③ Benefited Area of Water Use

Irrigation - K. Rejali basin and K. Besuk Semut basin. Power generation - Lumajang prefecture.

4.2 FACILITY PLANS

On the basis of the planning conditions mentioned in 4.1, the following facilities are planned.

① Intake Facilities

Taking the base flow discharge of K. Besuk Bang and K. Lengkong and the exploited groundwater.

② Groundwater Exploitation Facilities at K. Lengkong Fan

Pumping Wells (Well and A pump).

③ Water Conveyance Facilities (1)

Tunnel or open channel

④ Power Generating Stations

Hydro-electric power generation at the end of water conveyance facilities (1).

⑤ Water Conveyance Facility (2)

Open channel from K. Rejali to the irrigation area.

⑥ Cultivated Paddy Field

To facilitate the land improvement programme for the irrigation area, certain wastelands are reclaimed to be paddy fields in the K. Rejali and K. Semut basins.

Location of these facilities is indicated in Fig.-4.2. The facilities are illustrated in Fig.-4.3 to 4.7.

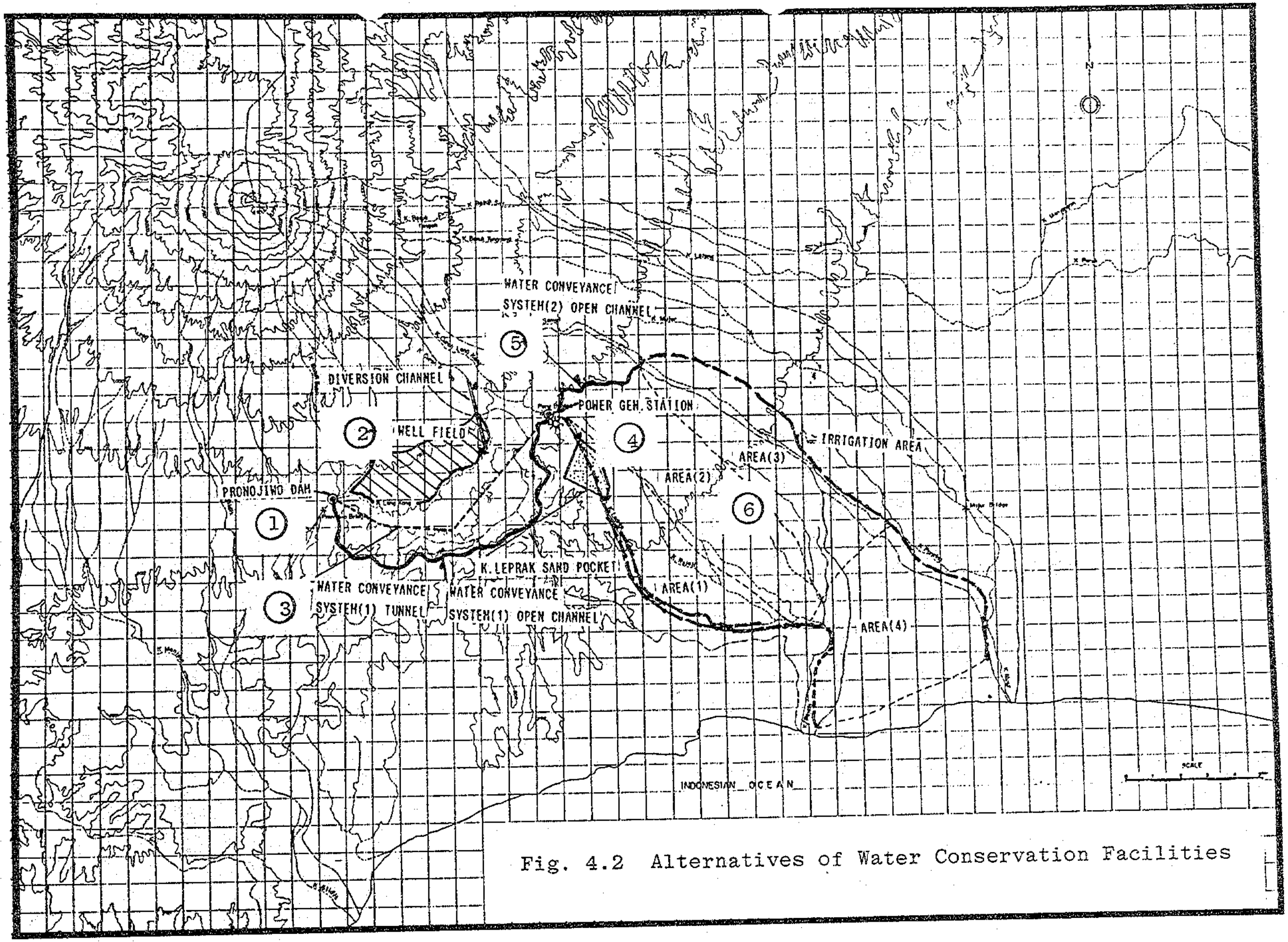
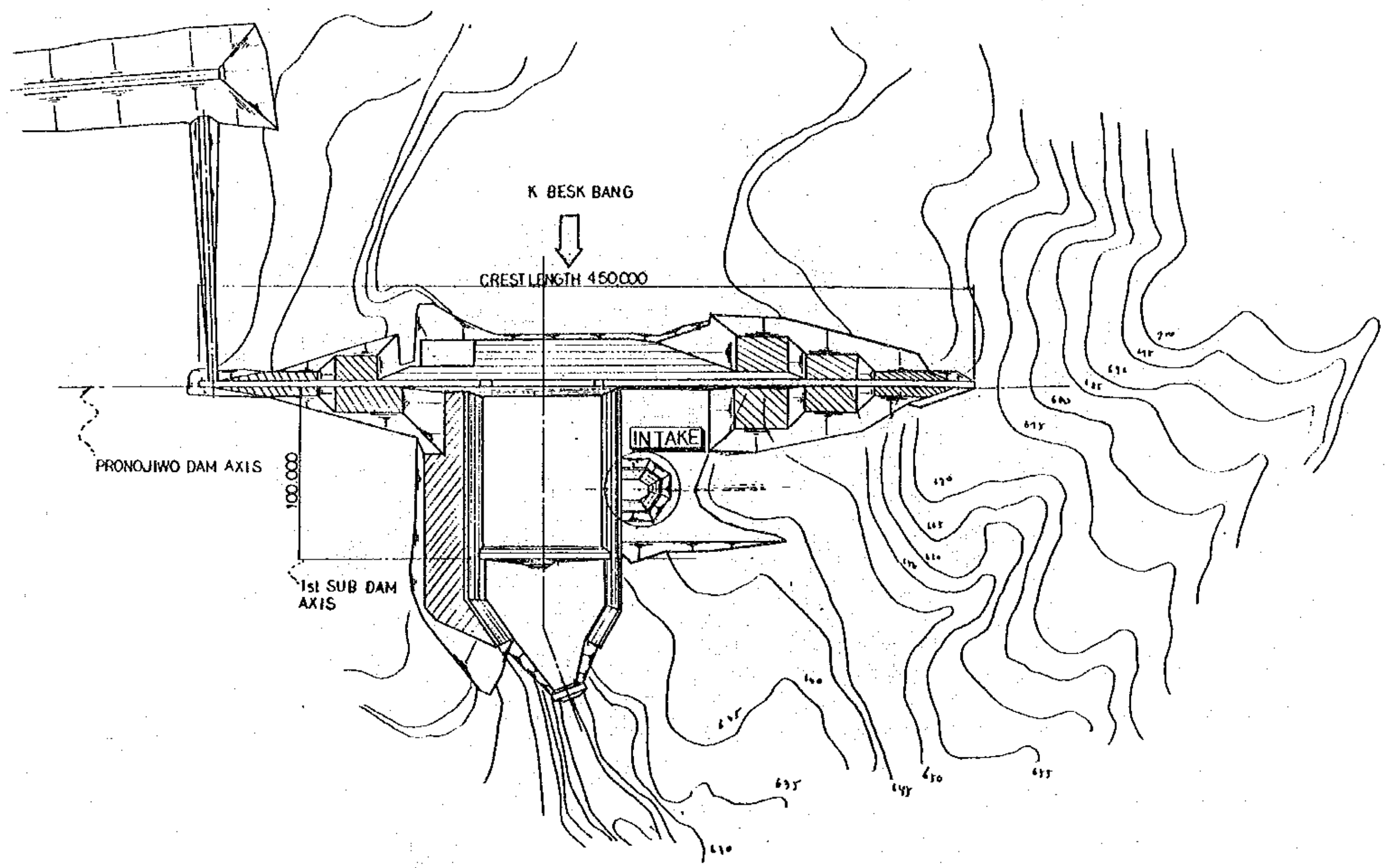
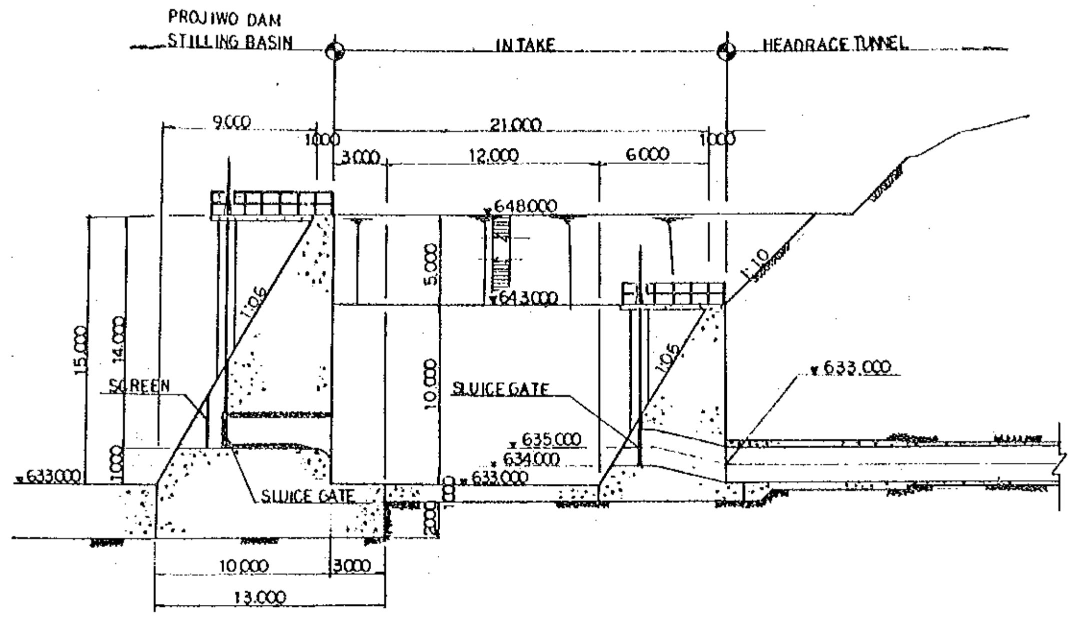


