high water level, for keeping dry works, the construction site shall be protected from the river water by cofferdam made of soil filled bags and seepage water inside of the cofferdam shall be drained by portable drainage pump.

After placement of base concrete, following works such as pipe setting and gabion works shall be completed.

d. Pipeline construction

In parallel with the construction of pump house, pipeline construction can be done which consists of pipe setting, maintenance box and outlet box. Excavation for these facilities shall be done by manpower. After completion of excavation, pipe setting and concrete placing are also done by manpower. The concrete shall be produced by portable concrete mixer. Special care must be paid for backfilling by manpower, not to destroy the concrete facilities.

6.6 Procurement of Equipment and Material for Construction

The Project site is located near the Surabaya city which is the largest commercial and industrial city of the region. Surabaya city is located about 100 km east from Bojonegoro which is the center of this Project. On the other hand, the Jakarta, capital of Indonesia is located about 600 km west from Surabaya, therefore, procurement will be made basically from the Surabaya city.

Proposed Project work can be itemized into four (4) works i.e.;

1) Earth works
2) Concrete works
3) Piping works
4) Installation of pumping equipments

Major materials for each segment are as follows:

Kind of work	Construction Material	Construction machine or tools
(1) Earth works	Limestone for foundation, Wet masonry, Sand bed, Pebble, Sodding	Vibratory roller, Compactor, Drain pump, Generator
(2) Concrete works	Cement, Aggregate (gravel, sand), Reinforced iron bar, Concrete admixture, Temporary material (form, scaffolding)	Concrete mixer, Vibrator, Generator
(3) Piping works	Steel pipe, Asbestos cement pipe, Valves, Paint	Welder, Pipe cutter
(4) Installation of pumping equipments	Double suction volute pump, Diesel engine, Small drain pump, Water supply tank, Fuel tank	Truck, Chain block

In principle, most of the construction material and equipment for the implementation of this Project can be procured in Indonesia. However, among various types of diesel powered engine, 18 ps and 25 ps water cooled diesel engine, and simple flow meter for this Project, are not available in Indonesia and to be procured from Japan.

(a) Procured in Indonesia

- Cement, Aggregate (gravel, sand), Stone material, Rock material, Brick
- Reinforced iron bar and construction steel (shape steel)
- Pipes (steel pipe, asbestos cement pipe, etc.)
- Pump, small water-cooled diesel engine less than 17 ps
- Construction machines (vibratory roller, compactor, vibrator)
- Temporary work materials (forms, scaffolding, drain pump, small generator)

(b) Procured from Japan

- Middle size water-cooled diesel engine
- Simple flow meter

6.7 Implementation Schedule

In the execution of the Project, it is to be divided into two phases as mentioned in 6.2. 18 pumping stations located near to Bojonegoro which is located in the center of the Project will be implemented as Phase I; and the rest 15 pumping stations which are located in the upper and lower part of the Project site will be implemented as Phase II.

Phase I				Phase II			
No.8	Ngringinrejo	No.17	Pilanggede	No.1	Tapelan	No.28	Banjar
9	Leran	18	Kedungbondo	2	Sumberarum	29	Keduyung
10	Trucuk	19	Cangakan	3	Tebon	30	Bulutigo
11	Tulungrejo	20	Kabalan	4	Perangi	31	Pelangwot
12	Mulyoagung	23	Karangtinoto	5	Banjarejo	32	Tamanprijek
13	Kalirejo	24	Bandungrejo	6	Ngraho	33	Tejoasri
14	Semanding	25	Klotok	7	Sudu		
15	Mulyorejo	26	Tanggungan	21	Mojorejo		
16	Sarirejo	27	Kalisati	22	Dengok		

Before the commencement of the construction work, detailed design (including detailed topo-survey) and preparation of tender document shall be made. It takes about three (3) months to complete all the works under Phase I and two and a half (2.5) months for Phase II.

For tendering, pre-qualification of tenderer and offering contract, it is necessary one and a half (1.5) months for Phase I and one (1) month for Phase II.

Implementation schedule and construction schedule for the Project are shown in Fig. 6-1 and Fig. 6-2. As shown in Fig. 6-1, it takes twelve (12) months to complete 18 pumping stations of Phase I with three parties and the same construction term will be necessary for Phase II also with three (3) parties.

Fig. 6 - 1 Implementation Schedule

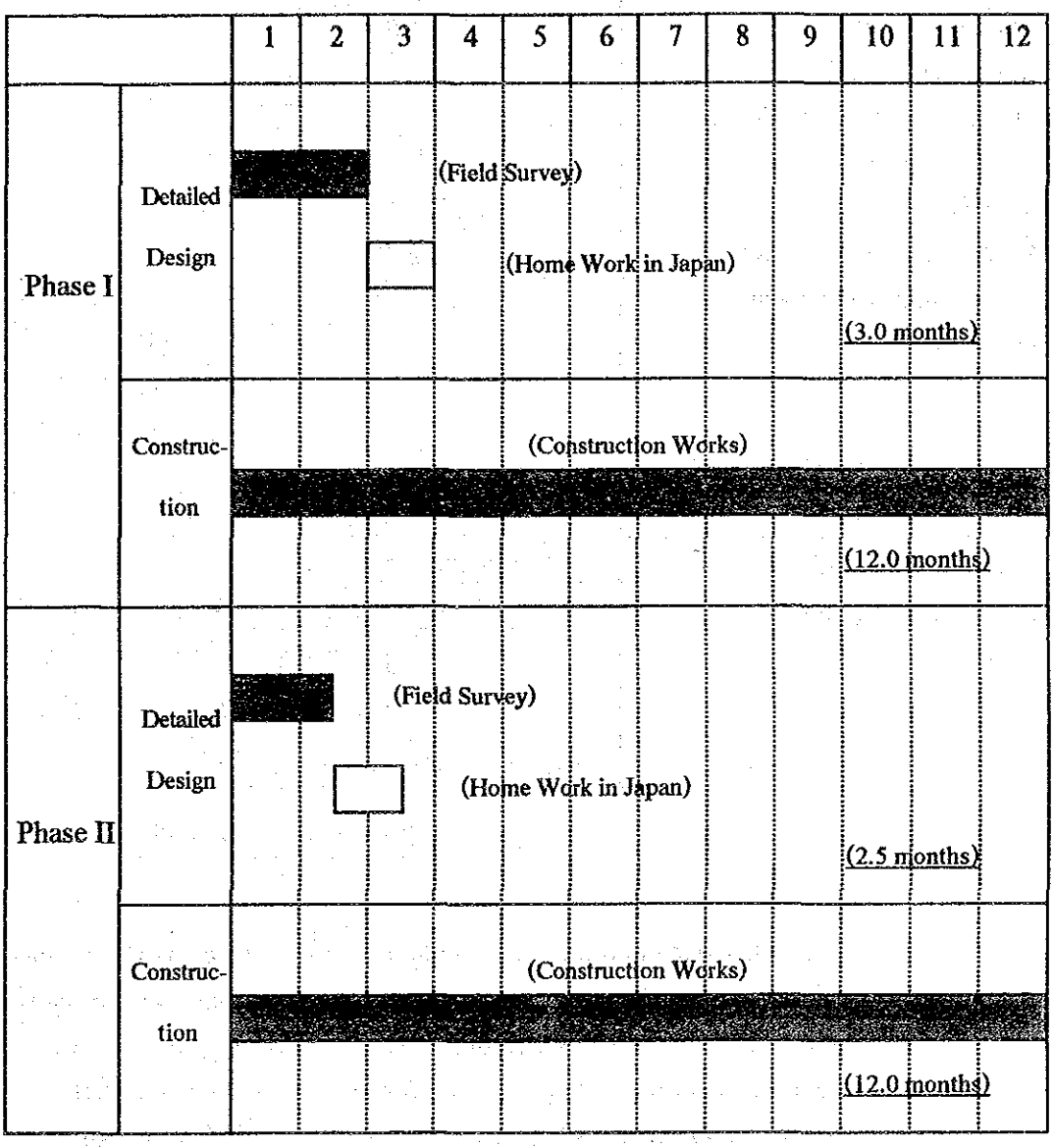
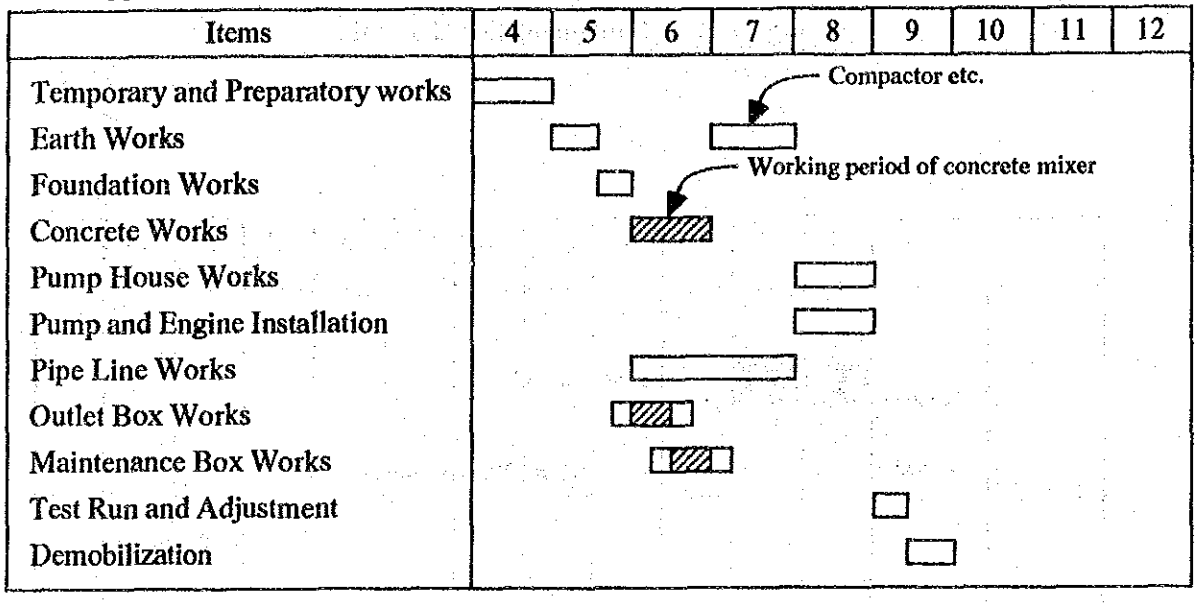
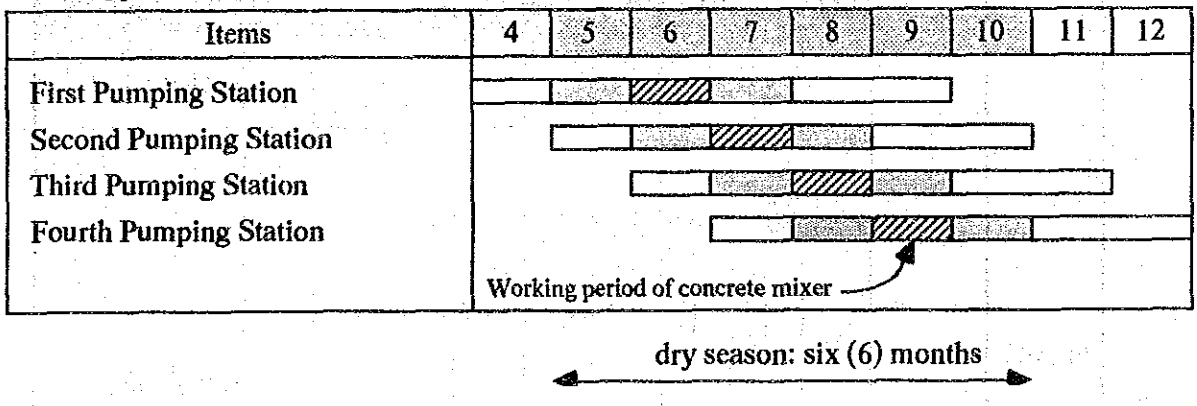


Fig. 6 - 2 Construction Schedule

(1) Typical construction schedule for one pumping station under the conditions of the dry season



(2) Typical construction schedule per one party



In order to complete one pumping station with one party, it takes six (6) months as shown in above table. Thus, maximum four (4) pumping stations can be completed by one party during one dry season. In case of the wet season, maximum two (2) pumping stations can be implemented by one party during one wet season because the workability of the wet season is 50 % to that of the dry season. Therefore, three (3) parties are able to complete twelve (12) and six (6) pumping stations during one dry season and one wet season respectively, and in this way total 18 pumping stations will be installed in one year under Phase I.

On the other hand, locational disadvantages (as the pumping stations are split into two areas) are taken into consideration, under Phase II ten (10) and five (5) pumping stations are supposed to be completed by three parties in the dry and wet season respectively.

6.8 Cost to Be Undertaken by the Government of Indonesia

Necessary amounts of the Project cost to be undertaken by the Government of Indonesia have been estimated as followings;

1.	Detailed design for secondary and tertiary canals	Rp. 177.5 million
2.	Land acquisition	Rp. 229.5 million
3.	Replacement of existing pumping stations	Rp. 12.0 million
4.	Construction of secondary and tertiary canals	Rp. 2,156.2 million
5.	Office expenses	Rp. 91.8 million
6.	Commission for banker	Rp. 11.5 million
	Total	Rp. 2,678.5 million

CHAPTER 7 PLAN OF OPERATION AND MAINTENANCE

7.1 Organization for Operation and Maintenance

The pump irrigation facilities specified in this Project are to be managed by the Provincial Government. The managements shall be conducted with the cooperation of administrative organizations consists of provincial office, 3 district offices, 11 sub district offices, and 33 villages. The general managements shall be undertaken by the Public Works Offices set up at province, district and sub district level while agricultural extension and the consultation for planning of on-farm facilities shall be done by the Agricultural Offices set up at same level offices mentioned earlier. Through these two (2) systems, the direction of management, operation and maintenance will be delivered from the higher offices to the lower ones.

Practical operation and maintenance (O & M) and the collection of the O&M fee shall be conducted by the Water Users Association composed of the beneficiaries. Such association shall be set up for each pumping station (therefore total of 33 associations) and be advised technically by the Sub District Public Works Office and managerially by the Chief of Village. These systems are shown in Fig.7-1.

The Water Users Association has a Chief, Vice chief, Secretary, Cashier etc., and set up a Operation Committee organized by the representatives from each irrigation block of 10-15 ha in size. The Operation Committee discusses and decides the management plan. The irrigation pump is operated by operators appointed by the Sub District Public Works Office and the works for O&M or repairs of the civil facilities are carried out by all members of the Association whenever required. The system of the Water Users Association is illustrated in Fig.7-2.

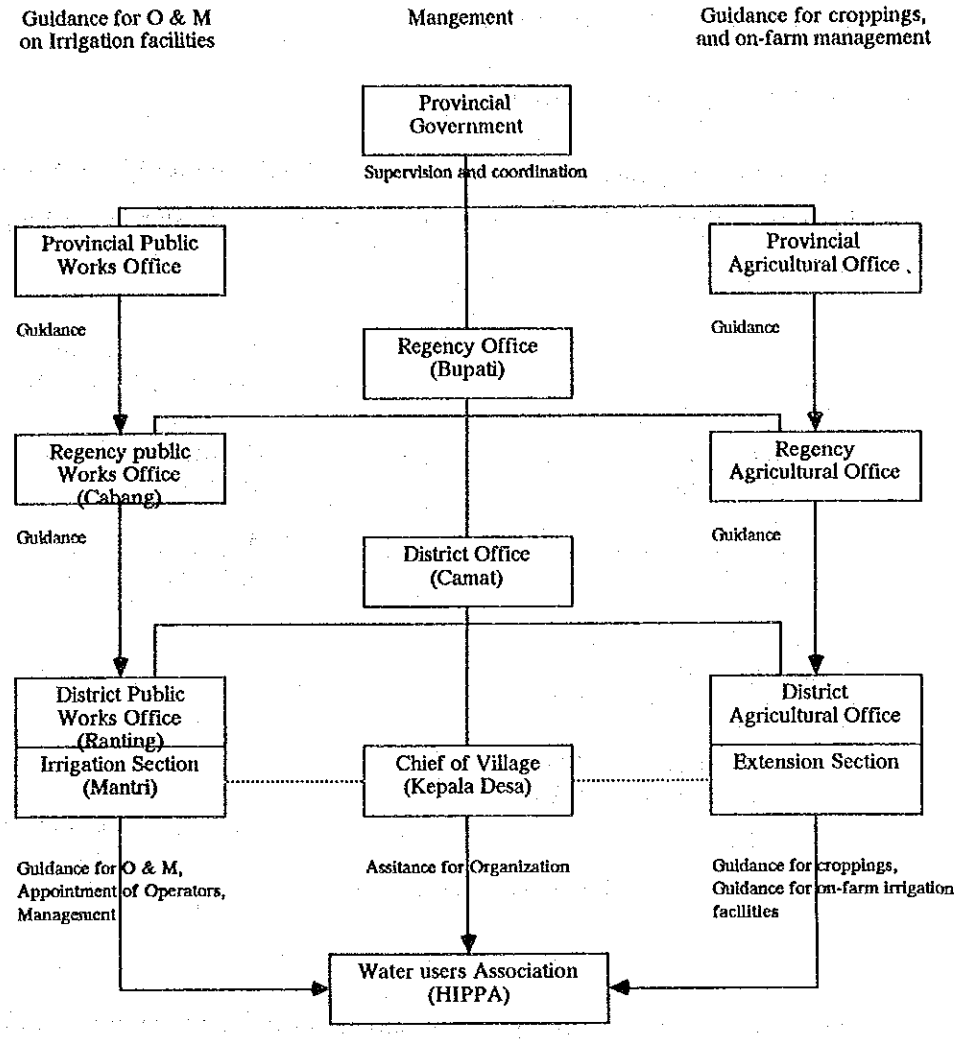


Fig. 7 - 1 Organization Chart for Operation and Maintenance

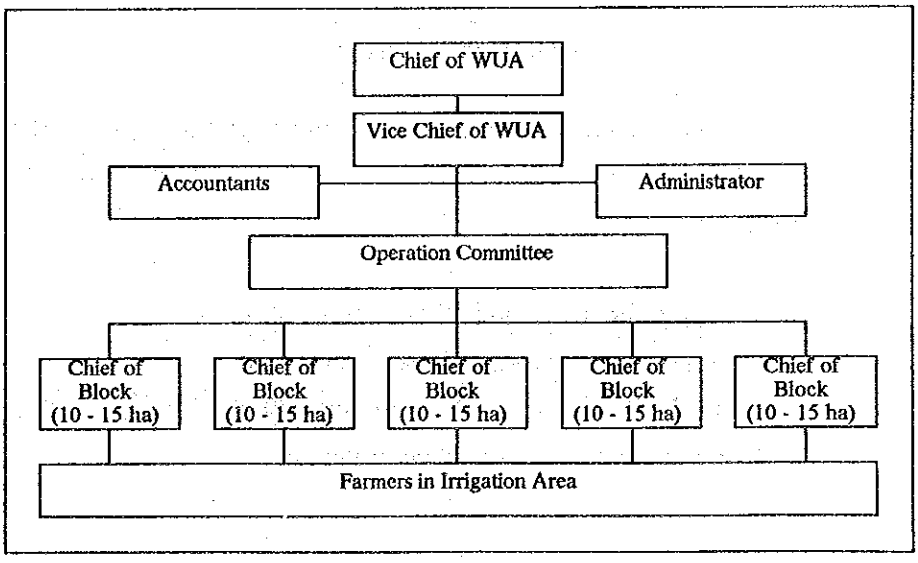


Fig. 7 - 2 Organization of Water Users Association

7.2 Plan of Operation and Maintenance

(1) The Plan of Pumping Operation

The pumping operation shall be undertaken by the Water Users Association in cooperation with the Sub District Public Works Office according to the following steps,

Water Users Association		Sub District Public Works Office
* Plan of cropping in the command area	→	* Planning for pumping operation
* Fuel service to pump operators	←	* Appointment of two (2) operators
* Start of pumping according to water requirement by operators		
* Record of pumped hours and amount of water by operators	→	* Check of recorded data
* Receive of recording data by Chief	←	

The expenses for pumping and O&M mentioned in section 7.3 shall be covered by irrigation fee collected from the command farmers. This irrigation fee may be paid in kind such as part of the crops harvested in command area.

(2) The Plan of Operation and Maintenance (O&M)

Basically the operation and maintenance of the pump irrigation facilities are conducted by Water Users Association itself. Common O&M includes followings:

to supply fuels, oil, and other expendables,
to repair equipments and supply spare parts,
to fix shed and pipes in the pumping station,
to eliminate deposits in the pumping pit,

to do other works for maintenance, and
to replace equipments.

If serious damages occur on the facilities, the Government of Indonesia shall allocate the needed budget.

(3) Support Services for Farming

To maximize the irrigation efficiency, appropriate support services for farming should be offered. There is an Agricultural Cooperative in each village, and the Sub District Agricultural Office shall give it necessary agricultural advices (to give the guidances for selecting crop type, application of agricultural chemicals and fertilizers, to exhibit the model cropping patterns, and to suggest how to control irrigation water, etc.).

7.3 Expenses for Operation and Maintenance

(1) Expenses for Operation and Maintenance

Annual operation and maintenance expenses of pump irrigation facilities of the Project are estimated regarding average size of the 33 stations. The calculation is carried out under the following conditions:

Assumption

Engine	:	19 ps x 2 nos.
Irrigated area	:	151.5 ha (Non-inundated area 90.2 ha)
		(Inundated area 61.3 ha)
Annual pumping hours	:	4,300 hr

Estimation

Items	Expenses (Rp. '000)
1) Operation Cost	14,709
Fuel, Oil, etc.	10,621
Operator fee	4,088
2) Maintenance Cost	8,240
Spare parts, Repairing charge	2,240
Civil facilities repairing charge	3,000
Communication and meeting expenses	3,000
3) Depreciation Cost	2,240
Pump and Engine	2,240
4) Total	25,189

As estimated above, annual operation and maintenance expenses per pumping station will be Rp. 25.2 million in average. The details are shown in Table A-20.

(2) Irrigation Fee

The expenses for operation and maintenance of the irrigation facilities mentioned above shall be covered by the irrigation fee collected from command farmers. Current irrigation fee generally accounts to 20 - 25 % of the agricultural outputs, while the new irrigation fee of the proposed Project is roughly estimated as follows.

Annual gross agricultural outputs from an average 151.5 ha of irrigation area are estimated. It is assumed that the cropping patterns are "Rice-Rice-Secondary Crops" in 90.2 ha of non-inundated area, and "Fallow-Rice-Rice" in 61.3 ha of inundated area. As a result, annual agricultural outputs per pumping station are calculated as Rp. 548.6 million per annum (refer to Table A-21 for more details).

Therefore, proposed irrigation fee is only 5% of annual gross agricultural outputs and is one fourth or one fifth to existing private pump irrigation fees.

CHAPTER 8 PROJECT BENEFITS AND CONCLUSION

8.1 General

The main scheme of the Project is to improve the irrigation facilities where water from the Solo river is pumped up to secure the irrigation farming. The concerned number of pumping stations are 20 for improvement and 13 for new installation. Total irrigation area of this Project is 5,000 ha.

In this Project, operation and maintenance of the irrigation facilities shall be carried out by command farmers. Command farmers of the Project area have lots of experiences in small pump irrigation, and are willing to join to the Project. The number of beneficial farmers of the Project is relatively large. It is assumed that annual income of the command farmers will be leveled up considerably. Furthermore, project benefit can be realized within very short period.

This Project conforms to the policies of central and regional governments which aim to construct and improve the small irrigation facilities with participation of the command farmers, and to increase crop productions by strengthening operation and maintenance activities. There are plenty of paddy fields to be irrigated under this Project and the Project will be a pilot case for those fields are not under this Project. In addition, this Project also has the potential to be a model case for managing the irrigation facilities with participation of the command farmers, and is expected to produce fruitful effects.

8.2 Project Benefits

8.2.1 Direct Benefits

Following three (3) factors are the major direct benefits of this Project.

1) Level up of agricultural productivity with establishing the pump irrigation system.
2) Secondary crops will be replaced by more profitable rice.
3) Reduction of irrigation fee of existing irrigation system.

(1) Increase of Crop Production

Improvement of the pumping irrigation facilities and their proper management will considerably increase the crop production in command area. As mentioned before, by the Project, cropping intensity of rice will be expanded due to its profitability; and owing to developed irrigation system (as planned) unit yield rate of rice must be increased substantially. As a result, annual rice production in the 5,000 ha of the Project area will reach to 63,500 ton which is 2.3 times as much as that of without Project condition. In case of secondary crops, though cropping intensity will be reduced, their unit yield rate will be increased. Thus the income of command farmers must be raised greatly by removing irrigation water shortage problem which was the most serious problem in the past.

