Ngobo	37.5	9.14	13.85
K. Dermo-Sukorejo	39	5.24	7.94
K. Gedog	25	1.21	1.83
K. Badak-Termas	40	18.20	27.58
K. Putih	26	13.54	20.52
K. Semut	18	7.14	10.82
K. Lekso	7	4.15	6.29
Total		66.00	100.00

Source : Information from G. Kelud Project

Table 3.6.9 REMAINING STORAGE CAPACITY AND CONTROL VOLUME

(Unit: x $10^6 m^3$)

Name of River	Design storage capacity (1)	Present retained (2)	Remaining storage capacity (3)	Estimated Control Volume (4)	Combined capacity (5)=(3)+(4)
K. Konto					
Lahar pocket	1.311	0.771	0.54	1.66	
Other structures	0.619	0.503	0.116	0.99	
Sub-total	1.93	1.274	0.656	2.65	3.306
K. Serinjing					
Lahar pocket	0.321	0.228	0.093	0.32	
Other structures	0.139	0.126	0.013	0.222	
Sub-total	0.46	0.354	0.106	0.542	0.649
K. Ngobo					
Lahar pocket	1.12	0.84	0.28	1.792	
Other structures	0.72	0.72	-	1.185	
Sub-total	1.84	1.56	0.28	2.977	3.257
K. Dermo - K. Sukorejo					
Check dam etc.	0.16	0.16	-	0.256	0.256
K. Gedok					
Lahar pocket	0.15	0.131	0.019	0.255	
Other structures	0.017	0.017	-	0.027	
Sub-total	0.167	0.148	0.019	0.282	0.301
K. Badak - K.Termas					
Lahar pocket	8.45	6.162	2.288	8.469	
Other structures	0.69	0.69	-	1.104	
Sub-total	9.14	6.862	2.288	9.573	11.861
K. Putih					
Lahar pocket	2.57	1.986	0.584	4.172	
Other structures	0.62	0.36	0.26	0.992	
Sub-total	3.19	2.346	0.844	5.164	6.008
K. Sumut					
Lahar pocket	1.66	1.252	0.408	2.739	
Other structures	0.57	0.317	0.163	0.912	
Sub-total	2.23	1.569	0.661	3.651	4.312
K. Lekso					
Check dam	0.29	0.29	-	0.464	0.464
Total	19.407	14.553	4.854	25.559	30.413

Table 3.6.10 MEAN MONTHLY RAINFALL IN THE UPPER K. KONTO BASIN

Month	Mean monthly rainfall (mm)
JAN.	502.45
FEB.	354.89
MAR.	364.58
APR.	209.47
MAY	136.42
JUN.	52.47
JUL.	24.96
AUG.	27.74
SEP.	54.57
OCT.	110.19
NOV.	212.78
DEC.	289.22
Total	**2,339.74**

Remarks : Rainfall data from 1977 to 1983

Table 3.7.1 ENERGY SALES AND PRODUCTION IN EAST JAVA AND ALL JAVA

Year	East Java			All Java		
	Energy sales (Gwh)	Annual growth (%)	Energy production (Gwh)	Energy sales (Gwh)	Annual growth (%)	Energy production (Gwh)
1975/76	528.6	15.0	683.0	2,498.7	26.1	2,889.9
1976/77	537.3	1.6	716.9	2,449.1	2.0	3,113.7
1977/78	580.3	8.0	775.1	2,837.3	15.9	3,588.8
1978/79	753.3	29.8	995.8	3,446.2	21.5	4,295.5
1979/80	919.0	22.0	1,262.1	4,135.1	20.0	5,153.1
1980/81	1,161.3	26.4	1,481.3	5,102.1	23.4	6,183.8
1981/82	1,475.4	27.0	1,903.0	6,209.1	21.7	7,531.3
1982/83	1,797.8	21.9	2,199.4	7,230.4	16.4	8,741.8
Average rate of annual growth		19.1			16.4	

(Source: Ref. EP-04)

PEAK DEMAND IN EAST JAVA

East Java	
Year	Peak Demand (MW)
1975/76	105
1976/77	116
1977/78	127
1978/79	171
1979/80	218
1980/81	226
1981/82	328
1982/83	389
Average rate of annual growth	20.6%

(Source: Ref. EP-08)

TABLE 3.7.2 HISTORIC POWER DEMAND AND FORECAST

Year	East Java				All Java		
	Energy production (Gwh)	Peak demand (MW)	Installed capacity (MW)	Energy Sales (Gwh)	Energy production (Gwh)	Peak demand (MW)	Installed capacity (MW)
1977/78	-	-	229	2,837	3,751	631	1,270
1978/79	-	-	396	3,446	4,521	781	1,632
1979/80	-	-	396	4,243	5,500	952	1,852
1980/81	-	-	423	5,112	6,583	1,184	1,854
1981/82	-	-	623	65,225	7,931	1,421	2,258
1982/83	2,156	410	623	7,225	9,127	1,770	2,485
1983/84	2,735	446	628	7,927	10,574	1,851	/1 2,679
1988/89	5,671	958	1,099	-	23,202	3,957	/1 6,082
1993/94	10,604	1,740	-	-	42,044	6,889	-
1998/99	17,560	2,892	-	-	67,894	11,101	-
2003/04	27,356	4,446	-	-	103,381	16,861	-

(Source: Ref. EP-10)
Note: / - Under construction or committed

COMPOSITION OF POWER SOURCES

(Unit: MW)

Plants	East Java			All Java		
	1983/84	1988/89 /1	1993/94 /2	1983/84	1988/89 /1	1993/94 /2
Hydro P.P	210.5	239.5	259.5	493.8 /3	1,745.4	2,765.4
Thermal (oil)	350.0	750.0	750.0	1,306.2	1,906.2	1,906.2
Thermal (coal)	-	-	1,600.0	-	1,600.0	4,400.0
Gas turbine	67.5	109.5	109.5	735.2	798.2	798.2
Geo-thermal	-	-	-	30.0	140.0	140.0

(Source: Ref. EP-10)

Note: /1 - On-going projects are included
/2 - Planned projects are included
/3 - Jatiluhur H.P.P. is included
/4 - No retirement of plants os considered

SUMMARY OF CAPIVE POWER

(As of 1980)

PLN's Wilayah	Captive power (KVA)			Received from PLN (KVA)
	Pure Captive	Stand-by & Others	Total	
Wilayah - XII (Jatim)	351.095	56.832	407.927	123.560
Wilayah - XIII (Jateng)	224.859	32,426	257,285	35,310
Jabar	455,061	29,542	484,603	71,603
DKI Raya	326,424	135,553	461,977	N/A
Total	781,485	118,800	1,611,792	230,473

(Source : Ref. EP-02)

Table 3.8.1 COMPARISON OF ENERGY OUTPUT AT KARANGKATES POWER STATION

Unit : GWh

Year	Actual Operation			H - Q Constant		
	Peak Energy Total	Off-Peak Energy Total	Total Energy	Peak Energy Total	Off-Peak Energy Total	Total Energy
1978	190.8	318.7	509.5	190.8	329.5	520.3
1979	183.3	333.8	517.1	189/5	346.0	535.5
1980	160.4	168.5	328.9	189.9	144.3	334.2
1981	190.0	249.1	439.1	190.2	239.2	429.4
1982	159.8	225.1	384.9	185.6	230.0	415.0
1983	179.6	275.3	454,9	190,5	252.5	443.0
Total	1,063.9	1,570.5	2.634.4	1.136.5	1,541.5	2,678.0

Table 3.8.2 COMPARISON OF OUTFLOW IN 1982

Unit m^3/s

Month	Actual Outflow	Outflow by HQ constant
June	43.73	40.36
July	55.91	37.60
Aug.	52.70	38.18
Sept.	43.83	39.14
Oct.	37.06	40.57
Nov.	37.10	42.88
Dec.	38.68	45.98