Fig. 4.2 Alternatives of Water Conservation Facilities

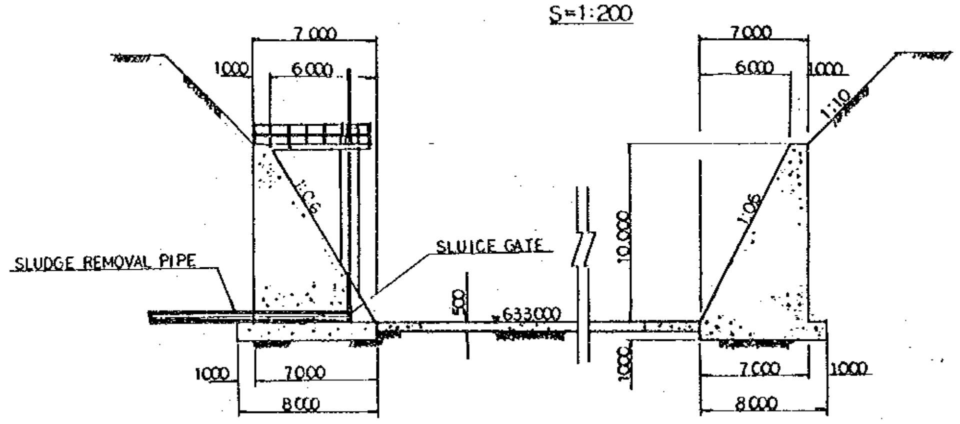
PLAN
S=1:2000



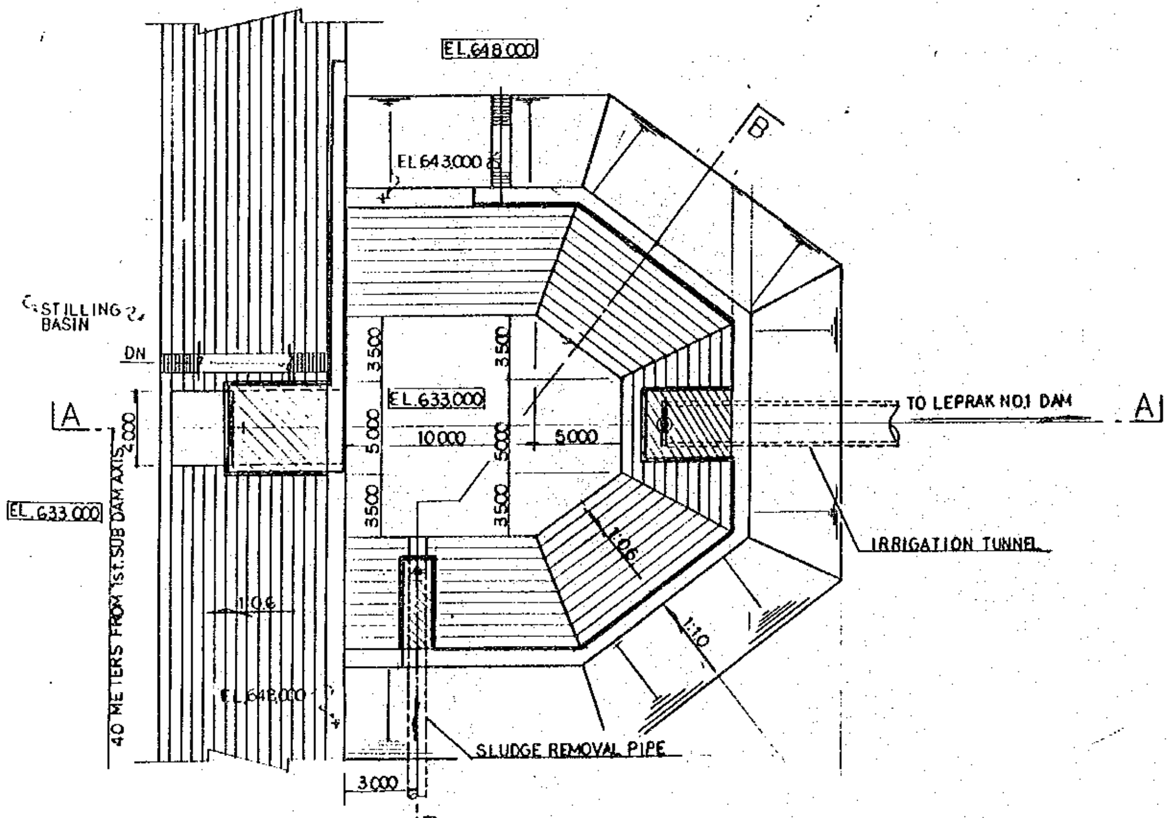
SECTION A-A
S=1:200



SECTION B-B
S=1:200



INTAKE
S=1:200



TYPICAL SECTION OF HEADRACE TUNNEL
S=1:25

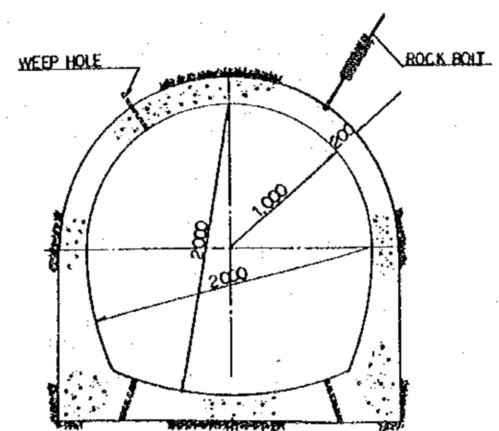
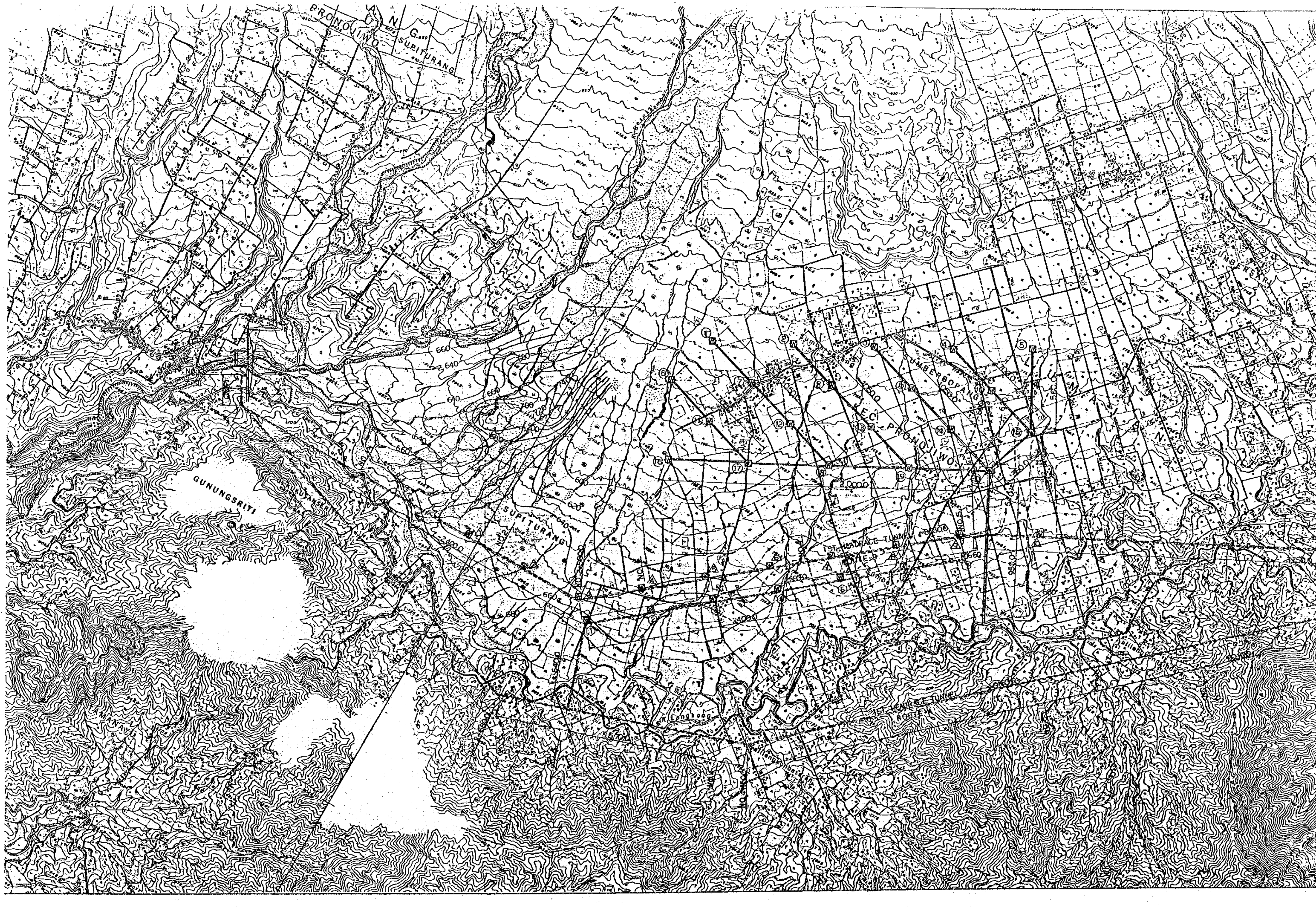