(2) Changing Cropping Pattern

As mentioned in (1), provided that the sufficient irrigation water would be secured, the secondary crops will be replaced by rice not only for its suitability to climate and soil to but also due to its higher profitability. The average net income by rice per cropping is Rp. 840 thousand, which is 1.5 times as that of maize or soybean (refer to Table A-22).

With the Project, the cropping intensity of rice can be raised from 130 % to 200 % in non-inundated area, and from 100 % to 200% in inundated area. This will directly enhance income of the command farmers.

(3) Mitigation of the Irrigation Fee

Since the pumping stations constructed by this Project are all public facilities and shall be operated by command farmers themselves, only indispensable expenses are imposed on the farmers as irrigation fee. This irrigation fee is very cheap as compared to that of existing private pumping stations. Project irrigation fee is estimated at 5 % of harvested output while it was 20 - 25 % in the previous system. It is assumed that net agricultural inputs excluding irrigation fee is 42 % of gross income, and the net income with Project will be 52 % of gross income. In contrary, in the previous facilities, the net

income rate was 33-38 %. By the above figures, it can be concluded that this Project will contribute to raise the income level of command farmers.

(4) Coverage of the Benefits

Out of three types of direct benefits, type (1) and (2) can be enjoyed in all over 5,000 ha of the Project area, while benefit (3) comes from existing irrigated area of 1,457 ha included into the Project area. Total farm households benefited account to 6,850 based on 0.73 ha per farm household in average and the number of beneficiaries are estimated to 29,500 with an average of 4.3 persons per household.

8.2.2 Indirect Benefits

From the provincial and national viewpoint, even the Project is small in scale, it is suited to the development strategies which aim to strengthen the self-sufficiency in rice production and to reduce the regional differentials in economy. Although the rice production from the Project area will account to only 0.76 % of total production of East Java Province, and 0.14 % of national production, it shall be recognized that this Project has a great importance as a pilot case. Vast increase of rice production in the Project area will surely influence the farmers of other rainfed areas under the same conditions to develop irrigation farming. Furthermore, it is expected that the design of pumping irrigation facilities of the Project can be used to other surrounding paddy fields irrigation Project; and the farmers' activities on operation and maintenance of irrigation facilities will be the focus of attention to other farmers.

With the increase in farm income of command farmers, their living standards as well as social structure will be improved gradually. One of the most remarkable effect of the Project is the increase of labor requirement due to increase of cropping intensity of paddy, increase of operation and maintenance of irrigation facilities, etc. It is important to solve the unemployment problem in the rural area where population density is high.

Table 8.1 Direct Benefits of the Project

Current Problem	Measure in the Project	Effects
Most of the existing 20 pumps constructed by PBS are in trouble	Rehabilitation of all pumping stations and pipelines	Expansion of irrigable acreage per pumping station. Agricultural income rises with increment of cropping area and yield per hectare Benefited area : 2,740 ha
Most of the fields are rainfed where only secondary crops can grow Yield per hectare of the crops are very low	New construction of 13 pumping stations with pipelines	Increase of agricultural income owe to increment of cropping intensity and yield per hectare Benefited area : 2,260 ha
Irrigation fee is very high due to using private pumping stations	33 pumping stations are all operated by Water Users Associations	Irrigation fee reduces from 20-25 % to only 5 % to the agricultural outputs. Benefited area : 1,457 ha
(total area)	(total project)	(total benefits)
Proposed project area is one of the poor rural areas fallen far behind the areas under big irrigation project and obliged to follow low living standard	Replacement or construction of the 33 pumping irrigation facilities and improvement of their management	Benefited area : 5,000 ha Farm households (benefited) : 6,850 Beneficiaries : 29,500 Rice production : 2.3 times of present (27,300t -> 63,500t) Crop production value : 1.9 times of present (Rp. 9,520 million-> Rp. 18,110 million)

8.3 Conclusion and Recommendation

The Project is, as mentioned above, quite fruitful for food crop production in the command area and also able to contribute to raise the living standards of the beneficial farmers. Furthermore, the irrigation facilities of the Project are expected to be operated and managed smoothly by the Water Users Association.

However, it shall be noticed that following implementations are effective to the Project promotion.

1) PBS should surely design and construct secondary and tertiary canals before completion of the Project.

2) Provincial, District and Sub District Public Works Offices and the Agricultural Offices should give proper control to the Water Users Associations responsible to manage the irrigation facilities.

3) Strengthening mutual cooperation between the Ministry of Public Works who undertakes the Project and the Provincial Government where control of the Project facilities will be transferred after completion of the Project.

APPENDIX

Contents of Appendix

1. Members of the Team

1 - 1 Basic Design Study

Name	Speciality	Organization
Mr. Norifumi TAKAMURA	Team Leader	Deputy Director, Construction Department, Kyusyu Agricultural Administration Office, MAFF
Mr. Ken-ichi SHISHIDO	Project Coordinator	First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA
Mr. Yoshimitsu YUKAWA	Irrigation Engineer (Chief Engineer)	Nippon Giken Inc.
Mr. Kiyoo WADA	Design Engineer	Nippon Giken Inc.
Mr. Masataka YAMAGUCHI	Cost Estimator	Nippon Giken Inc.

1 - 2 Explanation for Draft Final Report

Name	Speciality	Organization
Mr. Ken-ichi SHISHIDO	Project Coordinator	First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA
Mr. Yoshimitsu YUKAWA	Irrigation Engineer (Chief Engineer)	Nippon Giken Inc.

2. Survey Schedule

2 - 1 Basic Design Study

DATE		JAKARTA	SOLO (SURAKARTA)	BOJONEGORO
1990 Dec.	4 Tue	Arrival at Jakarta (Consultant).		
	5 Wed	Courtecy call at JICA. Courtecy call and explanation of inception report at DGWRD.		
	6 Thu	Movement to Solo.	Preliminary discussion at PBS. Preparation for field survey and survey works.	
	7 Fri		Discussion meeting for field survey. Collecting of data & informations. Selection of local contructor for survey.	
	8 Sat		Data collection. Selection of local contructor on topographic & cross section survey.	
	9 Sun		Movement to Bojonegoro.	
	10 Mon			Discussion meeting at PBS, H. Field survey of existing & proposed pump sites.
	11 Tue			Field survey of sites. Movement to Solo.
	12 Wed	Arrival at Jakarta (Advisory Team).	Movement to Jakarta.	Field survey of sites. Farm economic survey, interview.
	13 Thu	Courtecy call at JICA, EOJ. Courtecy call and discussion meeting at DGWRD.		Field survey of sites. Supervising for topographic & cross section survey. Farm economic survey, interview.
	14 Fri	Movement to Solo (Advisory Team, Consultant).		Field survey of sites. Data collection at Agricultural Office.
	15 Sat		Reconnaissance in Wonogiri dam.	Field survey of sites. Data collection at Agricultural Office.
	16 Sun		Field survey of existing pump stations. Movement to Bojonegoro.	Data arrangement.

	17 Mon			Discussion meeting at PBS, H. Field survey of existing & proposed pump sites. Return to Solo.
	18 Tue	Discussion meeting & signing on Minutes of Discussion at DGWRD.	Movement to Jakarta. Data arrangement.	
	19 Wed	Reporting to JICA & EOJ.	Movement to Bojonegoro.	Soil profile survey. Supervising for survey works.
	20 Thu	Leave for Japan (Advisory Team). Data Collection.		Data collection. Soil profile survey. Return to Solo.
	21 Fri	Return to Solo (Consultant).	Data analysis.	
	22 Sat		Data collection & analysis.	
	23 Sun		Data arrangement.	
	24 Mon		Hydrological analysis. Unit cost survey.	
	25 Tue		Hydrological analysis. Unit cost survey.	
	26 Wed		Hydrological analysis. Planning of cropping pattern.	
	27 Thu		Rough design of pump station. Ectimation of crop production cost & income.	
	28 Fri		Movement to Jakarta. Movement to Bojonegoro.	Supervising for survey works.
	29 Sat	Data collection at CBS. Discussion with JICA expert of DGWRD.		Supervising for survey works.
	30 Sun	Return to Solo.	Discussion among Team members.	Return to Solo.
	31 Mon		Checking on progress of field survey.	
1991 Jan.	1 Tue		Designing of pump type.	
	2 Wed		Designing of pump type. Planning of operation & maintenance.	
	3 Thu		Interim discussion meeting at PBS. Designing of irrigation facilities.	
	4 Fri		Estimation of O & M cost. Designing of irrigation facilities.	

5 Sat	Designing of irrigation facilities.
6 Sun	Discussion on O & M organization.
7 Mon	Checking results of survey works. Designing pump irrigation system.
8 Tue	Designing pump irrigation system. Cost estimation.
9 Wed	Cost estimation. Estmate of Project effects.
10 Thu	Preparation of progress report on field survey.
11 Fri	Preparation of progress report.
12 Sat	Final discussion meeting at PBS.
13 Sun	Movement to Jakarta.
14 Mon	Final Discussion Meeting at DGWRD.
15 Tue	Reporting to JICA.
16 Wed	Leave for Japan.
17 Thu	Arrival at Japan.

NOTES: DGWRD: Directorate General of Water Resources Development, Ministry of Public Works. Jakarta.
PBS : Bengawan Solo River Basin Development Project, DGWRD. Solo
PBSH : Lower Bengawan Solo River Basin Development Project, DGWRD. Bojonegoro.
JICA : Japan International Coorperation Agency, Jakarta Office.
EOJ : Embassy of Japan. Jakarta.

2 - 2 , Explanation for Draft Final Report

DATE		JAKARTA	SOLO (SURAKARTA)	BOJONEGORO
1991				
May	1 Wed	Arrival at Jakarta		
	2 Thu	Courtecy call at JICA. Courtecy call at DGWRD.		
	3 Fri	Movement to Solo.		
			Courtecy call and discussion on the draft final report at PBS.	
	4 Sat		Discussion meeting at PBS. Movement to Jakarta.	
	5 Sun	Preparation of Minutes of Discussion.		
	6 Mon	Preparation of Minutes of Discussion. Discussion meeting at DGWRD.		
	7 Tue	Signing on Minutes of Discussion at DGWRD. Leave for Japan.		
	8 Wed	Arrival at Tokyo.		

NOTES: DGWRD: Directorate General of Water Resources Development, Ministry of Public Works. Jakarta.
PBS : Bengawan Solo River Basin Development Project, DGWRD. Solo
PBSH : Lower Bengawan Solo River Basin Development Project, DGWRD. Bojonegoro.
JICA : Japan International Coorperation Agency, Jakarta Office.
EOJ : Embassy of Japan. Jakarta.

3. Member List of Persons Concerned

Japan International Cooperation Agency (JICA), Jakarta Office

Mr. Satoru Hagiwara	Assistant Resident Representative

Embassy of Japan (EOJ), Jakarta

Mr. Goichiro Yukawa	First Secretary

Directorate General of Water Resources Development (GDWRD), Ministry of Public Works, Jakarta

Mr. Katsumi Kimura	JICA Irrigation Expert, Directorate of Planning and Programming
Mr. Takuya Khon	Leader of JICA Experts on Rivers, Directorate of Rivers
Ir. Subandi Wirosoemarto	Director General of Water Resources Development
Ir. Hartono Pramudo, Dipl. HE.	Director, Directorate of Rivers
Ir. Siswoko, Dipl. HE.	Chief of Sub-Directorate of Planning and Design, Directorate of Rivers
Ir. Dhono Bantolo	Staff of Directorate of Planning and Programming
Ir. Wahyu Haryanto	Staff of Directorate of Rivers
Ir. Muryati Suryono	Staff of Directorate of Rivers

Bengawan Solo River Basin Development Project (PBS), Solo

Ir. Bambang Kuswidodo, Dipl. HE.	General Manager
Ir. Soeradji, Dipl. HE.	Deputy General Manager for Planning
Ir. Aris Harnanto, Dipl. HE.	Assistant for General Planning
Ir. Muchsin Zaini, Dipl. HE.	Assistant for Irrigation Design
Ir. Saksono Hadi, CES.	Assistant for Environment
Drs. Suprapto	Assistant for Survey and Investigation
Ir. Bambang Nurhadi, Dipl. HE.	Chief of Section of Weir Design

Ir. Masdjuni Masrie	Staff of Assistant for Irrigation Design
Ir. Nurrarudin Syah	Chief of Section of Controlling of Erosion & Sedimentation
Ir. Wuryanto Ahmad Sidiq	Staff of Assistant for General Planning

Bengawan Solo River Basin Development Project (PBSH), Bojonegoro

Ir. Wiswakarman, Dipl. HE.	Manager
Ir. Santoso	Assistant of Technical Design
Ir. Bambang Sukarno	Chief of Section of Design
Sutaryono, ME.	Supervisor

Public Work Office in Bojonegoro Residency

Ir. Sutomo	Chief of Irrigation Section
Ir. Sudiro	Staff of Irrigation Section

Public Works Office in Bojonegoro District

Ir. Waidi	Chief of Irrigation Section

Public Works Office in Tuban District

Ir. A. R. Wiryono	Chief of Irrigation Section

Public Works Office in Lamongan District

Soemitro BE	Chief of Irrigation Section

Agricultural Office in Bojonegoro Residency

Ir. Waluyo	Chief of Agricultural Bojonegoro Residency Office

Agricultural Office in Bojonegoro District

Ir. Adang Wangidiredja	Chief of Agricultural Bojonegoro Regency Office

4. Minutes of Discussion

4 - 1 Basic Design Study

MINUTES OF DISCUSSION
THE BASIC DESIGN STUDY
ON PUMPING STATION PROJECT
FOR BENGAWAN SOLO LOWER REACH

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a Basic Design study on the Pumping Station Project for Bengwan Solo Lower Reach (hereinafter referred to as "the Project") and the Japan International Cooperation Agency (hereinafter referred to as "JICA" sent the study team, headed by Mr. Norifumi TAKAMURA, Deputy Director, Department of Construction ,Kyushu Agricultural Administration Office, Ministry of Agriculutre, Forestry and Fisheries from December 4, 1990 to January 17, 1991.

The team had a series of discussions with the authorities concerned of the Government of Indonesia and conducted a field survey in the proposed Project area.

As a result of the discussions and field survey, both parties confirmed the main items described on the attached sheets. The team will proceed the works and prepare the Basic Design Study Report on the Project based on the items.

December 18, 1990

Mr. Norifumi TAKAMURA
Leader,
Basic Design Study Team,
J I C A

Ir. Soebandi WIROSOEMARTO
Director General of
Water Resources Development,
Ministry of Public Works

ATTACHED DOCUMENT

1. Objectives

The objective of the Project is to increase food production and farmers' income through rehabilitation and/or construction of pumping stations in Begawan Solo Lower Reach.

2. The Project requested by the Government of Indonesia

The Project requested by the Government of Indonesia are described in ANNEX I.

3. Excuting Agency

Ministry of Public Works will bear overall responsiblities for the administration and execution of the Project.

4. Grant Aid Programme extended by the team

① The Government of Indonesia has understood the system of Japanese Grant Aid explained by the Team.

② The Government of Indoneisa will take the neccesary measures, described in Annex II for smooth implementation of the Project on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

5. Schedule of the Study

① JICA will prepare the draft report in English and dispatch a mission in order to explain the contents of the Report around the end of April, 1991.

② In case that the contents of the report is accepted in principal by the Government of Indonesia, JICA will complete Final Report and send it to the Government of Indonesia by the end of June, 1991.

ANNEX I : Project Requested by the Government of the Republic of Indonesia

1. Project Site

Project site is shown in Figure. 1. The Project consists of rehabilirtation of existing pumping stations and newly construction of proposed stations. The name of Project site is as follows;

1) Rehabilitation of existing pumping station

(1) Tapelan
(2) Sumberarum
(3) Prangi
(4) Tebon
(5) Banjarejo
(6) Ngraho
(7) Sudu
(8) Ngringinrejo
(9) Leran
(10) Trucuk
(11) Tulungrejo
(12) Mulyoagung
(13) Kalirejo
(14) Semanding
(15) Mulyorejo
(16) Sarirejo
(17) Pilanggede
(18) Kedungbondo
(19) Cangakan
(20) Kabalan

2) Newly Construction of proposed pumping station

(21) Mojorejo
(22) Dengok
(23) Karangtinoto
(24) Bandungrejo
(25) Klotok
(26) Tanggungan
(27) Kalisari
(28) Durikulon*
(29) Keduyung
(30) Bulutigo
(31) Pelangwot
(32) Tamanprijet
(33) Tejoasri

note) (28) Durikulon* may be replaced to another site in case of technical difficulty.

2. Project component

The Project component consists of pump, driving engine/motor, water suction pipe, distribution pipe, fittings, accessories, pump house, its basement, suction pit, outlet tank, protection and necessory civil work.

note) Canal construction and on-farm development shall not be included by the Project component and be excuted by the government of Indonesia.

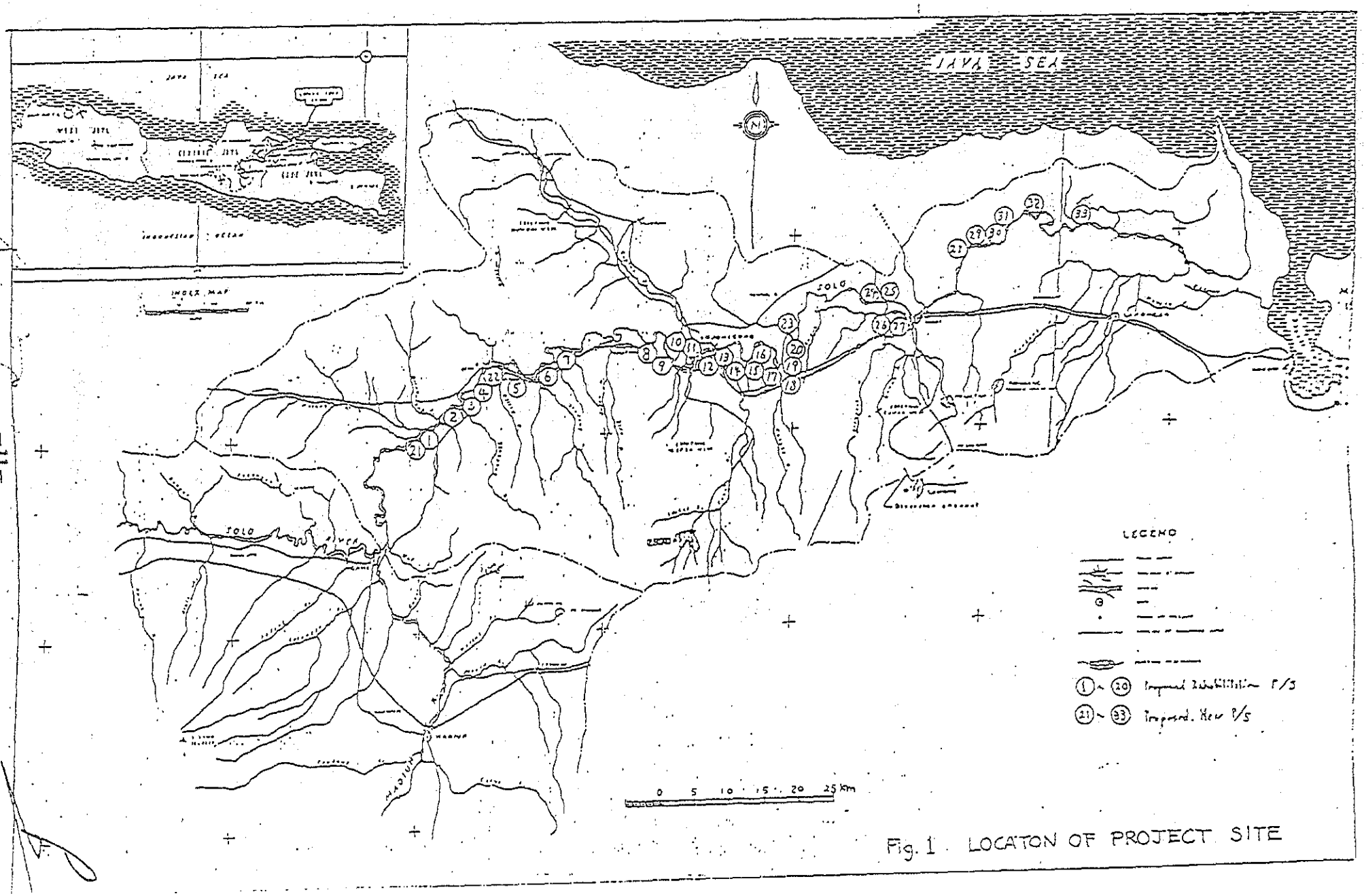


Fig. 1 LOCATON OF PROJECT SITE

ANNEX II : Necessary measures to be taken by the Government of the Republic of Indonesia

1. To provide data and information necessary for implementation of the Project.

2. To secure the land for the Project and to clear the site as needed before commencement of construction.

3. To provide facilities for electricity supply.

4. To ensure prompt unloading, tax exemption, customs clearance of the goods for the Project at the port of disembarkation in Indonesia and prompt internal transportation therein of the products purchasedunder the Grant Aid.

5. To exempt Japanese nationals engaged in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Indonesia with respect to the supply of the products and services under the verified contracts.

6. To accord Japanese nationals whose services may be required in connection with the Project under the verified contracts such facilities as may be necessary for their entry into Indonesia and stay therein for the duration of their work stay.

7. To provide necessary permissions, licences and other authorization for carrying out the Project.

8. To bear two kinds of commissions to the Japanese foreign exchange bank for the banking services, based upon the "Banking Arrangement", namely, the advising commission of the "Authorization to Pay" and payment commission.

9. To bear all the expenses, other than those to be borne by the Grant Aid.

10. To ensure the necessary budget and personnel for the proper and effective implementation of the Project, including operation and maintenance of the equipment provided under the Grant Aid.

4 - 2 Explanation for Draft Final Report

MINUTES OF DISCUSSION
THE BASIC DESIGN STUDY
ON
THE PUMPING STATION PROJECT
FOR
BENGAWAN SOLO LOWER REACHES

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a Basic Design Study on the Pumping Station Project for Bengwan Solo Lower Reaches ("the Project") and the Japan International Cooperation Agency ("JICA") sent a study team to the Republic of Indonesia from December 4, 1990 to January 17, 1991.

As a result of the study, JICA prepared a Draft Final Report and dispatched a team from May 1 to 8, 1991, to explain and discuss it.

The team held a series of discussions on the Project with the authorities concerned.

As a result of the discussions, both parties confirmed the main items described on the attached document. The team will proceed the works and prepare the Basic Design Study Report on the Project based on the items.

Jakarta, May 7, 1991

On behalf of JICA,

for Mr. Akira Takahashi
Resident Representative,
Japan International Cooperation
Agency in Indonesia

On behalf of the Government of
the Republic of Indonesia,

Ir. Hartono Pramudo, Dipl.HE.
Director of Rivers,
Directorate General of Water
Resources Development,
Ministry of Public Works

ATTACHED DOCUMENT

1. Draft Report

The Government of Indonesia accepted in principle the Draft Final Report prepared by JICA with minor changes. JICA will complete the Final Report considering the items described in Annex I.

2. Budget Allocation

The Government of Indonesia will allocate enough budget to implement the Project.

3. Grant Aid Programme

(1) The Government of Indonesia has understood the system of Japanese Grant Aid Programme explained by the Team.

(2) The Government of Indonesia will take the neccesary measures described in Annex II for smooth implementation of the Project on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

4. Submission of the Final Report

JICA will complete the Final Report and send it to the Government of Indonesia by the end of June, 1991.

ANNEX I : The items to be considered to complete the Final Report

1. Solo River Basin Development Project(PBS), Ministry of Public Works will implement the construction works of secondary and tertiary canals. Water Users Association will bear operation and maintenance cost in principle. However, the Government of Indonesia will allocate the needed budget for serious damages.

2. The scope of works of detailed design will be described in the Final Report.

3. The project cost to be undertaken by the Government of Indonesia will be modified based on their budgeting plan.

4. The design standard of the height of water-proof wall of pump house will be described in the Final Report.

5. The Final Report will mention that minimun monthly average flow to be compensated for Sembayat Barrage will be 11.5m³/sec, which is equivalent to 80% of dependable discharge analyzed by PBS, taking account of the storage effect of Sembayat Barrage.

