5 OMR Works of River Facilities after Consolidation of PKB, PGKS and PJT

5.1 Demarcation on Management of River Facilities

After consolidation of PKB, PGKS and PJT, the consolidated body (hereinafter tentatively referred to New PJT) will be authorized as the authority of rivers in the Brantas river basin by the Ministry of Public Works and be fully responsible for implementing water resources management and water resources development in the Brantas river basin.

Since there are so many rivers and river facilities in the Brantas river basin, those may not be managed thoroughly by only agency, that is, New PJT. Therefore, it is recommendable that 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. Considering function of rivers and river facilities, criteria of the demarcation are recommended as follows.

Works not to be delegated to the other agencies

The following works should not be delegated from New PJT to the other agencies:

(a) Responsibility for making and keeping of the ledgers of the rivers (ledger of river facilities and ledger of water right).
(b) Responsibility for establishing of river basin master plan.
(c) Responsibility for technical recommendation to the Minister of Public Works for approval of water right.

Rivers

River management will be executed by dividing them into following three stretches and delegating responsibilities for the management of their various subdivisions, except responsibilities described above.

(a) River stretches directly managed by New PJT: Those consist of a specified stretch of the trunk channel and specified stretches of the tributaries. Those stretches have most important role to control river flooding, to ensure availability of river water for various uses and to conserve and create river environment.

(b) River stretches managed by provincial governor: Those are specified stretches of the tributaries adjoining to the stretches managed by the New PJT. Those river stretches basically have catchment area more than 2 km^2.

(c) Rivers stretches managed by the head of regencies: The other river stretches of above two will be managed by the head of regencies. Management of those stretches are closely related to the regional plan.

The river stretches managed by New PJT will include the rivers presently managed by PKB, PGKS and PJT and some parts of the rivers presently managed by the governor, considering the function of the rivers.

River facilities

River facilities are the structures having a function related with river protection, extension, utilization and control, such as dam/reservoir, weirs, dike, revetment, groundsill, retarding basin, bridge, water intake, drainage culvert, siphon, sabo dam, etc.

Those river facilities will be classified into two (2) categories, namely the managed facilities and the permitted facilities.

(a) Managed facilities mean the facilities directly operated, maintained and rehabilitated by the river authority. Those will include flood control and multi-functional facilities, facilities of which operation will closely related to the river management activities, i.e. dike, revetment, groundsill, dam, weir, retarding basin, drainage culvert, flood control siphon and sabo dam etc.

(b) 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. Those facilities will include the facilities for single purpose, i.e. irrigation weir, industrial water intake, municipal water intake, irrigation water intake, bridge, aqueduct, single purpose dam, etc. The owners of these facilities will be obligated to report condition of their facilities to the river authority timely. In addition, the owners must repair their facilities by their own cost, when the river authority request repair of their facilities to them, to maintain the function of rivers.

In accordance with the above criteria, the rivers and river facilities to be managed by the New PJT are proposed as presented in Figure A7-16. In addition to these rivers and facilities, the sabo facilities constructed and presently managed by PGKS are also proposed to be managed.

As described above, the rivers and major facilities to be managed by New PJT are proposed in this study. However, the stretches of the rivers to be managed by New PJT, the provincial governor and the heads of regencies are not proposed in this study, because of the limitation of field inspection period. Therefore, it will be required to establish the demarcation of river stretches among related agencies by mutual consent with related agencies.

5.2 Organization and Staffing

In order to perform the OMR works of the proposed rivers and facilities including sabo facilities surely, site operation units and assistance and monitoring units are required within New PJT.

Proposed organization of New PJT is described in the ANNEX 12 of the Supporting Report II. Within this organization, implementation units and required manpower directly to operate and maintain the rivers and facilities are estimated and summarized below:

Directorate/Division	Required Manpower (persons/year)
Directorate of Infrastructure/ Division of OM	
- Division of Up-Stream	102.0
- Division of Down-Stream	118.0
Directorate for Technical Affair:	
- Bureau of Research and Development:	3.0
- Bureau of Technical Planning:	9.5
- Bureau of design	14.5
Total	247.0

Note: Manpower for indirect works is not included.

Mobilization of the Division of OM in New PJT is presented in Table A7-14.

5.3 Annual OM Cost

To operate and maintain the rivers and facilities managed by PJT sufficiently, PJT estimated standard annual OM budget based on frequencies of OM works, unit prices of the works and accumulated experiences.

Annual OM cost for New PJT is studied by the Study team based on the PJT's estimate. Estimated cost without personnel expenses and indirect cost is presented in Table A7-15. Therefore, total OM cost is summarized below:

Unit: Million Rp./year

Item	Amount	Remarks
Direct OM cost:	23,335	
Personnel expenses:	2,470	10.0 Million Rp/person/year
Indirect cost:	5,161	(1 + 2) x 20%
Total:	30,966	

Considering the total investment cost up to 1977, required cost of the OM works will correspond to nearly one percent of the investment cost.

6 Action Plan

In order to prepare New PJT by consolidation of PKB, PGKS and PJT in 2002 and change of 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

Table A7-1 General Feature of Dam

Item		Wlingi Dam	Sutami Dam	Lahor Dam	Sengguruh Dam	Bening Dam	Selorejo Dam
(1) CONSTRUCTION (Completion)		1976	1972	1977	1988	1982	1970
(2) MANAGEMENT							
Dam and Reservoir		PJT	PJT	PJT	PJT	PJT	PJT
Generating equipmnt		PT. PLN	PT. PLN	PT. PLN	PT. PLN	PT. PLN	PT. PLN
(3) LOCTION							
River		Brantas river	Brantas river	Lahor river	Brantas river	Bening river (Widas river)	Konto river
Catchment area	(km2)	2890.0	2050.0	160.0	1659.0	89.5	236.0
(4) RESERVOIR							
Surface area	(km2)	3.8	15.0	2.6	-	5.7	4.0
Storage capacity (gross)	(mil.m3)	24.0	343.0	36.1	21.5	32.9	62.3
(eff.)	(mil.m3)	5.2	253.0	29.4	2.5	28.4	50.1
Flood HWL	(SHVP m)	163.5	277.5	275.7	293.1	109.3	622.6
Normal HWL	(SHVP m)	163.5	272.5	272.7	292.5	108.6	622.0 (620.0)*
LWL	(SHVP m)	162.0	246.0	253.0	291.4	96.4	598.0
Mean discharge	m3/s	109.1	65.2	12.0	55.2	2.6	10.1
Design flood	m3/s	2824.0	1600.0	400.0	2950.0	530.0	700.0
(5) DAM							
Type		Rockfill, w/ center core	Rockfill, w/ center core	Rockfill, w/ center core	Rockfill	Homogeneous earthfill	Zoned earthfill
Crest elevation	(SHVP m)	167.0	278.5	278.0	296.0	111.6	625.0
Height	(m)	28.0	100.0	75.4	33.0	35.6	49.0
Crest length	(m)	717.0	810.0	433.0	378.0	640.0	447.0
Embankment volume	(m3)	630.0	6160.0	1670.0	447.0	800.0	1300.0
(6) SPILLWAY							
Type		Gate w/ open chute	Open chute, gated and non-gated	Open chute	Gate w/ open chute	Open chute, gated and non-gated	
Crest elevation of weir	(SHVP m)	153.5	267.0 / 272.5	272.7	278.0	103.9 / 108.6	622.0
Width	(m)	42.4	10.0 / 50.0	35.0	36.5	26.0 /20.0	30.0
Rated dicharge	(m3/s)	2824.0	1600.0	400.0	2950.0	530.0 / 20.0	680.0
No. of gate	(nos)	4	1	-	2	3	3
Width of gates	(m)	10.6	10.0	-	14.0	7.0	10.0
Height of gates	(m)	10.0	5.8	-	14.9	5.4	2.0
(7) POWER HOUSE							
Installed capacity	(MW)	2 x 27.8	3 x 35.0	-	2 x 14.5	1 x 0.65	1 x 4.8
Rated discharge	(m3/s)	2 x 74.8	3 x 51.4	-	2 x 91.5	1 x 4.5	1 x 14.9
(8) PURPOSE		(original) Afterbay (revised) Peak power generation Temporary storage of erupted material from G. Kelud Creation of water head for Irrigation	Flood Control Water supply enhancement Peak power generation	Sutami and Lahor dams are functioning as one reservoir.	Peak power generation	Water enhancement (Irrigation) Power generation (during irrigation water release)	Flood Control Water supply (Irrigation) Power Generation

* Note : Figures in ( ) means a water level in the rainy season

Table A7-2 Outline of Operation Rule for Dam (1/2)

Name	Wlingi Dam	Sutami (Karangkates) Dam	Lahor Dam
River	Brantas River	Brantas River	Lahor River
Construction (Power facility)	1976 (1978, 1980)	1972 (1973, 1976)	1977 (-)
Operation by	PJT	PJT	PJT
Establishment of Rule (Revision)	1978 ?	1972 (Feb. 1978)	Feb. 1978 -
Purpose	(original) - Afterbay for Sutami power station (revised) - Peak power generation (27MW x 2 nos., 164,000MWh/year) - Temporary storage of erupted material from G. Kelud. - Creation of water head for Irrigation (Lodoyo-Tulungagung Irrigation Area through Lodagung Intake)	Sutami and Lahor dams are functioning as one reservoir by using a connection tunnel. - Flood Control Peak inflow = 2,180 cum/s Peak outflow = 740 cum/s (50-year probable flood) - Enhancement of dry season flow - Peak power generation (35MW x 3 nos., 488,900MWh/year)	- Sutami and Lahor dams are functioning as one reservoir by using a connection tunnel. - same as left
Basic Consideration	- First priority = Irrigation water supply. - Effective storage capacity = for daily operation. - Remained volume = Peak power generation (5 hours a day)	- Minimum discharge responsible for the downstream = 35 cum/s - Maximization of power benefit - (Peak operation more than 5 hours. Offpeak discharge more than 25 cum/s) - No artificial flood control	
Operation Rule	- FHWL = EL. 164.5 m - Flood operation : WL more than EL. 163.5 m - Normal operation : HWL = EL. 163.5 m LWL = EL. 162.0 m	- Flood HWL = EL. 278.5 m - Designed Water Level HWL = 272.5 m HWL = 246.0 m - Scheduled Water Level HWL = 272.0 m (end of rainy season) HWL = 260.0 m (end of dry season)	- Flood HWL = EL. 275.7 m - Designed Water Level HWL = 272.7 m HWL = 253.0 m - Scheduled Water Level HWL = 272.0 m (end of rainy season) HWL = 260.0 m (end of dry season)

Table A7-2 Outline of Operation Rule for Dam (2/2)

Name	Sengguruh Dam	Bening Dam	Selorejo Dam
River	Brantas River	Bening River (Widas River Basin)	Konto River
Construction (Power facility)	1988 (1989)	1982 (1984)	Oct. 1970 (1973)
Operation by	PJT	PJT	PJT
Establishment of Rule (Revision)	Mar. 1989 -	Feb. 1982 -	1969 (1970, 1973)
Purpose	- Peak power generation (14.5MW x 2 nos., 91,020MWh)	- Water supply for Widas irrigation area (8,600ha) - Power generation (0.65MWx 1 nos.)	- Flood control Peak inflow = 329 cum/s Peak outflow = 186 cum/s (50-year probable flood) - Water supply for irrigation area along Konto river (27,706 ha) - Power Generation (4.48MW x 1 no.. 23,310MWh/year) - Water supply for Simen & Mendalan power stations
Basic Consideration	- First priority = Peak power supply (mor than 5 hours a day) - Effective storage capacity = for daily operation. - No artificial flood control	- Exclusive operation for irrigation water supply - Power generation is allowed only during supply of irrigation water. - No artificial flood control	- First priority = irrigation water supply.
Operation Rule	- Flood HWL = EL. 293.1 m - Scheduled Water Level HWL = EL 292.5 m LWL = EL 291.4 m	- Flood HWL = EL.109.3 m - Scheduled Water Level HWL = EL. 108.6 m LWL = EL. 96.0 m	- Flood HWL = EL. 622.6 m - Flood operation WL>EL. 622.0 and Inflow >100 cum/s - Scheduled Water Level HWL= EL. 620.0 m (Jan.-Apr.) HWL= EL. 622.0 m (May -Jun.) HWL= EL. 622.0 m (Jul. -Dec.) - LWL = EL. 598 m

Table A7-3 Outline of Operation Rule for Weir (1/2)

Name	Bangil Tak Spillway Gate	New Lengkong Dam	Menturus Rubber Dam	Jatimlerek Rubber Dam
River	Brantas River	Brantas River	Brantas River	Brantas River
Construction (Rehabilitation)	- (1992)	1973 (-)	1993 (-)	1991 (under renovation)
Operation by	PJT	PJT	PJT	PKJ3
Establishment of Rule (Revision)	Not yet (-)	1973 (-)	Dec.1993 (-)	Mar. 1992 (-)
Purpose	- Flood control (Intake for a part of excess design flood to Bangil Tak canal)	- Water supply (Irrigation, Domestic, Industrial)	- Irrigation Water supply through Menturus Intake, but no water supply in case that discharge at New Lengkong dam is less than 36 cum/s)	- Irrigation Water supply through Jatimlerek Intake, but no water supply in case that discharge at New Lengkong dam is less than 36 cum/s)
Operation Rule	- Not yet Established.	- Flood HWL = +19.50 m - Normal impounding water level Rainy season : min= 17.73, max= 17.83 m Dry season : min= 17.83, max= 17.88 m HWL=17.90	- Flood HWL = +27.90 m - Normal impounding water level min= 25.20 m, max= 25.50 m HWL = 25.74 m	- Flood HWL = +35.49 m - Normal impounding water level min= 32.54 m, max= 32.79 m HWL = 32.98 m

Name	Mrican Barrage	Lodoyo Afterbay	Jagir Dam	Gunungsari Dam
River	Brantas River	Brantas River	Wonokromo Canal	Surabaya River
Construction (Rehabilitation)	1991 (-)	1983 (-)	1917 (1979)	1907 (1981)
Operation by	PJT	PJT, PT PLN (Power facilities)	PU Peng. (PJT, BTS)	PJT
Establishment of Rule (Revision)	Dec. 1990 (-)	Jan. 1980 (-)	- (Jul. 1980)	- (Jul. 1980)
Purpose	- Irrigation Water supply through Warujayeng intake and Turitunggorono intake.	- Afterbay for Wlingi power Station (to regulate the peak outflow from the Wlingi power station by use of storage capacity) - Power generation (4.5MW x 1no., 36,700 MWh/year)	- Water supply (Domestic, Industrial) - Navigation of Mas-Surabaya rivers	(Orignal) - Water supply (Irrigation) & Navigation (revised) - Water supply (Irrigation , Domestic and Industrial)
Operation Rule	- Flood HWL = +58.28 m - Normal impounding water level = +57.30 m	- Flood HWL = +136.0 m - Daily operation Rainy season : 135.5 - 130.5 m Dry season : 136.0 - 130.5 m	- Flood HWL = +3.30 m - Normal impounding water level Rainy season : min= 2.80, max= 3.10 m Dry season : min= 3.00, max= 3.20 m	- Flood HWL = +4.60 m - Normal impounding water level Rainy season : min= 4.20, max= 4.60 - 4.65 m Dry season : min= 4.40, max= 4.70 - 4.75 m

Table A7-3 Outline of Operation Rule for Weir (2/2)

Name	Mlirip Gate	Gubeng Dam	Wonokromo Sluice	Tulungagung Gate
River	Surabaya/Brantas River	Mas River	Surabaya River/ Mas River	Ngrowo River / Parit Agung canal
Construction (Rehabilitation)	1857 (Oct. 1978)	1907 (1993)	1917 (1993)	1986 -
Operation by	PJT	PJT	PU Peng. (PJT, BTS)	PJT
Establishment of Rule (Revision)	- (Jul. 1980)	- (Aug. 1993)	- (1993)	Not yet established. (-)
Purpose	- To keep water level of Brantas River - Water intake of Surabaya River for irrigation, domestic and industrial water supply. - Flood control (to stop flood from Brantas river to Surabaya river)	- Water supply (Irrigation, Domestic, Industrial)	- To keep water level of Surabaya River - Water intake of Mas River for irrigation, domestic and industrial water supply. - Flood control (to stop flood from Surabaya river to Mas river)	- Irrigation water supply to the downstream area of Brantas river in dry season. - Flood control (to stop flood from Parit Agung canal to Brantas River
Operation Rule	- Flood HWL = +19.95 m - Normal impounding water level min= 17.90 m, max= 18.30 m	- Flood HWL = +2.20 m - Normal impounding water level = +2.10 m	- Flood HWL = +3.38 m - Normal impounding water level = + 3.00 m	- Not yet established. (After completion of the Wonorejo Project.)

Name	Tulungagung Inlet Gate			
River	Parit Agung Canal			
Construction (Rehabilitation)	1962, 1986, 1993(Power facilities) (-)			
Operation by	PJT, PT PLN(Power facilities)			
Establishment of Rule (Revision)	1962 (Jan. 1985, Sep. 1993)			
Purpose	- Flood control (to divert a flood from Ngrowo river basin into drainage Tunnel) Design discharge =1,043 cum/s (10-year) - Peak power generation (36 MW, 184 GWh/year)			
Operation Rule	- Flood HWL = + 79.00 m - Normal impounding water level Rainy season : 77.00 m Dry season : 79.00 m LWL = 77.00 m			

Table A7-4 Performance of Major Intake Facilities (1/2)

(unit: cum/s)

Year	Month	period	Voor I, II canals		Mlirip		Menturus		Jatimlerek		Waru-Jayeng		Turi-Tunggorono		Lodagung	
			Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual
1995	January	1st	34.14	46.34	20.00	39.27	2.75	2.61	1.73	1.99	12.89	11.64	12.50	11.57	9.52	9.00
		2nd	34.14	46.04	20.00	25.09	2.84	2.81	1.73	1.41	9.95	12.89	9.64	12.53	9.17	9.17
		3rd	34.14	36.68	20.00	26.03	2.72	2.80	1.73	1.24	9.95	12.88	9.64	12.52	8.13	8.23
	February	1st	28.71	38.15	20.00	33.12	1.99	1.37	1.73	1.03	9.95	12.92	9.64	12.30	7.63	7.64
		2nd	28.05	43.43	20.00	38.53	1.99	2.19	1.73	1.04	9.95	12.94	9.64	12.53	7.83	7.80
		3rd	27.86	56.95	20.00	56.31	1.87	2.35	1.37	1.81	9.95	12.94	9.64	12.53	7.14	7.21
	March	1st	26.77	62.52	20.00	61.65	1.69	1.93	0.98	0.40	10.05	12.93	9.73	12.52	7.11	7.10
		2nd	25.94	67.31	20.00	71.46	1.78	1.83	0.81	0.31	9.97	12.94	9.66	10.74	7.06	7.80
		3rd	22.34	58.01	20.00	70.89	1.58	1.77	0.54	0.65	9.16	12.91	8.88	8.37	7.52	8.10
	April	1st	22.34	39.54	20.00	61.45	1.58	1.62	0.54	1.08	9.16	9.57	8.88	8.94	8.94	8.99
		2nd	22.34	28.25	20.00	47.05	1.58	1.22	0.54	0.27	9.16	9.19	8.88	8.90	8.62	8.61
		3rd	22.34	38.38	20.00	73.76	1.58	1.85	0.54	0.74	9.16	9.20	8.88	8.91	8.59	8.60
	May	1st	22.34	33.60	20.00	75.55	1.58	1.83	0.54	1.98	9.16	9.20	8.88	8.91	7.02	8.01
		2nd	22.34	38.22	20.00	75.55	1.58	1.82	0.54	1.98	9.16	9.20	8.88	8.91	6.97	8.50
		3rd	22.34	38.22	20.00	44.42	1.58	1.71	0.54	1.98	9.16	9.20	8.88	8.91	6.97	8.50
	June	1st	24.00	40.99	20.00	49.95	2.00	1.11	1.30	0.42	7.50	9.21	6.50	8.92	9.00	9.95
		2nd	25.00	49.76	20.00	81.02	2.00	1.83	1.30	1.37	7.00	6.39	6.50	6.80	9.00	10.00
		3rd	26.00	42.74	20.00	81.65	2.00	1.81	1.00	1.24	7.00	6.08	6.50	6.55	9.00	10.00
	July	1st	23.00	43.19	20.00	66.50	2.00	0.00	1.00	1.20	7.00	6.09	6.50	6.55	9.00	8.91
		2nd	21.00	35.42	20.00	65.17	2.00	1.08	1.00	0.79	7.00	6.09	6.00	6.55	8.00	7.92
		3rd	21.00	39.51	20.00	63.20	2.00	0.00	0.80	0.83	7.00	5.55	5.00	6.81	6.00	6.05
	August	1st	21.00	32.71	20.00	38.07	2.00	0.00	0.70	0.23	4.00	5.03	5.00	5.04	6.00	6.00
		2nd	18.00	29.10	20.00	28.54	1.50	0.00	0.60	0.00	4.00	4.08	4.00	4.06	6.00	6.00
		3rd	16.00	27.60	20.00	23.80	1.50	0.00	0.50	0.00	4.00	4.07	3.50	4.02	6.00	6.00
	September	1st	11.00	21.29	20.00	21.88	1.20	1.34	0.50	0.00	4.00	4.06	3.50	4.03	6.00	6.00
		2nd	10.00	13.55	20.00	22.45	1.20	1.44	0.50	0.00	4.00	4.08	3.50	4.03	6.00	6.00
		3rd	8.00	14.45	20.00	20.92	1.00	0.99	0.50	0.40	4.00	4.08	3.50	4.03	6.00	6.00
	October	1st	8.00	12.01	20.00	21.01	1.00	0.98	0.40	0.89	3.00	3.57	3.00	3.49	6.00	6.00
		2nd	8.00	20.30	20.00	28.19	1.00	1.07	0.40	0.93	3.00	0.91	3.00	3.10	6.00	6.00
		3rd	11.00	21.61	20.00	39.50	1.00	1.23	0.40	0.95	3.00	3.04	3.00	3.10	6.00	6.00
	November	1st	13.00	21.26	20.00	39.77	1.00	1.47	0.40	0.85	3.00	4.47	3.00	5.08	7.00	6.00
		2nd	16.00	30.59	20.00	61.97	1.00	1.47	0.80	0.85	7.00	4.46	7.00	5.07	10.00	6.00
		3rd	16.00	34.55	20.00	75.44	1.00	1.46	1.20	0.73	10.00	4.46	10.00	5.07	12.50	6.00
	December	1st	24.95	39.35	20.00	49.10	1.72	1.64	2.16	2.06	6.74	12.55	6.95	12.57	9.06	9.51
		2nd	33.62	39.33	20.00	61.80	1.96	3.93	1.92	1.37	10.57	12.54	10.91	10.98	8.69	8.62
		3rd	32.66	39.33	20.00	67.59	2.20	3.85	1.73	0.40	9.39	12.54	9.69	12.37	7.70	7.72
Total Discharge(Million cum)			685.79	1153.43	630.72	1581.06	53.44	49.32	30.28	29.09	235.14	256.89	226.14	250.91	242.42	239.82

Table A7-4 Performance of Major Intake Facilities (2/2)

(unit: cum/s)

Year	Month	period	Voor I, II canals		Mlirip		Menturus		Jatimlerek		Waru-Jayeng		Turi-Tunggorono		Lodagung	
			Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual
1996	January	1st	34.14	42.67	20.00	55.69	2.75	4.01	1.73	2.11	12.50	12.59	12.89	12.91	9.52	9.50
		2nd	34.14	43.23	20.00	69.94	2.84	4.05	1.73	1.94	9.64	9.75	9.95	10.06	9.17	9.21
		3rd	34.14	39.87	20.00	69.95	2.72	4.12	1.73	1.77	9.64	9.73	9.95	9.98	8.13	8.03
	February	1st	28.71	43.92	20.00	62.33	1.99	4.12	1.73	0.84	9.64	9.74	9.95	10.00	7.63	7.70
		2nd	28.05	44.82	20.00	43.93	1.99	4.11	1.73	1.61	9.64	9.73	9.95	9.99	7.83	7.77
		3rd	27.86	49.21	20.00	46.44	1.87	4.07	1.37	1.45	9.64	9.75	9.95	10.01	7.14	7.28
	March	1st	26.77	48.77	20.00	45.98	1.69	4.12	0.98	0.74	9.73	9.50	10.05	9.85	7.11	7.01
		2nd	25.94	47.50	20.00	50.73	1.78	4.21	0.81	1.37	9.66	9.75	9.97	10.00	7.08	7.00
		3rd	22.34	42.80	20.00	61.70	1.58	4.58	0.54	1.72	8.88	9.39	9.16	9.65	7.52	7.35
	April	1st	22.34	41.50	20.00	68.54	1.58	4.41	0.54	1.22	8.88	8.98	9.16	9.24	8.94	8.96
		2nd	22.34	33.36	20.00	62.53	1.58	4.22	0.54	1.80	8.88	8.99	9.16	9.29	8.62	8.63
		3rd	22.34	34.37	20.00	61.57	1.58	4.24	0.54	1.47	8.88	8.96	9.16	9.24	8.59	8.60
	May	1st	22.34	45.46	20.00	61.62	1.58	3.37	0.54	0.99	8.88	8.96	9.16	9.23	7.02	7.05
		2nd	22.34	36.76	20.00	32.86	1.58	2.74	0.54	1.71	8.88	8.96	9.16	9.22	6.97	7.00
		3rd	22.34	35.70	20.00	33.44	1.58	2.30	0.54	1.28	8.88	8.97	9.16	9.23	6.97	8.47
	June	1st	23.47	32.84	20.00	33.46	1.67	1.99	0.74	1.18	8.40	8.47	8.14	8.25	9.00	9.00
		2nd	22.25	34.25	20.00	34.51	1.69	1.88	0.75	0.85	8.28	8.01	8.08	8.10	9.00	9.00
		3rd	22.07	26.62	20.00	32.36	1.72	1.85	0.76	0.85	7.39	7.45	8.12	8.13	9.00	9.00
	July	1st	18.95	25.01	20.00	33.38	1.83	1.85	0.88	0.86	6.69	6.73	8.31	8.32	9.50	9.50
		2nd	17.18	24.78	20.00	31.42	1.93	1.83	0.83	0.84	5.01	5.13	7.82	7.89	9.50	9.50
		3rd	14.20	25.60	20.00	31.22	1.93	1.16	0.67	0.85	4.73	4.89	6.94	7.04	9.50	9.50
	August	1st	12.77	24.03	20.00	31.86	1.93	1.94	0.52	0.86	4.69	4.87	5.65	5.94	9.50	9.50
		2nd	11.07	38.37	20.00	32.85	1.93	1.94	0.67	0.89	4.72	4.88	4.40	4.79	9.50	9.50
		3rd	11.07	28.73	20.00	23.80	1.89	1.96	0.64	0.83	4.75	4.88	4.54	4.59	7.00	7.08
	September	1st	10.67	25.36	20.00	24.67	1.31	1.48	0.50	0.76	4.43	4.27	4.96	5.02	6.00	6.00
		2nd	10.21	21.51	20.00	23.34	1.21	1.48	0.59	0.78	4.45	4.45	4.97	5.05	6.00	6.00
		3rd	8.37	21.65	20.00	27.35	1.13	1.48	0.60	0.74	4.42	4.45	5.02	5.05	6.00	6.00
	October	1st	8.37	26.85	20.00	30.70	1.13	1.48	0.60	0.80	4.42	4.46	5.02	5.06	6.00	6.00
		2nd	8.37	27.95	20.00	31.60	1.13	1.50	0.60	0.78	4.42	4.46	5.02	5.06	6.00	6.00
		3rd	11.16	34.82	20.00	36.80	1.13	1.48	0.60	0.85	4.42	4.09	5.02	5.07	6.00	6.00
	November	1st	13.95	42.44	20.00	37.50	1.13	1.47	0.60	0.85	4.42	4.47	5.02	5.08	6.00	6.00
		2nd	13.95	44.34	20.00	36.90	1.13	1.47	0.60	0.90	4.42	4.46	5.02	5.07	6.00	6.00
		3rd	13.95	51.84	20.00	37.20	1.13	1.46	0.60	0.75	4.42	4.47	5.02	5.08	6.00	6.00
	December	1st	29.45	56.35	20.00	37.24	1.72	2.22	2.16	0.75	6.74	7.14	6.95	6.32	9.06	8.93
		2nd	33.62	34.38	20.00	39.20	1.96	2.78	1.92	0.75	10.57	10.61	10.91	10.91	8.69	8.70
		3rd	32.66	46.70	20.00	35.75	2.20	2.75	1.73	1.23	9.39	8.40	9.69	11.56	7.70	7.72
Total Discharge(Million cum)			653.09	1161.98	632.45	1326.21	54.12	84.28	29.08	35.14	231.15	232.29	246.98	250.55	245.17	246.39