Fig. - 4.3

REPUBLIC OF INDONESIA	SCALE
THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU	1:2000 1:200 1:25
WATER TRANSPORT FACILITY INTAKE FACILITY	SMF I 2/10
JICA JAPAN INTERNATIONAL COOPERATION AGENCY	
DRAWN / CHECKED / APPROVED	


PRONOJIWO
SUPITURANG
GUNUNGSRITI
SUMBERBOPANG
KEC. PRONOJIWO
660
640
2,0000
1ST. HEADRACE TUNNEL

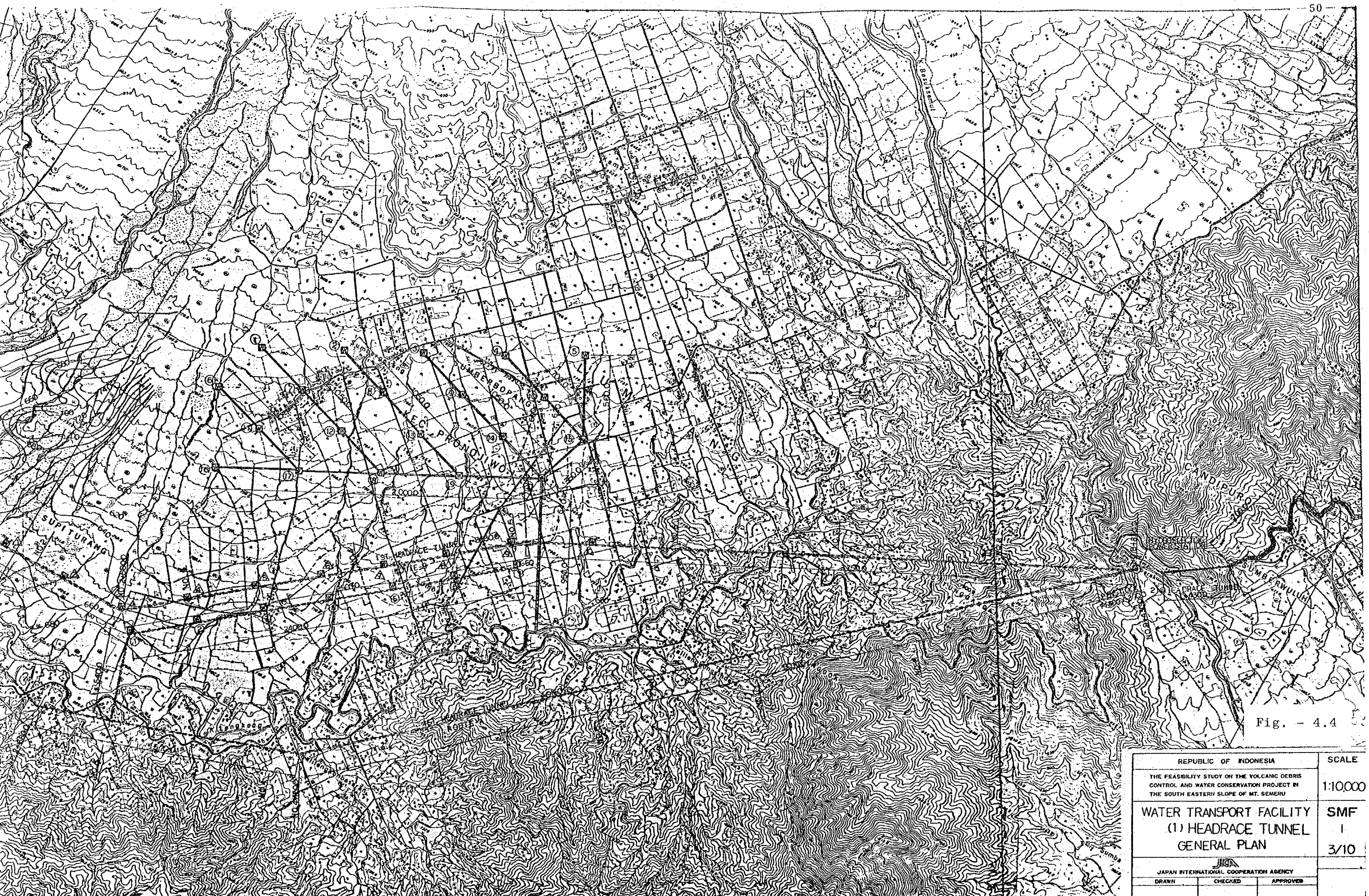
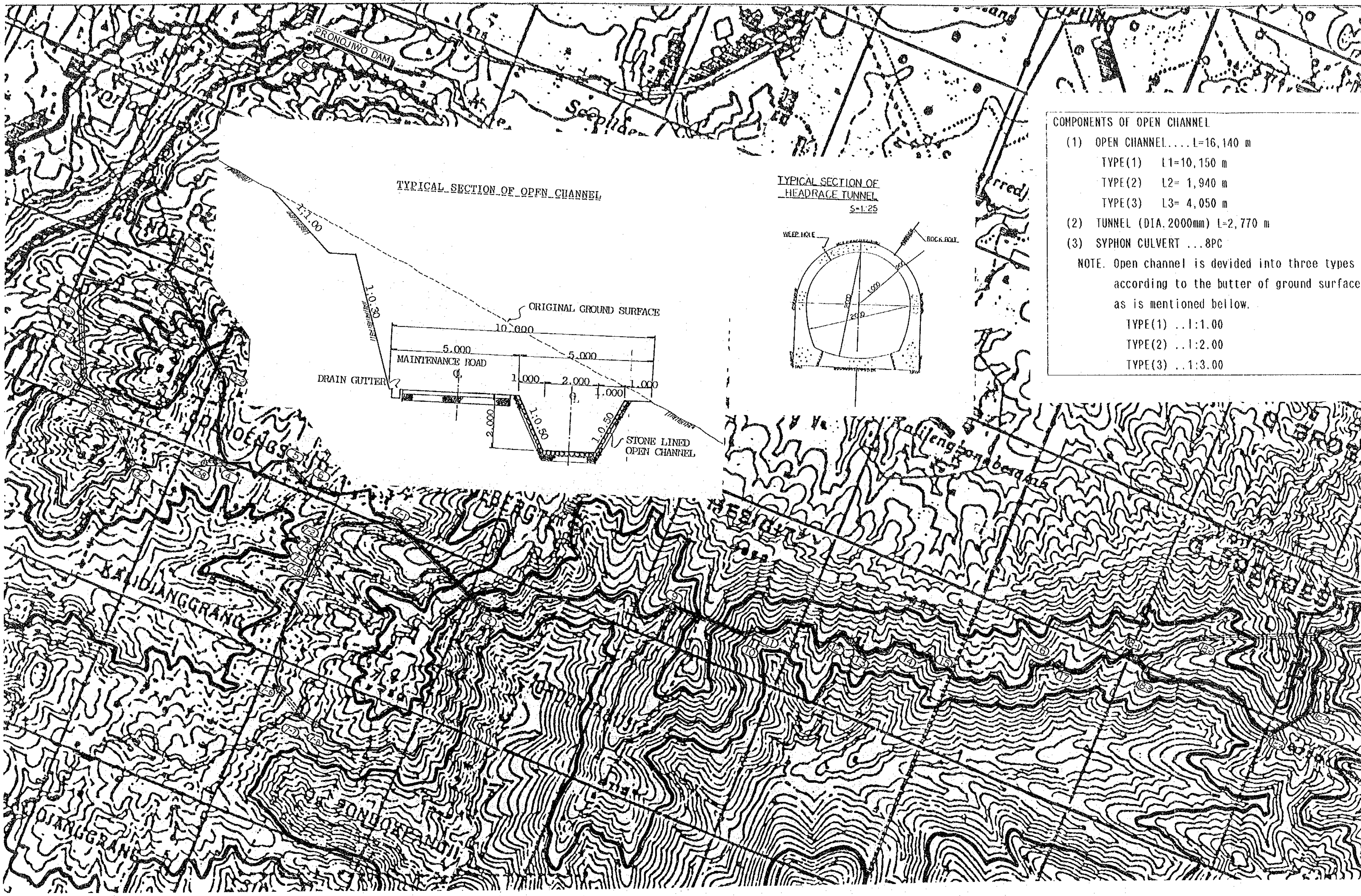


Fig. - 4.4

REPUBLIC OF INDONESIA	SCALE
THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU	1:10,000
WATER TRANSPORT FACILITY (1) HEADRACE TUNNEL GENERAL PLAN	SMF I 3/10
JICA JAPAN INTERNATIONAL COOPERATION AGENCY	
DRAWN / CHECKED / APPROVED	


PRONOJIWO DAM
TYPICAL SECTION OF OPEN CHANNEL
1:1.00
1:0.30
ORIGINAL GROUND SURFACE
10.000
5.000
5.000
MAINTENANCE ROAD
DRAIN GUTTER
1.000
2.000
1.000
1.000
2.000
1:0.50
1:0.50
STONE LINED
OPEN CHANNEL
TYPICAL SECTION OF
HEADRACE TUNNEL
S=1:25
WEEP HOLE
ROCK BOLT
COMPONENTS OF OPEN CHANNEL
(1) OPEN CHANNEL....L=16,140 m
TYPE(1) L1=10,150 m
TYPE(2) L2= 1,940 m
TYPE(3) L3= 4,050 m
(2) TUNNEL (DIA.2000mm) L=2,770 m
(3) SYPHON CULVERT ...8PC
NOTE. Open channel is devided into three types
according to the butter of ground surface
as is mentioned bellow.
TYPE(1) ..1:1.00
TYPE(2) ..1:2.00
TYPE(3) ..1:3.00

