社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
THE REPUBLIC OF INDONESIA

THE STUDY ON COMPREHENSIVE MANAGEMENT PLAN FOR THE WATER RESOURCES OF THE BRANTAS RIVER BASIN IN THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

OCTOBER 1998

NIPPON KOEI CO., LTD.
NIKKEN CONSULTANTS, INC.

THE STUDY
ON
COMPREHENSIVE MANAGEMENT PLAN
FOR
THE WATER RESOURCES OF THE BRANTAS RIVER BASIN
IN
THE REPUBLIC OF INDONESIA

COMPOSITION OF REPORTS

Volume I : ***Executive Summary***

Volume II : ***Main Report***

Volume III : ***Supporting Report I***

Annex
1. Meteorology and Hydrology
2. Watershed Conservation, Sabo, and Flood Control
3 Water Quality.
4. Water Demand Forecast
5. Water Balance Study
6. Water Resources Development
7. River Facility
8. Effective Operation of Water Resources
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10. River Environment

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Annex
11. Institutional Study
12. Organization and Management
13. Human Resources Development
14. Financial Plan and Budget Resources
15. Water Charge Mechanism
16. Economic Evaluation
17. Socio-economic Framework

Volume V : ***Data Book***

MH Meteorology and Hydrology
WQ Water Quality
IR Irrigation Water Demand
RS River Survey
CB Community and Beneficiaries' Participation Survey
BI Biodiversity Inventory Survey
AR PJT's Annual Report

EXCHANGE RATE

The exchange rates used in this Study are:
US Dollar(US$) 1.00 = Indonesia Rupiah(Rp.) 2,446.6
Japanese Yen(¥) = Indonesia Rp.21.4
as of June, 1997

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a development study on Comprehensive Management Plan for the Water Resources of the Brantas River Basin and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Hideki Sato of Nippon Koei Co., Ltd. four times between February 1997 and August 1998.

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

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

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

October 1998

Kimio Fujita
President
Japan International Cooperation Agency

October 1998

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

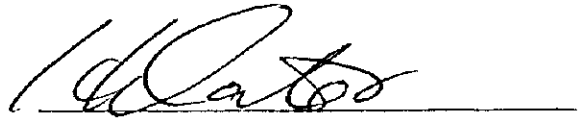
We are pleased to submit to you the Final Report on Comprehensive Management Plan for the Water Resources of the Brantas River Basin in the Republic of Indonesia.

We carried out the study for a period of 21 months from February 1997 through October 1998. The Final Report presents a master plan for comprehensive water resources management in the Brantas river basin for the target year 2020 to achieve efficient water use and appropriate water resources management, reflecting the increase in water demand and the deterioration of water quality currently prevailing in the Brantas river basin.

The master plan which includes the construction of water supply dams and the implementation of water saving measures is proved to be technically viable and economically feasible. For implementation of the master plan, the Final Report makes recommendations on overall water resources management including organizational and institutional aspects. Further, the Final Report proposes (1) the establishment of a new water resources management organization in the year 2002 to strengthen the existing water resources management system and (2) the expeditious implementation of the pre-consolidation 3-year program which is indispensable for the aforesaid establishment of a new water resources management organization.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Advisory Committee for the Study. We also wish to express our deep gratitude to the Government of the Republic of Indonesia, the Embassy of Japan in Indonesia, the JICA Indonesia Office and JICA experts for close cooperation and assistance extended to us during our investigation and study.

Very truly yours,



Hideki Sato
Team Leader
Comprehensive Management Plan for the Water Resources of the Brantas River Basin

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LOCATION MAP

KALIMANTAN
SUMATRA
JAWA SEA
Jakarta
Surabaya
PROJECT AREA
INDONESIAN OCEAN

SURABAYA URBAN DEVELOPMENT PROJECT
SURABAYA
Gunungsari Canal
Mas R.
Kedurus R.
Wonokromo R.
GUNUNGSARI DAM
KALI SURABAYA RIVER IMPROVEMENT
Surabaya River
KARANGPILANG TREATMENT WORKS
BRANTAS DELTA IRRIGATION AREA
MENTURUS RUBBER DAM
BENG IRRIGATION AREA 3200 HA
GOTTAN LOSARI IRRIGATION AREA 4200 HA
NEW LENGKONG DAM
KEDUNGWARAK DAM
JATIM LEREK RUBBER DAM
Marmoyo R.
BENG DAM
MOJOKERTO
Watudakon R.
Sadar R.
Porong River
SIDOARJO
MADURA STRAIT
SEMANTOK DAM
WIDAS EXTENSION AREA 2250 HA
TURI TUNGGORONO IRRIGATION AREA
Bening R.
BENING DAM
WIDAS IRRIGATION AREA
Widas River
WIDAS FLOOD CONTROL
Widas R.
GLATIK DAM
Lilo R.
KERTOSONO
NGANJUK
PASIR PETERONGAN IRRIGATION AREA
Brangkal R.
KALI PORONG RIVER IMPROVEMENT
Kambing R.
PASURUAN
UMBULAN SPRING
Kuncir R.
Kedung Soko R.
Konto R.
Brantas River
WARUJAYENG IRRIGATION AREA
MIDDLE REACH RIVER IMPROVEMENT
KUNCIR DAM
WIDAS SOUTH IRRIGATION AREA 5500 HA
MT. ARJUNO
BABADAN DAM
Kedak R.
MRICAN BARRAGE
KEDIRI
Serinjing R.
MT. WILIS
SELOREJO MULTIPURPOSE DAM
K.KONTO II DAM
MT. KELUD
MT. KAWI
MALANG
Amprong R.
UPPER BRANTAS WATERSHED MANAGEMENT
Lesti R.
Hanakan R.
Song R.
Hoding R.
TULUNGAGUNG GATE
Badak R.
Tugu R.
Agasiman R.
TUGU DAM
TULUNGAGUNG
Ngrowo R.
Dawir R.
Tawing R.
BLITAR
Putih R.
Jari R.
Lekso R.
Ewah R.
Bambang R.
Lahor R.
LAHOR DAM
Metro R.
Brantas R.
LUMBANGSARI DAM
KEPANJEN DAM
MT. SEMERU
WONOREJO IRRIGATION AREA
TRENGGALEK IRRIGATION AREA
Pant Raya
Pant Arjuno
UPPER LESTI WATERSHED MANAGEMENT
KESAMBEN DAM
FLOOD DIVERSION
Lesti R.
GENTENG I DAM
LESTI LEFT IRRIGATION AREA 2300 HA
LESTI III DAM
INDONESIAN OCEAN

LEGEND :

- Boundary of Catchment area for Brantas River Basin
- Dam Site
- Completed Project
- Under-Construction Project
- Proposed Project

SCALE
0 5 10 15 20 km

STUDY AREA

N

LOCATION MAP

KALIMANTAN
SUMATRA
JAVA SEA
Jakarta
Surabaya
INDONESIAN OCEAN
PROJECT AREA

SURABAYA URBAN DEVELOPMENT PROJECT
SURABAYA
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KALI SURABAYA RIVER IMPROVEMENT
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WIDAS FLOOD CONTROL
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WIDAS SOUTH IRRIGATION AREA 5500 HA
Brantas River
BABADAN DAM
MRICAN BARRAGE
MT. WILIS
KEDIRI
SELOREJO MULTIPURPOSE DAM
K KONTO II DAM
MT. ARJUNO
MT. KELUD
MT. KAWI
(MT. KELUD DEBRIS CONTROL)
SEGAWE WEIR
WONOREJO DAM
MALANG
UPPER BRANTAS WATERSHED MANAGEMENT
TULUNGAGUNG GATE
TULUNGAGUNG
BLITAR
TUGU DAM
WONOREJO IRRIGATION AREA
TRENGGALEK IRRIGATION AREA
WLINGI MULTIPURPOSE DAM
LAHOR DAM
LUMBANGSARI DAM
KEPANJEN DAM
MT. SEMERU
LODOYO TULUNGAGUNG IRRIGATION AREA
LODOYO AFTERBAY
UPPER LESTI WATERSHED MANAGEMENT
PARIT AGUNG CANAL
KESAMBEN DAM
SUTAMI MULTIPURPOSE DAM
SENGGURUH DAM
SOUTH TULUNGAGUNG TUNNEL
FLOOD DIVERSION
GENTENG I DAM
LESTI LEFT IRRIGATION AREA 2300 HA
LESTI III DAM
TULUNGAGUNG HEPP
INDONESIAN OCEAN

LEGEND :

- Boundary of Catchment area for Brantas River Basin
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SCALE

STUDY AREA

OUTLINE OF THE STUDY

1 Purpose of the Study

The Brantas river is the second largest river in the Java Island with a catchment area of about 11,800 km^2. It functions as the most important source of water supply in the East Java Province. Currently, almost all the water of the Brantas in the dry season has been utilized and some measures for enhancing water supply becomes indispensable to meet the increasing water demand. Meanwhile, the quality of river water has been deteriorating recently due to the growth of urbanization and industrialization around Surabaya district.

Under these situations, the strengthening of water resources management system aiming at either an efficient use of water or an appropriate water resources management is urgently required. Thus the present study pursues the following:

1) To prepare the master plan for the comprehensive water resources management in the Brantas river basin

2) To transfer the technology to counterpart staffs

2 Basic Concept of the Water Resources Management

The basic concept of water resources management is understood in this study as stated hereunder. The target year is set at the year 2020.

(1) Purpose and Scope of Water Resources Management

The purpose of the water resources management lies in supporting the growth of sustainable society. For this purpose, it is required for the responsible agency to supply water in time to meet demand. The following are the scope of water resources management:

(a) Watershed management

(b) Flood management

(c) Water supply management

(d) Water quality management

(e) River environment management

(2) Basic Principles of Water Resources Management

The basic principles of water resources management in this study are:

(a) Principle of "one river, one plan and one management"

(b) Full-cost recovery principle

(c) Polluters-pay principle

(d) Service to receive principle

(3) Socio-economic Framework in 2020

The socio-economic framework in 2020 was set up for this study on the basis of the Second 25-year Development Plan and the Sixth REPELITA having started in 1994/95 both of which were prepared by the Government of Indonesia. The following major indices of the framework is shown below, which are applied for water demand projection and other planning in this study for the Brantas river basin:

- GRDP growth rate : 7.6% per annum
- Population : 17.7 million
- Per capita GRDP : US$ 5,700

3 Master Plan for the Comprehensive Water Resources Management in the Brantas River Basin

The master plan for the comprehensive water resources management in the Brantas river basin is proposed as shown belowand the following are recommended for its implementation.

(1) Recommendation for Overall Water Resources Management

(a) Clarification of the definition of the basin water resources management:

The water resources management is defined as all the water related management including (i) watershed management, (ii) flood management, (iii) water supply management, (iv) water quality management and (v) river environment management.

(b) Understanding and consensus of the basic concept and principles of water resources management (cf. 2.(2))

(c) Clarification of the necessity of the maintenance and management of river facilities

(2) Recommendation on Managerial Aspects

(a) Strengthening of water resources management system

(i) The Ministry of Public Works(MPW) shall be primarily responsible for supervising the water resources management in the Brantas river basin while PJT shall be responsible for its implementation.

(ii) The Basin Water Resources Management Committee shall be newly established.

(iii) The New PJT shall be established through consolidating PKB, PGKS and PJT.

(b) Development of organization/management of PJT

(i) The New PJT shall be established in 2002 through the pre-consolidation 3-year program.

(ii) The New PJT which will be still Perum status shall be transformed to Persero Jasa Tirta in 2005 subject to introduction of self-supporting financial system.

(3) Master Plan for the Comprehensive Water Resources Management in the Brantas River Basin

(a) Projects Incorporated in the Master Plan(cf. Figure S.1)

The projects to be implemented towards 2020 as components of the master plan are recommended as follows:

(i) Dam construction for water supply
- Beng dam
- Genteng I dam
- Kedungwarak dam

(ii) Countermeasures for sedimentation in the existing dams
- Dredging works in Wlingi and Lodoyo dams
- Extension of the existing by-pass channel locating on the right bank nearby Wlingi dam

(iii) Water saving measures
- Improvement of existing irrigation channel(Concrete lining of channels)
- Re-cycling use of industrial and domestic water

(iv) Flood control
- Implementation of proposed Widas flood control project
- Construction of Lodoyo diversion channel
- Improvement of the existing FFWS

(v) Watershed conservation
- Experimental Research

(vi) Sabo
- Sabo works for Mt.Kelud eruption
- Sabo works in Lesti and Upper Brantas river basins

(vii) Monitoring of water quality

(viii) Improvement of river environment

(ix) Introduction of the inter-agency information system and management information system

(x) Implementation of human resources development

(b) Investment Cost of the Master Plan

The total investment amount for the master plan between 1999 and 2020 is about

2,800 billion Rupiah including VAT(US$1.14 billion equivalent), while about 4,200 billion Rupiah including VAT(US$1.72 billion equivalent). Respective project costs are shown in Figure S.1.

(c) Implementation Schedule of the Master Plan

Implementation schedule of the projects in the master plan is presented in Figure S.1. Implementation schedule of the Pre-consolidation 3-year Program and Action Plan towards 2020 is shown in Figure S.2.

