- Assist in the formation of water users' groups during preconstruction stage and their performance during construction and O & M stages;

- Assist in the layout, construction and O & M of the tertiary irrigation service units; and

- Assist in the programming and monitoring of soil improvement scheme with particular reference to improved cultivation techniques, water management and supply of agricultural production inputs.

7.4.2 Staff Training

Under the Project, emphasis would be placed upon local on-the-job and in-service practical training in specific technical skills including the field of tidal regulator operation, irrigated agricultural extension services, on-farm irrigation development practices, problem soil improvement and organization of water users' groups which would be particularly directed towards the needs of staff of the Project implementing agencies.

The Project would also provide the overseas training in a total amount equivalent to about 30 man-months. Each individual study period would not exceed two months since the objective is not formal academic training but the mind broadening exposure to relevant activities in other countries and the rapid application of the expertise acquired to concentrate the maximum benefits on the Project. To improve management expertise, visits would be arranged to the on-going similar-natured projects with a proven record of success in neighbouring countries under the assistance of the consultants. The field of study and the nomination of personnel for the overseas training would be decided by the Central Board. The cost required for overseas training would be Ɓ8.1 x 10^6 as estimated in Chapter 8.

7.5 Project Implementation Schedule

The proposed construction/implementation programme and related scheduling for various Project components have been examined in sufficient detail in the previous chapters and relevant paragraphs. As a result, the proposed Project implementation schedule as a whole has been established on the basis of the Project year (Thai fiscal) as is specified in Figure 7-3. The Project year 1 would need to complete the external loan procedures between Thai Government and international financing agency and concurrently to establish the Special Task Force Unit which would pay a crucial role in achieving the agricultural development as envisaged in the Project on the planned schedule. At the second half of the Project year 1, the Project office would be built at the UTR site and a consultant team would be recruited to carry out the engineering and advisory services required to ensure the rapid and sound execution of the Project.

In the Project year 2, three demonstration farms would be provided in each of Amphoe Muang Narathiwat, Rangae and Tak Bai after formation of three water users' groups. With the progress of detailed design work for RID major work in the Stage I development including two tidal regulators and eight acidic water flow check facilities, the contracts for construction work of such facilities would be concluded between the selected contractors at the end of this year to start the site construction work in the beginning of February in the Project year 3.

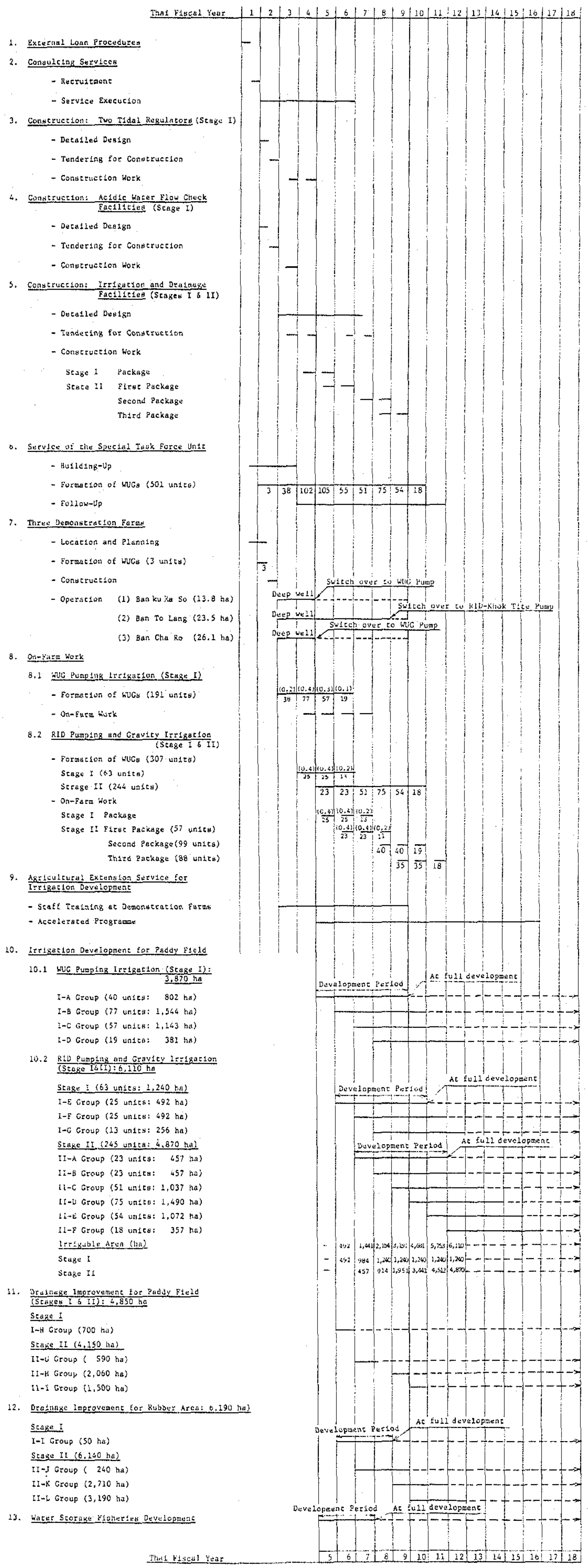
In the Project year 3, the Special Task Force Unit would devote himself to commence the demonstration operations at three farms with the first cultivation of irrigated wet-season paddy by using deep wells, to form the water users' groups in the Project, Stage I for ready irrigation immediately after completion of the Bang Nara water storage, and to make on-the-job training of extension workers for irrigated agriculture in the Stage I development. RID would be responsible for the construction of two tidal regulators during the Project years 3 and 4, while the acidic water flow checks at eight sites would be completed in the Project year 3 and subsequent training of the RID operators for those in addition to existing checks at nine sites would be promoted to achieve more refined operation procedures in the Project year 4.

As soon as the Bang Nara water storage with a strict control of the acidic water inflow is completed, the WUG irrigation development in the Project would be initiated in the Project year 5 for the first water users' groups which would have constructed their on-farm facilities in the Project year 4. The formation of water users' groups and subsequent construction of their on-farm works would be continued under the positive arrangements to be made by the Special Task Force Unit. It is scheduled that the last water users' groups out of 191 in total would construct their on-farm facilities in the Project year 7. The first water users' groups with a total number of 38 and a total irrigable area of 802 ha which would start the anticipated irrigated agricultural development in the Project year 5 would take a lead time or building-up period of about 5 years reaching the target crop production in view of good water control, accelerated extension services and adequate supplies of credit and inputs. It is assumed that while the projected yields of paddy and forage crops would be reached about 3 years after the start of irrigation, the target yields and production of dry-season field crops such as mungbeans, sweet corn and groundnuts, and vegetables would be obtained taking rather complicated process viz. gradual increase of the planted area and relevant yield during the five-year building-up period.

It is scheduled that construction of the RID major irrigation and drainage work in the Project would be commenced in line with the progress of detailed design, and its first package in Stage I would be constructed during the Project years 4 and 5 keeping a pace with the completion of two tidal regulators. In connection with the major work construction of the first package, 25 water users' groups covering an irrigable area of 492 ha would be properly organized to start the irrigation development with the anticipated lead time of 5 years to reach the target production that would be similar to that of the WUG pumping irrigation development.

The Project implementation schedule as proposed in Figure 7-3 explains that the construction of major work by RID would take 7 years from the Project year 3 to 9, and relevant on-farm work construction would be carried out during 8 years from the Project year 4 to 11 excluding that of three demonstration farms. The last water users' groups with a total of 18 units in the Project, Stage II which would be organized to construct their on-farm work in the Project year 11 and to start irrigation in the Project year 12 would reach the full production in the Project year 16.

Figure 7-3 Project Implementation Schedule



CHAPTER 8 COST ESTIMATE

8.1 Construction Cost

8.1.1 Basic Rates

The basic rate of labours, materials and construction equipment are given on the basis of prevailing rate in the Project site and Thailand.

(1) Labour Rate (Unit: ฿ per day)

Item	Rate	
Foreman	160	
Equipment Operator	120	
Operator Assistant	80	
Driver	80	
Steel Worker	90	
Concrete Worker	80	
Carpenter	100	
Mechanics	120	
Electrician	120	
Mason	100	
Common Labour	70	
Alien Expert	3,300	(Dredging Work)
Alien Expert Assistant	2,750	(-do-)

(2) Material Rate (Unit: ฿)

Item	Unit	Rate
Sand	cu.m	100
Gravel	cu.m	367
Riprap (UTR)	cu.m	300
Riprap (LTR)	cu.m	317
Laterite	cu.m	100
Reinforced Bar	ton	10,000

Item	Unit	Rate
Cement	Ton	2,000
Diesel Oil	ℓ	7.3
Electrical Charge	KWH	2.2
Steel Sheet Pile	Ton	15,000
Timber (Soft)	cu.m	6,500
Timber (Hard)	cu.m	8,500

(3) Hiring Rate of Equipment (Unit : ₿)

Item	Specification	Capital Cost (₿ x 10^3)	Hourly or Daily Rate
Bulldozer	15 ton, 150 P.S	1,800	640
Bulldozer	32 ton, 320 P.S	4,200	1,410
Backhoe	0.6 m^3, 108 P.S	2,000	610
Backhoe	1.2 m^3, 225 P.S	4,400	1,390
Tractor Shovel	1.8 m^3, 157 P.S	1,700	710
Dump Truck	8 ton, 242 P.S	650	220
Dump Truck	11 ton, 314 P.S	960	300
Motor Grader	3.1 m 110 P.S	1,240	450
Water Lorry	6 m^3 160 P.S	620	210
Tire Roller	10 - 20 ton 89 P.S	900	320
Drag line	1.2 m^3 170 P.S	6,500	1,770
Pile Driver	30 - 35 ton 105 P.S	5,300	1,880
Truck Mixer	3.2 m^3 220 P.S	740	270
Truck Crane	30 ton 185 P.S	4,400	1,070
Truck Crane	20 ton 175 P.S	2,900	700
Truck Crane	10 ton 175 P.S	1,600	430
Auto Concrete Plant	30 m^3/hr, 56 KW	3,400	1,060
Portable Concrete Mixer	0.3 m^3 11 KW	260	840/Day
Aggregate Scale		50	140/Day
Dredger	1,350 P.S	71,000	4,785/hr or 46,121/Day

Item	Specification	Capital Cost (฿ x 10^3)	Hourly or Daily Rate
Lift Boat	13 ton	1,300	668/Day or 172/H
Tug Boat	40 ton	6,000	6,654/Day
Barge	200 m^3	7,000	8,845฿/day

(4) Foreign and Local Currency Portion

Foreign and local currency portions for the basic rates are classified based on the prevailing percentage employed by the international financing agencies.

a. Labour Rate

Labour rate employed in Thailand is classified as the local currency, but alien expert and its assistant for the dredging work as the direct foreign currency.

b. Rate for Materials, Equipment and Other Work

The following percentage is used for the rate of materials, equipment and other works;

Item	Foreign Currency Portion	Local Currency Portion
Cement	60	40
Sand, Gravel & Riprap	0	100
Laterite	0	100
Reinforced Bar	70	30
Diesel Oil	80	20
Electrical Charge	0	100
Timber	20	80
Construction Equipment	100	0

Item	Foreign Currency Portion	Local Currency Portion
RC Pipe Work	65	35
Gate Work	70	30
Machinary Installation	70	30
Sheet Pile	100	-
Pump	100	-

Tax and duty for gates in the tidal regulators' work, pumps in the RID irrigation systems, electrical works etc. which are directly imported are included in the estimate based on the regulation in Thailand.

8.1.2 Unit Rates for Construction

Unit rates for construction are estimated based on the output of construction work and the basic rates for labours, materials and equipment. In addition, the overhead rate of 20 percent for UTR and LTR work to be carried out by the international contractor and 17 percent for other civil work on the local tender basis are also included.