Table A7-5 Number of Employees by Activity for Water Services Divisions in PJT

Activity	Upstream Water Services 1	Upstream Water Services 2	Upstream Water Services 3	Downstream Water Services 1	Downstream Water Services 2	Downstream Water Services 3
Chief of Division	1	-	-	1	-	-
Expert	-	-	-	1	-	-
Chief of Sub-Division	2	1	1	1	1	1
Expert of Civil Engineering	-	-	-	-	-	1
Coordinator	2	1	1	2	-	1
Administration Staff	3	3	2	8	3	3
Inspector						
- Civil Works	2	-	1	4	2	2
- Water Supply	1	-	1	-	-	-
Supervisor						
- Water Resources Infrastructure	6	8	4	-	-	3
- Hydro-meteorology	1	-	1	3		-
- Water Supply		-	-	1	1	2
Operator						
- Gate	5	8	3	6	6	7
- Telecommunication	5	4	2	2	-	-
- Motorboat	2	3	-	1	-	-
Laboratory Staff	-	-	-	1	11	-
Surveyor	-	-	-	1	-	-
Driver	3	2	1	3	2	1
Genaral Worker/ Maid	-	-	-	2	1	1
Guard	12	15	5	16	3	6
Total	45	45	22	53	30	28

Table A7-6 List of Heavy Equipment for Maintenance

Section: Bureau of HRD & General Affair/ Logistic

No.	Equipment	Program (Unit)			Actual (Unit)			Condition
		DUWS	DDWS	Total	DUWS	DDWS	Total	(%)
1	Bulldozer	1	-	1	-	-	-	-
2	Dump Truck	2	9	11	-	1	1	50
3	Excavator	1	1	2	-	1	1	50
4	Tender Boat	1	1	2	-	1	1	45
5	Dredger	1	3	4	-	-	-	-
6	Amphibius Clamshell	-	1	1	-	-	-	-
7	Light Truck	1	4	5	-	1	1	45
8	Motor Boat	3	2	5	-	-	-	-
9	Ordinary Truck	5	1	6	-	1	1	45
10	Swamp Dozer	1	-	1	-	1	1	50
11	Truck Trailler	1	1	2	-	-	-	-
12	Wheel Loader	-	2	2	-	-	-	-

Section: Division of Non Water Service

No.	Equipment	Program (Unit)			Actual (Unit)			Condition
		DUWS	DDWS	Total	DUWS	DDWS	Total	(%)
1	Air Compressor	-	3	3	-	2	2	55
2	Bulldozer	1	-	1	1	-	1	55
3	Crawler Crane	-	2	2	1	3	4	60
4	Dredger	2	-	2	2	1	3	60
5	Genset	-	1	1	-	3	3	60
6	Fuel Tanker	-	1	1	1	1	2	55
7	Light Truck	1	1	2	1	3	4	60
8	Road Roller	-	1	1	-	1	1	55
9	Swamp Dozer	2	-	2	2	1	3	60
10	Submersible Pump	-	2	2	-	2	2	60
11	Support Boat	1	-	1	3	2	5	55
12	Truck Crane	-	2	2	-	3	3	60
13	Truck W/Crane	1	1	2	4	3	7	55
14	Tractor Trailer	-	1	1	-	1	1	55

Source: PJT

Table A.7-7 Problem and Countermeasure related to River Facilities

Name of Facilities	Problem	Countermeasure	Remarks
Dam/Reservoir			
Wlingi Dam	Sedimentation	Countermeasure is be studied in this study.	
	Enceng Gondok (Water hyacinth)	Continuous removal of Enceng Gondok will be required and treatment/disposal method of removed Enceng Gondok shall be established.	In addition, decrease of Enceng Gondok shall be researched/developed
Sutami Dam	Sedimentation	Countermeasure is studied in this study.	
	No operation of hollow jet valve	Trial operation will be required to examine its function.	
Sengguruh Dam	Sedimentation	Countermeasure is studied in this study.	
	Enceng Gondok	Continuous removal of Enceng Gondok will be required and treatment/disposal method of removed rubbbish shall be established.	In addition, decrease of Enceng Gondok shall be researched/developed
Bening Dam	Shortage of inflow	Operation pattern including cropping pattern and power generation pattern shall be studied according to the abailable water.	
Weir			
Rangil Tak Spillway Gate	No use (No excess flood, No operation rule)	Operation rule shall be prepared, considering land use of the Rangil Tak canal and flood discharge of the main river.	In addition, the Rangil Tak canal shall be designated legally as the floodway/retarding pond by the DGWRD.
New Lengkong Dam	Enceng Gondok	Removal by public oriented activities led by Governor shall be continued.	In addition, decrease of Enceng Gondok shall be researched/developed
Jatimlerek Rubber Dam	Frequent deflation of rubber weir		Rehabilitation finished.
Lodoyo Dam	Unregulated outflow (sedimentation, operation rule)	Countermeasure for sedimentation is studied in this study. Operation shall be done according to the operation rule.	
	Enceng Gondok	Continuous removal of Enceng Gondok will be required and treatment/disposal method of removed Enceng Gondok shall be established.	In addition, one of the gate will be recommendable to replace to the sluice with flap gate type in order to flush the rubbishes smoothly.
Jagir Dam	Impounding water level over normal HWL due to the request of PDAM	PDAM should strenghen own intake capacity.	
	Superannuated gate system	Gate system shall be renovated and lowering of impounding water level shall be studied.	
	Rubbish	Continuous removal of rubbish and PROKASIH campain, simultaneously.	
Gunungsari Dam	Sedimentation	Continuous excavation and flushing of sediment will be required.	
	Enceng Gondok	It is desiable to conduct the same activities as those in New Lengkong Dam.	In addition, decrease of Enceng Gondok shall be researched/developed
Mlirip Gate	Superannuated stoplog (insufficient operation of intake discharge)	Under renovation to gate system by PKB (Wonorejo Project).	
	Enceng Gondok	Removal by public oriented activities led by Governor.	In addition, decrease of Enceng Gondok shall be researched/developed
Gubeng Dam	Sedimentation	Continuous excavation and flushing of sediment will be required.	
	Rubbish	Continuous removal of rubbish and PROKASIH campain, simultaneously.	
Tulungagung Gate	No use (no function before construction of Wonorejo Dam)	Under construction of Wonorejo Dam.	
Dike			
Dike from Ploso Town to Kediri City	Small-scale collapses and cutting of foot	Dikes shall be repaired.	
Revetment			
Downstream site of Jagir Dam	Collapses	Collapsed revetment shall be rehabilitated.	
Downstream site of Menturus Rubber	Broken	Broken parts of revetment shall be repaired.	
Retarding Basin			
All natural Retarding Basin	Possibilities of development.	Publicity activities/legal control seem to be required for easy implementation of the future.	
Groundsill			
Downstream site of Porong Toll Road Bridge	No function (concrete blocks are washed out)	Concrete blocks shall be re-installed.	
Bridge			
Most of old bridge	Group-of-piles type pier	In case of renovation/reconstruction, the piers of elliptic type shall be used.	
Ploso Railway Bridge	No use	Facilities shall be demolished by PERUMKA.	
Downstream site of Porong Railway	Wrecked piers	Facilities shall be demolished.	
Intake/Pump			
Losari, Gedek, Gumboogan, Watespiriggir (P), Keboan, Bebekan, Tapen (P), Gotan, Tunggorono, Turipinggir, Banjarsari, Old Mrican	Their roles already finished.	Facilities shall be demolished.	
Gempolkerep (P), Kedungsari (P), Pengkol, Bunder II (P), Besuk	cannot be used	Intake/pump facilities shall be renovated.	
Voor I canal, Voor II canal	Insufficient contrl of intake discharge	Sure operation in accordance with POLA is required.	Reallocation of water among all intake facilities shall be considered.
Sabo/check dam			
Wonokerto check dam	silting up with sediment	It is desiable to study and conduct the method of sediment removal by community	
Sea Dike Gate			
Six (6) gates	corrosion of metal parts	Gate system shall be rehabilitated by DPU Pengairan.	

Table A7-8 Summary of construction Costs of Alternatives for Sengguruh and Sutami Reservoirs

Unit: Million Rp.

Item	Alt. 1	Alt. 2	Alt. 3
I. Sengguruh reservoir	**586,198**	**586,198**	**11,063**
1. Land aquisision (1st-5th year)	17,500	17,500	0
2. Dredging	568,698	568,698	11,063
2.1 Dredging in 1st-5th year		0	
(1) Dredging incl. transpoting	97,976	97,976	2,239
(2) Miscelaneous (20% of (1))	19,595	19,595	448
2.2 Dredging in 6th -17th year		0	
(1)Dredging incl. transporting	410,116	410,116	7,614
(2) Miscelaneous (20% of (1))	41,012	41,012	761
II. Sutami reservoir	**443,345**		
1. Land aquisision (1st-5th year)	7,000		
2. Dredging	436,345		
2.1 Dredging in 1st-5th year			
(1) Dredging incl. Transpoting	39,822		
(2) Miscelaneous (20% of (1))	7,964		
2.2 Dredging in 6th -17th year			
(1)Dredging incl. transporting	353,235		
(2) Miscelaneous (20% of (1))	35,323		
III. Sediment conveying tunnel	**78,624**	**71,058**	
1.Land for inlet and outlet channels	188	188	
2. Construstion	78,436	70,870	
2.1 Tunnel		0	
(1) Tunnel excavation	40,967	36,144	
(2) Concrete lining	20,184	18,730	
(3) Support (20% of (1)+(2))	12,230	10,975	
(4) Inlet and outlet	342	307	
2.2 Inlet and outlet channels		0	
(1) excavation	670	670	
(2) slope protection	1,299	1,299	
(3) Inlet gate	2,745	2,745	
IV. Sabo dam (17 nos)	**87,594**	**87,594**	**87,594**
V. Total of direct cost	**1,195,761**	**744,850**	**98,657**
1. Land	24,688	17,688	0
2. Construction	1,171,073	727,162	98,657
VI. Engineering cost	**16,603**	**15,846**	**8,759**
(10% of III.2+IV)			
VII. OM cost of III.2+IV	**56,450**	**53,878**	**29,782**
((2% of III.2+IV) x 17 yrs)			
VIII. Administration	**59,788**	**37,242**	**4,933**
(5% of V)			
IX. Total	**1,328,602**	**851,816**	**142,131**
(V - VIII)			

Table A7-9 Comparison of Alternatives for Sengguruh and Sutami Reservoirs

	Present condition	Alt. 1	Alt. 2	Alt. 3
Countermeasure		- Construction of 17 sabo dams Storage capacity 15.1 mil cu.m - Sengguruh Dredging in rainy season 1.75 mil cum/yr Total (22yr) 38.5 mil cu.m - Sutami Dredging in rainy season 0.7 mil cum/yr Total (22yr) 15.4 mil cu.m - Construction of tunnel for sediment disposal D= 2.3 m L= 21.45 km	- Construction of 17 sabo dams Storage capacity 15.1 mil cu.m - Sengguruh Dredging in rainy season 1.75 mil cu.m/yr Total (22yr) 38.5 mil cu.m - Construction of tunnel for sediment disposal D= 2.1 m L= 21.45 km	- Construction of 17 sabo dams Storage capacity 15.1 mil cu.m - Sengguruh Dredging around Intake 0.04 mil cu.m/yr Total (22yr) 0.88 mil cu.m
Cost (million Rp.) - Sengguruh - Sutami - Tunnel - Sabo dam - Other (admi etc) - Total		586,198 443,345 78,624 87,594 132,841 1,328,602	586,198 - 71,058 87,594 106,966 851,816	11,063 - - 87,594 43,474 142,131
Storage Capacity	unit: mil cu.m 2020 1997 - Sengguruh Gross 0 3.4 Effective 0 1.2 - Sutami Gross 119.6 183.4 Effective 102.4 146.6	unit: mil cu.m 2020 2020-1997 - Sengguruh Gross 2.5 -0.9 Effective 1.2 0.0 - Sutami Gross 182.5 -0.9 Effective 146.0 -0.6	unit: mil cu.m 2020 2020-1997 - Sengguruh Gross 2.5 -0.9 Effective 1.2 0.0 - Sutami Gross 167.1 -16.3 Effective 135.3 -11.3	unit: mil cu.m 2020 2020-1997 - Sengguruh Gross 0.0 -3.4 Effective 0.0 -1.2 - Sutami Gross 134.9 -48.5 Effective 113.0 -33.6
Required water for dredging & disposal (unusable water in rainy season)		- Sengguruh Dredging 7.4 mil cu.m/yr Tunnel 34.6 mil cu.m/yr Sub-total 41.9 mil cu.m/yr - Sutami Dredging 2.9 mil cu.m/yr Total 44.9 mil cu.m/yr	- Sengguruh Dredging 7.4 mil cu.m/yr Tunnel 26.4 mil cu.m/yr Sub-total 33.7 mil cu.m/yr - Sutami Dredging 0.0 mil cu.m/yr Total 33.7 mil cu.m/yr	
Energy production	unit: MWh/year 2020 1997 - Sengguruh 0 80,820 - Sutami 456,659 465,302	unit: MWh/year 2020 2020-Present - Sengguruh 78,750 -2,070 - Sutami 456,400 -8,902	unit: MWh/year 2020 2020-Present - Sengguruh 79,155 -1,665 - Sutami 456,502 -8,800	unit: MWh/year 2020 2020-Present - Senggur 80,785 -35 * Run-of-river type - Sutami 458,697 -6,605
Benefit (mil. Rp.) - Effective storage capacity in Sutami - Energy production Sengguruh Sutami - total of Benefit		532,290 526,491 -15,668 1,043,113	390,170 528,123 -12,040 906,253	138,590 468,186 5,277 612,053
Benefit - Cost (mil. Rp.)		-285,489	54,437	469,922

Table A7-10 Transaction of Storage Capacity in Wlingi Reservoir

unit: 10^3 m^3

Year	Storage Capacity		Sediment Deposit	Removal of Sediment		Remarks
	Gross	Effective		Dredging	Flushing	
1977	24,000	5,200				
1982	18,317	Non-applicable	5,683	-	-	The Loan IP-347 was issued (on 1989) for atotal of 4 million m3 dredging volume as the target as increasing the reservoir capacity.
1985	14,444	Non-applicable	3,873	-	-	
1988	9,497	Non-applicable	4,947	-	-	
Jan. 1990	4,599	2,200	4,898			
			sub-total:	19,401		
Eruption (Feb. 1990)	(after eruption : calculated between the damsite and CRB 100)			-	-	
Mar. 1990	1,599	Non-applicable	3,000	1,700	1,900	Stage I Dredging - PLN
Aug. 1991	4,769	2,340	430	800	0	Stage II Dredging - IP-347
May 1992	2,509	1,090	3,060	0	215	Stage II Dredging - IP-347
Mar. 1993	1,984	1,210	740	3,204	0	Dredging Stage IV - IP-347
				379	189	Dredging Stage IV A - APBN
Mar. 1995	4,626	1,334	1,130	329	0	Dredging Stage IV B - APBN
Dec. 1995	4,943	1,589	12	531	0	Dredging Stage IV C - IP-347
Mar. 1996	5,328	1,630	146	428	0	
Jul. 1996	5,753	1,830	3			
		Total	27,922	7,371	2,304	

Source: The Brantas River Rehabilitation Project, Supporting Report 1, Evaluation of River Dredging Works in Wlingi reservoir and Proposed Further Dredging Plan for Wlingi and Lodoyo Reservoirs. December 1996

Table A7-11 Summary of Construction Cost of Alternatives for Wlingi and Lodoyo Reservoirs

Unit: Million Rp.

Item	Alt. 1	Alt. 2	Alt. 3
I. Wlingi Reservoir	**231,924**	**167,857**	**167,857**
1. Land acquisition (for 1st -5th year)	11,900	11,900	11,900
2. Dredging	220,024	155,957	155,957
2.1 Dredging in 1st-5th year			
(1) Dredging incl. Transpoting	39,871	39,871	39,871
(2) Miscelaneous (20% of (1))	7,974	7,974	7,974
2.2 Dredging in 6th -22th year			
(1)Dredging incl. transporting	156,526	98,284	98,284
(2) Miscelaneous (20% of (1))	15,653	9,828	9,828
II. Lodoyo Reservoir	**239,075**	**164,763**	**23,437**
1. Land acquisition (for 1st -5th year)	7,600	7,600	3,000
2. Dredging	231,475	157,163	20,437
2.1 Dredging in 1st-5th year			
(1) Dredging incl. Transpoting	25,464	25,464	10,052
(2) Miscelaneous (20% of (1))	5,093	5,093	2,010
2.2 Dredging in 6th -22th year			
(1)Dredging incl. transporting	182,653	115,096	7,614
(2) Miscelaneous (20% of (1))	18,265	11,510	761
III. Extension of Bypass channel to Semut River (l=8,764 m)	**0**	**38,856**	**38,856**
1. Land acquisition and house compensation cost	0	5,705	5,705
2. Direct construction cost	0	33,151	33,151
IV. Construction of new dam (Kesamben dam)	**0**	**0**	**0**
1. Land acquisition and house compensation cost	0	0	0
2. Direct construction cost	0	0	0
V. Total of direct cost	**470,999**	**371,476**	**230,151**
1. Land	19,500	25,205	20,605
2. Dredging/ construction (direct)	451,499	346,271	209,546
VI. Engineering	**0**	**3,315**	**3,315**
1. 10% of III.2	0	3,315	3,315
2. 10% of IV.2	0	0	0
VII. OM	**0**	**11,271**	**11,271**
1. 2% of III.2 x 17 yrs	0	11,271	11,271
1. 2% of IV.2 x 17 yrs	0	0	0
VIII. Admistration (5% of V)	**23,550**	**18,574**	**11,508**
IX. Total (V-VIII)	**494,548**	**404,636**	**256,245**

Table A7-12 Comparison of Alternatives for Wlingi and Lodoyo Reservoirs

	Alt.1	Alt.2	Alt.3
Countermeasure	- Dredging in Wlingi 1st - 5th yr : 1.19 mil cu.m/yr 6th - 22nd yr : 0.43 mil cu.m/yr - Dredging in Lodoyo 1st - 5th yr : 0.76 mil cu.m/yr 6th - 22nd yr : 0.73 mil cu.m/yr	- Dredging in Wlingi 1st - 5th yr : 1.19 mil cu.m/yr 6th - 22nd yr : 0.27 mil cu.m/yr - Dredging in Lodoyo 1st - 5th yr : 0.76 mil cu.m/yr 6th - 22nd yr : 0.46 mil cu.m/yr - Extension of Bypass Channel L=8.7km	- Dredging in Wlingi 1st - 5th yr : 1.19 mil cu.m/yr 6th - 22nd yr : 0.27 mil cu.m/yr - Dredging in Lodoyo 1st - 5th yr : 0.30 mil cu.m/yr 6th - 22nd yr : 0.04 mil cu.m/yr - Extension of Bypass Channel L=8.7km
Cost (mil. Rp.)			
- Wlingi	231,924	167,857	167,857
- Lodoyo	239,075	164,763	23,437
- Bypass channel	0	38,856	38,856
- Dam	0	0	0
- Other (admi etc)	23,549	33,160	26,095
- Total	494,548	404,636	256,245
Benefit (mil. Rp.)			
- Wlingi	1,099,199	1,099,709	935,778
- Lodoyo	218,060	218,196	218,470
- Kesamben	0	0	0
- Total	1,317,259	1,317,905	1,154,248
B-C	822,711	913,269	898,003

Table A7-13 Implementation Program and Disbursement Schedule for Maintenace and Rehabilitation Works for River Facilities (without VAT)

(Unit: Million Rp.)

Project	Total Cost	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Extension of Bypass Channel																							
Construction	44,684		11,171	11,171	11,171	11,171																	
Engineering Services	3,810	762	762	762	762	762																	
Administration	2,235	447	447	447	447	447																	
O/M	6,477						381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381
Total	57,206	1,209	12,380	12,380	12,380	12,380	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381	381
Dredging in Wlingi Reservoir																							
Construction	193,026	13,741	13,741	13,741	13,741	13,741	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313	7,313
Engineering Services																							
Administration	9,657	687	687	687	687	687	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366	366
O/M																							
Total	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
Dredging in Lodoyo Reservoir																							
Construction	189,485	8,776	8,776	8,776	8,776	8,776	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565	8,565
Engineering Services																							
Administration	9,471	439	439	439	439	439	428	428	428	428	428	428	428	428	428	428	428	428	428	428	428	428	428
O/M																							
Total	198,956	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
Dredging in Sengguruh																							
Construction	13,596	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618	618
Engineering Services																							
Administration	682	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
O/M																							
Total	14,278	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649
Grand Total	473,123	25,501	36,672	36,672	36,672	36,672	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702	17,702

Note: Physical contingency (15% of the total cost) is disbursed to the respective cost items.

Construction

Engineering Services

Table A7-14 Required Manpower for Division of OM in New PJT

Sub-Diviion of Upstream

River / Major Facility	Brantas	Brantas Sutami/ Lahor	Brantas Sengguruh	Brantas Wlingi	Brantas Lodoyo	Konto Selorejo	Ngrowo TA gate	Ngrowo TA Tunnel	Ngrowo Wonorejo	Ngrowo Segawe	Ngrowo Head works	Sub-Total
Chief of Division	1											1
Chief of Sub-Division	1	1				1	1					4
Coordinator	1	1				1	1		1			5
Supervisor												0
- Water Resources Infrastructure	1	3	3	3	3	2	2	2	3	1	1	24
- Civil Works (River)							4					4
- Civil Works (sabo)		2	4	2	2	2			2			14
- Hydro-meteorology	1						1					2
- Water Supply	1			1			1					3
Operator												0
- Gate		2	3	3	3	2	2	3	2	2	2	24
- Telecommunication	2	2	3	3	3	2	2	3	2	2	2	26
- Equipment, etc	-	1	1	1	1	1	1	1	1			8
Administration Staff (Water Supply	1			1			1					3
Total	9	16	14	14	12	11	16	9	11	5	5	118

Sub-Diviion of Downstream

River / Major Facility	Brantas Kediri	Brantas Mrican	Brantas Jatimlerek	Widas Bening	Brantas New Lengkong	Brantas Menturus	Surabaya Mlirip	Surabaya Gunungsari	Mas Gubeng	Mas Wonokromo	Surabaya Jagir	Sub-Total	Total
Chief of Division	1											1	2
Chief of Sub-Division	1				1			1				3	7
Coordinator	1			1	1			1				4	9
Supervisor												0	0
- Water Resources Infrastructure	1	1	1	2	1	1		1	1	1	1	11	35
- Civil Works (River)	8				4			4				16	20
- Civil Works (sabo)				2								2	16
- Hydro-meteorology	1			2								3	5
- Water Supply	1				1			1				3	6
Operator												0	0
- Gate		2	2	2	3	2	2	2	2	2	2	21	45
- Telecommunication	2	2	2	2	3	2	2	2	2	2	2	23	49
- Equipment, etc		1		1	2			2				6	14
Administration Staff (Water Supply	4				2			3				9	12
Total	20	6	5	12	18	5	4	17	5	5	5	102	220

Table A.7-15 Annual OM Cost for River facilities

I. Operation Cost

I.1 Patrol/Inspection of river and sabo facilities.	Rp.	49.1	million
I.2 Monitoring of river-bed materials	Rp.	7.0	million
I.3 Monitoring on storage capacities and sediment material in Sabo dams in Mt. Kelud area.	Rp.	105.9	million

II. Maintenance cost for river facilities.

River channel and facilities excluding dams and weir: Rp. 12,807.6 million

(29 rivers)

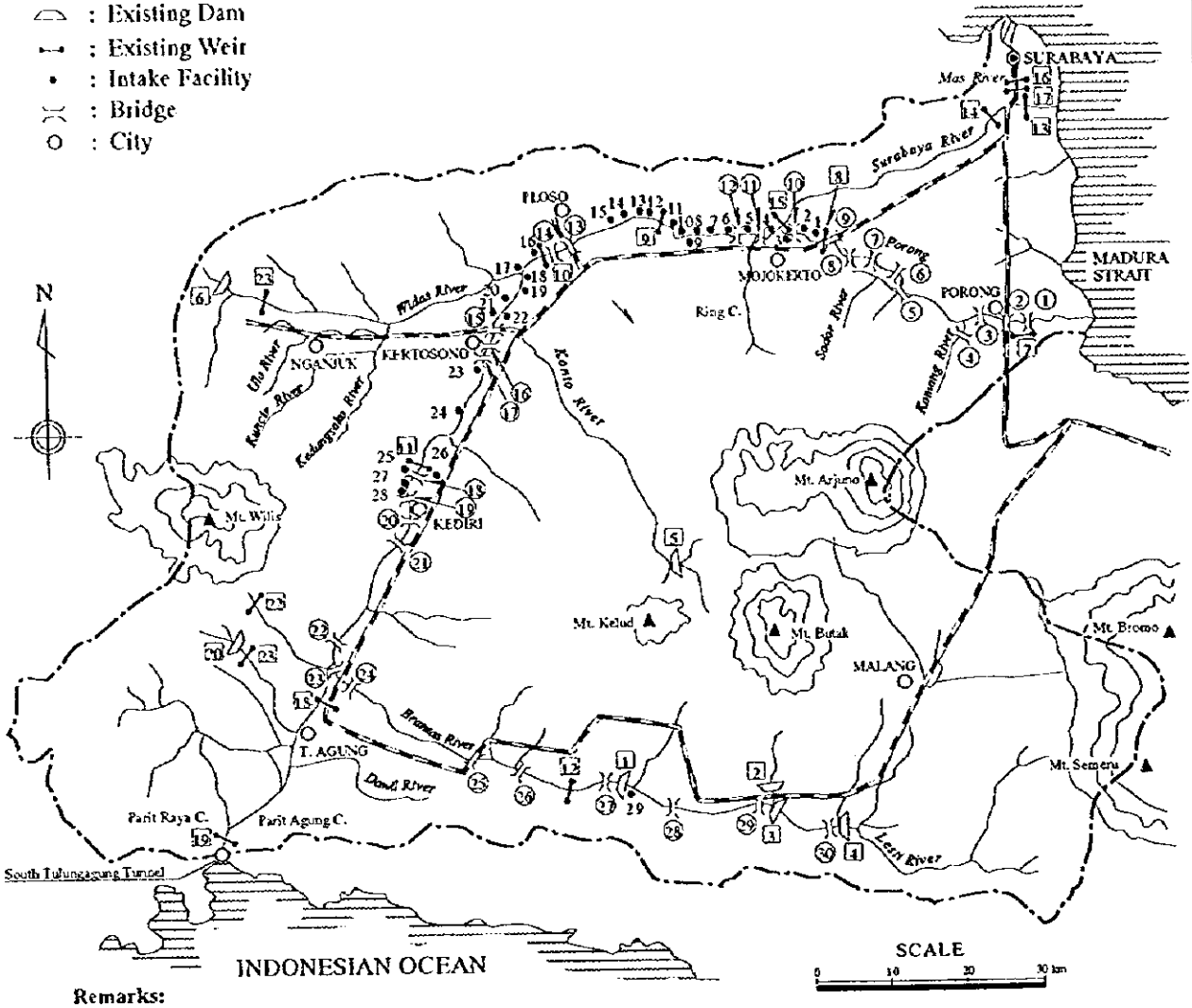
Brantas	3,616.5	Song	81.1
Amprong	74.0	Badak	196.6
Lesti	329.9	Konto	2,205.9
Lahor	9.3	Widas	398.8
Lekso	63.6	Kedungsoko	100.5
Semut	0.0	Ulo	52.9
Jari	63.7	Kuncir	199.0
Putih	35.0	Bening	0.0
Parit Agung	914.1	Beng	39.3
Parit Raya	569.5	Watudakon	66.1
Ngrowo	756.8	Porong	999.0
Ngasinan	38.9	Surabaya	278.8
Tawing	101.1	Wonokromo	168.9
Tugu	17.2	Mas	630.2
Bodeng	47.6	Sumber Brantas	737.1
Meteo-hydrological observation in downstream basin			16.2

III. Operation and Maintenance cost of dam and weirs Rp. 5,352.0 million

(Dredging costs of Sengguruh, Wlingi and Lodoyo reservoirs are not included in the above cost.)