4 Pre-consolidation 3-year Program

The establishment of New PJT through consolidating PKB, PGKS and PJT is proposed in 2002 in this study. For its smooth realization, the Pre-consolidation 3-year Program is recommended hereunder covering the preparation in both managerial and technical aspects. (cf. Figure S.2)

(1) Managerial Aspects

- Detailed study on the organizations of PKB, PGKS and PJT
- Confirmation of the tasks of water resources management
- Clarification of the responsibility and authority of the related agencies
- Coordination of works among member agencies of the Basin Water Resources Management Committee
- Preparation of the prospectus for New PJT
- Institutional preparation for the establishment of New PJT
- Training and education of New PJT staff

(2) Technical Aspects

- Preparation of river inventory and establishment of a rule for sharing the management responsibility for river structures
- Planning of the inter-agency information system and management information system
- Training and education of New PJT's technical staff

The program will be completed within three(3) years starting from the beginning of 1999 and completing in 2002. Some specialists and/or consultants will be employed for the implementation considering both its wide scope and short period. The scope of works to be done by the specialists/consultants will include the following.

a) Preparation of the implementation program for the Pre-consolidation 3-year Program

b) Detailed study of the current organization of PKB, PGKS and PJT

c) Support of preparing the brief paper for establishing the New PJT

d) Support of amending the institution and legislation

e) Support of preparing the specifications for technical related matters

f) Support of preparing the internal regulations in administrative sectors

g) Development of water charge system

h) Implementation of Inter-agency Information System and Management Information System within the New PJT

i) Implementation of 3-year training program

5. Feasibility Study

Besides the above Pre-consolidation 3-year Program, it is recommended to conduct the following studies separately in accordance with medium and long-term development plans:

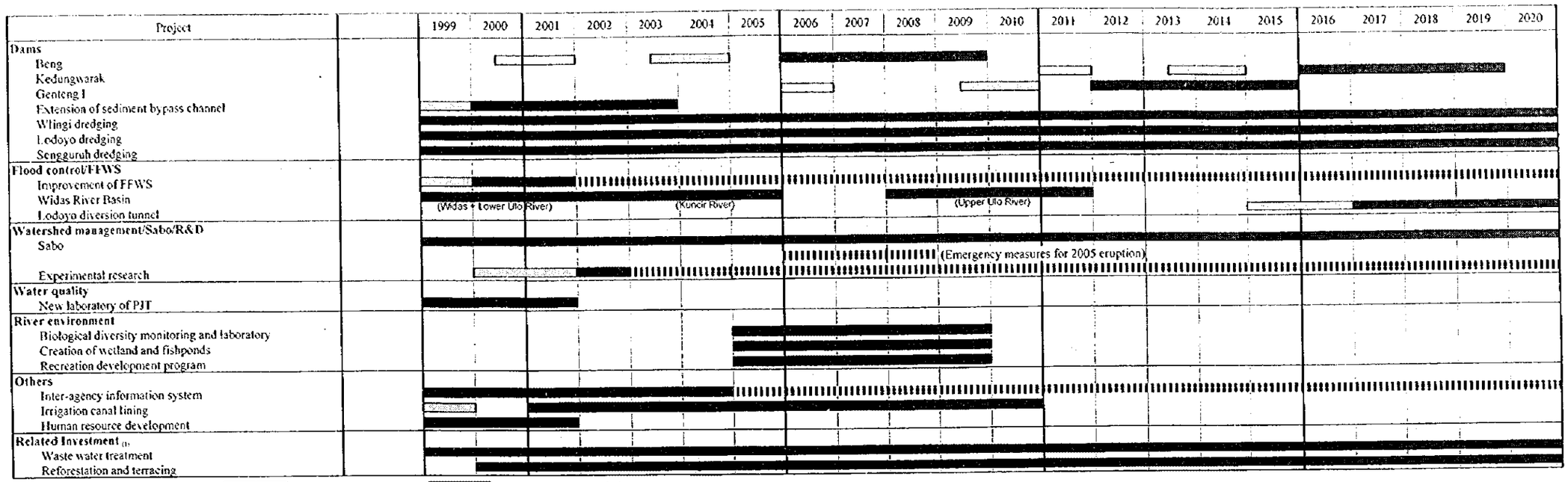
(a) Preparation of master plan for watershed management and water quality control

(b) Feasibility study on water resources development plan for selected priority projects among the projects incorporated in the Master Plan.

6. Economic Condition in Indonesia

During the study, drastic devaluation of Indonesian Rupiah against US dollar shook the Indonesian economy in June 1998. Though the economic turmoil is under recovery, it is impractical and unrealistic to predict future exchange rate of Indonesian Rupia appropriately at present. In this context, the exchange rate as of June 1998 is applied in this study as a macro-economic projection index.

Figure S.1 Implementation Schedule of Water Resources Management Master Plan for the Brantas River Basin



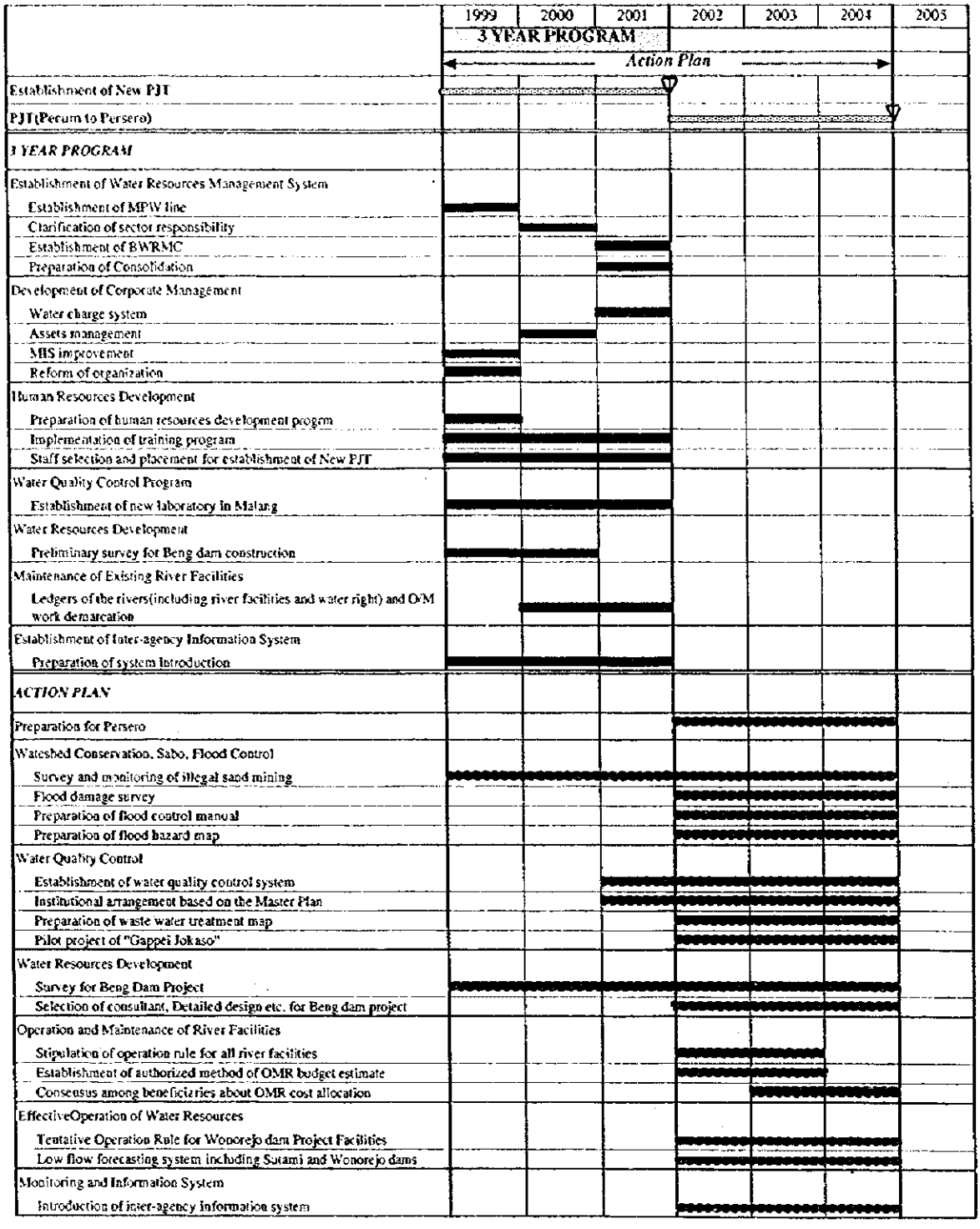
Investment Schedule

(Unit : million Rp. in 1997 price level)

Project	Total	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Dams																							
Beng	265,397	0	0	0	0	1,740	3,769	27,850	65,410	70,409	70,409	25,810	0	0	0	0	0	0	0	0	0	0	0
Kedungwarak	143,847	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,055	2,287	13,459	34,532	38,426	38,426	15,662	0
Genteng I	290,662	0	0	0	0	0	0	0	0	0	0	3,542	7,674	6,776	58,273	80,930	80,930	52,537	0	0	0	0	0
Extension of sediment bypass channel	50,729	1,209	12,380	12,380	12,380	12,380	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wlingi dredging	202,683	14,428	14,428	14,428	14,428	14,428	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679	7,679
Lodoyo dredging	198,056	9,215	9,215	9,215	9,215	9,215	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993	8,993
Sengguruh dredging	14,278	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649
Total	*1,165,652*	*25,501*	*36,672*	*36,672*	*36,672*	*38,412*	*21,090*	*45,171*	*82,731*	*87,730*	*87,730*	*46,673*	*24,995*	*24,097*	*75,594*	*99,306*	*100,538*	*83,317*	*51,853*	*55,747*	*55,747*	*32,983*	*17,321*
Flood control/FFWS																							
Improvement of FFWS	56,667	7,617	8,016	446	0	0	856	61	61	1,086	6,133	6,989	5,108	61	0	0	856	61	61	1,086	6,133	6,989	5,047
Widas River	124,236	1,292	5,882	18,727	19,745	20,074	17,890	12,973	0	0	695	5,398	13,130	8,430	0	0	0	0	0	0	0	0	0
Lodoyo diversion tunnel	421,998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,130	9,671	100,342	100,341	100,341	99,173
Total	*602,901*	*8,909*	*13,898*	*19,173*	*19,745*	*20,074*	*18,746*	*13,034*	*61*	*1,086*	*6,828*	*12,387*	*18,238*	*8,491*	*0*	*0*	*855*	*12,191*	*9,732*	*101,428*	*106,474*	*107,330*	*104,220*
Watershed management/Sabo/R&D																							
Sabo	559,992	1,890	19,055	19,325	34,800	34,801	34,801	34,801	63,763	47,450	47,450	18,488	18,488	18,488	18,488	18,488	18,488	18,488	18,488	18,488	18,488	18,488	18,488
Experimental research	6,984	0	482	781	674	160	162	165	860	165	165	165	165	860	165	165	165	165	860	165	165	165	165
Total	*566,976*	*1,890*	*19,537*	*20,106*	*35,474*	*34,961*	*34,963*	*34,966*	*64,623*	*47,615*	*47,615*	*18,653*	*18,653*	*19,348*	*18,653*	*18,653*	*18,653*	*18,653*	*19,348*	*18,653*	*18,653*	*18,653*	*18,653*
Water quality																							
New laboratory of PJT	4,500	500	500	3,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
River environment																							
Biological diversity monitoring and laboratory	480	0	0	0	0	0	0	96	96	96	96	96	0	0	0	0	0	0	0	0	0	0	0
Creation of wetland and fishponds	44	0	0	0	0	0	0	9	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0
Recreation development program	648	0	0	0	0	0	0	130	130	130	130	130	0	0	0	0	0	0	0	0	0	0	0
Total	*1,172*	*0*	*0*	*0*	*0*	*0*	*0*	*234*	*234*	*234*	*234*	*234*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Others																							
Inter-agency information system	17,714	42	191	241	2,583	2,608	67	0	0	1,997	1,997	0	0	0	1,997	1,997	0	0	0	1,997	1,997	0	0
Irrigation canal lining	160,365	4,719	1,976	15,691	15,691	15,691	15,691	15,691	15,691	15,691	15,691	15,691	15,691	0	0	0	0	0	0	0	0	0	0
Human resource development	18,000	6,000	6,000	6,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	*196,079*	*10,761*	*8,167*	*21,932*	*18,274*	*18,299*	*15,758*	*15,691*	*15,691*	*17,688*	*17,688*	*15,691*	*15,691*	*0*	*1,997*	*1,997*	*0*	*0*	*0*	*1,997*	*1,997*	*0*	*0*
GRAND TOTAL (without VAT)	2,537,280	47,561	78,774	101,383	110,165	111,746	90,557	109,096	163,340	154,353	160,095	93,638	77,577	51,936	96,244	119,956	120,047	114,161	80,933	177,825	182,871	158,966	140,194
VAT (10%)	253,728	4,756	7,877	10,138	11,017	11,175	9,056	10,910	16,334	15,435	16,010	9,364	7,758	5,194	9,624	11,996	12,005	11,416	8,093	17,783	18,287	15,897	14,019
GRAND TOTAL (with VAT)	2,791,008	52,317	86,651	111,521	121,182	122,921	99,613	120,006	179,674	169,789	176,105	103,002	85,335	57,130	105,868	131,952	132,052	125,577	89,026	195,608	201,158	174,863	154,213
Related Investment (1)																							
Waste water treatment	3,995,000	77,000	77,000	127,000	127,000	127,000	127,000	127,000	186,300	186,300	186,300	186,300	188,300	220,300	220,300	220,300	220,300	220,300	221,800	221,800	221,800	221,800	283,800
Reforestation and terracing	162,294	0	1,009	8,069	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064	8,064
Total of related investments	4,157,294	77,000	78,009	135,069	135,064	135,064	135,064	135,064	194,364	194,364	194,364	194,364	196,364	228,364	228,364	228,364	228,364	228,364	229,864	229,864	229,864	229,864	291,864

(1) Related to Water Resources Management Plan, but not included in the program cost.