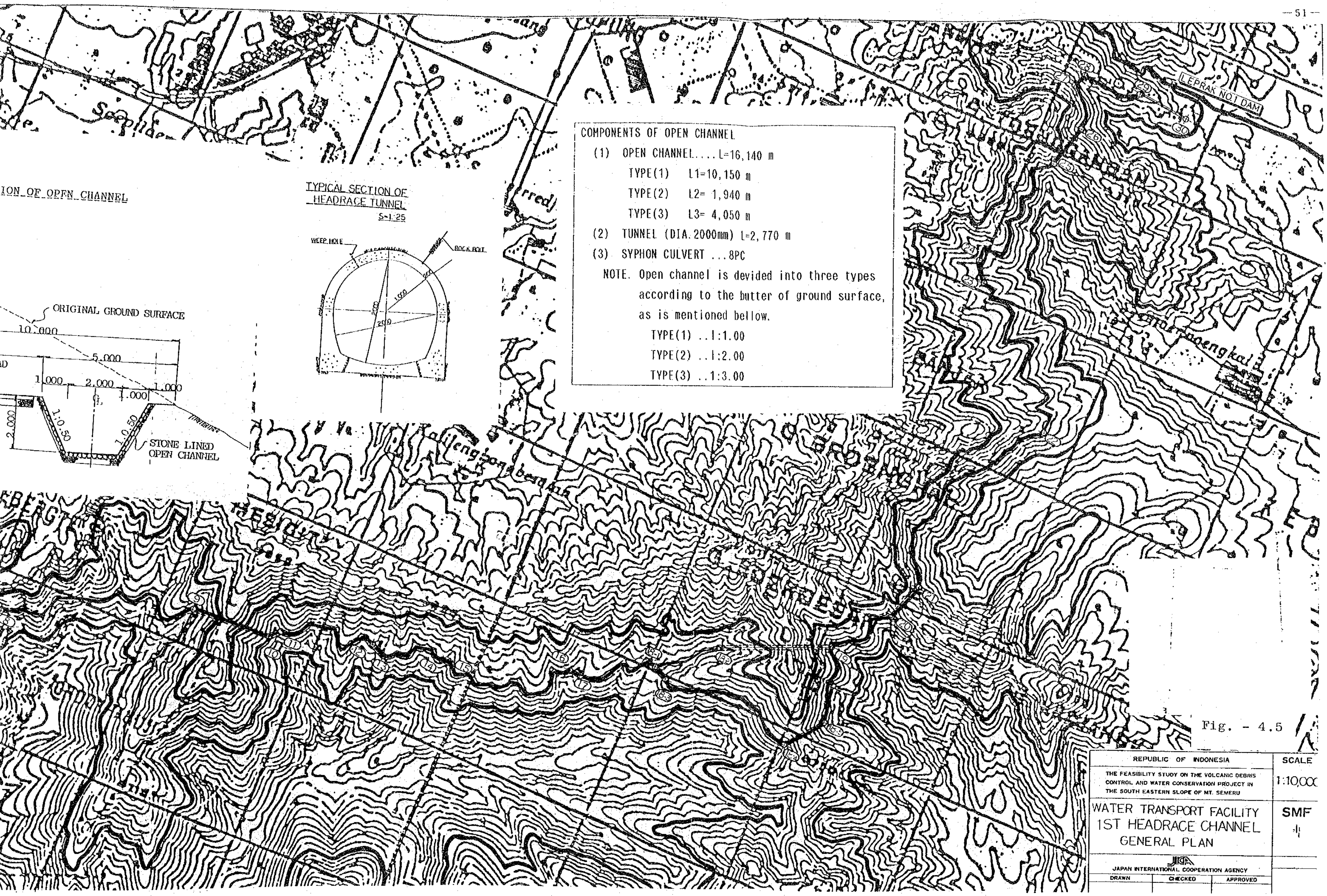

LEPRAK NO.1 DAM
ION OF OPEN CHANNEL
ORIGINAL GROUND SURFACE
10.000
5.000
1.000 2.000 1.000 1.000
1:0.50
1:0.50
2.000
STONE LINED OPEN CHANNEL
TYPICAL SECTION OF HEADRACE TUNNEL
S=1:25
WEEP HOLE
ROCK BOLT
COMPONENTS OF OPEN CHANNEL
(1) OPEN CHANNEL....L=16,140 m
TYPE(1) L1=10,150 m
TYPE(2) L2= 1,940 m
TYPE(3) L3= 4,050 m
(2) TUNNEL (DIA.2000mm) L=2,770 m
(3) SYPHON CULVERT ...8PC
NOTE. Open channel is devided into three types according to the butter of ground surface, as is mentioned bellow.
TYPE(1) ..1:1.00
TYPE(2) ..1:2.00
TYPE(3) ..1:3.00
REPUBLIC OF INDONESIA
THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU
SCALE
1:10,000
WATER TRANSPORT FACILITY
1ST HEADRACE CHANNEL
GENERAL PLAN
SMF
JICA
JAPAN INTERNATIONAL COOPERATION AGENCY
DRAWN
CHECKED
APPROVED

Fig. - 4.5

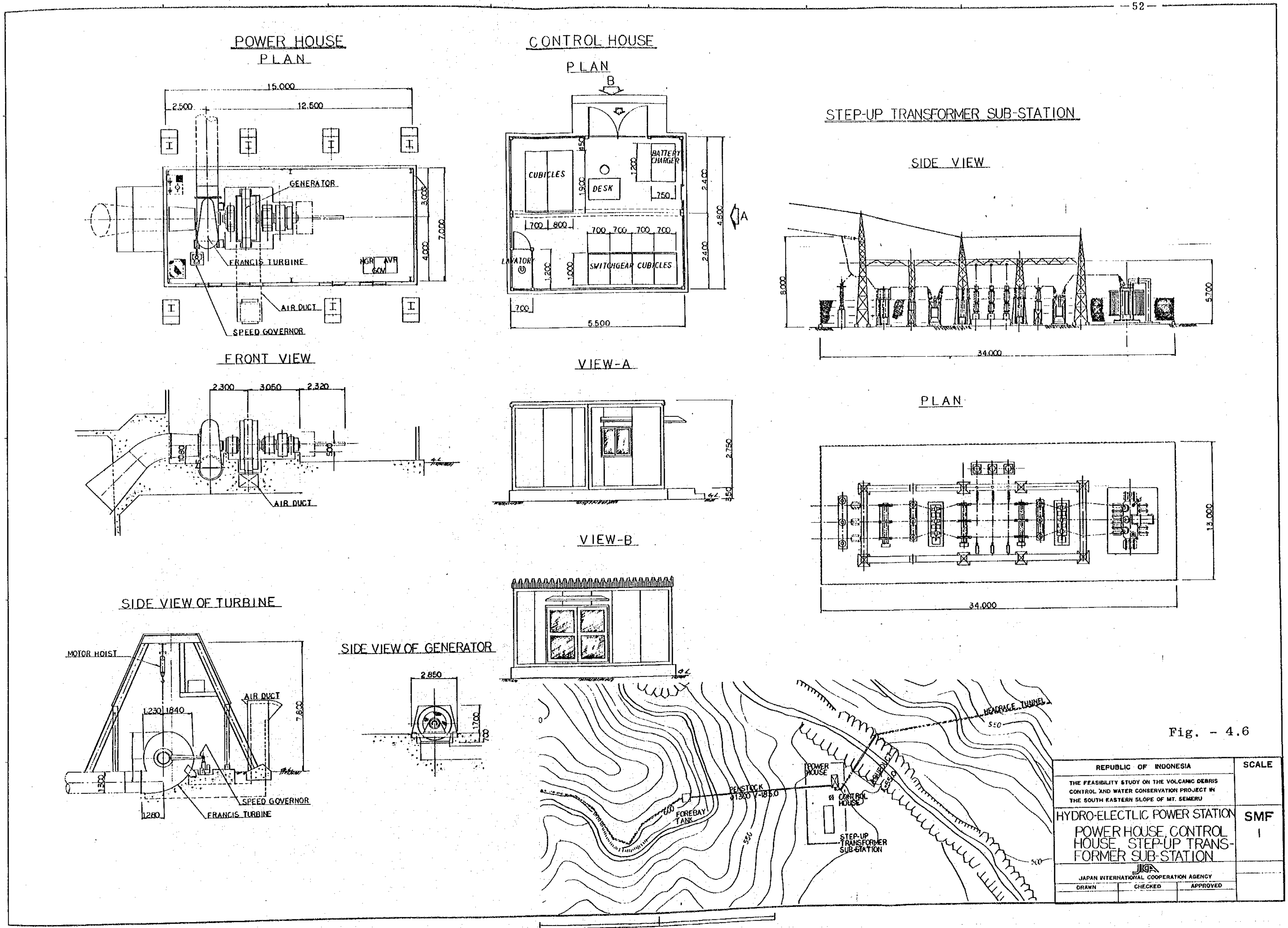
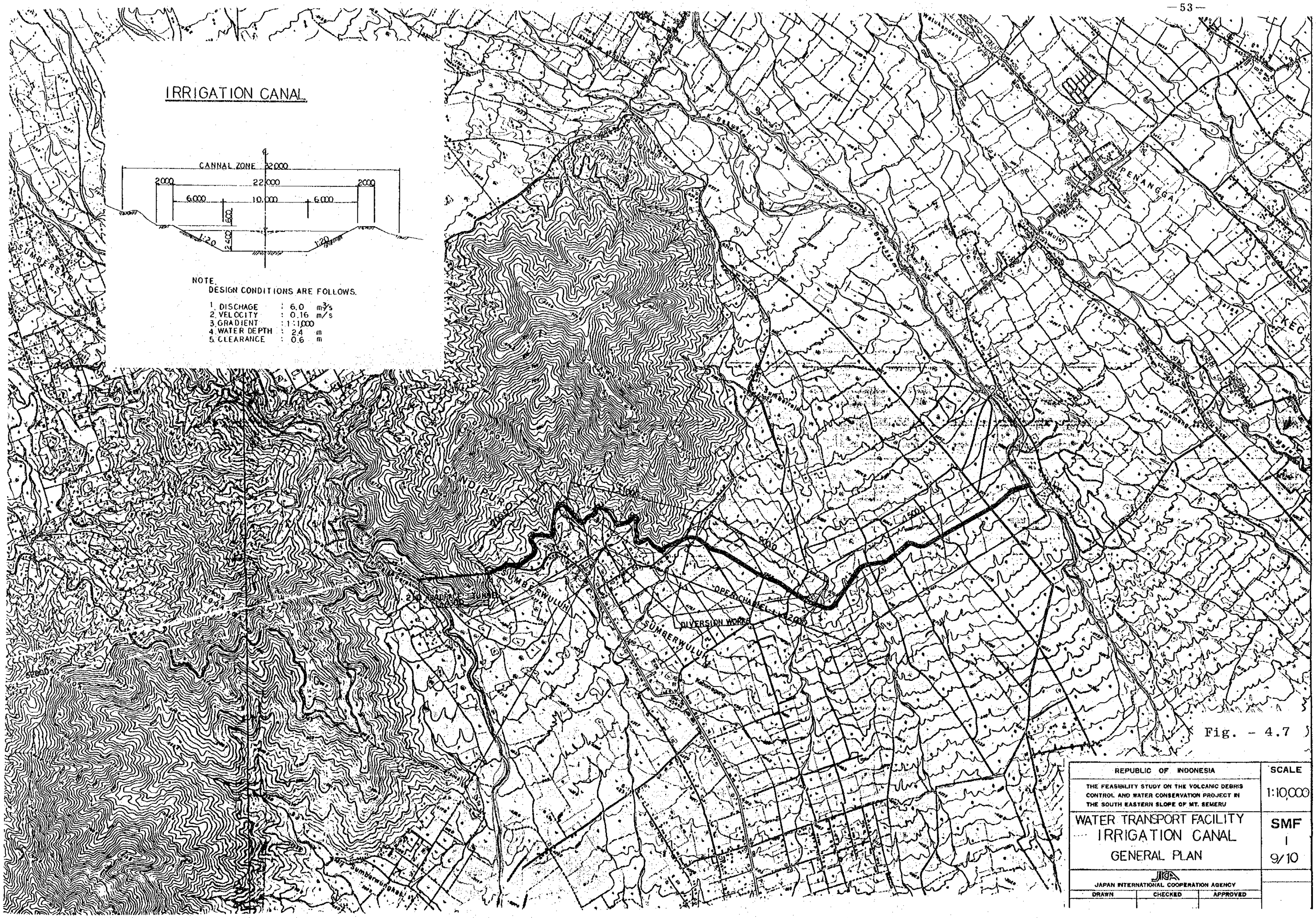