ANNEX II : Necessary measures to be taken by the Government of the Republic of Indonesia

1. To provide data and information necessary for implementation of the Project.

2. To secure the land for the Project and to clear the site as needed before commencement of construction.

3. To ensure prompt unloading, tax exemption, customs clearance of the materials and equipments for the Project at the port of disembarkation in Indonesia.

4. To exempt Japanese nationals engaged in the Project from customs duties, internal taxes (including VAT) and other fiscal levies which may be imposed in Indonesia with respect to the supply of the products and services under the verified contracts.

5. To accord Japanese nationals whose services may be required in connection with the Project under the verified contracts such facilities as may be necessary for their entry into Indonesia and stay therein for the duration of their work stay.

6. To provide necessary permissions, licences and other authorization for carrying out the Project.

7. To bear two kinds of commissions to the Japanese foreign exchange bank for the banking services, based upon the "Banking Arrangement", namely, the advising commission of the "Authorization to Pay" and payment commission.

8. To bear all the expenses, other than those to be borne by the Grant Aid.

9. To ensure the necessary budget and personnel for the proper and effective implementation of the Project, including operation and maintenance of the facilities provided under the Grant Aid.

5. Country Data

Items	Year	Unit	Data
1. Basic indicator			
a. Population	mid-1988	mn	174.2
b. Area		'000 km2	1,905
c. GNP per capita			
1) GNP per capita	1988	US$	440
2) Average annual growth rate	1965-88	%	4.3
d. Average annual rate of inflation	1965-80	%	34.2
	1980-88	%	8.5
e. Lift expancy at birth	1988	years	61
f. Adult illiteracy (Female)	1985	%	35
(Total)	1985	%	26
2. Growth of production			
a. Average annual growth rate			
1) GDP	1965-80	%	8.0
	1980-88	%	5.1
2) Agriculture	1965-80	%	4.3
	1980-88	%	3.1
3) Industry	1965-80	%	11.9
	1980-88	%	5.1
4) (Manufacturing)	1965-80	%	12.0
	1980-88	%	13.1
5) Service, etc.	1965-80	%	7.3
	1980-88	%	6.4
3. Structure of production			
a. GDP	1965	mn US$	3,840
	1988		83,220
b. Distribution of gross domestic product			
1) Agriculture	1965	%	56
	1988	%	24
2) Industry	1965	%	13
	1988	%	36
3) (Manufacturing)	1965	%	8
	1988	%	19
4) Service, etc.	1965	%	31
	1988	%	40
4. Agriculture and food			
a. Value added in agriculture	1970	mn current US$	4,340
	1988		20,055
b. Cereal imports	1974	'000 tons	1,919
	1988		1,702
c. Food aid in cereals	1974/75	'000 tons	301
	1987/88		319
d. Fertiliger consumption	1970/71	100g/ha	133
	1987/88		1,068
e. Average index of food production per capita			
(1979-81=100)	1986-88		117

5. Commercial energy			
a. Average annual energy growth rate			
1). Energy production	1965-80	%	9.9
	1980-88	%	1.0
2) Energy consumption	1965-80	%	8.4
	1980-88	%	4.5
b. Energy consumption per capita	1965	kg of oil eq.	91
	1988	kg of oil eq.	229
c. Energy imports as a percentage of merchandise exports			
	1965	%	3
	1988	%	14
6. Structure of manufacturing			
a. Value added in manufacturing	1970	mn current US$	994
	1987	mn current US$	12,876
b. Distribution of manufacturing value added			
1) Food, beverages, and tobacco	1987	%	22
2) Textiles and clothing	1987	%	13
3) Machinery and transport equipment	1987	%	8
4) Chemicals	1987	%	9
5) Others	1987	%	48
7. Manufacturing earnings and output			
a. Earnings per employee			
1) Growth rate	1970-80	%	5.6
	1980-88	%	6.0
2) Index (1980=100)	1985		139
	1986		144
b. Total earnings as a percentage of value added	1970	%	26
	1985	%	19
	1986	%	19
c. Gross output per employee (1980=100)	1970		42
	1985		141
	1986		156
8. Growth of consumption and investment			
a. Average annual growth rate			
1) General government consumption	1965-80	%	11.4
	1980-88	%	2.9
2) Private consumption	1965-80	%	5.9
	1980-88	%	7.2
3) Gross domestic investment	1965-80	%	16.1
	1980-88	%	1.9
9. Structure of demand			
Distribution of gross domestic product			
1) General government consumption	1965	%	5
	1988	%	9
2) Private consumption, etc.	1965	%	87
	1988	%	65
3) Gross domestic investment	1965	%	8
	1988	%	22
4) Gross domestic savings	1965	%	8
	1988	%	25
5) Exports of goods and nonfactor services	1965	%	5
	1988	%	25
6) Resource balance	1965	%	0
	1988	%	4

10. Structure of consumption			
Percentage share of total household consumption			
1) Food		%	
Total		%	48
Cereals and tubers		%	21
2) Clothing and footwear		%	7
3) Gross rents, fuel and power			
Total		%	13
Fuel and power		%	7
4) Medical care		%	2
5) Education		%	4
6) Transport and communication			
Total		%	4
Motor cars		%	0
7) Other consumption			
Total		%	22
Other consumer durables		%	5
11. Central government expenditure			
a. Percentage of total expenditure			
1) Defence	1972	%	18.6
	1988	%	8.3
2) Education	1972	%	7.4
	1988	%	10.0
3) Health	1972	%	1.4
	1988	%	1.8
4) Housing, amenities; social security and welfare	1972	%	0.9
	1988	%	1.7
5) Economic service	1972	%	30.5
	1988	%	-
6) Others	1972	%	41.3
	1988	%	78.2
b. Total expenditure as a percentage of GNP	1972	%	15.1
	1988	%	22.7
c. Overall surplus/deficit as a percentage of GNP	1972	%	-2.5
	1988	%	-3.3
12. Central Government current revenue			
a. Percentage of total current revenue			
1) Tax revenue			
Tax on income, profit, and capital gain	1972	%	45.5
	1988	%	55.9
Social security contributions	1972	%	0.0
	1988	%	0.0
Domestic taxes on goods and services	1972	%	22.8
	1988	%	24.5
Tax on international trade and trans actions	1972	%	17.6
	1988	%	5.6
Other taxes	1972	%	3.5
	1988	%	3.0
2) Nontax revenue	1972	%	10.6
	1988	%	11.0
b. Total current revenue as a percentage of GNP	1972	%	13.4
	1988	%	19.2

13. Money and interest rates			
a. Monetary holdings, broadly defined			
1) Average annual nominal growth rate	1965-80	%	54.4
	1980-88	%	23.8
2) Average outstanding as a percentage of GDP	1980	%	13.2
	1988	%	28.5
b. Average annual inflation (GDP deflator)	1980-88	%	8.5
c. Nominal interest rates of banks (average annual percentage)			
1) Deposit rate	1980	%	6.00
	1988	%	17.72
2) Lending rate	1980	%	
	1988	%	22.10
14. Growth of merchandise trade			
a. Marchandise trade			
1) Exports	1988	mn US$	19,677
2) Imports	1988	mn US$	15,732
b. Average annual growth rate			
1) Exports	1965-80	%	9.6
	1980-88	%	2.9
2) Imports	1965-80	%	14.2
	1980-88	%	-2.1
c. Terms of trade (1980=100)	1985		94
	1988		70
15. Structure of merchandise imports			
a. Percentage share of merchandise imports			
1) Food	1965	%	6
	1988	%	3
2) Fuels	1965	%	3
	1988	%	18
3) Other primary commodities	1965	%	2
	1988	%	5
4) Machinery and transport equipment	1965	%	39
	1988	%	39
5) Other manufactures	1965	%	50
	1988	%	36
16. Structure of merchandise exports			
a. Percentage share of merchandise exports			
1) Fuels, minerals, and metals	1965	%	43
	1988	%	49
2) Other primary commodities	1965	%	53
	1988	%	22
3) Machinery and transport equipment	1965	%	3
	1988	%	1
4) Other manufactures	1965	%	1
	1988	%	28
5) (Textiles and clothing)	1965	%	0
	1988	%	8

17. Balance of payments and reserves			
a. Current account balance			
1) After official transfers	1970	mn US$	-310
	1988	mn US$	-1,189
2) Before official transfers	1970	mn US$	-376
	1988	mn US$	-1,500
b. Net worker's remittance	1970	mn US$	-
	1988	mn US$	99
c. Net direct private investment	1970	mn US$	83
	1988	mn US$	542
d. Gross international reserves	1970	mn US$	160
	1988	mn US$	6,322
18. Official development assistance: receipts			
a. Net disbursement of ODA from all sources			
1) Amounts	1982	mn US$	906
	1983	mn US$	744
	1984	mn US$	673
	1985	mn US$	603
	1986	mn US$	711
	1987	mn US$	1,246
	1988	mn US$	1,632
2) Per capita	1988	US$	9.3
3) As a percentage of GNP	1988	%	2.1
19. Population growth and projections			
a. Average annual growth of population	1965-80	%	2.4
	1980-88	%	2.1
	1988-2000	%	1.7
b. Population	1988	mn	175
	2000	mn	213
	2025	mn	282
c. Hypothetical size of stationary population		mn	370
d. Age structure of population			
1) 0-14 years	1988	%	37.3
	2025	%	23.3
2) 15-64 years	1988	%	58.9
	2025	%	68.2
20. Demography and fertility			
a. Crude birth rate per thousand population	1965		43
	1988		28
b. Crude death rate per thousand population	1965		20
	1988		9
c. Women of child bearing age as a percentage of population			
	1965	%	47
	1988	%	51
d. Total fertility rate	1965		5.5
	1988		3.4
	2000		2.5
e. Assumed year of reaching net reproduction rate of 1		Year	2005

21. Health and nutrition			
a. Population per physician	1965		31,700
	1984		9,460
b. Population per Nursing person	1965		9,490
	1984		1,260
c. Births attended by health staff	1985	%	43
d. Babies with low birth weight	1985	%	14
e. Infant mortality rate (per thousand live birth)	1965		128
	1988		68
f. Daily calorie supply (per capita)	1965	cal.	1,800
	1986	cal.	2,579
22. Education			
a. Percentage of age group enrolled in education			
1) Primary	1965	%	72
	1987	%	118
2) Secondary	1965	%	12
	1987	%	46
3) Tertiary	1965	%	1
	1987	%	-
23. Income distribution			
a. Percentage shore of household income, by percentile group of households			
1) Lowest 20%	1987	%	8.8
2) Second quintile		%	12.4
3) Third quintile		%	16.0
4) Fourth quintile		%	21.5
5) Highest 20%		%	41.3
6) Highest 10%		%	26.5
24. Urbanization			
a. Urban population			
1) As a percentage of total population	1965	%	16
	1988	%	27
2) Average annual growth rate	1965-80	%	4.8
	1980-88	%	4.8
b. Percentage of urban population			
1) In largest city	1960	%	20
	1980	%	23
2) In cities of over 500,000 persons	1960	%	34
	1980	%	50
c. Number of cities of over 500,000 persons	1960		3
	1980		9
Source : World Development Report 1990, World Development Indicators. The World Bank			

TECHNICAL DATA

List of Tables

Table A-1 Location of the Pumping Stations

No.	Name of Station	Sub District (Kecamatan)	District (Kabupaten)
Existing			
1	TAPELAN	NGRAHO	BOJONEGORO
2	SUMBERARUM	NGRAHO	BOJONEGORO
3	TEBON	PADANGAN	BOJONEGORO
4	PERANGI	PADANGAN	BOJONEGORO
5	BANJAREJO	PADANGAN	BOJONEGORO
6	NGRAHO	KALITIDU	BOJONEGORO
7	SUDU	KALITIDU	BOJONEGORO
8	NGRINGINREJO	KALITIDU	BOJONEGORO
9	LERAN	KALITIDU	BOJONEGORO
10	TRUCUK	BOJONEGORO	BOJONEGORO
11	TULUNGREJO	BOJONEGORO	BOJONEGORO
12	MULYOAGUNG	BOJONEGORO	BOJONEGORO
13	KALIREJO	BOJONEGORO	BOJONEGORO
14	SEMANDING	KOTA BOJONEGORO	BOJONEGORO
15	MULYOREJO	BALEN	BOJONEGORO
16	SARIREJO	BALEN	BOJONEGORO
17	PILANGGEDE	BALEN	BOJONEGORO
18	KEDUNGBONDO	BALEN	BOJONEGORO
19	CANGAKAN	KANOR	BOJONEGORO
20	KABALAN	KANOR	BOJONEGORO
Proposed			
21	MOJOREJO	NGRAHO	BOJONEGORO
22	DENGOK	PADANGAN	BOJONEGORO
23	KARANGTINOTO	RENGEL	TUBAN
24	BANDUNGREJO	PLUMPANG	TUBAN
25	KLOTOK	WIDANG	TUBAN
26	TANGGUNGAN	BAURENO	BOJONEGORO
27	KALISARI	BAURENO	BOJONEGORO
28	BANJAR	WIDANG	TUBAN
29	KEDUYUNG	LAREN	LAMONGAN
30	BULUTIGO	LAREN	LAMONGAN
31	PELANGWOT	LAREN	LAMONGAN
32	TAMANPRIJEK	LAREN	LAMONGAN
33	TEJOASRI	LAREN	LAMONGAN

Table A-2 Land Use in Bojonegoro, Tuban, and Lamongan Districts

(Unit : ha)

District (Kabupaten)	House Compound & Surroundings	Bareland/ Garden/ Shifting Cultivation	Steppe Pasture	Dike	Water Pond
Bojonegoro	23,185	31,774	8	-	88
Tuban	14,828	61,144	1,862	623	18
Lamongan	12,730	33,326	2	592	-
Total	50,743	126,244	1,872	1,215	106
Ratio	0.139	0.345	0.005	0.003	0.000

District (Kabupaten)	Preliminaly Land not Utilized	Land with Grown Wood	Estates	Wet Land	Total
Bojonegoro	116	410	-	61,722	117,303
Tuban	249	83	74	53,027	131,908
Lamongan	70	4	-	70,023	116,747
Total	435	497	74	184,772	365,958
Ratio	0.001	0.001	0.000	0.505	1.000

Source : East Java Figures, 1988. East Java Statistics Office and the Government of East Java

Table A-3 Area, Yield and Production of Food Crops in Bojonegoro Residency* (1989)

Crop	Planted Area (ha)	Hervested Area (ha)	Yield (kg/ha)	Production (ton)
Paddy	255,520	247,829	5,662	1,403,275
Maize	218,575	160,083	2,373	379,871
Soybean	53,863	51,217	1,061	54,329
Cassava	17,602	19,205	15,421	296,160
Sweet Poteto	2,441	2,045	8,723	17,838
Peanut	31,478	30,739	967	29,728
Green Pea	15,798	17,710	963	17,059
Sorghum	3,217	3,394	2,911	9,880

*Bojonegoro Residency includes Bojonegoro, Tuban, and Lamongan Districts.
Source: Year Book 1989, Agriculture Office, Bojonegoro

Table A-4 Area, Production and Yield of Main Food Crops in Bojonegoro Residency*, East Java Province and Indonesia (1988)

Crop / Item	Bojonegoro Residency	East Java Province	Indonesia
Paddy			
Paddy in Total			
Harvested Area (ha)	246,653	1,612,530	10,452,179
Production (ton)	1,285,743	8,263,470	44,779,244
Yield (kg/ha)	5,213	5,125	4,284
Wetland Paddy			
Harvested Area (ha)	230,634	1,520,975	9,310,721
Production (ton)	1,239,743	8,023,652	42,417,716
Yield (kg/ha)	5,375	5,275	4,556
Dryland Paddy			
Harvested Area (ha)	16,019	91,555	1,141,998
Production (ton)	46,000	239,818	2,361,528
Yield (kg/ha)	2,872	2,619	2,068
Palawija			
Maize			
Area (ha)	160,083	5,778,091	13,264,680
Production (ton)	379,871	2,528,705	6,212,965
Yield (kg/ha)	2,373	2,285	2,135
Soybean			
Area (ha)	51,217	531,964	1,425,751
Production (ton)	54,329	459,382	1,300,868
Yield (kg/ha)	1,061	1,158	1,096
Cassava			
Area (ha)	19,205	50,399,538	208,511,042
Production (ton)	296,160	4,031,963	17,091,069
Yield (kg/ha)	15,421	12,500	12,200
Sweat Potato			
Area (ha)	2,045	2,454,310	19,775,278
Production (ton)	17,838	245,431	2,126,374
Yield (kg/ha)	8,723	10,000	9,300
Peanut			
Area (ha)	30,739	143,093	618,402
Production (ton)	29,728	142,807	615,325
Yield (kg/ha)	967	1,002	1,005

* Bojonegoro Residency includes Bojonegoro, Tuban, and Lamongan Districts.
Source : Statistical Year Book of Indonesia, 1989. Central Bereau of Statistics.
Year Book, 1989. Agriculture Office, Bojonegoro.

Table A-5 Average Crop Production during Development Program in Bojonegoro Residency*

(Unit: ton)

	I 1963-73	II 1974-78	III 1979-83	IV 1984-88	1989
Paddy	341,542	661,389	855,961	1,265,944	1,403,275
Bojonegoro	118,266	180,830	310,352	438,093	
Tuban	91,436	132,265	186,174	261,305	
Lamongan	131,839	348,292	359,435	566,545	
Maize	101,580	137,895	170,281	456,420	379,871
Soybean	15,828	25,670	37,554	53,520	54,329
Cassava	211,487	202,093	198,118	311,574	296,160
Sweet Potato	26,333	23,784	23,872	23,144	17,838
Peanut	13,384	20,515	25,808	28,808	29,728
Sorghum	379	9,523	14,585	8,398	9,880
Green Pea	8,287	14,800	4,890	11,633	

*Bojonegoro Residensy includes Bojonegoro, Tuban, and Lamongan Districts.

Table A-6 Number of Water Users Association

District	Number of Village	Number of Water Users Association			
		Total	Less Developed	Medium Developed	Well Developed
Bojonegoro	430	237	78	117	42
Tuban	319	217	103	86	28
Lamongan	425	355	214	119	22
Total	1,174	809	395	322	92

Source : Year Book, 1989. Agriculture Office, Bojonegoro

Table A-7 Distribution of Paddy Field and Dryland in Bojonegoro Residency* (1989)

(Unit:ha)

Distribution	Bojonegoro	Tuban	Lamongan	Total
I. Paddy Field	73,305	55,708	82,943	211,956 (100%)
Irrigated/Technical	16,351	8,067	6,846	31,264 (15%)
Irrigated/Semi-Tech.	5,178	6,434	13,866	25,478 (12%)
Irrigated/Non-Tech./Public	785	1,982	17,207	19,974 (9%)
Irrigated/Non-Tech./Private	4,356	2,430	8,050	14,836 (7%)
Rainfed	46,635	36,770	36,380	119,785 (57%)
Others	0	25	594	619 (0%)
II. Dryland	151,653	128,285	83,948	363,886 (100%)
Yard	25,229	14,969	12,463	52,661 (14%)
Upland Paddy	33,574	58,922	33,678	126,174 (35%)
Upland Field	6	3,197	521	3,724 (1%)
Grass Land	8	1,355	2	1,365 (0%)
State Forest	86,136	44,496	29,669	160,301 (44%)
Others	6,700	5,346	7,615	19,661 (5%)

*Bojonegoro Residency includes Bojonegoro, Tuban, and Lamongan Districts.
Source: Year Book 1989, Agriculture Office, Bojonegoro

Table A-8 List of the Project Area

(Unit: ha)

No.	Name of Station	Potential Area	Existing Irrigated Area	Project Area		
				Total Area	Non-Inundated Area	Inundated Area
1	TAPELAN	59	25	60	32	28
2	SUMBERARUM	141	40	150	150	0
3	TEBON	50	40	50	43	7
4	PERANGI	80	35	80	55	25
5	BANJAREJO	87	60	90	36	54
6	NGRAHO	160	25	160	127	33
7	SUDU	382	40	200	169	31
8	NGRINGINREJO	217	55	200	165	35
9	LERAN	83	20	90	69	21
10	TRUCUK	126	40	130	111	19
11	TULUNGREJO	109	25	110	0	110
12	MULYOAGUNG	173	100	180	180	0
13	KALIREJO	270	40	160	160	0
14	SEMANDING	171	25	180	180	0
15	MULYOREJO	235	30	200	90	110
16	SARIREJO	290	170	200	40	160
17	PILANGGEDE	81	43	90	40	50
18	KEDUNGBONDO	145	120	100	100	0
19	CANGAKAN	207	35	140	75	65
20	KABALAN	162	30	170	80	90
21	MOJOREJO	150	24	150	130	20
22	DENGOK	200	11	200	200	0
23	KARANGTINOTO	200	30	200	140	60
24	BANDUNGREJO	240	70	200	190	10
25	KLOTOK	296	0	200	170	30
26	TANGGUNGAN	116	9	120	50	70
27	KALISARI	78	0	80	0	80
28	BANJAR	190	0	190	0	190
29	KEDUYUNG	290	75	200	10	190
30	BULUTIGO	300	125	200	20	180
31	PELANGWOT	255	150	200	20	180
32	TAMANPRIJEK	184	100	120	20	100
33	TEJOASRI	250	75	200	125	75
	TOTAL	5,977	1,667	5,000	2,977	2,023

Table A-9 Crop Yield by Conditions of Irrigation

(Unit : ton/ha)

Crop	Area	Irrigated Area		Non-Irrigated Area	Sub District (Kecamatan)
		Technical	Non-Tech.		
Paddy	A1	8.5	6.5	4.5	Kapas, Balen, Sumberrejo
	A2	6.2	5.3	4.0	Baureno, Kepohbaru, Kalitidu, Padangan
	A3	5.4	4.5	3.5	Ngraho, Tambakrejo, Sugihwaras
Maize	A1	4.5	3.2	1.0	Bojonegoro
	A2	2.8	1.6	0.5	Kepohbaru, Kedungadem, Padangan, Purwosari
Soybean	A1	2.6	1.9	1.0	Balen, Kapas, Bojonegoro
	A2	1.8	1.2	0.4	Baureno, Padangan, Dander

Source : Agriculture Office, Bojonegoro

Table A-10 Crop Production in the Project Area

Crops	Area (ha)	Yield (t/ha)	Production (ton)
With Project Condition			
Non-Inundated Area			
Paddy(Wet Season)	2,977	6.0	17,862.0
Paddy(Dry Season 1)	2,977	6.5	19,350.5
Maize	2,382	3.0	7,146.0
Soybean	595	2.0	1,190.0
Inundated Area			
Paddy(Dry Season 1)	2,023	6.5	13,149.5
Paddy(Dry Season 2)	2,023	6.5	13,149.5
Total			
Paddy	10,000		63,511.5
Maize	2,382		7,146.0
Soybean	595		1,190.0
Without Project Condition			
Existing Irrigated Area			
Non-Inundated Area			
Paddy(Wet Season)	413	6.0	2,478.0
Paddy(Dry Season 1)	124	6.5	806.0
Maize(Dry Season 1)	231	3.0	693.0
Soybean(Dry Season 1)	58	2.0	116.0
Maize(Dry Season 2)	330	3.0	990.0
Soybean(Dry Season 2)	83	2.0	166.0
Inundated Area			
Paddy(Dry Season 1)	1,044	6.5	6,786.0
Maize(Dry Season 2)	835	3.0	2,505.0
Soybean(Dry Season 2)	209	2.0	418.0
Total			
Paddy	1,581		10,070.0
Maize	1,396		4,188.0
Soybean	350		700.0
Rainfed Area			
Non-Inundated Area			
Paddy(Wet Season)	2,564	4.0	10,256.0
Paddy(Dry Season 1)	769	4.0	3,076.0
Maize(Dry Season 1)	1,436	1.0	1,436.0
Soybean(Dry Season 1)	359	0.8	287.2
Maize(Dry Season 2)	2,051	1.0	2,051.0
Soybean(Dry Season 2)	513	0.8	410.4
Inundated Area			
Paddy(Dry Season 1)	979	4.0	3,916.0
Maize(Dry Season 2)	783	1.0	783.0
Soybean(Dry Season 2)	196	0.8	156.8
Total			
Paddy	4,312		17,248.0
Maize	4,270		4,270.0
Soybean	1,068		854.4
Grand Total			
Paddy	5,893		27,318.0
Maize	5,666		8,458.0
Soybean	1,418		1,554.4
Increment (With-Without)			
Paddy	4,107		36,193.5
Maize	-3,284		-1,312.0
Soybean	-823		-364.4