Figure S.2 Implementation Schedule of Pre-consolidation 3-year Program and Action Plan



THE STUDY

ON

COMPREHENSIVE MANAGEMENT PLAN

FOR

THE WATER RESOURCES OF THE BRANTAS RIVER BASIN

IN

THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME I EXECUTIVE SUMMARY

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ABBREVIATIONS

1 UNIT

Length		Weight	
mm	millimeter	gr	gram
cm	centimeter	kg	kilogram
m	meter	t, ton	metric ton
km	kilometer		
Area		**Time**	
mm^2	square millimeter	sec	second
cm^2	square centimeter	min	minute
m^2	square meter	hr	hour
km^2	square kilometer	yr	year
ha	hectare		
Volume		**Others**	
cm^3	cubic centimeter	%	percent
m^3	cubic meter	℃	degree centigrade
Ltr	liter	10^3	thousand
		10^6	million
		10^9	billion

2 PLAN

ADIPURA	Kota Bersih *(Clean City)*
PROKASIH	Program Kali Bersih *(Clean River Program)*
REPELITA VI	Rencana Pembangunan Lima Tahun Tahap VI *(Sixth Five Year Development Plan)*

3 ORGANIZATION

BAPEDAL	Badan Pengendalian Dampak Lingkungan *(Environmental Impact Management Agency)*
BAPEDALDA	Badan Pengendalian Dampak Lingkungan Daerah *(Provincial Office of Environmental Impact Management Agency)*
BAPPEDA	Badan Perencanaan Pembangunan Daerah *(Regional Development Planning Agency)*
BAPPENAS	Badan Perencanaan Pembangunan Nasional *(National Development Planning Agency)*
BBLH	Biro Bina Lingkungan Hidup *(Bureau of Environmental Guidance, East Java)*
BKPMD	Badan Koordinasi Penanaman Modal Daerah *(East Java Regional Investment Coordinating Board)*
BMG	Badan Meteorologi dan Geofisika *(Meteorological and Geophysical Agency)*
BPPI	Balai Penelitian dan Pengembangan Industri, Surabaya *(Agency of Industrial Research and Development, Surabaya)*

BPPT	Badan Pengkajian dan Penerapan Teknologi *(Agency for the Assessment and Application of Technology)*
BPS	Biro Pusat Statistik *(Central Bureau of Statistic)*
BRLKT	Balai Rehabilitasi Lahan dan Konservasi Tanah *(Land Rehabilitation and Soil Conservation Agency, Ministry of Forestry)*
BTKL	Balai Teknik Kesehatan Lingkungan *(Agency of Environment Health Techniques, Ministry of Health)*
DBPP	Direktorat Bina Program Pengairan *(Directorate of Planning and Programming, DGWRD)*
Dep.HUT	Departmen Kehutanan *(Ministry of Forestry)*
Dep.KES/MOH	Departemen Kesehatan *(Ministry of Health)*
Dep.KEU	Departemen Keuangan *(Ministry of Finance)*
Dep.PE/MME	Departemen Pertambangan dan Energi *(Ministry of Mining and Energy)*
Dep.PRINDAG/MIT	Departemen Perindustrian dan Perdagangan *(Ministry of Industry and Trade)*
Dep.PU	Departemen Pekerjaan Umum *(Ministry of Public Works)*
Dep.TAN	Departmen Pertanian *(Ministry of Agruculture)*
DGWRD	Direktorat Jenderal Pengairan *(Directorate General of Water Resources Development, Ministry of Public Works)*
DIPENDA	Dinas Pendapatan Daerah Propinsi Daerah Tingkat I *(Provincial Revenue Service)*
DIPERTA	Dinas Pertanian Daerah Propinsi Daerah Tingkat I *(Provincial Agricultural Service)*
DJBM	Direktorat Jenderal Bina Marga *(Directorate General of Highways, Ministry of Public Works)*
DJCK	Direktorat Jenderal Cipta Karya *(Directorate General of Human Settlements,Ministry of Publiuc Works)*
DPERIKAN	Dinas Perikanan Daerah Propinsi Daerah Tingkat I *(Provincial Fishery Service)*
DPRIND	Dinas Perindustrian Daerah Propinsi Daerah Tingkat I *(Provincial Industry Service)*
DPU	Dinas Pekerjaan Umum *(Public Works Service)*
DPUK	Dinas Pekerjaan Umum Kabupaten *(Municipal Public Works Service)*
DPU Pengairan	Dinas Pekerjaan Umum Pengairan Daerah Propinsi Daerah Tingkat I *(Provincial Water Resources Service)*
GOI	*(Government of Indonesia)* Pemerintah Indonesia
GOJ	*(Government of Japan)* Pemerintah Jepang

HIPPA	Himpunan Petani Pemakai Air *(Water Users Association)*
IBRD	*(International Bank for Reconstruction and Development)*
IPAIR	Iuran Pelayanan Irigasi *(Irrigation Service Fee)*
JICA	*(Japan International Cooperation Agency)*
Kem. Neg. LH	Kementrian Negara Lingkungan Hidup *(State Ministry of Environment)*
KPH	Kesatuan Pemangku Hutan *(Unit of Forestry Management)*
KPPPLH	Komisi Pengendalian dan Penanggulangan Pencemaran Lingkungan Hidup *(Commision for Environmental Pollution Control and Abatement)*
LIPI	Lembaga Ilmu Pengetahuan Indonesia *(Indonesian Institute of Science)*
MIT/Dep.PRIND	*(Ministry of Industry and Trade)* Departemen Perindustrian dan Perdagangan
MME/Dep.PE	*(Ministry of Mining and Energy)* Departemen Pertambangan dan Perdagangan
MOC	*(Ministry of Construction, Japan)*
MOF	(Ministry of Finance)
MOH/Dep.KES	*(Ministry of Health)* Departemen Kesehatan
OECF	*(Overseas Economics Cooperation Fund, Japan)*
PBS	Proyek Induk Pengembangan Wilayah Sungai Bengawan Solo *(Bengawan Solo River Basin Project)*
PDAB	Perusahaan Daerah Air Bersih *(Regional Clean Water Supply Company)*
PDAM	Perusahaan Daerah Air Minum *(Regional Drinking Water Supply Company)*
PGK	Proyek Gunung Kelud *(Volcanic Disaster Prevention Project of Mt. Kelud, DOI)*
PGKS	Proyek Pengendalian Banjir Lahar G. Kelud Semeru *(Volcanic Disaster Prevention Project of Mt. Kelud Semeru)*
PJT	Perum Jasa Tirta *(Jasa Tirta Public Corporation)*
PKB	Proyek Pengembangan Wilayah Sungai Kali Brantas *(Brantas River Basin Development Project)*
PLN	Perusahaan Umum Listrik Negara *(State Electric Power Company)*
PLN PJB II	P.T. PLN Pembangkitan Tenaga Listrik Jawa - Bali II *(PLN Electric Power Generator Corporation Java Bali II)*
POJ	Perum Otoritas Jatiluhur *(Jatiluhur Authority Public Corporation)*
PPPLD	Pengendalian dan Penanggulangan, Pencemaran Limbah Domestik *(Work Team for Controlling and Overcoming Domistic Waste Pollution)*

PPPLI	Pengendalian dan Penanggulangan, Pencemaran Limbah Industri *(Work Team for Controlling and Overcoming Industrial Waste Pollution)*
UNDP	*(United Nations Development Program)*
USAID	*(United States of Agency for International Development)*
WARDEC	*(Water Resources Development Corporation)*

4 OTHERS

APBD	Anggaran Pendapatan dan Belanja Daerah *(Provincial Government Resources and Expenditure Budget)*
APBN	Anggaran Pendapatan dan Belanja Negara *(Central Government Resources and Expenditure Budget)*
BOD	*(Biochemical Oxygen Demand)*
Bupati	*(Head of Regency)*
Camat	*(Head of sub District)*
COD	*(Chemical Oxygen Demand)*
CPI	*(Costumer Price Index)*
DIP	Daftar Isian Proyek *(Development Budget Allocation)*
DO	*(Dissolved Oxygen)*
EOM	*(Effective Operation & Maintenance (ISSD under IBRD)*
FFWS	*Flood Forecasting and Warning System*
GDP	*(Gross Domestic Product)*
GERBANG KERTOSUSILA	Gresik, Bangkalan, Mojokerto, Surabaya, Sidoarjo,Lamongan
GRDP	*(Gross Regional Domestic Product)*
HWL	*(High Water Level)*
IPEDA	Iuran Pendapatan Daerah *(Village Land Tax)*
ISF	*(Irrigation Service Fee)*
ISSP	*(Irrigation Subsector Project) (IBRD Project)*
Kabupaten	*(Regency)*
Kanwil	Kantor Wilayah *(Provincial Office of a Ministry)*
Kecamatan	*(District)*
Kotamadya	*(Municipality)*
LWL	*(Low Water Level)*
O&M	*(Operation & Maintenance)*
Polowijo	*(Second crop or collective term for all annual crops other than paddy and sugarcane)*
SS	(Suspended Solid)

I SCOPE OF THE STUDY

I.1 Background of the Study

The Brantas river has a catchment area of 11,800 km^2, which is the second largest in Java island. The Brantas river is the primary water resources in East Java Province.

The comprehensive development master plan studies of the Brantas river basin were conducted in 1961, 1973 and 1984 by OTCA(Overseas Technical Cooperation Agency) and JICA(Japan International Cooperation Agency). The projects proposed in those master plans have been realized for various aspects.

In 1987, the Phase I Special Assistance for Project Sustainability(SAPS-I) in Brantas River Basin Development Projects by the Overseas Economic Cooperation Fund, Japan (OECF) recommended to establish a new organization for the Brantas river basin management. Perusahaan Umum Jasa Tirta (PJT) was established in 1990 by the Government Regulation No.5.

In 1991, a follow-up study to sustain the project benefit was conducted under the OECF's SAPS II Program including improvement of the operation and maintenance system of the Brantas river basin as well as strengthening of the PJT organization.

To cope with serious water supply and quality problems, the Wonorejo Multipurpose Dam is under construction to supply raw water to Surabaya and its vicinity for domestic and industrial uses. Establishment of a comprehensive water resources management plan has been proposed to strengthen the river basin management system aiming at efficient use and adequate management of the water resources.

I.2 Objectives of the Study

The objectives of the Study on Comprehensive Management Plan for the Water Resources of the Brantas River Basin in the Republic of the Indonesia(the Study) are as follows:

1) to formulate a comprehensive water resources management plan of the Brantas river basin including a structural development plan for appropriate development and management of the Brantas river basin, and

2) to transfer technology on planning methods and skills to the counterpart personnel.

I.3 Study Area

The objective area of the Study is the whole Brantas river basin. The existing plan of water supply to the outside area from the Brantas river shall be incorporated as the giving conditions in formulating water allocation plan as well as the existing plan of water supply from outside of the Brantas river basin to the Metro Surabaya area.

I.4 Scope of the Study

Phase I : [Basic Study and Review of the Existing Studies]

The present status of water management of the Brantas river and the facilities in the Brantas river basin shall be studied and examined through study and analysis of the collected data and documents as well as field investigations.

Phase II : [Formulation of Comprehensive Water Resources Management Plan]

Appropriate water use and management plan shall be formulated. Further, the comprehensive water resources management plan including improvement plans for the monitoring system, the institutional framework and the legal framework shall be formulated to implement the aforesaid water use and management plan.

I.5 Implementation Organization

The Directorate General of Water Resources Development(DGWRD), Ministry of Public Works act as the counterpart body to the JICA Study Team.

The Steering Committee, chaired by the Director of Directorate of Water Resources Management and Conservation, DGWRD was organized in June 1997, consisting of DGWRD, Ministry of Home Affairs, Perum Jasa Tirta(PJT) and other related organizations.

The implementing organization of the Study is shown in Figure 1.

I.6 Study Schedule and Activities

The Study comprises the following two phases:

Phase I: Basic study and review of the existing studies during a period of February to October 1997

Phase II: Formulation of comprehensive Water Resources Management Plan during a period of October 1997 to July 1998.

The following field surveys have been carried out on a sub-contract basis during the study period:

(a) Biodiversity inventory survey of the Brantas river

(b) River survey

(c) Community and beneficiaries' participation survey

Transfer technology activities consists of on-the-job-training and lectures to the counterpart group. The following lectures were conducted during the study period:

(i) Water resources development scenario and concept of water balance calculation,

(ii) Hydrologic observation and analysis,

(iii) Irrigation water demand,

(iv) Water quality improvement plan,

(v) Demand forecast for domestic and industrial waters, and

(vi) Financial Plan and Budget Resources, and Future development scenario of PJT.

II PRESENT CONDITION OF THE STUDY AREA

II.1 Natural Condition

The Brantas river in the East Java lies between 110°30'and 112°55'east longitude and between 7°01' and 8°15'south latitude. The area of the basin is approximately 11,800 km^2.

The basin's climate is dominated by tropical monsoons. In normal years, the rainy season extends about 6 months from November to April, and the dry season prevails from May to October. The average annual rainfall over the basin is around 2,000 mm with more than 80% occuring in the rainy season.

II.2 Socio-economy of Brantas River Basin

The population of the Brantas river basin was 13,154 thousand in 1994, accounting for 42% and 7% of the East Java Province's and Indonesia's population. The rate of population growth was 1% per year between 1990 and 1994. The population of municipalities accounted for 26% of the total population.

Gross Regional Domestic Product (GRDP) in the Brantas river basin was 39,019 billion Rupiahs, or US$17,349 million (applying 2,249 Rupiahs per US$1.0, the average of 1995), in 1995. GRDP per capita in Brantas was US$1,269, about 46% and 44% higher than those of East Java Province ($872) and Indonesia ($880). The Brantas river basin has experienced high economic growth since 1980s. The GRDP of Brantas grew at 7.6% per year during the 1983-1995 period, while the growth rates in East Java and Indonesia during the same period were 6.8% per year and 6.4% per year. The growth of GRDP in Brantas accelerated in late 1980s : up from 5 to 6 % per year in early to middle 1980s to 7 to 8 % per year since late 1980s, which is caused by the rapid industrialization of the Metro Surabaya area and its outskirts.

The majority of labor force in the Brantas river basin (53%) are still engaged in agriculture activities.

II.3 Economic Development Plans

The Indonesian Government started the second 25-Year Development Plan in 1994/1995 fiscal year. The plan shows the direction of social and economic development in Indonesia until fiscal year 2019/20. According to the plan, Indonesia aims to enter into a take-off stage based on the philosophy of Development Trilogy : harmony between equity, economic growth and stability. The targets during 25 years include average growth rates at 1.2% per year for population and 7.3% per year for economic growth.

As the first 5-year socio-economic development plan, Repelita VI was started in 1994/1995 fiscal year. Repelita VI stipulates the following development targets.

- population : 1.5 % per year
- GDP : 6.2 % per year (revised to 7.1% in 1996)
- agriculture : 3.4 % per year

- industry : 9.4 % per year

A development plan for the East Java Province is currently being prepared by the provincial office. Its draft version includes the following targets.

- economic growth : 7.7% per year
- population growth : 1.4 to 1.7 % per year
- increase in land use
  - Industrial area : 3.0 % per year
  - Agriculture area : 0.3 % per year
  - Residential area : 0.8 % per year

Based on those figures, the following indicators are forecast as the socio-economic framework for the year 2020:

- GRDP growth : 7.6% per year
- population in 2020 : 17,697 thousand
- GRDP per capita : about US$5,700.

II.4 General Feature of the Brantas River Basin

The Brantas river originates from the southern slope of the Arjuno Mountain Complex and debouches to the Madura Strait. The total length of the main course is as long as 320 km.

The Brantas river flows southward and turns to westward near Kepanjen. After joining the Lesti river on the left bank and the Metro river on the right bank, the river reaches the Sutami dam site where the river bed elevation is about 200 m SHVP. The total catchment area at the dam site is about 2,050 km^2.

The river continues to flow westward up to the confluence with the Ngrowo river through Wlingi and Lodoyo dams on it. The total catchment area at the confluence is about 3,600 km^2.