(Unit: %)

	Item	International Contract Case	Local Contract Case
(1)	Profit	6.5	5.0
(2)	Administration	3.5	2.0
(3)	Tax	3.4	3.4
(4)	Cost reserved	4.1	4.1
(5)	Insurance	1.5	1.5
(6)	Overhead rate *	20	17

$$* \text{ Rate of Overhead} = \frac{\{1+(1)\} \times \{1+(2)\}}{\{1-(3)\} \times \{1-(4)\} \times \{1-(5)\}}$$

The summary of unit rates including overhead for the major work is shown in Table 8-1:

Table 8-1 Summary of Unit Rates

(Unit: ฿)

Description	Unit	Total	F.C	L.C	Remarks
1. <u>Tidal Regulator Work</u>					
Site Clearing	Ha	10,000	8,870	1,130	
Caldron Excavation	Cu.m	49	38	11	Backhoe & Bulldozer
Fill by Caldon Excavation	cu.m	44	34	10	Transport & Compaction
Conneciton Channel Excavation	cu.m	53	52	1	Dredger
-do-	cu.m	42	40	2	Dragline
Stripping at Road and Sapi Yo Site	cu.m	20	18	2	Bulldozer
Borrow Area Excava-tion	cu.m	21	19	2	Tractor Shovel
Embankment by Borrow	cu.m	46	41	5	Transport & Compaction
Stripping at Closure Dam	cu.m	53	52	1	Dredger
Embankment at Closure Dam	cu.m	53	52	1	Dredger
Riprap Pitching	cu.m	700	-	700	Hand
Riprap Dumping at Dam	cu.m	470	30	440	Barge
Riprap Dumping	cu.m	470	40	430	Bulldozer Pushing
Laterite Paving	cu.m	131	9	122	
RC Pile, 0.4x0.4x12m	P.C.S	11,400	7,400	4,000	
RC Pile, 0.4x0.4x6m	P.C.S	5,650	3,700	1,950	
Steel Sheet Pile	Ton	20,000	15,800	4,200	
Lean Concrete	cu.m	1,550	610	940	C = 280 kg
Reinforced concrete for Structure, 220 kg/cm^2	cu.m	4,700	1,662	3,038	C = 350 kg Bar=80kg/cu.m
Reinforced concrete for Apron, 180kg/cm^2	cu.m	4,100	1,473	2,627	C = 320kg, Bar=60kg/cu.m

Description	Unit	Total	F.C	L.C	Remarks
2. Other Civil Work					
Clearing	Ha.	10,000	8,870	1,130	
Access Road	km	80,000	72,000	8,000	
Excavation	cu.m	21	19	2	Backhoe
Disposal, 0.5 km	cu.m	16	15	1	
Backfill	cu.m	13	12	1	Transport & Compaction
Fill by Excavation	cu.m	24	20	4	Transport & Compaction
Fill by Excavation, 3 km	cu.m	48	43	5	Transport & Compaction
Fill from Borrow, 10 km	cu.m	87	79	8	Excavation, Transport & Compaction
Sand Bed	cu.m	140	-	140	
Riprap Pitching	cu.m	630	-	630	Hand
Riprap Grouted	cu.m	855	113	742	Bulldozer Pushing
RC Pile, 0.4x0.4x10m	P.C.S	10,250	6,791	3,459	
RC Pile, 0.4x0.4x22m	P.C.S	21,000	14,060	6,940	
RC Pile, 0.4x0.4x28m	P.C.S	26,000	17,394	8,606	
Lean Concrete	cu.m	1,570	573	997	C = 280kg
Plain Concrete	cu.m	2,650	573	2,077	C = 280kg
Lining Concrete	cu.m	1,800	721	1,079	C = 280kg
Reinforced Concrete, 220 kg/cm^2	cu.m	4,000	1,296	2,704	C = 320 kg, Bar = 70 kg
Reinforced Concrete, 180 kg/cm^2	cu.m	3,500	1,169	2,331	C = 350 kg, Bar = 60 kg
PC Pipe, 800 mm	m	2,400	1,560	840	
PC Pipe, 700 mm	m	2,270	1,475	795	
PC Pipe, 600 mm	m	1,870	1,215	655	
RC Pipe, ⌀1000mm	m	1,800	1,170	630	
RC Pipe, ⌀800 mm	m	1,300	845	455	
RC Pipe, ⌀600 mm	m	1,000	650	350	
RC Pipe, ⌀500 mm	m	800	520	280	
RC Pipe, ⌀450 mm	m	740	481	259	

Description	Unit	Total	F.C	L.C	Remarks
RC Pipe, ϕ300 mm	m	600	390	210	
RC Pipe, ϕ225 mm	m	440	286	154	
Radial Gate, 6.0x 4.5 m	set	460,000	322,000	138,000	
Slide Gate, 3.0x 2.9 m	set	160,000	112,000	48,000	
Slide Gate, 2.5 x 2.0 m	set	72,000	50,400	21,600	
Slide Gate, 2.3 x 0.8 m	set	29,000	20,300	8,700	
Slide Gate, 2.0 x 0.7 m	set	25,000	17,500	7,500	
Slide Gate, 1.7 x 0.6 m	set	17,000	11,900	5,100	
Slide Gate, 1.4 x 0.5 m	set	12,000	8,400	3,600	
Slide Gate, 1.1 x 0.4 m	set	9,000	6,300	2,700	
Slide Gate, 0.8 x 0.8 m	set	10,000	7,000	3,000	
Slide Gate, 0.8 x 0.3 m	set	6,000	4,200	1,800	
Slide Gate, 0.6 x 0.6 m	set	7,000	4,900	2,100	
Slide Gate, 0.4 x 0.4 m	set	4,000	2,800	1,200	

8.1.3 Summary of Construction Cost

Construction cost is estimated based on approximate quantities calculated on preliminary design level for the relevant facilities and the unit rates as shown in Table 8-1. Detail of the cost estimate is compiled in Tables X-1 to X-8 of Appendix X and summarized in Table 8-2.

Table 8-2 Construction Cost Summary

(Unit: ฿ x 10^6)

	L.C.	F. C.			Total	Refer to Appendix Table No.
		I.F.C.	D.F.C.	Total		
A. Major Work						
A.1. Tidal Regulators	117.92	78.31	162.10	240.41	358.33	
A.1.1 Upper Tidal Regulator	86,78	54,77	125.31	180.08	266.86	
1. Civil Work	56.72	50.79	21.14	71.93	128.65	X-1
1.1 Temporary Work	2.85	1.64	2.75	4.39	7.24	
1.2 Regulator Body and Connection Channel	40.66	39.28	18.39	57.67	98.33	
1.3 Sapi Yo Closure Dam	1.57	0.93	-	0.93	2.50	
1.4 Bang Nara Closure Dam	10.04	5.50	-	5.50	15.54	
1.5 Road	0.63	2.48	-	2.48	3.11	
1.6 O&M Facilities	0.97	0.96	-	0.96	1.93	
2. Gate Work	30.06	3.98	104.17	108.15	138.21	X-2
2.1 Manufacturing	-	-	93.72	93.72	93.72	
2.2 Transportation	0.34	0.80	4.49	5.29	5.63	
2.3 Installation	29.72	3.18	4.04	7.22	36.94	
2.4 O&M Equipment	-	-	1.92	1.92	1.92	
A.1.2 Lower Tidal Regulator	31.14	23.54	36.79	60.33	91.47	
1. Civil Work	21.77	21.95	5.41	27.36	49.13	X-1
1.1 Temporary Work	1.49	0.77	0.91	1.68	3.17	
1.2 Regulator Body and Connection Channel	16.16	16.69	4.50	21.19	37.35	
1.3 Bang Nara Closure Dam	2.13	1.22	-	1.22	3.35	
1.4 Road	0.96	2.57	-	2.57	3.53	
1.5 O&M Facilities	1.03	0.70	-	0.70	1.73	
2. Gate Work	9.37	1.59	31.38	32.97	42.34	X-2
2.1 Manufacturing	-	-	27.17	27.17	27.17	
2.2 Transportation	0.12	0.29	1.59	1.88	2.00	

	L.C.	F. C.			Total	Refer to Appendix Table No.
		I.F.C.	D.F.C.	Total		
2.3 Installation	9.25	1.30	1.45	2.75	12.00	
2.4 O&M Equipment	-	-	1.17	1.17	1.17	
A.2. Acidic Water Flow Check Facilities	8.41	7.42	-	7.42	15.83	X-3
A.2.1 Ku Bae Ya Hae	0.74	0.64	-	0.64	1.38	
A.2.2 Sg. Padi No.1	3.24	3.06	-	3.06	6.30	
A.2.3 Sg. Padi No. 2	3.24	3.06	-	3.06	6.30	
A.2.4 Bang Toei No. 2	0.19	0.08	-	0.08	0.27	
4.2.5 Bang Toei No. 3	0.19	0.08	-	0.08	0.27	
4.2.6 Bang Toei No. 4	0.19	0.08	-	0.08	0.27	
4.2.7 Bang Toei No. 5	0.19	0.08	-	0.08	0.27	
4.2.8 To Lang No. 2	0.43	0.34	-	0.34	0.77	
A.3. Irrigation and Drainage System	117.63	170.78	34.06	204.84	322.47	
A.3.1 Drainage Improvement	41.16	53.08	-	53.08	94.24	X-4
1. Ban Lo Mo	0.09	0.36	-	0.36	0.45	
2. Khlong Ku Ra Po	4.78	5.78	-	5.78	10.56	
3. Khlong Na Ko	3.21	4.42	-	4.42	7.63	
4. Khlong To Che	12.23	15.03	-	15.03	27.26	
5. Khlong Chang	18.49	24.36	-	24.36	42.85	
6. Ban Sala Pradu	0.10	0.27	-	0.27	0.37	
7. Khlong Sala Mai	2.26	2.86	-	2.86	5.12	
A.3.2 RID Pumping Irrigation	75.93	117.14	34.06	151.20	227.13	X-5
1. Pu Ta	3.18	2.77	2.08	4.85	8.03	
2. Khao Kong	6.78	11.97	3.12	15.09	21.87	
3. Du Song	12.03	18.11	4.86	22.97	35.00	
4. Tan Yong Mat	8.12	9.43	4.31	13.74	21.86	
5. Khok Ti Te	19.99	30.86	7.63	38.49	58.48	
6. Maru Bo	5.78	8.27	2.95	11.22	17.00	
7. Sala Mai	5.13	7.27	2.67	9.94	15.07	

	L.C.	F. C.			Total	Refer to Appendix Table No.
		I.F.C.	D.F.C.	Total		
8. Ko Sawat	5.74	10.96	1.77	12.73	18.47	
9. Phru Kap Daeng	4.88	7.98	2.68	10.66	15.54	
10. Ku Cham	4.30	9.52	1.99	11.51	15.81	
A.3.3 RID Gravity Irrigation	0.54	0.56	-	0.56	1.10	X-6
Sub-total (A)	243.96	256.51	196.16	452.67	696.63	
B. Demonstration Farms	0.80	1.00	-	1.00	1.80	X-7
B.1 Ban Ku Ra So (13.8ha)	0.23	0.32	-	0.32	0.55	
B.2 Ban To Lang (23.5ha)	0.17	0.25	-	0.25	0.42	
B.3 Ban Cha Ro (26.1 ha)	0.40	0.43	-	0.43	0.83	
C. WUG Pumps and On-Farm Work	39.10	24.31	-	24.31	63.41	X-8
C.1 WUG Pumping Irrigation	16.03	10.00	-	10.00	26.03	
C.2 On-Farm Work for RID Pumping and Gravity Irrigation	23.07	14.31	-	14.31	37.38	
Total Construction Cost (A to C)	283.86	281.82	196.16	477.98	761.84	

8.2 Project Cost

8.2.1 Associated Cost

In addition to the construction cost for civil work as mentioned in para. 8.1, the cost to be associated for the Project implementation including the components of land acquisition, consultants and overseas training, engineering and administration and equipment for O&M has been estimated in line with the Project implementation programme as proposed in Chapter 7. While detailed estimate of such cost is compiled in Tables X-9 to X-13 of Appendix X, a total cost by component is included in Table 8-3.

The engineering and administration cost includes that of the building, equipment, pre-engineering work and administration to be required for the Project implementation period. The building component would be composed of the Project office, residences, dormitory, garage and warehouse, and workshop to accommodate the officials of RID and Special Task Force Unit which would be located at the UTR site and be transferred to the O&M use after completion of the construction work. It is anticipated that such facilities would be built in the Project years 1 & 2.

The pre-engineering work would have such items as the mapping survey for 13,000 ha, profile and cross-section survey for canals, cadastral survey for on-farm work design and geological survey in the form of auger testing which would be needed for the detailed design of related facilities by RID. The equipment to be procured would include the vehicles such as station wagons, motorbicycles, pick-up trucks and flat bed trucks as well as those for survey and office use which would be used by RID and Special Task Force Unit in accordance with the manpower and work volume.

Additional administration cost to be incurred for the Project implementation has been estimated on the basis of staffing plan for

RID, Special Task Force Unit and DOAE, as is detailed in Table X-13 of Appendix X. The administration cost for the proposed accelerated extension service programme by DOAE has been extended to the Project year 16.