Table A-11 Crop Production Value in the Project Area

Crops	Cropped Area (ha)	Prod'n (ton)	Price (Rp/kg)	Gross Value (million Rp)
With Project Condition				
Paddy	10,000	63,512	250	15,878
Palawija				2,227
Maize	2,382	7,146	250	1,787
Soybean	595	1,190	370	440
Total	12,977			18,105
Without Project Condition				
Existing Irrigated Area				
Paddy	1,581	10,070	250	2,518
Palawija				1,306
Maize	1,396	4,188	250	1,047
Soybean	350	700	370	259
Total	3,327			3,824
Rainfed Area				
Paddy	4,312	17,248	250	4,312
Palawija				1,383
Maize	4,270	4,270	250	1,068
Soybean	1,068	854	370	316
Total	9,650			5,695
Whole Area				
Paddy	5,893	27,318		6,830
Palawija				2,689
Maize	5,666	8,458		2,115
Soybean	1,418	1,554		575
Total	12,977			9,519
Increment (With-Without)				8,586

Table A-12 Unit Irrigation Diversion Requirement (1 to 5)

- PROPOSED PADDY 1 -

Month	OCT			NOV			DEC			JAN			FEB			MAR			APR		
Decade	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
LP(1st)			150.0	150.0	150.0	150.0	150.0	150.0													
Re			12.4	39.9	39.9	39.9	55.1	55.1													
Net			137.6	110.1	110.1	110.1	94.9	94.9													
Area Ratio			0.17	0.17	0.17	0.17	0.17	0.17													
WR			23.4	18.7	18.7	18.7	16.1	16.1													
LP(2nd)				50.0	50.0	50.0	50.0	50.0	50.0												
Re				39.9	39.9	39.9	55.1	55.1	55.1												
Net				10.1	10.1	10.1	0.0	0.0	0.0												
Area Ratio				0.17	0.17	0.17	0.17	0.17	0.17												
WR				1.7	1.7	1.7	0.0	0.0	0.0												
ETo						5.4	4.8	4.6	4.5	4.4	4.5	4.5	4.5	4.6	4.5	4.5	4.5	4.7	4.8		
Average Kc						1.20	1.20	1.21	1.23	1.24	1.26	1.27	1.27	1.26	1.26	1.25	1.23	1.19	1.15		
ETcrop						6.5	5.8	5.6	5.5	5.5	5.7	5.7	5.7	5.8	5.7	5.6	5.5	5.6	5.5		
P&S						2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		
ETcrop,P&S						84.8	77.6	75.7	82.9	74.6	76.7	84.9	77.2	78.0	61.4	76.3	75.4	83.5	75.2		
Re						39.9	55.1	55.1	55.1	69.8	69.8	69.8	55.5	55.5	55.5	52.5	52.5	52.5	33.6		
Net						44.9	22.5	20.6	27.8	4.8	6.9	15.1	21.6	22.4	5.8	23.8	22.9	31.0	41.6		
Area Ratio						0.08	0.25	0.42	0.58	0.75	0.92	1.00	1.00	0.92	0.75	0.58	0.42	0.25	0.08		
WR						3.6	5.6	8.6	16.1	3.6	6.4	15.1	21.5	20.6	4.4	13.8	9.6	7.8	3.3		
Net Farm Req. (mm)			23.4	20.4	20.4	24.8	21.8	24.8	16.1	3.6	6.4	15.1	21.6	20.6	4.4	13.8	9.6	7.8	3.3		
Overall Effi.			0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85		
Diversion Req. (mm)			27.5	24.0	24.0	29.3	25.6	29.2	19.0	4.2	7.5	17.8	25.4	24.3	5.1	16.2	11.3	9.1	3.9		
Diversion Req.(l/s/ha)			0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.0	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.0		

Note: LP; Land Preparation Requirement.
Re; Effective Rainfall; 70% of monthly rainfall (one in five year low) at Bojonegoro.
P&S; Percolation and Lateral Seepage Requirement.
ETo; Reference Crop Evapotranspiration.
Kc; Crop Coefficient.
ETcrop; Crop Evapotranspiration; = ETo x Kc.
Net; Net Crop Water Requirement; = Water Requirement - Effective Rainfall.
Diversion Req.(l/s/ha); Unit Irrigation Diversion Requirement in l/s/ha; this requirement is computed considering "Area Expansion Factor", which is applied to the standard irrigation diversion requirement as a reduced demand of 80%.

Source: Study Team's estimate using the following data;
- Canadian International Development Agency, LOWER SOLO RIVER DEVELOPMENT PROJECT, Appendix F Agriculture, Part 6 Crop Water Requirement, 1986.
- Hydrometeorological data collected from PBS, Ministry of Public Works.
- Farm survey conducted by the Study Team.

Table A-12 Unit Irrigation Diversion Requirement (2 to 5)

- PROPOSED PADDY 2 -

Month	MAR			APR			MAY			JUN			JUL			AUG			SEP		
Decade	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
LP(1st)	150.0	150.0	150.0	150.0	150.0	150.0															
Re	52.5	52.5	52.5	33.6	33.6	33.6															
Net	97.5	97.5	97.5	116.4	116.4	116.4															
Area Ratio	0.17	0.17	0.17	0.17	0.17	0.17															
WR	16.6	16.6	16.6	19.8	19.8	19.8															
LP(2nd)		0.0	0.0	0.0	0.0	0.0	0.0														
Re																					
Net																					
Area Ratio																					
WR																					
ETo			4.7	4.8	4.8	4.8	4.7	4.4	4.2	4.3	4.1	4.2	4.3	4.5	4.7	5.0					
Average Kc			1.20	1.20	1.21	1.23	1.24	1.26	1.27	1.27	1.26	1.26	1.25	1.23	1.19	1.15					
ETcrop			5.6	5.8	5.8	5.9	5.8	5.5	5.3	5.5	5.2	5.3	5.4	5.5	5.6	5.8					
P&S			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0					
ETcrop,P&S			84.0	77.6	78.1	79.0	78.3	75.4	80.7	74.6	71.7	72.9	73.8	75.4	83.5	77.5					
Re			52.5	33.6	33.6	33.6	8.6	8.6	8.6	6.5	6.5	6.5	2.1	2.1	2.1	0.0					
Net			31.5	44.0	44.5	45.4	69.6	66.8	72.0	68.1	65.1	66.4	71.7	73.3	81.4	77.5					
Area Ratio			0.08	0.25	0.42	0.58	0.75	0.92	1.00	1.00	0.92	0.75	0.58	0.42	0.25	0.08					
WR			2.5	11.0	18.7	26.4	52.2	61.5	72.0	68.1	59.9	49.8	41.6	30.8	20.4	6.2					
Net Farm Req. (mm)	16.6	16.6	19.1	30.8	38.5	46.1	52.2	61.5	72.0	68.1	59.9	49.8	41.6	30.8	20.4	6.2					
Overall Effi.	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85					
Diversion Req. (mm)	19.5	19.5	22.5	36.2	45.3	54.3	61.5	72.3	84.8	80.1	70.5	58.6	48.9	36.2	23.9	7.3					
Diversion Req.(l/s/ha)	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.5	0.5	0.3	0.2	0.1					

Note: LP; Land Preparation Requirement.
Re; Effective Rainfall; 70% of monthly rainfall (one in five year low) at Bojonegoro.
P&S; Percolation and Lateral Seepage Requirement.
ETo; Reference Crop Evapotranspiration.
Kc; Crop Coefficient.
ETcrop; Crop Evapotranspiration; = ETo x Kc.
Net; Net Crop Water Requirement; = Water Requirement - Effective Rainfall.
Diversion Req.(l/s/ha); Unit Irrigation Diversion Requirement in l/s/ha; this requirement is computed considering "Area Expansion Factor", which is applied to the standard irrigation diversion requirement as a reduced demand of 80%.

Source: Study Team's estimate using the following data;
- Canadian International Development Agency, LOWER SOLO RIVER DEVELOPMENT PROJECT, Appendix F Agriculture, Part 6 Crop Water Requirement, 1986.
- Hydrometeorological data collected from PBS, Ministry of Public Works.
- Farm survey conducted by the Study Team.

Table A-12 Unit Irrigation Diversion Requirement (3 to 5)

- PROPOSED PADDY 3 -

Month	JUN			JUL			AUG			SEP			OCT			NOV			DEC		
Decade	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
LP(1st)			150.0	150.0	150.0	150.0	150.0	150.0													
Re			6.5	2.1	2.1	2.1	0.0	0.0													
Net			143.5	147.9	147.9	147.9	150.0	150.0													
Area Ratio			0.17	0.17	0.17	0.17	0.17	0.17													
WR			24.4	25.1	25.1	25.1	25.5	25.5													
LP(2nd)				0.0	0.0	0.0	0.0	0.0	0.0												
Re																					
Net																					
Area Ratio																					
WR																					
ETo					4.5	4.7	5.0	5.3	5.5	5.8	5.9	6.0	6.2	6.2	6.1	6.0	5.7	5.4			
Average Kc					1.20	1.20	1.21	1.23	1.24	1.26	1.27	1.27	1.26	1.26	1.25	1.23	1.19	1.15			
ETcrop					5.4	5.6	6.1	6.5	6.8	7.3	7.5	7.6	7.8	7.8	7.6	7.4	6.8	6.2			
P&S					2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0			
ETcrop,P&S					74.0	84.0	88.5	85.2	97.0	93.1	94.9	96.2	98.1	98.1	105.9	93.8	87.8	82.1			
Re					2.1	2.1	0.0	0.0	0.0	3.5	3.5	3.5	12.4	12.4	12.4	39.9	39.9	39.9			
Net					71.9	81.9	88.5	85.2	97.0	89.6	91.4	92.7	85.8	85.8	93.5	53.9	47.9	42.2			
Area Ratio					0.08	0.25	0.42	0.58	0.75	0.92	1.00	1.00	0.92	0.75	0.58	0.42	0.25	0.08			
WR					5.8	20.5	33.8	49.4	72.8	82.4	91.4	92.7	78.9	64.3	54.2	22.6	12.0	3.4			
Net Farm Req. (mm)			24.4	25.1	30.9	45.6	59.3	74.9	72.8	82.4	91.4	92.7	78.9	64.3	54.2	22.6	12.0	3.4			
Overall Effi.			0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85			
Diversion Req. (mm)			28.7	29.6	36.3	53.7	69.8	88.1	85.6	97.0	107.6	109.1	92.8	75.7	63.8	26.6	14.1	4.0			
Diversion Req.(l/s/ha)			0.3	0.3	0.3	0.5	0.6	0.8	0.7	0.9	1.0	1.0	0.9	0.7	0.5	0.2	0.1	0.0			

Note: LP; Land Preparation Requirement.
Re; Effective Rainfall; 70% of monthly rainfall (one in five year low) at Bojonegoro.
P&S; Percolation and Lateral Seepage Requirement.
ETo; Reference Crop Evapotranspiration.
Kc; Crop Coefficient.
ETcrop; Crop Evapotranspiration; = ETo x Kc.
Net; Net Crop Water Requirement; = Water Requirement - Effective Rainfall.
Diversion Req.(l/s/ha); Unit Irrigation Diversion Requirement in l/s/ha; this requirement is computed considering "Area Expansion Factor", which is applied to the standard irrigation diversion requirement as a reduced demand of 80%.

Source: Study Team's estimate using the following data;
- Canadian International Development Agency, LOWER SOLO RIVER DEVELOPMENT PROJECT, Appendix F Agriculture, Part 6 Crop Water Requirement, 1986.
- Hydrometeorological data collected from PBS, Ministry of Public Works.
- Farm survey conducted by the Study Team.

Table A-12 Unit Irrigation Diversion Requirement (4 to 5)

- PROPOSED PALAWIJA -

Month	JUN			JUL			AUG			SEP			OCT			NOV			DEC		
Decade	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
LP(1st)			35.0	35.0	35.0	35.0	35.0	35.0													
Re			6.5	2.1	2.1	2.1	0.0	0.0													
Net			28.5	32.9	32.9	32.9	35.0	35.0													
Area Ratio			0.17	0.17	0.17	0.17	0.17	0.17													
WR			4.8	5.6	5.6	5.6	6.0	6.0													
LP(2nd)				15.0	15.0	15.0	15.0	15.0	15.0												
Re				2.1	2.1	2.1	0.0	0.0	0.0												
Net				12.9	12.9	12.9	15.0	15.0	15.0												
Area Ratio				0.17	0.17	0.17	0.17	0.17	0.17												
WR				2.2	2.2	2.2	2.6	2.6	2.6												
ETo					4.5	4.7	5.0	5.3	5.5	5.8	5.9	6.0	6.2	6.2	6.1	6.0	5.7	5.4	4.8		
Average Kc					0.58	0.60	0.63	0.71	0.80	0.87	0.94	1.04	1.01	0.94	0.91	0.83	0.69	0.38	0.00		
ETcrop					2.6	2.8	3.2	3.8	4.4	5.0	5.6	6.2	6.3	5.8	5.5	5.0	3.9	2.0	0.0		
P&S					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
ETcrop,P&S					26.1	30.8	31.7	37.6	48.2	50.2	55.7	62.1	62.9	58.4	60.9	49.8	39.1	20.3	0.0		
Re					2.1	2.1	0.0	0.0	0.0	3.5	3.5	3.5	12.4	12.4	12.4	39.9	39.9	39.9	55.1		
Net					24.0	28.7	31.7	37.6	48.2	46.7	52.2	58.6	50.5	46.1	48.5	9.9	0.0	0.0	0.0		
Area Ratio					0.08	0.25	0.42	0.58	0.75	0.92	1.00	1.00	1.00	0.92	0.75	0.58	0.42	0.25	0.08		
WR					1.9	7.2	13.3	21.8	36.1	43.0	52.2	58.6	50.5	42.4	36.4	5.7	0.0	0.0	0.0		
Net Farm Req. (mm)			4.8	7.8	9.7	15.0	21.8	30.3	38.7	43.0	52.2	58.6	50.5	42.4	36.4	5.7	0.0	0.0	0.0		
Overall Effi.			0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65		
Diversion Req. (mm)			7.4	12.0	14.9	23.0	33.6	46.7	59.5	66.2	80.3	90.2	77.7	65.2	56.0	8.8	0.0	0.0	0.0		
Diversion Req.(l/s/ha)			0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.5	0.1	0.0	0.0	0.0		

Note: LP; Land Preparation Requirement.
Re; Effective Rainfall; 70% of monthly rainfall (one in five year low) at Bojonegoro.
ETo; Reference Crop Evapotranspiration.
Kc; Crop Coefficient.
ETcrop; Crop Evapotranspiration; = ETo x Kc.
Net; Net Crop Water Requirement; = Water Requirement - Effective Rainfall.
Diversion Req.(l/s/ha); Unit Irrigation Diversion Requirement in l/s/ha; this requirement is computed considering "Area Expansion Factor", which is applied to the standard irrigation diversion requirement as a reduced demand of 80%.

Source: Study Team's estimate using the following data;
- Canadian International Development Agency, LOWER SOLO RIVER DEVELOPMENT PROJECT, Appendix F Agriculture, Part 6 Crop Water Requirement, 1986.
- Hydrometeorological data collected from PBS, Ministry of Public Works.
- Farm survey conducted by the Study Team.

Table A-12 Unit Irrigation Diversion Requirement (5 to 5)

- EXISTING PALAWIJA -

Month	MAR			APR			MAY			JUN			JUL			AUG			SEP		
Decade	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
LP(1st)	35.0	35.0	35.0	35.0	35.0	35.0															
Re	52.5	52.5	52.5	33.6	33.6	33.6															
Net	0.0	0.0	0.0	1.4	1.4	1.4															
Area Ratio	0.17	0.17	0.17	0.17	0.17	0.17															
WR	0.0	0.0	0.0	0.2	0.2	0.2															
LP(2nd)		15.0	15.0	15.0	15.0	15.0	15.0														
Re		52.5	52.5	33.6	33.6	33.6	8.6														
Net		0.0	0.0	0.0	0.0	0.0	0.0														
Area Ratio		0.17	0.17	0.17	0.17	0.17	0.17														
WR		0.0	0.0	0.0	0.0	0.0	0.0														
ETo			4.7	4.8	4.8	4.8	4.7	4.4	4.2	4.3	4.1	4.2	4.3	4.5	4.7	5.0	5.3				
Average Kc			0.58	0.60	0.63	0.71	0.80	0.87	0.94	1.04	1.01	0.94	0.91	0.83	0.69	0.38	0.00				
ETcrop			2.7	2.9	3.0	3.4	3.8	3.8	3.9	4.5	4.1	3.9	3.9	3.7	3.2	1.9	0.0				
P&S			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
ETcrop,P&S			38.0	28.8	30.2	34.1	37.6	38.3	43.4	44.7	41.4	39.5	39.1	37.4	35.7	19.0	0.0				
Re			52.5	33.6	33.6	33.6	8.6	8.6	8.6	6.5	6.5	6.5	2.1	2.1	2.1	0.0	0.0				
Net			0.0	0.0	0.0	0.5	29.0	29.6	34.8	38.2	34.9	32.9	37.0	35.3	33.6	19.0	0.0				
Area Ratio			0.08	0.25	0.42	0.58	0.75	0.92	1.00	1.00	1.00	0.92	0.75	0.58	0.42	0.25	0.08				
WR			0.0	0.0	0.0	0.3	21.7	27.3	34.8	38.2	34.9	30.3	27.8	20.4	14.1	4.8	0.0				
Net Farm Req. (mm)	0.0	0.0	0.0	0.2	0.2	0.5	21.7	27.3	34.8	38.2	34.9	30.3	27.8	20.4	14.1	4.8	0.0				
Overall Effi.	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65				
Diversion Req. (mm)	0.0	0.0	0.0	0.4	0.4	0.8	33.4	42.0	53.5	58.7	53.7	46.6	42.7	31.5	21.7	7.3	0.0				
Diversion Req.(l/s/ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.5	0.5	0.4	0.4	0.3	0.2	0.1	0.0				

Note: LP; Land Preparation Requirement.
Re; Effective Rainfall; 70% of monthly rainfall (one in five year low) at Bojonegoro.
ETo; Reference Crop Evapotranspiration.
Kc; Crop Coefficient.
ETcrop; Crop Evapotranspiration; = ETo x Kc.
Net; Net Crop Water Requirement; = Water Requirement - Effective Rainfall.
Diversion Req.(l/s/ha); Unit Irrigation Diversion Requirement in l/s/ha; this requirement is computed considering "Area Expansion Factor", which is applied to the standard irrigation diversion requirement as a reduced demand of 80%.

Source: Study Team's estimate using the following data;
- Canadian International Development Agency, LOWER SOLO RIVER DEVELOPMENT PROJECT, Appendix F Agriculture, Part 6 Crop Water Requirement, 1986.
- Hydrometeorological data collected from P&S, Ministry of Public Works.
- Farm survey conducted by the Study Team.

Table A-13 Proposed Irrigation Diversion Requirement

Item	Area (ha)	JAN			FEB			MAR			APR			MAY			JUN		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
(Unit Irri. Req.)																			
NON-INUNDATED AREA																			
Paddy 1		0.0	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.0								
Paddy 2								0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.5
Palawija																			0.1
Total (l/s/ha)		0.0	0.1	0.1	0.2	0.2	0.1	0.4	0.3	0.3	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.6
INUNDATED AREA																			
Paddy 2								0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.5
Paddy 3																			0.3
Total (l/s/ha)								0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.8
(Diversion Req.)																			
EXISTING PUMP STA.																			
Non-Inundated	1,902	0.00	0.19	0.19	0.38	0.38	0.19	0.76	0.57	0.57	0.57	0.76	0.95	1.14	1.33	1.33	1.33	1.33	1.14
Inundated	838	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.17	0.25	0.34	0.42	0.50	0.59	0.59	0.59	0.59	0.67
Sub-total (m3/s)	2,740	0.00	0.19	0.19	0.38	0.38	0.19	0.93	0.74	0.74	0.82	1.10	1.37	1.64	1.92	1.92	1.92	1.92	1.81
PROPOSED PUMP STA.																			
Non-Inundated	1,075	0.00	0.11	0.11	0.22	0.22	0.11	0.43	0.32	0.32	0.32	0.43	0.54	0.65	0.75	0.75	0.75	0.75	0.65
Inundated	1,185	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.24	0.24	0.36	0.47	0.59	0.71	0.83	0.83	0.83	0.83	0.95
Sub-total (m3/s)	2,260	0.00	0.11	0.11	0.22	0.22	0.11	0.67	0.56	0.56	0.68	0.90	1.13	1.36	1.58	1.58	1.58	1.58	1.59
GRAND TOTAL (m3/s)	5,000	0.00	0.30	0.30	0.60	0.60	0.30	1.60	1.30	1.30	1.50	2.00	2.50	3.00	3.50	3.50	3.50	3.50	3.40

Item	Area (ha)	JUL			AUG			SEP			OCT			NOV			DEC		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
(Unit Irri. Req.)																			
NON-INUNDATED AREA																			
Paddy 1													0.2	0.2	0.2	0.3	0.2	0.3	0.2
Paddy 2		0.5	0.3	0.2	0.1														
Palawija		0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.5	0.1	0.0	0.0	0.0		
Total (l/s/ha)		0.6	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.7	0.3	0.2	0.3	0.2	0.3	0.2
INUNDATED AREA																			
Paddy 2		0.5	0.3	0.2	0.1														
Paddy 3		0.3	0.3	0.5	0.6	0.8	0.7	0.9	1.0	1.0	0.9	0.7	0.5	0.2	0.1	0.0			
Total (l/s/ha)		0.8	0.6	0.7	0.7	0.8	0.7	0.9	1.0	1.0	0.9	0.7	0.5	0.2	0.1	0.0			
(Diversion Req.)																			
EXISTING PUMP STA.																			
Non-Inundated	1,902	1.14	0.76	0.76	0.76	0.76	0.95	1.14	1.33	1.52	1.33	1.14	1.33	0.57	0.38	0.57	0.38	0.57	0.38
Inundated	838	0.67	0.50	0.59	0.59	0.67	0.59	0.75	0.84	0.84	0.75	0.59	0.42	0.17	0.08	0.00	0.00	0.00	0.00
Sub-total (m3/s)	2,740	1.81	1.26	1.35	1.35	1.43	1.54	1.90	2.17	2.36	2.09	1.73	1.75	0.74	0.46	0.57	0.38	0.57	0.38
PROPOSED PUMP STA.																			
Non-Inundated	1,075	0.65	0.43	0.43	0.43	0.43	0.54	0.65	0.75	0.86	0.75	0.65	0.75	0.32	0.22	0.32	0.22	0.32	0.22
Inundated	1,185	0.95	0.71	0.83	0.83	0.95	0.83	1.07	1.19	1.19	1.07	0.83	0.59	0.24	0.12	0.00	0.00	0.00	0.00
Sub-total (m3/s)	2,260	1.59	1.14	1.26	1.26	1.38	1.37	1.71	1.94	2.05	1.82	1.47	1.35	0.56	0.33	0.32	0.22	0.32	0.22
GRAND TOTAL (m3/s)	5,000	3.40	2.40	2.61	2.61	2.81	2.90	3.61	4.11	4.40	3.90	3.20	3.10	1.30	0.80	0.89	0.60	0.89	0.60

Source : Computed by the Study Team.

Note : EXISTING PUMP STA.; Pump stations (No.1 to No.20) to be rehabilitated.
PROPOSED PUMP STA.; Pump stations (No.21 to No.33) to be constructed newly.

Table A-14 Present Irrigation Diversion Requirement (1 to 2)

Item	Area (ha)	JAN			FEB			MAR			APR			MAY			JUN		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
(Unit Irri. Req.)																			
NON-INUNDATED AREA																			
Paddy 1		0.0	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.0								
Paddy 2 (30 %)								0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.5
Palawija 1 (70 %)								0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.5	0.5	0.4
Palawija 2																			0.1
Total (l/s/ha)		0.0	0.1	0.1	0.2	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.2	0.4	0.5	0.5	0.6	0.6	0.5
INUNDATED AREA																			
Paddy								0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.5
Palawija																			0.1
Total (l/s/ha)		0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.6
(Diversion Req.)																			
PRESENT IRRI. AREA																			
Non-Inundated	413	0.00	0.04	0.04	0.08	0.08	0.04	0.11	0.07	0.07	0.04	0.05	0.06	0.16	0.20	0.23	0.23	0.23	0.22
Inundated	1,044	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.21	0.31	0.42	0.52	0.63	0.73	0.73	0.73	0.73	0.63
Total (m3/s)	1,457	0.00	0.04	0.04	0.08	0.08	0.04	0.32	0.27	0.27	0.35	0.47	0.58	0.79	0.93	0.96	0.96	0.96	0.85

Source : Computed by the Study Team.
Note : In the estimation of present unit irrigation requirement except for Palawija 1, proposed figures are adopted.
PRESENT IRRI. AREA; Total present irrigation area concerning to the pump stations included in the Project.