After joining the Ngrowo river, the Brantas river flows north-northeastward up to Ploso through Kediri and Kertosono, and then turns to eastward to Mojokerto, where it branches into the Porong river debouching to the Madura Strait and the Surabaya river debouching to the sea at the north of Surabaya city. Tributaries in this stretch are the Widas river and the Konto river. The total catchment area at the Lengkong dam site is about 8,650 km^2 .

The Porong river works as a flood diversion canal in the rainy season. The Surabaya river works as water supply canal to the Surabaya city as well as drain of the city.

II.5 History of the Brantas River Basin Development

Water resources in the Brantas river basin have been developed by more than 20 projects for irrigation, domestic and industrial water supplies, and hydropower generation, since a completion of the South Tulungagung Drainage Project in 1961. Principal feature of the projects are described in Chapter II.5 of the Main Report.

III BASIC CONCEPT OF THE WATER RESOURCES MANAGEMENT

The basic concept of water resources management for the Brantas river basin is presented herein. This is prepared in due considerations of the present condition and problems encountered in the currently adopted management system , required tasks of the management and detailed scope of works in view of technical and managerial aspects.

III.1 Understanding of Nature of Water

The general understanding on the nature of water and river is confirmed hereunder. A relevant schematics on a general model of hydrological cycle and hydrosocial cycle is shown in Figure 2.

-Water is vital for all the life on the Earth
-Water is a natural grace given by God
-Water resources is economic goods as well as social goods
-Water is limited resources
-River water varies in its quantity with season and place
-Water demand and consumption increase with the development of society
-Water resources development is necessitated to cope with flood and water demand increase
-Water resources development needs some costs

Besides the above, Mt. Kelud is one of the special condition to be considered in the water resources management in this river basin. Mt. Kelud which is a volcano located in the center of the Brantas river basin has erupted once in 15 years interval on average and each eruption has extruded a huge amount of debris, which together with flood has brought about destructive damages to the people and properties. Mt. Kelud is thus obliged to be included in formulating the water resources management plan of the Brantas.

With the understanding on all the nature of water described above, the basic concept of water resources management is discussed in this chapter.

III.2 Objective of Water Resources Management

Objective of water resources management is to manage "Water and River" in order to support sustainable society building by means of its impartial and effective uses.

With the development of society and high economic activities, such water-related problems as described below have been brought about.

1) Shortage of water in serious drought year
2) Water struggle
3) Needs of sustainable water conservation
4) Increase of flood damage potential
5) Deterioration of water quality
6) Worsening of river environment

In order to solve these problems described above, the water resources management system should be established.

III.3 Tasks of Water Resources Management

From the above considerations, tasks of water resources management are set extending to five (5) water resources management sectors as follows.

(1) Watershed management

1) Water resources conservation management
2) Landslide and erosion prevention management
3) Sediment control management
4) Mt. Kelud debris control management

(2) Flood control management

1) Flood control works management
2) Flood damage management

(3) Water quantity management

1) Water supply management
2) Water resources development management
3) Water balance management
4) Low water management

(4) Water quality management

1) River water quality management
2) Domestic waste water management
3) Industrial waste water management

(5) River environment management

1) Land use in river area management
2) Biota in the river area management
3) Recreational use in river space management

These tasks should be accomplished through the following principal activities.

a) Monitoring present condition and data collection and compilation
b) Preliminary analysis to grasp the present condition and problems encountered
c) Preparation of master plan on water resources management
d) Feasibility study and detailed design of the projects identified in the master plan including the incidental requirement for maintenance and repairing.
e) Implementation of the projects
f) Follow-up monitoring and evaluation which should be reflected to the next program formulation

These works in each step should be executed in consideration of community and beneficiaries participation reflecting their needs and requirement to the water resources management activities.

III.4 Fundamental Problems on Water Resources Management

Fundamental problems on water resources management of the Brantas are pointed out hereunder. These problems are topmost important in relation to each task of water resources management.

(1) Lack of man power with sufficient experiences

(2) Need of further water resources development

(3) To prepare master plan of water resources management incorporated with water resources development

(4) To formulate comprehensive plan in due consideration of competitive components by sector

(5) To undertake more elaborate and serious operation and maintenance works of completed projects/structures

(6) Organization of operation and maintenance

Many agencies are involved in the water resources management of the Brantas. Duties and tasks of those agencies are not always definitive. There are some duplication and some shortage of tasks which is not obligated to any agency.

(7) Finance and budget

1) The PJT's operation budget has been borne from the beneficiaries in principle. However, its basis is not clear. Dare say, PJT seeks a fund source which has the capacity to pay, and receives payment accordingly. This implies that proper cost allocation to the beneficiaries in consideration of specified or unspecified beneficiaries is not applied. This would bring about some problems in the future for the operation of PJT.

2) The full cost recovery principle, including beneficiaries pay principle, and government obligation to pay principle should be considered.

3) The annual revenue of PJT seems not to be always appropriately equivalent to the services PJT extended.

4) Water resources related facilities which have been handed over from PKB to PJT are not always registered in the balance sheet. This implies that actual cost of water service inclusive O/M cost and depreciation cost of the facilities are not counted for. For future operation of PJT, it is strongly suggested that a property management system be properly established.

III.5 Basic Concept of Water Resources Management

In due consideration of the present condition and problems encountered whose fundamental ones are stated in the previous sub-chapter, following basic principles are proposed to be adopted for water resources management of the Brantas river basin.

(1) Purpose and scope of water resources management

1) Primary objective of water resources management is to support the sustainable society building by means of distributing water in time and in place as required.

2) Water resources management shall cover the tasks of 1) water resources conservation, 2) flood control, 3) water quantity control, 4) water quality control, and 5) river environment protection.

3) Environmental capacity shall be considered for the whole river basin. Water resources development and water use shall be limited to an extent to retain the natural environmental capacity as a whole river basin.

(2) One River-One Plan-One Management principle

1) One river shall be developed and managed in accordance with one comprehensive development and management plans.

2) One river shall be managed by one management system

   a) "One Management system" is defined in principle as one responsible line organization and institution.

   b) Management system shall be established with unified management organization and coordinating agencies which are closely related to water resources management.

   c) Coordination shall be done especially to eliminate the following conceivable problems which are contradictory and competitive each other.

      i) Land development for farm land, plantation, and forestry in view of economic development and watershed management for water conservation, prevention of landslide and land erosion
      ii) Water allocation among different water users
      iii) Water use and waste water treatment
      iv) Water use and river environment

(3) Full cost recovery principle

All the costs required for water resources development and management shall be recovered according to the following principles.

1) Beneficiaries pay principle

All the beneficiaries are obligated to pay water service fee. Provided the following shall be considered.

2) Government obligation principle

In case many unspecified beneficiaries are not attributable to specific benefits such as those of flood control, water quality control, river environment etc., the cost shall be born by the Government.

(4) Polluters pay principle

1) People and industries which utilize public sewerage system including waste water treatment plant shall pay a "sewerage service charge".

2) Polluters of industrial manufacturing, if the waste water from the industry is beyond the specified water quality determined by the Government, shall pay a "penalty".

3) Polluters of industry shall pay a "polluters fee" before the waste water treatment system is established. This regulation, if issued, should be limited in terms of validity. Polluters fee will be used for building waste water treatment plants

(5) Service to receive principle

1) Implementing agency of water resources management shall receive the service fee corresponding to the cost and fee of services that the implementing agency renders.

These basic concepts of water resources management is summarized and tabulated in Table 1. In the same table, proposals/adoptions of the Study Team are denoted corresponding to each item of basic concepts of water resources management. Details of these proposals are explained in Chapter IV for each sector.

IV WATER RESOURCES MANAGEMENT STUDY

IV.1 Meteorology and Hydrology

(1) Meteorological and Hydrological Observations

Meteorological and hydrological observations are conducted in the Brantas river basin by several agencies including PJT, Dinas PU Pengairan (Provincial Water Resources Service) and BRLKT (Land Rehabilitation and Soil Conservation Bureau, Ministry of Forestry) etc. The Planning and Controlling Unit is responsible for the meteorological and hydrological observation in PJT. The site observation by PJT is carried out by ASA I (Division of upstream water service) and ASA II (Division of downstream water service).

The PJT operates 109 meteorological stations(including 26 telemetering stations) for meteorological observation, while 52 stations(including 21 telemetering stations) conduct water level and outflow observation.

(2) Sedimentation in the Existing Reservoirs

(a) Present Sediment Condition in the Reservoir

Gross and effective storage volume of the existing dams at the completion of the construction are shown below to compare with the respective volumes based on the latest survey of each dam.

(Unit: Million m^3)

Name of Reservoirs	HWL El.m	LWL El.m	Const. Year	Survey	Gross Storage			Effective Storage		
					Original	Survey	%	Original	Survey	%
Sengguruh	292.5	291.4	1988	1996	21.5	3.4	15	2.5	1.2	47
Sutami	272.5	246.0	1972	1997	343.0	*183.4*	53	253.0	*146.6*	*58*
Lahor	272.7	253.0	1977	1995	36.1	32.9	91	29.4	26.5	90
Wlingi	263.5	262.0	1976	1996	24.0	5.0	21	5.2	1.4	27
Lodoyo	136.0	130.5	1980	1996	5.8	2.4	41	4.2	2.4	56
Selorejo	622.0	598.0	1970	1993	62.3	48.8	78	50.1	44.5	89
Bening	108.6	96.4	1982	1993	32.9	31.7	96	28.4	28.0	99

Note *: Source: PJT. Figures in italic were calculated by the Study Team.

The above table shows a large reduction in the effective storage of the Sengguruh, Sutami, Wlingi and Lodoyo reservoirs.

Figure 3 show the change of longitudinal profile of the Sutami reservoir(the lowest elevation) along the Brantas river. The change of accumulated sediment volume calculated from the storage shown above is illustrated in Figure 4. The figure shows clearly that the completion of the Sengguruh dam in 1988 has reduced the additional sedimentation in the Sutami reservoir. Even though after the Sengguruh reservoir is almost full by accumulated sediment after 1993, the increase of sediment in the Sutami reservoir has been still insignificant.

(b) Estimate of Reservoir Storage Volume

Estimation of the effective storage capacity of the Sutami and Lahor reservoirs towards year 2020 is based on the change of sediment volume as follows:

Year	Sutami reservoir			Lahor reservoir		
	Gross Storage ($Mil.m^3$)	Effective Storage ($Mil.m^3$)	Storage between El.260m and H.W.L ($Mil.m^3$)	Gross Storage ($Mil.m^3$)	Effective Storage ($Mil.m^3$)	Storage between El.260m and H.W.L ($Mil.m^3$)
2000	180.72	144.76	94.18	31.99	25.75	20.33
2010	171.73	138.52	93.29	30.20	24.16	18.92
2020	162.74	132.28	92.40	28.41	22.57	17.51

(3) Flood Analysis

In order to review the design flood discharge distribution recommended in the previous master plan study (Widas flood control and drainage project), rainfall data for the recent 13 years; year 1984 through 1996 are additionally included in the present study while the previous study used the rainfall data for a period of 1960 through 1983.

The following table shows the probable three day rainfall by Gumbel method of the New Lengkong dam catchment, which is studied in the previous master plan study and the present study.

Return Period(Year)	Previous Study(1960~1983) (mm)	Present Study(1960~1996) (mm)
10	96	94
25	106	105
50	114	113
100	121	121

Estimated probable rainfall in the table show that the present value is almost the same as the previous study.

Recent big flood were observed in March 1984 and March 1992. The maximum discharge at Ploso station(downstream of Jatimlerek rubber dam) were 1,228 m^3/s and 1,078 m^3/s, respectively. The discharge of 1,228 m^3/s at Ploso station is less than 1,500 m^3/s of the present design flood discharge that is based on the flood runoff analysis of the previous master plan study. Therefore, the present design flood distribution is not changed and utilized in this study.

(4) Lowflow Analysis

(a) Natural Flow at the New Lengkong Dam

In order to examine low flow balance under various conditions of demand, reservoir capacity etc., a simulated runoff (called as "natural flow") is computed assuming no intakes nor supply from storage. The 10-day base natural flow at the New Lengkong dam from 1977 to 1996 is calculated based on the observed discharges at the New Lengkong dam . Since the inflow from the tributaries will not be expected in a drought season, the calculation of the natural flow is

limited to the main stream of the Brantas river. The schematic diagram of the concept of natural flow calculation is illustrated in Figure 5.

(b) Drought Year

To work out available discharge during a drought season in the Brantas river basin, total discharge in drought season is analyzed and the drought season is defined as the six months from June to November in the present Study. The total natural flow at the New Lengkong dam during the drought season is compared for the late 20 years.

The year 1977 that is the second droughtiest year in the late 20 years is adopted as a 10-year drought year. The natural flow during a drought season is about 819 million m^3 in 1977 and 741 million m^3 in 1982 which is the most severe drought year among the 20 years.

IV.2 Watershed Conservation, Sabo and Flood Control

IV.2.1 Present Conditions and Problems

Based on the surveys and plans by East Java Province and Perum Perhutani, land use in the whole basin in 1990 was estimated at farm land: 55%, forest: 26%, homestead area: 14% and others: 5%, respectively. On the other hand, in 2008, farm land will be decreased and forest and homestead areas will be increased comparing with those in 1990. In order to manage the watershed surely, it is required to observe land use continuously.

Critical land of erosion is widely distributed in the basin. Potential critical land of erosion may be estimated around 3,300 km^2 in the basin based on the critical land map reported by Ministry of Forest in 1988. Especially devastation is remarkable in the upper basin from the Sengguruh dam and its sediment dicharge is estimated at 1.89 mm/km^2/year. To keep the storage capacities of the Sengguruh and Sutami reservoirs, it is urgently required to conduct the land concervation and sabo works in the upper basin from the Sengguruh dam.

To establish the watershed conservation plan in the Brantas river basin, it is important to clarify relations between geological feature, soil condition, vegetation, land use, sediment production and discharge, since it is not quantitatively analyzed yet. Therefore it is desirable to prepare investigating and studying those relations for the Brantas river basin.

Sediment yield in the Mt. Kelud basin mainly result from eruption of Mt. Kelud. As the result, Wlingi and Lodoyo reservoirs are damaged by sediment deposition coming from southern slopes of Mt. Kelud. In order to settle this problem, sabo works have been being constructed by PGKS based on the master plan formulated in 1970. The progress of the sabo works is only about 50 % by the storage capacity of the master plan. Since it is forecasted that Mt. Kelud erupt in 2005, it is necessary to grasp urgently the present conditions of deposited sediment amount in the basin, to prepare a detailed sediment control plan for the next eruption and to execute the continuous sabo works.