Table 3.8.3 EQUATION OF INFLOW FORECASTING

FOR KARANGKATES - LAHOR RESERVOIR

	Jun	Jul	Aug	Sept	Oct
A_0	-11.0899638	-15.5299962	-2.87097038	-0.61494647	3.07925388
A_1	0.0149239665	0.0525167239	0.0384507892	0.042389943	0.0313118965
A_2	0.0297891733	0.0101756963	0.0107804442	0.005352747	0.0105785789
A_3	0.0083712475	0.0242773289	0.169692058	0.020534444	0.01038751
A_4	-0.0541001518	0.0124031042	-0.020504488	-0.014334763	-0.0272584739
A_5	0.0987755701	0.0498220939	0.0459776609	0.034219894	0.0369615015
A_6	0.169481819	0.0461714545	0.0428709541	0.010738026	0.031367007
A_7	0.0506207894	0.0559367462	0.0027992661	-0.004698774	-0.022273360
RR	0.973412	0.963390	0.931206	0.883487	0.879276

$$Qi = A_0 + A_1 * R_{11} + A_2 * R_{12} + A_3 * R_1 + A_4 * R_2 + A * R_3 + A_6 * R_4 + A_7 * R_5$$

Where,

Qi : Monthly runoff (mm)

$A_0 \ldots\ldots A_7$: constant

R_{11} : monthly runoff in November

R_{12} : monthly " in December

R_1 : " in January

R_2 : " in February

R_3 : " in March

R_4 : " in April

R_5 : " in May

RR : Correlation coefficient

Table 3.8.4 CHECKING OF SPILLWAY CAPACITY OF EXISTING DAM

Particulars	Karangkates	Lahor	Selorejo	Wlingi
A. Original Design				
1. Dam Crest EL.	EL. 279.0 m	EL. 278.0 m	EL. 625.0 m	EL. 167.5 m
Core top	EL. 278.5 m	EL. 277.5 m	EL. 624.5 m	EL. 167.0 m
2. Spillway				
(1) Gated spillway				
Soil EL.	EL. 267.0 m	-	-	EL. 163.5 m
Opening width	10.0 m	-	-	10.6m x 4 nos
(2) Non-gated spillway				
Crest EL.	EL. 272.5 m	EL. 272.7 m	EL. 620.0 m	-
Crest Width	50.0 m	35 m	30 m	-
(3) Design flood				
Water level	EL. 375.5 m	EL. 275.6 m	EL. 622.8 m	EL. 164.5 m
(4) Design Flood				
Inflow (Peak)	1,540 m^3/s	580 m^3/s	680 m^3/s	2,824 m^3/s
(5) Design outflow	1,530 m^3/s	360 m^3/s	290 m^3/s	2,300 m^3/s
(without gate)	(530 m^3/s)			
(6) Max. capacity	1,600 m^3/s	540 m^3/s	430 m^3/s	3,900 m^3/s
B. Checking				
1. 200 yr x 1.2 Flood				
(1) Inflow (peak)	3,939 m^3/s	645 m^3/s	818 m^3/s	2,927 m^3/s
(2) Outflow (peak)	1,046 m^3/s	295 m^3/s	280 m^3/s	2,900 m^3/s
(3) Highest water level /1	EL. 276.17 m	EL. 275.18m	EL.622.78 m	EL.163.70m
(4) Allowable water level /2	EL. 275.5 m	EL. 275.6 m	EL. 622.8 m	EL.164.50m
2. 10,000 yr Flood				
(1) Inflow (peak)	6,241 m^3/s	2,776 m^3/s	2,009 m^3/s	4,596 m^3/s
(2) Outflow (peak)	1,764 m^3/s	816 m^3/s	779 m^3/s	3,983 m^3/s
(3) Highest water level /1	EL. 278.42 m	EL. 277.58m	EL. 625.40m	EL.166.10 m
(4) Allowable water level /3	EL. 278.0 m	EL. 276.5 m	EL. 623.5 m	EL.166.0 m

Note: /1 : Water level formed by the existing spillway capacity
/2 : According to Japanese standard
/3 : 1 m from core top + 0.5 if gated.

TABLE 3.8.5(1) FEATURES OF FUTURE DAM PROJECT

Storage Type Dam

River Name	Name of Dam	Catchment Area km^2	HWL/ LWL El.m	Storage Gross/Net $\times 10^3 m^3$	Embank-ment $\times 10^3 m^3$	Storage Efficiency	Data Topo Geo.
Brantas	Kali Lanang	85	720	50,180	6,790	6.3	1/50,000
			677.5	42,900			No
Amprong	Lojing	54	750	21,900	1,560	11.9	1/2,500
			720	17,300			No
	Tumpang	62	750	26,000	6,320	4.1	1/2,500
			670	25,600			No
Genteng	Genteng I	160	436	86,000	2,240	31.3	1/2,500
			408.5	70,000			Available
Ngrowo	Klotok /1	33	200	33,100			1/50,000
			165	31,200			Available
K.Konto	Konto I	66	1,055	31,000	3,350	4.8	1/50,000
			1,038	16,000			No
	Konto II	169	980	53,000	5,810	7.5	1/5,000
			944	43,500			No
	Konto III	189	885	116,000	16,930	6.8	1/5,000
			772	114,500			No
Widas	Kuncir, al IV	70	471	50,500	10,000	4.7	1/2,500
			423	47,000			Available
	Kedungwarak	32	170	57,600	79	712	1/2,500
			152	55,950			Available
	Semantok	61	96.5	44,000	2,040	19.6	1/2,500
			80	40,000			No
	Babadan	/2	175	99,700	6,970	12.9	1/50,000
				89,700			No
Beng	Beng	134	73	160,000	720	209.8	1/50,000
			50	150,000			No

Remarks

/1 : Dam and reservoir is in the limestone area. Countermeasures against leakage from reservoir will be costly. Then high storage efficiency is disregarged.

/2 : Adjustable by trans-basin.

TABLE 3.8.5(2) FEATURES OF FUTURE DAM PROJECT

Channel Type Dam

River Name	Name of Dam	Catchment Area km^2	HWL/ LWL El.m	Storage Gross/Net $x10^3$ m^3	Hydropower Head/Q 90 m/ m^3/s	MW/GWh	Embank 10^3 Energy/Vol	Data Topo Geo
Brantas	Malang	518	417.5	7,550	21.7	6.7	96	1/2500
			407.5	4,040	7.7	13.0	135	No
	Tambaksari	738	395	2,870	19.2	8.4	55	1/2500
			375	1,610	11.0	16.3	296	No
	Lumbansari	842	375	6,000	28.5	14.2	88	1/2500
			365	3,290	12.5	27.7	315	No
	Blobo	851	347.5	1,993	14.2	7.2	112	1/2500
			337.5	1,508	12.7	13.9	124	No
	Kepanjen	912	317.5	1.490	19.7	8.3	38	1/2500
			307.5	1,130	10.6	15.8	415	Available
Jilu	Jilu I	48	540	180	38.3	1.1	5	1/2500
			535	115	0.7	2.1	420	No
	Jilu II	94	500	1,990	18.3	1.0	88	1/2500
			495	882	1.4	2.0	23	No
	Jilu III	156	462.5	1,765	15.8	1.5	96	1/2500
			457.5	584	2.3	2.8	29	No
Amprong	Amprong	333	447.5	1,600	16.8	3.4	72	1/2500
			442.5	989	5.0	6.4	89	No
Bango	Bango	175	450	1,250	10.8	1.1	18	1/2500
			445	568	2.6	2.2	122	No
Lesti	Lesti I	80	462.5	1,980	1,68	0.9	24	1/2500
			457.5	1,080	1.5	2.7	113	No
	Lesti II	148	397.5	4,040	20.8	2.2	202	1/2500
			392.5	959	2.7	6.6	33	Available
	Lesti III	355	342.5	8,530	20.8	5.4	44	1/2500
			337.5	2,535	6.5	15.8	359	Available
	Lesti IV	417	322.5	6,110	20.8	6.3	196	1/2500
			317.5	1,880	7.6	18.5	94	No
Genteng	Genteng II	170	365	2,700	21.0	15.3	107	1/2500
			353	713	10.0	15.3	143	Available
Metro	Metro	236	312.5	2,300				1/2500
			302.5	1,040	3.5			Available