8.2.2 Project Cost

The base cost for the Project as a whole which includes the construction cost and its associated cost is compiled in Table 8-3 on the basis of price level at 1986-February term dividing into local cost, indirect foreign cost and direct foreign cost at Baht currency rate. The base cost contains various taxes and duties related to construction work and equipment procurement to be incurred in the Project. The physical contingency has been taken at 10 percent of the base cost. The price contingency has been given by the escalation factor of 3 percent per annum for both the local and foreign currencies taking into account the price/cost analysis of the Thai construction sector by RID as well as the recent stable price trend in the developed countries in view of the sharp fall in the price of crude oil, continued weak demand and falling prices for agricultural products.

Table 8-3 summaries the total Project cost by component which has been estimated at ฿1,206 million (or US$46 million) including the price contingencies of ฿171 million. The Project cost is classified into 42 percent of the local currency, 31 percent of the indirect foreign cost and 27 percent of the direct foreign cost. The above cost includes the contribution that farmers are expected to make in construction of the on-farm works and procurement of the WUG pumps. The Project cost by the Project year (Thai fiscal year) is also summarized in Table 8-4 during the Project years 1 to 16, which has been estimated in line with the Project implementation schedule as proposed in Table 7-3 of Chapter 7, while its detailed breakdown and supporting data by item and component are available in Tables X-14 to X-16 of Appendix X.

Table 8-3 Project Cost Summary

(Unit ฿ x 10^6)

	L.C.	F.C.			Total	Appendix Table No.
		I.F.C.	D.F.C.	Total		
A. Major Work						
A.1. Tidal Regulators	117.92	78.31	162.10	240.41	358.33	X-1&X-2
A.2. Acidic Water Flow Check Facilities	8.41	7.42	-	7.42	15.83	X-3
A.3. Irrigation and Drainage System	117.63	170.78	34.06	204.84	322.47	
A.3.1. Drainage Improvement	41.16	53.08	-	53.08	94.24	X-4
A.3.2. RID Pumping Irrigation	75.93	117.14	34.06	151.20	227.13	X-5
A.3.3. RID Gravity Irrigation	0.54	0.56	-	0.56	1.10	X-6
Sub-Total (A)	243.96	256.51	196.16	452.67	696.63	
B. Demonstration Farms	0.80	1.00	-	1.00	1.80	X-7
C. WUG Pumps and On-Farm Work	39.10	24.31	-	24.31	63.41	X-8
D. O & M Equipment	1.03	0.32	7.65	7.97	9.00	X-9
E. Land Acquisition	20.99	-	-	-	20.99	X-10
E.1. Tidal Regulators	3.50	-	-	-	3.50	
1. Upper Tidal Regulator	2.50	-	-	-	2.50	
2. Lower Tidal Regulator	1.00	-	-	-	1.00	
E.2. Acidic Flow Check Facilities	-	-	-	-	-	
E.3. Irrigation and Drainage Systems	17.49	-	-	-	17.49	
1. Drainage Improvement	6.47	-	-	-	6.47	
2. RID Pumping Irrigation	10.92	-	-	-	10.92	
3. RID Gravity Irrigation	0.10	-	-	-	0.10	
E.4. Demonstration Farms	-	-	-	-	-	

	L.C.	F.C.			Total	Appendix Table No.
		I.F.C.	D.F.C.	Total		
F. Consultants and Training	23.76	-	52.34	52.34	76.10	
F.1. Consulting Services	23.61	-	44.39	44.39	68.00	X-11
F.2. Overseas Training	0.15	-	7.95	7.95	8.10	X-12
G. Engineering and Administration	64.54	2.65	5.91	8.56	73.10	X-13
G.1. Building	7.95	2.65	-	2.65	10.60	
G.2. Equipment	1.04	-	5.91	5.91	6.95	
G.3. Pre-Engineering Work	2.99	-	-	-	2.99	
G.4. Administration	52.56	-	-	-	52.56	
Base Cost (A. to G.)	394.17	284.80	262.06	546.86	941.03	
H. Physical Contingencies (10%)	39.43	28.49	26.20	54.69	94.12	
Sub-Total (A. to H.)	433.60	313.29	288.26	601.55	1,035.15	
I. Price Contingencies (3% p.a.)	76.35	59.11	35.75	94.86	171.21	
Total Cost (A. to I.)	509.95	372.40	324.01	696.41	1,206.36	

Table 8-4 Project Cost Summary by Fiscal Year

(Unit: ฿x10^6)

Thai Fiscal Year / Cost Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
A. Major Work	-	-	224.96	165.83	58.47	36.09	62.61	105.54	43.03	-	-	-	-	-	-	-	696.63
A.1. Tidal Regulators	-	-	209.13	149.20	-	-	-	-	-	-	-	-	-	-	-	-	358.33
A.2. Acidic Water Flow Checks	-	-	15.83	-	-	-	-	-	-	-	-	-	-	-	-	-	15.83
A.3. Irrigation and Drainage	-	-	-	16.63	58.47	36.09	62.61	105.54	43.03	-	-	-	-	-	-	-	322.47
B. Demonstration Farms	-	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.80
C. WUG Pumps and On-Farm Work	-	-	-	5.18	13.52	13.59	6.94	6.12	9.19	6.73	2.14	-	-	-	-	-	63.41
C.1. WUG Pumps	-	-	-	5.18	10.49	7.77	2.59	-	-	-	-	-	-	-	-	-	26.03
C.2. RID Pumps and Gravity	-	-	-	-	3.03	5.82	4.35	6.12	9.19	6.73	2.14	-	-	-	-	-	37.38
Sub-total (A+B+C)	-	1.80	224.96	171.01	71.99	49.68	69.55	111.66	52.22	6.73	2.14	-	-	-	-	-	761.84
D. O&M Equipment	-	-	-	-	3.49	-	4.52	0.61	0.38	-	-	-	-	-	-	-	9.00
E. Land Acquisition	-	3.50	3.10	2.97	-	6.63	4.79	-	-	-	-	-	-	-	-	-	20.99
F. Consultants and Training	-	23.52	19.32	19.15	7.54	6.57	-	-	-	-	-	-	-	-	-	-	76.10
G. Engineering and Administration	5.52	9.08	7.74	6.20	7.20	6.73	7.34	7.46	6.19	4.16	3.24	0.91	0.63	0.35	0.21	0.14	73.10
Base cost (X)	5.52	37.90	255.12	199.33	90.32	69.61	86.20	119.73	58.79	10.89	5.38	0.91	0.63	0.35	0.21	0.14	941.03
H. Physical contingencies (10%)	0.55	3.79	25.51	19.93	9.04	6.96	8.63	11.98	5.88	1.09	0.54	0.09	0.06	0.04	0.02	0.01	94.12
Total Cost (X+H=Y)	6.07	41.69	280.63	219.26	99.36	76.57	94.83	131.71	64.67	11.98	5.92	1.00	0.69	0.39	0.23	0.15	1,035.15
I. Price Contingencies (3%, p.a.)	0.18	2.54	26.09	27.51	15.82	14.85	21.80	35.14	19.72	4.12	2.27	0.43	0.32	0.20	0.13	0.09	171.21
Total Project Cost (Y+I)	6.25	44.23	306.72	246.77	115.18	91.42	116.63	166.85	84.39	16.10	8.19	1.43	1.01	0.59	0.36	0.24	1,206.36

8.3 Project Cost for Stage I Development

As is explained in para. 4.1.3. of Chapter 4, it has been envisaged that the proposed Project would be implemented in two stages within the RID's responsibility. The Stage I development would involve (1) the construction of two tidal regulators such as UTR and LTR to be supplemented with that of acidic water flow check facilities at 8 sites which would complete the Bang Nara fresh water storage and (2) the construction of major work relevant to RID pumping irrigation schemes at Pu Ta, Sala Mai and Ko Sawat and drainage improvement schemes at Ban Lo Mo, Ban Sala Pradu and Khlong Sala Mai which are located in the relatively low-lying areas. With this Stage I development, 3,870 ha of existing paddy field below about EL + 2m which is distributed on the fringes of the Bang Nara water storage would be irrigated by the WUG's portable pumps and on-farm work; on the other hand, three RID pumping irrigation schemes would bring 1,240 ha of existing paddy field into irrigation through the provision of WUG's on-farm work.

Tables X-15 and X-16 of Appendix X indicate the construction cost of RID irrigation and drainage system and WUG pumps and on-farm work which would be required for the Stage I development. The cost for other items such as O&M equipment, consultants and training and engineering and administration required for the Stage I development has been calculated on the basis of a construction cost ratio (0.6) occupied in the Stage I within that of the total Project. The Project cost to be required for the Stage I development is summarized by component in Table 8-5. The total Project cost has been estimated at ฿687 million (US$26 million) with the breakdown of ฿278 million (41 percent) for local currency, ฿155 million (22 percent) for indirect foreign cost and ฿254 million (37 percent) for direct foreign cost. In addition, the Stage I Project cost by Thai fiscal year during the Project years 1 to 12 is also summarized in Table 8-6.

Table 8-5 Project Cost Summary by Staging

(Unit : ฿x10^6)

Cost Item	Total				Stage I				Stage II			
	L.C.	I.F.C.	D.F.C.	Total	L.C.	I.F.C.	D.F.C.	Total	L.C.	I.F.C.	D.F.C.	Total
A. Major Work	243.96	256.51	196.16	696.63	142.83	110.22	168.62	421.67	101.13	146.29	27.54	274.96
A.1. Tidal Regulators	117.92	78.31	162.10	358.33	117.92	78.31	162.10	358.33	-	-	-	-
A.2. Acidic Water Flow Checks	8.41	7.42	-	15.83	8.41	7.42	-	15.83	-	-	-	-
A.3. Irrigation and Drainage	117.63	170.78	34.06	322.47	16.50	24.49	6.52	47.51	101.13	146.29	27.54	274.96
B. Demonstration Farms	0.80	1.00	-	1.80	0.80	1.00	-	1.80	-	-	-	-
C. WUG Pumps and On-Farm Work	39.09	24.32	-	63.41	20.72	12.92	-	33.64	18.37	11.40	-	29.77
C.1. WUG Pumps	16.02	10.01	-	26.03	16.02	10.01	-	26.03	-	-	-	-
C.2. RID Pumps and Gravity	23.07	14.31	-	37.38	4.70	2.91	-	7.61	18.37	11.40	-	29.77
Sub-total (A+B+C)	283.85	281.83	196.16	761.84	164.35	124.14	168.62	457.11	119.50	157.69	27.54	304.73
D. O & M Equipment	1.03	0.32	7.65	9.00	0.61	0.18	4.59	5.38	0.42	0.14	3.06	3.62
E. Land Acquisition	20.99	-	-	20.99	6.60	-	-	6.60	14.39	-	-	14.39
F. Consultants and Training	23.76	-	52.34	76.10	14.25	-	31.40	45.65	9.51	-	20.94	30.45
G. Engineering and Administration	64.54	2.65	5.91	73.10	37.93	1.56	3.55	43.04	26.61	1.09	2.36	30.06
Base Cost (X)	394.17	284.80	262.06	941.03	223.74	125.88	208.16	557.78	170.43	158.92	53.90	383.25
H. Physical Contingencies (10%)	39.43	28.49	26.20	94.12	22.38	12.58	20.82	55.78	17.05	15.91	5.38	38.34
Total Cost (X+H=Y)	433.60	313.29	288.26	1,035.15	246.12	138.46	228.98	613.56	187.48	174.83	59.28	421.59
I. Price Contingencies (3% p.a.)	76.35	59.11	35.75	171.21	32.40	16.18	25.17	73.75	43.95	42.93	10.58	97.46
Total Project Cost (Y+I)	509.95	372.40	324.01	1,206.36	278.52	154.64	254.15	687.31	231.43	217.76	69.86	519.05

Table 8-6 Project Cost Summary by Fiscal Year for Stage I Development

(Unit : ฿x10^6)