Sengguruh	689.3	Menturus	104.6
Sutami	802.6	New Lengkong	285.7
Lahor	234.7	Jagir	228.3
Selorejo	341.2	Gunungsari	138.7
Bening	228.1	Mlirip	17.1
Wlingi	694.9	Gubeng	32.6
Lodoyo	269.5	Wonokromo	34.3
Mrican	237.9	Wonorejo	945.7
Jatimlerek	66.8		

IV. Maintenance cost of Mt. Kelud sabo works	Rp.	1,970.0	million
V. Sub-total of I. - IV.	Rp.	20,291.6	million
VI. Contingency (15% of V)	Rp.	3,043.7	million
V. Grand-total	Rp.	23,335.3	million



Remarks:

Dam

1. Wlingi
2. Lahor
3. Sutami
4. Sengguruh
5. Selorejo
6. Bening
7. Wonorejo

Weir

7. Bangil Tak
8. New Lengkong
9. Menturus
10. Jatimlerek
11. Mrican
12. Lodoyo
13. Jagir
14. Gunungsari
15. Mlirip
16. Gubeng
17. Wono Kromo
18. Tulungagung
19. Tulungagung Tunnel
21. Glatik
22. Segawe Weir
23. Tiudan

Bridge

1. Porong (Toll)
2. Porong (Railway)
3. Porong (Road)
4. Inspection
5. Trolley
6. Trolley
7. Ngrame (Road)
8. Footpath
9. Cepiples (Railway)
10. New Mojokerto (Road)
11. Moojokerto (Road)
12. Watudakon (Trolley)
13. Ploso (Road)
14. Ploso (Railway)
15. Kertosono (Railway)
16. Kertosono (Road)
17. New Kertosono (Road)
18. Jongbiru (Trolley)
19. New Kediri II (Road)
20. Kediri (Road)
21. New Kediri (Road)
22. Jeli (Trolley)
23. Jeli (Railway)
24. Jeli (Road)
25. Railway
26. Kedemangan (Road)
27. Grondong (Road)
28. Ngembul (Road)
29. Belly (Road)
30. Sengguruh (Road)

Intake

1. Voor II canal
2. Voor I canal
3. Jatikulon
4. Ajinomoto (P)
5. Losari
6. Gedek Intake
7. Gempolkerep (P)
8. Gembongan
9. Sotowuluh
10. Kedungsari (P)
11. Keboan
12. Menturus
13. Bebekan
14. Tunggorono
15. Tapen (P)
16. Jatimlerek
17. Bunder (P)
18. Tunggorono
19. Turipinggir
20. Pengkol
21. Kedungkudi
22. Bunder II (P)
23. Besuk
24. Banjarsari
25. Warujayeng Intake
26. Turitunggorono
27. (P)
28. Mrican
29. Lodagung

Figure A7-1 Location Map of Major River Facilities (1/2)

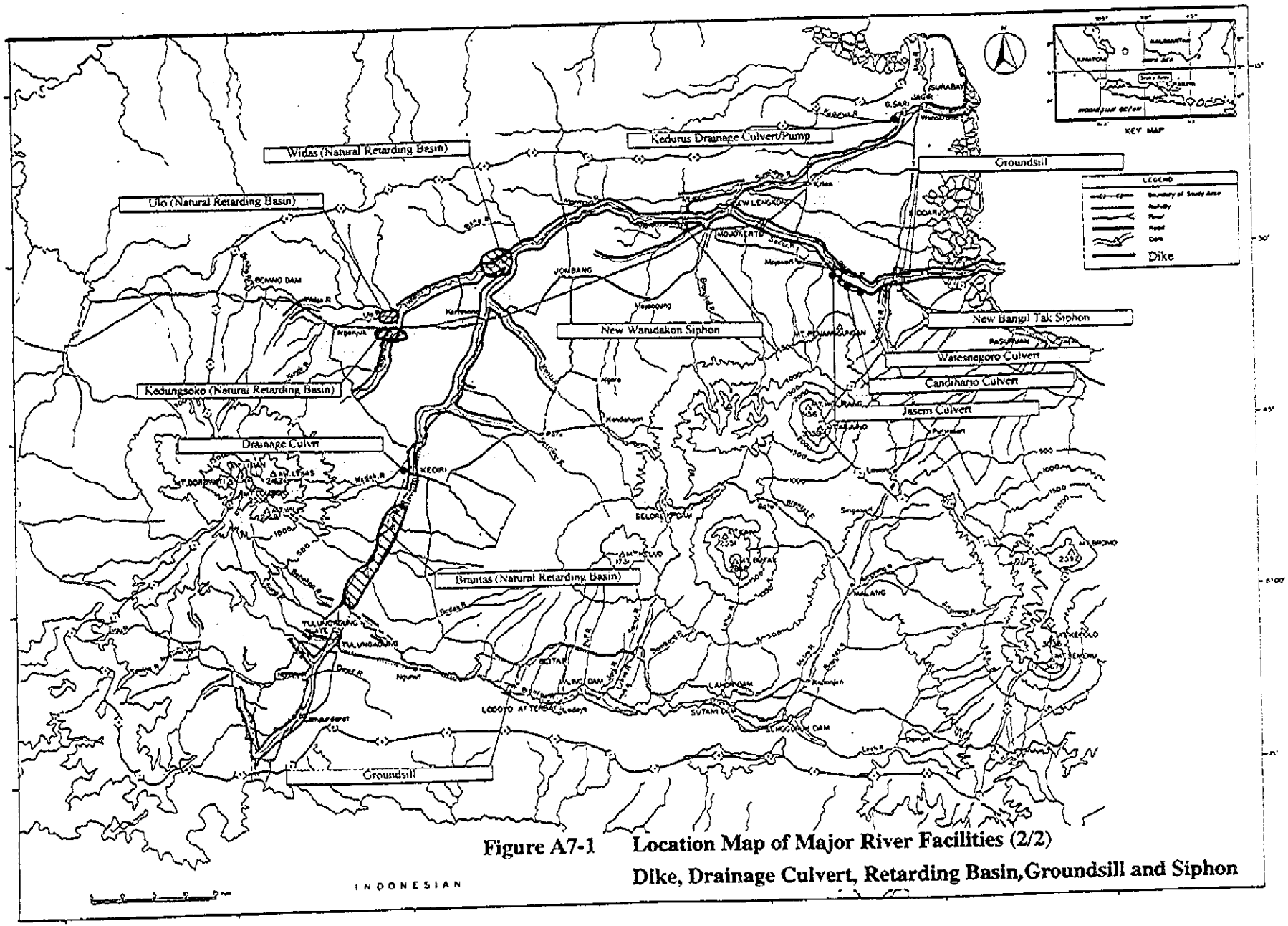
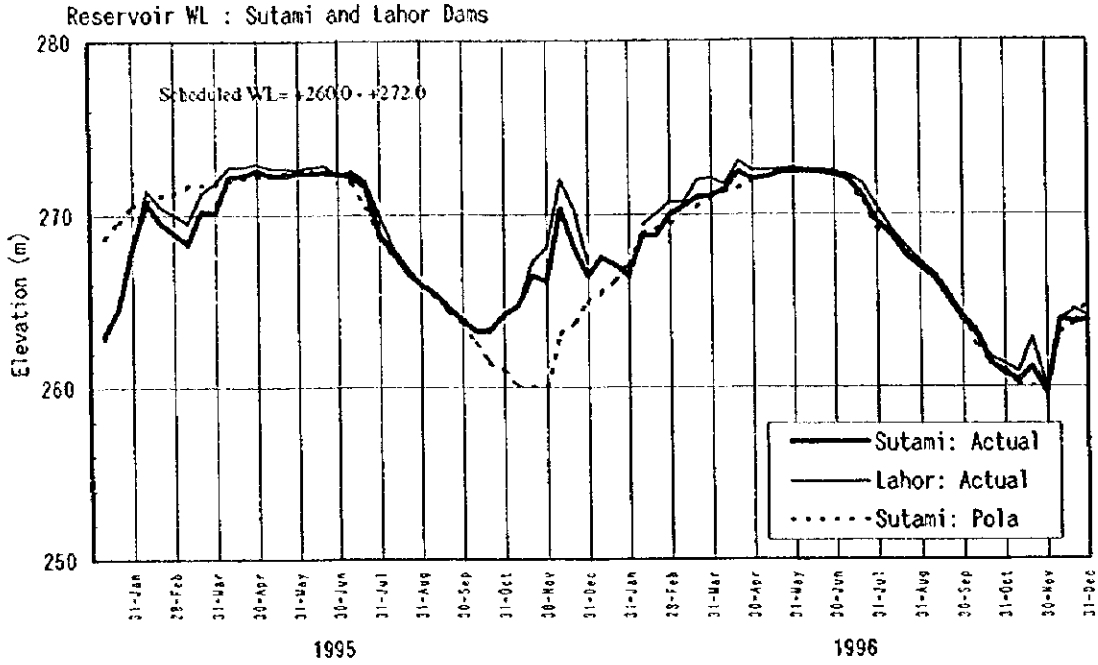


Figure A7-1 Location Map of Major River Facilities (2/2)
Dike, Drainage Culvert, Retarding Basin, Groundsill and Siphon



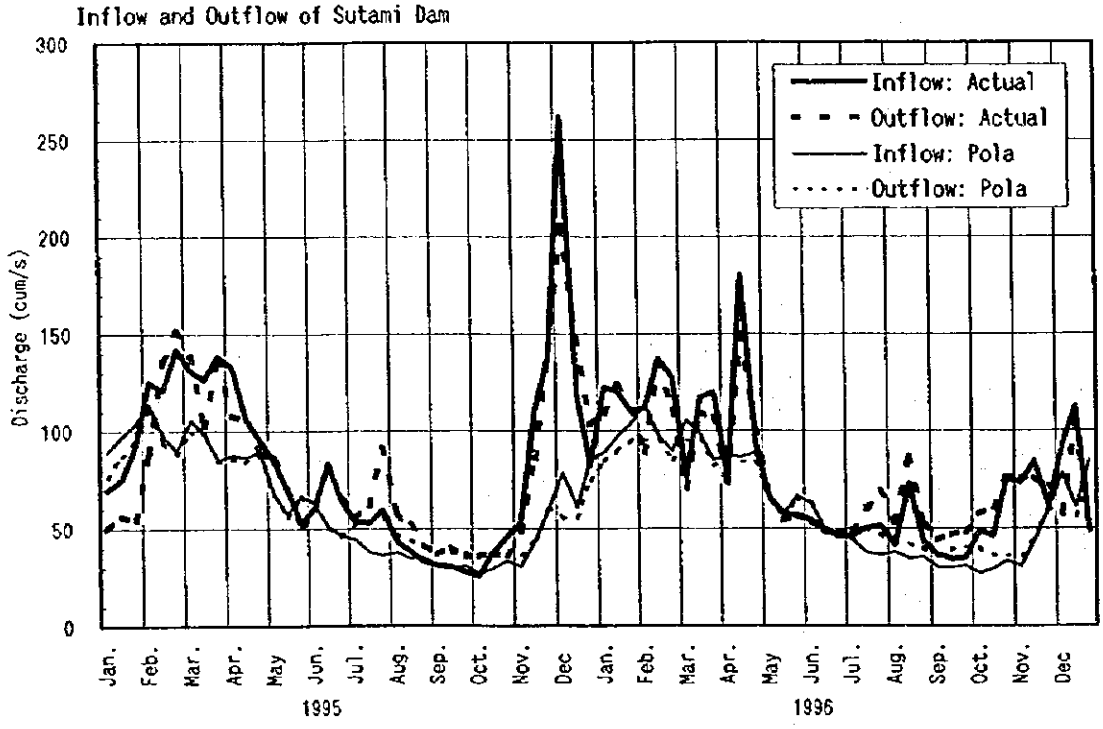
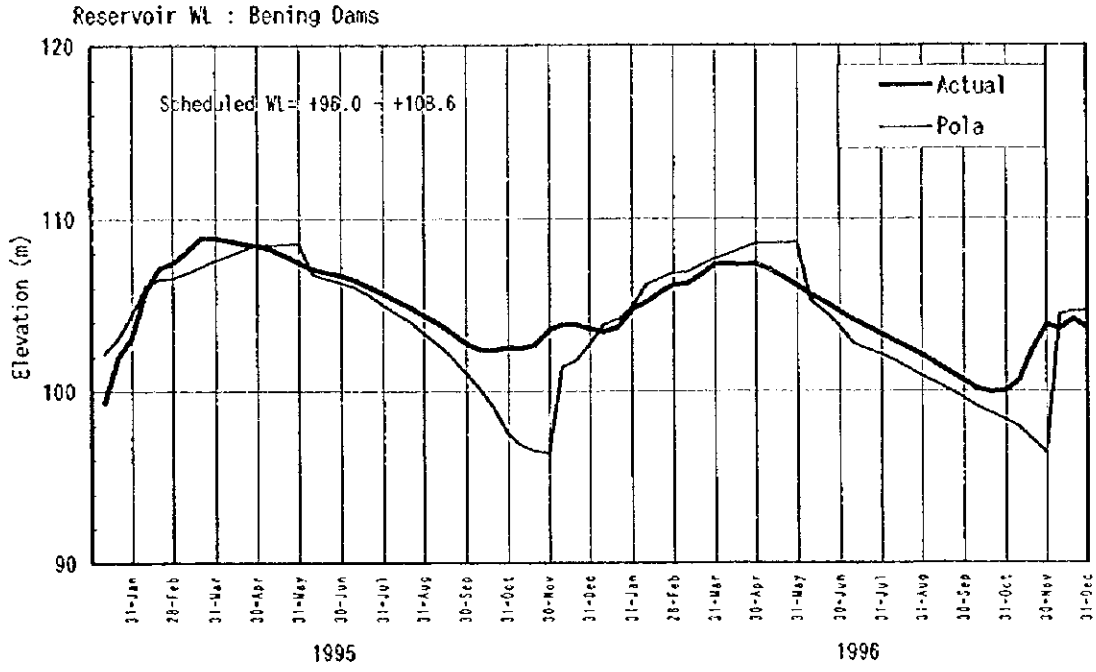


Figure A7-2 Performance of Dam (1/4) Sutami and Lahor Dams



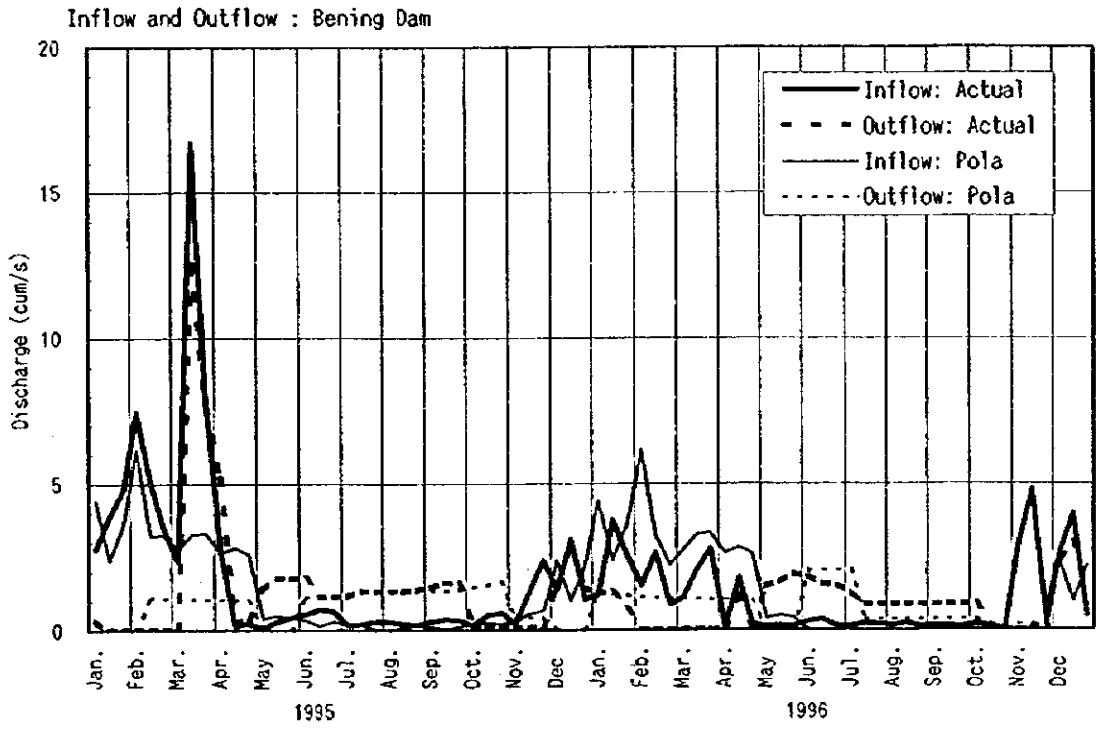
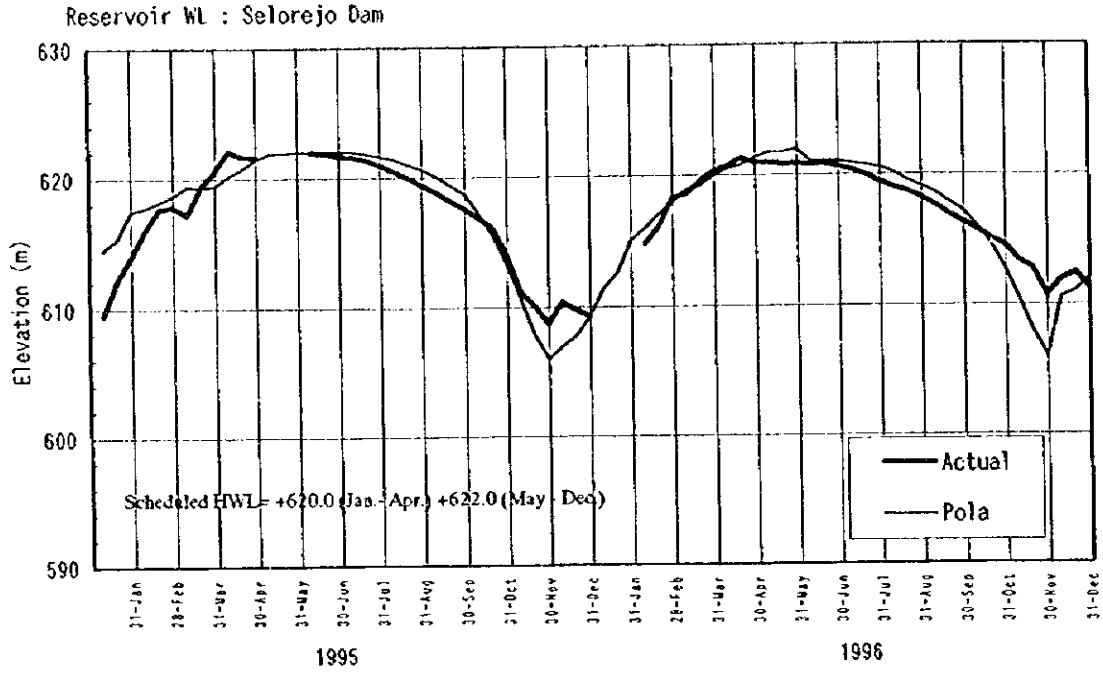


Figure A7-2 Performance of Dam (2/4) Bening Dam



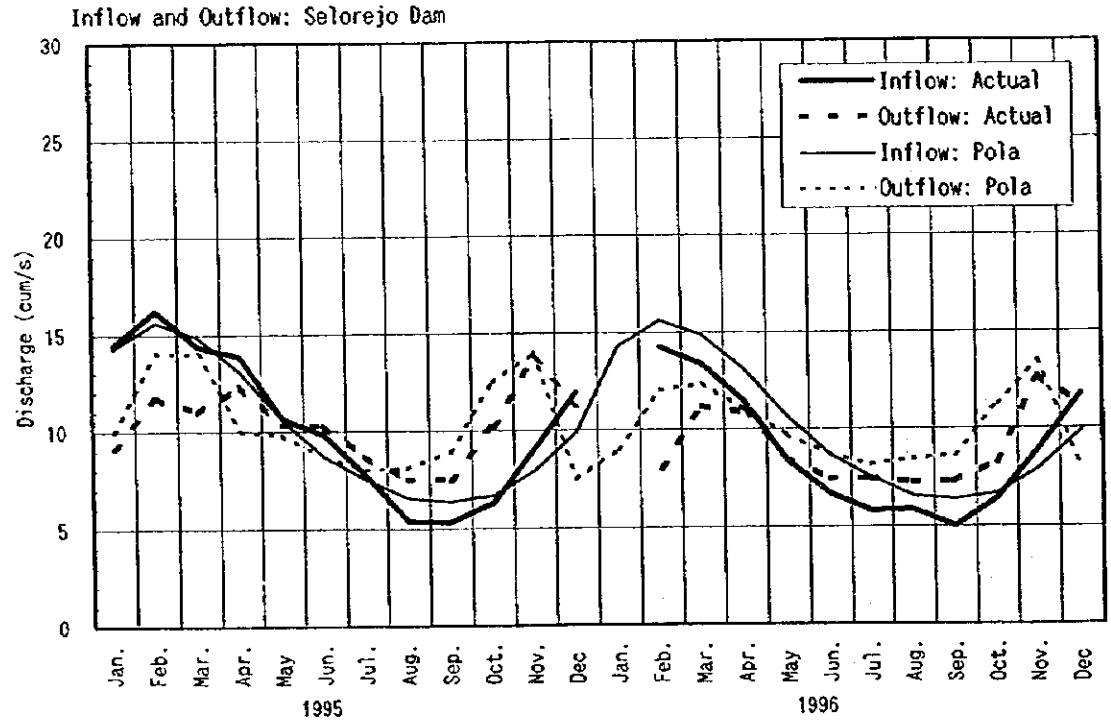
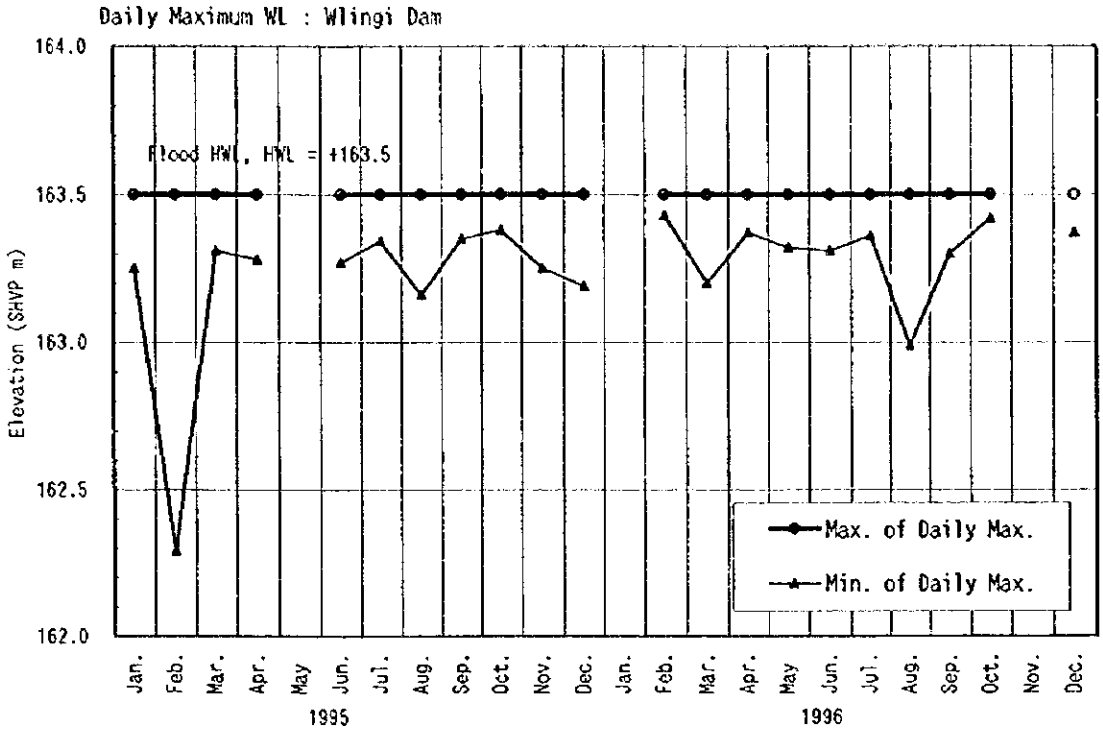


Figure A7-2 Performance of Dam (3/4) Selorejo Dams



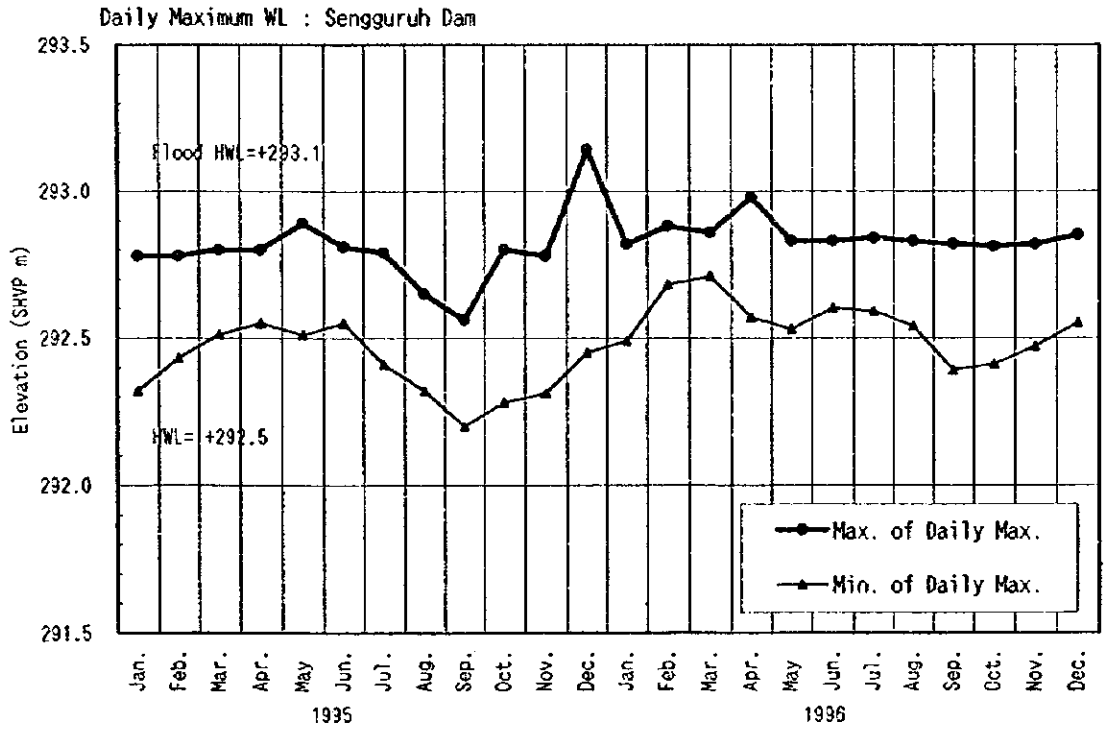
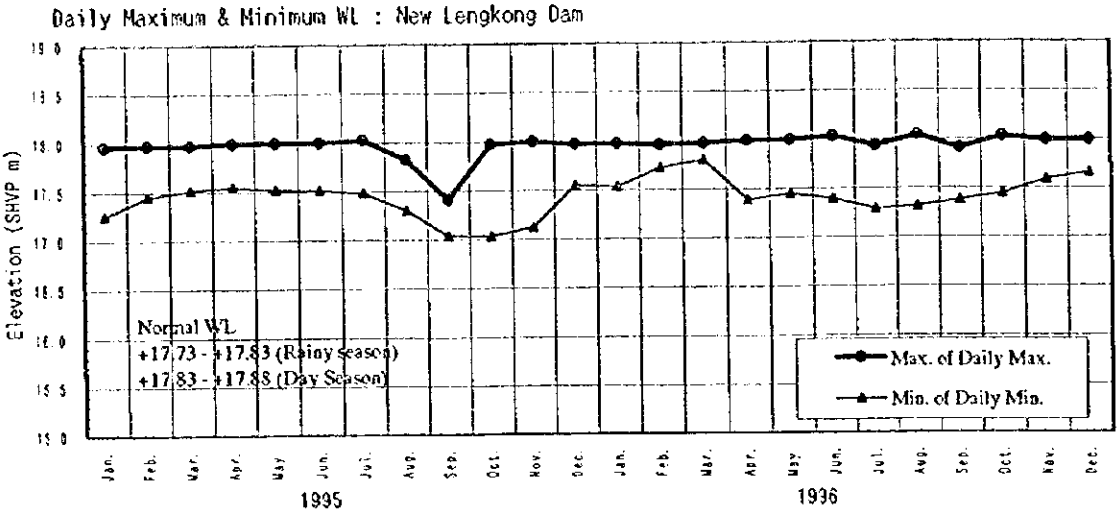
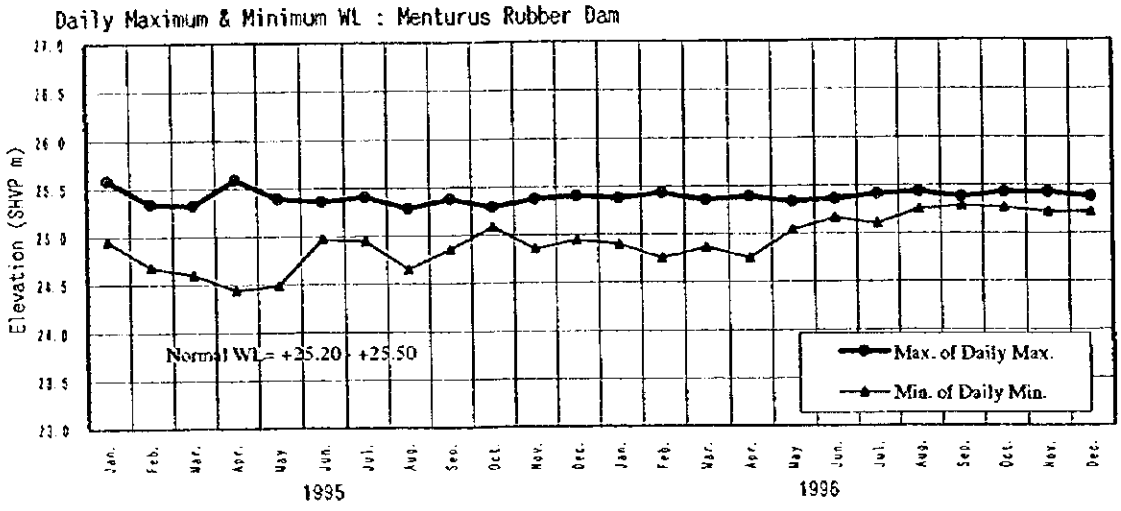