Table 3.8.6 UNIT WATER COST

(1) VALUE OF IRRIGATION WATER

Case I : Irrigated Paddy ——— Non-irrigated Polowijo

Required irrigation water : 1,350 mm
12,600 m^3/ha

Primary Profit

Irrigated paddy	Rp.1,028 x 10^3
Non-irrigated polowijo (Gottan-Losari)	Rp.162 x 10^3
	Rp.868 x 10^3

Value of irrigation water

Rp.866 x 10^3/12,600 = Rp.69/m^3

Case II : Irrigated - Polowijo -Non-irrigated Polowijo

Required irrigation water : 300 mm
3,000 m^3/ha

Primary profit

Irrigated polowijo	Rp. 371 x 10^3/ha
Non-Irrigated polowijo	Rp.162 x 10^3/ha
	Rp.209 x 10^3/ha

Value of irrigation water

Rp.209 x 10^3/3000 = Rp. 70 / m^3

Value of Irrigation Water on an Average = Rp.70 / m^3

(2) ALLOWABLE MAXIMUM RAW WATER COST

1. Umbulan Spring Project[/1] (Capacity 3m^3/s)

Capital Cost ;	Pipeline	Rp. 135 x 10^9
	Transmission Pump	Rp. 5.52 x 10^9
	Total	Rp. 140.52 x 10^9

Table 3,8,7(1) PROJECT BENEFIT AND EIRR

	Unit	Genteng I	Kali Konto II	Babadan	Kuncir	Semantok
POSITIVE BENEFIT						
1. Water Supply						
Effective storage	$x10^6 m^3$	70	63	84	22.5	40
Benefit	Rp. 10^6/Y	7,000	6,300	8,400	2,250	4,000
2. Hydropower						
Installed capacity	MW	18.6	62	9.4	4.3	-
Annual energy	Gwh	54.9	207.4	28.1	28.3	-
Capacity benefit	Rp. 10^6/Y	1,082	3,608	547	250	-
Energy benefit	Rp. 10^6/Y	6,640	25,086	3,399	3,423	-
3. Sediment control						
Downstream reservoir		K. Kates	Selorejo			
Dead storage	$x10^6 m^3$	16	10			
Total benefit	Rp. 10^6	1,600	1,000			
Annual benefit	Rp. 10^6/Y	32	20			
4. Flood control						
Total Positive Benefit	Rp. 10^6/Y	14,742	35,014	11,799	5,923	4,000
NEGATIVE BENEFIT						
1. Land						
Reservoir area	ha	410	220	250	128	350
Land cost	Rp. 10^6/Y	205	110	188	64	263
2. Pump up						
Installed capacity	MW	-				
Annual energy	Gwh	-				
Capacity cost	Rp. 10^6/Y	-				
Energy cost	Rp. 10^6/Y	-				
Total Negative Benefit	Rp. 10^6/Y	205	10	188	64	263
NET BENEFIT	Rp. 10^6/Y	14,549	34,904	12,158	5,859	3,737
CAPITAL COST						
Dam and Power	Rp. 10^6	91,102	202,741	140,111	75,083	73,167
Pump & Pipeline	Rp. 10^6					
Irrigation	Rp. 10^6				(5,560)	
Total	Rp. 10^6	91,102	202,741	140,111	75,083	73,161
CONSTRUCTION PERIOD	Years	4	5	4	4	4
ANNUAL O & M COST	Rp. 10^6/Y	911	2,027	1,401	751	732
B-C at D.F. = 12%	Rp. 10^6	2,745	10,459	-49,597	-30,036	-39,660
EIRR	%	12.4	12.7	6.6	5.8	2.9

Table 3.8.7(2) PROJECT BENEFIT AND EIRR

	Unit	Kedungwarak	Beng	Lumbangsari	Kepanjen
POSITIVE BENEFIT					
1. Water Supply					
Effective storage	$x10^6 m^3$	54	150	-	-
Benefit	$Rp.10^6/Y$	5,400	15,000	-	-
2. Hydropower					
Installed capacity	MW	0.7	12	10.8	6
Annual energy	Gwh	3.0	10.4	46.9	32.5
Capacity benefit	Rp. $10^6/Y$	-	-	629	349
Energy benefit	Rp. $10^6/Y$	363	1,258	5,670	3,931
3. Sediment control					
Downstream reservoir					
Dead storage	$x10^6 m^3$				
Total benefit	Rp. 10^6				
Annual benefit	Rp. $10^6/Y$				
4. Flood control					
Total Positive Benefit	Rp. $10^6/Y$	5,763	16,258	6,299	4,280
NEGATIVE BENEFIT					
1. Land					
Reservoir area	ha	640	1,300	Not provided	Not provided
Land cost	Rp. $10^6/Y$	480	975		
2. Pump up					
Installed capacity	mW	7.7	5.9		
Annual energy	Gwh	27.6	21.5		
Capacity cost	Rp. $10^6/Y$	1,581.6	1,211.9		
Energy cost	Rp. $10^6/Y$	662.4	516.0		
Total Negative Benefit	Rp. $10^6/Y$	2,724	2,702.9		
NET BENEFIT	Rp. $10^6/Y$	3,039	13,555.1	6,299	4,280
CAPITAL COST					
Dam and Power	Rp. 10^6	5,834	34,909	343,926	20.712
Pump & Pipeline	Rp. 10^6	35,609	21,219		
Irrigation	Rp. 10^6		5,175		
Total	Rp. 10^6	41,503	61,303	343,926	20,712
CONSTRUCTION PERIOD	Years	4	4	4	4
ANNUAL O & M COST	Rp. $10^6/Y$	415	610	339	207
B-C at D.F. = 12%	Rp. 10^6	-17,653	21,694	5,663	5,745
EIRR	%	5.3	16.6	14.2	15.6

Table 3.8.8 GENERAL FEATURES OF ALTERNATIVE DEVELOPMENT PLANS FOR WIDAS BASIN DEVELOPMENT

I. Flood Control Plan
(1) River channel improvement
(2) Floodway
(3) Retarding basin
(4) Combination of the above component

II. Dam/Irrigation Plan	Irri. Area (ha)	Dam Scheme HWL/LWL (m)	Dam Height (m)	Dam Volume ($10^6 m^3$)	Effective Storage ($10^6 m^3$)	IRR (%)
(1) Kuncil dam scheme						
(1.1) Dam and irrigation	6,270	446/418	100	6.85	22.5	4.1
(1.2) Dam and water supply	-	446/418	100	6.85	22.5	5.8
(2) Kedung Warak dam scheme						
(2.1) Dam and irrigation						
(a) 950 ha	950 (ppm)	164.5/152	26.5	0.14	28.0	10.5
(b) 720 ha	720 (ppm)	164.5/152	26.5	0.14	28.0	10.8
(2.2) Dam and water supply						
(a) With pump-up	-	170/152	32.0	0.22	54.0	5.3
(b) Without pump-up*	(950)	164.5/152	26.5	0.14	28.0	11.8
(3) Samantok						
(3.1) Dam and irrigation						
(a) 1,300 ha (2,250 - 950 ha)	1,300	89.8	36.3	2.70	16.9	0.5
(b) 1,530 ha (2,250 - 720 ha)	1,530	92.4	38.9	3.40	24.4	0.3
(3.2) Dam and water supply	-	96.5/80	43.0	5.28	40.0	2.9