Thai Fiscal Year / Cost Item	1	2	3	4	5	6	7	8	9	10	11	12	Total
A. Major Work	-	-	224.96	165.83	30.88	-	-	-	-	-	-	-	421.67
A.1. Tidal Regulators	-	-	209.13	149.20	-	-	-	-	-	-	-	-	358.33
A.2. Acidic Water Flow Checks	-	-	15.83	-	-	-	-	-	-	-	-	-	15.83
A.3. Irrigation and Drainage	-	-	-	16.63	30.88	-	-	-	-	-	-	-	47.51
B. Demonstration Farms	-	1.80	-	-	-	-	-	-	-	-	-	-	1.80
C. WUG Pumps and On-Farm Work	-	-	-	5.18	13.52	10.80	4.14	-	-	-	-	-	33.64
C.1. WUG Pumps	-	-	-	5.18	10.49	7.77	2.59	-	-	-	-	-	26.03
C.2. RID Pumps and Gravity	-	-	-	-	3.03	3.03	1.55	-	-	-	-	-	7.61
Sub-total (A+B+C)	-	1.80	224.96	171.01	44.40	10.80	4.14	-	-	-	-	-	457.11
D. O & M Equipment	-	-	-	-	2.09	-	2.71	0.36	0.22	-	-	-	5.38
E. Land Acquisition	-	3.50	3.10	-	-	-	-	-	-	-	-	-	6.60
F. Consultants and Training	-	14.11	11.59	11.49	4.52	3.94	-	-	-	-	-	-	45.65
G. Engineering and Administration	3.31	5.46	4.64	3.72	4.32	4.03	4.40	4.47	3.71	2.49	1.94	0.55	43.04
Base Cost (X)	3.31	24.87	244.29	186.22	55.33	18.77	11.25	4.83	3.93	2.49	1.94	0.55	557.78
H. Physical Contingencies (10%)	0.33	2.48	24.43	18.62	5.53	1.88	1.13	0.49	0.39	0.25	0.19	0.06	55.78
Total Cost (X+H=Y)	3.64	27.35	268.72	204.84	60.86	20.65	12.38	5.32	4.32	2.74	2.13	0.61	613.56
I. Price Contingencies (3% p.a.)	0.11	1.66	24.99	25.70	9.68	4.00	2.85	1.42	1.32	0.94	0.82	0.26	73.75
Total Project Cost (Y+I)	3.75	29.01	293.71	230.54	70.54	24.65	15.23	6.74	5.64	3.68	2.95	0.87	687.31

8.4 Operation and Maintenance Cost

8.4.1 Operation and Maintenance Cost for Total Project

The O&M equipment including the vehicles for RID staff and those for routine repair works would be procured in the Project years 5, 7, 8 and 9 and has been included as part of the Project cost in Table 8-3. Annual cost for O&M at full development of the Project to be borne by RID which deals with the three tidal regulators, acidic water inflow check structures and irrigation and drainage systems as well as the operation of Bang Nara water storage, has been estimated as follows:

		(Unit: ฿x10^3)
(1)	Salaries and Wages	4,130
(2)	Equipment: Fuel and Repair	1,774
(3)	Material Supplies	1,373
(4)	RID Pump Electricity	2,296
(5)	General Expenditure	287
	Total	9,860

(฿978 per ha for a total irrigable area of 9,980 ha)

Detailed breakdown of the above annual cost by component at full development as well as such cost by fiscal year during the irrigation development period of the Project years 5 to 16 which would correspond to the expansion of an irrigable area, are explained in Table X-17 of Appendix X.

Table X-17 of Appendix X also explains the motive power cost for the operation of the WUG pumps in terms of gasoline and for that of the RID pumps in terms of electricity.

8.4.2 Operation and Maintenance Cost for Stage I Development

Annual cost for O&M at full development of the Project, Stage I to be borne by RID has been estimated as follows:

		(Unit: ฿x10^3)
(1)	Salaries and Wages	1,627
(2)	Equipment: Fuel and Repair	643
(3)	Material Supplies	548
(4)	RID Pump Electricity	360
(5)	General Expenditure	95
	Total	3,274

(฿641 per ha for a total irrigable area of 5,110 ha)

Detailed breakdown of the above cost as well as the cost by fiscal year during the development period of the Project years 5 to 13 are shown in Table X-17 of Appendix X.

CHAPTER 9 PROJECT EVALUATION

9.1 General

The proposed Project has been contemplated toward improving the living standard of the population in its Southernmost Changwat of Narathiwat, to which a greater attention has recently been accorded in the national development effort. The Project is anticipated to contribute specifically to the Bang Nara river basin development through flood mitigation and water quality improvement in Mae Nam Bang Nara and provision of irrigated modern agriculture. These objectives are to be achieved through construction of the tidal regulator in each of the upper and lower reaches of the river and the irrigation and drainage facilities for existing paddy field and rubber planted area where the net cultivated area to be served would be 10,500 ha of paddy area with cropping intensity of 125 percent and 6,250 ha of rubber area.

Project evaluation has been undertaken in a standard manner, i.e., from economic, financial, and socio-economic viewpoints. The criteria employed to evaluate the economic performance of the Project are the economic internal rate of return (EIRR) and the net present value(NPV) at a discount rate of 8 percent and 10 percent. Sensitivity analysis has also been undertaken in order to assess the effect of change in the basic economic parameters on the economic performance of the Project and thus to provide some indication for the Project implementation and development. Financial evaluation has been made through the analysis of farm budget and cost recovery index. Finally, relevance of the Project has also been investigated through consideration of probable socio-economic impacts of the Project implementation on its farmers and environment.

9.2 Methodology

The economic evaluation of the Project is undertaken essentially to provide a basis for assessment of its contribution to an objective of the national development relative to the use of scarce resources employed. This is basically done by a comparison of quantifiable monetary benefits and costs of the situation with and without the project implementation.

Market prices with which these benefits and costs are estimated would not be considered to reflect the real or efficiency value of goods and services to the country because of the various tariff and non-tariff restrictions in trade as well as the distorted factors of production in the domestic market. To redress these price distortions, adjustment has been made to enable comparison of the traded/tradable components valued at border prices with the non-traded/non-tradable components initially valued at domestic prices and adjusted by various conversion factors.

9.3 Economic Analysis

9.3.1 General Parameters

The following are the general parameters with which the Project benefits and costs have been estimated:

(1) Standard Conversion Factor and Other Factors

The World Bank estimate in 1980 of 0.92 has been employed as standard conversion factor, and other specific conversion factors are also quoted from the World Bank estimate. (Source: Shadow Prices for Economic Appraisal of Projects in Thailand, March, 1982)

(2) Exchange Rates

As of the early 1986, the exchange rate of the Thai Baht to the US Dollar averages 26.3. Conversion of the border prices is based on these rates.

(3) Price Basis

The economic evaluation has been attempted using the 1986 constant prices.

(4) Project Life

The project life has been considered to be 50 years assuming that the major construction components would have a durable life of the corresponding period given the sufficient operation and maintenance of the components.

9.3.2 Benefit Parameters

Project benefit comprises incremental net production value in agriculture and fisheries. The following describe the estimation procedures of the Project input and output prices:

(1) Output Prices

For estimation of the financial prices of the internationally traded/tradable farm products, the world market prices have been quoted from June 1985 World Bank Commodity Forecasts for 1995 prices expressed in 1983 constant US Dollar. These have been adjusted using MUV index at the relevant exchange rate to arrive at the 1986 price. Farmgate prices have been estimated by considering the various cost components between the border (Bangkok or Songkhla) and the Project area such as transport, handling and storage, processing, tax, and margins. Economic farmgate prices have been derived by excluding various transfer payments and adjusting domestic financial costs by relevant conversion factors.

The financial prices of domestically traded outputs are determined on the basis of Agricultural Commodity Statistics (MOAC) and the field survey. Economic farmgate prices of these outputs are estimated on the same principle as the internationally traded commodities, being on average 4 percent higher than the financial prices. Economic price of fish has also been estimated by applying the distortion factor of 4 percent to the financial prices obtained in the field survey.

(2) Input Prices

Economic pricing of the input materials, both traded and non-traded, has been done basically on the same principle as the output prices. Financial price of seed commercially produced is estimated using the local retail market prices as prepared by DOAE and has been converted by economic/financial price ratio of its output to arrive at its economic price. Fertilizers are all internationally traded/tradable inputs and thus are priced in the same manner as the internationally traded output. The economic price of agro-chemical and lime dust is estimated by applying the economic/financial price ratio of three fertilizers combined to the financial price obtained from DOAE or the local market.

(3) Economic Cost of Farm Labor

During the wet season, farm labor requirement in paddy production is generally met by the family labor force drawing even the females, children and old people. Hired laborers, though limited, are reportedly required during the harvesting period at the imputed rate ranging from ฿40 to 65 per man-day (share cropping is common) or about ฿50 on average.

Labor requirement in the rubber tapping and its sheet processing since early morning till almost noon exists for about 10 months from mid-April to mid-February and the hired labor in the tapping constitutes about one third of the total labor demand and the sheet processing also requires the female labor as well. The imputed wage rate on the basis of 50 percent share cropping is estimated at about ฿60-70 per man-day. In the afternoon, the local farmers also have to attend to the vegetable and fruit gardens as well as the livestock. The combined wet season wage rate thus would be assumed at around ฿60.

Farm work becomes scarce and the demand for farm labor declines especially in post planting and harvesting period or December and April, respectively. Thus, the daily wage would fall at most by 20 percent or so to an average ฿50. In the Project area, the seasonality of labor demand in paddy production is considerably offset by the relatively constant labor demand in rubber tapping and sheet processing and by other off-farm employment opportunities. The problem of unemployment and underemployment in the Project area is thus rather limited during the wet season and possibly moderate during the dry season. Though the hired labor requirement in the paddy production is rather limited in extent, it constitutes a considerable part in the rubber tapping, with its wage generally offsetting the minimum wage rate of ฿60 in 1986.

The preceding suggests that the labor market in both the wet and dry seasons is functioning rather well and competitive, which implies the close proximity of the present market wage rate to the economic rate. Under the with-Project situation, with introduction of dry season crops, the current moderate unemployment in the dry season would be almost eliminated and the dry season wage rate would increase closer to the wet season rate, from ฿50 per man-day to ฿60 per man-day. Thus, the adjusted conversion factor for (hired) farm labor is 1.00 x 0.92 (SCF) for both the wet and the dry seasons With the Project, or the economic wage rate of ฿55 and ฿46, respectively.

9.3.3 Cost Parameters

The Project cost largely consists of capital cost, operation & maintenance cost, and replacement cost. Residual value of facilities and equipment at the end of Project life has been ignored due to its negligible nature.

(1) Capital Cost

The Project capital cost is constituted by (1) construction cost of two tidal regulators, (2) construction cost of acidic water flow checks, (3) construction cost of irrigation and drainage facilities, (4) cost of establishing three demonstration farms, (5) cost of pumping facilities and on-farm work, (6) cost of O&M equipment, (7) cost of land acquisition, (8) cost of consulting services and staff training, (9) cost of engineering and administration,(10) physical and price contingencies. These costs are initially estimated using financial prices and have been broken down into the foreign and local cost components in order to derive the economic capital cost.

While the economic foreign cost components would be evaluated at the border price at the conversion factor of 1.00, the local cost components which are largely divided into transfer payment, unskilled labor and others would be converted into the economic cost by eliminating from the local cost portion the transfer element such as tax and duties and by applying specific conversion factor to the unskilled labor and standard conversion factor to the other cost items. These adjustments are undertaken for the major project components. The construction conversion factors for major components are estimated in Table XI-1-17 in Appendix XI. and the conversion factor for unskilled construction labor has been estimated in the following manner:

(2) Economic Opportunity Cost of Unskilled Construction Labor

The unskilled labor market in the Project area becomes relatively competitive in the dry season when there are alternative employment opportunities available. This implies that the economic opportunity cost of unskilled construction labor, which is readily available in the dry season, would most likely be equal to that of the hired farm labor during the dry season. Thus, given the average market wage rate of ₿60 per man-day for unskilled construction labor, the pertinent conversion factor is taken as ₿50/₿60 x 0.92 = 0.77.

(3) Summary of Capital Cost

Capital cost of the Project is summarized below:

(Unit: ₿ x 10^6)

Capital Cost Item	Financial Cost	CF	Economic Cost
A. Major Work			
A.1 Tidal Regulators	358.33	0.87	311.75
A.2 Acidic Water Flow Checks	15.83	0.92	14.56
A.3 Irrigation and Drainage	322.47	0.93	299.90
B. Demonstration Farms	1.80	0.93	1.67
C. WUG Pumps and On-Farm Work			
C.1 WUG Pumps	26.03	0.92	23.95
C.2 RID Pumps and Gravity	37.38	0.92	34.39
D. O & M Equipment	9.00	0.90	8.10
E. Land Acquisition	20.99	0.92	19.31
F. Consultants and Training	76.10	0.92	70.01
G. Engineering and Administration	73.10	0.92	67.25
Base Cost	941.03	-	850.89
H. Physical Contingencies(10%)	94.12	-	85.09
I. Price Contingencies(3%)	171.21	-	-
Total	1,206.36		935.98

(4) O & M and Replacement Cost

The recurrent operation and maintenance cost covers salaries and wages for project personnel, equipment, material supplies, pump electricity, etc. These should be converted into economic cost using the specific conversion factors for each component as in the capital cost. For the Project evaluation, however, the financial cost is applied, primarily because of its minor importance relative to the capital cost.