Figure A7-2 Performance of Dam (4/4) Wlingi and Senngurah Dams





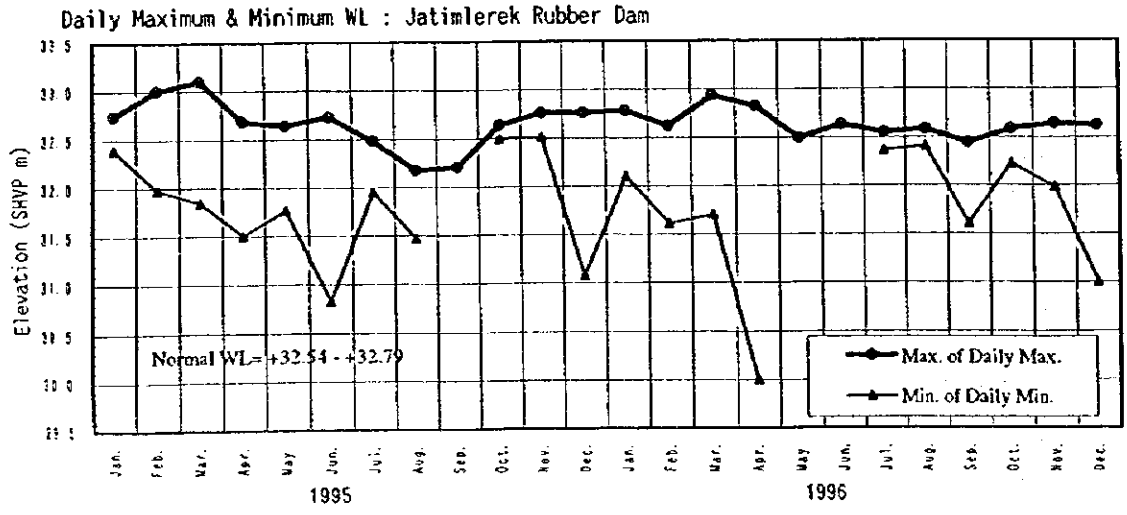
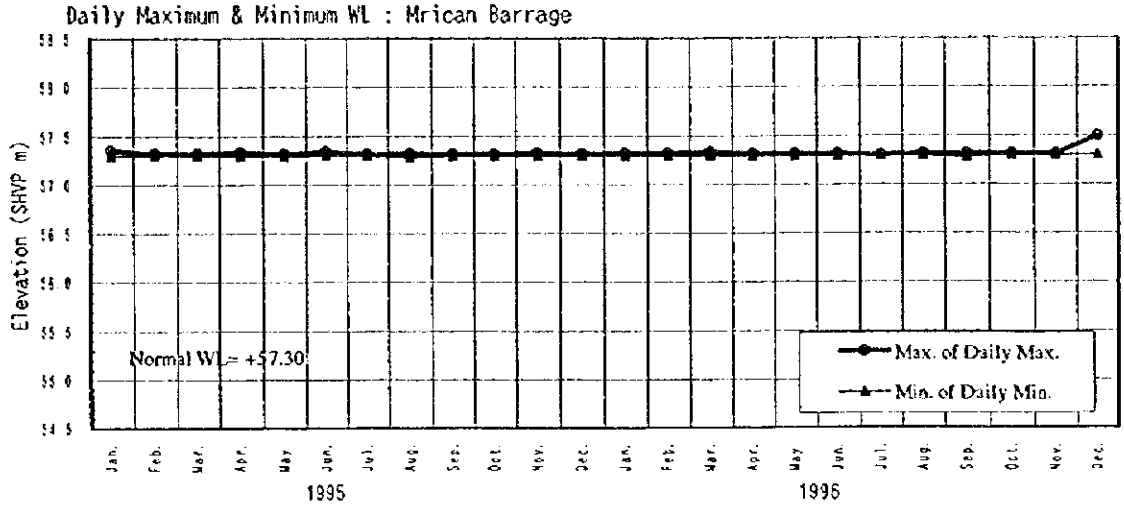


Figure A7-3 **Performance of Weir (1/3)**
New Lengkong Dam, Menturus and Jatimlerek Rubber Dam



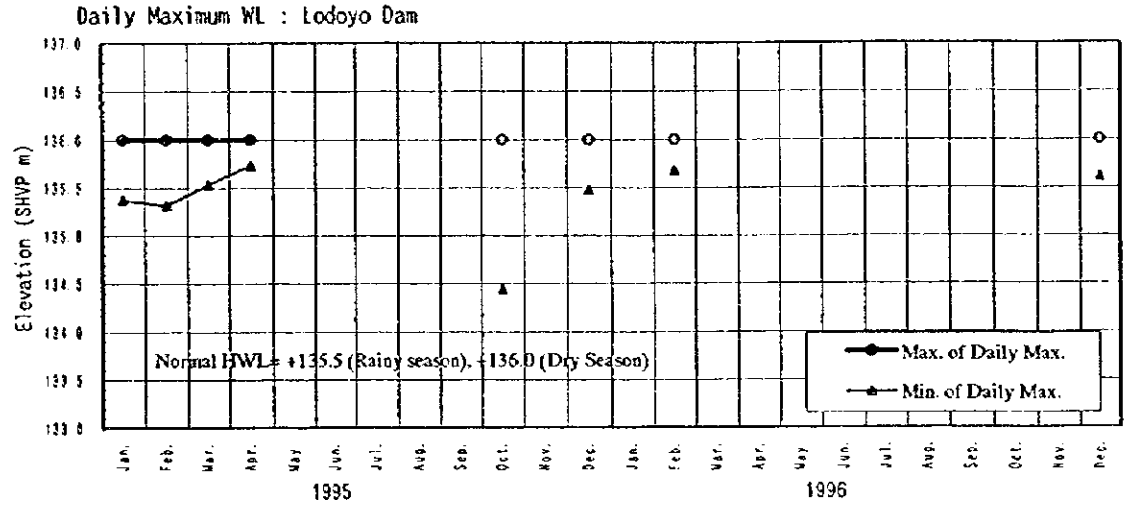
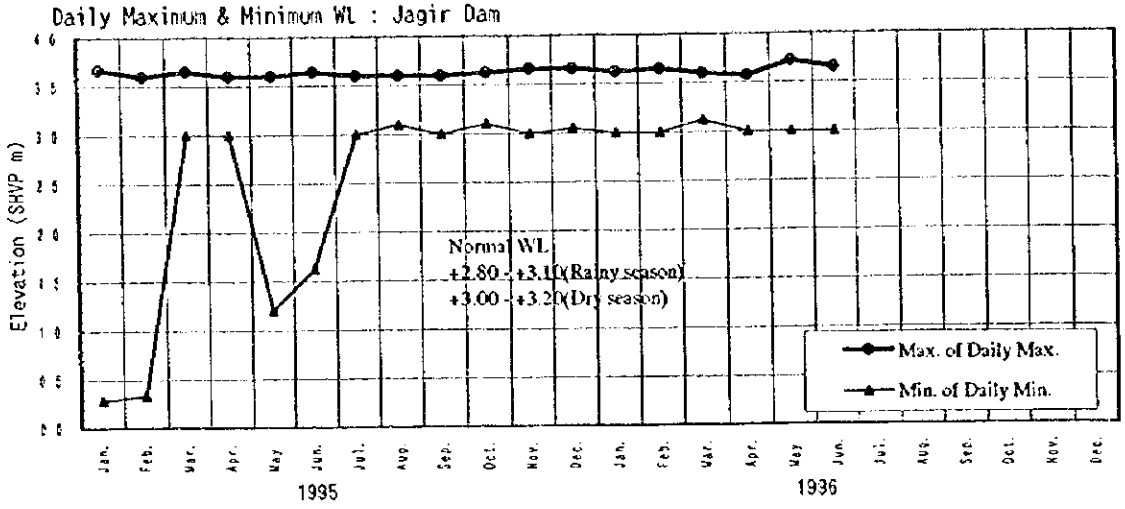
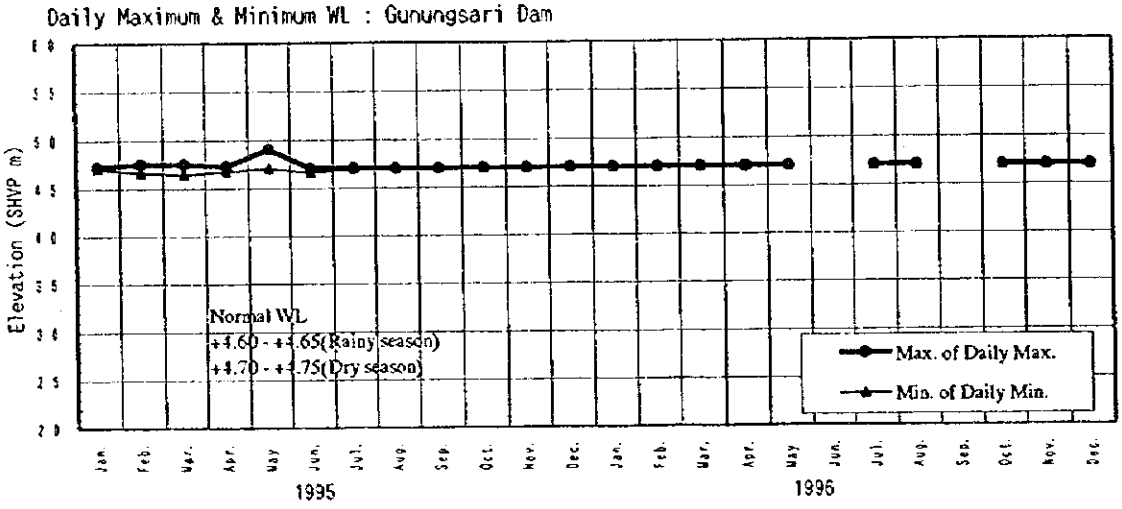


Figure A7-3 **Performance of Weir (2/3)**
Mrican Barrage, Lodoyo Dam





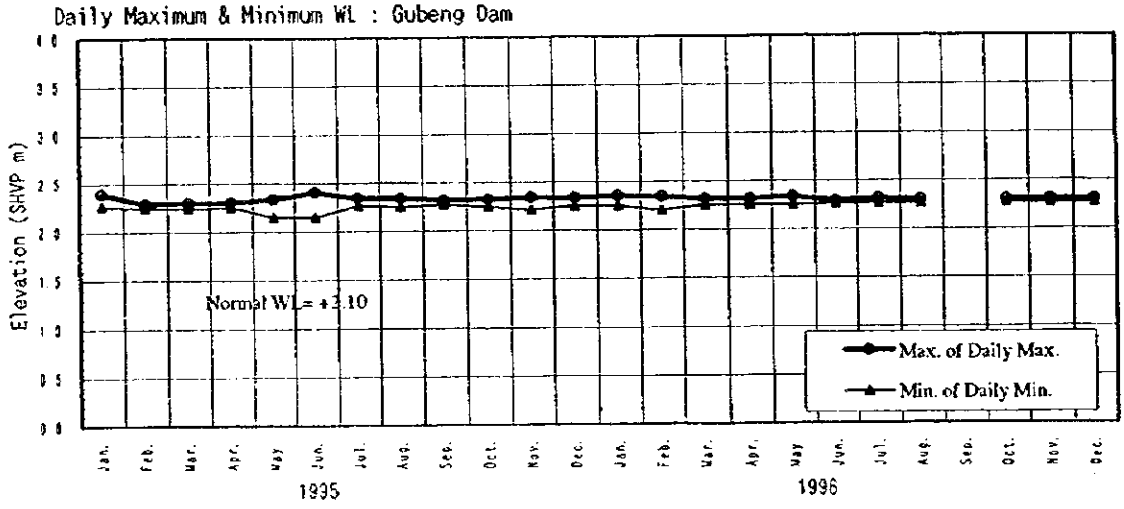


Figure A7-3 **Performance of Weir (3/3)**
Jagir Dam, Gunungsari Dam, Gubeng Dam

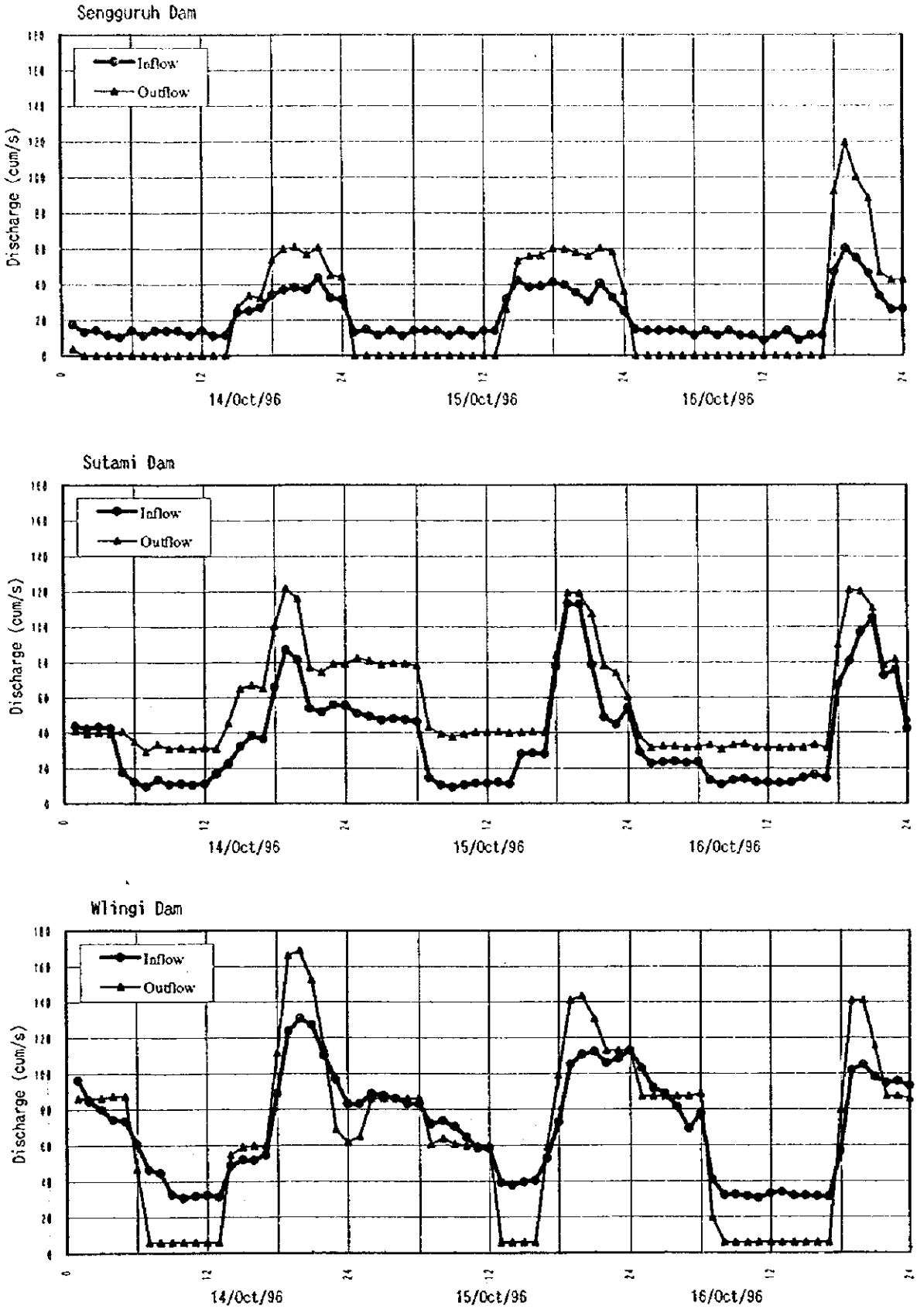
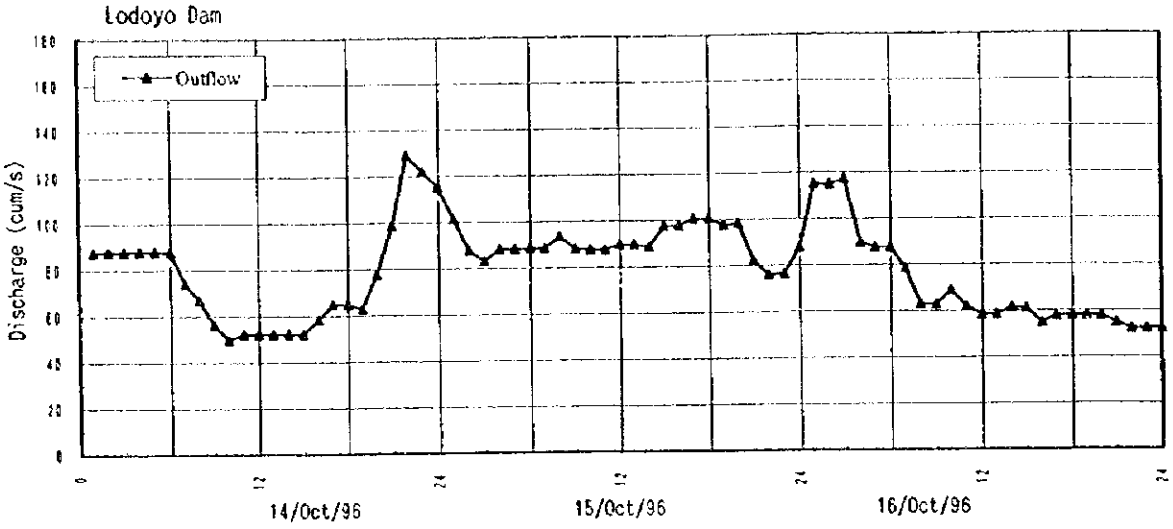
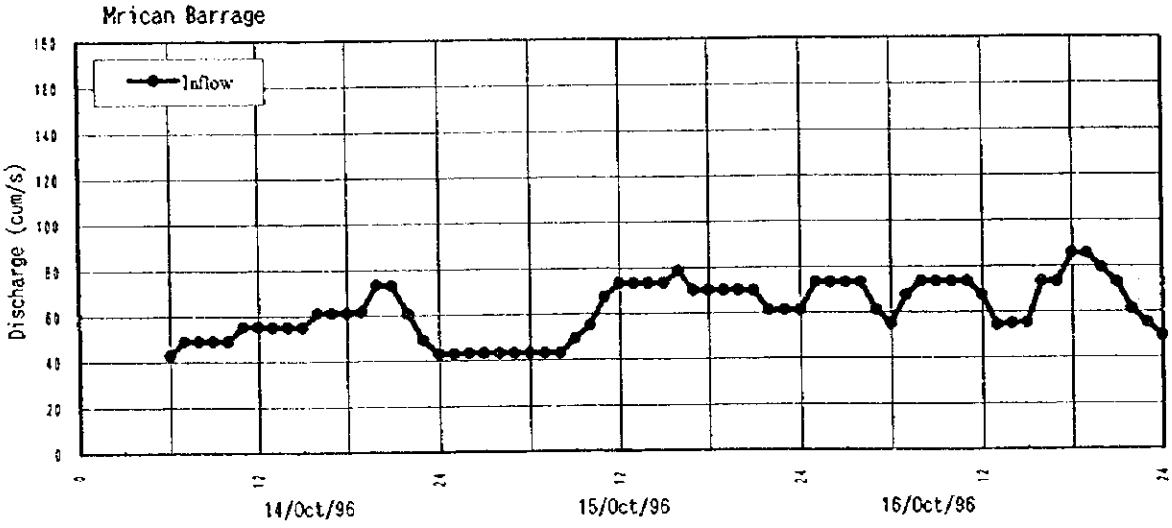


Figure A7-4 Hourly Operation of Dam and Weir (1/2)





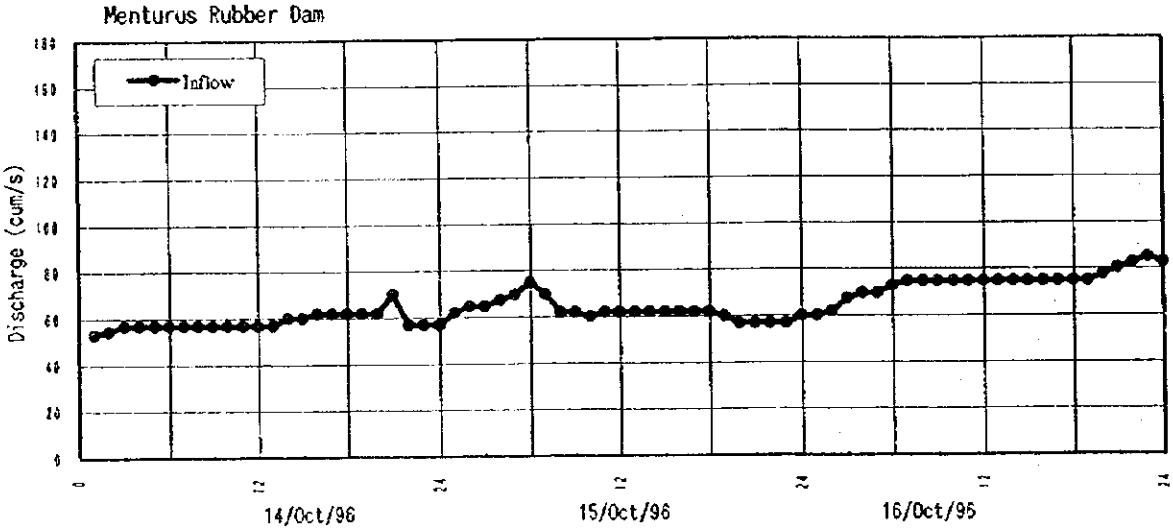


Figure A7-4 Hourly Operation of Dam and Weir (2/2)

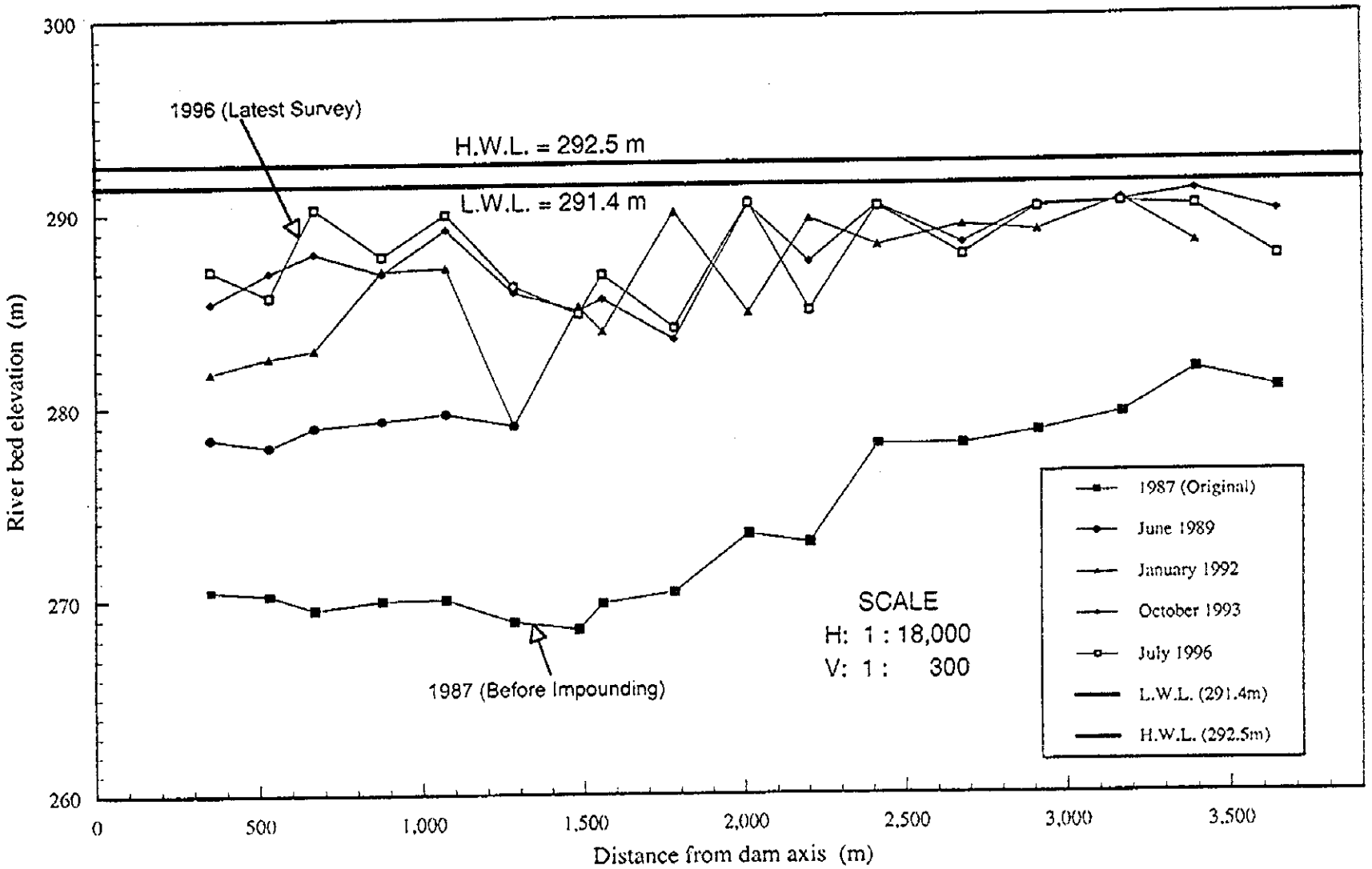


Figure A7-5 Longitudinal Profile of Sengguruh Reservoir (1/2: Brantas River)