*: Four years among 5 years for irrigation, and one year for water supply

Table 3.10.1 AVAILABLE WATER AT JABON-PERNING SITE

(Unit: MCM)

Year	Annual (Dec - Nov)	Wet Season (Dec - May)	Dry Season (Jun - Nov)
1963/64	8,176.3	5,380.6	2,795.7
64/65	5,305.9	4,438.8	867.1
65/66	6,841.7	5,813.1	1,028.6
66/67	7,011.2	6,161.2	850.0
67/68	9,883.9	6,881.0	3,002.9
68/69	8,028.3	6,817.7	1,210.6
69/70	7,275.8	6,024.1	1,251.7
70/71	8,367.5	6,126.1	2,241.4
71/72	6,360.2	5,449.1	911.1
72/73	8,482.4	6,274.8	2,207.7
73/74	7,270.2	5,512.2	1,758.0
74/75	11,336.8	8,059.8	3,277.0
75/76	7,607.5	6,394.9	1,212.6
76/77	5,098.8	4,282.0	816.8
77/78	8,217.9	5,831.1	2,386.7
78/79	8,942.2	6,951.1	1,991.1
79/80	5,345.5	4,227.5	1,118.0
80/81	7,724.1	6,091.6	1,632.5
81/82	6,942.3	6,108.8	833.5
82/83	8,383.1	6,574.0	1,809.2
Ave.	7,630.1	5,970.0	1,660.1
Max.	11,336.8	8,059.8	3,277.0
Min.	5,098.8	4,227.5	816.8

Table 3.10.2 RETURN FROM K.NGROWO BASIN

Unit : m^3/s

	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Ave.
1982							
Return flow	3.29	2.38	1.71	1.99	2.02	1.88	2.21
Run-off	7.59	4.75	3.35	2.02	1.24	1.10	3.34
Total	10.88	7.13	5.06	4.01	3.26	2.98	5.55
	Total volume = 87.7 MCM						
1965							
Return flow	3.29	2.38	1.71	1.99	2.02	1.88	2.21
Run-off	6.21	4.41	2.98	1.74	1.16	1.74	3.04
Total	9.50	6.79	4.69	3.73	3.18	3.62	5.25
	Total volume = 82.9 MCM						
1970							
Return flow	3.29	2.38	1.71	1.99	2.02	1.88	2.21
Run-off	28.77	7.72	5.21	3.89	2.57	20.00	11.26
Total	32.06	10.10	6.92	5.88	4.59	21.88	13.47
	Total volume = 212.9 MCM						
1974							
Return flow	3.29	2.38	1.71	1.99	2.02	1.88	2.21
Run-off	10.79	7.22	7.93	6.37	58.49	77.62	28.01
Total	14.08	9.60	9.64	8.36	60.51	79.50	30.22
	Total volume = 477.8 MCM						

Table 3.10.3 REMARKABLE CHANGE IN IRRIGATION ARREA IN K. BRANTAS BASIN

Lodoyo - Tulungagug Irrigation

Name of Irrigation section	1975	1984	Increase	
			(ha)	(%)
Blitar	31,667	34,986	3,319	10.5
Tulungagung	30,202	34,268	4,066	13.5

Source: ANNEX - AI

Wonokromo Section in Surabaya Delta

Year	Irrigation area (ha)	Source
1964	6,831	WR - 02
1965	6,831	WR - 02
1966	6,805	WR - 02
1967	6,791	WR - 02
1968	6,775	WR - 02
1969	6,775	WR - 02
1970	6,729	WR - 02
1971	6,729	WR - 02
1975	5,356	WR - 04
1976	5,223	WR - 04
1977	4,976	WR - 04
1978	4,819	WR - 04
1979	4,581	WR - 04
1980	4,411	WR - 04
1984	2,989	AI - 2

(Ref. Fig. WR - 1.2)

Table 3.10.4 WATER DEMAND FOR IRRIGATION

Present : Authorized (Wet season paddy + dry season paddy) + Polowijo + Sugarcane

Unit : MCM

Irrigation Area	June	July	Aug.	Sept.	Oct.	Nov.	Total
Molek	7.72	4.45	3.57	6.47	4.86	7.19	34.26
Lodoyo	28.47	21.23	15.23	17.21	18.01	16.19	116.34
Mrican	34.13	15.60	15.18	23.69	11.47	14.49	114.56
Turitunggorono	21.62	13.60	8.56	15.03	13.13	9.76	81.70
Jatimlerek-Bunder	2.16	2.11	1.21	1.95	2.17	1.44	11.04
Gottan etc.	2.58	2.78	3.46	4.61	5.49	4.29	23.21
Jatikulon	1.51	1.43	1.02	1.24	0.77	0.61	6.58
Wonokromo	2.10	1.56	0.69	1.23	1.72	1.67	8.88
Porong	19.47	16.22	10.07	12.11	24.27	24.12	106.26
Mangetan	21.09	17.38	11.50	16.89	33.95	33.12	133.93
	140.76	96.36	70.49	100.43	115.84	112.88	636.76

Future project : Authorized (Wet season + dry season paddy) + Polowijo + Sugarcane

Unit : MCM

Irrigation Area	June	July	Aug.	Sept.	Oct.	Nov.	Total
Lesti left	1.25	3.70	3.07	0.43	0.33	0.68	9.46
Papar-Peterongan	16.43	1.58	0	0	0	1.93	19.94
Gottan etc.	4.82	2.24	0	0.95	3.26	2.67	13.94
Groundwater	39.12	22.12	35.62	51.22	31.31	48.42	227.81
	61.62	29.64	38.69	52.60	34.90	53.70	271.15

Unauthorized dry season paddy

Unit : MCM

Irrigation Area	June	July	Aug.	Sept.	Oct.	Nov.	Total
Molek	1.82	0.92	0.06	0	0	0	2.80
Jatimlerek-Bunder	0.61	0.58	0.10	0	0	0	1.29
Jatikulon	0.34	0.26	0.02	0	0	0	0.62
Wonokromo	0.78	0.66	0.22	0	0	0	1.66
Porong	5.42	4.72	2.18	0.15	0	0	12.47
Mangetan	12.39	10.79	4.98	0.34	0	0	28.50
	21.36	17.93	7.56	0.49	0	0	47.34

TABLE 3.10.5(1) FUTURE WATER DEMAND (1985)

Item		Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Average
Domestic water		9.52	9.52	9.52	9.52	9.52	9.52	9.52
SMA domestic	surface w.	5.57	5.57	5.57	5.57	5.57	5.57	5.57
	spring w.	-	-	-	-	-	-	-
SMA social	surface w.	0.36	0.36	0.36	0.36	0.36	0.36	0.36
SMA commercial	surface w.	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Other domestic	ground w.	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Other S/C	ground w.	0.70	0.70	0.70	0.70	0.70	0.70	0.70
City water	surface w.	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Irrigation water		62.83	42.96	29.42	38.93	43.25	43.55	43.41
Authorized :		(54.30)	(35.97)	(26.32)	(38.65)	(43.25)	(43.55)	(40.26)
Paddy	surface w.	41.30	23.85	7.10	0.78	1.00	18.27	15.31
Polowijo/ sugar cane	surface w.	13.00	12.12	19.22	37.87	42.25	25.28	24.95
Future :								
Paddy	surface w.							
	ground w.							
Polowijo/ sugar cane	surface w.							
	ground w.							
Unauthorized:	surface w.	(8.53)	(6.99)	(3.10)	(0.28)	(0.00)	(0.00)	(3.15)
Industrial water		7.68	7.68	7.68	7.32	5.22	4.22	6.64
Authorized :		(6.10)	(6.10)	(6.10)	(5.74)	(3.64)	(2.64)	(5.06)
SMA industry	surface w.	3.57	3.57	3.57	3.21	1.98	1.98	2.98
Other industry	surface w.	2.53	2.53	2.53	2.53	1.66	0.66	2.08
Future :		(1.58)	(1.58)	(1.58)	(1.58)	(1.58)	(1.58)	(1.58)
SMA industry	surface w.	1.58	1.58	1.58	1.58	1.58	1.58	1.58
Other industry	surface w.	-	-	-	-	-	-	-
Fishery		13.54	13.54	13.54	13.54	13.54	0.00	11.32