Summary of annual O & M cost at full development period is as follows.

(Unit: ฿ x 10^3)

O & M Cost Item	Financial Cost
(A) By RID	
1. Salaries & Wages	4,130
2. Equipment (Fuel & Repair)	1,774
3. Material Supplies	1,373
4. Pump Electricity	2,296
5. General Expenditures	287
Sub-Total	9,860
(B) By WUG	
1. Repair	125
2. Gasoline	532
Sub-Total	657
Total	10,517

The equipment and facilities to be replaced during the Project life period comprise RID pumps and WUG Pumps. The replacement cost of these items should also converted into economic one, but again the financial cost is used for evaluation for the same reason and summarized below.

Replacement Cost Item	Useful Life (Year)	Financial Cost (Million ฿)
RID Pumps	25	37.94
WUG Pumps	10	2.50

(5) Project Cost Flow

On the basis of the proposed construction plan, annual stream of the economic Project cost for the original case is as follows:

Year	Capital Cost (%)		O & M Cost (%)	
	Stage I	Stages I + II	Stage I	Stages I + II
1st	0.5	0.6	0	0
2nd	4.1	4.0	0	0
3rd	42.7	27.1	0	0
4th	33.1	21.2	0	0
5th	9.8	9.6	23.7	22.1
6th	3.7	7.4	49.1	29.6
7th	2.7	9.2	36.5	37.8
8th	1.5	12.7	68.2	52.0
9th	0.8	6.2	79.4	63.0
10th	0.5	1.2	89.6	65.3
11th	0.4	0.6	96.7	84.1
12th	0.2	0.1	99.7	93.6
13th	0.0	0.1	100.0	98.2
14th	.	0.1	.	99.3
15th	.	0.1	.	99.7
16th	.	0.1	.	100.0
17th	.	0.0	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
50th	0.0	0.0	100.0	100.0

9.3.4 Project Benefit

(1) Estimation of Benefit

The Project benefit is measured by the incremental net production value as occasioned by the project implementation. The incremental net production value as expressed in economic terms is the difference of the annual gross production value net of production cost between the with-and the without-Project conditions in the future. Benefit categories considered are net agricultural income from paddy, rubber, and other upland and fruit tree crop as well as from freshwater fisheries in the Bang Nara water storage. The incremental net production benefit is summarized as in the following page.

(2) Development of Benefit Accrual

The gestation period between the completion of on-farm work and the full benefit accrual for each group is estimated at five years for paddy, upland crops, fruit, and fisheries and at three years for rubber. The incremental benefit develops in the following proportion:

(Year)	1	2	3	4	5
Paddy, Upland Crops Fruit, Fisheries	0.50	0.80	0.90	0.95	1.00
Rubber	0.80	0.90	1.00		

According to the proposed Project implementation schedule, the construction of two tidal regulators would be undertaken in the Project years 3 and 4 and the concomittant formation of WUGs and on-farm work in the WUG pumping irrigation scheme would start in the Project years 4 and 5, respectively and would be completed in a staged manner for 4 groups in five years each. Formation of the WUGs and on-farm work in the part of RID pumping and gravity irrigation scheme would similarly be commenced in the Project years 4 and 5 and would be completed for the initial 3 groups in five years each. Thus, the benefit from the Stage I construction would accrue initially in the Project year 5 and reach the full development stage in the Project year 12.

Project Benefit (Economic)

Description	Planted Area (ha)	Yield (t/ha)	Price (฿/ton)	G.P.V. (฿/ha)	Production cost (฿/ha)	N.P.V. (฿/ha)	N.P.V. (000฿)
1. Without Project							
Paddy, Local, Indigenous	5,767	1.3	4,317	5,612	3,941	1,671	9,637
Paddy, Local, Improved	1,605	1.7	4,317	7,339	4,604	2,735	4,390
Rubber	6,250	0.71	25,891	18,383	11,464	6,919	43,244
						(Total)	57,271
2. With Project							
Paddy, Local, Improved	3,370	2.8	4,317	12,088	5,662	6,426	21,656
Paddy, HYV, RD13	4,810	3.4	4,585	15,589	6,274	9,315	44,805
Paddy, HYV, RD7	1,600	3.7	4,585	16,965	6,796	10,169	16,270
Paddy, Local, Improved (no irrigation)	354	1.7	4,317	7,339	4,604	2,735	968
Rubber (Drainage Improved)	6,250	0.96	25,891	24,855	15,301	9,554	59,713
Sweet Corn	620	3.0	2,447	7,341	4,704	2,637	1,635
Mungbean	620	1.2	7,744	9,293	5,336	3,957	2,453
Groundnut	620	1.8	7,835	14,103	9,031	5,072	3,145
Vegetables/*	620	-	-	-	-	-	37,375
(Tomato)	(310)	(15.0)	(8,012)	(120,180)	(24,317)	(95,863)	(29,718)
(Chili)	(310)	(12.0)	(4,228)	(50,736)	(26,037)	(24,699)	(7,657)
Longkong	60	4.0	46,000	184,000	29,429	154,571	9,274
Forage	200	40.0	195	7,800	2,522	5,278	1,056
Aquaculture	1,390	0.15	18,000	2,700	988	1,712	2,380
						(Total)	200,730
3. Incremental Benefit							143,459

/* --- including others such as white cabbage, Chinese cabbage, green cabbage, Chinese kale, stringbean, cucumber, long eggplant, and so on, for which tomato and chili have been selected as representatives for the Project evaluation.

On the other hand, the construction of irrigation and drainage facilities in the remaining RID-operated scheme (Stage II) and would start in the Project year 5 and end in the Project year 9, while the formation of WUGs and on-farm work would equally start in the Project years 5 and 6 each and would take 5 years for the remaining 6 groups. The benefit from the Stage II development would thus accrue initially in the Project year 7 and reach the full development stage in the Project year 16. As a whole, combining the benefit accrual from these two areas, the Project benefit would increase in the following manner.

Year	Crop Benefit(%)		Fisheries Benefit(%)
	Stage I	Stages I + II	
1st - 4th	0	0	0
5th	5	4	50
6th	23	14	80
7th	45	27	90
8th	60	39	95
9th	80	53	100
10th	92	71	.
11th	97	85	.
12th	99	94	.
13th	100	97	.
14th	.	99	.
15th	.	99	.
16th	.	100	.
.	.	.	.
.	.	.	.
50th	100	100	100

9.3.5 Economic Internal Rate of Return (EIRR)

On the basis of the Project benefit and cost stream estimated as above, the economic internal rate of return for the original case has been calculated at 8.4 percent for the Stage I development only and at 10.3 percent for the Project as a whole including those of both the Stages I and II. The EIRR thus calculated would not be so high; however, in view of the Government concern for development of the Project area which is one of the most depressed and sensitive border areas, the Project economic feasibility would be justifiable for the country as a whole. The net present value at the discount rate of 8 percent and 10 percent for the case of Stages I and II would be ฿214.7 x 10^6 and ฿19.1 x 10^6, respectively.

9.3.6 Sensitivity Analysis

The sensitivity analysis for the entire Project has been made for the following cases:

Case 1: 10 percent Project cost overrun which reflects changes in the material and equipment cost as well as increase in the physical contingencies.

Case 2: 10 percent Project benefit decrease due to depressed crop yield.

Case 3: Two year delay in benefit accrual period at each stage of development due to insufficient production incentive, technical and organizational difficulty in water supply and extension services.

Case 4: Two year delay in the construction of Stage II area due to administrative or financial constraints.

Case 5: Combination of Case 1 and Case 2.

Case 6: Combination of Case 1, Case 2, and Case 3.

Case 7: Combination of Case 1 to Case 4.

Case 8: 36 percent decline in the world market price of paddy.

Case 9: Extension of the Project development period from five years to ten years for the Stage I and to eight years for the Stage II.

The results of sensitivity analysis is presented below.

Case	EIRR (%)	NPV (Million ฿) 8%	10%
Case 1	9.5	150.7	-39.6
Case 2	9.0	85.7	-72.1
Case 3	9.4	138.5	-44.2
Case 4	10.0	177.5	-2.8
Case 5	8.2	21.7	-130.8
Case 6	7.6	-45.2	-186.5
Case 7	7.4	-64.6	-192.1
Case 8	7.5	-46.1	-166.4
Case 9	9.5	141.5	- 41.0

The results indicate that the Project would be more sensitive to the benefit side and less sensitive to the cost side. Unless there is a significant decline in these parameters combined, the sensitivity analysis shows that the Project feasibility would be sustained against possible changes in the parameters.

9.4 Financial Analysis

The financial feasibility of the Project has been investigated on the basis of farm budget analysis and cost recovery index.

9.4.1 Farm Budget Analysis

The farm budget has been analyzed for two model farm types, i.e., sole paddy farm and mixed rubber/paddy farm with three different farm sizes, i.e., small, medium, and large. Another typical farm type in the Project area, i.e., sole rubber farm has been excluded because the Project benefit is expected primarily for the paddy producers. The size of typical farms is determined on the basis of the farm economic survey.

The Project implementation would, in general, increase the per capita net income by 1.6 to 2.5 times from ฿3,700 - ฿5,300 to about ฿6,200 - ฿9,700 in the 1986 constant price level as follows (for details, see Tables XI-2-1 and X-2-2 of Appendix XI):

(Unit: ฿)

Per Capita Income(Baht)	Paddy Farm Small	Paddy Farm Medium	Paddy Farm Large	Rubber/Paddy Farm Small	Rubber/Paddy Farm Medium	Rubber/Paddy Farm Large
Without Project	3,700	4,100	3,850	3,950	4,500	5,250
With Project	6,750	8,550	9,650	6,200	7,750	9,300
Increment	3,000	4,460	5,800	2,250	3,250	4,050

The Project implementation would help eliminate the possible poverty group and substantially raise the standard of living above the poverty line of ฿3,870 and the rural average income of ฿5,580 as is explained in para. 3.2.1 of Chapter 3. The Project would give rise to more benefit for the paddy farmers than mixed rubber/paddy farmers and for the large-size farmers than the smaller ones. This is because the Project is designed to benefit primarily the paddy producers and also because the large farmers can afford the production of fruit which has a higher profitability. In spite of the Project implementation, the off-farm employment is anticipated to remain constant because the farm labor requirement with the Project would not significantly absorb the off-farm labor supply.

9.4.2 Cost Recovery

The Project cost inclusive of recurrent cost would be recovered by general and specific, or indirect and direct levies. In Thailand, the Government imposes general or indirect taxes and duties that range from the municipal (tax) to the national (export duties and premium) level for the incremental production of selected commodities. These revenues would have to be duly taken into account when investigating the cost recovery index (though not explicitly dealt with in this analysis).

Part of the Project cost would also be recovered by specific or direct levies, such as recurrent and non-recurrent land tax and recurrent charge on the irrigation water supplied to the Project farmers. These levies would certainly have to be considered in relation to the willingness or ability-to-pay under the with-Project condition.

At present, no irrigation water charge is imposed in Thailand except for the NEA pump irrigation scheme. Assuming that the Government would determine to levy some water charge on the Project farmers in future, the water charge that fully covers the O & M cost and on-farm development cost has been estimated using 1986 constant prices. With the grace period of 5 years, repayment period of 20 years, and discount rate of 14 percent, and the irrigated hectares of 9,980 ha, the cost-covering charge inclusive of O & M cost would be about ฿2,300 per ha per year at full development period. This corresponds to 8 to 13 percent of the net production value from paddy area with the Project as follows:

Farm Type & Size		Average Paddy Area (ha)	Water Charge (A) (฿/ha/year)	NPV (B) (฿/year)	(A)/(B) (%)
Paddy	- Small	1.2	2,750	24,450	12
	- Medium	1.8	4,150	32,800	13
	- Large	2.8	6,450	52,700	12
Rubber/Paddy	- Small	0.8	1,850	20,750	9
	- Medium	1.2	2,750	28,600	10
	- Large	1.3	3,000	39,350	8

The willingness-to-pay of the farmers as investigated in the farm economic survey would be 10 percent of the annual gross paddy production, which corresponds to about ฿1,200 per hectare at 1986 price level. This amount is capable of recovering more than 50 percent (฿1,200/฿2,300) of cost of the on-farm work and O & M cost.

9.5 Socio-Economic Impacts

In addition to the Project benefit that can be quantified and valuated in monetary terms, every project entails costs and benefits that are intangible and do not lend themselves to valuation. Because these costs and benefits are a factor for project selection, it would be important that they are at least identified and if possible, quantified. These are discussed below.