Flood control works have been being impremented according to the master plan fomulated in 1985 (refered to as the 1985 Master Plan). Remained works in the 1985 Master Plan are the

Widas flood control project and the construction of the Lodoyo diversion tunnel. The Widas flood control project has been implemented with a safety level of 10 years return period which responds to the first stage plan formulated in the 1985 Master Plan. The progress of the project is around 65% as of 1997.

According to the river survey results of the Brantas river, riverbed elevations have a tendency of degradation in the lower and middle stretches. It can be said that the amount of degradation corresponds to that of illegal sand mining volume estimated by the site survey. On the other hand, as sabo works have been executed in the upstream basin to cope the sediment disaster due to the eruption of Mt. Kelud and sediment supply to the river will be decreased, collapse of river facilities is predicted due to riverbed degradation. Therefore, it is recomendable to conduct the following activities:

- To continue investigation on riverbed fluctuation.
- To prohibit illegal sand mining.
- To persuade sand-miners to move from the river channel to the sand pockets.
- To study the measures to let the deposited sediment flow out from the sand pockets safely, in consideration of the riverbed variation in the lower and middle stretches and sediment discharge from the upstream stretches and tributaries in balance.
- To repair and strengthen sand-pocket and mined sand transportation facilities (road and railway).

IV.2.2 Proposed Projects and Their Outlines

(1) Watershed Conservation

(a) Reforestation and Terracing

The reforestation of 170 km^2 and construction of terracing of 3,070 km^2 are proposed in the erosive areas in order to mitigate soil erosion, decrease runoff and improve environment condition in the mountain areas. Target year of this watershed conservation will be set on the year of 2020. BRLKT would implement these projects.

(b) Experimental Research

It is recommended to set up experimental research basin in the river basins of Konto, Lesti and Ngrowo for the purpose of investigating land use, runoff and sediment yield for the river management in the future. Neighboring basic basin and erosive basin (about 1 km^2) will be selected and relationship of rainfall amount, runoff-rate and sediment yield is clarified. Then reforestation will be stepwise carried out in the erosive site and effect of reforestation be investigated in comparison with those of basic basin. PJT would implement these projects, in cooperation with Sub-BRLKT.

(2) Sabo

(a) Mt. Kelud Basin

Sabo works are proposed for next eruption predicted in year 2005. The proposed volume to be controlled is estimated under an assumption of 1990 eruption scale as follows:

(1)Total eruption volume	142 million m^3
(2)Volume fly off basin	37 million m^3
(3)Volume to be transported into river channels	46 million m^3
(4)Volume to be transported into river for three years after eruption (short-term volume)	7 million m^3
(5)Long-term volume to be controlled: (5)=(1)-(2)-(3)-(4)	52 million m^3

The above (4) short-term volume =7 million m^3 will be controlled by an urgent works after eruption.

(b) Upper Brantas Basin and Lesti River

In order to mitigate sediment transported to reservoirs of the Sengguruh and Sutami dams, 17 sabo dams are proposed to construct in the upper basin from the Sengguruh dam. Total control volume is 15.1million m^3.

(3) Flood Control

Since no remarkable change is observed in the Widas river basin, it is recommended to carry out continuously the ongoing and remained flood control works in accordance with the scheme developed by the 1985 Master Plan.

The Lodoyo diversion tunnel project is indispensable one in the viewpoint of the existing river channel improvement in the 1985 Master Plan and disaster prevention measures of Mt. Kelud. It is recommended to commence this project after finishing of the Widas project.

As a part of flood control project, non-structural measures are requisite. In this study, it is recommended to prepare hazard map and to announce the hazard map to people. For reference, the Study team selects the Porong River as a model and the hazard map along the Porong river is prepared for 50 year probable flood as shown in Figure 6.

IV.2.3 Required Cost and Benefit

Required cost consists of construction cost including administration cost, engineering services cost, contingency, O/M cost, and land compensation. It is noted that cost of experimental research basin includes those of land condition analysis by the LANDSAT.

(1) Watershed Conservation

Construction cost

- Reforestation and terracing: Rp.162,294 million (implemented by Sub-BRLKT and Perum

Perhutani)
- Experimental research: Rp.6,984 million (implemented by PJT in cooperation with Sub-BRLKT)

Benefit
- Benefit is counted as decrease of cost of riverbed excavation owing to decreased sediment volume by watershed conservation measures. Benefit by watershed conservation is calculated at Rp. 1,643million per year.

(2) Sabo Works

Construction Cost (implemented by PGKS, later by New PJT)
- Mt. Kelud basin: Rp.470,373million
- Lesti and upper brantas basin: Rp.133,235 million

Benefit
- Mt.Kelud Basin: Benefit is estimated at Rp.29,539 million per annum as decrease of channel excavation for the design sediment volume to be controlled (52 million m^3). Lesti and upper Brantas river: Benefit is considered to be reduction of dredging cost owing to decrease of sediment inflow into the reservoir of the Sengguruh dam. The benefit is Rp.10, 600 million per year under an assumption that the total control volume of 17 dams is filled in 22 years.

(3) Flood Control Works

Construction Cost (implemented by PKB, later by New PJT)
- Widas river : Rp.135,761 million
- Brantas and Lodoyo diversion tunnel: Rp.421,988 million

Benefit
- Economic internal rate of return was estimated at 15.0% in the 1985 Master Plan.

IV.2.4 Action Program

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of status to Persero in 2005, the following activities will be required.

1999 – 2001

(a) Preparation for land use map which is drawn in detail erosion area and forestry zone, for the purpose of the watershed conservation.
(b) Preparation for sediment control master plan based on the detailed investigation on the debris run-off from the Mt. Kelud basin.
(c) Review of master plan on watershed conservation based on the recent basin conditions.
(d) Preparation of implementation program for watershed conservation plan and recommendation on its execution to administrator.

(e) Investigation on present condition of sabo facilities.
(f) Preparation on quality improvement and transportation measures for product made from deposit materials in sand-pocket.
(g) Preparation for the ledgers of the rivers.
(h) Survey and setting out the boundary sticks of retarding basin which was recommended in the 1985 master plan.

2002 – 2004

(a) Preparation of flood control manual by mutual consent with related agencies.
(b) Preparation and announcement of hazard map in the whole basin.

1999 – 2004 (continuous Investigation)

(a) Investigation on actual conditions of illegal sand mining on riverbed.
(b) Investigation on actual conditions of flood damage.

IV.3 Water Quality

IV.3.1 Water Quality Monitoring System

As of 1997, three agencies including PJT, PROKASIH and Kanwil PU monitor water quality at total 92 points in the whole Brantas river basin. In addition, PJT and PROKASIH monitor the waste water of 41 and 58 industries respectively. In the case of monitoring by PJT, sample taking and analysis is made by laboratory staff. Annual monitoring costs are Rp.75 millions for sampling and test, and Rp.78 millions for personnel expenses, data examination and reporting.

IV.3.2 Present Conditions of Water Quality

During the dry season, the lower flow discharge combined with pollution loads causes deterioration of water quality so much that BOD ranges from 5 to 12 mg/l. While during the rainy season especially at the beginning, river water contains a lot of silt. The Surabaya river is one of the most contaminated rivers in the Brantas river basin by organic pollutant. The BOD values are always as high as 10 to 20 mg/l. The second worst stream is the upper reaches near Malang city. The BOD there is monitored at 8 to 15 mg/l.

IV.3.3 Existing Pollution Sources

As of 1994, total pollution load of BOD produced by inhabitants within the Brantas river basin was estimated at about 380 t/d and that from the industries being monitored by PJT and PROKASIH (62 factories) was estimated at about 2,000 t/d. In addition to the above, pollutants from the irrigated areas, livestock, organic garbage or solid wastes and natural sources affects the river water quality.

IV.3.4 Domestic and Industrial Waste Water Control and Treatment Systems

(1) Present System

There is no centralized treatment facility for domestic waste water in the Brantas river basin. Leaching pits and/or septic tanks are common for "black water". However, no treatment facility exists for "gray water".

The East Java province has published the regional industrial effluent standards indicating the volume, concentration and pollution load for categorized industries. A waste water audit of industries discharging high pollution loads is implemented by the Work Team for Controlling and Overcoming Industrial Waste Pollution (PPPLI).

All the priority industries selected by PPPLI have their own waste water treatment plants. Most of the other industries, however, do not have efficient waste water treatment plant. The off-site waste water treatment facilities for industries are installed in an industrial district in Surabaya. Those for small scale factories are installed in Sidoarjo and Malang.

(2) Plan

For domestic sewage, a centralized waste water treatment system has been proposed around the Mas river and the Wonokromo river. For industrial waste, a centralized treatment plant has been proposed along the Mastrip road. A pollution charge system has been proposed by PJT and related agencies.

IV.3.5 Water Quality in 2020 During the Dry Season

(1) Method of Water Quality Calculation

The dry season accounting for 6 months from June to November is given priority for the study. Ten control points for water quality are selected from the densely populated areas and intakes of PDAM water supply treatment plants. BOD is used as a typical parameter of organic pollution in the rivers in this study.

(2) Water Quality With Projects

(a) Calculation cases

In order to set the level of treatment of domestic and industrial waste water in 2020, three cases are assumed: 1) the currently scheduled program by the Government 2) Case 1 added by a treatment project and 3) the new methodology proposed by the Study Team as shown below.

- Case I: Present scheduled progress
- Case II : Case I and centralized waste water treatment along the Surabaya river
- Case III : New methodology proposed by the Study Team

(b) Results of calculation

The river water quality at each control point in 2020 assuming 10-year-drought (allowing for 8.02m^3/l from the Wonorejo Dam project) is projected in terms of BOD value as summarized below.

- Case I : 2 - 17 mg/l
- Case II : 2 - 14 mg/l
- Case III : 2 - 13 mg/l

IV.3.6 Water Quality During the Rainy Season

The correlation between SS and other parameters (BOD, T-P) during the rainy season are computed at 0.5-0.6 of correlation coefficients. That is to say, SS would contain organic components. Another possibility is the existence of insoluble organic pollutants such as solid waste and/or sludge disposed or dumped in and around the rivers. In particular, the correlation between SS and T-P indicates that SS could contain agricultural chemicals and/or livestock excreta. Therefore, non-point sources including agricultural activities are considered to play an important role on the water quality during the rainy season.

IV.3.7 Water Quality Improvement Plan

(1) Basic Principles for Formulating of Water Quality Improvement Plan

The target level of river water quality in 2020 is set up at less than 6 mg/l of BOD, considering the water quality standards of the East Java province and existing objectives. It is recommended that present objectives should be upgraded in the stretches being classified as C.

The plan is formulated based on the water quality during the dry season in principle. Considering the possibility of implementation of countermeasures in Indonesia, Case III is adopted for formulating water quality improvement plan from among the cases calculated in III.3.5.4 of Volume II, Main Report.

(2) Water Quality Monitoring

To make data more reliable and useful for management decisions, addition of monitoring points, items and frequency are necessary. As for facilities, an expansion of existing laboratories and the construction of a new laboratory in the upper stream area in Malang is recommended for proper timing of monitoring. For continuous monitoring, it is necessary to maintain the measuring instruments in good condition. Costs for the recommended monitoring are estimated at Rp. 550 million per year.

(3) Domestic Pollution Control

A centralized waste water treatment system, on-site treatment system (combined type private

sewage treatment system) and sanitation facilities are considered to be appropriate for treatment of domestic waste water. Required investment costs for the waste water treatment systems including sanitation facilities are estimated at Rp.1,050 million in total.

(4) Industrial Waste Water Control

Considering the magnitude of impacts by "major producers", these industries should meet the effluent standards. Pollution load reduction ratio of other industries is 20%. Industries in hot zone and industrial estates will be connected with the centralized treatment system.

The costs are estimated indicatively assuming full development of the facilities of each site for the maximum number of industries to be treated. The estimated investment requires (constant values as of 1990) is Rp.2,280,000 million in total.

(5) Agricultural Pollution and Other Pollution Controls

The waste water from livestock houses should be treated before all other agricultural pollution sources. Pollution loads from agricultural chemicals which would be mainly brought by soil erosion should be considered. In addition, solid waste and sludge controls are necessary. The pollution control for natural source will be implemented as watershed management.

(6) Direct Purification

The optimum allocation of water for river maintenance flow is one element of water quality improvement activities. Necessary river maintenance flow to reach the river water quality target is 0.1 - 24 m^3/s at control points.

In addition, accumulated sediments, domestic waste and sludge in ditches should be cleared in order to minimize wash-out pollution loads. There are other ways to purify water in the streams such as a biological purification reactions, which deserve full consideration for the research and development.

(7) Supporting Activities

To carry out the water quality improvement plan, the strengthening of the institutions concerned and the promotion of the human resource development and public participation are recommended.

IV.3.8 Management Organization

It is recommended for PJT to have a responsibility for the water quality management as a water supplier. The PJT should have a leadership of the water quality management and a line management responsibility will be required. On the other hand, PJT can delegate its tasks to other agencies for implementation of the projects. Taking into consideration the functions of BAPEDALDA, execution of pollution control shall be done under the instructions and/or coordination of BAPEDALDA.

IV.3.9 Requirements to PJT

An independent department for Water Quality Management is necessary for PJT in which a planning and coordination section, a water quality monitoring section, a research and development section and a laboratory are to be included. For the Department, environmental planners, water quality engineers, computer technicians will be required. And an additional preparation of a new work office and related facilities will be necessary. Necessary investment cost for establishment of the Department in PJT are estimated at Rp. 4,500 million.

IV.3.10 Project Implementation Program

(1) Implementation Schedule

The countermeasures shall be focused on pollution sources which can be specified at first. In addition, in order to put priority for implementation on the proposed countermeasures, institutional and/or legislative necessity shall be taken into consideration. The countermeasures are divided into four groups, urgent, high priority, medium priority and low priory.

(2) Responsible Organizations

The implementation of the water quality improvement activities is proposed to be managed and administered by PJT with the cooperation of BAPEDALDA.

IV.3.11 Action Plan

The proposed water quality improvement plan in the previous sections is a desirable picture in 2020. The picture of an improvement plan in 2004 is shown below.

- Establishment of continuous water quality management system
- Strengthening of legislation and institutions
- Preparation of waste water treatment map
- Implementation of a model project of Gappei Johkaso
- Implementation of M/P and F/S

IV.3.12 Recommendations

The following items are recommended for water quality management of the Brantas river basin.