TABLE 3.10.5(2) FUTURE WATER DEMAND (1990)

Item		Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Average
Domestic water		12.70	12.70	12.70	12.70	12.70	12.70	12.70
SMA domestic	surface w.	5.80	5.80	5.80	5.80	5.80	5.80	5.80
	spring w.	1.70	1.70	1.70	1.70	1.70	1.70	1.70
SMA social	surface w.	0.43	0.43	0.43	0.43	0.43	0.43	0.43
SMA commercial	surface w.	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Other domestic	ground w.	3.45	3.45	3.45	3.45	3.45	3.45	3.45
Other S/C	ground w.	0.84	0.84	0.84	0.84	0.84	0.84	0.84
City water	surface w.	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Irrigation water		86.31	53.73	43.60	59.13	56.28	64.26	60.40
Authorized :		(54.30)	(35.97)	(26.32)	(38.65)	(43.25)	(43.55)	(40.26)
Paddy	surface w.	41.30	23.85	7.10	0.78	1.00	18.27	15.31
Polowijo/ sugar cane	surface w.	13.00	12.12	19.22	37.87	42.25	25.28	24.95
Future :		(23.77)	(11.06)	(14.45)	(20.29)	(13.03)	(20.71)	(17.15)
Paddy	surface w.	6.85	1.35	0.00	0.00	0.00	1.42	1.58
	ground w.	10.56	5.78	2.66	1.98	0.00	14.94	5.93
Polowijo/ sugar cane	surface w.	1.83	1.45	1.15	0.53	1.34	0.61	1.15
	ground w.	4.53	2.48	10.64	17.78	11.69	3.74	8.47
Unauthorized:	surface w.	(8.24)	(6.70)	(2.83)	(0.19)	(0.00)	(0.00)	(3.00)
Industrial water		7.91	7.91	7.91	7.55	5.45	5.45	6.87
Authorized :		(6.10)	(6.10)	(6.10)	(5.74)	(3.64)	(2.64)	(5.06)
SMA industry	surface w.	3.57	3.57	3.57	3.21	1.98	1.98	2.98
Other industry	surface w.	2.53	2.53	2.53	2.53	1.66	0.66	2.08
Future :		(1.81)	(1.81)	(1.81)	(1.81)	(1.81)	(1.81)	(1.81)
SMA industry	surface w.	1.81	1.81	1.81	1.81	1.81	1.81	1.81
Other industry	surface w.	-	-	-	-	-	-	-
Fishery	surface w.	13.54	13.54	13.54	13.54	13.54	0.00	11.32

TABLE 3.10.5(3) FUTURE WATER DEMAND (2000)

Item		Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Average
Domestic water		21.85	21.85	21.85	21.85	21.85	21.85	21.85
SMA domestic	surface w.	11.56	11.56	11.56	11.56	11.56	11.56	11.56
	spring w.	2.20	2.20	2.20	2.20	2.20	2.20	2.20
SMA social	surface w.	0.62	0.62	0.62	0.62	0.62	0.62	0.62
SMA commercial	surface w.	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Other domestic	ground w.	5.41	5.41	5.41	5.41	5.41	5.41	5.41
Other S/C	ground w.	1.16	1.16	1.16	1.16	1.16	1.16	1.16
City water	surface w.	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Irrigation water		86.31	53.73	43.60	59.13	56.28	64.26	60.40
Authorized :		(54.30)	(35.97)	(26.32)	(38.65)	(43.25)	(43.55)	(40.26)
Paddy	surface w.	41.30	23.85	7.10	0.78	1.00	18.27	15.31
Polowijo/ sugar cane	surface w.	13.00	12.12	19.22	37.87	42.25	25.28	24.95
Future :		(23.77)	(11.06)	(14.45)	(20.29)	(13.03)	(20.71)	(17.15)
Paddy	surface w.	6.85	1.35	0.00	0.00	0.00	1.42	1.58
	ground w.	10.56	5.78	2.66	1.98	0.00	14.94	5.93
Polowijo/ sugar cane	surface w.	1.83	1.45	1.15	0.53	1.34	0.61	1.15
	ground w.	4.53	2.48	10.64	17.78	11.69	3.74	8.47
Unauthorized:	surface w.	(8.24)	(6.70)	(2.83)	(0.19)	(0.00)	(0.00)	(3.00)
Industrial water		10.80	10.80	10.80	10.44	8.34	7.34	9.76
Authorized :		(6.10)	(6.10)	(6.10)	(5.74)	(3.64)	(2.64)	(5.06)
SMA industry	surface w.	3.57	3.57	3.57	3.21	1.98	1.98	2.98
Other industry	surface w.	2.53	2.53	2.53	2.53	1.66	0.66	2.08
Future :		(4.70)	(4.70)	(4.70)	(4.70)	(4.70)	(4.70)	(4.70)
SMA industry	surface w.	4.70	4.70	4.70	4.70	4.70	4.70	4.70
Other industry	surface w.	-	-	-	-	-	-	-
Fishery	surface w.	13.54	13.54	13.54	13.54	13.54	0.00	11.32

TABLE 3.10.5(4) FUTURE WATER DEMAND (2010)

Item		Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Average
Domestic water		34.24	34.24	34.24	34.24	34.24	34.24	34.24
SMA domestic	surface w.	20.31	20.31	20.31	20.31	20.31	20.31	20.31
	spring w.	2.20	2.20	2.20	2.20	2.20	2.20	2.20
SMA social	surface w.	0.91	0.91	0.91	0.91	0.91	0.91	0.91
SMA commercial	surface w.	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Other domestic	ground w.	7.52	7.52	7.52	7.52	7.52	7.52	7.52
Other S/C	ground w.	1.57	1.57	1.57	1.57	1.57	1.57	1.57
City water	surface w.	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Irrigation water		86.31	53.73	43.60	59.13	56.28	64.26	60.40
Authorized :		(54.30)	(35.97)	(26.32)	(38.65)	(43.25)	(32.55)	(40.26)
Paddy	surface w.	41.30	23.85	7.10	0.78	1.00	18.27	15.31
Polowijo/ sugar cane	surface w.	13.00	12.12	19.22	37.87	42.25	25.28	24.95
Future		(23.77)	(11.06)	(14.45)	(20.29)	(13.03)	(20.71)	(17.15)
Paddy	surface w.	6.85	1.35	0.00	0.00	0.00	1.42	1.58
	ground w.	10.56	5.78	2.66	1.98	0.00	14.94	5.93
Polowijo/ sugar cane	surface w.	1.83	1.45	1.15	0.53	1.34	0.61	1.15
	ground w.	4.53	2.48	10.64	17.78	11.69	3.74	8.47
Unauthorized :	surface w.	(8.24)	(6.70)	(2.83)	(0.19)	(0.00)	(0.00)	(3.00)
Industrial water		13.87	13.87	13.87	13.51	11.41	10.41	12.83
Authorized :		(6.10)	(6.10)	(6.10)	(5.74)	(3.64)	(2.64)	(5.06)
SMA industry	surface w.	3.57	3.57	3.57	3.21	1.98	1.98	2.98
Other industry	surface w.	2.53	2.53	2.53	2.53	1.66	0.66	2.08
Future :		(7.77)	(7.77)	(7.77)	(7.77)	(7.77)	(7.77)	(7.77)
SMA industry	surface w.	7.77	7.77	7.77	7.77	7.77	7.77	7.77
Other industry	surface w.	-	-	-	-	-	-	-
Fishery		13.54	13.54	13.54	13.54	13.54	0.00	11.32