(1) Enhancement of Cooperation among Project Farmers

Efficient use of irrigation water is a prerequisite for success of the Project. Thus, it is quite important that the water user's group be established and managed accordingly. Its organizational activities would strengthen the cooperative spirit among the Project farmers and help improve their technical and management skill as well.

Formation of WUG and strengthening of other organizational activities would contribute to the social and institutional objective of the country. In these institutional arrangements, the requirement given by the local residents would be carefully taken into account whenever necessary, so that too significant a change in traditional values and pattern of Muban life would be minimized.

(2) Reduction of Regional Disparity

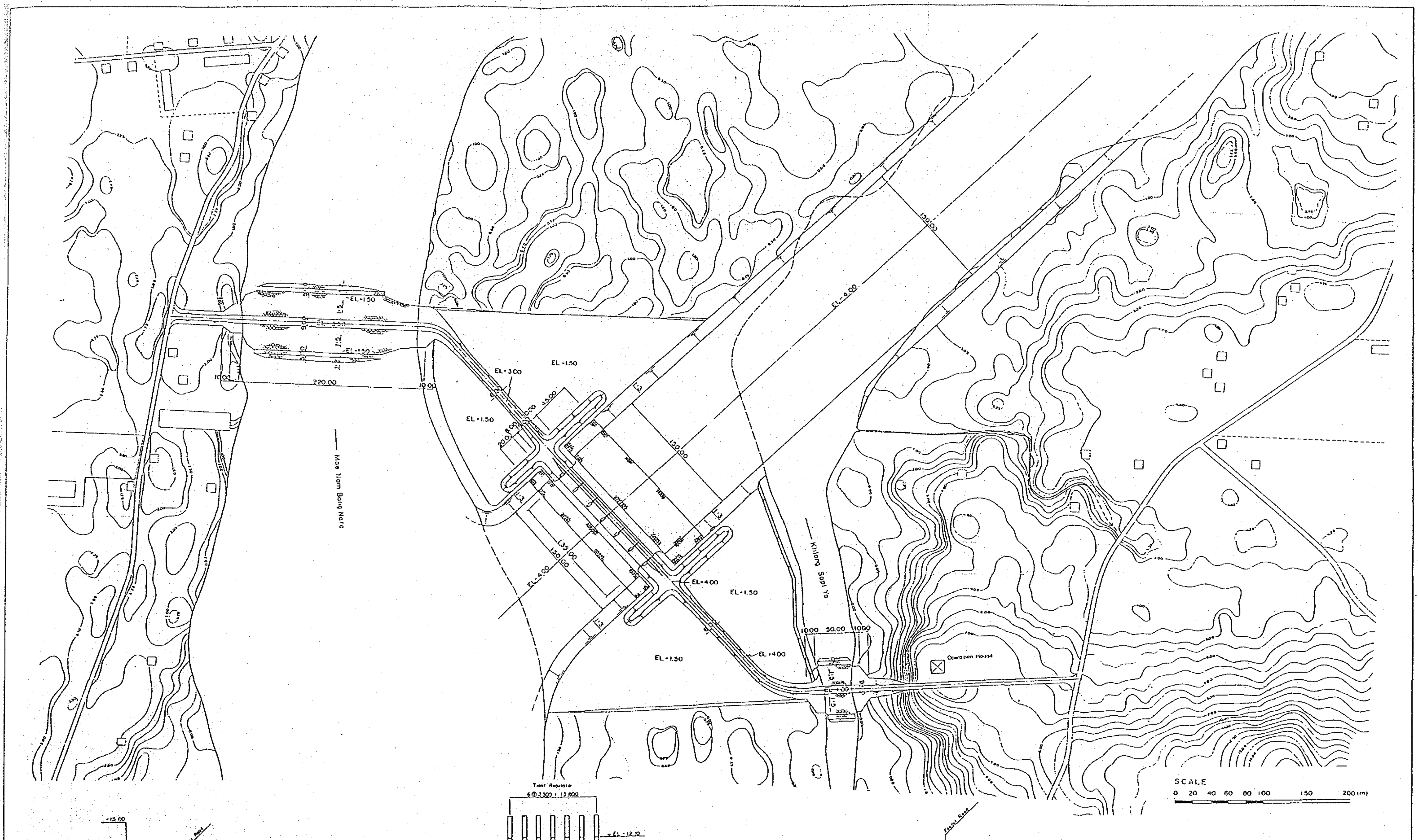
Improvement in the living standard among the Project farmers would help reduce the regional disparity especially among the Southern Region and with the neighboring Malaysia. This would significantly contribute to the maintenance of national security in the sensitive border area. Increased farm income would also leave the farmers more surplus to be invested for education of their children, which would help improve the communication and thus accelerate the assimilation of the Thai Muslim.

(3) Development of Agriculture Related Industry and Employment

The incremental agricultural production is anticipated to contribute to the development of agriculture related industry and the expansion of employment opportunities in post-harvest treatment, processing, and distribution sectors.

(4) Creation of Employment Opportunity

The Project implementation would give rise to the employment opportunity of about 414,000 man-days for the unskilled labor force in eleven years of construction, which corresponds to the total income of about ₱24.82 x 10^6 among the labor force.

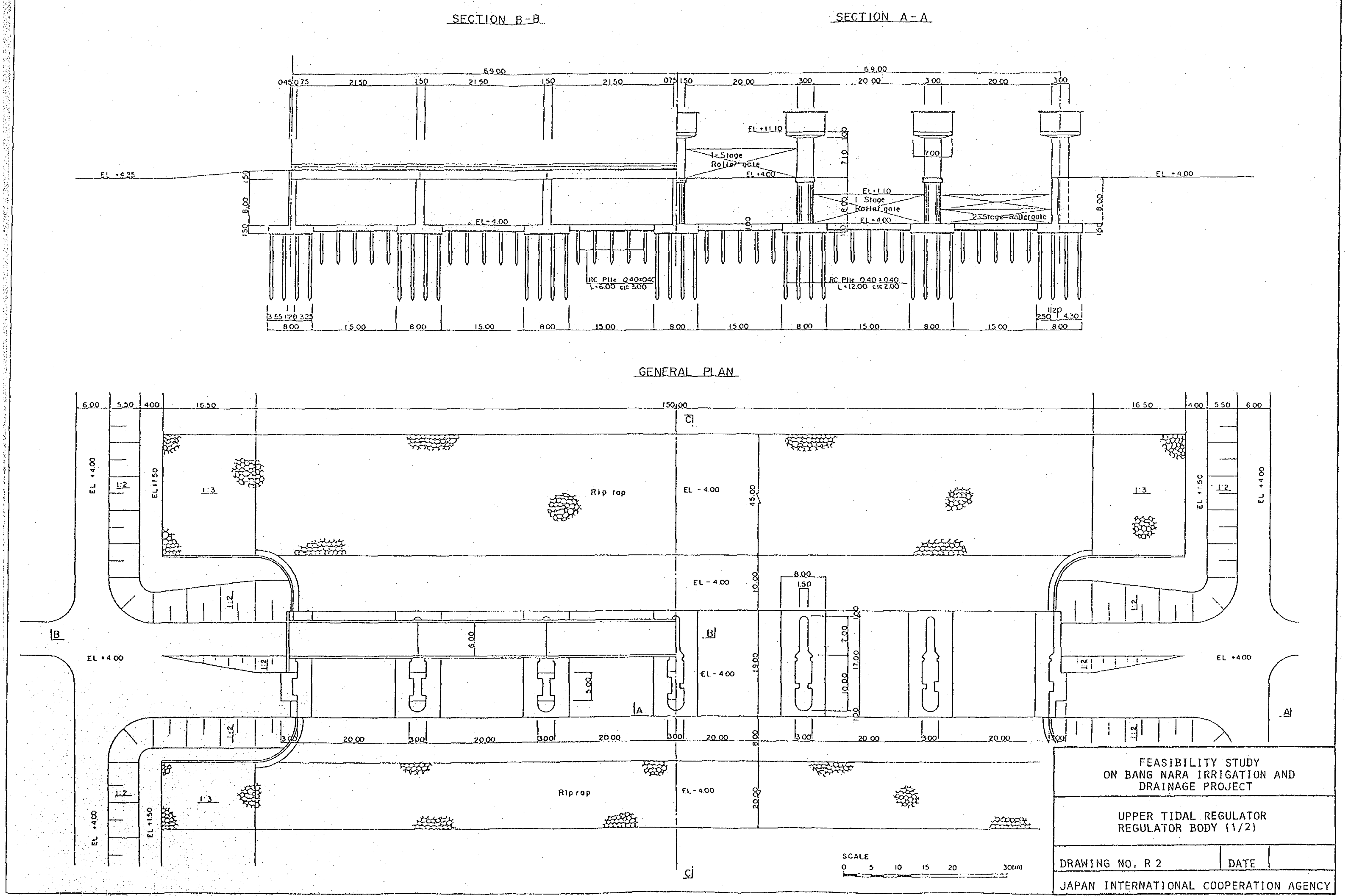


FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

UPPER TIDAL REGULATOR
GENERAL PLAN

DRAWING NO. R1	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY



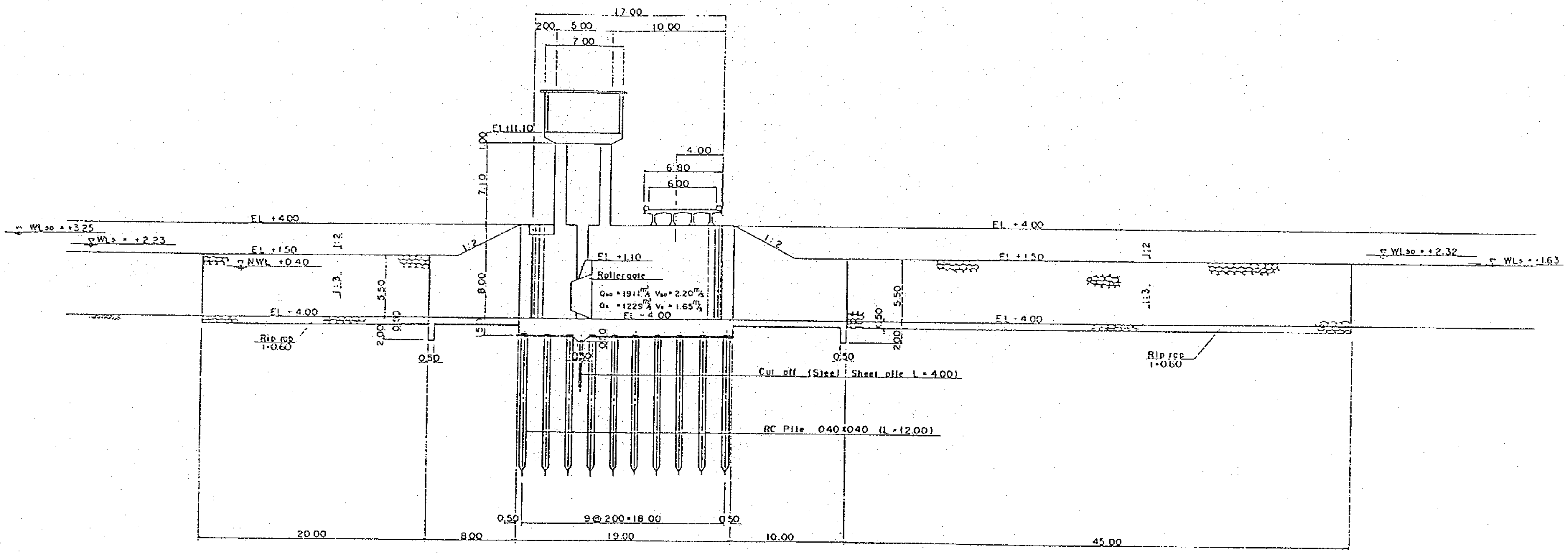
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

UPPER TIDAL REGULATOR
REGULATOR BODY (1/2)

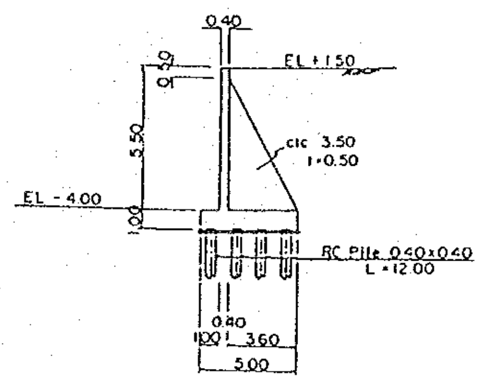
DRAWING NO. R 2	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

SECTION C - C



WING WALL



SCALE
0 2 4 6 8 10 15 20(m)