- Utilization of a Pollution Charge System
- Improvement of Kampung
- Cleaner Production
- Research and development of appropriate technology in Indonesia
- Industrial audit (on-site industrial pollution inspection system)
- Environment impact assessment
- Utilization of ISO 14000

IV.4 Water Demand Forecast

A water demand projection is made for irrigation, brackish water fishery, domestic use, industrial demand and river maintenance flow towards the target year 2020. Projection of water demand is based on the present water supply condition, socio-economic development forecast and several assumptions. Water demand forecasted in the Study is only for water taken from the main Brantas river.

Irrigation water demand in 1996 is about 88 % of the total water demand in the Brantas river basin, while it would be only 38 % in 2020 even though it will still be the most major user in the basin. The second largest user in the basin in 2020 will be domestic water supply, which will be about 25 % of the total demand.

IV.4.1 Condition of Demand Forecast

(1) Irrigation Water Demand and Supply System

(a) The objective irrigation area of the Study is figured out at 83,281 ha . It is presumed that the annual reduction rate of irrigation area is some 0.38% from 1996 to 2020.

(b) It is assumed that the future cropping patterns will principally follow the present prevailing patterns.

(c) It is assumed that some 30% of the irrigation water requirements will come back to the Brantas river.

(d) Water demand without any saving measure and that considering water saving by canal concrete lining has been figured out in the irrigation sector.

(2) Brackish Water Fishery

(a) Fishery water demand is assumed to be supplied by the return flow from the Delta Brantas irrigation area. In case no sufficient return flow from the Delta Brantas irrigation area, individual water demand is considered for the fishery.

(b) Provincial land use data shows reduction of the fishpond area from 15,700 to 11,500 ha. in 2020. Fishery demand is based on the assumption of 50 % each for the intensive and extensive fishponds.

(3) Domestic Water Demand

(a) Domestic water demand is projected for urban and rural areas of each regency and municipality based on the following assumptions:

Item	Area	1996	2020
Population (x 1,000)	Urban	6,545	9,312
	Rural	7,263	8,385
PDAM pipe water service (%)	Urban	25	100
	Rural	0	0
Water consumption per capita (lcd)	Urban	70 - 224	120-250
	Rural	50-60	60
Un-accounted-for water (%)	Urban	19 - 54	20
	Rural	0	0

(b) The domestic water demand for 2020 in the whole Brantas river basin area is projected.

(c) Present supply capacity of other sources than the Brantas main river including other tributaries and ground water is assumed to be maintained. Increment of water demand shall be covered by the surface water of the Brantas main river only.

(4) Industrial Water Demand

(a) The industrial water demand is projected for three types of industries : sugar, paper and others.

(b) Present supply capacity of other sources than the Brantas main river including other tributaries and ground water is assumed to be maintained. Increment of water demand shall be covered by the surface water of the Brantas main river only.

(c) Water demand without any saving measure and that considering water saving by water recycling have been figured out in the industrial water demand.

(d) Present industrial water demand in the Brantas river basin including other water sources, the rate of change in production, the rate of change in water use amount, etc. which are used for projection are as follows:

Item	Unit	Sugar	Paper	Other	Total
Water demand in 1996	million m^3/year	117	49	49	215
Rate of change in production	%/year	0.0	6.3	8.3	8.3
Elasticity	-	0.55	0.51	0.90	0.53
Rate of change in water use amount	%/year	0.0	3.2	7.5	4.4
Gross water demand in 2020	million m^3/year	117	104	278	499
Rate of recycling	%	45	43	52	48
Net water demand in 2020	million m^3/year	64	59	133	257

(5) River Maintenance Flow

(a) The river maintenance flow is defined as the minimum water flow which shall satisfy concurrently the compositions of water quality, recreation and ablution, aesthetics, preservation of biota and navigation for beneficial uses during the dry season

(b) River maintenance water demand is projected by 10 locations of monitoring points in the Brantas river, Surabaya river and Poring river. Out of 10 points, water quality at 9 points are critical and required maintenance flow has been determined in consideration of minimum required flow at respective critical points. River maintenance flow of 20 m^3/s is required to meet with the minimum requirement of 24 m^3/s at Ngagel point incorporating water flow for other use.

IV.4.2 Water Demand Projection in 2020

The following summarizes water demand projections by sector which need surface water of the Brantas main river as water sources:

(unit : million m^3)

		Present		2020	
		Annual	(Drought Season)	Annual	(Drought Season)
Irrigation	(no saving)	1,943.2	1,035.1	1,409.3	683.5
	(saving)	-	-	1,286.1	624.0
Fishery		40.8	20.4	268.7	134.3
Domestic/Business& Social		108.0	54.0	930.0	465.0
Industry	(no saving)	104.0	78.8	388.0	233.8
	(saving)	-	-	146.0	89.3
Maintenance Flow		-	-	632.5	316.2
Total Demand	(no saving)	2,196.0	1,188.3	3,628.5	1,832.8
	(saving)	-	-	3,263.3	1,628.8
Net Requirement	(no saving)	1,768.5	964.2	2,731.1	1,354.8
	(saving)	-	-	2,589.6	1,281.3

Note : Total above shows an accumulation of the respective demands.

IV.5 Water Balance

IV.5.1 Basic Condition of Water Balance Study

(a) Available river flow

Natural flow estimated by applying 1977 discharge at New Lengkong dam is assumed to be non-regulated and available river discharge. No inflow is assumed to be available from the tributaries during drought season.

(b) Water balance system

The water balance study is made incorporating various water intakes and return flows as shown in Figure 7.

(c) Return flow of irrigation ,domestic and industrial waters

(i) Return flow from each irrigation area is assumed to be 30 % of demand. Return flow from the domestic and industrial water uses in the urban area is assumed to be 80 %.

(ii) As shown in Figure 7, return flows from several irrigation and domestic demand areas would not come back to the main Brantas river course.

IV.5.2 Water Balance Analysis

(1) Water Demand

Water balance analysis studied in the Study are the combination of the following demands against natural flow for various years as follows:

(a) Demand in present condition(1996) and in 2020. Demand in 2010 was preliminarily worked out and used for analysis.

(b) Demand without or with water saving measures in irrigation and industrial water uses.

(2) Water Balance of Demand and Natural Flow

The following table shows expected water deficit of water resources covered by the natural flow for the 12 years against the water demand in 2020.

		1982	1977	1987	1980	1994	1991	1988	1996	1979	1995	1981	1978
Drought Probability		1/20	2/20	3/20	4/20	5/20	6/20	8/20	10/20	12/20	15/20	19/20	20/20
Natural Flow in Drought Season (million m3)		741	819	891	992	1,034	1,054	1,382	1,598	1,737	2,008	2,317	3,928
Deficit in Drought Season (million m3)	No Saving	609	624	532	563	328	341	333	168	215	176	114	0
	With Saving	536	565	467	497	263	273	280	121	178	144	91	0
Nos. of Days to Suffer Water Deficit	No Saving	210 (30)	160 (10)	170 (10)	170 (10)	170 (10)	170	140	120	110	80	60	0
	With Saving	200 (20)	160 (10)	170 (10)	170 (10)	160 (10)	150	120	110	80	80	50	0

Note : A figure in a parenthesis shows a number of days to suffer water deficit in May or December.

It is observed in the above that the year 1977 suffered the severest drought condition in terms of total water deficit in the 6 month of drought season, though 1977 has been defined as 10 year drought year(2nd in 20 years) since it was defined in terms of the natural flow quantity in the same period.

In case of severe ranking 5 years, water deficit were caused even in May or December. While, the most of years except 4 years including 1980, 1982, 1987 and 1991 have scarce water deficit in June.

No deficit is observed at all by natural flow in 1978 throughout a year which is the most ample rainy year among the examined 20 years.

(3) Water Balance Incorporating Water Resources Development

Further to the analysis mentioned above, the water supply capacities including the existing Sutami/Lahor dam, Wonorejo dam under construction, Beng and the other dams to be available in the Brantas river basin in a drought season as well as water saving measures are taken into

consideration in the water balance analysis.

Result of water balance analyses for the respective 12 years are summarized in Table 2.

Main results obtained through the water balance analysis are as follows:

(a) Present

(i) Every 2 years, a water deficit would be expected in case 20 m^3/s of river maintenance flow is considered. While water deficit would be expected every 5 years in case of no maintenance flow considered

(ii) As long as the present situation is concerned, the storage capacity of the Sutami and Lahor dams over 260.0 in water level seems to be almost sufficient enough for normal years except for some drought years which might be encountered once every 5 years(maintenance flow not considered).

(b) Year 2010 (20 m^3/s of river maintenance flow incorporated)

(i) Development of two more dams will be necessary by 2010 if no water saving measures are taken up to cover drought condition which might be foreseen every 5 years.

(ii) Only one dam is necessary for construction in case both water saving measures in irrigation and industry sectors would be realized and storage until El.246.0 m would be used in the Sutami dam.

(c) Year 2020 (20 m^3/s of river maintenance flow incorporated)

(i) Construction of 3 dams as well as water saving measures should be necessary for 2020 to cope with a 10 year drought condition.

(ii) By 2 dam constructions and realization of water saving measures, no water deficit might be expected at all for other drought cases.

IV.6 Water Resources Development

The Study of water resources development in terms of water supply in the Brantas river basin, especially for Surabaya and its vicinity area toward year 2020, aims to select some promising projects and recommend a project to be implemented after the Wonorejo Dam Project.

The present Study recommend the Beng dam project as the next one to the Wonorejo Dam Project and the Genteng I dam and the Kedungwarak dam projects to be implemented by the target year 2020.

The existing water resources development projects in the Brantas river basin are categorized into (i) Existing development plans in the Brantas river basin, (ii) Existing dam and reservoirs in Brantas river basin, and (iii) Existing development plans outside the Brantas river basin. The objective projects are only that the development plans formulated in the previous studies are followed in the Study and new project identification is not considered for water resources

development.

IV.6.1 Selection of Promising Projects

(1) First Screening

Main objective of the proposed projects shall be of domestic and industrial water supplies and then other development scheme including hydropower, irrigation, and flood control are not evaluated in the Study.

Out of projects identified and studied in the previous studies, Beng dam (pump up scheme from Brantas river), Kedungwarak dam(pump up scheme from Widas river), Babadan dam (interbasin water transfer scheme), Tugu dam and Genteng I dam projects have been selected for evaluation.

In view of the development objective and storage capacity of the existing dam and reservoirs, only Sutami and Lahor dam and reservoirs are studied further in view of water supply.

As water supply projects located outside the Brantas river basin, the Umbulan Bulk Water Supply Project and the Sembayat Barrage Project in the Lower Solo basin have been evaluated in the Study.

Figure 8 shows locations of the above projects.

(2) Second Screening

The 5 projects selected out of proposed ones in the Brantas river basin are estimated of its construction cost(including dam, pump-up facilities and water treatment facility), land compensation and resettlement costs, and operation and maintenance costs. The unit water cost is worked out on the basis of the aforementioned costs and applying a discount rate of 12% per annum. and price level as of June 1997.

No.	Project Name	Total Supply Capacity in mil. m^3	Total Const. Cost (Rp.mil.)	Land /Resettlement Cost (Rp.mil.)	Annual Operat'n Cost (Rp.mil.)	Unit Water Cost (Rp./ m^3)
(1)	Beng Dam(pump up)	147	399,948	132,000	48,905	889
(2)	Kedungwarak Dam(pump up)	54	180,209	62,900	21,541	1,091
(5)	Babadan Dam	84	580,593	19,120	26,980	1,403
(6)	Tugu Dam	21	213,766	16,240	10,795	2,177
(9)	Genteng I Dam	70	399,159	7,680	22,374	1,199

Out of five projects listed above, the following three projects are selected in view of its rather low unit water cost:

(i) Beng Dam

(ii) Genteng I Dam

(iii) Kedungwarak Dam

In addition to the economic aspect described in the following table, the Umbulan Bulk Water Supply project is assumed to be a committed project for implementation with commissioning expected by the year 2005.

The Sembayat Barrage Project seems to be rather expensive one for urban water supply due to long water conveyance pipeline. Furthermore in view of uncertainty of budget availability and construction schedule, its implementation will be considered in the program to be after the projects in the Brantas river basin.

Project Name	Total Supply Capacity (in mil. m^3)	Total Const. Cost (Rp.mil.)	Land /Resettlement Cost (Rp.mil.)	Annual Operat'n Cost (Rp.mil.)	Unit Water Cost (Rp./ m^3)
Umbulan Bulk Water Supply	60.7	270,500	3,380	13,615	907
Sembayat Barrage	108.8	589,739	85,058	48,051	1,387

The water resources development projects to be implemented towards the year 2020 are presented as follows;

Priority	Project	Status	Supply Capacity(mil. m^3)	Discharge(m^3/sec)
1.	Wonorejo Dam	Under const.	89.4	5.75
1.	Wonorejo Push-back Scheme	Under const.	35.3	2.27
2.	Umbulan Bulk Water Supply	Committed	60.7	4.27
3.	Beng Dam	Recommended	147.0	9.45
4.	Kedungwarak Dam	Proposed	54.0	3.5
4.	Genteng I Dam	Proposed	70.0	4.5
5.	Sembayat Barrage	Proposed	108.8	7.0
Total			587.5	36.74

IV.6.2 Recommended Implementation Program

The Study recommends the Beng dam project as next project to be developed to meet increasing water demand especially in Surabaya area. The Beng dam project is selected as the most prospective one in water supply aspect only. Other than the Beng dam project, the Genteng I dam and the Kedungwarak dam projects have been evaluated as prospective ones out of the existing project plans in the Brantas river basin.

(1) Measures Against Increasing Water Demand

Forecasted water demand in a drought season(June to November)is about 1,355 million m^3 in 2020. Annual natural flow in 1977 which is assumed as the 10 year drought year in the Study is worked out to be about 5,800 million m^3 as available discharge volume in a year. Natural flow during 6 months of drought season is about 820 million m^3, out of which 716 million m^3 would be available to cope with the forecasted water demand. Hence, about 639 million m^3 is

assumed as a water deficit for 6 months in a drought season.

In order to cope with such deficit, the following water storage dam and several projects are considered as countermeasures:

(a) Utilization of existing dams (Sutami and Lahor reservoirs)

(b) Wonorejo Multipurpose Dam Project and Umbulan Bulk Water Supply Project

(c) Proposed Development Projects including Beng dam, Genteng I dam and Kedungwarak dam

(d) Water saving measure for irrigation water demand

The Study has proposed water saving by concrete canal lining to decrease seepage loss in the main and secondary canals of the existing 11 irrigation systems 175,947 ha in total). It is expected that the gross total demand of irrigation water in drought season could be saved by about 59.5 million m^3 in 2020 demand basis and construction cost of Rp. 236,581 million.