TABLE 3.10.5(5) FUTURE WATER DEMAND (2020)

Item		Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Average
Domestic water		53.51	53.51	53.51	53.51	53.51	53.51	53.51
SMA domestic	surface w.	35,06	35.06	35.06	35.06	35.06	35.06	35.06
	spring w.	2.20	2.20	2.20	2.20	2.20	2.20	2.20
SMA social	surface w.	1.33	1.33	1.33	1.33	1.33	1.33	1.33
SMA commercial	surface w.	3.24	3.24	3.24	3.24	3.24	3.24	3.24
Other domestic	surface w.	9.60	9.60	9.60	9.60	9.60	9.60	9.60
Other S/C	ground w.	2.08	2.08	2.08	2.08	2.08	2.08	2.08
City water	surface w.	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Irrigation water		86.31	53.73	43.60	59.13	56.28	64.26	60.40
Authorized :		(54.30)	(35.97)	(26.32)	(38.65)	(43.25)	(43.55)	(40.26)
Paddy	surface w.	41.30	23.85	7.10	0.78	1.00	18.27	15.31
Polowijo/ sugar cane	surface w.	13.00	12.12	19.22	37.87	42.25	25.28	24.95
Future :		(23.77)	(11.06)	(14.45)	(20.29)	(13.03)	(20.71)	(17.15)
Paddy	surface w.	6.85	1.35	0.00	0.00	0.00	1.42	1.58
	ground w.	10.56	5.78	2.66	1.98	0.00	14.94	5.93
Polowijo/ sugar cane	wurface w.	1.83	1.45	1.15	0.53	1.34	0.61	1.07
	ground w.	4.53	2.48	10.64	17.78	11.69	3.74	8.47
Unauthorized:	surface w.	(8.24)	(6.70)	(2.83)	(0.19)	(0.00)	(0.00)	(3.00)
Industrial water		19.46	19.46	19.46	19.10	17.00	16.00	18.42
Authorized :		(6.10)	(6.10)	(6.10)	(5.74)	(3.64)	(2.64)	(5.06)
SMA industry	surface w.	3.57	3.57	3.57	3.21	1.98	1.98	2.98
Other industry	surface w.	2.53	2.53	2.53	2.53	1.66	0.66	2.08
Future :		(13.36)	(13.36)	(13.36)	(13.36)	(13.36)	(13.36)	(13.36)
SMA industry	surface w.	13.36	13.36	13.36	13.36	13.36	13.36	13.36
Other industry	surface w.	-	-	-	-	-	-	-
Fishery		13.54	13.54	13.54	13.54	13.54	0.00	11.32

Table 3.10.6 VOLUME OF DEFICIT TO FUTURE DEMAND

Unit : MCM

Year \ Demand	1985	1990	2000	2010	2020
1964	81.2	253.3	359.0	495.2	714.3
1965	441.0	813.4	1,003.0	1,247.4	1,640.5
1966	315.1	651.9	841.5	1,085.9	1,479.0
1967	458.1	830.5	1,020.1	1,264.5	1,657.6
1968	28.5	104.8	168.8	264.9	462.0
1969	235.6	532.4	711.7	942.7	1,314.3
1970	237.2	524.2	693.0	910.7	1,274.7
1971	164.2	346.1	462.2	623.5	885.5
1972	401.7	769.4	959.0	1,203.4	1,596.5
1973	38.6	163.4	275.8	437.3	731.1
1974	55.3	259.2	399.7	604.0	932.6
1975	6.7	60.0	113.9	213.9	408.1
1976	287.1	611.4	789.7	1,020.8	1,392.4
1977	491.3	863.7	1,053.2	1,297.7	1,690.8
1978	65.2	187.5	275.4	409.3	668.8
1979	143.0	330.3	459.7	639.6	946.8
1980	413.9	763.7	942.9	1,174.0	1,545.6
1981	154.7	340.0	479.0	689.6	1,039.7
1982	474.6	847.0	1,036.6	1,281.0	1,674.1
1983	171.4	361.1	490.3	668.0	974.8

Table 3.10.7(1) WATER BALANCE AT JABON-PERNING SITE

WATER BALANCE AT JABON-ETC DEMAND=2000 YEAR=1970 UNIT: M(M3/S) : VOL(MCM)

	DOMES (SHA)	DOMES (RURAL)	CITY-W (SHA)	PADDY (AUTHO)	SUGAR+ POLOWIJO	INDUSTRY (AUTHO)	PADDY (UN-A)	N-IRRIG (G-W)	N-IRRIG (S-W)	INDUSTRY (FUTURE)	FISHERY	TOTAL DEMAND	AVAILA BLE-Q	SURPLUS /DEFICIT
JUN - 1	15.23	6.57	15.00	43.90	12.80	6.10	8.17	35.09	8.74	4.70	33.54	149.11	208.01	58.83
- 2	15.23	6.57	15.00	42.66	13.13	6.10	8.25	35.09	9.16	4.70	33.54	149.23	121.30	-27.93
- 3	15.23	6.57	15.00	37.55	13.01	6.10	8.30	35.09	8.10	4.70	33.54	143.26	100.83	-42.41
MEAN												147.46	144.72	-2.75
JUL - 1	15.23	6.57	15.00	31.83	12.54	6.10	7.98	8.26	4.32	4.70	63.54	126.47	93.54	-32.93
- 2	15.23	6.57	15.00	24.24	12.01	6.10	6.98	8.26	1.84	4.70	63.54	114.59	80.10	-34.49
- 3	15.23	6.57	15.00	16.25	11.83	6.10	5.27	8.26	1.84	4.70	63.54	104.59	67.01	-37.58
MEAN												114.87	76.88	-38.70
AUG - 1	15.23	6.57	15.00	10.92	13.48	6.10	6.26	13.30	1.10	4.70	63.54	107.15	69.64	-37.51
- 2	15.23	6.57	15.00	8.23	13.13	6.10	2.80	13.30	1.16	4.70	63.54	104.28	64.58	-39.70
- 3	15.23	6.57	15.00	3.96	12.30	6.10	1.60	13.30	0.63	4.70	63.54	102.93	53.56	-49.37
MEAN												104.73	62.30	-42.43
SEP - 1	15.23	6.57	15.00	1.96	12.23	5.74	0.36	19.76	0.26	4.70	63.54	119.55	58.95	-58.60
- 2	15.23	6.57	15.00	0.39	11.97	5.74	0.0	19.76	0.30	4.70	63.54	119.90	54.20	-65.70
- 3	15.23	6.57	15.00	0.0	12.90	5.74	0.0	19.76	0.84	4.70	63.54	124.28	51.80	-72.48
MEAN												119.91	54.31	-65.60
OCT - 1	15.23	6.57	15.00	0.09	44.66	5.64	0.0	11.69	1.30	4.70	63.54	116.42	48.98	-67.43
- 2	15.23	6.57	15.00	0.34	44.99	5.64	0.0	11.69	1.37	4.70	63.54	117.07	46.70	-70.37
- 3	15.23	6.57	15.00	2.42	37.58	5.64	0.0	11.69	1.35	4.70	63.54	111.72	42.03	-69.67
MEAN												114.96	45.78	-69.17
NOV - 1	15.23	6.57	15.00	8.34	35.55	2.64	0.0	18.68	0.82	4.70	0.0	101.55	54.16	-53.39
- 2	15.23	6.57	15.00	15.01	33.67	2.64	0.0	18.68	1.23	4.70	0.0	102.73	80.25	-22.48
- 3	15.23	6.57	15.00	31.45	24.63	2.64	0.0	18.68	4.04	4.70	0.0	116.96	139.23	24.27
MEAN												108.41	91.41	-17.00
VOL IN O-S	240.4	103.9	237.2	242.0	396.5	80.0	87.3	227.8	63.3	74.3	1170.0	1870.1	1251.2	-618.9