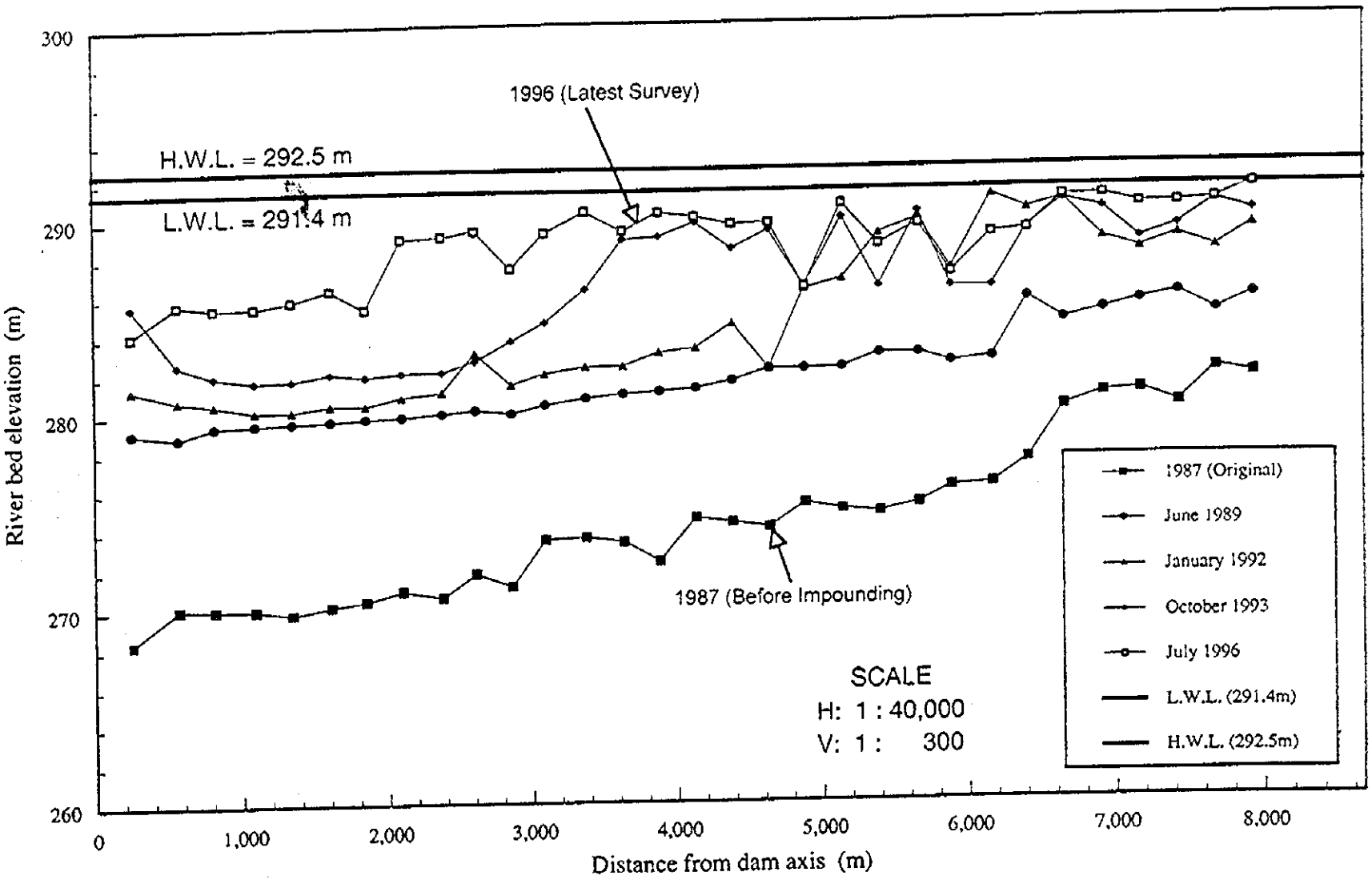


Figure A7-5 Longitudinal Profile of Sengguruh Reservoir (2/2: Lesti River)

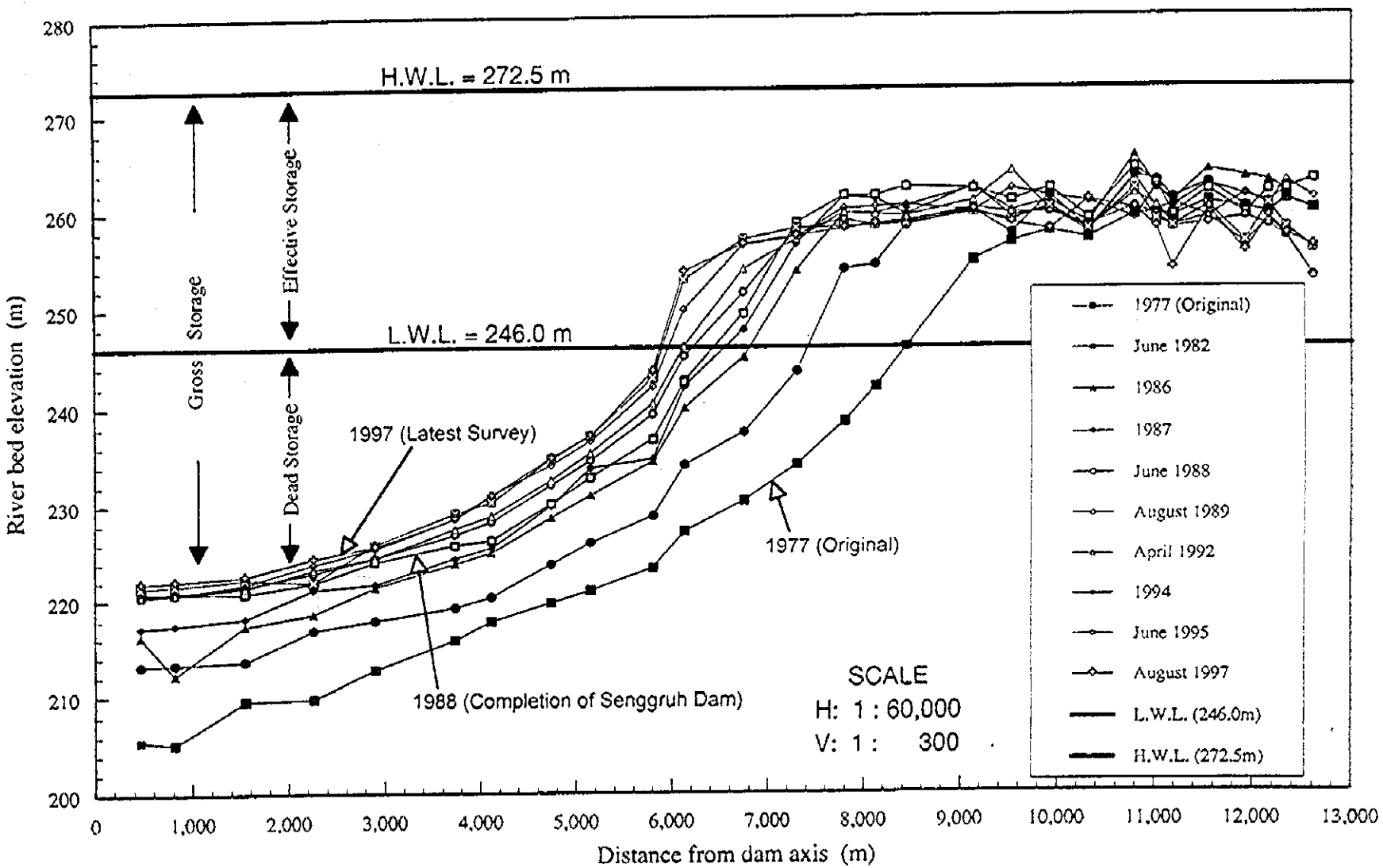
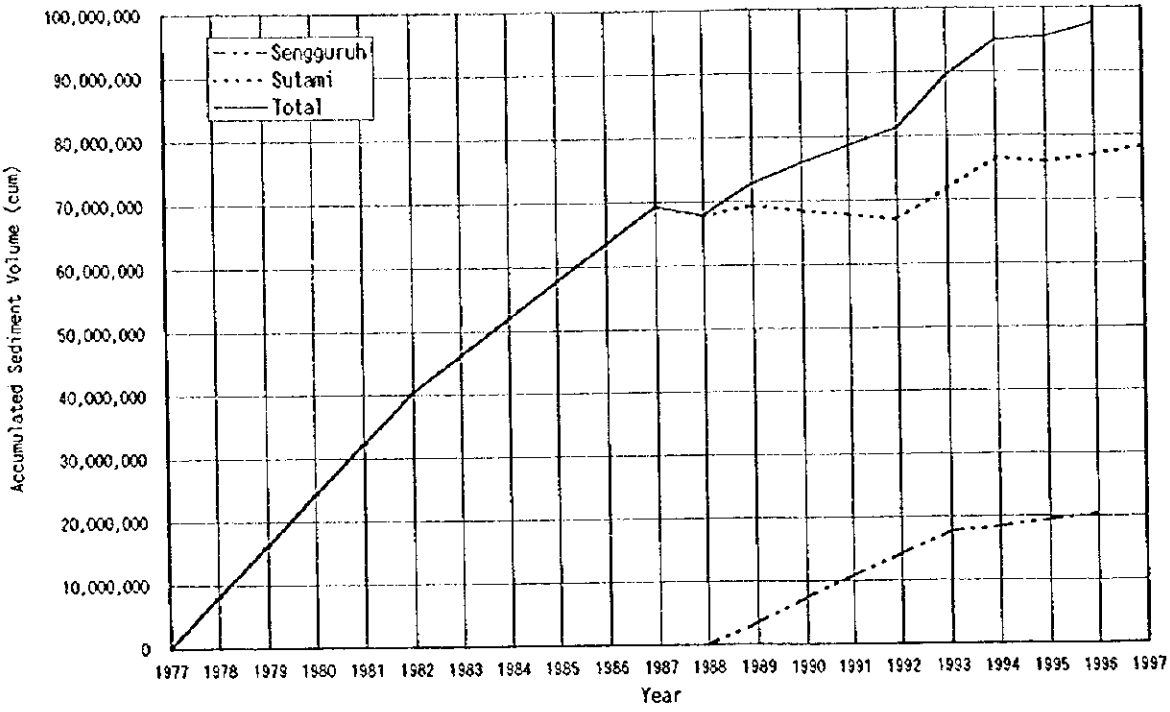


Figure A7-6 Longitudinal Profile of Sutami Reservoir

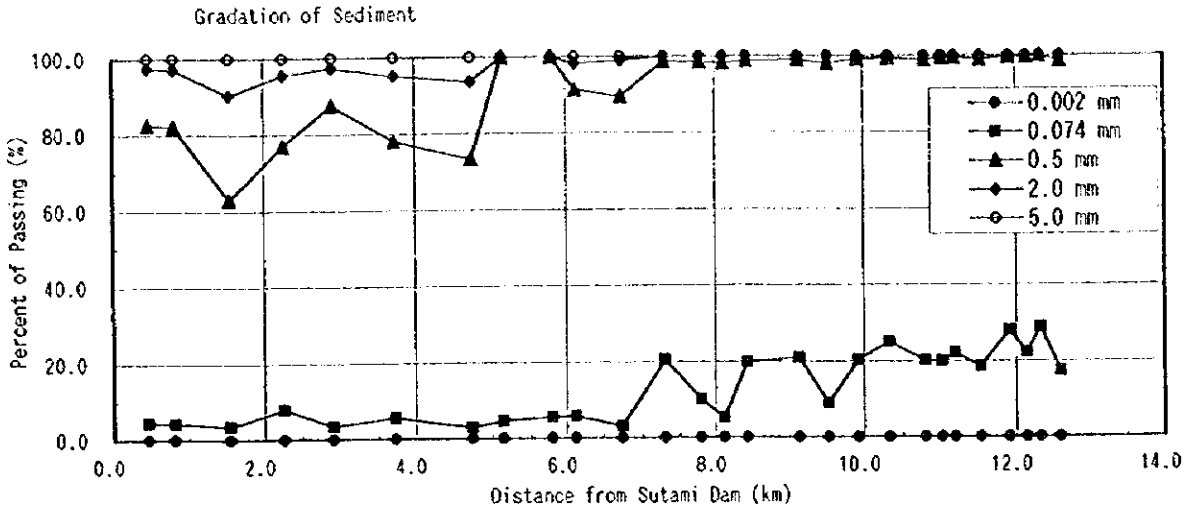


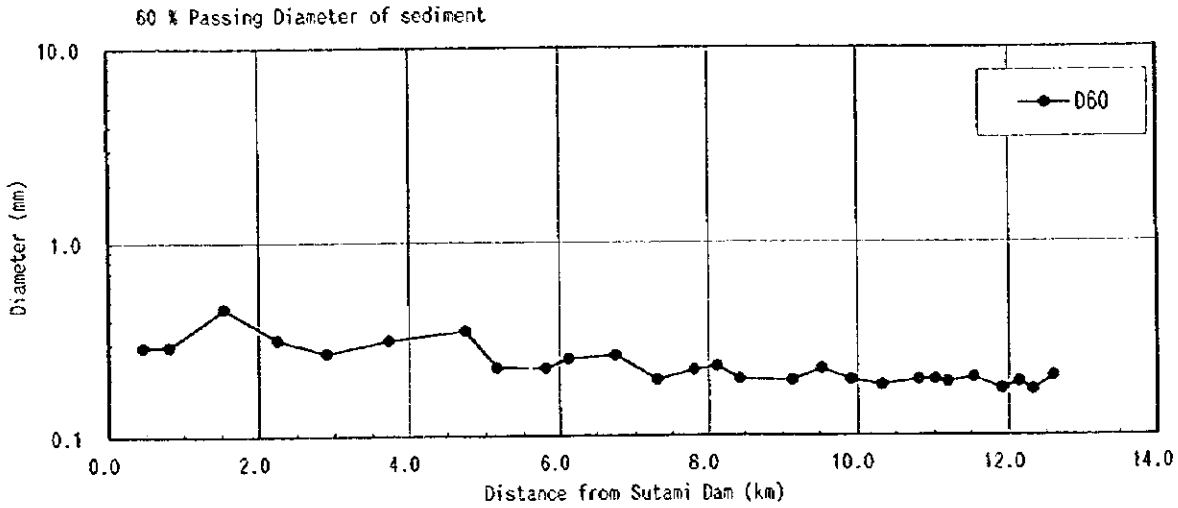
Unit: cum

Year	Accumulated Sediment Volume (Survey)				Accumulated Sediment Volume			Remarks
	Sengguruh			Sutami	Sengguruh	Sutami	Total	
	Reservoir	Dreding	Wonokerto					
1977	-	-	-	0		0	0	
1978	-	-	-	-		8,076,501	8,076,501	
1979	-	-	-	-		16,153,002	16,153,002	
1980	-	-	-	-		24,229,503	24,229,503	
1981	-	-	-	-		32,306,004	32,306,004	
1982	-	-	-	40,382,505		40,382,505	40,382,505	
1983	-	-	-	-		46,159,430	46,159,430	Commencement of construction of Sengguruh dam
1984	-	-	-	-		51,936,355	51,936,355	
1985	-	-	-	-		57,713,279	57,713,279	
1986	-	-	-	-		63,490,204	63,490,204	
1987	-	-	-	69,267,129		69,267,129	69,267,129	
1988	0	-	-	67,857,166	0	67,857,166	67,857,166	Completion of construction of Sengguruh dam
1989	-	-	0	69,282,230	3,404,067	69,282,230	72,686,297	Completion of construction of Wonokerto Check dam
1990	-	-	645,000	-	7,453,134	68,529,186	75,982,320	Full of sediment in Wonokerto Check dam
1991	-	-	-	-	10,857,201	67,776,141	78,633,342	
1992	-	-	-	67,023,097	14,261,268	67,023,097	81,284,365	
1993	17,020,335	69,490	-	-	17,734,825	71,715,207	69,450,032	
1994	-	63,075	-	76,407,316	18,466,575	76,407,316	94,873,891	
1995	-	400,030	-	75,898,161	19,535,281	75,898,161	95,433,442	
1996	19,026,361	233,575	-	-	20,437,531	77,076,012	97,513,543	
1997			-	78,253,862		78,253,862		

Note:
(1) Sediment volume of the Sengguruh reservoir is calculated by the Study Team in accordance with the survey report by PJT.
(2) Dredging volume is actual volume informed from PJT.
(3) Wonokerto means Wonokerto check dam. Sediment volume is designed capacity.
(4) Sediment volume of the Sutami rservoir is calculated by the Study team based on the original survey data.
(5) Sediment volume in 1977 is set at 0 due to the lack of applicable survey result before 1977.

Figure A7-7 Transition of Sediment Volume in Sengguruh and Sutami Reservoirs





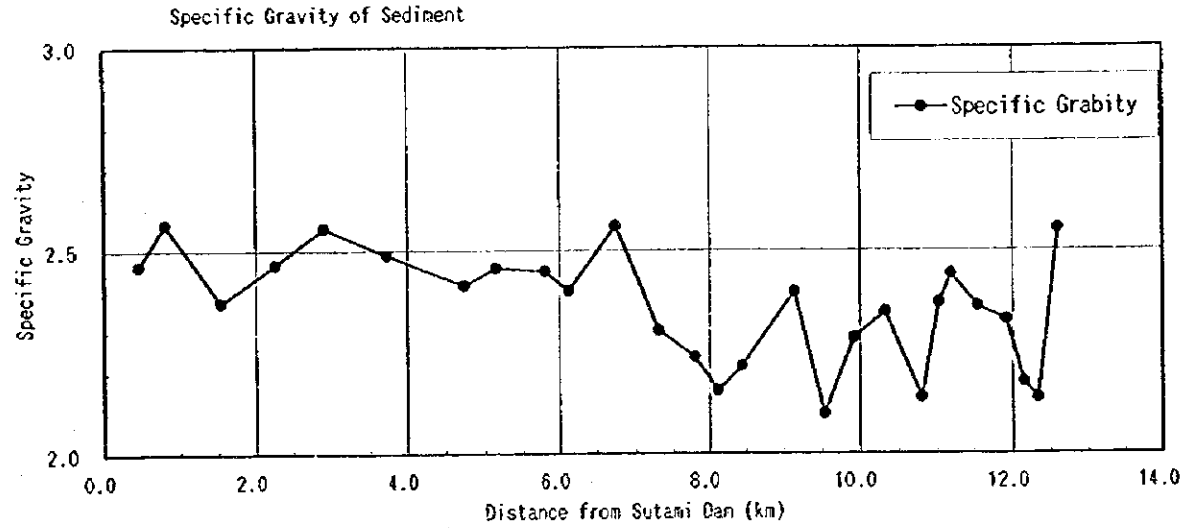


Figure A7-8 Characteristics of Sediment in Sutami Reservoir

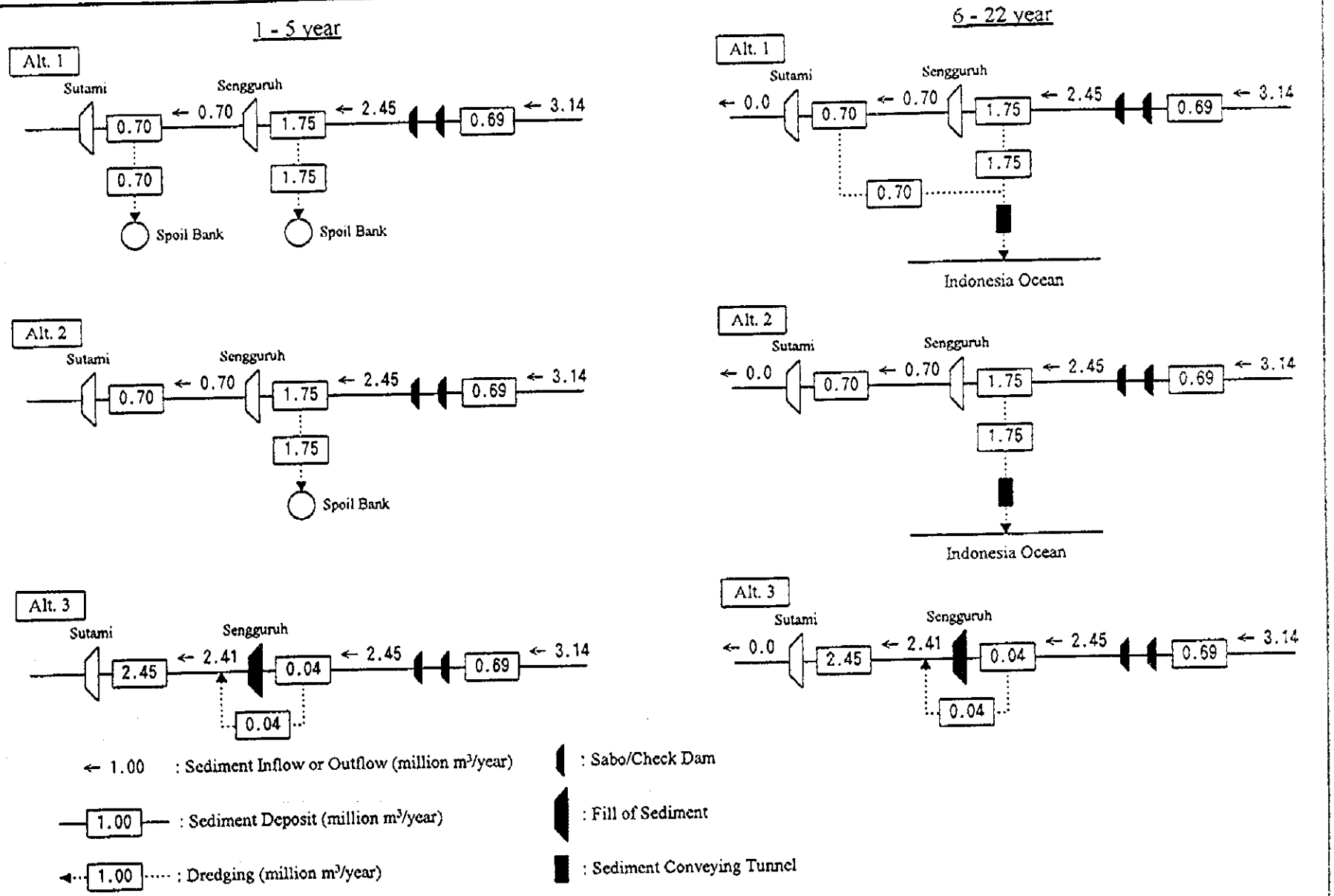


Figure A7-9 Alternative of Countermeasure for Sengguruh and Sutami Reservoirs

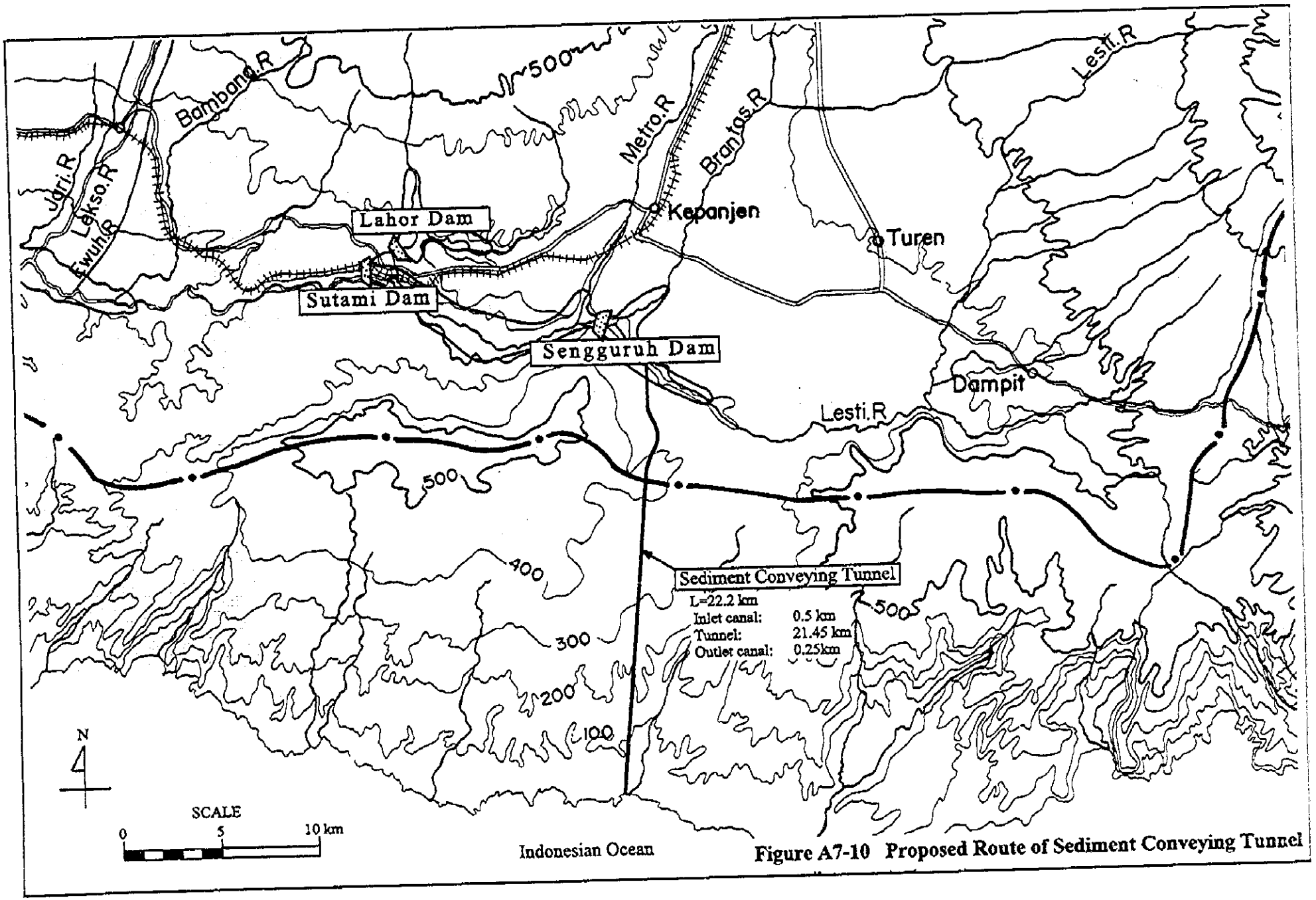


Figure A7-10 Proposed Route of Sediment Conveying Tunnel

Sediment Transport capacity of Inlet Canal

Dimension of Inlet Canal

B=3.0m, Side Slope = 1.0 : 0.5 Gradient I=1/77.35

Formula of Sediment Load

Bed load: Sato-Kikkawa-Ashida Formula

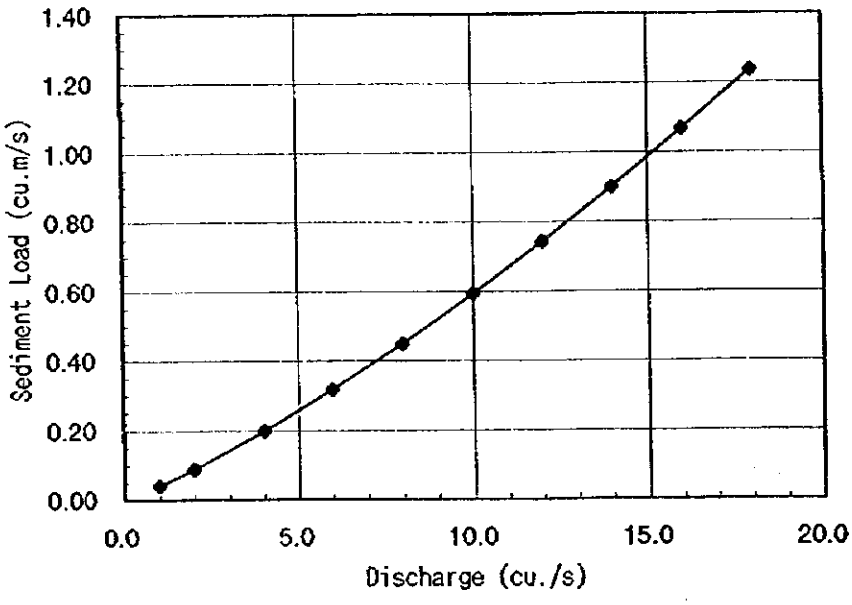
Suspended load: Ashida-Michiue Formula

Estimation Results

Unit: m^3/s

Q	SEDIMENT LOAD		
	BED LOAD	SUSPEN D LOAD	TOTAL LOAD
1.0	0.00125	0.03934	0.04059
2.0	0.00244	0.08536	0.08780
4.0	0.00478	0.19182	0.19660
6.0	0.00678	0.31024	0.31702
8.0	0.00867	0.43926	0.44793
10.0	0.01066	0.58164	0.59230
12.0	0.01250	0.72956	0.74206
14.0	0.01430	0.88492	0.89922
16.0	0.01627	1.05150	1.06777
18.0	0.01799	1.21804	1.23603

Note: Above sediment incude voids. (void ratio=0.42)