(e) Water saving measure for industrial water demand

In terms of gross demand of industrial water in 2020, about 242 million(annual) m^3 and 144.5 million m^3 (semi-annual; June to November) are respectively assumed to be decreased by introducing water recycling process. Required cost for improvement of water use efficiency is supposed to be shouldered by respective factories.

Water demand in the drought season and supply measures including the existing, construction on-going, implementation committed and proposed are summarized as follows as well as water saving measures:

	Water Demand	Water Resources and Water Saving			
		Development Capacity (million m^3)	Capacity Accumulated (million m^3)	Construction Cost (Rp.million)	Unit Water Cost (Rp/ m^3)
Net Total Water Demand in Drought Season in 2020 (million m^3)	1,355				
Naturalized Flow in Drought Period (10-year drought year: Jun. - Nov. excld. excess)		716	716		
Existing Dams (estimated capacity as of 2020)					
Sutami/Lahor Dams(WL:272.5 - 260.0)		97	813		
Sutami/Lahor Dams(WL:260.0 - 246.0)		39	(852)		
Wonorejo Multipurpose Dam Project					
Wonorejo Dam		89.4	902 (941)		
Push-back Scheme		35.3	938 (977)		
Umbulan Bulk Water Supply(Committed)		60.7	998(1,037)		
Water Saving Measures(Net saving Demand)					
Irrigation(Canal Lining : proposed)		44.6	1,043(1,082)	236,581	922
Industry(Water Recycling : proposed)		28.9	1,072(1,111)	-	
Water Resources Development(proposed)					
Beng Dam(dam & pump-up)		147	1,219(1,258)	133,374	889
Genteng I Dam(dam)		70	1,289(1,328)	271,542	1,199
Kedungwarak Dam(dam & pump-up)		54	1,343(1,382)	80,952	1,091

Note : (1) Accumulated capacity shown in a parenthesis shows that including the reservoir storage capacity between El.260.0 m and El.246.0 m in the Sutami and Lahor dams.

(2) Construction costs above show those excluding water treatment plant.

(3) Unit water cost is estimated based on the total construction cost including that of water treatment plant, land acquisition and resettlement costs and operation and maintenance cost.

Development of the Beng dam project is firstly recommended to cover water deficit to be expected in the year 2020 in case of a 10 year drought year. However the Beng dam project is still insufficient for the 2020 demand and another water resources development would be required. Both Genteng I dam project and the Kedungwarak dam project should be considered, however priority of development will be subject to the further stage study. The Genteng I dam project is tentatively proposed as the second one in the Study to develop after the Beng dam project in consideration of hydropower development in the project and advantageous location of the dam which is upstream of the Sutami dam.

Water saving projects such as irrigation canal lining and industry water recycling need rather high cost for implementation, however their economic index in terms of the unit water cost is almost same as that of proposed water resources development in case of 10 years construction period.

Operation of the Sutami and Lahor dams is recommended to use storage capacity effectively until WL.246.0 m(Sutami) in case of severe drought condition. The storage between WL.260.0 m(present operating minimum waterlevel) and WL.246.0 m shall be effectively utilized in the

later period of the drought season.

(2) Project Implementation Program

The implementation program of the water resources development project consists of the following projects:

(a) Wonorejo dam project (under construction) to be completed as scheduled

(b) Umbulan bulk water supply project (construction committed) to be completed by 2005

(c) Beng dam project(proposed) to be completed in 2009

(d) Genteng I dam and Kedungwarak dam projects(proposed) to be implemented during 2010 to 2020, and

(e) Canal lining project of the existing major irrigation systems(proposed) of which construction is proposed for 10 years starting from the year 2001.

Required total costs for the implementation of the proposed projects is Rp.722.4 billion excluding those for water treatment facilities. Proposed implementation schedule is presented in Figure 14.

(3) Action Plan

The action plan for the period from 1999 to 2004 for the projects included in the implementation program consists of the following activities:

(a) Preliminary investigation and survey for the Beng dam project

- (i) Hydrological investigation in the project area : 1999 - 2005
- (ii) Investigation of the intake site in the Brantas river and water pump-up line between the intake and Beng dam sites : 1999
- (iii) Investigation of land use and resettlement requirement in the project area : 1999 - 2000

(b) Pre-feasibility and Feasibility studies

- (i) Arrangement of the technical assistance for the Pre-feasibility and Feasibility studies: 1999
- (ii) Pre-feasibility studies for the Beng dam, Genteng dam and Kedungwarak dam projects and Feasibility study for the Beng dam project : 2000 - 2001
- (iii) Selection of the consultants, Detailed design services and Procurement of the contractor(s) for the Beng dam project

IV.7 River Facilities

IV.7.1 Present Condition of River Facilities

(1) Existing River Facilities and Present Condition

Many kinds and numbers of river facilities exist in the river courses of the Brantas river basin.

These facilities have been relatively well operated and maintained through the efforts by the authorities concerned to keep the essential function. However, problems to be solved still remain. Among those problems, the sedimentation in the Sengguruh, Sutami, Wlingi and Lodoyo dams is recognized to be the most serious problem in the Brantas river basin.

(2) Organization for Operation, Maintenance and Rehabilitation (OMR)

Executing agencies responsible for OMR of the major river facilities are divided into five authorities, as mentioned below:

Agency	OMR Works
PKB:	Large scale rehabilitation works of facilities.
PGKS:	OMR work for the sabo facilities around Mt. Kelud.
PJT:	OMR works for most of river facilities.
PT PLN:	OMR works for power generating equipment.
DPU Pengairan:	OMR works for most of irrigation intake facilities and a part of municipal water intake facilities.

(3) Problems of Present OMR Works

Based on the studies on the present condition of the river facilities and the organization related to their OMR works, the following problems are identified and recommendations are presented.

Problem

(a) There is no authority to grasp the present condition of the OMR works for all of the river facilities in the basin. Therefore, there is no overall inventory for the river facilities in the basin.

(b) There is no responsible authority to plan and control the OMR works for all of the river facilities in the basin. Because, there are serious problems to be solved and there are no established measures for the dams/reservoirs, although those are the trunk facilities for water use in the basin.

(c) Repairs of the flood control facilities are delayed in comparison with the well-maintained water-use facilities. The cost of these activities would have to be borne by the Government. On the other hand, PJT did not get the national budget (APBN) for maintenance of the flood control facilities. A cause of delay is considered that the allocation of the OMR budget between the flood control and the water use is not definite.

IV.7.2 Improvement of Operational Function of the Existing River Facilities

As mentioned above, there are some problems to hinder the original function of river facilities. Out of them, problems due to sediment in the Sengguruh, Sutami, Wlingi and Lodoyo reservoirs are most serious in consideration of water use.

(1) Sedimentation in Sengguruh and Sutami Reservoirs

The original functions of the Sengguruh and Sutami dams and present storage capacities of two reservoirs are summarized as follows.

Name of Reservoir	Compl.	Survey	Effective storage (Mil.m3)			Original Function
			Original	Survey	Survey	
Sengguruh	1988	Jul.1996	2.5	1.2	48.0	Peak power generation
Sutami	1972	Oct.1997	253.0	*146.6*	*57.9*	Flood control, Peak power generation, Water supply for irrigation, domestic and industrial use.

Source: Perum Jasa Tirta. *Italic* figures are estimated by the Study Team.

In case of silting up of the Sengguruh reservoir, sediment discharge from the upstream basin will flow into the Sutami reservoir and be deposited therein. The Sutami dam is the only facility on the mainstream of the Brantas River, to enhance water in dry season and to control flood discharge in rainy season. Therefore, decrease of the storage capacity due to sediment in the Sutami reservoir becomes most serious problem of the water use in the Brantas river basin.

To control sediment inflow of 3.14 million m^3/year into the Sengguruh and Sutami reservoirs, construction of sabo dams is indispensable in the upstream basin and it is proposed to construct 17 sabo dams with total sediment storage capacity of 15.1 million m^3. Based on this condition, the following measures are proposed in this study.

(a) It is difficult to dispose the dredged material due to the vast volume. Therefore, large scale dredging works in the reservoirs will not be carried out.

(b) The Sengguruh dam will have limited hydroelectric power generation as the run-of-river type. To secure the hydroelectric power generation of the Sengguruh dam, maintenance dredging shall be carried out around the intake of the generator.

(c) Development of small dam shall be required, instead of increasing works of effective effective storage capacity of the Sutami reservoir.

Required cost consisting of dredging cost and administration cost from 1999 to the target year 2020 is estimated at Rp. 14.3 billion (Rp. 630 million/year). To implement proposed measures, it is urgently required to establish the new operation rule of the Sengguruh dam as the run-of-river type hydroelectric power generation facility by mutual consent with PT PLN.

(2) Sedimentation in Wlingi and Lodoyo Reservoirs

The Wlingi and Lodoyo dams are located at the southern skirts of Mt. Kelud in the upstream stretches of the Brantas River. The two dams were constructed for the purpose of efficient use of discharge from the Sutami dam. The original functions of the dams and present storage capacities of two reservoirs are summarized as follows:

Name of Reservoir	Compl.	Survey	Effective storage			Original Function
			Original	Survey	%	
Wlingi	1977	Nov.1996	5.2	1.4	27.1	Peak power generation, creation of water heads for irrigation, temporary storage of the erupted material of Mt. Kelud.
Lodoyo	1983	Nov.1996	4.2	1.9	45.5	Afterbay of the Wlingi and Sutami dam, Power generation

Source: PJT

Mt. Kelud, which is the main source of the sediment yield at the Wlingi and Lodoyo reservoirs, erupted in February 1990. After this eruption, the sediment filled up the Wlingi reservoir. As a solution measures, a sediment bypass channel from the Putih River to the downstream site of the Lodoyo dam is being constructed. And removal works of sediment deposits in the Wlingi reservoir were implemented through several stages of dredging and flushing.

To cope with the annual sediment discharge of 1.43 million m3 and to maintain the function of afterbay for the Sutami reservoir, the following measures are proposed in this study.

(a) The sediment bypass channel shall be extended to the Semut River within five (5) years, to reduce sediment inflow into the Wlingi reservoir.

(b) To restore the original function of the Wlingi dam, the effective storage capacity of the Wlingi reservoir shall be restored in 5 years and shall be maintained thereafter.

(c) The Lodoyo dam shall also function as the afterbay of the Sutami and Wlingi reservoirs. The effective storage capacity of the Lodoyo reservoir shall be restored in 5 years. After that, the effective capacity shall be maintained.

Required cost from 1999 to the target year 2020, including cost of physical contingencies, engineering services cost and administration cost, is estimated as follows:

Works	Required Cost (Billion Rp.)
Extension of Sediment Bypass Channel:	57.2
Dredging Works in Wlingi reservoir:	202.7
Dredging Works in Lodoyo reservoir:	199.0

Among proposed works, it is desirable to complete the extension works of the bypass channel and the restoration works of effective storage capacities in the reservoirs as soon as possible. Therefore, it is urgently required to make the detailed design of the bypass channel extension and dredging plan of the reservoirs.

IV.7.3 OMR Works After Consolidation of PKB, PGKS and PJT

(1) Demarcation on Management of River Facilities

After consolidation of PKB, PGKS and PJT, the consolidated body (hereinafter tentatively referred to New PJT) will be fully responsible for implementing water resources management in the Brantas river basin. However, cooperation of the other agencies will be essential for the water resources management.

It is recommendable that a part of the management of rivers and river facilities in the Brantas river basin be delegated to the other agencies, except a kind of important works. Criteria on demarcation are recommended as follows:

Works not to be delegated to the other agencies
New PJT shall be responsible for making and keeping of the ledgers of the rivers (ledger of river facilities and ledger of water right), for establishing of river basin master plan and for technical recommendation to the Minister of Public Works for approval of water right.

Rivers
River management shall be executed by dividing them into three stretches and delegating responsibilities for the management of their various subdivisions, except responsibilities described above. River management shall be implemented by New PJT, the provincial governor and the head of regencies.

River facilities
The river facilities shall be classified into two (2) categories, namely the managed facilities and the permitted facilities. Managed facilities mean the facilities directly operated and maintained by the river authority. Permitted facilities mean the facilities constructed and managed by the other authorities, parties or persons to achieve the own purposes, under permission of the river authority.

In accordance with the above criteria, 29 rivers out of 40 rivers presently managed by PJT and the sabo facilities presently managed by PGKS are proposed to be managed by the New PJT. Detailed demacation of river stretches and river facilities will be required to be established by muatual consent with related agencies.

(2) Annual OM cost

Annual OM cost for New PJT is studied by the Study team based on the PJT's estimate. Required OM cost without personnel expenses and indirect cost is estimated at Rp. 23.4 billion.

IV.7.4 Action Plan

In order to prepare establishment of New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of it's status from Perum to Persero in 2005, the followings will be required to the OMR of the river facilities:

1999 - 2001

(a) Making of the ledgers of the rivers (ledger of river facilities and ledger of water right) in the whole Brantas river basin: 1999-2001.
(b) Preparation of OM method and arrangement of manpower for OM of the Wonorejo dam: until 2000.
(c) Establishment of demarcation of the river stretches and river facilities among related agencies based on the ledgers of the rivers: 2000-2001.
(d) Establishment of standard for approval on the construction of river facilities by mutual consent with related agencies: 2000-2001.

2002 – 2004

(a) Stipulation of the operation rules for all river facilities in the Brantas river basin by mutual consent with related agencies, to avoid the conflicts and disputes on the water resources management: 2002-2003.
(b) Establishment of authorized method of the budget estimates for OMR activities: 2002-2003.
(c) Making of a consensus among beneficiaries about allocation of OMR cost: 2003-2004.

IV.8 Effective Operation of Water Resources

(1) Reservoir Facilities in the Basin and its Present Conditions

At present, dams for purpose of water supply and flood control in the Brantas river basin are the following four:

Dam Name	River	Catchment Area (km^2)	Completed Year	Effective storage V (Million m^3)	Function
Sutami	Mainstream	2,050.0	1972	253.0	F/C, W/S & P/G
Lahor	Lahor	160.0	1977	29.4	Auxiliary dam for Sutami dam
Selorejo	Konto	89.5	1970	50.1	F/C, W/S & P/G
Bening	Bening (Widas)	236.0	1982	28.4	W/S & P/G

Remarks, F/C: Flood Control, W/C: Water Supply, P/G: Power Generation

Out of them, the Sutami and Lahor dams are connected by tunnel channel and the both dams are functioning as one dam in the mainstream of the Brantas River. The Selorejo and Bening dams are located in the tributaries, so that the water supply ability is limited in the respective tributary basin.