POWER HOUSE
PLAN
15.000
2.500
12.500
GENERATOR
FRANCIS TURBINE
AIR DUCT
SPEED GOVERNOR
NGR AVR GOV
3.000
4.000
7.000
FRONT VIEW
2.300
3.050
2.320
1.080
500
AIR DUCT
SIDE VIEW OF TURBINE
MOTOR HOIST
AIR DUCT
1.230 1.840
7.800
1.300
1.280
SPEED GOVERNOR
FRANCIS TURBINE
SIDE VIEW OF GENERATOR
2.850
1.700
700
CONTROL HOUSE
PLAN
B
A
CUBICLES
DESK
BATTERY CHARGER
LAVATORY
SWITCHGEAR CUBICLES
850
1.200
1.900
750
700 800
700 700 700 700
1.200
1.000
2.400
2.400
4.800
700
5.500
VIEW-A
2.750
350
VIEW-B
STEP-UP TRANSFORMER SUB-STATION
SIDE VIEW
8.000
5.700
34.000
PLAN
13.000
34.000
HEADRACE TUNNEL
550
POWER HOUSE
PENSTOCK φ1300 V-185.0
CONTROL HOUSE
FOREBAY TANK
STEP-UP TRANSFORMER SUB-STATION
550
500
REPUBLIC OF INDONESIA
THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU
HYDRO-ELECTLIC POWER STATION
POWER HOUSE, CONTROL HOUSE, STEP-UP TRANS-FORMER SUB-STATION
JICA
JAPAN INTERNATIONAL COOPERATION AGENCY
DRAWN
CHECKED
APPROVED
SCALE
SMF
I

Fig. - 4.6


IRRIGATION CANAL
CANNAL ZONE 32,000
22,000
2000
2000
6,000
10,000
6,000
600
2,400
1:20
1:20
NOTE.
DESIGN CONDITIONS ARE FOLLOWS.
1. DISCHAGE : 6.0 m³/s
2. VELOCITY : 0.16 m/s
3. GRADIENT : 1:1,000
4. WATER DEPTH : 2.4 m
5. CLEARANCE : 0.6 m
PENANGGAL
KEC. CANDIPURO
SUMBERWULUH
SUMBERWULUH
DIVERSION WORKS
OPEN CHANNEL
Fig. - 4.7
REPUBLIC OF INDONESIA
THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU
SCALE
1:10,000
WATER TRANSPORT FACILITY
IRRIGATION CANAL
GENERAL PLAN
SMF
I
9/10
JICA
JAPAN INTERNATIONAL COOPERATION AGENCY
DRAWN
CHECKED
APPROVED

4.3 DEVELOPED WATER

Through the combination of the facilities mentioned above, 1) the base flow of K. Glidik (at Planned Pronojiwo Dam), 2) the groundwater in K. Lengkong Fan area and 3) the base flow of K. Rejali (at K. Leprak No. 1 Check Dam) will be developed.

We set up the following cases according to the amount of developed water, on the basis of the study on water resources potential discussed in Chapter 3: (Refer to Fig.-4.8)

① Case-1 (No Groundwater)

Total ammount of developed water is 3.5 $m^3/s/y$. This amount of water is composed of:

- 2.468 $m^3/s/y$ of K. Glidik base flow;
- 0.992 $m^3/s/y$ of K. Rejali base flow.

The water to be charged into the hydro-electric power station is 2,924 $m^3/s/y$, composed of K. Glidik base flow and the diverted base flow from K. Rejali.

② Case-2 (Groundwater, 0.5 $m^3/s/y$)

Total amount of developed water is 4.0 $m^3/s/y$. This amount of water is composed of:

- 2.468 $m^3/s/y$ of K. Glidik base flow
- 0.992 $m^3/s/y$ of K. Rejali base flow
- 0.500 $m^3/s/y$ of groundwater developed

The water to be charged into the hydro-electric power station is 3,219 m /s/y, composed of K. Glidik base flow, the diverted base flow from K. Rejali and the groundwater developed (annual mean; 0.5 m^3/s, maximum; 1.0 m^3/s).

③ Case-3 (Groundwater, 1.0 $m^3/s/y$)

Total amount of developed water is 4.5 m /s/y. This amount of water is composed of:

- 2.468 $m^3/s/y$ of K. Glidik base flow
- 0.992 $m^3/s/y$ of K. Rejali base flow
- 1.000 $m^3/s/y$ of groundwater developed

The water to be charged into the hydro-electric power station is 3.270 m /s, composed of K. Glidik base flow, the diverted base flow from K. Rejali and the groundwater developed (annual mean; 1.0 m^3/s, maximum; 2.0 m^3/s).

The baseflow data used are compiled in Appendix-1.

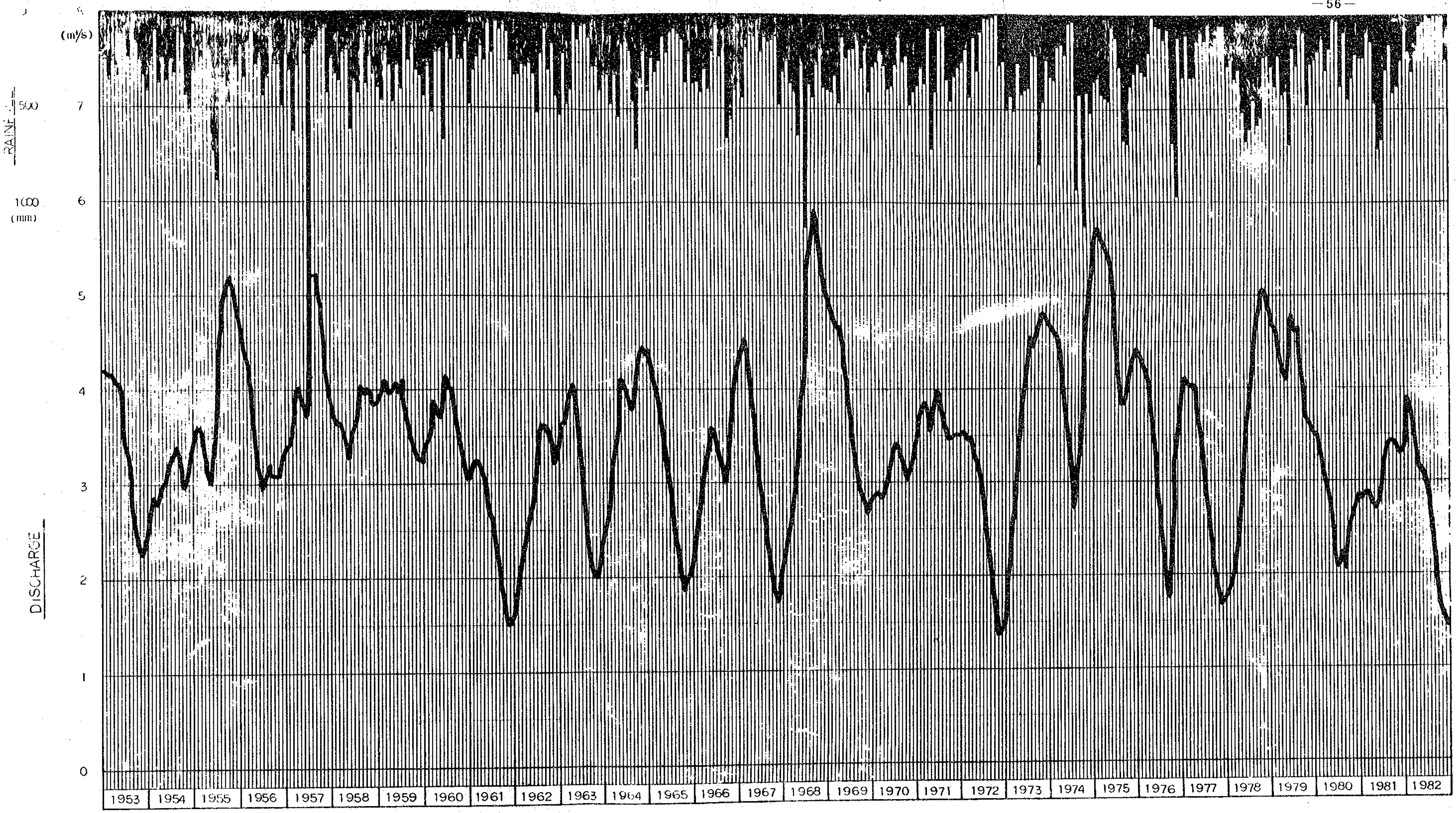


Fig. - 4.8

NOTE,

1. RAINFALL INDICTES OBSERVED DATA OF SUPIT-URAN.
2. DISCHAGE INDICATES SUM-UPPED DISCHAGE OF K.REJALI AND K.GLIDIK OBTAINED BY SIMULATION.