Table A-15 Incremental Irrigation Diversion Requirement (1 to 2)

Item	Area (ha)	JAN			FEB			MAR			APR			MAY			JUN		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
(Diversion Req.)																			
Proposed	5,000	0.0	0.3	0.3	0.6	0.6	0.3	1.6	1.3	1.3	1.5	2.0	2.5	3.0	3.5	3.5	3.5	3.5	3.4
Present	1,457	0.0	0.0	0.0	0.1	0.1	0.0	0.3	0.3	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.0	1.0	0.8
Increse (m3/s)	3,543	0.0	0.3	0.3	0.5	0.5	0.3	1.3	1.0	1.0	1.1	1.5	1.9	2.2	2.6	2.5	2.5	2.5	2.6
Monthly Ave				0.2			0.4			1.1			1.5			2.4			2.5

Table A-14 Present Irrigation Diversion Requirement (2 to 2)

Item	Area (ha)	JUL			AUG			SEP			OCT			NOV			DEC		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
(Unit Irri. Req.)																			
NON-INUNDATED AREA																			
Paddy 1													0.2	0.2	0.2	0.3	0.2	0.3	0.2
Paddy 2 (30 %)		0.5	0.3	0.2	0.1														
Palawija 1 (70 %)		0.4	0.3	0.2	0.1	0.0													
Palawija 2		0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.5	0.1	0.0	0.0	0.0		
Total (l/s/ha)		0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.7	0.3	0.2	0.3	0.2	0.3	0.2
INUNDATED AREA																			
Paddy		0.5	0.3	0.2	0.1														
Palawija		0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.5	0.1	0.0	0.0	0.0		
Total (l/s/ha)		0.6	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.8	0.7	0.6	0.5	0.1	0.0	0.0	0.0	0.0	0.0
(Diversion Req.)																			
PRESENT IRRI. AREA																			
Non-Inundated	413	0.22	0.17	0.17	0.17	0.17	0.21	0.25	0.29	0.33	0.29	0.25	0.29	0.12	0.08	0.12	0.08	0.12	0.08
Inundated	1,044	0.63	0.42	0.42	0.42	0.42	0.52	0.63	0.73	0.84	0.73	0.63	0.52	0.10	0.00	0.00	0.00	0.00	0.00
Total (m3/s)	1,457	0.85	0.58	0.58	0.58	0.58	0.73	0.87	1.02	1.17	1.02	0.87	0.81	0.23	0.08	0.12	0.08	0.12	0.08

Source : Computed by the Study Team.
Note : In the estimation of present unit irrigation requirement except for Palawija 1, proposed figures are adopted.
PRESENT IRRI. AREA; Total present irrigation area concerning to the pump stations included in the Project.

Table A-15 Incremental Irrigation Diversion Requirement (2 to 2)

Item	Area (ha)	JUL			AUG			SEP			OCT			NOV			DEC		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
(Diversion Req.)																			
Proposed	5,000	3.4	2.4	2.6	2.6	2.8	2.9	3.6	4.1	4.4	3.9	3.2	3.1	1.3	0.8	0.9	0.6	0.9	0.6
Present	1,457	0.8	0.6	0.6	0.6	0.6	0.7	0.9	1.0	1.2	1.0	0.9	0.8	0.2	0.1	0.1	0.1	0.1	0.1
Increse (m3/s)	3,543	2.6	1.8	2.0	2.0	2.2	2.2	2.7	3.1	3.2	2.9	2.3	2.3	1.1	0.7	0.8	0.5	0.8	0.5
Monthly Ave				2.1			2.1			3.0			2.5			0.9			0.6

Table A-16 Observed Monthly Average Flow of the Solo River at Babat (Without Project Condition)

(Unit:m3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Max	Annual Min	Annual Ave
1959	1,001.0	976.2	851.6	468.3	398.7	184.8	47.4	0.4	3.8	2.5	37.1	651.8	1,001.0	0.4	384.6
1960	613.0	888.3	816.8	733.4	567.5	49.8	11.3	0.5	0.5	1.6	272.6	288.3	888.3	0.5	353.0
1961	522.0	594.8	666.2	365.7	308.5	34.3	0.5	1.2	3.1	4.6	26.4	120.3	666.2	0.5	219.9
1962	786.6	702.7	653.1	945.0	304.5	56.6	40.7	16.8	0.7	5.0	135.3	393.5	945.0	0.7	336.7
1963	727.7	856.3	1,064.4	528.3	71.9	41.5	14.6	1.7	0.8	0.1	7.4	116.5	1,064.4	0.1	285.9
1964	184.1	239.7	530.6	519.4	264.3	159.9	21.9	10.8	12.2	271.6	322.9	189.8	530.6	10.8	226.5
1965	497.8	734.6	621.0	417.9	49.8	23.2	13.0	8.0	7.7	7.8	8.3	281.9	734.6	7.7	222.6
1966	646.3	939.8	1,492.6		770.9	513.0	416.7	45.4	40.6	42.5	230.4	519.3	1,492.6	40.6	
1967	881.5	723.1	564.8	373.1	99.2	27.9	13.0	8.6	7.8	7.7	21.3	277.8	881.5	7.7	250.5
1968	422.1	606.3	927.5	601.0	548.4		509.9	225.2	2.8	3.0	327.8	744.7	927.5	2.8	
1969	636.5	942.0	857.2	847.0	75.1	7.1	2.2	1.4	0.2	2.4	83.7	394.9	942.0	0.2	320.8
1970	425.7	872.3	989.7	470.5	431.8	155.9	41.3	6.5	37.9	56.4	198.7	529.7	989.7	6.5	351.4
1971	1,376.1	1,208.4	916.0	635.7	460.5	293.7	54.8	26.0	7.8	139.9	655.8	850.7	1,376.1	7.8	552.1
1972	651.7	488.3	842.5	445.8	376.8	41.5	21.8	16.5	13.5	12.1	52.2		842.5	12.1	
1973		1,845.3	1,872.9	916.3	1,134.5	350.3	243.6	110.9	198.7	113.8	494.7	826.2	1,134.5	110.9	
1974	493.8	892.2	1,043.4	923.8	518.4	112.6	111.5	165.9	230.0	435.9	679.8	605.4	1,043.4	111.5	517.7
1975	791.1	1,282.0		1,330.0	949.5	279.1	264.8	180.5	243.8	599.3	772.2	819.2	1,330.0	180.5	
1976	1,036.8	550.6	795.7	496.8	243.3	141.7	36.5	14.5	7.3	75.0	267.0	224.9	1,036.8	7.3	324.2
1977	526.2	743.7	888.4	622.3	241.8	324.4	92.8	37.0	11.5	7.3	22.2	289.5	888.4	7.3	317.3
1978	1,117.9	968.8	894.5	356.4	412.8	485.6	557.7	286.8	173.6	69.6	236.8	741.6	1,117.9	69.6	518.5
1979	1,001.7	823.4	807.1	1,126.9	883.7	325.2	54.8	28.7	18.7	49.4	221.8	378.8	1,126.9	18.7	476.6
1980	581.9	783.1	628.1	787.1	283.8	55.0	35.8	51.1	12.5	32.1	305.8	499.7	787.1	12.5	331.3
1981	645.6	742.9	387.9	270.0	335.5	199.7	288.4	101.7	116.7	132.5	352.4	622.1	742.9	101.7	349.5
1982	1,609.8	1,378.6	1,105.8	721.5	122.4	67.9	34.4	36.4	29.2	25.1	34.6	353.2	1,609.8	25.1	459.9
(59-82)															
Max	1,609.8	1,378.6	1,492.6	1,330.0	1,134.5	513.0	557.7	225.2	243.8	599.3	772.2	850.7	1,609.8	180.5	552.1
Min	184.1	239.7	387.9	270.0	49.8	7.1	0.5	0.4	0.2	0.1	7.4	116.5	530.6	0.1	219.9
Ave	746.8	828.9	844.2	647.6	406.9	178.9	122.1	54.3	48.9	87.4	236.5	465.3	1,004.1	31.0	357.8
1983	887.8	831.6	747.1	654.1	844.7	225.8	79.0	62.8	54.7	122.9	517.0	498.2	844.7	54.7	457.1
1984	1,166.1	1,651.6	1,044.7	648.9	288.8	111.4	102.0	69.0	233.9	212.2	139.3	751.9	1,651.6	69.0	535.0
1985	861.6	1,026.2	1,143.2	716.8	227.1	242.8	69.2	49.2	43.1	86.8	172.0	428.7	1,143.2	43.1	422.2
1986	1,099.3	1,484.2	1,578.4	1,361.8	152.2	317.8	135.2	52.4	103.9	103.5	377.0	269.7	1,578.4	52.4	586.3
1987	1,383.5	1,798.8	1,075.1	289.8	189.9	119.4	45.0	29.4	24.9	22.0	73.4	675.0	1,798.8	22.0	463.9
1988	663.3	880.1	731.0	353.9	323.2	128.5	39.4	31.4	21.2	47.8	357.7	447.6	880.1	21.2	335.4
1989	789.3	943.6	709.0	558.1	379.7	629.6	287.3	84.2	35.2	58.1	221.6	412.5	943.6	35.2	425.0
1990	892.4	788.2	586.5	332.5	218.8	93.9	77.3	31.5	27.1	28.7			892.4	28.7	
(83-90)															
Max	1,383.5	1,798.8	1,578.4	1,361.8	844.7	629.6	287.3	84.2	233.9	212.2	517.0	751.9	1,798.8	69.0	586.3
Min	663.3	788.2	586.5	289.8	189.9	93.9	39.4	29.4	21.2	28.7	73.4	269.7	844.7	28.7	335.4
Ave	957.9	1,175.5	951.9	609.5	318.1	233.7	104.3	51.2	68.0	83.3	265.4	497.7	1,216.6	39.8	460.7

Source : Discharge data collected from PBS, Ministry of Public Works.
Note : Construction of the Wonogiri Dam had been completed in the year 1982.

Table A-17 Estimated Monthly Average Flow of the Solo River at Babat (With Project Condition)

(Unit:m3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Max	Annual Min	Annual Ave
I.I.D.R	0.2	0.4	1.1	1.5	2.4	2.5	2.1	2.1	3.0	2.5	0.9	0.6	3.0	0.2	1.6
1983	807.6	831.2	746.0	692.6	842.3	223.3	76.9	60.7	51.7	120.4	516.1	497.6	842.3	51.7	455.5
1984	1,165.9	1,651.2	1,043.6	647.4	286.4	108.9	99.9	66.9	230.9	209.7	138.4	751.3	1,651.2	66.9	533.4
1985	861.4	1,825.8	1,142.1	715.3	224.7	248.3	67.1	47.1	40.1	84.3	171.1	428.1	1,142.1	40.1	420.6
1986	1,899.1	1,483.8	1,577.3	1,360.3	149.8	315.3	133.1	50.3	100.9	101.0	376.1	269.1	1,577.3	50.3	584.7
1987	1,383.3	1,798.4	1,874.0	208.3	107.5	116.9	42.9	27.3	21.9	19.5	72.5	674.4	1,798.4	19.5	462.2
1988	663.1	879.7	729.9	352.4	320.8	126.0	37.3	29.3	18.2	45.3	356.8	447.0	879.7	18.2	333.8
1989	789.1	943.2	707.9	556.6	377.3	627.1	285.2	82.1	32.2	47.6	220.7	411.9	943.2	32.2	423.4
1990	892.2	787.8	585.4	331.0	216.4	91.4	75.2	29.4	24.1	18.2			892.2	18.2	
(83-90)															
Max	1,383.3	1,798.4	1,577.3	1,360.3	842.3	627.1	285.2	82.1	230.9	209.7	516.1	751.3	1,798.4	66.9	584.7
Min	663.1	787.8	585.4	208.3	107.5	91.4	37.3	27.3	18.2	18.2	72.5	269.1	842.3	18.2	333.8
Ave	957.7	1,175.1	950.8	608.0	315.7	231.2	102.2	49.1	65.8	80.8	264.5	497.1	1,215.8	37.1	459.1

Source: Computed by the Study Team.
Note: Above figures are calculated by subtracting the incremental irrigation diversion requirement (I.I.D.R.) from the observed flow data after the construction of the Wonogiri Dam.

Table A-18 Water Level of the Solo River at Pumping Stations

No.	Name of Station	Distance (m)	Section Interval (m)	LLWL (m)	LWL (m)	HWL (m)	HHWL (m)
	(NAPEL Gstn*)	0	0	31.02	31.63	36.11	38.68
21	MOJOREJO	35,714	35,714	22.21	22.73	26.81	29.38
1	TAPELAN	38,571	2,857	21.50	22.02	26.07	28.64
2	SUMBERARUM	41,429	2,858	20.88	21.31	25.32	27.89
3	TEBON	45,714	4,285	19.74	20.24	24.21	26.78
4	PERANGI	47,143	1,429	19.39	19.88	23.88	26.41
22	DENGOK	51,429	4,286	18.32	18.82	22.72	25.29
	(CEPU Gstn)	52,857	1,428	17.96	18.46	22.35	24.92
5	BANJAREJO	58,571	5,714	16.94	17.43	21.34	23.90
6	NGRAHO	62,143	3,572	16.29	16.79	20.71	23.27
7	SUDU	66,071	3,928	15.57	16.08	20.02	22.57
8	NGRINGINREJO	90,000	23,929	11.20	11.76	15.81	18.32
9	LERAN	96,428	6,428	10.03	10.60	14.67	17.17
10	TRUCUK	100,000	3,572	9.39	9.96	14.04	16.54
11	TULUNGREJO	101,428	1,428	9.12	9.70	13.79	16.28
	(BOJONEGORO Gstn)	110,000	8,572	7.55	8.15	12.28	14.85
12	MULYOAGUNG	111,071	1,071	7.39	7.99	12.15	14.62
13	KALIREJO	114,286	3,215	6.90	7.51	11.77	14.21
14	SEMANDING	117,143	2,857	6.46	7.09	11.43	13.84
15	MULYOREJO	120,000	2,857	6.03	6.66	11.09	13.47
16	SARIREJO	123,571	3,571	5.48	6.13	10.67	13.01
17	PILANGGEDE	126,071	2,500	5.10	5.76	10.37	12.68
18	KEDUNGBONDO	127,143	1,072	4.94	5.60	10.24	12.55
19	CANGAKAN	130,000	2,857	4.51	5.18	9.90	12.18
20	KABALAN	131,428	1,428	4.29	4.96	9.73	11.99
23	KARANGTINOTO	139,285	7,857	3.09	3.80	8.80	10.98
24	BANDUNGREJO	151,785	12,500	1.19	1.94	7.31	9.36
25	KLOTOK	153,928	2,143	0.86	1.62	7.06	9.09
26	TANGGUNGAN	158,571	4,643	0.16	0.93	6.50	8.49
27	KALISARI	159,285	714	0.05	0.82	6.42	8.39
	(BABAT Gstn)	160,714	1,429	0.00	0.61	6.25	8.21
28	BANJAR	164,643	3,929	0.00	0.58	5.98	7.86
29	KEDUYUNG	176,071	11,428	0.00	0.51	5.21	6.84
30	BULUTIGO	178,571	2,500	0.00	0.49	5.04	6.62
31	PELANGWOT	182,500	3,929	0.00	0.46	4.77	6.27
32	TAMANPRIJEK	186,428	3,928	0.00	1.44	4.50	5.92
33	TEJOASRI	198,571	12,143	0.00	0.39	4.02	5.28
	(RIVERMOUTH)	252,851	54,280	0.00	0.00	0.00	0.00

Source : Water Level Records, 1983-1990. PBS

*Gstn : Gauging Station
HHWL : Highest water level at 10-year return period.
It is not higher than highest water level at 25-year return period plus 0.25 m.
HWL : Highest monthly average water level during 8 years.
LWL : Lowest monthly average water level during 8 years.
LLWL : Lowest water level during 8 years.

Table A-19 Monthly Rainfall and Rain Days

Measuring Station : Bojonegoro

Month / Year	Jan. RF mm	Jan. RD days	Feb. RF mm	Feb. RD days	Mar. RF mm	Mar. RD days	Apr. RF mm	Apr. RD days	May RF mm	May RD days	Jun. RF mm	Jun. RD days	Jul. RF mm	Jul. RD days	Aug. RF mm	Aug. RD days	Sep. RF mm	Sep. RD days	Oct. RF mm	Oct. RD days	Nov. RF mm	Nov. RD days	Dec. RF mm	Dec. RD days	Annual Rainfall mm
1979	305	14	228	12	225	14	269	11	222	10	103	6	11	1	33	1	70	5	109	7	195	10	269	14	2,039
1980	299	17	238	11	228	12	197	10	13	2	28	2	93	5	74	4	15	2	96	17	262	14	208	15	1,751
1981	277	16	336	16	244	14	144	10	182	10	129	8	152	6	38	4	122	8	66	6	331	13	332	15	2,353
1982	338	18	420	17	413	15	335	14	73	4	29	2	6	1	0	0	31	2	23	2	91	6	248	14	2,007
1983	320	16	285	14	229	15	239	13	233	12	37	2	9	2	0	0	6	1	179	10	297	13	388	13	2,222
1984	371	18	341	16	205	12	127	10	91	7	19	2	19	2	88	3	124	8	123	8	217	10	267	14	1,992
1985	312	14	306	13	299	14	150	8	56	4	90	4	77	5	25	2	54	4	173	6	188	11	276	13	2,006
1986	373	16	278	13	332	13	264	10	37	6	279	11	14	4	48	3	102	7	107	8	250	13	236	11	2,320
1987	399	19	283	15	227	12	80	7	84	5	65	3	11	1	4	1	19	2	53	3	171	8	301	13	1,697
Average	333	16	302	14	267	13	201	10	110	7	87	4	44	3	34	2	60	4	103	7	222	11	281	14	2,043
Average Rainfall a Rain Day mm/day	21		22		21		20		16		22		15		17		15		15		20		20		19

*RF : Rainfall
*RD : Rain Days

Table A-20 Estimation of O & M Cost for the Average Pumping Station Per Year

Item	Cost
A. Operation Cost	14,709,000
A-1. Fuel and Oil Engine Power : 38 ps Unit Fuel Consumption : 0.2 l/ps*hr Operation Hour Per Year : 4,300 hr Unit Price of Fuel : 250 Rp./l Oil and Others : 30 % of Fuel 38*0.2*4300*250*1.30	10,621,000
A-2. Operator Working Hour : 12 hr/day, 365 days Number of Operators : 2 persons Wage Rate for Normal Time : 400 Rp./hr Wage Rate for Overtime : 600 Rp./hr (400*8+600*4)*365*2	4,088,000
B. Maintenance Cost	8,240,000
B-1. Spare Parts and Repair 10 % of Pump and Engine Price	2,240,000
B-2. Civil Works Civil Worker : 100 persons, 10 days Wage Rate : 3,000 Rp./day 100*10*3000	3,000,000
B-3. Communication Cost	3,000,000
C. Depreciation Life Years of Pump and Engine : 10 years	2,240,000
D. Total O & M Cost Per Year	25,189,000

Table A-21 Estimation of Gross Output on Average Project Area Per Year

(Unit : '000 Rp.)

Item	Gross Output by Season			
	Wet	Dry 1	Dry 2	Year
Non-Inundated Area (90.2 ha)	Paddy	Paddy	Palawija	Total
Gross Output Per ha	1,500	1,625	748	3,873
Gross Output in Total				349,345
Inundated Area (61.3 ha)	Fallow	Paddy	Paddy	Total
Gross Output Per ha	0	1,625	1,625	3,250
Gross Output in Total				199,225
Total Gross Output Per Year (151.5 ha)				548,570

Description of Gross Output Per ha	Production	Unit Price	Output
	kg	Rp./kg	Rp.
Paddy (Wet)	6,000	250	1,500,000
Paddy (Dry)	6,500	250	1,625,000
Palawija			748,000
Palawija (Maize : 80 %)	3,000	250	750,000
Palawija (Soybean : 20 %)	2,000	370	740,000

Table A-22 Present Production Cost and Income (1989)

(Unit : Rp./ha)

Items	Paddy	Maize	Soybean
Labor	596,000	340,000	328,000
Hired	450,000	265,000	240,000
Family	146,000	75,000	88,000
Inputs	141,100	161,300	111,600
Seed	20,000	62,000	40,000
Fertilizer	88,500	73,000	44,000
Insecticide	17,600	8,800	17,600
Others	15,000	17,500	10,000
Land Cost	200,000	150,000	150,000
Land Tax	10,000	5,000	5,000
Production Cost			
Economic	947,100	656,300	594,600
Real	601,100	431,300	356,600
Gross Income	1,439,375	975,000	918,750
Net Income			
Economic	492,275	318,700	324,150
Real	838,275	543,700	562,150
Net Income / Gross Income			
Economic	0.34	0.33	0.35
Real	0.58	0.56	0.61

Source : Year Book 1989. Agriculture Office, Bojonegoro

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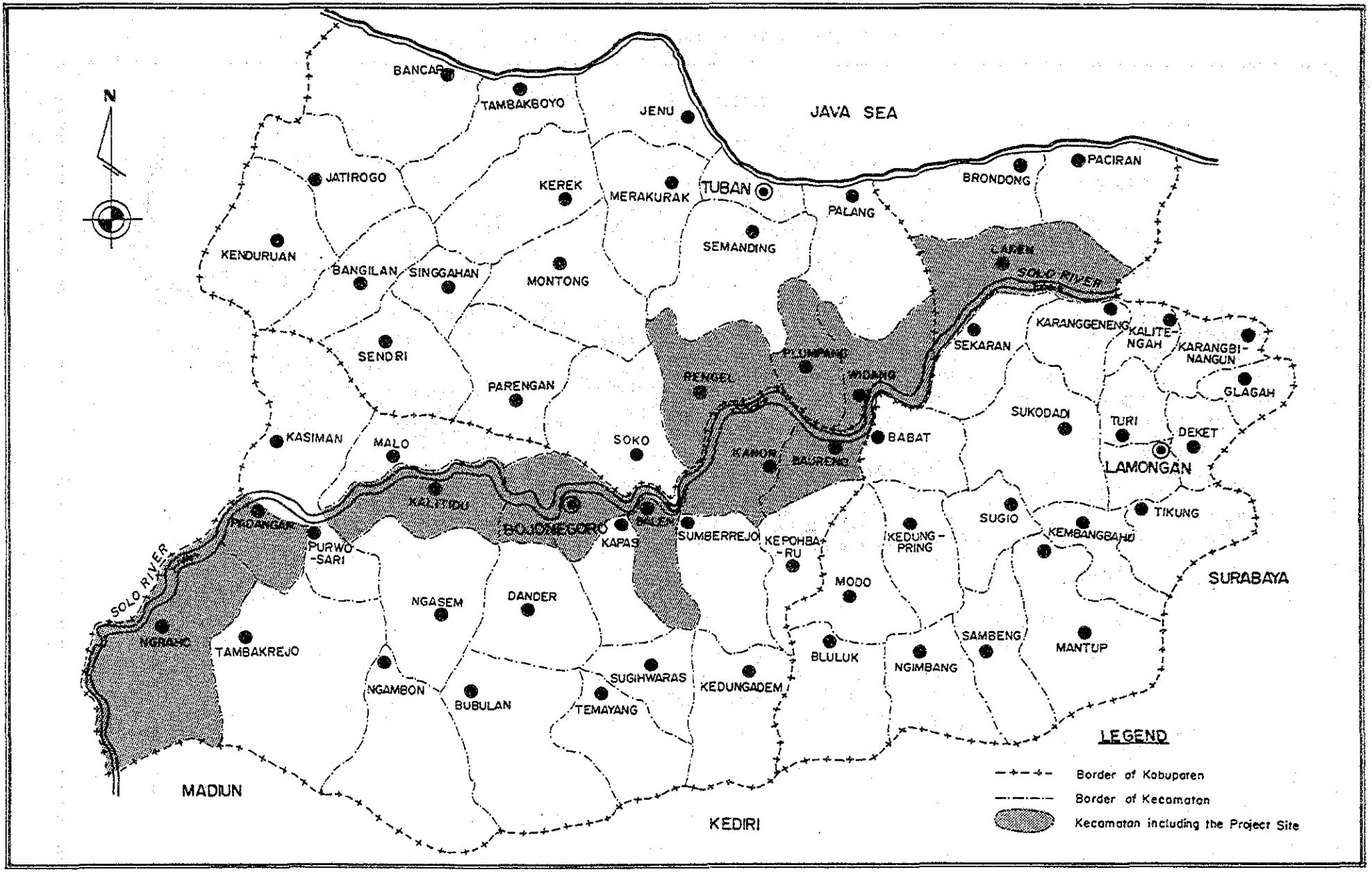