VOL OF DEFICIT IN DRY SEASON = -693.0

WATER BALANCE AT JABON-ETC DEMAND=2000 YEAR=1974 UNIT: M(M3/S) : VOL(MCM)

	DOMES (SHA)	DOMES (RURAL)	CITY-W (SHA)	PADDY (AUTHO)	SUGAR+ POLOWIJO	INDUSTRY (AUTHO)	PADDY (UN-A)	N-IRRIG (G-W)	N-IRRIG (S-W)	INDUSTRY (FUTURE)	FISHERY	TOTAL DEMAND	AVAILA BLE-Q	SURPLUS /DEFICIT
JUN - 1	15.23	6.57	15.00	43.90	12.80	6.10	8.17	35.09	8.74	4.70	33.54	149.11	208.51	58.83
- 2	15.23	6.57	15.00	42.66	13.13	6.10	8.25	35.09	9.16	4.70	33.54	149.23	120.03	-29.20
- 3	15.23	6.57	15.00	37.55	13.08	6.10	8.30	35.09	8.10	4.70	33.54	143.26	105.32	-37.94
MEAN												147.46	144.62	-2.84
JUL - 1	15.23	6.57	15.00	31.83	12.54	6.10	7.98	8.26	4.32	4.70	63.54	126.47	93.86	-32.61
- 2	15.23	6.57	15.00	24.24	12.01	6.10	6.98	8.26	1.84	4.70	63.54	114.59	85.40	-29.19
- 3	15.23	6.57	15.00	16.25	11.83	6.10	5.27	8.26	1.84	4.70	63.54	104.59	69.49	-35.10
MEAN												114.87	82.48	-32.39
AUG - 1	15.23	6.57	15.00	10.92	13.48	6.10	6.26	13.30	1.10	4.70	63.54	107.15	85.33	-21.82
- 2	15.23	6.57	15.00	8.23	13.13	6.10	2.80	13.30	1.16	4.70	63.54	104.28	72.14	-32.14
- 3	15.23	6.57	15.00	3.96	12.30	6.10	1.60	13.30	0.63	4.70	63.54	102.93	65.45	-37.48
MEAN												104.73	74.02	-30.70
SEP - 1	15.23	6.57	15.00	1.96	12.23	5.74	0.36	19.76	0.26	4.70	63.54	119.55	78.30	-65.25
- 2	15.23	6.57	15.00	0.39	11.97	5.74	0.0	19.76	0.30	4.70	63.54	119.90	67.18	-52.72
- 3	15.23	6.57	15.00	0.0	12.90	5.74	0.0	19.76	0.84	4.70	63.54	124.28	62.55	-61.73
MEAN												119.91	65.88	-55.23
OCT - 1	15.23	6.57	15.00	0.09	44.66	5.64	0.0	11.69	1.30	4.70	63.54	116.42	116.33	-0.09
- 2	15.23	6.57	15.00	0.34	44.99	5.64	0.0	11.69	1.37	4.70	63.54	117.07	101.15	-15.92
- 3	15.23	6.57	15.00	2.42	37.58	5.64	0.0	11.69	1.35	4.70	63.54	111.72	92.49	-19.23
MEAN												114.96	102.97	-11.99
NOV - 1	15.23	6.57	15.00	8.34	35.55	2.64	0.0	18.68	0.82	4.70	0.0	101.55	104.51	+2.96
- 2	15.23	6.57	15.00	15.01	33.67	2.64	0.0	18.68	1.23	4.70	0.0	102.73	324.94	+222.21
- 3	15.23	6.57	15.00	31.45	24.63	2.64	0.0	18.68	4.04	4.70	0.0	116.96	268.91	+151.95
MEAN												108.41	198.01	+89.50
VOL IN O-S	240.4	103.9	237.2	242.0	396.5	80.0	87.3	227.8	63.3	74.3	579.0	1870.1	1758.0	-112.1

VOL OF DEFICIT IN DRY SEASON = +399.7

Table 3.10.7(2) WATER BALANCE AT JABON-PERNING SITE

WATER BALANCE AT JABON+ETC DEMAND=2000 YEAR=1982 UNIT: 6(M3/S) : VOL(MCM)

	DOMES (SHA)	DOMES (RURAL)	CITY-W (SHA)	PADDY (AUTHO)	SUGAR+ POLONIJO	INDUSTRY (AUTHO)	PADDY (UN-A)	N-IRRIG (G-W)	N-IRRIG (S-W)	INDUSTRY (FUTURE)	FISHERY	TOTAL DEMAND	AVAILA BLE-R	SURPLUS /DEFICIT
JUN - 1	15.23	6.57	15.00	43.90	32.10	6.10	8.17	35.09	8.78	6.70	13.54	169.88	93.62	-37.26
- 2	15.23	6.57	15.00	62.46	33.33	6.10	8.25	35.09	9.16	6.70	13.54	169.23	82.42	-86.86
- 3	15.23	6.57	15.00	31.55	33.08	6.10	8.30	35.09	8.10	6.70	13.54	163.26	74.87	-88.39
MEAN												167.46	83.30	-84.35
JUL - 1	15.23	6.57	15.00	31.83	32.54	6.10	3.88	8.26	4.72	6.70	13.54	126.47	68.82	-57.65
- 2	15.23	6.57	15.00	26.24	32.01	6.10	6.88	8.26	3.96	6.70	13.54	119.59	69.88	-50.70
- 3	15.23	6.57	15.00	16.25	31.83	6.10	5.27	8.26	1.84	6.70	13.54	109.59	93.03	-31.24
MEAN												118.87	81.84	-53.24
AUG - 1	15.23	6.57	15.00	10.92	35.89	6.10	4.20	33.30	1.70	6.70	13.54	107.15	56.07	-51.08
- 2	15.23	6.57	15.00	8.33	19.15	6.10	2.80	33.30	1.16	6.70	13.54	104.28	52.91	-51.37
- 3	15.23	6.57	15.00	3.96	22.30	6.10	1.60	33.30	0.63	6.70	13.54	102.93	45.32	-57.61
MEAN												104.23	51.23	-53.69
SEP - 1	15.23	6.57	15.00	1.96	32.23	5.74	0.56	19.76	0.26	6.70	13.54	115.55	61.62	-63.93
- 2	15.23	6.57	15.00	0.39	38.67	5.74	0.0	19.76	0.50	6.70	13.54	119.90	45.35	-74.55
- 3	15.23	6.57	15.00	0.0	42.90	5.74	0.0	19.76	0.84	6.70	13.54	126.21	45.24	-80.96
MEAN												119.91	45.66	-74.47
OCT - 1	15.23	6.57	15.00	0.09	44.66	3.64	0.0	11.69	1.50	6.70	13.54	116.62	41.51	-74.91
- 2	15.23	6.57	15.00	0.34	44.59	3.64	0.0	11.69	1.57	6.70	13.54	117.07	39.83	-77.24
- 3	15.23	6.57	15.00	2.42	37.58	3.64	0.0	11.69	1.55	6.70	13.54	111.32	35.69	-75.63
MEAN												114.96	38.97	-75.93
NOV - 1	15.23	6.57	15.00	8.34	35.35	2.64	0.0	18.68	0.82	6.70	0.0	107.53	37.02	-70.51
- 2	15.23	6.57	15.00	15.01	23.67	2.64	0.0	18.68	1.23	6.70	0.0	102.73	35.89	-66.84
- 3	15.23	6.57	15.00	31.45	16.83	2.64	0.0	18.68	4.06	6.70	0.0	114.96	34.88	-80.08
MEAN												108.41	35.93	-72.48
VOL IN 0-5	240.8	103.9	237.2	242.0	344.3	80.0	47.2	227.8	63.3	76.5	179.0	1870.1	832.5	-1037.6
VOL OF DEFICIT IN DRY SEASON =														-1037.6