Relation between Discharge and Sediment Load

Required Water, Tunnel Diameter

Alternative	Dredging Volume (Mil. m^3/year)	Operation day (day/year)	Operation hour (hr/day)	Dredging Volume (m^3/hr)	Dredging Volume (m^3/s)	Required Water (m^3/s)	Tunnel Diameter (m)
Alt. 1	2.45	105	17	1373	0.381	6.98	2.30
Alt. 2	1.75	105	17	980	0.272	5.25	2.10

Figure A7-11 Required Water for Discharging Dredged Slurry

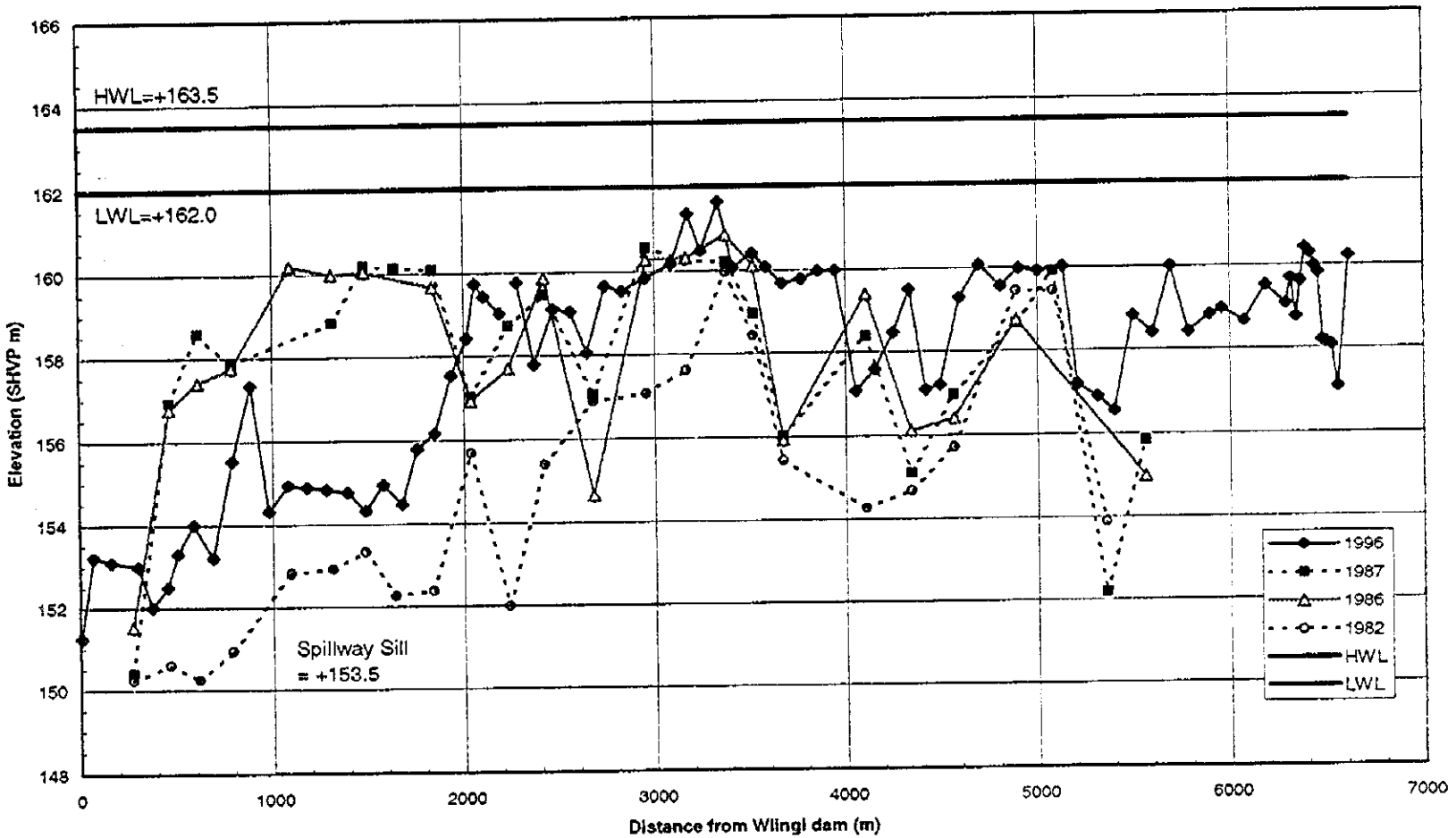


Figure A7-12 **Longitudinal Profile of Wlingi Reservoir**

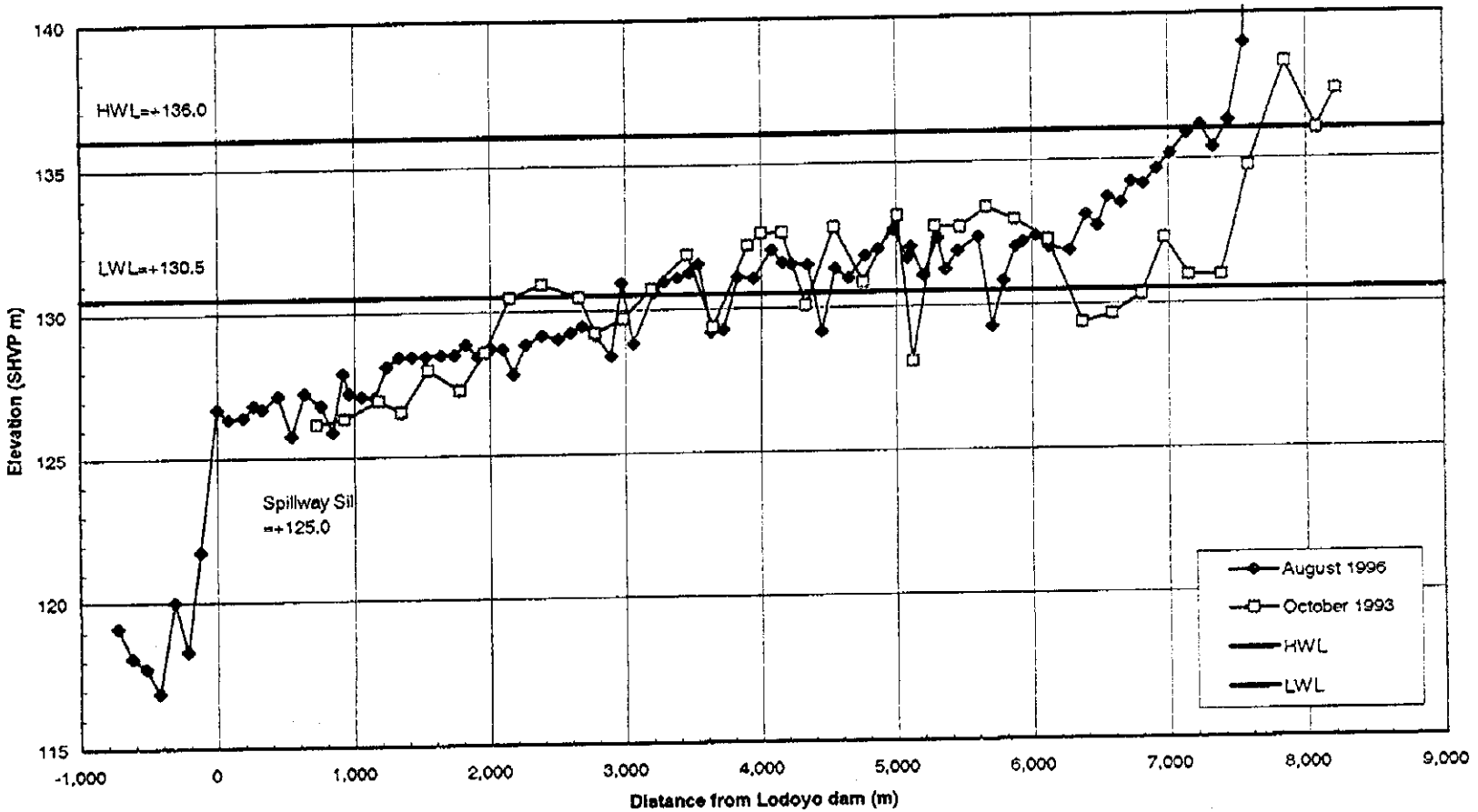


Figure A7-13 **Longitudinal Profile of Lodoyo Reservoir**

Source: The Brantas Rehabilitation Project,
Comprehensive Study of Sediment Bypass Channel,
Final Report, December 1996

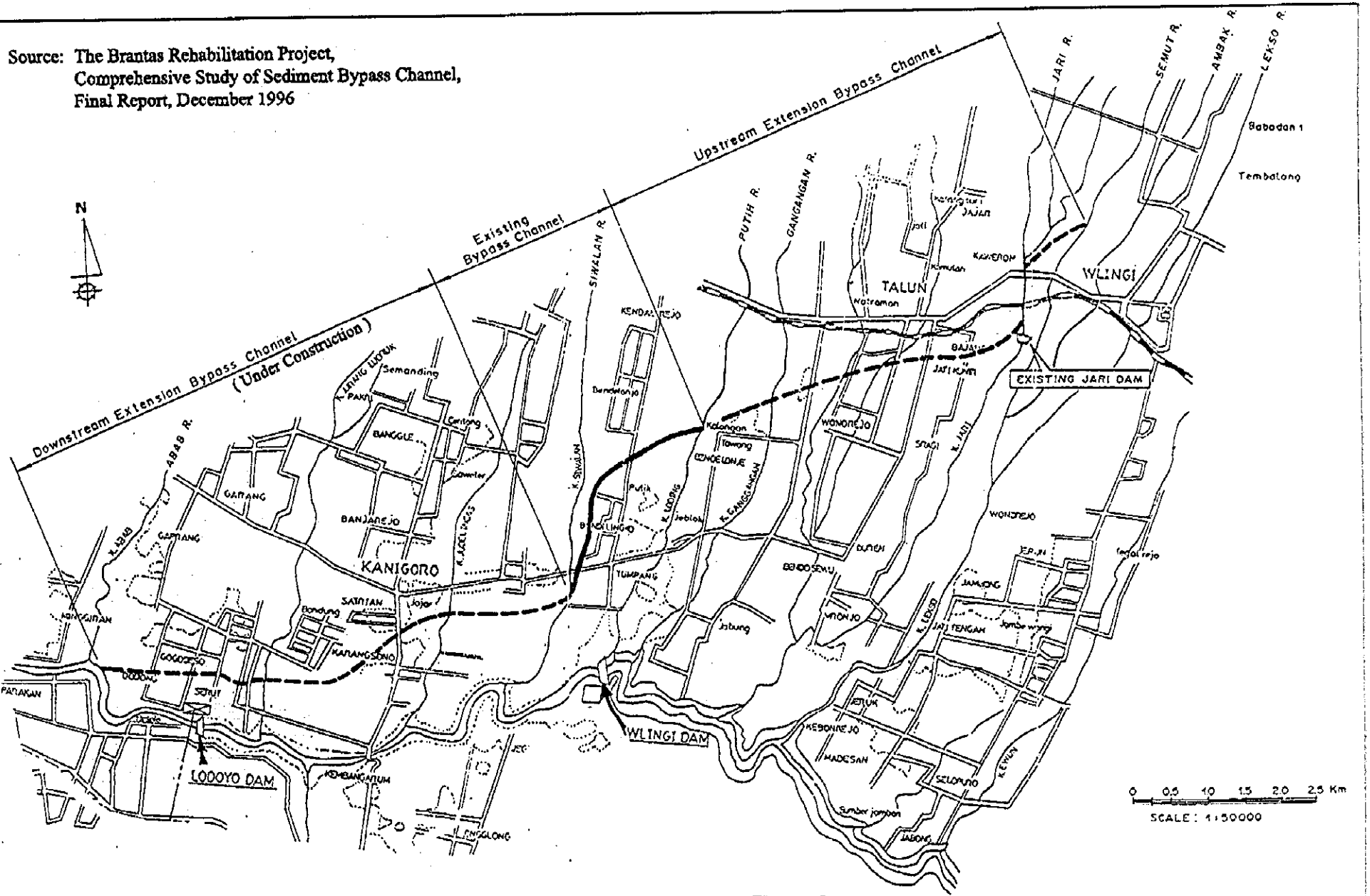


Figure A7-14 Proposed Route for Extesion of Sediment Bypass Channel

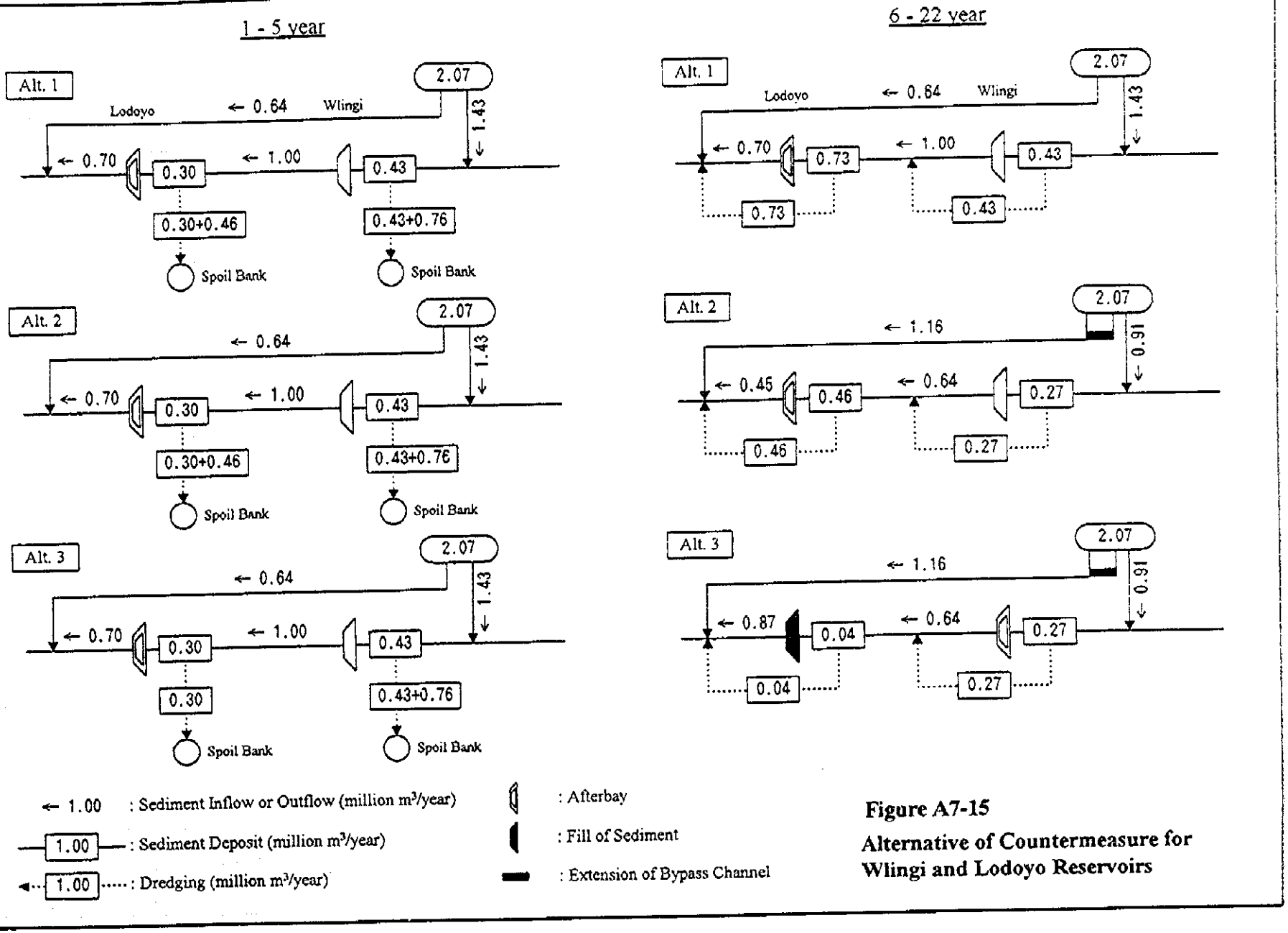
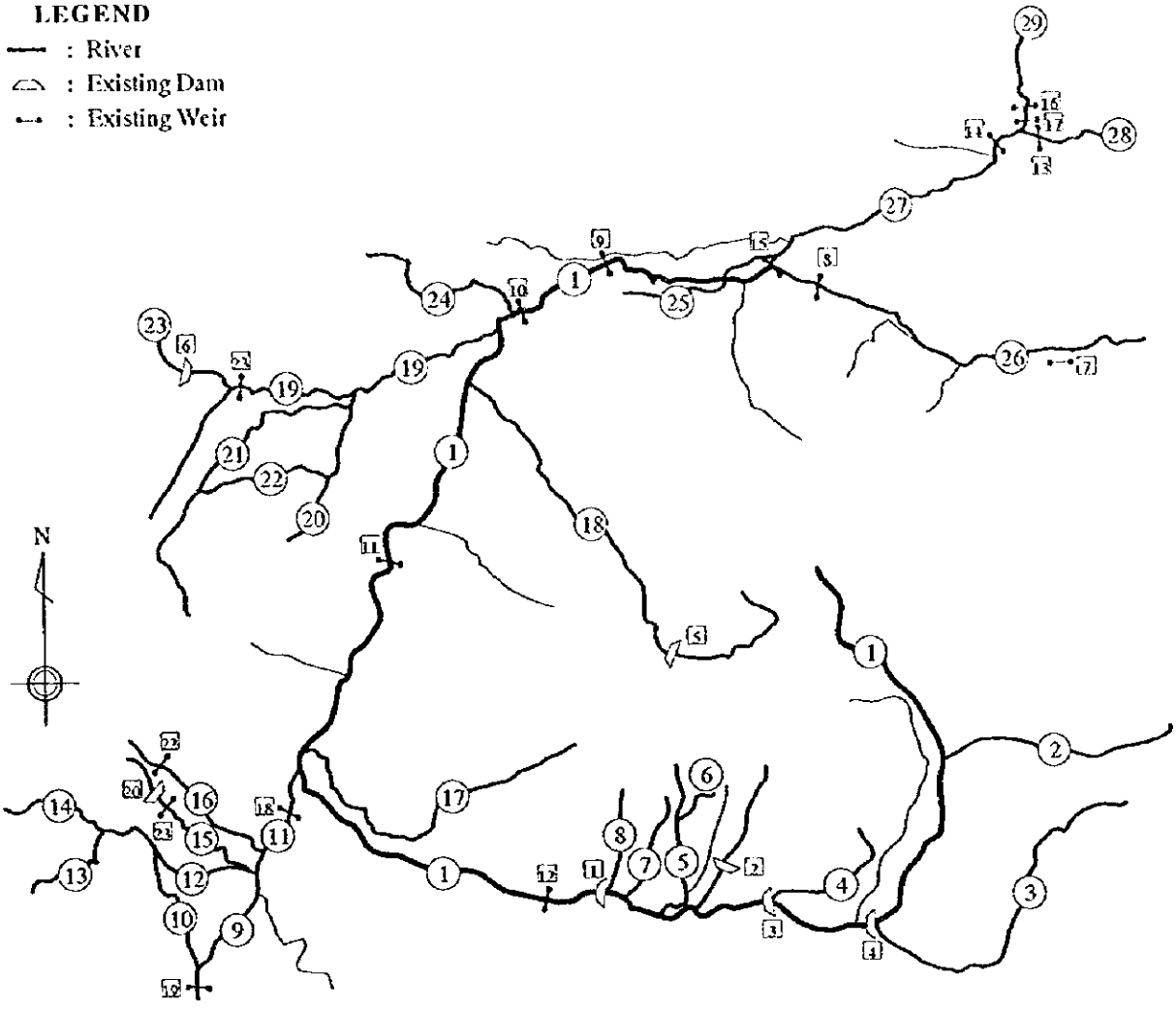


Figure A7-15
Alternative of Countermeasure for Wlingi and Lodoyo Reservoirs



Remarks:

River

(1)	Brantas	(16)	Song
(2)	Amprong	(17)	Badak
(3)	Lesti	(18)	Konto
(4)	Lahor	(19)	Widas
(5)	Lekso	(20)	Kedungsoko
(6)	Semut	(21)	Ulo
(7)	Jari	(22)	Kuncir
(8)	Putih	(23)	Bening
(9)	Parit Agung	(24)	Beng
(10)	Parit Raya	(25)	Watudakon
(11)	Ngrowo	(26)	Porong
(12)	Ngasinan	(27)	Surabaya
(13)	Tawing	(28)	Wonokromo
(14)	Tugu	(29)	Mas
(15)	Boding		

Major facility

Dam

[1]	Wlingi
[2]	Lahor
[3]	Sutami
[4]	Sengguruh
[5]	Selorejo
[6]	Bening
[20]	Wonorejo

Weir

[7]	Bangil Tak
[8]	New Lengkong
[9]	Menturus
[10]	Jatimlerek
[11]	Mrican
[12]	Lodoyo
[13]	Jagir
[14]	Gunungsari
[15]	Mlirip
[16]	Gubeng
[17]	Wonokromo
[18]	Tulungagung
[19]	Tulungagung Tunnel
[21]	Glatik
[22]	Segawe Weir
[23]	Tiudan

Figure A7-16 Rivers and Facilities Proposed To Be Managed By PJT

ANNEX - 8

EFFECTIVE OPERATION OF WATER RESOURCES

ANNEX - 8 EFFECTIVE OPERATION OF WATER RESOURCES

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1 Reservoir Facilities in the Basin and its Present Conditions

At present, There are four dams for purpose of water supply and flood control in the Brantas river basin. Location of the dams is shown in Figure A8-1. Catchment areas, design effective storage volume and design functions of those dams are shown below:

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. Therefore, the Sutami dam with the Lahor dam are the only facility for water supply and flood control in the mainstream of the Brantas River.

The reservoir operation in the Brantas river basin is executed 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. Performance of the practical operation based on POLA is monitored by PJT through the telephone and/or observation equipment of the flood forecasting and warning system (FFWS).

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. Actual intake discharges of the major intake facilities are shown in Table A8-1 and summarized below:

Unit: Million m^3

Name of Intake	1995		1996	
	Pola	Actual	Pola	Actual
Voor I and II canals	685.79	1153.43	653.09	1161.98
Mlirip	630.72	1581.06	632.45	1326.21
Menturus	53.44	49.32	54.12	84.28
Jatimlerek	30.28	29.09	29.08	35.14
Warujayeng	235.14	256.89	231.15	232.29
Turitunggorono	226.14	250.91	246.98	250.55
Lodagung	242.42	239.82	245.17	246.39

As the results, excessive water is allocated to the intake at the downstream site as the residual water. This result indicates the following matters:

(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 as the residual water.

(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 discharge 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 difficult to cultivate land immediately, however, it is efficient to reallocate the excessive intake discharge 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 observation equipment of 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 change the water allocation to the most suitable one on the way of actual operation of a POLA, technically.

The water demand will be increased in future, and proper water allocation is indispensable. Therefore, it is recommended to perform the water reallocation flexibly and properly on the way of actual operation of a POLA.

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 Wonorejo and Sutami Dams

At present, the Wonorejo multipurpose dam project is under implementing in the Ngrowo river basin. General features of the Wonorejo multipurpose dam project are shown in Table A8-2. The purpose of the project is as follows:

(a) to supply raw water for Surabaya and its vicinity in dry season for municipal and industrial use with supplementary maintenance water for the Surabaya River,

(b) to control floods from the Song and Gondang Rivers, and

(c) to generate electric power for local use.

The water conveyance system of in the Ngrowo river basin after completion of construction of the project is presented at Figure A8-2. According to the plan, totally 31.5 million m^3 of municipal and industrial water will be supplied to Surabaya from the Wonorejo reservoir through the Tiudan diversion canal and from the Parit Agung Canal pushed back by the Tulungagung pump station (completion in the year 2003). Therefore, two facilities will be used for water supply in future, that is, the Sutami dam and the Wonorejo dam. However, the integrated operation rule of two facilities is not yet formulated.

In this study, from the view of the integrated operation of two facilities, simple simulation study is carried out about following three cases by using the water balance study model described in ANNEX-5 "WATER BALANCE STUDY" of this report:

Case 1: Priority to the water supply from the Sutami dam. Deficit of water will be supplied from the Sutami dam and the Tulungagung pump station, firstly. After empty of the Sutami reservoir, deficit of water will be supplied from the Wonorejo dam and the Tulungagung pump station. Water supply capacity of the Tulungagung pump station is considered 1.18 m^3/s as the dependable firm discharge of the push back scheme.

Case 2: Priority to the water supply from the Wonorejo dam. Deficit of water will be supplied from the Wonorejo dam and the Tulungagung pump station, firstly. After empty of the Wonorejo reservoir, deficit of water will be supplied from the Sutami dam and the Tulungagung pump station.

Case 3: Effective storage capacity basis: Deficit of water will be supplied from the Tulungagung pump station, firstly. Remained deficit of water will be supplied from the Sutami dam (62%) and Wonorejo dam (38%) at the same time on the basis of ratio for the effective storage volumes.

Simulation results for various natural flow conditions in dry season under the present demand in 1996 are shown in Tables A8-3 and A8-4. This simulation is the roughly estimate, however, 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:

1999 - 2001

(a) Set up of tentative rule for water allocation and reservoir operation of the Wonorejo dam by mutual consent with related agencies: 1999.

(b) Establishment of proper water allocation rule including water reallocation during operation by mutual consent with related agencies, and monitoring of reallocation of water: 1999 – 2001.

(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: 1999 – 2000.

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: 2002.

(b) Establishment of the proper low flow forecast in the Brantas river basin including the Ngrowo river basin: 2002 –2003.

(c) Detailed study on the integrated operation method of the Wonorejo dam system and the Sutami dam: 2002 – 2003.

(d) Establishment of the integrated operation rule of the Wonorejo dam system and the Sutami dam by mutual consent with related agencies: 2003 – 2004.