REPUBLIC OF INDONESIA	SCALE
THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU	
HYDROGICAL DATA RAINFALL AND RUNOFF (K.REJALI + K.GLIDIK)	SMF 1
JAPAN INTERNATIONAL COOPERATION AGENCY	
DRAWN / CHECKED / APPROVED	

4.4 UTILIZATION OF DEVELOPED WATER

The developed water will be used for the following purposes:

① Irrigation to devastated area;

② Hydro-electric power generation at the end of the water conveyance channel from K. Glidik.

4.4.1 IRRIGATION

(1) Irrigation Area

The devastated area extending from the K. Rejali basin to K. Pancing basin, not exceeding EL. 500 m, where there is no irrigation at present is chosen to be the target area for the irrigation programme.

This area is divided into the following sub-areas. Refer to Fig.4.9.

① Area-1; K. Leprak basin and K. Rejali basin. Some 580 ha will be irrigated.

② Area-2; K. Seluman basin surrounded by Area-1 and Area-3. Some 720 ha will be irrigated.

③ Area-3; K. Pancing basin. Some 550 ha will be irrigated.

④ Area-4; The downstream area of K. Rejali and K. Mujur. Some 2,580 ha will be irrigated.

The maximum potential area to be irrigated will be therefore about 4,500 ha.

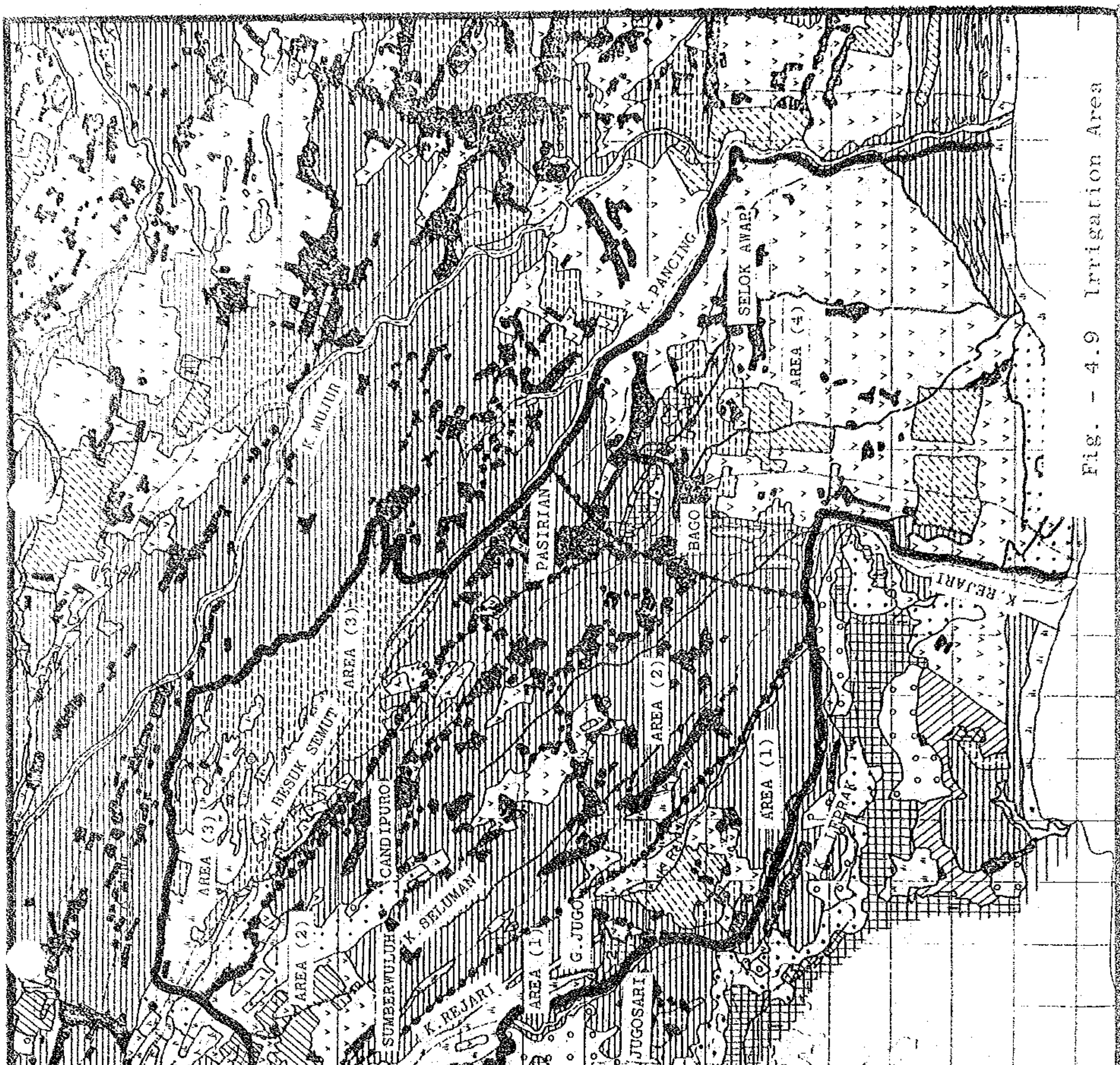


Fig. - 4.9 Irrigation Area

(2) Irrigation Pattern and Gross Duty of Water

Irrigation to paddy fields will be carried out through the year, and the number of harvest times is expected to be two and a half times per one year on the basis of the actual land and water use investigation.

(3) Gross Duty of Water

Gross duty of water shall be set up on the basis of material collected so far and existing data, because the survey to collect basic data such as water requirement in depth, evapotranspiration and percolation has not been conducted in this F/S.

Gross duty of water in each intake shown on Table-4.1 stands at between 0.62 lit./s/ha and 1.50 lit./s/ha (0.80 lit./s/ha on average) in the yearly mean. However, it ranges from 0.67 lit./s/ha to 1.08 lit./s/ha in PROSIDA data. Refer to Table 4.2.

In this study, gross duty of water is established at 1.0 lit./s/ha, taking the above two values into consideration.

Accordingly, with every 1.0 $m^3/s/y$ of newly developed water, 1,000 ha of paddy fields will be irrigated and a total of 2,500 ha of the same paddy fields will be harvested in a year.

Table-4.3 shows the conditions of the irrigated area.

Table - 4.1 Gross Duty of Water from Irrigation Office

(Unit:lit./Sec/ha)

Intake	1	2	3	4	5	6	7	8	9	10	11	12	Ave.
Rowogedang	1.05	1.14	0.83	0.61	0.60	0.46	0.55	0.50	0.25	0.47	0.73	0.73	0.66
Lobang I	1.03	0.95	1.13	0.98	0.61	0.54	0.45	0.39	0.25	0.28	0.36	0.50	0.62
Lobang II	1.35	1.40	1.08	0.79	1.03	0.61	0.57	0.57	0.32	0.48	0.82	1.05	0.84
Klerek	1.12	0.97	0.92	0.86	0.71	0.55	0.49	0.49	0.34	0.41	0.52	0.76	0.68
Kedungcaring	1.14	1.23	0.62	0.60	0.92	0.53	0.49	0.50	0.31	0.42	0.66	0.87	0.69
Soponyono	0.87	0.95	0.49	0.54	0.70	0.58	0.56	0.58	0.39	0.33	0.60	0.86	0.62
Dam Rejali	0.68	0.73	0.65	0.81	0.90	0.81	0.75	0.79	0.65	0.78	0.95	0.97	0.79
Talang	1.68	2.14	1.81	1.81	1.77	1.49	1.45	1.30	0.83	1.03	1.19	1.48	1.50
Average	1.12	1.19	0.94	0.88	0.91	0.70	0.66	0.64	0.42	0.53	0.73	0.90	0.80

Note:

Table - 4.2 Gross Duty of Water from PROSIDA

(Unit:lit./Sec/ha)

Intake	1	2	3	4	5	6	7	8	9	10	11	12	Ave.
Area more in percolation	1.20	1.20	1.22	1.13	1.01	1.02	0.94	0.95	1.04	0.98	1.08	1.15	1.08
Area less in Percolation	0.70	0.74	0.70	0.67	0.64	0.59	0.63	0.62	0.69	0.67	0.69	0.73	0.67

Source: Water use concept for rice field (an analysis)