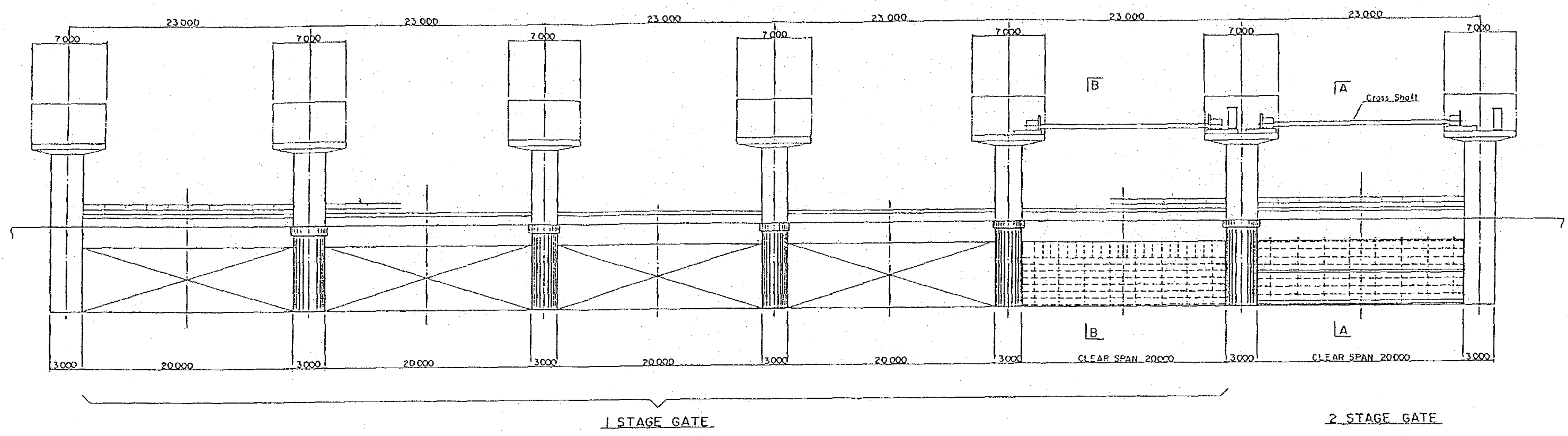
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

UPPER TIDAL REGULATOR
REGULATOR BODY (2/2)

DRAWING NO. R 3	DATE	

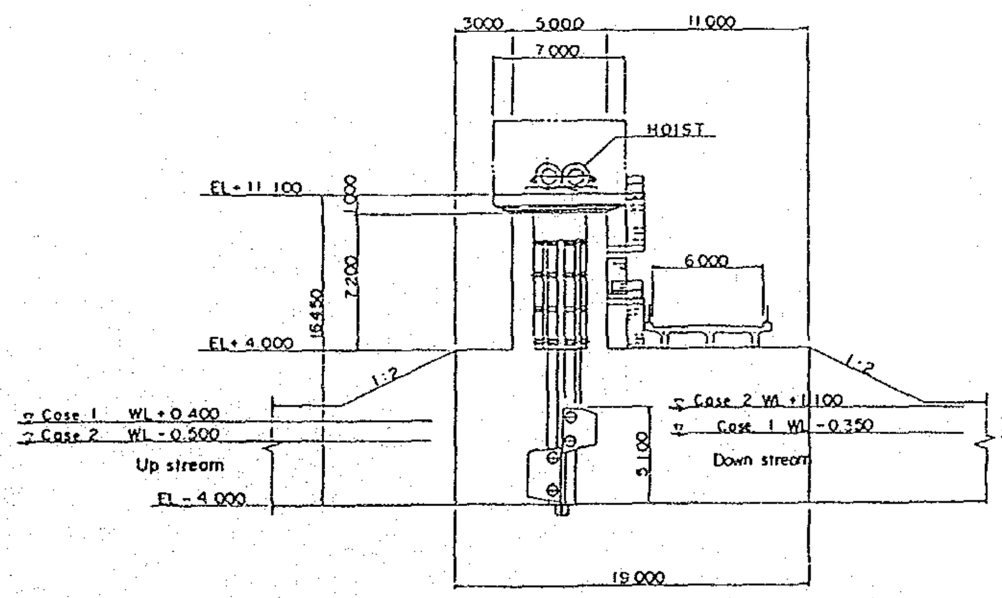
JAPAN INTERNATIONAL COOPERATION AGENCY

ELEVATON (UPSTREAM VIEW)

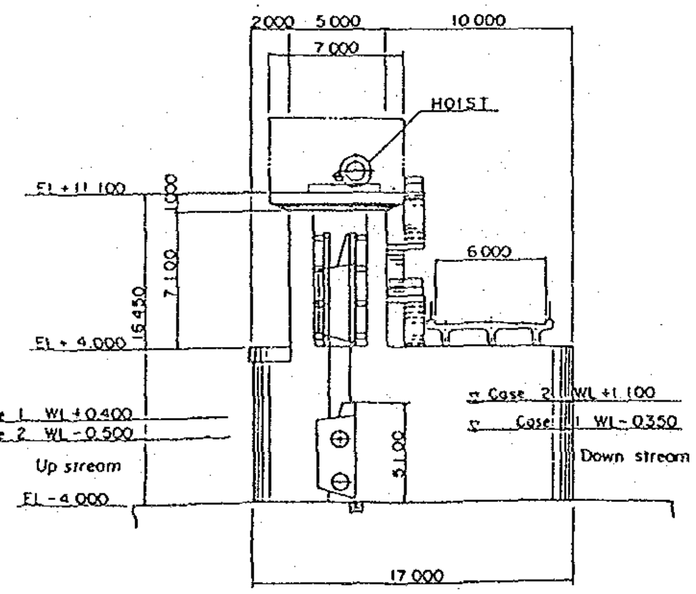


UPPER TIDAL REGULATOR GATE DESIGN CONDITION

	I - STAGE GATE	2 - STAGE GATE
TYPE	Shell Type Roller Gate	Shell Type Roller Gate
QUANTITY	5	1
CLEAR SPAN	20,000	20,000
GATE HEIGHT	5,100	5,100
DESIGN WATER LEVEL	Up stream	Down stream
Case - 1	WL + 0.400	WL - 0.350
Case - 2	WL - 0.500	WL + 1.100
ELEVATION Operating Floor	EL + 11.100	
Sill	EL - 4.000	
HOIST	Wire Rope Winch	
Operating Speed	0.3 m/min	



SECTION A - A
2-STAGE GATE



SECTION B - B
1-STAGE GATE

SCALE 0 2 4 6 8 10 15 20(m)

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

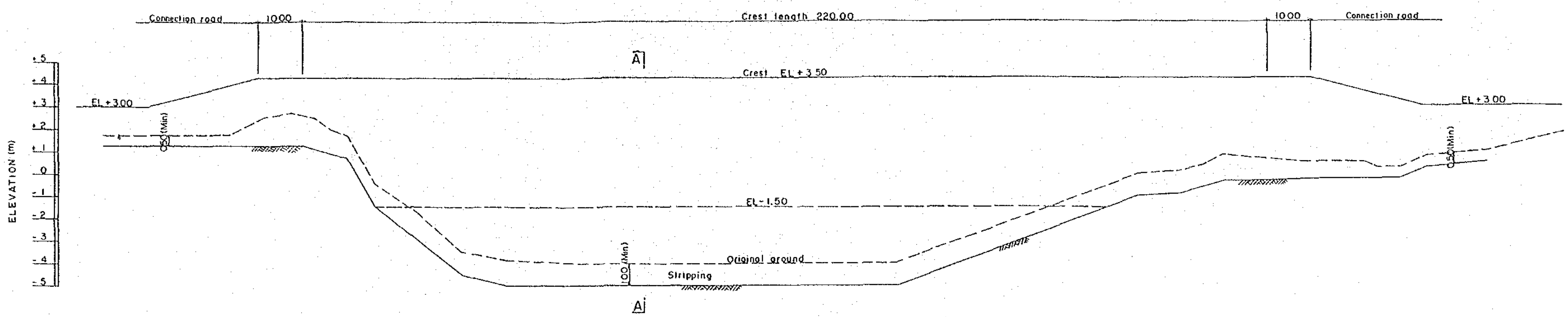
UPPER TIDAL REGULATOR
GATE ARRANGEMENT

DRAWING NO. R 4	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

LONGITUDINAL SECTON

SCALE 0 10 20 30 40 50 (m)



SECTION A - A

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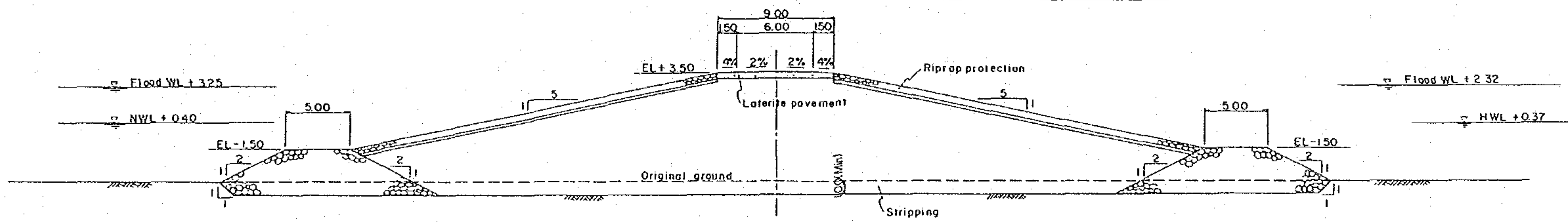
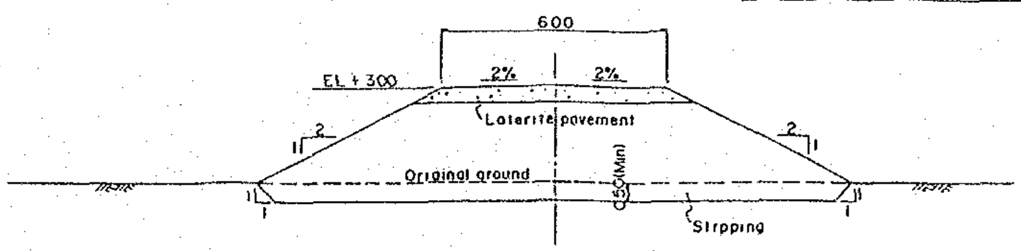


CONNECTION ROAD

SCALE 0 1 2 3 4 5 10 (m)