The reservoir operation in the Brantas river basin is executing based on the reservoir operation patterns (POLA) dividing into the dry and rainy seasons. The patterns are determined by

Provincial Water Management Committee among the patterns prepared by PJT on the basis of water allocation forecast for wet season water, normal water and low-water.

(2) Reallocation of Water

At present, the water supply from the Sutami and Lahor dams has been executed to satisfy the water allocation determined by POLA. As the results, the following matters are recognized.

(a) In case of that the basin's run-off flow in the downstream stretch from dam is more than the forecast run-off discharge at the time of preparation of POLA, much water is actually taken at the downstream intake.

(b) In reverse case of the above which is less basin's run-off inflow, shortage of water at the downstream intake is covered owing to water reserved in the allowable range of change of reservoir water level.

(c) Accordingly, the intake water at the downstream intake is always excessive than run-off flow from the upper basin. That is different from the water allocation determined by POLA.

It is efficient to distribute the excessive intake water at the downstream side to the other intakes with potentially cultivated area in the upstream basin. At present, PJT is able to grasp the low-water flow utilizing FFWS, and the major irrigation water in the mainstream of the Brantas River is taken by the weir with gate facilities. Considering the above, it is possible to execute the most suitable water allocation at present. The water demand will be increased in future, and proper water allocation is indispensable. Therefore, it is recommended the water reallocation.

(3) Operation of Sutami Dam

The existing water supply of the Sutami dam, in principal, has been executed on the basis of POLA determined by water allocation utilizing reservoir volume from reservoir water level EL.272.0m to EL.260.0m. That is, reservoir volume from EL.260.0m to EL.246.0m (LWL) is not used for extra room except an example which the said volume was used in the low-water year in the past. According to the record from 1977 to 1996, the lowest water level in the reservoir was EL.247.81m in November 1977.

With regard to operation rule of the Sutami dam, essentially, it is desired to set up to the range of LWL. However, at the present time, since the proper forecast of reservoir inflow is not established yet, it is worry to empty the reservoir volume for water supply in the case of POLA to use the reservoir volume up to LWL.

Based on the above circumstances, it is recommended to prepare the water allocation and reservoir operation pattern applying the same method of POLA preparation assuming that reservoir volume from HWL to LWL is used on the basis of 1977 year flow data which is low-water with 10-year return period. In the practical operation, this water allocation and reservoir operation pattern will be used as a reference, in order to judge the condition of drought quickly, to make the measures for drought precisely and to use the reservoir storage effectively.

The above proposal is tentative proposal until establishment of proper inflow forecast. Therefore it is desired to prepare operation rule which is used the reservoir volume up to LWL based on proper inflow forecast.

(4) Integrated Operation of Sutami and Wonorejo Dams

At present, the Wonorejo dam in the Ngrowo river basin is under construction. According to the plan, totally 31.5 million m^3 of municipal and industrial water will be supplied to Surabaya from the Wonorejo dam (completion in the year 2000) and the Tulungagung pump station (completion in the year 2003). In this study, from the view of the integrated operation of reservoir on the both dams of Wonorejo and Sutami, simple simulation study is carried out. And the following matters can be considered and recommended.

(a) As drought condition becomes serious, it is not recommended to give the priority to the water supply from the Sutami dam. In case of empty storage of the Sutami reservoir, deficit of water will not be supplied from the Wonorejo dam sufficiently, because the maximum water supply from the Wonorejo dam is limited to 15.0 m^3/s by the Tiudan diversion canal.

(b) Considering benefit of power supply in the stretches from the Sutami dam to the confluence of the Ngrowo River, it is not recommended to give the priority to the water supply from the Wonorejo dam.

(c) Based on the above, therefore, it is recommended to give the priority to the water supply from the Sutami dam in the ordinary drought condition and to allocate the water supply to both dams on the basis of the storage capacities, during the decision of POLA and on the way of actual operation.

(d) The low flow forecasting is the basic matter of the integrated operation of the reservoirs, therefore, it is desirable to study and formulate the low flow forecasting method.

(5) Action Plan

In order to prepare establishment of New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of it's status from Perum to Persero in 2005, the followings will be required for the effective use of the water resources:

<u>1999 - 2001</u>

(a) Set up of tentative rule for water allocation and reservoir operation of the Wonorejo dam by mutual consent with related agencies.

(b) Establishment of proper water allocation rule including water reallocation during operation by mutual consent with related agencies, and monitoring of reallocation of water.

(c) Set up of the study for POLA to prepare the water allocation and operation pattern for the low-water pattern with 10-year return period as a reference of the practical operation.

2002 – 2004

(a) Set up of tentative rule for water allocation and operation of the Wonorejo dam system including the Tulungagung pump station by mutual consent with related agencies.
(b) Establishment of the proper low flow forecast in the Brantas river basin including the Ngrowo river basin.
(c) Detailed study on the integrated operation method of the Wonorejo dam system and the Sutami dam.
(d) Establishment of the integrated operation rule of the Wonorejo dam system and the Sutami dam by mutual consent with related agencies.

IV.9 Monitoring and Information System

(1) Flood Forecasting and Warning System

The existing Flood Forecasting and Warning System (FFWS) consists of sub-systems for telemetering, analysis and communication. FFWS serves for flood control in the Brantas river basin. The observed data are rainfalls (26), water levels (river: 10, reservoir: 11) and outflows from dams and weirs (10) as shown in Figure-9. Most part of operation and maintenance of FFWS are carried out by PJT.

Problems of the existing FFWS and the proposed measures to the problems are as follows:

(a) Some water level gauges in the river do not function well in dry season under influence of sedimentation and river bed erosion. Shifting the stations are proposed as a major measure.

(b) Hourly outflow data of dam/weir are sent from each dam/weir office to Master Station by telemetering system, through operator's manual operation at each office. Some sent data of outflow are not fit for the actual condition because of delay of manual typing into terminal of telemetering system for automatic data collecting. To reduce the above manual operation's problem, supporting equipment are proposed for discharge calculation.

(c) Timely revise of the coefficient (H-V curves) in FFWS and verification of flood forecasting program are difficult. Technical problems are major reasons. To solve these problems, modification of FFWS to be able to change the H-V curves easily and establishment hydrological database system to be able to use the data effectively for verification of the program are proposed and other analysis.

(d) Staff for flood control operation do not have experience of the action based on flood forecasting by FFWS, because of no big flood since commencement of FFWS

operation. In this situation, a trial operation for flood control based on FFWS operation are proposed.

(2) Low Water Management System

Low water management is executed based on "POLA OPERASI WADUK-WADUK"(POLA, operation pattern of reservoirs) decided by the Provincial Water Management Committee (PWMC). At present, allocation of low flow is monitored by PJT based on daily report from the sites on telephone line and FFWS as auxiliary measure.

On the other side, expansion plan of FFWS has been proposed at Wonorejo Multipurpose Dam Construction Project. The plan aims to establish the telecommunication system for low water management using the FFWS, as well as to expand the function of FFWS incorporating with the new facilities to be constructed for the project. At the plan, observation station linking to FFWS will be expanded for monitoring river water level and intake dischaege.

The committee discuss and adjust the water allocation against the drought. The committee took respective measures against the each drought under discussions based on each drought conditions, because there are no standards for adjustment of water allocation against drought. In view of the situation above-mentioned, it is recommendable that clear standards on water allocation against drought are established and the committee gets the information on discharge of river and water volume in reservoir habitually so that the committee could take a proper and prompt action against the drought.

It is recommendable that the information monitored and managed by PJT shall be given to all the agencies concerned, for deep understanding about the present condition of reservoirs and rivers.

(3) Water Quality Data Management System

Water quality monitoring, which is carried out by manual sampling and testing at several agencies including PJT, is a part of pollution control activities. It is recommendable that pollution control activities are supervised by PJT, and the monitoring and the monitored data are managed by PJT too(refer to IV.3 Water Quality Management).

On the other side, automatic water quality monitoring stations are proposed to be installed by the Wonorejo project.

The above situations mean that water quality data and data user will increase. Accordingly, management of water quality data by PJT will become more important. To manage and use the water quality data efficiently, establishment of water quality database system are required.

(4) Establishment of Inter-agency Information System

This Study team proposes to reorganize the water resources management system. Proposed management system will be required to be operated through cooperation of all the agencies concerned.

At present, there are much useful information under many agencies concerned with the water resources management in the Brantas river basin. However, it seems that the information of one agency is not used effectively by the other agencies, due to the problems of information management in each agency and problems of information exchange between agencies.

In consideration of the above matters, the unified management of data and information will be essential for the water resources management in cooperation with agencies concerned. Therefore, it is required to establish the information management (exchange) system linking all the agencies concerned with water resources management(= Inter-agency Information System).

Establishment of Inter-agency Information System including the proposed functions for low water management and water quality data management is proposed as wide area network system using computer system in Brantas river basin (Figure 10).

(5) Cost Estimate

The costs are estimated about 938 million rupiah for improvement of FFWS, and about 5,729 million rupiah for Establishment of Inter-agency Information System including the information system for low water management and water quality database system. The cost are estimated including engineering service and administration costs. Operation and maintenance cost from 1999 to the target year 2020 are estimated 62,975 million rupiah for FFWS, and 30,968 million rupiah for Inter-agency Information System. The OM cost are estimated including replacement cost of electric and electronic facilities of each system.

(6) Action Plan

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of status from Perm to Persero in 2005, the following will be required to the best use of FFWS and the suitable Inter-agency Information System introduction and effective use of the system.

<u>1999-2001</u>

(a) Improvement of facilities to make the best use of FFWS and the information to be collect through it.

(b) Preparation for establishment of Inter-agency Information System in cooperation with agencies concerned under the guidance of the specialist.

- Decision of basic policy of Inter-agency Information System.
- Analysis and evaluation of present information management.
- Investigation, planning and designing of the optimum system.

<u>2002-2004</u>

(a) Introduction of Inter-agency Information System.

- Installation of equipment for the system and test of operation.
- Training of the system manager of New PJT and end users.

IV.10 River Environment

The sections have provided discussions of the present conditions of the environment with focus on the preservation of biodiversity.The biodiversity have specific importance and values. For example, the indigenous fish have economic, social and ecological values and they contribute in real terms to the consumption or production needs in E. Java. The river environment is important because of the potential for this area to become a major producer of fish, the first step for its success will be a clean river.

Similarly, for recreational uses the river and reservoirs must have a pollution free environment The PJT reservoirs in Selorejo, Sutami and Bening have eutrophic conditions in water which has a negative impact on its recreational uses. More needs to done by PJT to make the reservoirs generate higher revenues and environmental clean-up is on the top of that agenda. For the Brantas river itself, the upper area has tremendous potential for eco-tourism development. Further feasibility is proposed for this activity which will provide biodiversity conservation also. In the middle river area the recreational potential of the Kademangen area also should be further evaluated. This area also has the largest variety of fish. This is an area where fishing should be incorporated into recreational activities.

The conservation framework has been presented to improve the river environment and enhance its recreational potential. Attempt has been made to strike an optimal balance between conserving biodiversity and advancing human sustainable living. The conservation framework will help to integrate different methods and sectors involving components as varied as protected areas, technical measures in forestry, seed banks, aquaculture, botanical gardens, on-farm conservation areas, and settlements including Surabaya and Malang.

The sections incorporate the findings of the Biodiversity Survey which had been carried out with a sub-contract to the Fisheries Faculty of Brawijaya University. Thus the river environment has brought forward awareness of and attention to biodiversity issues as part of the comprehensive management of Brantas river. The objectives of the survey were: 1. to provide the team with data and analysis of all of Brantas riverís ecosystems, fauna and flora of the watershed and its inventory. 2. The survey has helped to consider biological categories as indicator of Brantas riverís environmental conditions. 3. To provide a complete inventory of all biodiversity for the study.

The biodiversity survey had to deal with the water pollution and waste disposal; the decrease of self purification capacity; and also the issue of ocean water intrusion. The specific fishery related problems had the issue of only 16 indigenous species; uncontrollable fish catchment; and eutrophication in the reservoirs. The macroinvertibrates are in danger due to sand mining activities. The plankton and periphyton communities indicate instability. The flora has to deal with forest loss; mangrove conversion to other land use.

The parameters for the Initial Environmental Examination and the methodology to be used including, the impact areas and problems and further for the upper, middle and the lower reaches are discussed and are presented here in summary:

Summary of Initial Environmental Examination

Impact Areas/Problems	Further Study
Brantas Watershed Management	Reconfirmation of Development Plans
Flood Control	Reconfirmation of Control Plan
Water Resources and Supply	Maximum Availability of Water
Water Quality	Emphasis on Malang and Surabaya
Conservation of Biodiversity	Upper, Middle and Delta
Recreation Development	Economic Feasibility

Lastly, the action plan in broad outline dealing with the quality and quantity is summarized below:

Pollution control and river biodiversity conservation have to be on a convergent path in the Brantas basin for a sustainable water resources management plan. The PROKASIH 2005 Vision reiterates this as ìthe problem of water supply in broad outline includes the problem of quality and quantityî. For the PJT management to succeed, ìone river, one plan, and one coordination managementî must become the road map.

The preservation of maximum extent of the natural state of the river will be a key future goal. The realistic target for the year 2020 will include the reclamation of the lost indigenous species (there were 87 species in 1962 only 10 out of total 50 have been present in 1997).

The indigenous species with an economic potential, for example the good tasting Pugnacious macronema (Wakal) and Ucheng, and Panchas panchas as an aquarium fish should be promoted.

The biodiversity survey has provided valuable data including 174 species of plant vegetation and 50 species of fish, efforts to harness their economic potential be included in any future plan.

The conservation framework above allows for a step by step plan to be developed and refined for specific Brantas basin requirements.

At PJT, river environment is now considered to be a key problem. An Environment Unit will be set up next year. Meanwhile, the PJT would need to show institutional capability to the newly constituted BAPEDALDA which is going to have the Vice-Chairmanís position in PROKASIH. These actions will go quite some distance in correcting the present status.

Land zoning should be applied to preserve the relatively pristine river areas like, Sumber Brantas, Junggo, and Kademangan.