Table - 4.3 Conditions of Irrigation Area

Stage	Field Classification	Crops	Items	Area-1	Area-2	Area-3	Area-4			
			Area No.				4.1	4.2	4.3	4.4
			Field Area (ha) Each	579.4	720.8	552.7	1,647.1	500.0	500.0	32.1
			Field Area (ha) Total	579.4	1,300.2	1,852.9	3,500.0	4,000.0	4,500.0	4,532.1
			Gross-Duty of Water (m^3/s) Each	0.58	0.72	0.55	1.65	0.50	0.50	0.03
			Gross-Duty of Water (m^3/s) Total	0.58	1.30	1.85	3.50	4.00	4.50	4.53
Without Project	Dry Field(1)		Field Area	102.7	0.0	0.0	200.8	60.7	61.0	4.0
			Total Field Area	102.7	102.7	102.7	303.5	364.2	425.2	429.2
		Sugar Cone	Harv. Area	102.7	0.0	0.0	200.8	60.7	61.0	4.0
			Total Harv. Area	102.7	102.7	102.7	303.5	364.2	425.2	429.2
	Dry Field(2)		Field Area	230.6	466.4	26.0	1,446.9	437.6	440.0	28.2
			Total Field Area	230.6	697.0	723.0	2,169.9	2,607.5	3,047.5	3,075.7
		Maize	Harv. Area	440.7	187.8	7.9	2,893.8	875.2	879.9	692.9
			Total Harv. Area	440.7	628.5	636.4	3,530.2	4,405.4	5,285.3	5,341.8
		Soy Bean	Harv. Area	146.9	0	0	1,446.9	437.6	440.0	28.2
			Total Harv. Area	146.9	146.9	146.9	1,593.8	2,031.4	2,471.4	2,499.6
		Cassava	Harv. Area	251.1	1,211.4	70.1	0.0	0.0	0.0	0.0
			Total Harv. Area	251.1	1,462.5	1,532.6	1,532.6	1,532.6	1,532.6	1,532.6
	Forest		Field Area	23.8	174.8	142.5	0.0	0.0	0.0	0.0
			Total Field Area	23.8	198.6	341.1	341.1	341.1	341.1	341.1
	Devastrated Field		Field Area	222.3	79.6	384.2	0.0	0.0	0.0	0.0
			Total Field Area	222.3	301.9	686.1	686.1	686.1	686.1	686.1
With Project	Paddy Field		Field Area	579.4	720.8	552.7	1,647.1	500.0	500.0	32.1
			Total Field Area	579.4	1,300.2	1,852.9	3,500.0	4,000.0	4,500.0	4,532.1
		Rice	Harv. Area(x2.5)	1,448.5	1,802.0	1,381.8	4,117.8	1,250.0	1,250.0	80.3
			Total harv. Area	1,448.5	3,250.5	4,632.3	8,750.1	10,000.0	11,250.0	11,330.4

4.4.2 HYDRO-ELECTRIC POWER GENERATION

Using the developed water, the hydro-electric power generation station (90 m water head) installed at the end of the water conveyance channel, near K. Leprak No. 1 Check Dam, will produce the following electric power according to the amount of the developed water:

① In the case of the total developed water = 3.5 m^3/s/y, the base flow of K. Glidik and K. Rejali (diverted portion, 46%) will be developed;

- Maximum output, 2,200 KW

- Annual output of electric energy
  16.7 x 10 KWH/y

② In the case of the total developed water = 4.0 m /s/y, developed groundwater of 0.5 m^3/s/y is added to ① ;

- Maximum output, 2,200 KW

- Annual output of electric energy,
  18.5 x 10 KWH/y

③ In the case of the total developed water = 4.5 m /s/y, developed groundwater of 1.0 m^3/s/y is added to ① ;

- Maximum output, 2,200 KW

- Annual output of electric energy,
  19.5 x 10 KWH/y

Detailed information is compiled in Appendix-2.

4.5 COST

The project cost consists of the following items.

(1)	Construction Cost	Direct Cost	Materials Cost
			Machine Hiring Cost
			Labour Cost
		Indirect Cost = Direct Cost x 15%	

(2) Land Acquisition Cost

(3) Engineering Service Cost = (1) x 10%

(4) Government Administration Cost = (1) x 10%

(5) Project Mangement Cost

(6) Physical Contingency = (1) x 10%

After a rough design of each facility was made, the cost estimate was calculated on the basis of unit price of materials, labour cost and labour efficiency in Lumajang Prefecture of East-Java of Indonesia.

The cost of those materials and machines, not available in Indonesia, was calculated by using the spot price estimate based on the C.I.F. price at Surabaya from Japan.

The unit price for each cost is based on the standard of 1982.

The exchange rate between local currency and foreign currency is as follows:

1US$ = 650 Rp = 240 Yen

The following two points were revised to calculate the economic cost.

① Shadow wage of unskilled labour was scaled down to (wage of unskilled labour) x 0.5.

② Tax was deducted from the machinery hire cost (which is equivalent to the foregin currency portion) and the opportunity cost's interest rate, which was eliminated in the hire cost calculation, was added to the machinery hire cost.

Tax is imposed at the following rate:

$$0.2 \times \frac{a+1}{2a} \quad \text{(a is service life)}$$

Since the average service life of machinery is regarded as 5 years, the tax rate is 0.12.

The opportunity cost's interest rate is added to the machinery hire cost excluding tax, however, the real interest rate (19%) which was explained in the paragraph on direct damage was applied at this time as the opportunity interest rate.

The transform formula in which the machinery hire cost is converted into the economic cost, is as follows:

$$A' = (1.0 = 0.2 \times \frac{a + 1}{2a}) \quad (1 + r) \times A$$

Given a = (Machinery's) service life
r = Opportunity cost interest rate
A = Machinery hire cost
A' = Revised machinery hire cost

Further, operation expenses were established so that the same amount of expenses may be allocated to each facility every year throughout the construction period.

The economic cost obtained in the above manner and the maintenance cost for each facility is shown in Table-4.4 and 4.5.

The background data of cost estimation is compiled in Appendix-3.

Table - 4.5 Characteristics of Water Conservation Facilities

NO.		FACILITY	DIMENSION	ECONOMIC COST (10^6 RP.)	MAIN. COST (10^6 RP./y)	CONST. PERIOD (YEAR)	DEP. PERIOD (YEAR)	REMARKS
(1)	1	INTAKE	Q_{max} = 6.0 m^3/s	338.8	1.7	2	80	
(2)	2.1	PUMPING WELLS(1)	Q = 0.5 $m^3/s/y$	1,688.7	562.9	2	50	
(3)	2.2	PUMPING WELLS(2)	Q = 1.0 $m^3/s/y$	3,503.2	1,126.5	3	50	
(4)	3.1	TUNNEL	9.160 m	23,566.6	117.8	5	50	
(5)	3.2	OPEN CHANNEL	19,120 m	12,363.4	61.8	5	50	
(6)	4.1	POWER GEN. ST(1)	16,747 MWH	2,745.4	29.0	2	50	
(7)	4.2	POWER GEN. ST(2)	18,500 MWH	2,745.4	29.0	2	50	
(8)	4.3	POWER GEN. ST(3)	19,473 MWH	2,745.4	29.0	2	50	
(9)	5	IR. OPEN CHANNEL	4,630 m	909.9	4.5	2	50	
(10)	6.1	CUL. FIELD(1)	3,500 ha	479.6	2.4	2	100	
(11)	6.2	CUL. FIELD(2)	4,000 ha	491.9	2.5	2	100	
(12)	6.3	CUL. FIELD(3)	4,500 ha	504.5	2.5	2	100	

Table - 4.4 Cost Estimation of Water Conservation Facilities

(Unit; 10^6 Rp.)

NO.		FACILITY	CONSTRUCTION COST			④ LAND AQUISI-TION	⑤ ENGI-NEERING SERVISES	⑥ ADMINI-STRATION	⑦ CONTIN-GENCY	⑧ ECONO-MIC COST
			① DIRECT	② UNDIRECT	③ TOTAL					
①	1	INTAKE	210.3	31.5	241.8	0.8	24.2	24.2	24.2	315.2
②	2.1	PUMPING WELLS(1)	1,050.2	157.5	1,207.7	0.8	120.8	120.8	120.8	1,570.9
③	2.2	PUMPING WELLS(2)	2,100.4	315.1	2,415.5	1.6	241.6	241.6	241.6	3,141.9
④	3.1	TUNNEL	13,158.3	1,973.7	15,132.0	0.0	1,513.2	1,513.2	1,513.2	19,671.6
⑤	3.2	OPEN CHANNEL	6,889.8	1,033.5	7,923.3	19.8	792.3	792.3	792.3	10,320.0
⑥	4.1	POWER GEN. ST(1)	1,708.2	256.2	1,964.4	0.3	196.4	196.4	196.4	2,553.9
⑦	4.2	POWER GEN. ST(2)	1,708.2	256.2	1,964.4	0.3	196.4	196.4	196.4	2,553.9
⑧	4.3	POWER GEN. ST(3)	1,708.2	256.2	1,964.4	0.3	196.4	196.4	196.4	2,553.9
⑨	5	IR. OPEN CHANNEL	531.0	79.7	610.7	52.4	61.1	61.1	61.1	846.4
⑩	6.1	CUL. FIELD(1)	298.4	44.8	343.2	-	34.3	34.3	34.3	446.1
⑪	6.2	CUL. FIELD(2)	306.1	45.9	352.0	-	35.2	35.2	35.2	457.6
⑫	6.3	CUL. FIELD(3)	313.9	47.1	361.0	-	36.1	36.1	36.1	469.3

NOTE: ② = ① x 15%, ⑤ = ③ x 10%, ⑦ = ③ x 10%
③ = ① + ②, ⑥ = ③ x 10%, ⑧ = ③ + ④ + ⑤ + ⑥ + ⑦

4.6 ALTERNATIVE PLANS FOR WATER CONSERVATION

4.6.1 ALTERNATIVE PLANS

There can be various water conservation plans based on the different combination of facilities.

① Alternative Plan - A:

No groundwater exploitation. Water conveyance is by tunnel. An annual average rate of 3.5 m^3/s will be used for irrigation. Also 1,419 m^3/s will be constantly used for power generation. The annual average of the latter will be 2,924 m^3/s.

② Alternative Plan - B:

No groundwater exploitaton. Water conveyance is by open channel. The water volume to be used for irrigation and power generation will be the same as Plan - A.

③ Alternative Plan - C:

Exploitation by pumping wells (maximum volume 1.0 m^3/s). Irrigation water volume by an open tunnel will be an annual average of 4.0 m^3/s. For power generation, 2,419 m^3/s (constant) and 3.219 m^3/s (annual average).