Table A8-1 Performance of Major Intake Facilities (1/2)

(unit: cum/s)

Year	Month	period	Voor I. II canals		Mlirip		Menturus		Jatimlerek		Waru-Jayeng		Turi-Tunggorono		Lodagung	
			Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual
1995	January	1st	34.14	46.34	20.00	39.27	2.75	2.61	1.73	1.99	12.89	11.64	12.50	11.57	9.52	9.00
		2nd	34.14	46.04	20.00	25.09	2.84	2.81	1.73	1.41	9.95	12.89	9.64	12.53	9.17	9.17
		3rd	34.14	36.68	20.00	26.03	2.72	2.80	1.73	1.24	9.95	12.88	9.64	12.52	8.13	8.23
	February	1st	28.71	38.15	20.00	33.12	1.99	1.37	1.73	1.03	9.95	12.92	9.64	12.30	7.63	7.64
		2nd	28.05	43.43	20.00	38.53	1.99	2.19	1.73	1.04	9.95	12.94	9.64	12.53	7.83	7.80
		3rd	27.86	56.95	20.00	56.31	1.87	2.35	1.37	1.81	9.95	12.94	9.64	12.53	7.14	7.21
	March	1st	26.77	62.52	20.00	61.65	1.69	1.93	0.98	0.40	10.05	12.93	9.73	12.52	7.11	7.10
		2nd	25.94	67.31	20.00	71.46	1.78	1.83	0.81	0.31	9.97	12.94	9.66	10.74	7.06	7.80
		3rd	22.34	58.01	20.00	70.89	1.58	1.77	0.54	0.65	9.16	12.91	8.88	8.37	7.52	8.10
	April	1st	22.34	39.54	20.00	61.45	1.58	1.62	0.54	1.08	9.16	9.57	8.88	8.94	8.94	8.99
		2nd	22.34	28.25	20.00	47.05	1.58	1.22	0.54	0.27	9.16	9.19	8.88	8.90	8.62	8.61
		3rd	22.34	38.38	20.00	73.76	1.58	1.85	0.54	0.74	9.16	9.20	8.88	8.91	8.59	8.60
	May	1st	22.34	33.60	20.00	75.55	1.58	1.83	0.54	1.98	9.16	9.20	8.88	8.91	7.02	8.01
		2nd	22.34	38.22	20.00	75.55	1.58	1.82	0.54	1.98	9.16	9.20	8.88	8.91	6.97	8.50
		3rd	22.34	38.22	20.00	44.42	1.58	1.71	0.54	1.98	9.16	9.20	8.88	8.91	6.97	8.50
	June	1st	24.00	40.99	20.00	49.95	2.00	1.11	1.30	0.42	7.50	9.21	6.50	8.92	9.00	9.95
		2nd	25.00	49.76	20.00	81.02	2.00	1.83	1.30	1.37	7.00	6.39	6.50	6.80	9.00	10.00
		3rd	26.00	42.74	20.00	81.65	2.00	1.81	1.00	1.24	7.00	6.08	6.50	6.55	9.00	10.00
	July	1st	23.00	43.19	20.00	66.50	2.00	0.00	1.00	1.20	7.00	6.09	6.50	6.55	9.00	8.91
		2nd	21.00	35.42	20.00	65.17	2.00	1.08	1.00	0.79	7.00	6.09	6.00	6.55	8.00	7.92
		3rd	21.00	39.51	20.00	63.20	2.00	0.00	0.80	0.83	7.00	5.55	5.00	6.81	6.00	6.05
	August	1st	21.00	32.71	20.00	38.07	2.00	0.00	0.70	0.23	4.00	5.03	5.00	5.04	6.00	6.00
		2nd	18.00	29.10	20.00	28.54	1.50	0.00	0.60	0.00	4.00	4.08	4.00	4.06	6.00	6.00
		3rd	16.00	27.60	20.00	23.80	1.50	0.00	0.50	0.00	4.00	4.07	3.50	4.02	6.00	6.00
	September	1st	11.00	21.29	20.00	21.88	1.20	1.34	0.50	0.00	4.00	4.06	3.50	4.03	6.00	6.00
		2nd	10.00	13.55	20.00	22.45	1.20	1.44	0.50	0.00	4.00	4.08	3.50	4.03	6.00	6.00
		3rd	8.00	14.45	20.00	20.92	1.00	0.99	0.50	0.40	4.00	4.08	3.50	4.03	6.00	6.00
	October	1st	8.00	12.01	20.00	21.01	1.00	0.98	0.40	0.89	3.00	3.57	3.00	3.49	6.00	6.00
		2nd	8.00	20.30	20.00	28.19	1.00	1.07	0.40	0.93	3.00	0.91	3.00	3.10	6.00	6.00
		3rd	11.00	21.61	20.00	39.50	1.00	1.23	0.40	0.95	3.00	3.04	3.00	3.10	6.00	6.00
	November	1st	13.00	21.26	20.00	39.77	1.00	1.47	0.40	0.85	3.00	4.47	3.00	5.08	7.00	6.00
		2nd	16.00	30.59	20.00	61.97	1.00	1.47	0.80	0.85	7.00	4.46	7.00	5.07	10.00	6.00
		3rd	16.00	34.55	20.00	75.44	1.00	1.46	1.20	0.73	10.00	4.46	10.00	5.07	12.50	6.00
	December	1st	24.95	39.35	20.00	49.10	1.72	1.64	2.16	2.06	6.74	12.55	6.95	12.57	9.06	9.51
		2nd	33.62	39.33	20.00	61.80	1.96	3.93	1.92	1.37	10.57	12.54	10.91	10.98	8.69	8.62
		3rd	32.66	39.33	20.00	67.59	2.20	3.85	1.73	0.40	9.39	12.54	9.69	12.37	7.70	7.72
Total Discharge(Million cum)			685.79	1153.43	630.72	1581.06	53.44	49.32	30.28	29.09	235.14	256.89	226.14	250.91	242.42	239.82

Table A8-1 Performance of Major Intake Facilities (2/2)

(unit: cum/s)

Year	Month	period	Voor I, II canals		Mlirip		Menturus		Jatimlerek		Waru-Jayeng		Turi-Tunggorono		Lodagung	
			Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual	Pola	Actual
1996	January	1st	34.14	42.67	20.00	55.69	2.75	4.01	1.73	2.11	12.50	12.59	12.89	12.91	9.52	9.50
		2nd	34.14	43.23	20.00	69.94	2.84	4.05	1.73	1.94	9.64	9.75	9.95	10.06	9.17	9.21
		3rd	34.14	39.87	20.00	69.95	2.72	4.12	1.73	1.77	9.64	9.73	9.95	9.98	8.13	8.03
	February	1st	28.71	43.92	20.00	62.33	1.99	4.12	1.73	0.84	9.64	9.74	9.95	10.00	7.63	7.70
		2nd	28.05	44.82	20.00	43.93	1.99	4.11	1.73	1.61	9.64	9.73	9.95	9.99	7.83	7.77
		3rd	27.86	49.21	20.00	46.44	1.87	4.07	1.37	1.45	9.64	9.75	9.95	10.01	7.14	7.28
	March	1st	26.77	48.77	20.00	45.98	1.69	4.12	0.98	0.74	9.73	9.50	10.05	9.85	7.11	7.01
		2nd	25.94	47.50	20.00	50.73	1.78	4.21	0.81	1.37	9.66	9.75	9.97	10.00	7.08	7.00
		3rd	22.34	42.80	20.00	61.70	1.58	4.58	0.54	1.72	8.88	9.39	9.16	9.65	7.52	7.35
	April	1st	22.34	41.50	20.00	68.54	1.58	4.41	0.54	1.22	8.88	8.98	9.16	9.24	8.94	8.96
		2nd	22.34	33.36	20.00	62.53	1.58	4.22	0.54	1.80	8.88	8.99	9.16	9.29	8.62	8.63
		3rd	22.34	34.37	20.00	61.57	1.58	4.24	0.54	1.47	8.88	8.96	9.16	9.24	8.59	8.60
	May	1st	22.34	45.46	20.00	61.62	1.58	3.37	0.54	0.99	8.88	8.96	9.16	9.23	7.02	7.05
		2nd	22.34	36.76	20.00	32.86	1.58	2.74	0.54	1.71	8.88	8.96	9.16	9.22	6.97	7.00
		3rd	22.34	35.70	20.00	33.44	1.58	2.30	0.54	1.28	8.88	8.97	9.16	9.23	6.97	8.47
	June	1st	23.47	32.84	20.00	33.46	1.67	1.99	0.74	1.18	8.40	8.47	8.14	8.25	9.00	9.00
		2nd	22.25	34.25	20.00	34.51	1.69	1.88	0.75	0.85	8.28	8.01	8.08	8.10	9.00	9.00
		3rd	22.07	26.62	20.00	32.36	1.72	1.85	0.76	0.85	7.39	7.45	8.12	8.13	9.00	9.00
	July	1st	18.95	25.01	20.00	33.38	1.83	1.85	0.88	0.86	6.69	6.73	8.31	8.32	9.50	9.50
		2nd	17.18	24.78	20.00	31.42	1.93	1.83	0.83	0.84	5.01	5.13	7.82	7.89	9.50	9.50
		3rd	14.20	25.60	20.00	31.22	1.93	1.16	0.67	0.85	4.73	4.89	6.94	7.04	9.50	9.50
	August	1st	12.77	24.03	20.00	31.86	1.93	1.94	0.52	0.86	4.69	4.87	5.65	5.94	9.50	9.50
		2nd	11.07	38.37	20.00	32.85	1.93	1.94	0.67	0.89	4.72	4.88	4.40	4.79	9.50	9.50
		3rd	11.07	28.73	20.00	23.80	1.89	1.96	0.64	0.83	4.75	4.88	4.54	4.59	7.00	7.08
	September	1st	10.67	25.36	20.00	24.67	1.31	1.48	0.50	0.76	4.43	4.27	4.96	5.02	6.00	6.00
		2nd	10.21	21.51	20.00	23.34	1.21	1.48	0.59	0.78	4.45	4.45	4.97	5.05	6.00	6.00
		3rd	8.37	21.65	20.00	27.35	1.13	1.48	0.60	0.74	4.42	4.45	5.02	5.05	6.00	6.00
	October	1st	8.37	26.85	20.00	30.70	1.13	1.48	0.60	0.80	4.42	4.46	5.02	5.06	6.00	6.00
		2nd	8.37	27.95	20.00	31.60	1.13	1.50	0.60	0.78	4.42	4.46	5.02	5.06	6.00	6.00
		3rd	11.16	34.82	20.00	36.80	1.13	1.48	0.60	0.85	4.42	4.09	5.02	5.07	6.00	6.00
	November	1st	13.95	42.44	20.00	37.50	1.13	1.47	0.60	0.85	4.42	4.47	5.02	5.08	6.00	6.00
		2nd	13.95	44.34	20.00	36.90	1.13	1.47	0.60	0.90	4.42	4.46	5.02	5.07	6.00	6.00
		3rd	13.95	51.84	20.00	37.20	1.13	1.46	0.60	0.75	4.42	4.47	5.02	5.08	6.00	6.00
	December	1st	29.45	56.35	20.00	37.24	1.72	2.22	2.16	0.75	6.74	7.14	6.95	6.32	9.06	8.93
		2nd	33.62	34.38	20.00	39.20	1.96	2.78	1.92	0.75	10.57	10.61	10.91	10.91	8.69	8.70
		3rd	32.66	46.70	20.00	35.75	2.20	2.75	1.73	1.23	9.39	8.40	9.69	11.56	7.70	7.72
Total Discharge(Million cum)			653.09	1161.98	632.45	1326.21	54.12	84.28	29.08	35.14	231.15	232.29	246.98	250.55	245.17	246.39

Table A8-2 Principal Features of the Wonorejo Multipurpose Dam Project

Description		Description		Description	
1. Segawe Diversion Scheme		Dam height	: 100 m	**3. Tiudan Headwork & Canal**	
1) Intake Weir		Crest length	: 545 m		
Catchment area	: 82.8 km^2	Embankment volume	: 6.15 million m^3	1) Tiudan Headwork	
Annual mean runoff	: 6.4 m^3/sec			Type	: Gated weir
Weir type	: Gated weir	3) Spillway		Crest elevation	: EL. 102.0 m
Crest elevation	: EL. 250 m	Design flood (Peak inflow)	: 820 m^3/s	Height	: EL. 12.0 m
Weir height	: 12 m	Type	: Non-gated side overflow weir, open chute and horizontal stilling basin	Gate	: 4 nos. 5.8 m H x 6.5 m B
Gate	: 4 nos. 7.8 m H x 6 m B			2) Canal	
High water Level	: EL. 248.5 m	Overflow weir length	: 110 m	Type	: Open trapezoidal canal
Discharge capacity	: 530 m^3/s	Design capacity	: 540 m^3/s	Length	: 3.6 km including aqueduct
				Flow capacity	: 15.0 m^3/s
2) Connection Tunnel		4) Waterway			
section	: 2r horse shoe	Type of intake	: Inclined intake	**4. Tulungagung Pumping Station**	
Diameter	: 5.0 m	Elevation of inlet sill	: EL. 136.5 m and EL. 127.0 m		
Length	: 765 m	Waterway tunnel		1) Approach channel	
Discharge capacity	: 160 m^3/s	Upstream of plug	: Diversion tunnel, D = 5 m	Type	: Trapezoidal section
		Downstream of plug	: Steel conduit, D = 1.9 m	Length	: 104m
2. Wonorejo Dam		Outlet valve	: Hollow jet valve, D = 1.6 m, 0.25 m		
1) Reservoir		Outlet capacity	: 43 m^3/s at HWL	2) Pump house	
Catchment area	: 126.3km^2 incl. the Kali Song			Type	: Concrete pile foundation
Annual mean runoff	: 8.1 m^3/s or 255 million m^3	5) Wonorejo Power Station		Height	: 20.5 m
Reservoir Area	: 3.85 km^2 at HWL	Diameter of penstock	: 1.9 m	Width	: 13.0 m
High water level	: EL. 183.0 m	Length of penstock	: 195 m	Length	: 27.5 m
Low water level	: EL. 141.0 m	Turbine	: 1 unit x 6,500 kW Horizontal Francis type		
Rated water level (for power generation)	: EL. 173.0 m	Generator	: 1 unit x 7,000 kVA, Synchronous type	3) Pump	
Minimum operation level (for power generation)	: EL 153.0 m	Rated head, gross	: 63.9 m	Type	: Vertical shaft mixed flow
Flood water level	: EL. 185.0 m	Tail water level	: EL. 109.1 m	Unit	: 3 nos.
Gross storage capacity	: 122 million m^3	Max. discharge	: 12.0 m^3/s	Engine	: 350 PS/unit
Active storage capacity	: 106 million m^3	Annual energy output	: 31.7 GWh	Capacity	: 225 m^3/min./unit
				Head	: 4.4 m
2) Dam		6) Transmission Line		Dia.	: 1.35 m
Type of dam	: Zoned rockfill with center core	Voltage	: 70 kV		
Crest elevation	: EL. 188.0 m	Length	: 13 km		

Table A8-3 Summary of Water Balance on Integrated Operation of Sutami and Wonorejo Reservoirs

Unit: Million m^3

Discharge Condition / Water Allocation	1996 Water Demand without River Maintenance water							1996 Water Demand with River Maintenance water						
	Deficit	Water Supply				Minimum Storage		Deficit	Water Supply				Minimum Storage	
		Sutami	Wonorejo	Push-back	Total	Sutami	Wonorejo		Sutami	Wonorejo	Push-back	Total	Sutami	Wonorejo
1977: 2/20 Drought														
Priority to Sutami dam	46.8	173.2	72.0	14.6	259.8	0.0	34.0	270.0	173.2	106.0	15.6	294.8	0.0	0.0
Priority to Wonorejo dam	13.6	173.2	106.0	14.6	293.8	0.0	0.0	270.0	173.2	106.0	15.6	294.8	0.0	0.0
Storage capacity Basis	13.6	173.2	106.0	14.6	293.8	0.0	0.0	270.0	173.2	106.0	15.6	294.8	0.0	0.0
1980: 4/20 Drought														
Priority to Sutami dam	14.2	181.5	34.8	13.6	229.9	0.0	71.2	205.8	173.2	106.0	16.6	295.8	0.0	0.0
Priority to Wonorejo dam	0.0	124.5	106.0	13.6	244.1	57.0	0.0	205.8	173.2	106.0	16.6	295.8	0.0	0.0
Storage capacity Basis	0.0	142.9	87.6	13.6	244.1	38.6	18.4	205.8	173.2	106.0	16.6	295.8	0.0	0.0
1988: 8/20 Drought														
Priority to Sutami dam	0.0	89.2	0.0	8.4	97.6	91.3	106.0	46.0	173.4	45.9	13.6	232.8	0.0	60.1
Priority to Wonorejo dam	0.0	13.9	75.3	8.4	97.6	159.3	30.7	0.0	159.3	106.0	13.6	278.9	14.1	0.0
Storage capacity Basis	0.0	55.3	33.9	8.4	97.6	122.4	72.1	0.0	165.9	99.4	13.6	278.9	7.5	6.6
1986: 16/20 Drought														
Priority to Sutami dam	No deficit under the condition of potential flow.							0.0	41.4	0.0	5.1	46.1	135.7	106.0
Priority to Wonorejo dam								0.0	0.0	41.0	5.1	46.1	173.2	65.0
Storage capacity Basis								0.0	25.4	15.6	5.1	46.1	151.3	90.4

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (1/8)

1977: 2/20 Drought

			1996 Water Demand without River Maintenance water								
			Deficit	Stami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	14.6	161.6	13.4	106.0	0.0	1.2	1.2	14.6	0.0
	2nd	10	26.5	139.7	25.3	106.0	0.0	1.2	1.2	26.5	0.0
	3rd	11	16.9	124.8	15.7	106.0	0.0	1.2	1.2	16.9	0.0
August	1st	10	25.7	103.6	24.5	106.0	0.0	1.2	1.2	25.7	0.0
	2nd	10	26.9	81.4	25.8	106.0	0.0	1.2	1.2	26.9	0.0
	3rd	11	22.2	61.4	21.1	106.0	0.0	1.2	1.2	22.2	0.0
September	1st	10	22.7	42.7	21.5	106.0	0.0	1.2	1.2	22.7	0.0
	2nd	10	26.1	21.2	24.9	106.0	0.0	1.2	1.2	26.1	0.0
	3rd	10	32.6	0.0	24.6	100.1	6.8	1.2	8.0	32.6	0.0
October	1st	10	35.7	0.0	0.0	87.1	15.0	1.2	16.2	16.2	19.5
	2nd	10	24.7	0.0	0.0	74.2	15.0	1.2	16.2	16.2	8.5
	3rd	11	27.5	0.0	0.0	59.9	15.0	1.2	16.2	16.2	11.3
November	1st	10	30.7	0.0	0.0	47.0	15.0	1.2	16.2	16.2	14.5
	2nd	10	16.4	0.0	0.0	34.0	15.0	1.2	16.2	16.2	0.2
	3rd	10	0.0	0.0	0.0	34.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			307.4		173.2		72.0	14.6	86.6	259.8	47.6
Priority to Wonorejo dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	14.6	173.2	0.0	94.4	13.4	1.2	14.6	14.6	0.0
	2nd	10	26.5	164.3	10.3	81.4	15.0	1.2	16.2	26.5	0.0
	3rd	11	16.9	163.7	0.7	67.2	15.0	1.2	16.2	16.9	0.0
August	1st	10	25.7	155.4	9.5	54.2	15.0	1.2	16.2	25.7	0.0
	2nd	10	26.9	146.1	10.8	41.2	15.0	1.2	16.2	26.9	0.0
	3rd	11	22.2	140.4	6.1	27.0	15.0	1.2	16.2	22.2	0.0
September	1st	10	22.7	134.7	6.5	14.0	15.0	1.2	16.2	22.7	0.0
	2nd	10	26.1	126.1	9.9	1.1	15.0	1.2	16.2	26.1	0.0
	3rd	10	32.6	100.1	30.1	0.0	1.2	1.2	2.4	32.6	0.0
October	1st	10	35.7	70.3	34.5	0.0	0.0	1.2	1.2	35.7	0.0
	2nd	10	24.7	50.0	23.5	0.0	0.0	1.2	1.2	24.7	0.0
	3rd	11	27.5	25.0	26.3	0.0	0.0	1.2	1.2	27.5	0.0
November	1st	10	30.7	0.0	28.9	0.0	0.0	1.2	1.2	30.1	0.6
	2nd	10	16.4	0.0	0.0	0.0	0.0	1.2	1.2	1.2	15.2
	3rd	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			307.4		173.2		106.0	14.6	120.6	293.8	13.6
Storage capacity Basis											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	14.6	166.0	8.3	101.6	5.1	1.2	6.3	14.6	0.0
	2nd	10	26.5	152.5	15.7	93.3	9.6	1.2	10.8	26.5	0.0
	3rd	11	16.9	143.2	9.7	87.6	6.0	1.2	7.1	16.9	0.0
August	1st	10	25.7	130.1	15.2	79.6	9.3	1.2	10.5	25.7	0.0
	2nd	10	26.9	116.3	16.0	71.1	9.8	1.2	11.0	26.9	0.0
	3rd	11	22.2	103.9	13.1	63.5	8.0	1.2	9.2	22.2	0.0
September	1st	10	22.7	92.3	13.4	56.4	8.2	1.2	9.4	22.7	0.0
	2nd	10	26.1	79.0	15.4	48.2	9.5	1.2	10.6	26.1	0.0
	3rd	10	32.6	62.2	19.5	37.9	11.9	1.2	13.1	32.6	0.0
October	1st	10	35.7	43.7	21.4	26.6	13.1	1.2	14.3	35.7	0.0
	2nd	10	24.7	31.1	14.6	18.9	8.9	1.2	10.1	24.7	0.0
	3rd	11	27.5	15.6	16.3	9.4	10.0	1.2	11.2	27.5	0.0
November	1st	10	30.7	0.0	18.0	0.0	10.9	1.2	12.1	30.1	0.6
	2nd	10	16.4	0.0	0.0	0.0	0.0	1.2	1.2	1.2	15.2
	3rd	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			307.4		173.2		106.0	14.6	120.6	293.8	13.6

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (2/8)

1977: 2/20 Drought

			1996 Water Demand with River Maintenance water								
			Deficit	Stami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	34.6	144.3	33.4	106.0	0.0	1.2	1.2	34.6	0.0
	2nd	10	46.5	105.2	45.3	106.0	0.0	1.2	1.2	46.5	0.0
	3rd	11	36.9	71.3	35.7	106.0	0.0	1.2	1.2	36.9	0.0
August	1st	10	45.7	32.8	44.5	106.0	0.0	1.2	1.2	45.7	0.0
	2nd	10	46.9	0.0	37.9	99.2	7.8	1.2	9.0	46.9	0.0
	3rd	11	42.2	0.0	0.0	85.0	15.0	1.2	16.2	16.2	26.1
September	1st	10	42.7	0.0	0.0	72.0	15.0	1.2	16.2	16.2	26.5
	2nd	10	46.1	0.0	0.0	59.1	15.0	1.2	16.2	16.2	29.9
	3rd	10	52.6	0.0	0.0	46.1	15.0	1.2	16.2	16.2	36.4
October	1st	10	55.7	0.0	0.0	33.1	15.0	1.2	16.2	16.2	39.5
	2nd	10	44.7	0.0	0.0	20.2	15.0	1.2	16.2	16.2	28.5
	3rd	11	47.5	0.0	0.0	5.9	15.0	1.2	16.2	16.2	31.3
November	1st	10	50.7	0.0	0.0	0.0	6.9	1.2	8.0	8.0	42.6
	2nd	10	36.4	0.0	0.0	0.0	0.0	1.2	1.2	1.2	35.2
	3rd	10	11.9	0.0	0.0	0.0	0.0	1.2	1.2	1.2	10.7
Total Volume (Million m^3)			564.8		173.2		106.0	15.6	121.6	294.8	270.0
Priority to Wonorejo dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	34.6	157.3	18.4	93.0	15.0	1.2	16.2	34.6	0.0
	2nd	10	46.5	131.1	30.3	80.1	15.0	1.2	16.2	46.5	0.0
	3rd	11	36.9	111.4	20.7	65.8	15.0	1.2	16.2	36.9	0.0
August	1st	10	45.7	85.9	29.5	52.9	15.0	1.2	16.2	45.7	0.0
	2nd	10	46.9	59.3	30.8	39.9	15.0	1.2	16.2	46.9	0.0
	3rd	11	42.2	34.6	26.1	25.6	15.0	1.2	16.2	42.2	0.0
September	1st	10	42.7	11.6	26.5	12.7	15.0	1.2	16.2	42.7	0.0
	2nd	10	46.1	0.0	13.5	0.0	14.7	1.2	15.9	29.3	16.8
	3rd	10	52.6	0.0	0.0	0.0	0.0	1.2	1.2	1.2	51.4
October	1st	10	55.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	54.5
	2nd	10	44.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	43.5
	3rd	11	47.5	0.0	0.0	0.0	0.0	1.2	1.2	1.2	46.3
November	1st	10	50.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	49.5
	2nd	10	36.4	0.0	0.0	0.0	0.0	1.2	1.2	1.2	35.2
	3rd	10	11.9	0.0	0.0	0.0	0.0	1.2	1.2	1.2	10.7
Total Volume (Million m^3)			564.8		173.2		106.0	15.6	121.6	294.8	270.0
Storage capacity Basis											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	34.6	155.3	20.7	95.0	12.7	1.2	13.9	34.6	0.0
	2nd	10	46.5	131.0	28.1	82.1	15.0	1.2	16.2	44.3	2.2
	3rd	11	36.9	110.0	22.1	69.2	13.6	1.2	14.7	36.9	0.0
August	1st	10	45.7	86.1	27.6	56.2	15.0	1.2	16.2	43.8	1.9
	2nd	10	46.9	61.6	28.4	43.3	15.0	1.2	16.2	44.6	2.4
	3rd	11	42.2	37.4	25.5	29.0	15.0	1.2	16.2	41.6	0.6
September	1st	10	42.7	15.2	25.8	16.0	15.0	1.2	16.2	41.9	0.8
	2nd	10	46.1	0.0	17.6	3.1	15.0	1.2	16.2	33.8	12.3
	3rd	10	52.6	0.0	0.0	0.0	3.6	1.2	4.7	4.7	47.8
October	1st	10	55.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	54.5
	2nd	10	44.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	43.5
	3rd	11	47.5	0.0	0.0	0.0	0.0	1.2	1.2	1.2	46.3
November	1st	10	50.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	49.5
	2nd	10	36.4	0.0	0.0	0.0	0.0	1.2	1.2	1.2	35.2
	3rd	10	11.9	0.0	0.0	0.0	0.0	1.2	1.2	1.2	10.7
Total Volume (Million m^3)			564.8		173.2		106.0	15.6	121.6	294.8	270.0

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (3/8)

1980: 4/20 Drought

			1996 Water Demand without River Maintenance water								
			Deficit	Stami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	18.3	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	10.0	165.6	8.8	106.0	0.0	1.2	1.2	10.0	0.0
	3rd	10	17.1	151.8	16.0	106.0	0.0	1.2	1.2	17.1	0.0
July	1st	10	26.7	129.7	25.6	106.0	0.0	1.2	1.2	26.7	0.0
	2nd	10	23.5	110.4	22.4	106.0	0.0	1.2	1.2	23.5	0.0
	3rd	11	31.8	81.3	30.6	106.0	0.0	1.2	1.2	31.8	0.0
August	1st	10	3.1	84.0	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	15.2	71.8	14.1	106.0	0.0	1.2	1.2	15.2	0.0
	3rd	11	25.8	48.5	24.6	106.0	0.0	1.2	1.2	25.8	0.0
September	1st	10	22.1	30.4	20.9	106.0	0.0	1.2	1.2	22.1	0.0
	2nd	10	28.7	6.7	27.5	106.0	0.0	1.2	1.2	28.7	0.0
	3rd	10	30.6	0.0	7.8	93.0	15.0	1.2	16.2	23.9	6.7
October	1st	10	25.9	0.0	0.0	80.1	15.0	1.2	16.2	16.2	9.7
	2nd	10	6.5	5.6	0.0	80.1	0.0	0.0	0.0	0.0	0.0
	3rd	11	8.7	0.0	5.9	78.6	1.6	1.2	2.8	8.7	0.0
November	1st	10	9.7	0.0	0.0	71.2	8.6	1.2	9.7	9.7	0.0
	2nd	10	29.0	25.0	0.0	71.2	0.0	0.0	0.0	0.0	0.0
	3rd	10	258.0	104.9	0.0	71.2	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			28.0		181.5		34.8	13.6	48.4	229.9	14.2
Priority to Wonorejo dam											
June	1st	10	18.3	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	10.0	173.2	0.0	98.4	8.8	1.2	10.0	10.0	0.0
	3rd	10	17.1	172.4	1.0	85.4	15.0	1.2	16.2	17.1	0.0
July	1st	10	26.7	163.2	10.6	72.5	15.0	1.2	16.2	26.7	0.0
	2nd	10	23.5	156.9	7.4	59.5	15.0	1.2	16.2	23.5	0.0
	3rd	11	31.8	142.1	15.6	45.3	15.0	1.2	16.2	31.8	0.0
August	1st	10	3.1	144.7	0.0	45.3	0.0	0.0	0.0	0.0	0.0
	2nd	10	15.2	144.7	0.0	33.1	14.1	1.2	15.2	15.2	0.0
	3rd	11	25.8	135.6	9.6	18.9	15.0	1.2	16.2	25.8	0.0
September	1st	10	22.1	130.5	5.9	5.9	15.0	1.2	16.2	22.1	0.0
	2nd	10	28.7	112.7	20.6	0.0	6.8	1.2	8.0	28.7	0.0
	3rd	10	30.6	87.2	29.5	0.0	0.0	1.2	1.2	30.6	0.0
October	1st	10	25.9	65.9	24.7	0.0	0.0	1.2	1.2	25.9	0.0
	2nd	10	6.5	71.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	8.7	64.4	7.5	0.0	0.0	1.2	1.2	8.7	0.0
November	1st	10	9.7	57.0	8.6	0.0	0.0	1.2	1.2	9.7	0.0
	2nd	10	29.0	82.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	258.0	161.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			28.0		124.5		106.0	13.6	119.6	244.1	0.0
Storage capacity Basis											
June	1st	10	18.3	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	10.0	168.5	5.5	103.1	3.3	1.2	4.5	10.0	0.0
	3rd	10	17.1	159.9	9.9	97.9	6.1	1.2	7.2	17.1	0.0
July	1st	10	26.7	146.2	15.9	89.5	9.7	1.2	10.9	26.7	0.0
	2nd	10	23.5	134.3	13.9	82.1	8.5	1.2	9.7	23.5	0.0
	3rd	11	31.8	116.2	19.0	71.1	11.6	1.2	12.8	31.8	0.0
August	1st	10	3.1	118.9	0.0	71.1	0.0	0.0	0.0	0.0	0.0
	2nd	10	15.2	111.4	8.7	66.5	5.3	1.2	6.5	15.2	0.0
	3rd	11	25.8	96.9	15.2	57.6	9.3	1.2	10.5	25.8	0.0
September	1st	10	22.1	85.7	12.9	50.7	7.9	1.2	9.1	22.1	0.0
	2nd	10	28.7	71.0	17.0	41.7	10.4	1.2	11.6	28.7	0.0
	3rd	10	30.6	55.2	18.3	32.0	11.2	1.2	12.4	30.6	0.0
October	1st	10	25.9	41.9	15.3	23.9	9.4	1.2	10.6	25.9	0.0
	2nd	10	6.5	47.6	0.0	23.9	0.0	0.0	0.0	0.0	0.0
	3rd	11	8.7	43.1	4.7	21.2	2.9	1.2	4.0	8.7	0.0
November	1st	10	9.7	38.6	5.3	18.4	3.3	1.2	4.4	9.7	0.0
	2nd	10	29.0	63.6	0.0	18.4	0.0	0.0	0.0	0.0	0.0
	3rd	10	258.0	143.5	0.0	18.4	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			28.0		142.9		87.6	13.6	101.1	244.1	0.0