WATER BALANCE AT JABON+ETC DEMAND=2000 YEAR=1983 UNIT: 6(M3/S) : VOL(MCM)

	DOMES (SHA)	DOMES (RURAL)	CITY-W (SHA)	PADDY (AUTHO)	SUGAR+ POLONIJO	INDUSTRY (AUTHO)	PADDY (UN-A)	N-IRRIG (G-W)	N-IRRIG (S-W)	INDUSTRY (FUTURE)	FISHERY	TOTAL DEMAND	AVAILA BLE-R	SURPLUS /DEFICIT
JUN - 1	15.23	6.57	15.00	43.90	32.10	6.10	8.17	35.09	8.78	6.70	13.54	169.88	90.44	-39.44
- 2	15.23	6.57	15.00	62.46	33.33	6.10	8.25	35.09	9.16	6.70	13.54	169.23	82.24	-86.99
- 3	15.23	6.57	15.00	31.55	33.08	6.10	8.30	35.09	8.10	6.70	13.54	163.26	75.27	-87.99
MEAN												167.46	82.02	-86.64
JUL - 1	15.23	6.57	15.00	31.83	32.54	6.10	3.88	8.26	4.72	6.70	13.54	126.47	70.42	-56.05
- 2	15.23	6.57	15.00	26.24	32.01	6.10	6.88	8.26	3.96	6.70	13.54	119.59	69.90	-49.69
- 3	15.23	6.57	15.00	16.25	31.83	6.10	5.27	8.26	1.84	6.70	13.54	109.59	58.83	-49.76
MEAN												118.87	69.45	-51.44
AUG - 1	15.23	6.57	15.00	10.92	35.89	6.10	4.20	33.30	1.70	6.70	13.54	107.15	58.41	-48.74
- 2	15.23	6.57	15.00	8.33	19.15	6.10	2.80	33.30	1.16	6.70	13.54	104.28	55.23	-49.05
- 3	15.23	6.57	15.00	3.96	22.30	6.10	1.60	33.30	0.63	6.70	13.54	102.93	47.08	-55.85
MEAN												104.23	53.37	-51.36
SEP - 1	15.23	6.57	15.00	1.96	32.23	5.74	0.56	19.76	0.26	6.70	13.54	115.55	49.78	-65.77
- 2	15.23	6.57	15.00	0.39	38.67	5.74	0.0	19.76	0.50	6.70	13.54	119.90	47.42	-72.48
- 3	15.23	6.57	15.00	0.0	42.90	5.74	0.0	19.76	0.84	6.70	13.54	126.21	45.24	-80.96
MEAN												119.91	47.48	-72.43
OCT - 1	15.23	6.57	15.00	0.09	44.66	3.64	0.0	11.69	1.50	6.70	13.54	116.62	43.29	-73.33
- 2	15.23	6.57	15.00	0.34	44.59	3.64	0.0	11.69	1.57	6.70	13.54	117.07	41.44	-75.63
- 3	15.23	6.57	15.00	2.42	37.58	3.64	0.0	11.69	1.55	6.70	13.54	111.32	37.05	-74.27
MEAN												114.96	40.48	-74.41
NOV - 1	15.23	6.57	15.00	8.34	35.35	2.64	0.0	18.68	0.82	6.70	0.0	107.53	38.79	-68.74
- 2	15.23	6.57	15.00	15.01	23.67	2.64	0.0	18.68	1.23	6.70	0.0	102.73	37.96	-64.77
- 3	15.23	6.57	15.00	31.45	16.83	2.64	0.0	18.68	4.06	6.70	0.0	114.96	48.40	-66.56
MEAN												108.41	41.72	-68.69
VOL IN 0-5	240.8	103.9	237.2	242.0	344.3	80.0	47.2	227.8	63.3	76.5	179.0	1870.1	867.1	-1003.0
VOL OF DEFICIT IN DRY SEASON =														-1003.0

Table 3.12.1 (1) RISK RESULTANT MATRIX

Sector	Dam Development	Flood Control	Agriculture and Irrigation	Sediment Control (Watershed Management)	Water Utility (Water Allocation)	The Others
A. Non-renewable Resources						
1. Geological features	-	-	-	-	-	-
2. Mineral resources	-	-	-	-	-	-
3. Topography	Erosion at the quarries around Karangkates dam	-		-	-	-
4. Soil	-	-	Soil devastation due to multiple paddy harvests and deficiency of nutritious elements	-	-	-
5. Sedimentation	Sedimentation in Karangkates reservoir	-	Erosion due to cultivation at the slope of the mountain side	-	-	-
6. Climate including hydrology	-	-	-	-	-	-

Table 3.12.1 (2) RISK RESULTANT MATRIX

Sector	Dam Development	Flood Control	Agriculture and Irrigation	Sediment Control (Watershed Management)	Water Utility (Water Allocation)	The Others
7. Archaeology and historical remains	-	-	-	-	-	-
B. Renewable Resources						
1. Air	-	-	-	-	-	Air pollution in Surabaya area
2. Water	* Water hyacinth in Wlingi reservoir	* Blockings of inland drainage by the diking	* Water shortage induced by developments Effect of fertilizers and agricultural chemicals	* Decreases of available water by reforestation		* Worsening of water quality in Surabaya area
3. Land use pattern	-	-	-	-	-	-
4. Forest, including hydro-function	* Forest reduction due to the emergence of reservoirs and quarries	-	Over cultivation at the slope of the mountain side	-	-	-
5. Native flora	-	-	- do -	-	-	-
6. Native fauna	-	-	-	-	-	-
7. Public works facilities	-	-	-	-	-	-

Table 3.12.1 (3) RISK RESULTANT MATRIX

Sector	Dam Development	Flood Control	Agriculture and Irrigation	Sediment Control (Watershed Management)	Water Utility (Water Allocation)	The Others
C. Technology						
1. Construction methods	-	-	-	-	-	-
2. Operating rule of reservoir	-	-	-	-	-	-
3. Externalities to agriculture	-	-	-	-	-	-
4. Externalities to small scale industry, home industry and handicrafts	-	-	-	-	-	-
5. Externalities to medium and large scale industry	-	-	-	-	-	-
6. Externalities to everyday life and activities	-	-	-	-	-	-
D. Human Environment						
1. Demography	-	-	-	-	-	-
2. Economic activities	-	-	-	-	-	-

Table 3.12.1 (47) RISK RESULTANT MATRIX

Sector	Dam Development	Flood Control	Agriculture and Irrigation	Sediment Control (Watershed Management)	Water Utility (Water Allocation)	The Others
3. Land tenure relations	-	-	-	-	-	-
4. Food production	-	-	-	-	-	-
5. Other agricultural production	-	-	-	-	-	-
6. Health	-	-	-	-	-	* Effect of worsening water quality on the health
7. Other social infrastructures education, productive skills. Community institutions, etc.	-	-	-	-	-	-
8. Anthropology and culture, including incidence of urbanization	-	-	-	-	-	-
E. The others	-	-	-	-	-	Bad smell due to the worsening of water quality Dumpings to the river

LEGEND * Environmental problems induced by the master plan in 1973.