④ Alternative Plan - D:

Replace the open tunnel of Plan - C with an open channel. Other particulars are the same as for Plan - E.

⑤ Alternative Plan - E:

Exploitation of water by pumping wells (maximum volume 2 m^3/s). Irrigation water volume by an open tunnel will be an annual average of 4.5 m^3/s. For power generation, 3,000 m^3/s (constant) and 3,270 m^3/s (annual average).

⑥ Alternative Plan - F:

Replace the open tunnel of Plan - E with an open channel. Other particulars will be the same as for Plan - E.

4.6.2 PRELIMINARY EVALUATION

The economic benefits derived from the water conservation project can be expressed by the difference of "with project" and "without project".

Each alternative plan mentioned above will give the following beneficial economic effects in econimic view point.

① Increase in agricultural products

② Generation of hydro-electric power

The basic theory of economic evaluation (or estimation of "Interval Rate of Return" (I.R.R.) is the same as in the economic evaluation of debris control facility. Refer to Supporting Report (2), FIRST PRIORITY PROJECT. Computer output is compiled in Appendix-4.

(1) Irrigation

The unit price, yield and input cost for each crop are summarized in Table-4.6.

Table-4.6 Unit for Each Crops

Crop \ Unit Price	Price 10 Rp/ton	Yield ton/ha	Input Cost 10 Rp/ha
Paddy Rice (wet season)	135	3.7, max. 4.5 increasing rate 1.2% p.a.	150
Paddy Rice (dry season)		4.0, max. 4.9 increasing rate 1.2% p.a.	
Sugar Cane	15	80	420
Maize	120	0.8	30
Soy Bean	300	0.92	70
Cassava	45	9.7	50

(a) Prices of Agricultural Products

The crops being cultivated at present are paddy rice (in the rainy season), sugar cane, maize, soy bean and cassava. Almost all these crops are consumed by the farmers so that only a small portion is traded on the local markets. Therefore, the local prices were used for economic analysis.

(b) Crop per Hectar

The crop per hectar was estimated from information collected by field survey. However, the paddy rice harvest was converted into dry unhulled rice (gabah kering) at a proportion of 80:65 proportion on the basis of harvest of dried ears of rice (padi kering) according to the weight conversion table prepared by the Food Agency (BULOG).

The crop of dried ears of rice in the rainy season is 4.6 ton/ha and 4.9 ton/ha in the dry season. On the basis of dry unhulled rice, the crop is 3.7 ton/ha in the rainy season and 4.0 ton/ha in the dry season. Though recently the crop of paddy rice per hectar has grown at the pace of an average 1.2 percent every year (from 1970 to 1982), 5.5 ton/ha in the rainy season and 6.0 ton/ha in the dry season seem to be the upper limit. Therefore, the crop of paddy rice is supposed to increase at the pace of 1.2 percent every year by setting 1982 as the basic year and setting an upper limit of 5.5 ton/ha in the rainy season and 6.0 ton/ha in the dry season. On the other hand, the upper limit of dry unhulled rice is set at 4.5 ton/ha in the rainy season and 4.9 ton/ha in the dry season.

The crop of maize with husk (jagung glondhong) is estimated at 1.6 ton/ha. When the husk, tassel and core are taken off and dried (pipilan kering), the weight is reduced almost to half. Therefore, the crop of dried corn is estimated at 0.8 ton/ha.

In regard to agricultural products other than paddy rice, the crop is supposed to remain unchanged in the future because a conspicuous growth is not seen in the yield per hectar.

(c) Input Cost

A field survey for collecting information on agricultural investment in agricultural products was conducted in 4 Kecamatans in Kab. Lumanjang. Fertilizer, seeds and saplings, labour wage and other expenditures are included in the cost.

(d) Harvest Acreage

The harvest acreage for each main agricultural product, as well as the cropping pattern, classified by the case With Project and the case Without Project, was found through the land utilization map in the water resources development beneficiary area. Refer to Fig.-4.9.

(2) Hydro-electric Power Generation

The construction of this hydro-electric power station will bring to bear no influence on the sort of operation of any other sort of hydro and thermal station.

Therefore, the econmic benefit of the station is limited to the saving of fuel by thermal power station.

The alternative stations according to the developed water will generate the power and save the cost of fuel as follows:

① In the case of the total developed water = 3.5 m^3/s/y, the base flow of K. Glidik and K. Rejali (diverted portion, 46%) will be developed;

- Annual output of electic energy
  16.7×10^6 KWH/y

- Annual saving in cost of fuel
  446×10^6 Rp/y

② In the case of the total developed water = 4.0 m^3/s/y, developed groundwater of 0.5 m^3/s/y is added to ①;

- Annual output of electric energy,
  $18.5 \times 10m^3$ KWH/y

- Annual saving in cost of fuel
  $493 \times 10m^3$ Rp/y

③ In the case of the total developed water = 4.5 m^3/s/y, developed groundwater 1.0 m /s/y is added to ①;

- Annual output of electric energy,
  19.5×10^6 KWH/y

- Annual saving in cost of fuel
  512×10^6 Rp/y

The used unit price of cost (UC_f) (at the sending end) is as follow:

$$UC_f = \frac{16.8 \times 10^{-2} \text{ US\$/lit} \times 2630 \text{ kcal/KWH}}{10.9 \text{ kcal/lit}}$$
$$= 4.1 \times 10^{-2} \text{ US\$/KWH}$$
$$= 26.65 \times \text{Rp/KWH}$$

Details are described in Appendix-2.

(3) I.R.R.

Table-4.7 shows the combination of facilities for each plan and their respective preliminary economic evaluation, or I.R.R.

We summerized the evaluation of the plans as follows:

① Among the alternative plans, the plan-B in which there is the least amount of ground water development with the open channel water conveyance system shows highest I.R.R. of 16.19%;

② However, as the economic evaluation of each plan is carried out on the basis of the mean amount of the developed water, the stable water supply by the ground water development during the dry seasons should be also evaluated reasonably in the next study;

Table - 4.7 Ecomonic Evaluation of Water Conservation Projects

ALTERNATIVE	FACILITY						ECONOMIC COST (10^6RP)	MAINTE-NANCE COST (10^6 PR/Y)	DEVELOPED WATER (m^3/s)	POWER GENERA-TION (10^6 KWH/Y)	INTERNAL RATE OF RETURN (%)	REMARKS
	INTAKE	GROUNDWATER DEVELOPMENT SYSTEM	WATER CONVEYANCE SYSTEM (1)	WATER POWER GENERATION STATION	WATER CONVEYANCE SYSTEM (2)	NEWLY CULTIVATED FIELD						
1	①	-	④	⑥	⑨	⑩	23,832	155.4	3.5	16.747	10.41	
2	①	-	⑤	⑥	⑨	⑩	14,482	99.4	3.5	16.747	16.19	
3	①	②	④	⑦	⑨	⑪	25,416	718.4	4.0	18.500	9.56	
4	①	②	⑤	⑦	⑨	⑪	16,064	662.4	4.0	18.500	14.61	
5	①	③	④	⑧	⑨	⑫	26,998	1,282.0	4.5	19.473	8.65	
6	①	③	⑤	⑧	⑨	⑫	17,646	1,226.0	4.5	19.473	12.97	

Facility No. is refered to Table-6.2.

③ From the standpoint of maintaining the area's basis of livlihood as well as economic considerations, several of the water development plans examined are thought to be promising undertakings. Should it be judged desirable to execute such undertakings, it would be mandatory to confirm their feasibility by carrying out a more advanced study than the present one.

4.7 COMBINED PROJECT PLAN

On the basis of the following preconditions for planning, the economic aspects of the projects combined with the control facility project and the water conservation projects, were studied:

① The sediment control facility project was studied exhaustively at a "Feasibility Study" level, however, the water conservation projects were only studied in a cursory manner.

② Therefore, a total evaluation on the economic, social and technical aspects will have to be carrried out, adding such appropriate studies as on water resources potential, on water conservation facilities, on irrigation design and on power generation plans.

Table-4.8 shows the economic evaluation of the combined project plans.

The combined project of the first priority facility project and the alternative plan-B for water conservation project shows the highest I.R.R. of 10.78%.

Table-4.8 Economic Evaluation of Combined Project Plans

Item	Alternative	A	B	C	D	E	F
Principal Facilities		Sediment Control Works;		Curah Kobo'an Check Dam No. 6 K. Leprak Sand Pocket		Diversion Work	
		Tunnel	Open Channel Water Conveyance	Pumping Well ($0.5\ m^3/s/y$)	Pumping Well ($0.5\ m^3/s/y$)	Pumping Well ($1.0\ m^3/s/y$)	Pumping Well ($1.0\ m^3/s/y$)
		Hydroelectric Power Plant (Volume of Developed Water $3.5\ m^3/s/y$)	Hydroelectric Power Plant (Volume of Developed Water $3.5\ m^3/s/y$)	Hydroelectric Power Plant (Volume of Developed Water $4.0\ m^3/s/y$)	Hydroelectric Power Plant (Volume of Developed Water $4.0\ m^3/s/y$)	Hydroelectric Power Plant (Volume of Developed Water $4.5\ m^3/s/y$)	Hydroelectric Power Plant (Volume of Developed Water $4.5\ m^3/s/y$)
Economic Cost (10^6 Rp)	Debris Control	20,390.0	20,390.0	20,390.0	20,390.0	20,390.0	20,390.0
	Water conservation	23,832.0	14,482.0	25,416.3	16,064.0	26,998.0	17,646.0
	Total	44,222.0	34,872.0	45,806.0	36,454.0	47,388.0	38,036.0
Maintenance Cost (10^6 Rp/y)	Debris control	36.0	36.0	36.0	36.0	36.0	36.0
	Water conservation	155.4	99.4	718.4	662.4	1,282.0	1,226.0
	Total	233.0	135.4	754.4	698.4	1,318.0	1,262.0
I.R.R. (%)	Debris control	6.49	6.49	6.49	6.49	6.49	6.49
	Water conservation	10.41	16.19	9.56	14.61	8.65	12.97
	Total	8.58	10.78	8.11	10.18	7.63	9.55