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (4/8)

1980: 4/20 Drought

			1996 Water Demand with River Maintenance water								
			Deficit	Stami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	1.7	172.9	0.3	105.8	0.2	1.2	1.4	1.7	0.0
	2nd	10	30.0	157.5	17.9	96.4	10.9	1.2	12.1	30.0	0.0
	3rd	10	37.1	138.2	22.3	84.6	13.7	1.2	14.8	37.1	0.0
July	1st	10	46.7	113.8	28.3	71.6	15.0	1.2	16.2	44.4	2.3
	2nd	10	43.5	91.1	26.3	58.6	15.0	1.2	16.2	42.4	1.1
	3rd	11	51.8	61.3	31.4	44.4	15.0	1.2	16.2	47.5	4.2
August	1st	10	16.9	52.9	9.8	39.2	6.0	1.2	7.2	16.9	0.0
	2nd	10	35.2	34.6	21.1	28.0	12.9	1.2	14.1	35.2	0.0
	3rd	11	45.8	8.4	27.6	13.8	15.0	1.2	16.2	43.8	1.9
September	1st	10	42.1	0.0	9.7	0.8	15.0	1.2	16.2	25.9	16.2
	2nd	10	48.7	0.0	0.0	0.0	0.9	1.2	2.1	2.1	46.5
	3rd	10	50.6	0.0	0.0	0.0	0.0	1.2	1.2	1.2	49.5
October	1st	10	45.9	0.0	0.0	0.0	0.0	1.2	1.2	1.2	44.7
	2nd	10	13.5	0.0	0.0	0.0	0.0	1.2	1.2	1.2	12.3
	3rd	11	28.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	27.5
November	1st	10	29.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	28.6
	2nd	10	9.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	238.0	87.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			258.3		173.2		106.0	16.6	122.6	295.8	205.8
Priority to Wonorejo dam											
June	1st	10	1.7	173.2	0.0	105.5	0.5	1.2	1.7	1.7	0.0
	2nd	10	30.0	161.3	13.8	92.6	15.0	1.2	16.2	30.0	0.0
	3rd	10	37.1	143.2	21.0	79.6	15.0	1.2	16.2	37.1	0.0
July	1st	10	46.7	116.8	30.6	66.6	15.0	1.2	16.2	46.7	0.0
	2nd	10	43.5	93.1	27.4	53.7	15.0	1.2	16.2	43.5	0.0
	3rd	11	51.8	59.3	35.6	39.4	15.0	1.2	16.2	51.8	0.0
August	1st	10	16.9	58.7	0.8	26.5	15.0	1.2	16.2	16.9	0.0
	2nd	10	35.2	42.2	19.1	13.5	15.0	1.2	16.2	35.2	0.0
	3rd	11	45.8	13.3	30.4	0.0	14.2	1.2	15.4	45.8	0.0
September	1st	10	42.1	0.0	15.4	0.0	0.0	1.2	1.2	16.6	25.4
	2nd	10	48.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	47.5
	3rd	10	50.6	0.0	0.0	0.0	0.0	1.2	1.2	1.2	49.5
October	1st	10	45.9	0.0	0.0	0.0	0.0	1.2	1.2	1.2	44.7
	2nd	10	13.5	0.0	0.0	0.0	0.0	1.2	1.2	1.2	12.3
	3rd	11	28.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	27.5
November	1st	10	29.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	28.6
	2nd	10	9.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	238.0	87.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			288.3		173.2		106.0	16.6	122.6	295.8	205.8
Storage capacity Basis											
June	1st	10	1.7	172.7	0.5	106.0	0.0	1.2	1.2	1.7	0.0
	2nd	10	30.0	147.9	28.8	106.0	0.0	1.2	1.2	30.0	0.0
	3rd	10	37.1	116.8	36.0	106.0	0.0	1.2	1.2	37.1	0.0
July	1st	10	46.7	77.4	45.6	106.0	0.0	1.2	1.2	46.7	0.0
	2nd	10	43.5	40.8	42.4	106.0	0.0	1.2	1.2	43.5	0.0
	3rd	11	51.8	0.0	42.9	98.7	7.6	1.2	8.8	51.8	0.0
August	1st	10	16.9	0.0	0.0	85.8	15.0	1.2	16.2	16.2	0.8
	2nd	10	35.2	0.0	0.0	72.8	15.0	1.2	16.2	16.2	19.1
	3rd	11	45.8	0.0	0.0	58.6	15.0	1.2	16.2	16.2	29.6
September	1st	10	42.1	0.0	0.0	45.6	15.0	1.2	16.2	16.2	25.9
	2nd	10	48.7	0.0	0.0	32.6	15.0	1.2	16.2	16.2	32.5
	3rd	10	50.6	0.0	0.0	19.7	15.0	1.2	16.2	16.2	34.5
October	1st	10	45.9	0.0	0.0	6.7	15.0	1.2	16.2	16.2	29.7
	2nd	10	13.5	0.0	0.0	0.0	7.8	1.2	9.0	9.0	4.5
	3rd	11	28.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	27.5
November	1st	10	29.7	0.0	0.0	0.0	0.0	1.2	1.2	1.2	28.6
	2nd	10	9.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	238.0	87.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			288.3		173.2		106.0	16.6	122.6	295.8	205.8

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (5/8)

1988: 8/20 Drought

			1996 Water Demand without River Maintenance water								
			Deficit	Stami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	6.4	168.7	5.2	106.0	0.0	1.2	1.2	6.4	0.0
	2nd	10	0.0	170.8	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	4.2	167.9	3.0	106.0	0.0	1.2	1.2	4.2	0.0
August	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	10.4	165.2	9.2	106.0	0.0	1.2	1.2	10.4	0.0
	3rd	11	11.2	155.7	10.0	106.0	0.0	1.2	1.2	11.2	0.0
September	1st	10	14.6	144.1	13.4	106.0	0.0	1.2	1.2	14.6	0.0
	2nd	10	19.0	128.7	17.8	106.0	0.0	1.2	1.2	19.0	0.0
	3rd	10	22.1	110.7	20.9	106.0	0.0	1.2	1.2	22.1	0.0
October	1st	10	23.6	91.3	22.4	106.0	0.0	1.2	1.2	23.6	0.0
	2nd	10	0.0	104.0	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	112.9	0.0	106.0	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	128.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			97.6		89.2		0.0	8.4	8.4	97.6	0.0
Priority to Wonorejo dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	6.4	173.2	0.0	101.5	5.2	1.2	6.4	6.4	0.0
	2nd	10	0.0	173.2	0.0	101.5	0.0	0.0	0.0	0.0	0.0
	3rd	11	4.2	173.2	0.0	98.7	3.0	1.2	4.2	4.2	0.0
August	1st	10	0.0	173.2	0.0	98.7	0.0	0.0	0.0	0.0	0.0
	2nd	10	10.4	173.2	0.0	90.7	9.2	1.2	10.4	10.4	0.0
	3rd	11	11.2	173.2	0.0	81.2	10.0	1.2	11.2	11.2	0.0
September	1st	10	14.6	173.2	0.0	69.6	13.4	1.2	14.6	14.6	0.0
	2nd	10	19.0	170.8	2.8	56.6	15.0	1.2	16.2	19.0	0.0
	3rd	10	22.1	165.7	5.9	43.7	15.0	1.2	16.2	22.1	0.0
October	1st	10	23.6	159.3	7.4	30.7	15.0	1.2	16.2	23.6	0.0
	2nd	10	0.0	171.9	0.0	30.7	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	30.7	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	30.7	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	30.7	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	30.7	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			97.6		13.9		75.3	8.4	83.6	97.6	0.0
Storage capacity Basis											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	6.4	170.4	3.2	104.3	2.0	1.2	3.2	6.4	0.0
	2nd	10	0.0	172.5	0.0	104.3	0.0	0.0	0.0	0.0	0.0
	3rd	11	4.2	170.7	1.8	103.2	1.1	1.2	2.3	4.2	0.0
August	1st	10	0.0	173.2	0.0	103.2	0.0	0.0	0.0	0.0	0.0
	2nd	10	10.4	168.3	5.7	100.2	3.5	1.2	4.7	10.4	0.0
	3rd	11	11.2	162.4	6.2	96.6	3.8	1.2	5.0	11.2	0.0
September	1st	10	14.6	155.2	8.3	92.2	5.1	1.2	6.3	14.6	0.0
	2nd	10	19.0	145.6	11.1	86.3	6.8	1.2	8.0	19.0	0.0
	3rd	10	22.1	134.4	12.9	79.5	7.9	1.2	9.1	22.1	0.0
October	1st	10	23.6	122.4	13.9	72.1	8.5	1.2	9.7	23.6	0.0
	2nd	10	0.0	135.1	0.0	72.1	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	144.0	0.0	72.1	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	159.3	0.0	72.1	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	72.1	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	72.1	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			97.6		55.3		33.9	8.4	42.3	97.6	0.0

Table A8-4 Water Balance on Integrated Operation of Sutami and Wonorejo Dams (6/8)

1988; 8/20 Drought

			1996 Water Demand with River Maintenance water								
			Deficit	Sutami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	8.9	166.6	7.7	106.0	0.0	1.2	1.2	8.9	0.0
July	1st	10	26.4	144.8	25.2	106.0	0.0	1.2	1.2	26.4	0.0
	2nd	10	17.6	130.6	16.5	106.0	0.0	1.2	1.2	17.6	0.0
	3rd	11	24.2	108.7	23.0	106.0	0.0	1.2	1.2	24.2	0.0
August	1st	10	0.0	109.0	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	30.4	83.7	29.2	106.0	0.0	1.2	1.2	30.4	0.0
	3rd	11	31.2	55.2	30.0	106.0	0.0	1.2	1.2	31.2	0.0
September	1st	10	34.6	26.3	33.4	106.0	0.0	1.2	1.2	34.6	0.0
	2nd	10	39.0	0.0	30.4	99.6	7.4	1.2	8.6	39.0	0.0
	3rd	10	42.1	0.0	0.0	86.7	15.0	1.2	16.2	16.2	25.9
October	1st	10	43.6	0.0	0.0	73.7	15.0	1.2	16.2	16.2	27.4
	2nd	10	5.3	0.0	0.0	70.1	4.2	1.2	5.3	5.3	0.0
	3rd	11	10.7	0.0	0.0	61.1	9.5	1.2	10.7	10.7	0.0
November	1st	10	2.3	0.0	0.0	60.1	1.1	1.2	2.3	2.3	0.0
	2nd	10	0.0	66.2	0.0	60.1	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	111.5	0.0	60.1	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			278.9		173.4		45.9	13.6	59.4	232.8	46.0
Priority to Wonorejo dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	8.9	173.2	0.0	99.4	7.7	1.2	8.9	8.9	0.0
July	1st	10	26.4	164.4	10.2	86.4	15.0	1.2	16.2	26.4	0.0
	2nd	10	17.6	163.1	1.5	73.4	15.0	1.2	16.2	17.6	0.0
	3rd	11	24.2	155.6	8.0	59.2	15.0	1.2	16.2	24.2	0.0
August	1st	10	0.0	155.8	0.0	59.2	0.0	0.0	0.0	0.0	0.0
	2nd	10	30.4	143.5	14.2	46.2	15.0	1.2	16.2	30.4	0.0
	3rd	11	31.2	129.2	15.0	32.0	15.0	1.2	16.2	31.2	0.0
September	1st	10	34.6	113.3	18.4	19.0	15.0	1.2	16.2	34.6	0.0
	2nd	10	39.0	93.6	22.8	6.0	15.0	1.2	16.2	39.0	0.0
	3rd	10	42.1	64.3	33.9	0.0	7.0	1.2	8.2	42.1	0.0
October	1st	10	43.6	27.6	42.4	0.0	0.0	1.2	1.2	43.6	0.0
	2nd	10	5.3	24.1	4.2	0.0	0.0	1.2	1.2	5.3	0.0
	3rd	11	10.7	15.1	9.5	0.0	0.0	1.2	1.2	10.7	0.0
November	1st	10	2.3	14.1	1.1	0.0	0.0	1.2	1.2	2.3	0.0
	2nd	10	0.0	80.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	125.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			278.9		159.3		106.0	13.6	119.6	278.9	0.0
Storage capacity Basis											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	8.9	169.1	4.8	103.5	2.9	1.2	4.1	8.9	0.0
July	1st	10	26.4	155.6	15.6	95.2	9.6	1.2	10.8	26.4	0.0
	2nd	10	17.6	146.8	10.2	89.8	6.3	1.2	7.4	17.6	0.0
	3rd	11	24.2	133.2	14.2	81.5	8.7	1.2	9.9	24.2	0.0
August	1st	10	0.0	133.5	0.0	81.5	0.0	0.0	0.0	0.0	0.0
	2nd	10	30.4	117.8	18.1	71.9	11.1	1.2	12.3	30.4	0.0
	3rd	11	31.2	100.1	18.6	61.1	11.4	1.2	12.6	31.2	0.0
September	1st	10	34.6	82.2	20.7	50.1	12.7	1.2	13.9	34.6	0.0
	2nd	10	39.0	61.9	23.5	37.7	14.4	1.2	15.6	39.0	0.0
	3rd	10	42.1	39.6	25.9	24.7	15.0	1.2	16.2	42.1	0.0
October	1st	10	43.6	15.9	27.4	11.8	15.0	1.2	16.2	43.6	0.0
	2nd	10	5.3	13.7	2.6	10.4	1.6	1.2	2.8	5.3	0.0
	3rd	11	10.7	8.1	5.9	7.0	3.6	1.2	4.8	10.7	0.0
November	1st	10	2.3	7.5	0.7	6.6	0.4	1.2	1.6	2.3	0.0
	2nd	10	0.0	73.7	0.0	6.6	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	119.0	0.0	6.6	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			278.9		165.9		99.4	13.6	113.0	278.9	0.0

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (7/8)

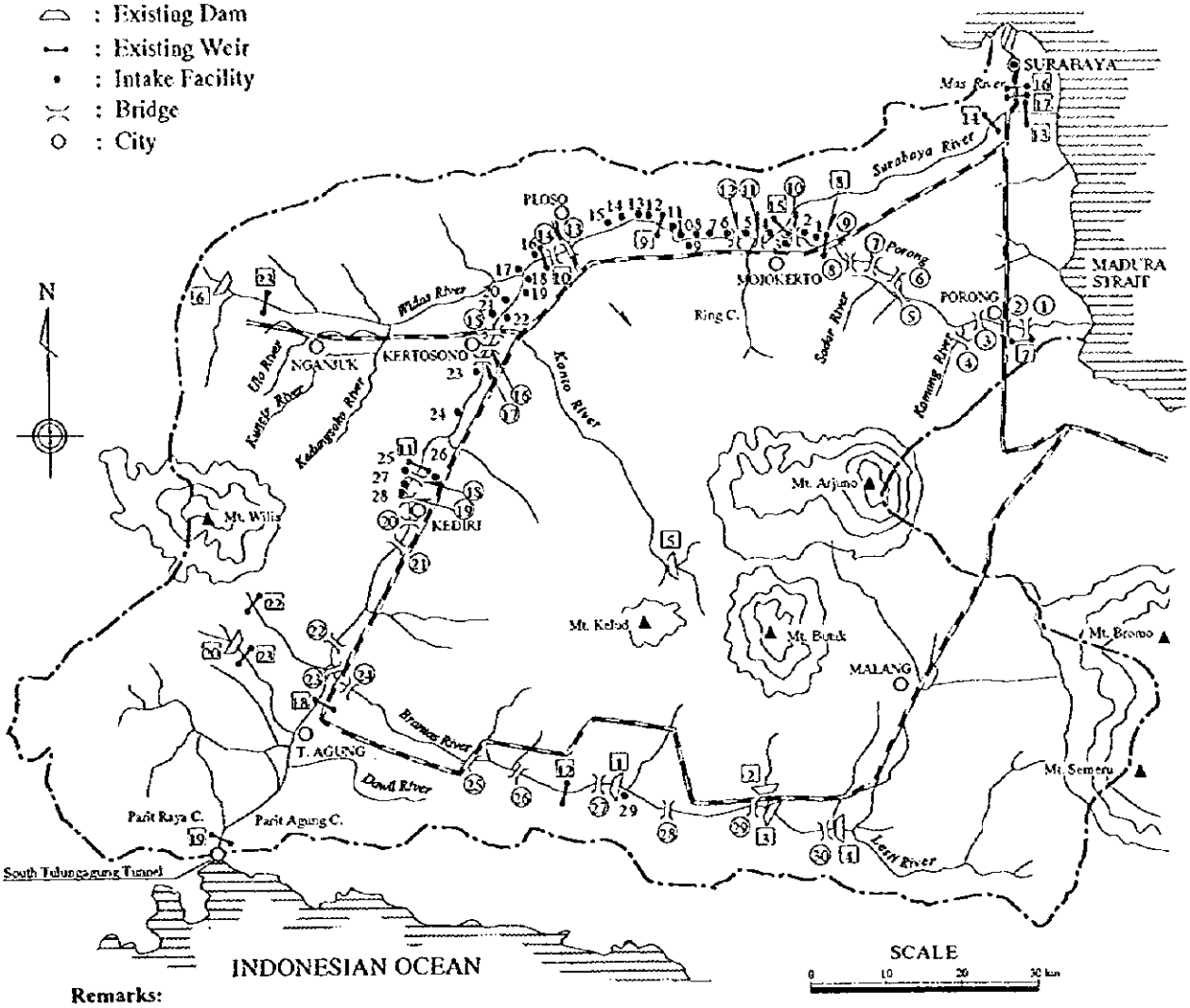
1986: 1/20 Drought

			1996 Water Demand without River Maintenance water								
			Deficit	Sutami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
August	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
September	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
October	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			0.0		0.0		0.0	0.0	0.0	0.0	0.0
Priority to Wonorejo dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
August	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
September	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
October	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			0.0		0.0		0.0	0.0	0.0	0.0	0.0
Storage capacity Basis											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
August	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
September	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
October	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			0.0		0.0		0.0	0.0	0.0	0.0	0.0

Table A8-4 Water Balance on Intrgrated Operation of Sutami and Wonorejo Dams (8/8)

1986: 16/20 Drought

			1996 Water Demand with River Maintenance water								
			Deficit	Sutami		Wonorejo				Total	Deficit
			without Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Storage Volume (Million m^3)	Water Supply (m^3/s)	Push-back (m^3/s)	Sub-total Water Supply (m^3/s)	Water Supply (m^3/s)	with Water Supply (m^3/s)
Priority to Sutami dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
August	1st	10	9.6	165.9	8.4	106.0	0.0	1.2	1.2	9.6	0.0
	2nd	10	14.9	154.1	13.7	106.0	0.0	1.2	1.2	14.9	0.0
	3rd	11	0.0	154.4	0.0	106.0	0.0	0.0	0.0	0.0	0.0
September	1st	10	0.0	157.7	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	12.9	147.6	11.7	106.0	0.0	1.2	1.2	12.9	0.0
	3rd	10	10.2	139.8	9.0	106.0	0.0	1.2	1.2	10.2	0.0
October	1st	10	5.9	135.7	4.7	106.0	0.0	1.2	1.2	5.9	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			46.1		41.0		0.0	5.1	5.1	46.1	0.0
Priority to Wonorejo dam											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
August	1st	10	9.6	173.2	0.0	98.7	8.4	1.2	9.6	9.6	0.0
	2nd	10	14.9	173.2	0.0	86.9	13.7	1.2	14.9	14.9	0.0
	3rd	11	0.0	173.2	0.0	86.9	0.0	0.0	0.0	0.0	0.0
September	1st	10	0.0	173.2	0.0	86.9	0.0	0.0	0.0	0.0	0.0
	2nd	10	12.9	173.2	0.0	76.8	11.7	1.2	12.9	12.9	0.0
	3rd	10	10.2	173.2	0.0	69.0	9.0	1.2	10.2	10.2	0.0
October	1st	10	5.9	173.2	0.0	65.0	4.7	1.2	5.9	5.9	0.0
	2nd	10	0.0	173.2	0.0	65.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	65.0	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	65.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	65.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	65.0	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			46.1		0.0		41.0	5.1	46.1	46.1	0.0
Storage capacity Basis											
June	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
July	1st	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	106.0	0.0	0.0	0.0	0.0	0.0
August	1st	10	9.6	168.7	5.2	103.2	3.2	1.2	4.4	9.6	0.0
	2nd	10	14.9	161.4	8.5	98.7	5.2	1.2	6.4	14.9	0.0
	3rd	11	0.0	161.7	0.0	98.7	0.0	0.0	0.0	0.0	0.0
September	1st	10	0.0	164.9	0.0	98.7	0.0	0.0	0.0	0.0	0.0
	2nd	10	12.9	158.7	7.2	94.9	4.4	1.2	5.6	12.9	0.0
	3rd	10	10.2	153.8	5.6	92.0	3.4	1.2	4.6	10.2	0.0
October	1st	10	5.9	151.3	2.9	90.4	1.8	1.2	3.0	5.9	0.0
	2nd	10	0.0	173.2	0.0	90.4	0.0	0.0	0.0	0.0	0.0
	3rd	11	0.0	173.2	0.0	90.4	0.0	0.0	0.0	0.0	0.0
November	1st	10	0.0	173.2	0.0	90.4	0.0	0.0	0.0	0.0	0.0
	2nd	10	0.0	173.2	0.0	90.4	0.0	0.0	0.0	0.0	0.0
	3rd	10	0.0	173.2	0.0	90.4	0.0	0.0	0.0	0.0	0.0
Total Volume (Million m^3)			46.1		25.4		15.6	5.1	20.7	46.1	0.0



Remarks:

Dam

1 Wlingi
2 Lahor
3 Sutami
4 Sengguruh
5 Selorejo
6 Bening
20 Wonorejo

Weir

7 Bangil Tak
8 New Lengkong
9 Menturus
10 Jatimlerek
11 Mrican
12 Lodoyo
13 Jagir
14 Gunungsari
15 Mlirip
16 Gubeng
17 Wono Kromo
18 Tulungagung
19 Tulungagung Tunnel
21 Glatik
22 Segawe Weir
23 Tiudan

Bridge

1 Porong (Toll)
2 Porong (Railway)
3 Porong (Road)
4 Inspection
5 Trolley
6 Trolley
7 Ngrame (Road)
8 Footpath
9 Cepiples (Railway)
10 New Mojokerto (Road)
11 Moojokerto (Road)
13 Watudakon (Trolley)
13 Ploso (Road)
14 Ploso (Railway)
15 Kertosono (Railway)
16 Kertosono (Road)
17 New Kertosono (Road)
18 Jongbiru (Trolley)
19 New Kediri II (Road)
20 Kediri (Road)
21 New Kediri (Road)
22 Jeli (Trolley)
23 Jeli (Railway)
24 Jeli (Road)
25 Railway
26 Kedemangan (Road)
27 Grondong (Road)
28 Ngembul (Road)
29 Belly (Road)
30 Sengguruh (Road)

Intake

1 Voor II canal
2 Voor I canal
3 Jatikulon
4 Ajinomoto (P)
5 Losari
6 Gedek Intake
7 Gempolkerep (P)
8 Gembongan
9 Sotowuluh
10 Kedungsari (P)
11 Keboan
12 Menturus
13 Bebekan
14 Tunggorono
15 Tapen (P)
16 Jatimlerek
17 Bunder (P)
18 Tunggorono
19 Turipinggir
20 Pengkol
21 Kedungkudi
22 Bunder II (P)
23 Besuk
24 Banjarsari
25 Warujayeng Intake
26 Turitunggorono
27 (P)
28 Mrican
29 Lodagung

Figure A8-1 Location Map of Major River Facilities

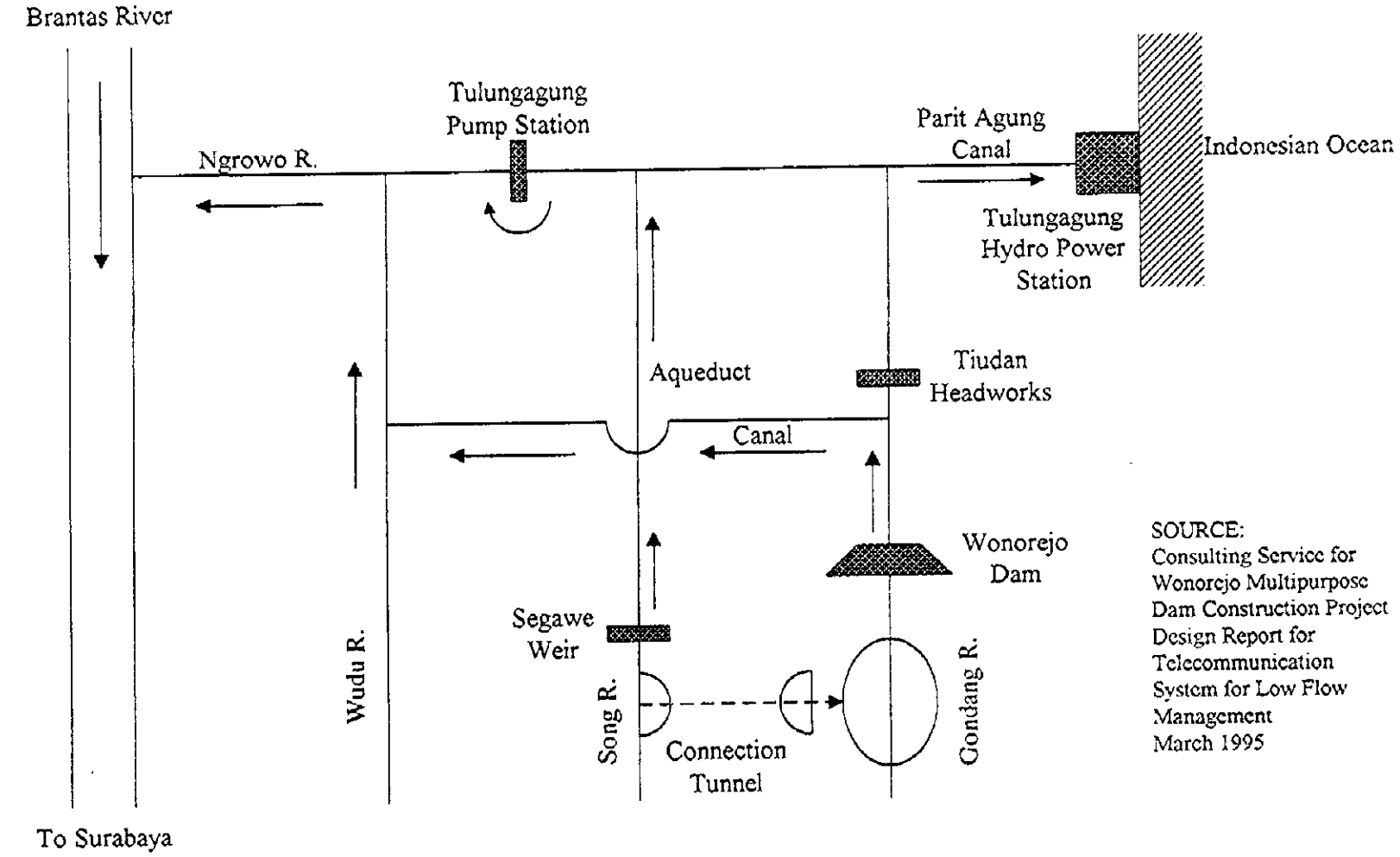


Figure A8-2 Ngrowo River Water Conveyance System