Fig. A-1 Administrative Map

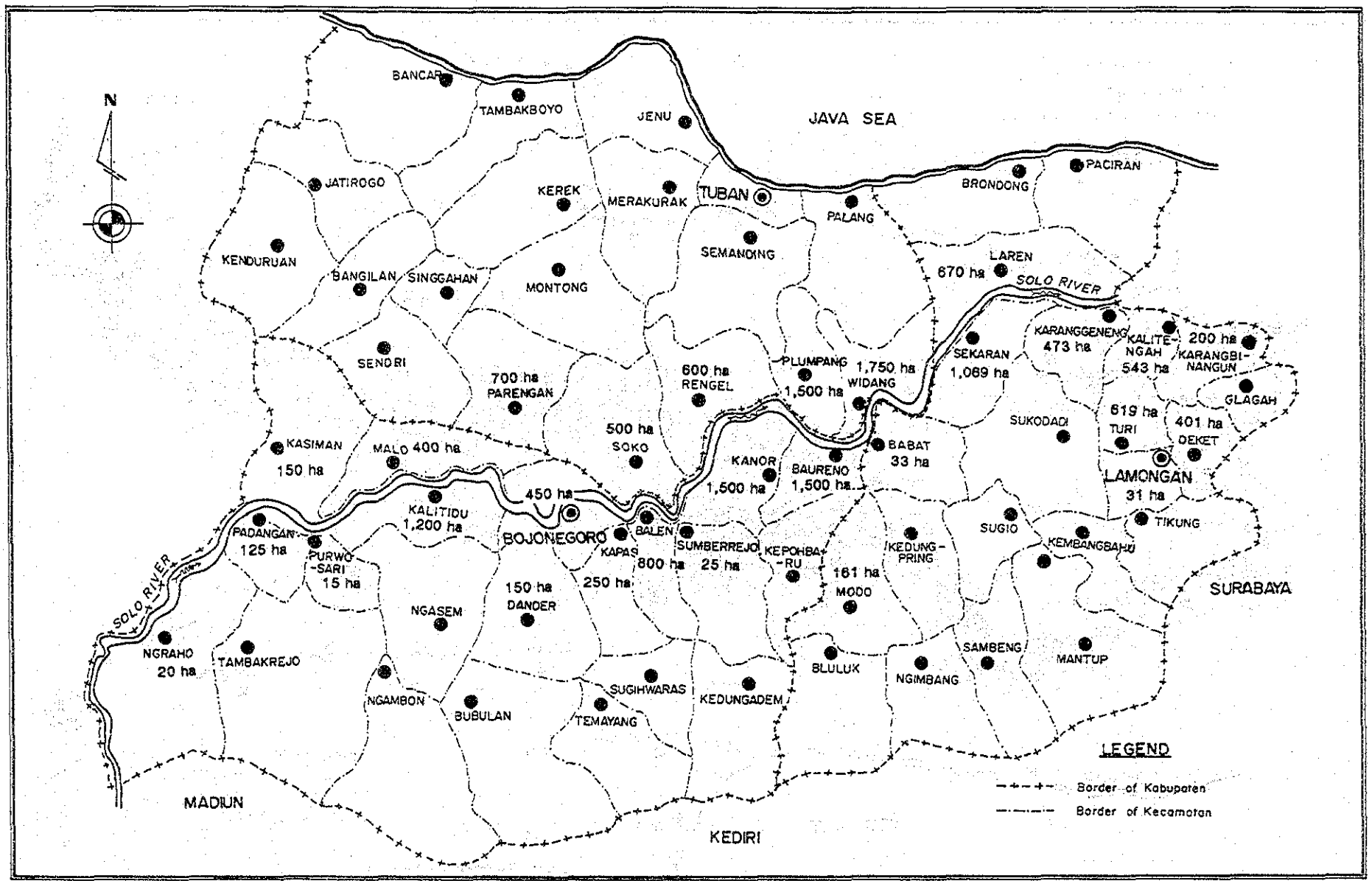


Fig. A-2 Annual Flooding Area by Sub Districts

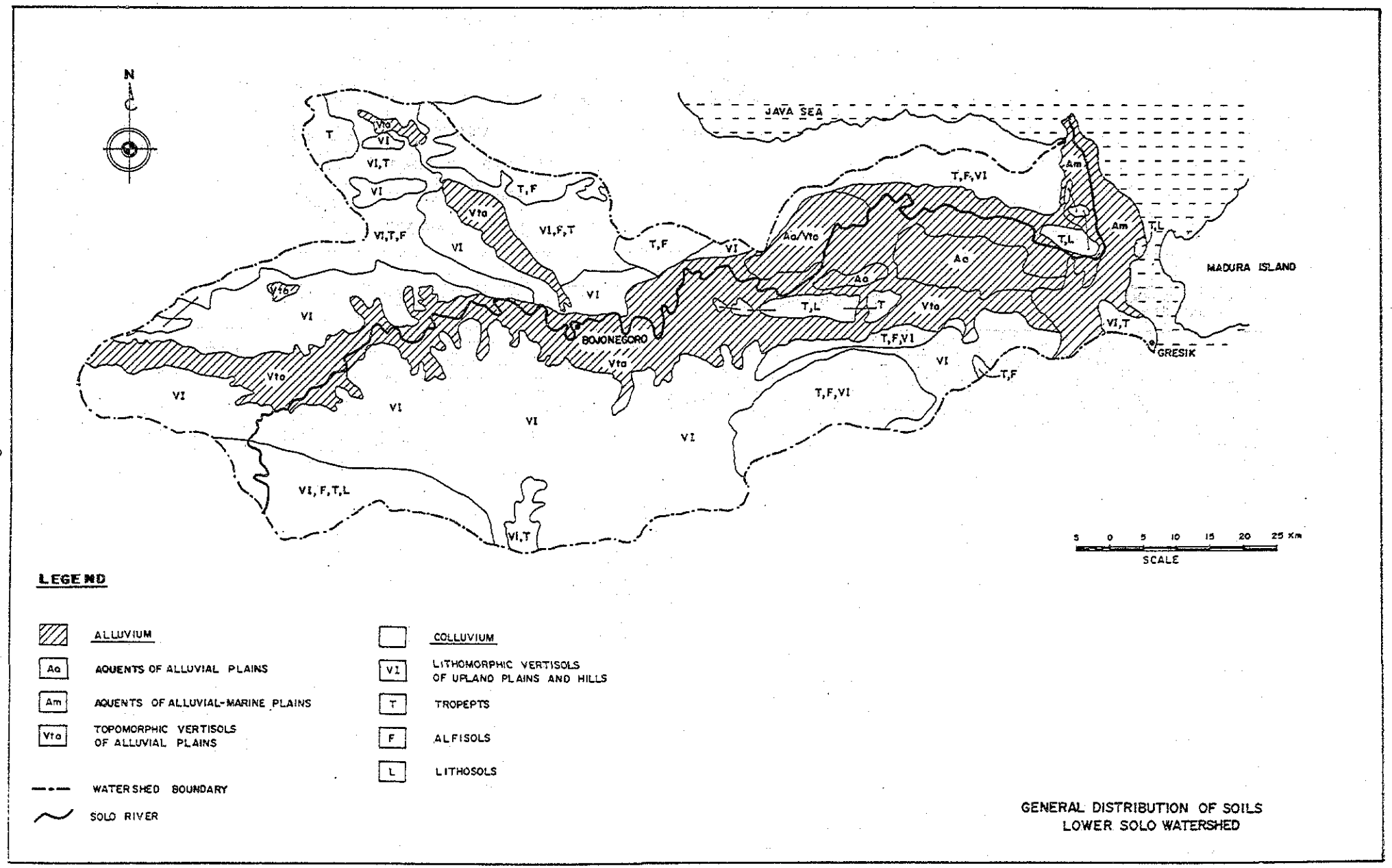


Fig. A-3 General Distribution of Soils

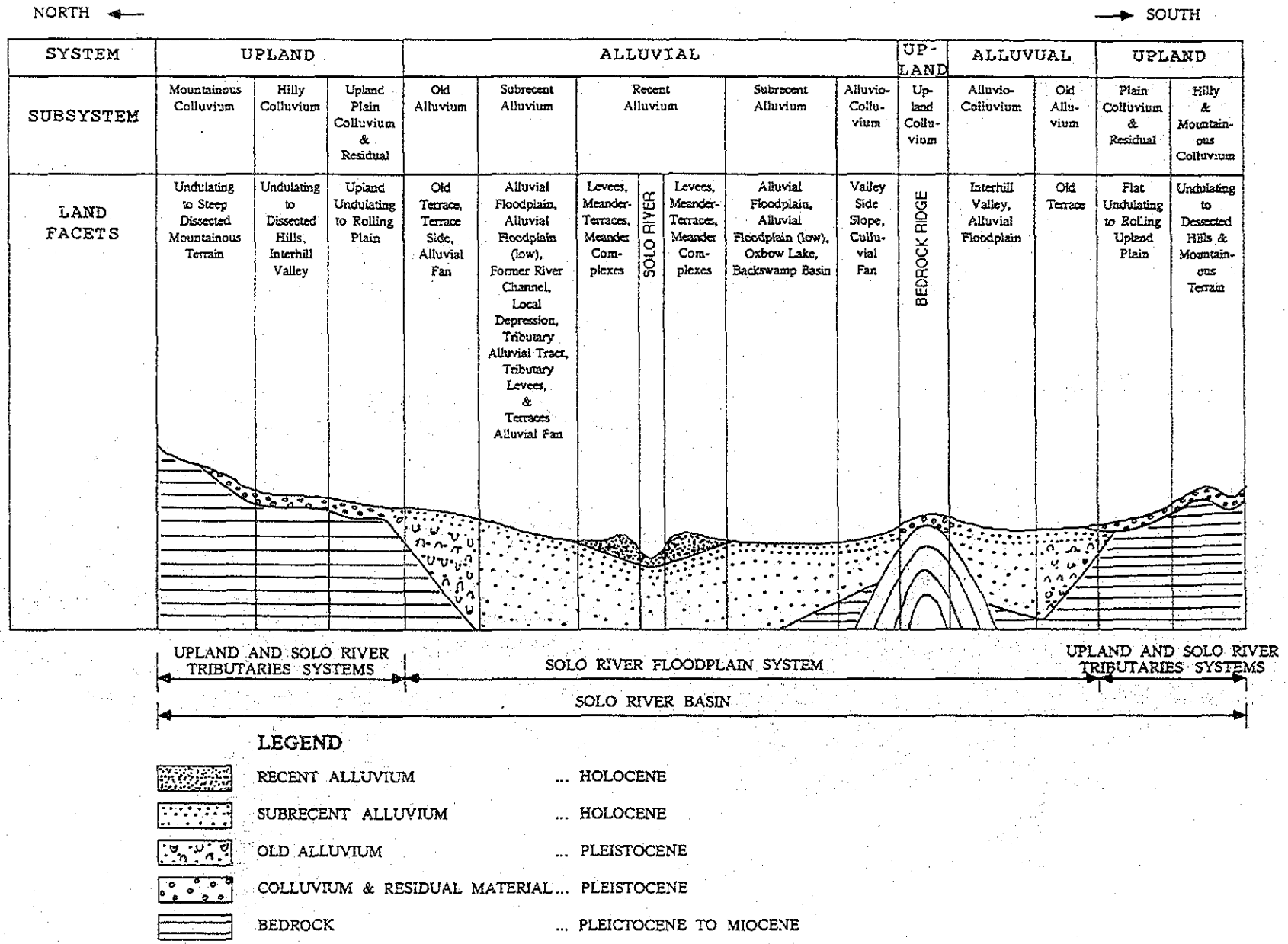
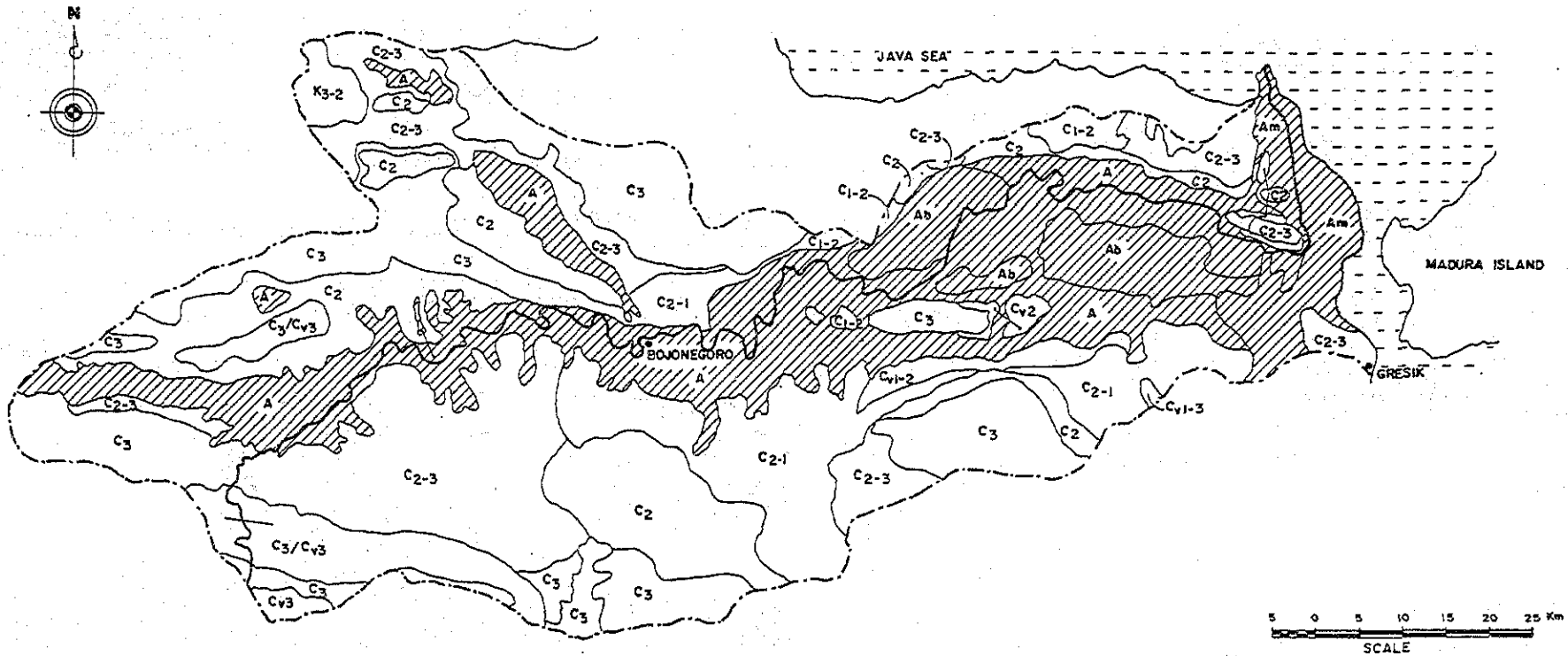


Fig. A-4 **Scheme of Terrain and Geologic Sequences**



LEGEND

MAPPING SYMBOL	PHYSIOGRAPHIC UNIT	DOMINANT SLOPE RANGE %
A	ALLUVIAL PLAINS	0-1
Ab	MAJOR ALLUVIAL BACKSWAMP BASIN	0-1
Am	ALLUVIO-MARINE PLAINS	0-1
---	WATERSHED BOUNDARY	
~	SOLO RIVER	

MAPPING SYMBOL	PHYSIOGRAPHIC UNIT	DOMINANT SLOPE RANGE %
C_1	COLLUVIAL SEDIMENTARY PLAINS	0-4
C_2	COLLUVIAL SEDIMENTARY HILLY TERRAIN	4-12
C_3	COLLUVIAL SEDIMENTARY MOUNTAINOUS TERRAIN	12-30
K_{3-2}	KARST HILLY TO MOUNTAINOU TERRAIN	4-20
V	SYMBOL INDICATING VOLCANIC ROCKS	

GENERAL PHYSIOGRAPHY
LOWER SOLO WATERSHED

Fig. A-5 General Physiography

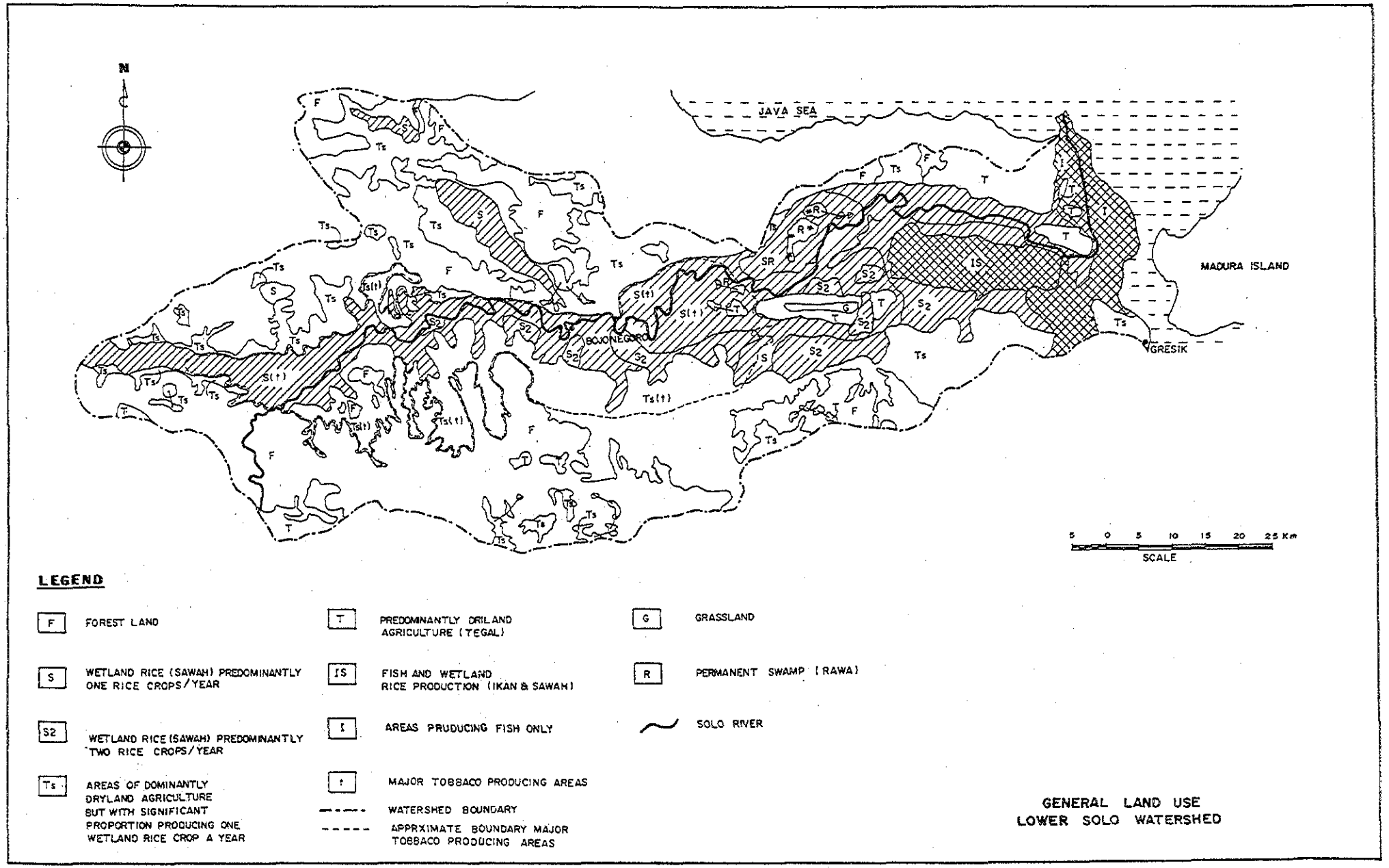


Fig. A-6 General Land Use

PLATES

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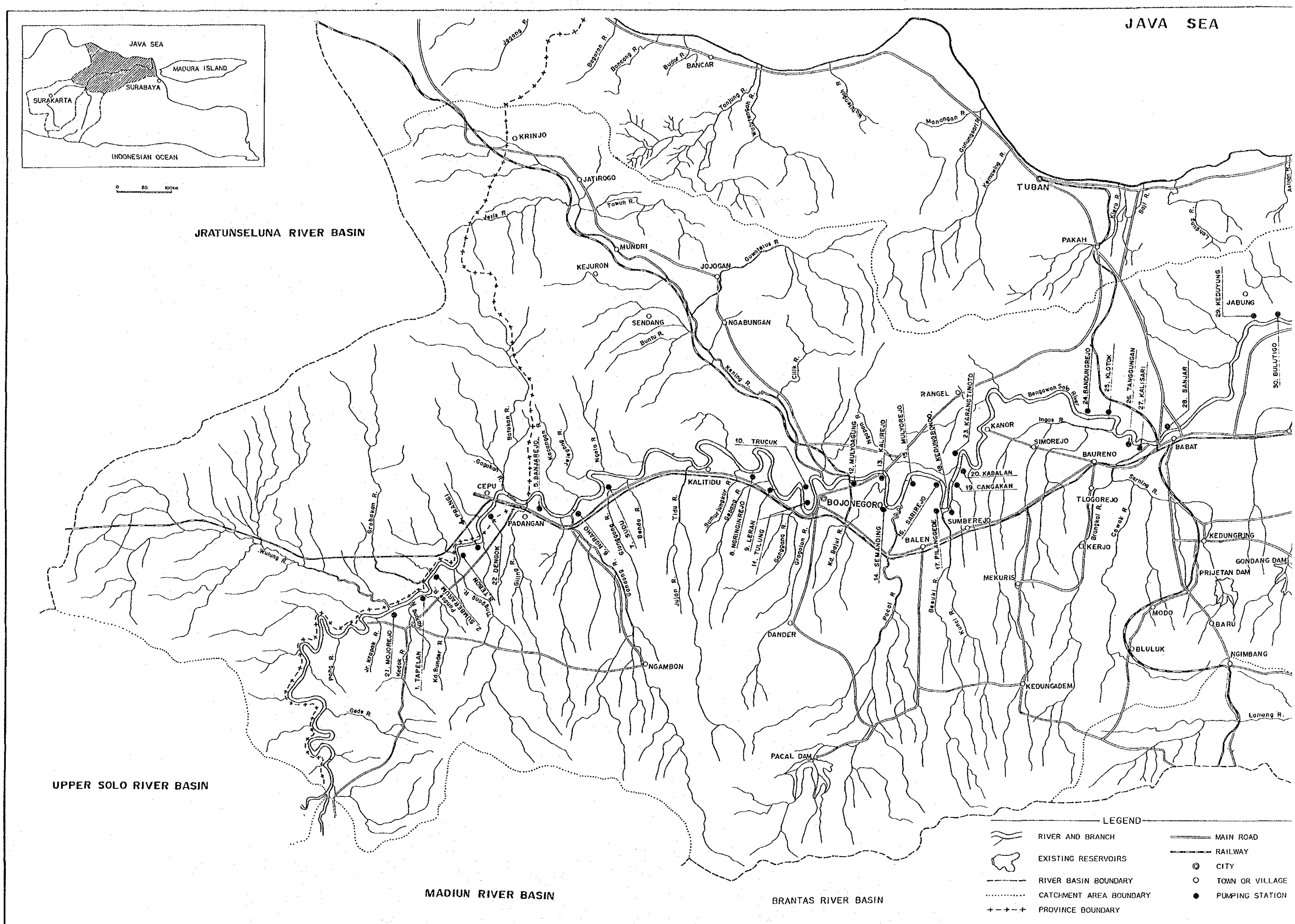
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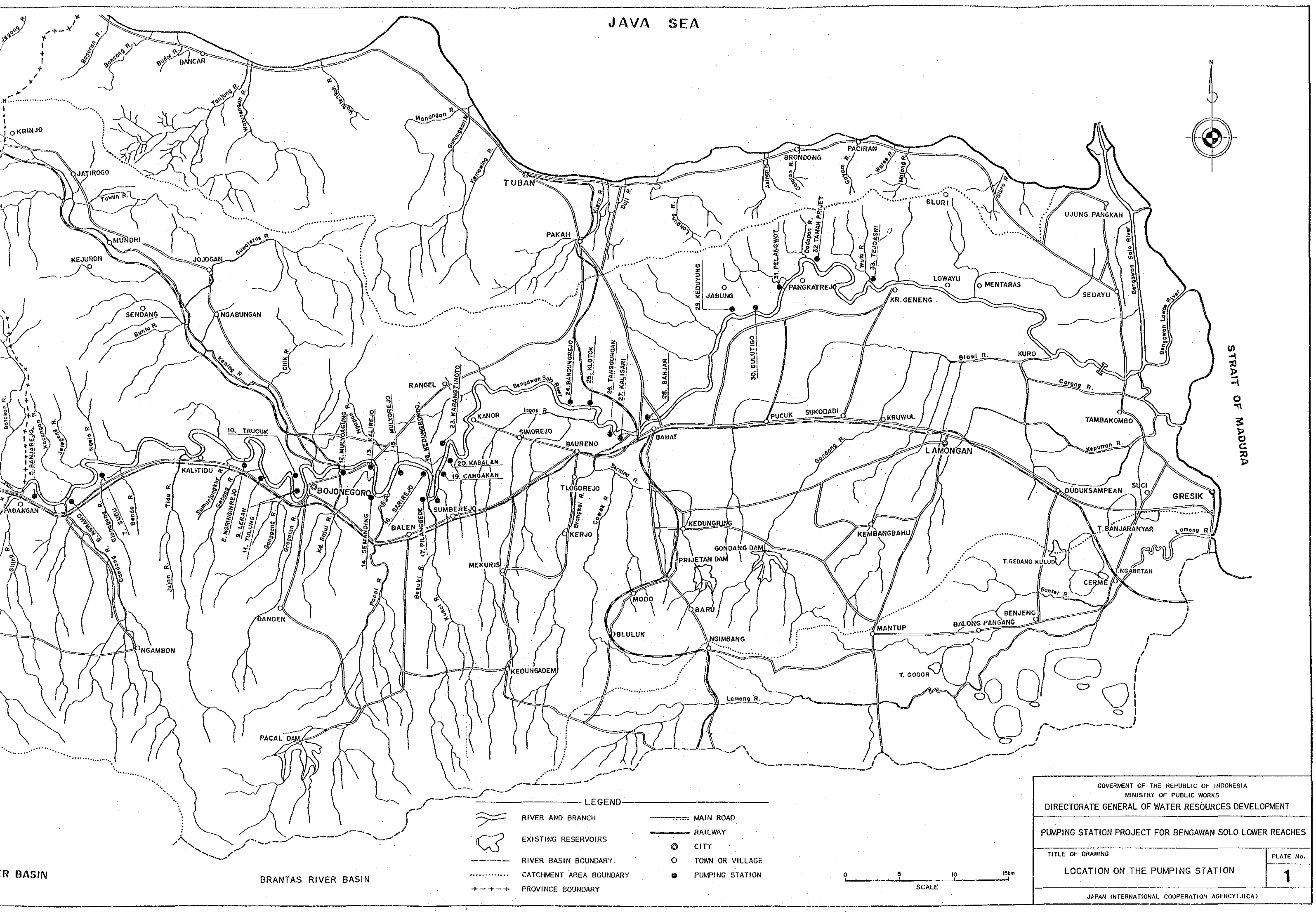
SURABAYA
SURAKARTA
INDONESIAN OCEAN
JRATUNSELUNA RIVER BASIN
UPPER SOLO RIVER BASIN
MADIUN RIVER BASIN
BRANTAS RIVER BASIN
TUBAN
BOJONEGORO
CEPU
PADANGAN
KALITIDU
BABAT
BAURENO
KANOR
SIMOREJO
RANGEL
BALEN
SUMBEREJO
TLOGOREJO
KERJO
MEKURIS
KEDUNGADEM
DANDER
NGAMBON
PACAL DAM
KEDUNGRING
GONDANG DAM
PRIJETAN DAM
MODO
BARU
BLULUK
NGIMBANG
JABUNG
PAKAH
KRINJO
JATIROGO
MUNDRI
KEJURON
JOJOGAN
NGABUNGAN
SENDANG
BANCAR
1. TAPELAN
2. SUMBERAGUNG
3. KEDUNGPRAHU
4. PRANGI
5. BANJAREJO
6. NGRAHO
7. SUDU
8. NGRINGINREJO
9. LERAN
10. TRUCUK
11. TULUNG
12. MULYOAGUNG
13. KALIREJO
14. SEMANDING
15. MULYOREJO
16. SARIREJO
17. PILANGGEDE
18. KEDUNGBONDO
19. CANGAKAN
20. KABALAN
21. MOJOREJO
22. DENGOK
23. KARANGTINOTO
24. BANDUNGREJO
25. KLOTOK
26. TANGGUNGAN
27. KALISARI
28. SANJAR
29. KEDUYUNG
30. BULUTIGO
LEGEND
RIVER AND BRANCH
EXISTING RESERVOIRS
RIVER BASIN BOUNDARY
CATCHMENT AREA BOUNDARY
PROVINCE BOUNDARY
MAIN ROAD
RAILWAY
CITY
TOWN OR VILLAGE
PUMPING STATION


JAVA SEA
STRAIT OF MADURA
N
BANCAR
KRINJO
JATIROGO
TUBAN
PAKAH
MUNDRI
KEJURON
JOJOGAN
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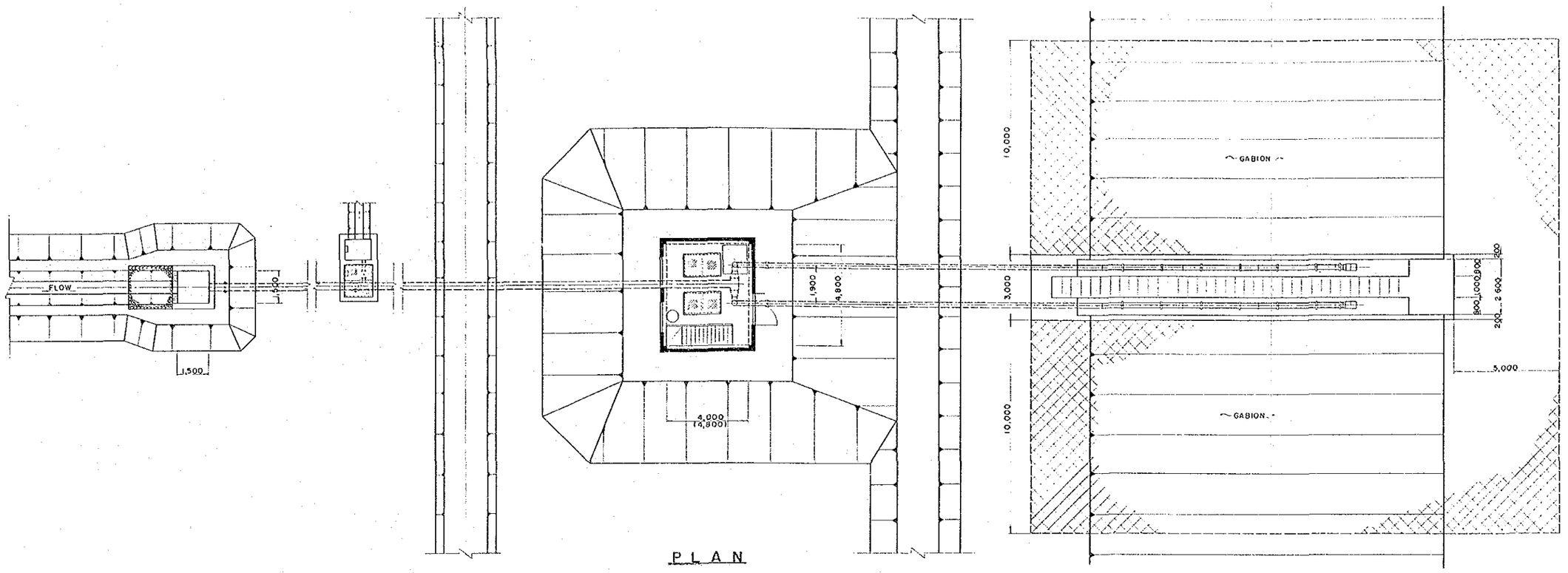
BRONDONG
PACIRAN
BLURI
UJUNG PANGKAH
SEDAYU
LOWAYU
MENTARAS
JABUNG
PANGKATREJO
KR. GENENG
KURO
TAMBAKOMBO
RANGEL
KANOR
SIMOREJO
BAURENO
BABAT
PUCUK
SUKODADI
KRUWUL
LAMONGAN
DUDUKSAMPEAN
SUCI
GRESIK
T. BANJARANYAR
KEDUNGRING
KEMBANGBAHU
GONDANG DAM
PRIJETAN DAM
T. GEDANG KULUD
CERME
T. NGABETAN
BENJENG
BALONG PANGANG
MANTUP
T. GOGOR
MODO
BARU
BLULUK
NGIMBANG
KEDUNGADEM
MEKURIS
KERJO
TLOGOREJO
SUMBEREJO
BALEN
BOJONEGORO
KALITIDU
PADANGAN
DANDER
NGAMBON
PACAL DAM
5. BANJAREJO
6. NGAHO
7. Bendo
8. NGRINGINREJO
9. LERAN
10. TRUCUK
11. TULUNG
12. MULYOAGUNG
13. KALIREJO
14. SEMANDING
15. MULYOREJO
16. SARIREJO
17. PILANGGEDE
18. KEDUNGBONDO
19. CANGAKAN
20. KABALAN
23. KARANGTINOTO
24. BANDUNGREJO
25. KLOTOK
26. TANGGUNGAN
27. KALISARI
28. BANJAR
29. KEDIYUNG
30. BULUTIGO
31. PELANGWOT
32. TAMAN PRIJET
33. TEJOASRI
Bengawan Solo River
Bengawan Lawas River
Blawi R.
Corong R.
Kepuhon R.
Gondang R.
Lamong R.
Bonter R.
Pacal R.
Tuban R.
Kening R.
Buntu R.
Jujan R.
Tidu R.
Manongan R.
Kerawing R.
Bagaran R.
Budur R.
Tanjung R.
R BASIN
BRANTAS RIVER BASIN
LEGEND
RIVER AND BRANCH
EXISTING RESERVOIRS
RIVER BASIN BOUNDARY
CATCHMENT AREA BOUNDARY
PROVINCE BOUNDARY
MAIN ROAD
RAILWAY
CITY
TOWN OR VILLAGE
PUMPING STATION
0 5 10 15km
SCALE
GOVERMENT OF THE REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
PUMPING STATION PROJECT FOR BENGAWAN SOLO LOWER REACHES
TITLE OF DRAWING
LOCATION ON THE PUMPING STATION
PLATE No.
1
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)



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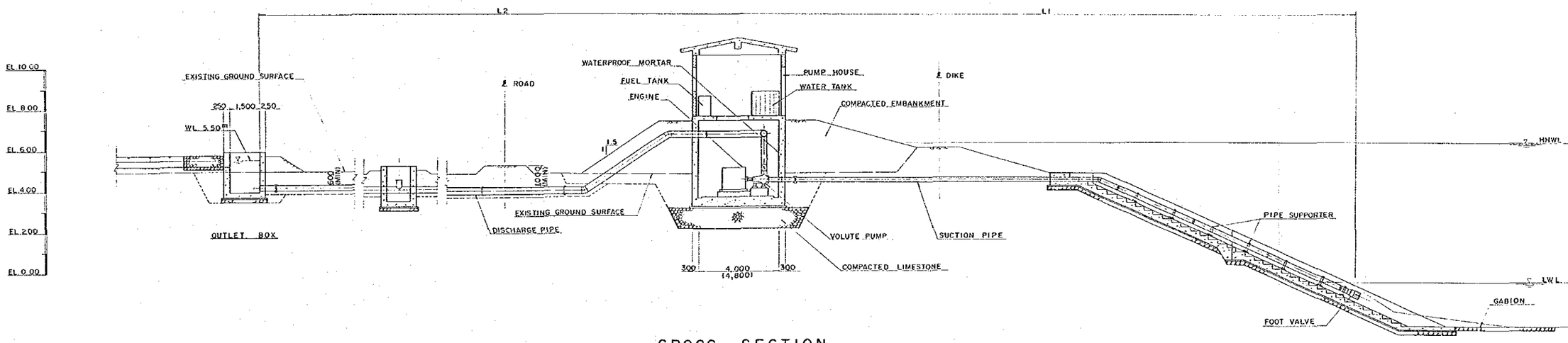


CROSS SECTION

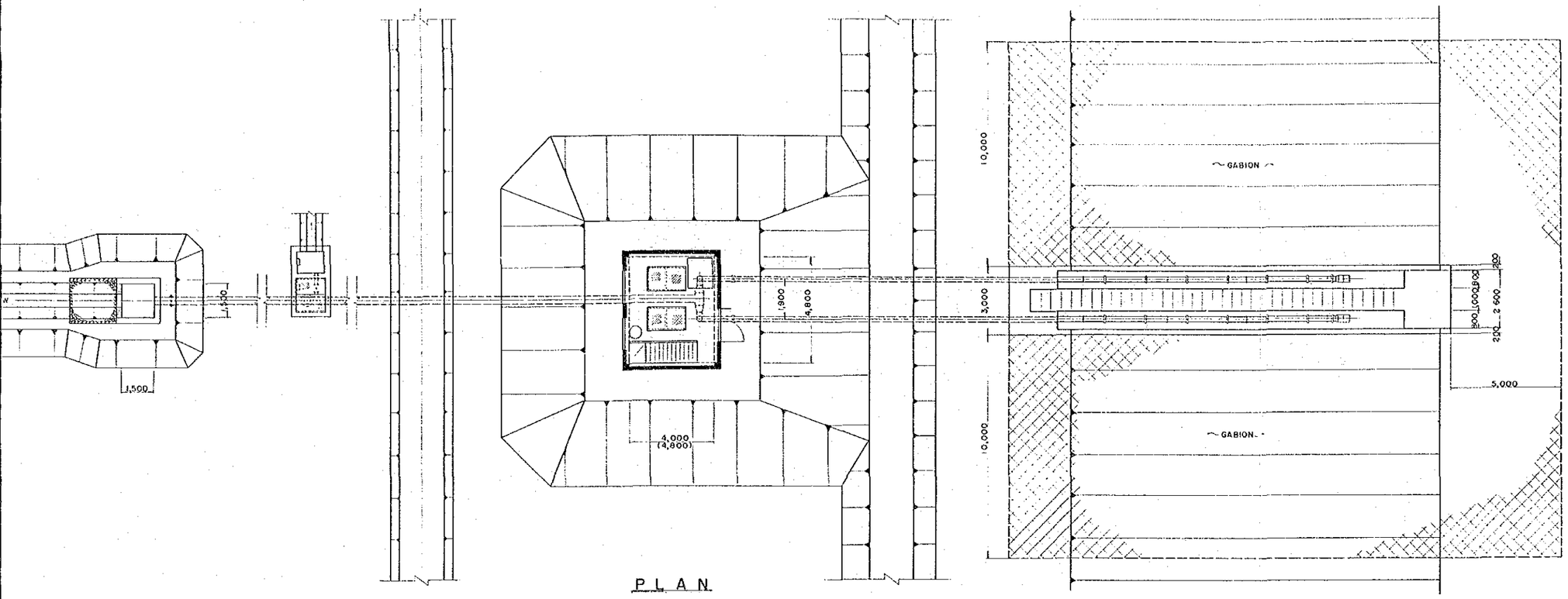
GOVERMENT OF THE
MINISTRY OF
DIRECTORATE GENERAL OF W

PUMPING STATION PROJECT FOR

TITLE OF DRAWING :

GENERAL PLAN OF PUM

JAPAN INTERNATIONAL CO



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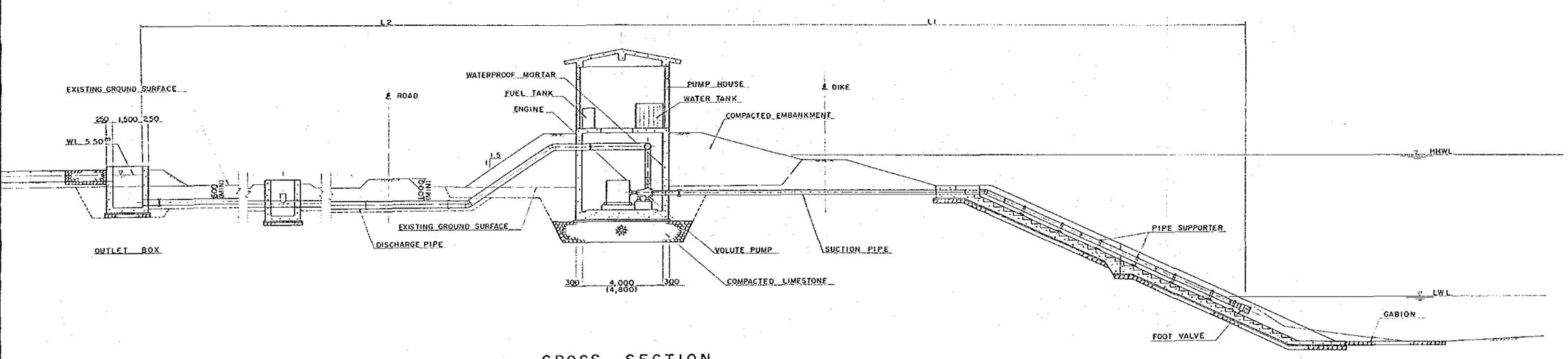


CROSS SECTION

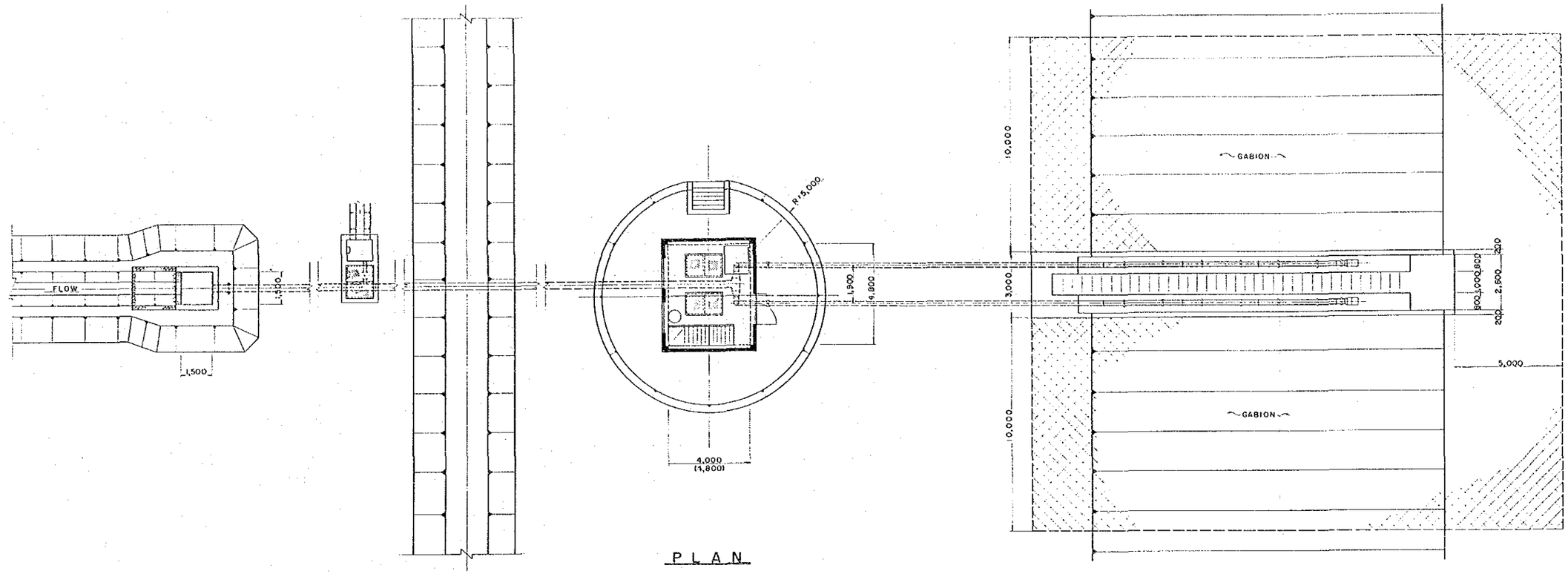
GOVERMENT OF THE REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

PUMPING STATION PROJECT FOR BENGAWAN SOLO LOWER REACHES

TITLE OF DRAWING :
GENERAL PLAN OF PUMPING STATION (1)

PLATE NO.
2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



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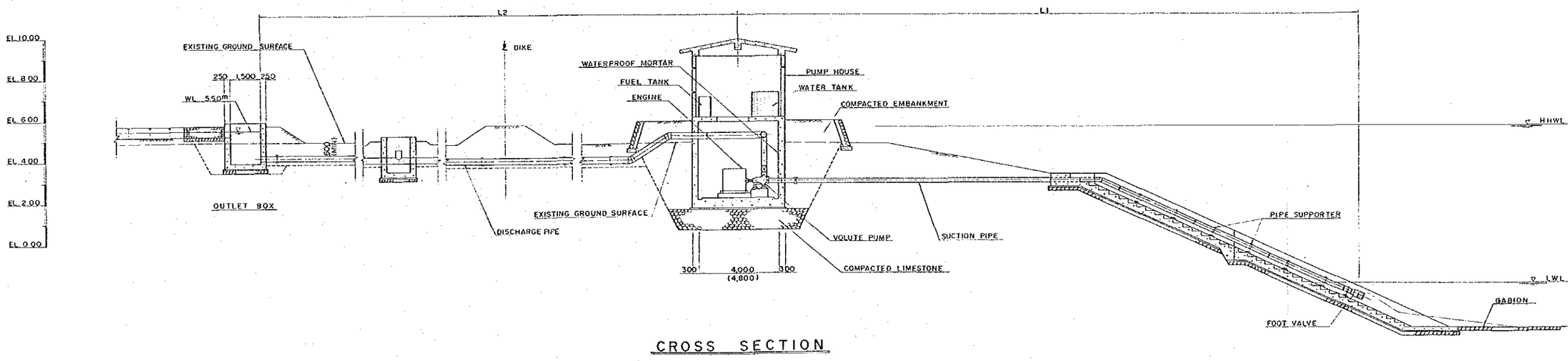


CROSS SECTION

0 5 10m

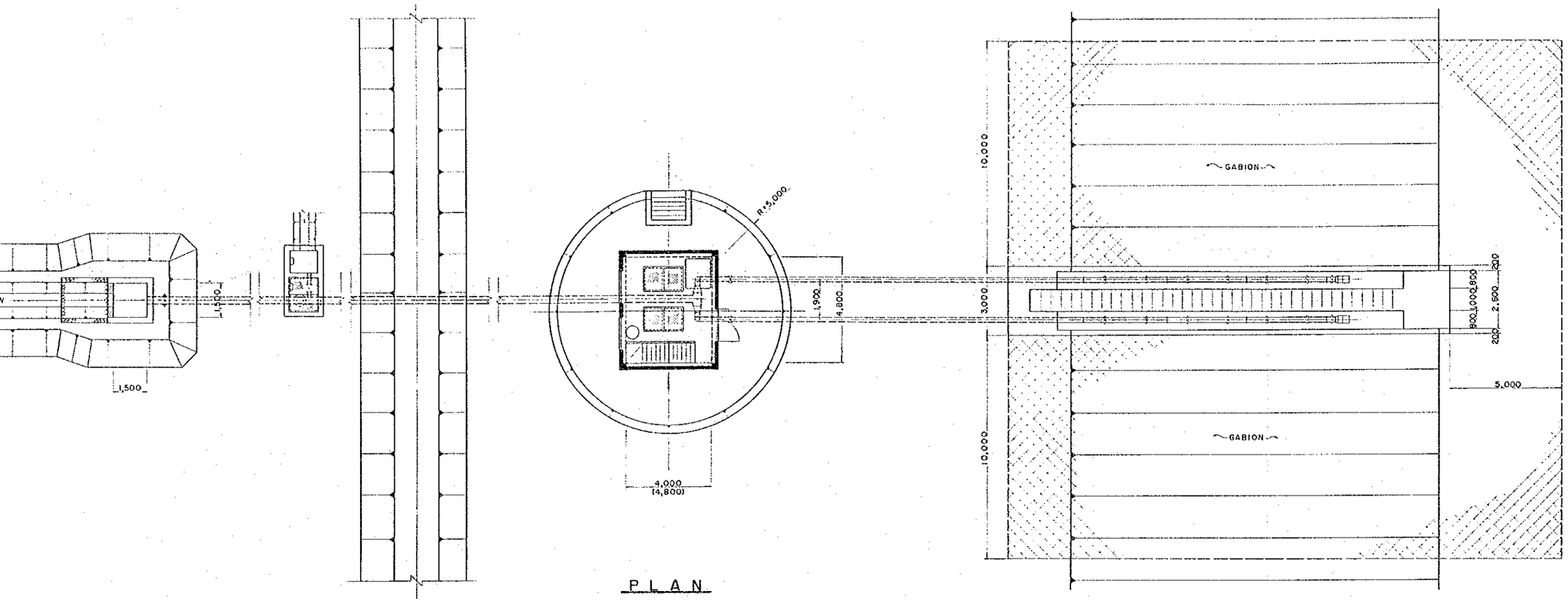
GOVERMENT OF THE R
MINISTRY OF PU
DIRECTORATE GENERAL OF WA

PUMPING STATION PROJECT FOR

TITLE OF DRAWING :

GENERAL PLAN OF PUMP

JAPAN INTERNATIONAL COO



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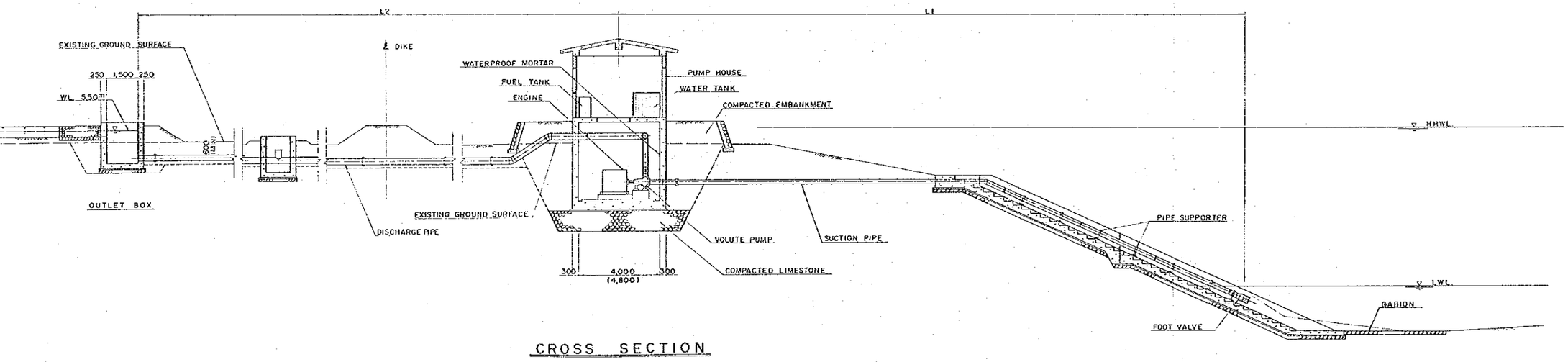


CROSS SECTION

0 5 10m

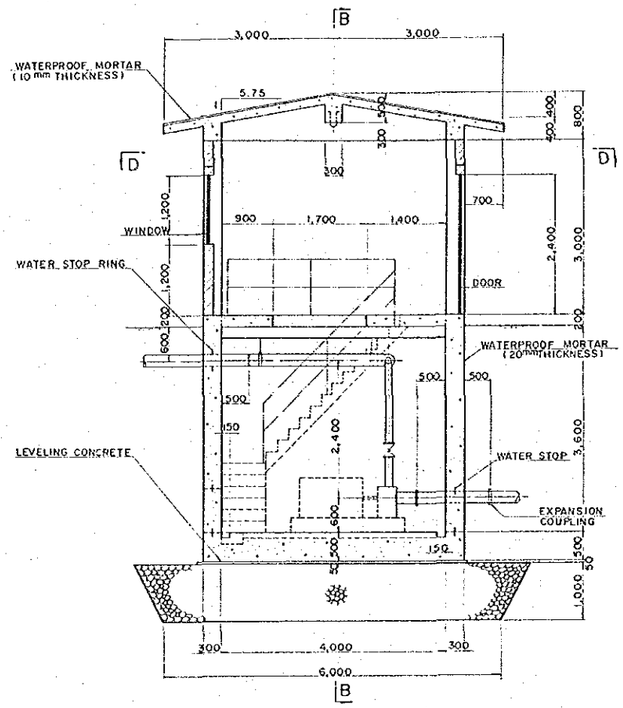
GOVERMENT OF THE REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

PUMPING STATION PROJECT FOR BENGAWAN SOLO LOWER REACHES

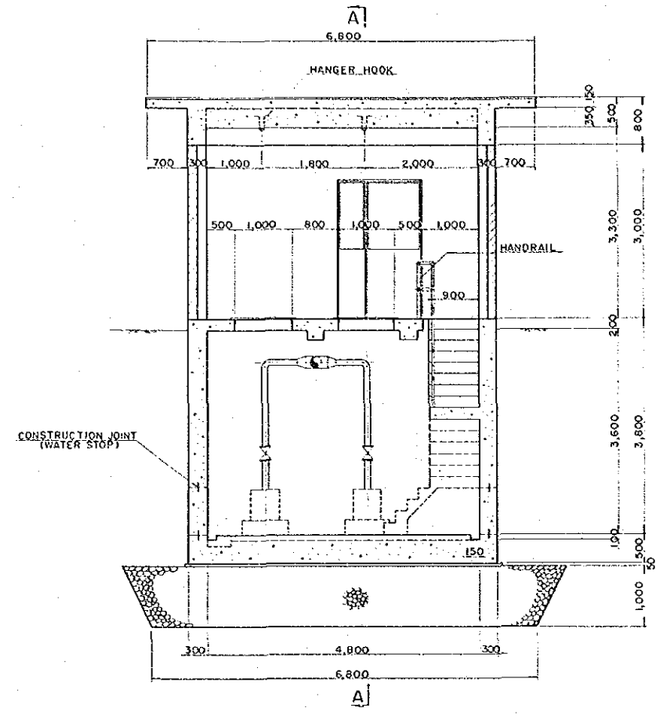
TITLE OF DRAWING :
GENERAL PLAN OF PUMPING STATION (2)

PLATE NO.
3

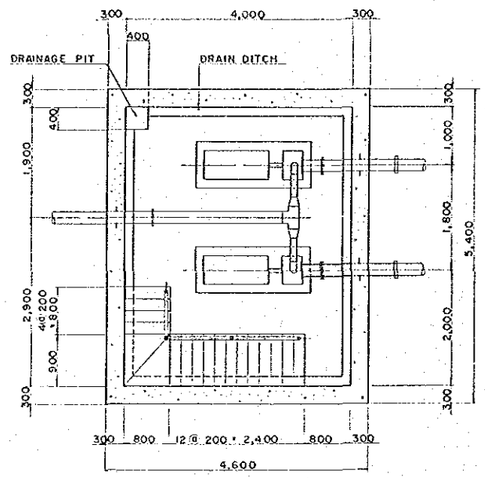
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



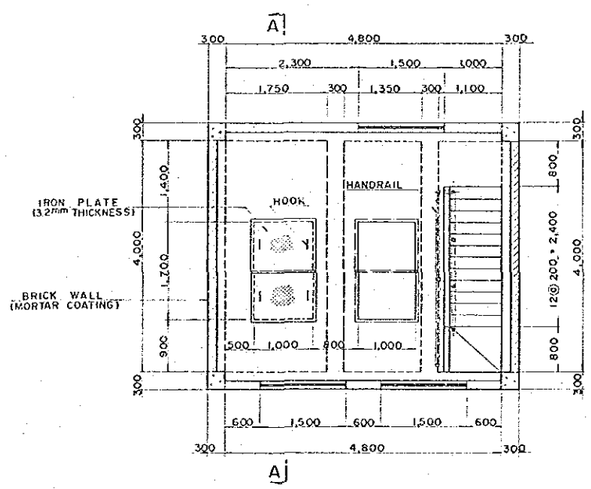
CROSS SECTION OF PUMP STATION (A – A)



CROSS SECTION OF PUMP STATION (B – B)



SECTION C – C



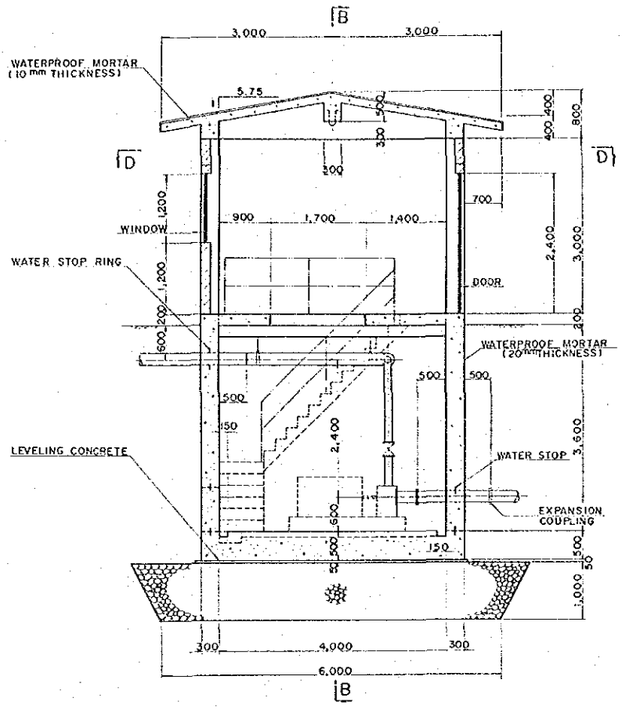
SECTION D – D

GOVERMENT OF THE R
MINISTRY OF PU
DIRECTORATE GENERAL OF WA

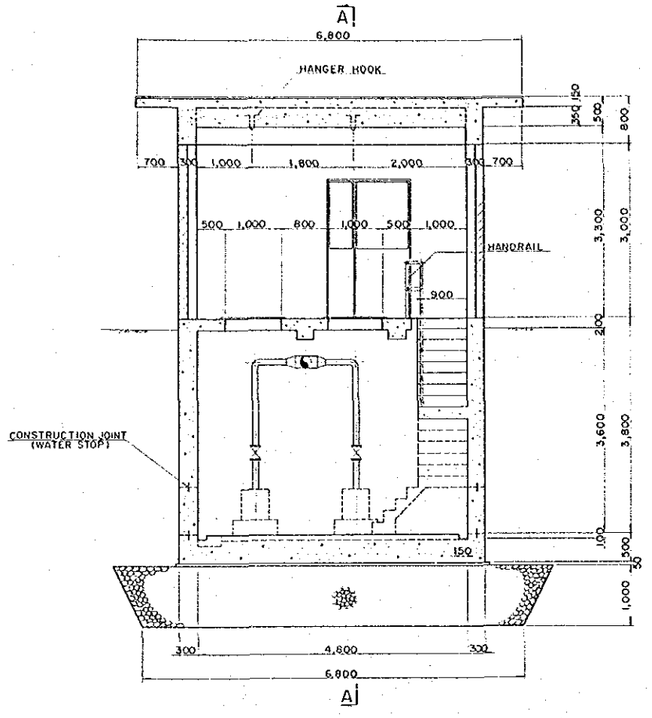
PUMPING STATION PROJECT FOR E

TITLE OF DRAWING:
GENERAL PLAN OF PUMPIN

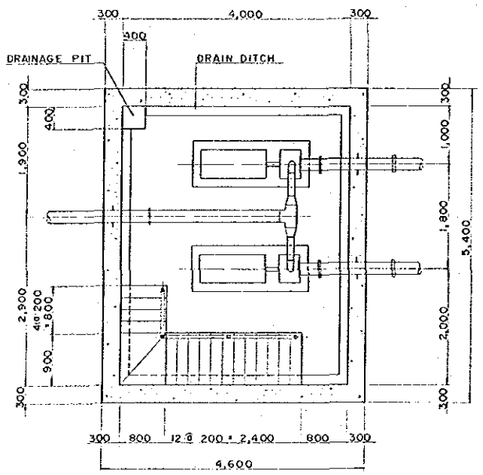
JAPAN INTERNATIONAL COO



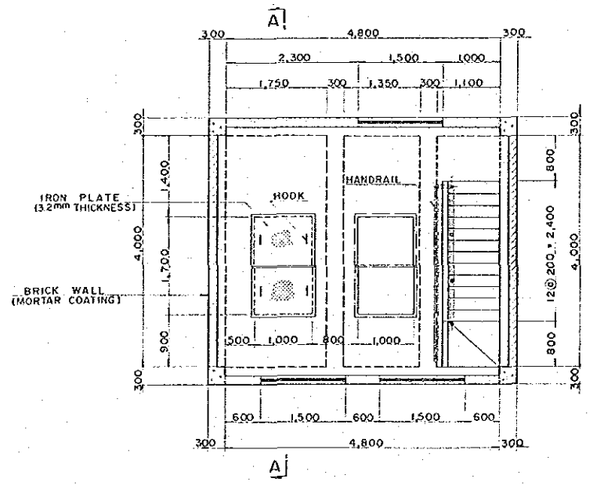
CROSS SECTION OF PUMP STATION (A – A)



CROSS SECTION OF PUMP STATION (B – B)



SECTION C – C



SECTION D – D

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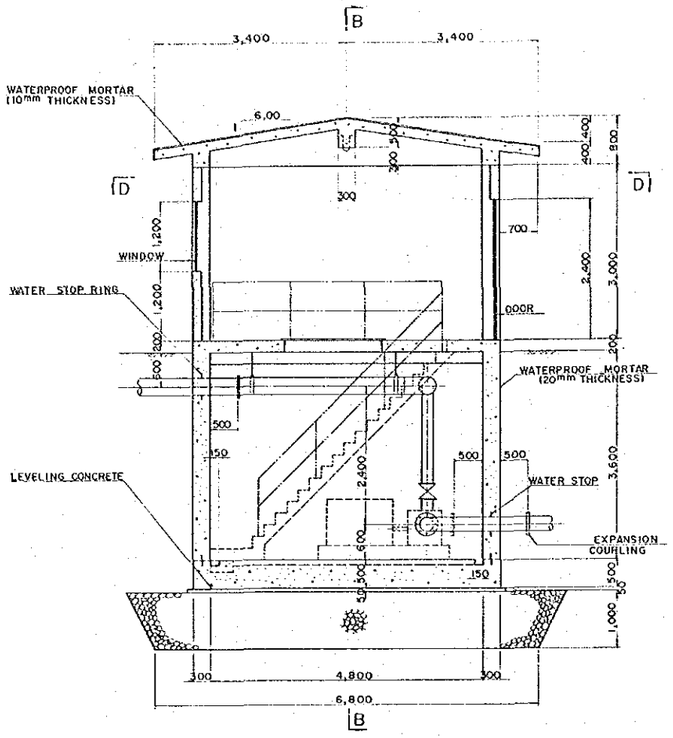
GOVERMENT OF THE REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

PUMPING STATION PROJECT FOR BENGAWAN SOLO LOWER REACHES

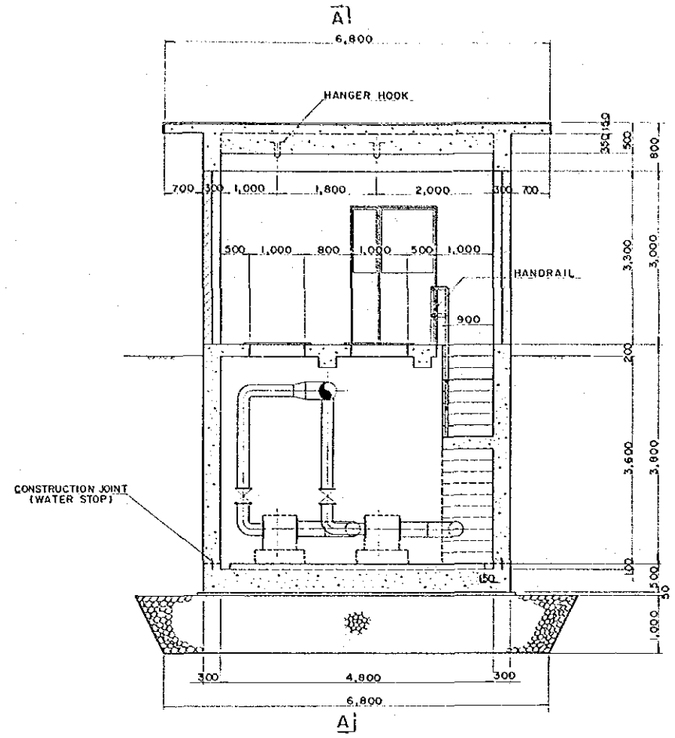
TITLE OF DRAWING:
GENERAL PLAN OF PUMPING STATION (3)

PLATE NO.
4

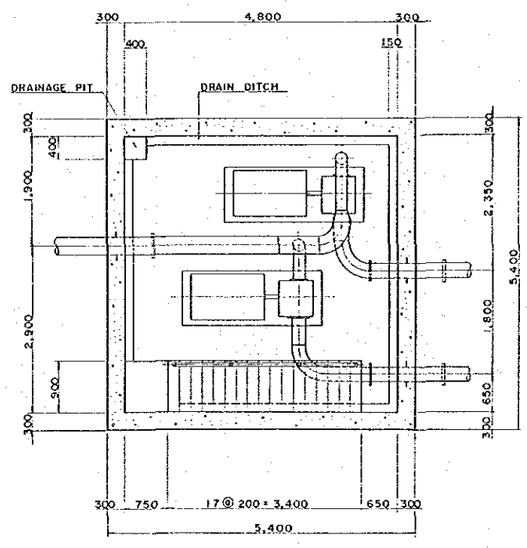
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



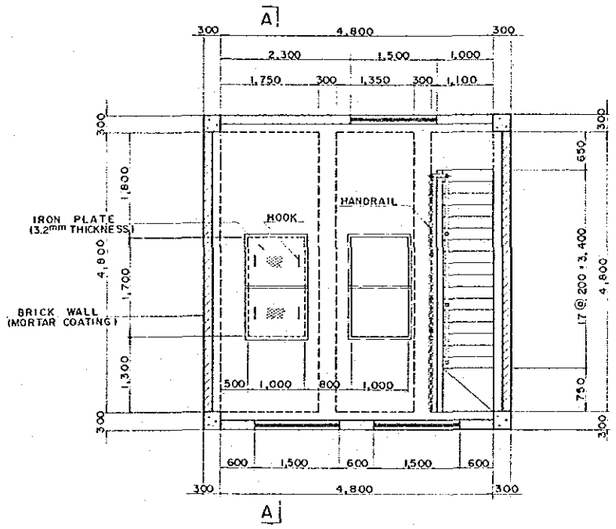
CROSS SECTION OF PUMP STATION (A – A)



CROSS SECTION OF PUMP STATION (B – B)



SECTION C – C



SECTION D – D

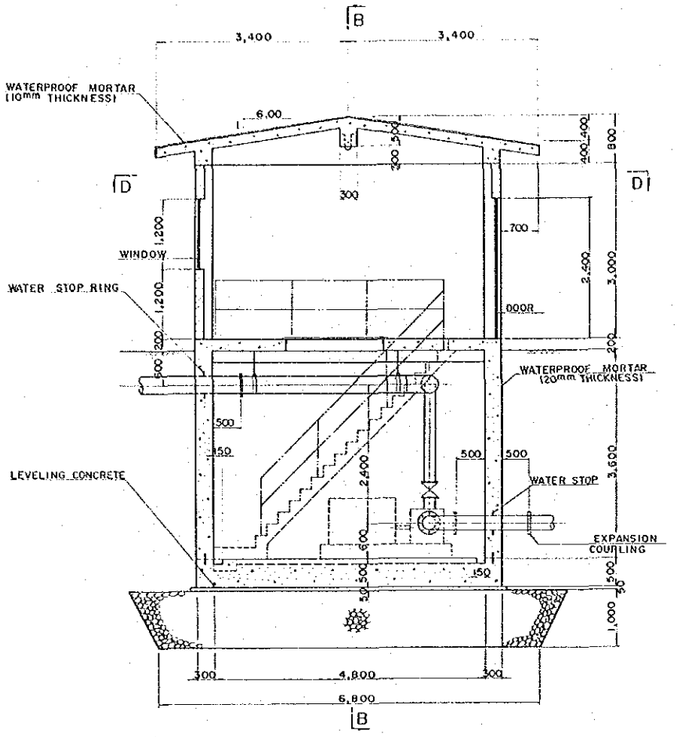
GOVERMENT OF TI
MINISTRY OF
DIRECTORATE GENERAL OF

PUMPING STATION PROJECT FO

TITLE OF DRAWING :

GENERAL PLAN OF PUM

JAPAN INTERNATIONAL



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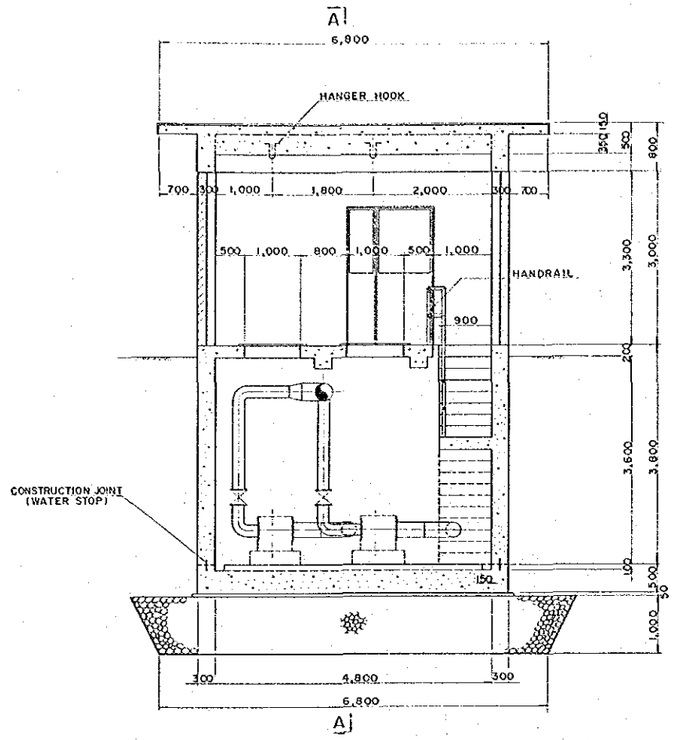

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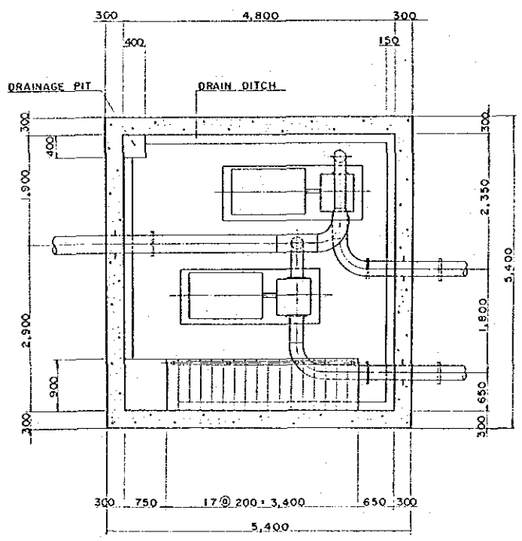
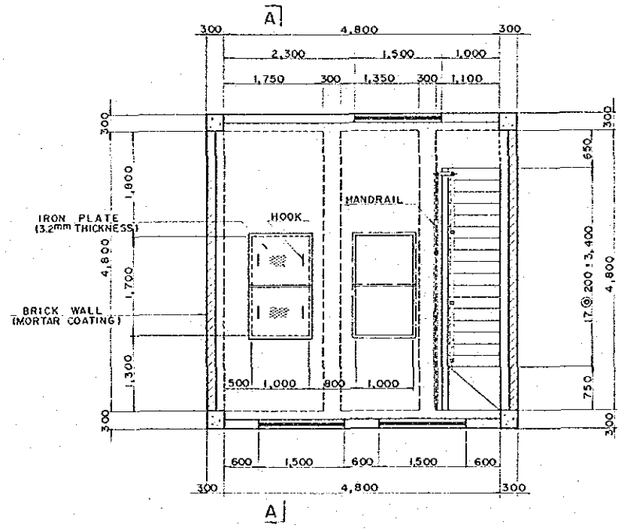


SECTION C – C



SECTION D – D

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

PUMPING STATION PROJECT FOR BENGAWAN SOLO LOWER REACHES

TITLE OF DRAWING :
GENERAL PLAN OF PUMPING STATION (4)

PLATE NO.
5

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)