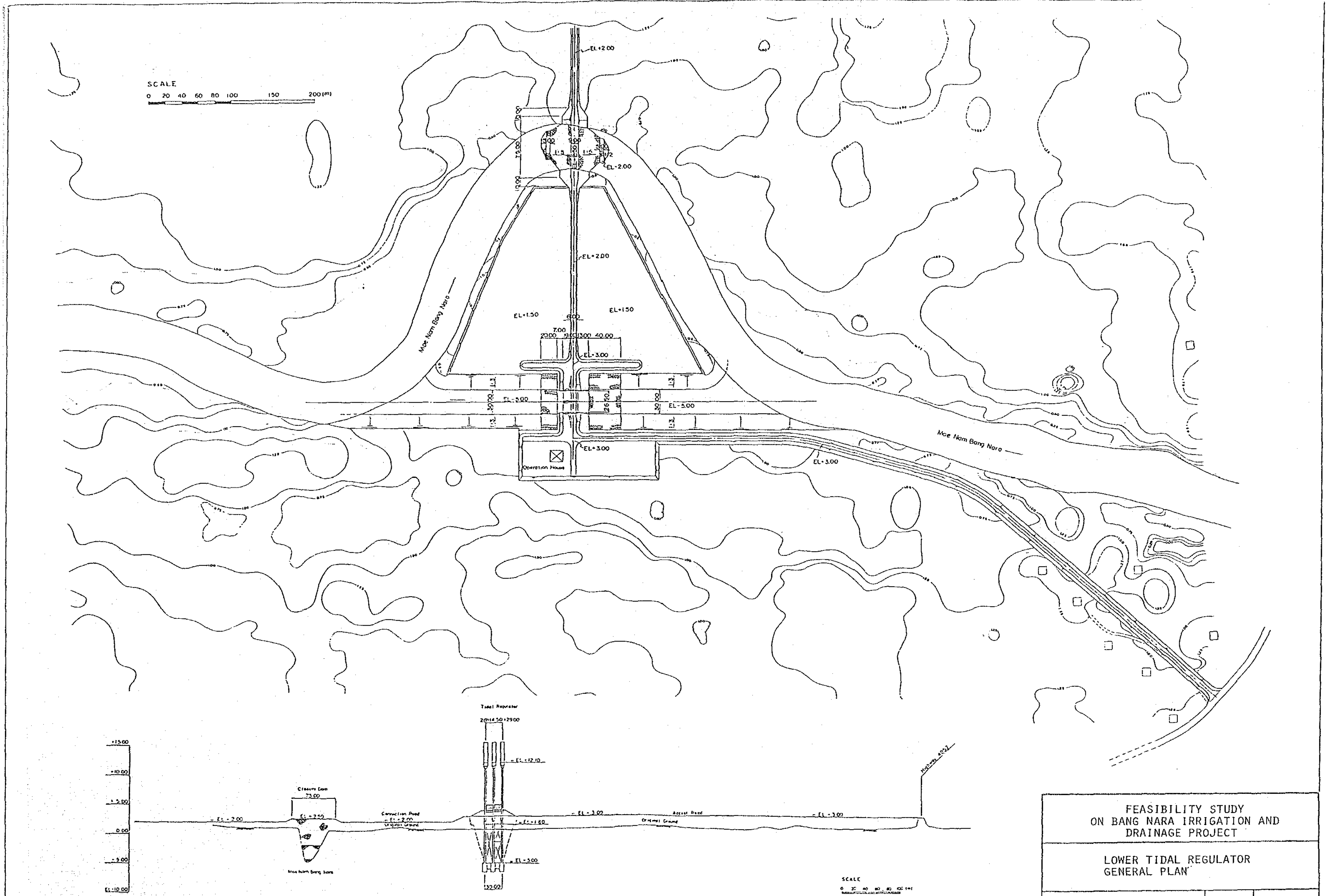


FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

UPPER TIDAL REGULATOR
CLOSURE DAM

DRAWING NO. R 5	DATE	

JAPAN INTERNATIONAL COOPERATION AGENCY

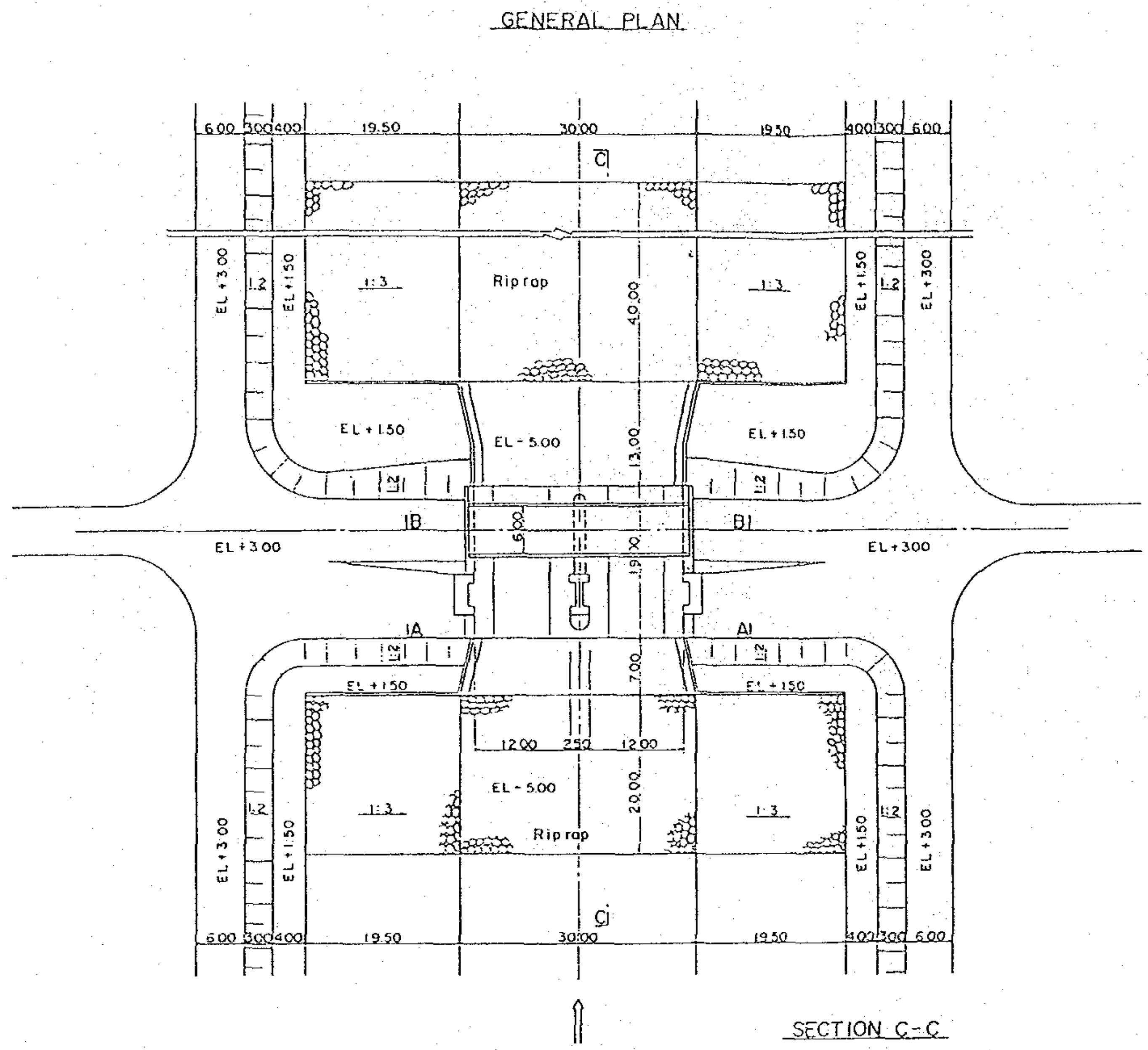


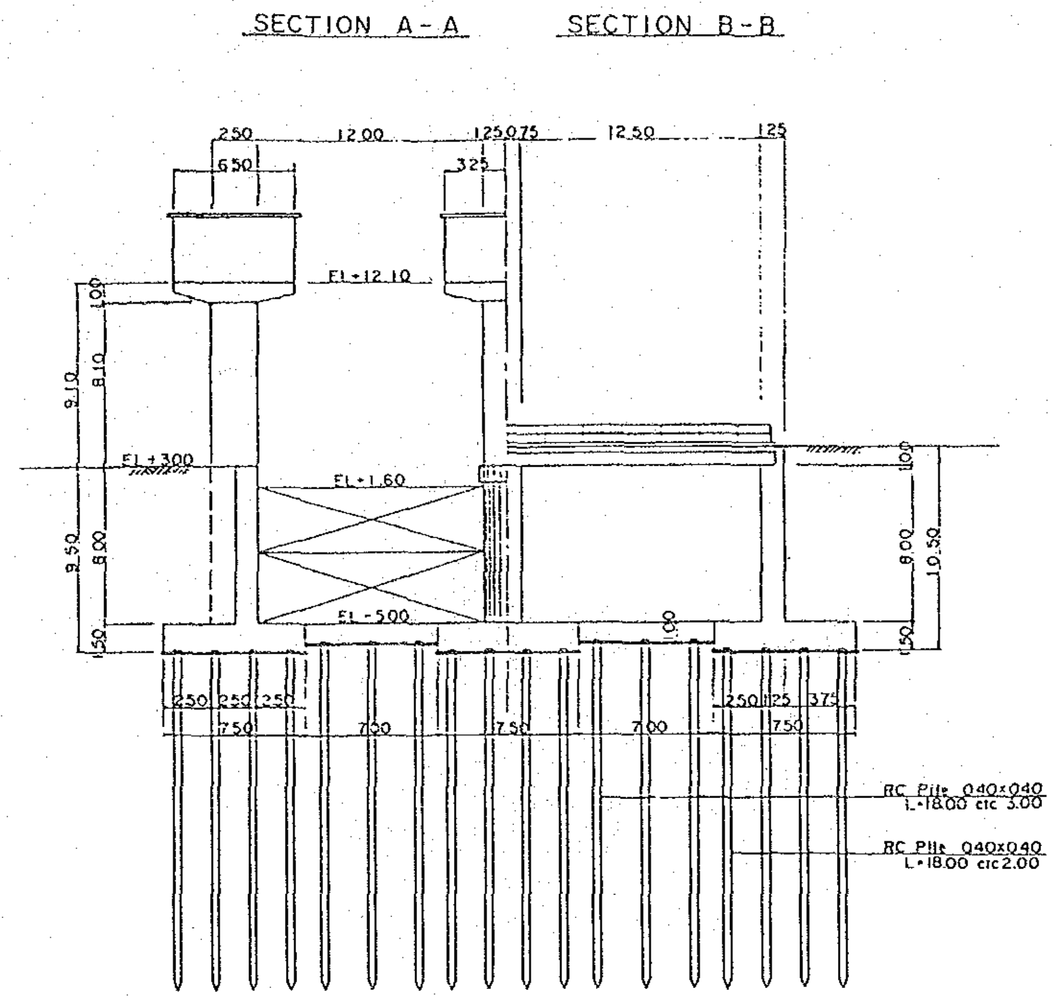
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

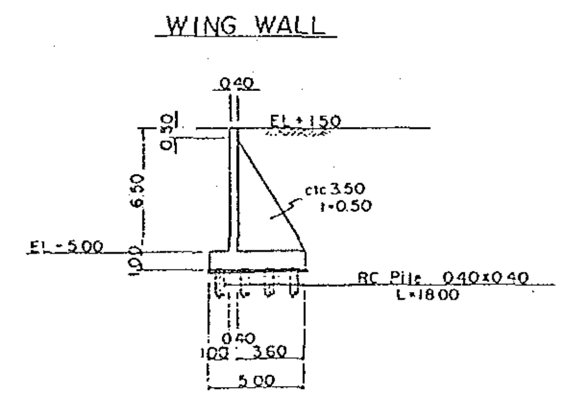
LOWER TIDAL REGULATOR
GENERAL PLAN

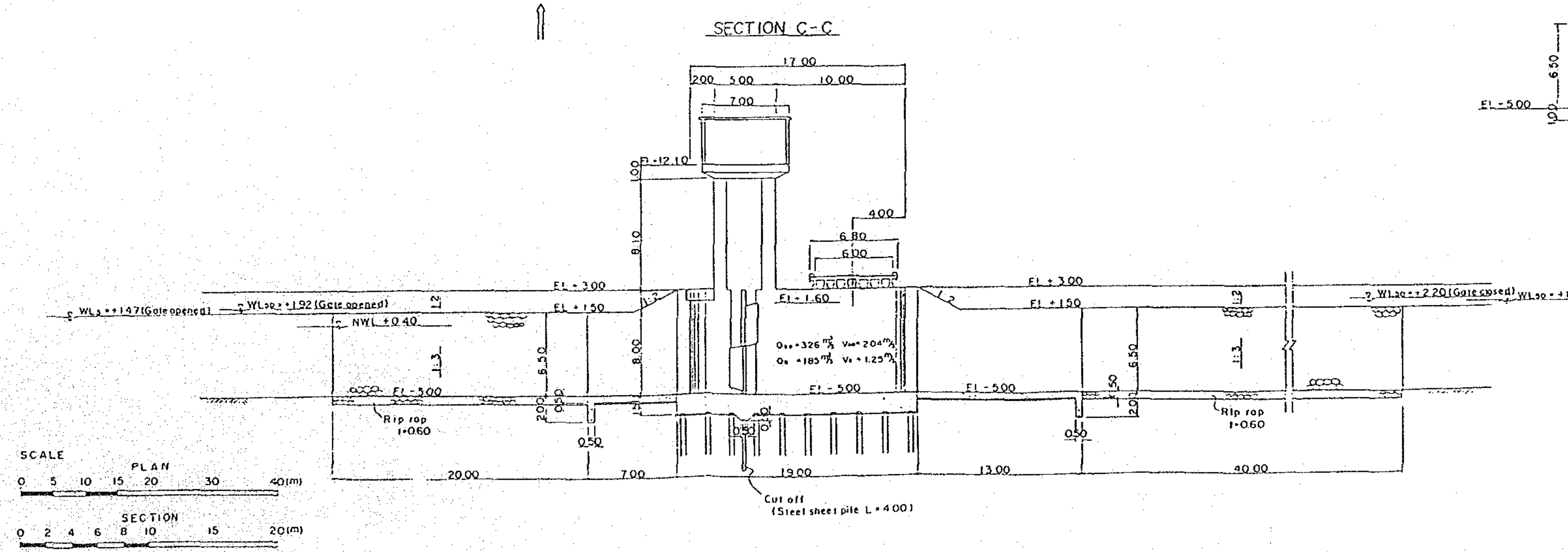
DRAWING NO. R 6 | DATE

JAPAN INTERNATIONAL COOPERATION AGENCY









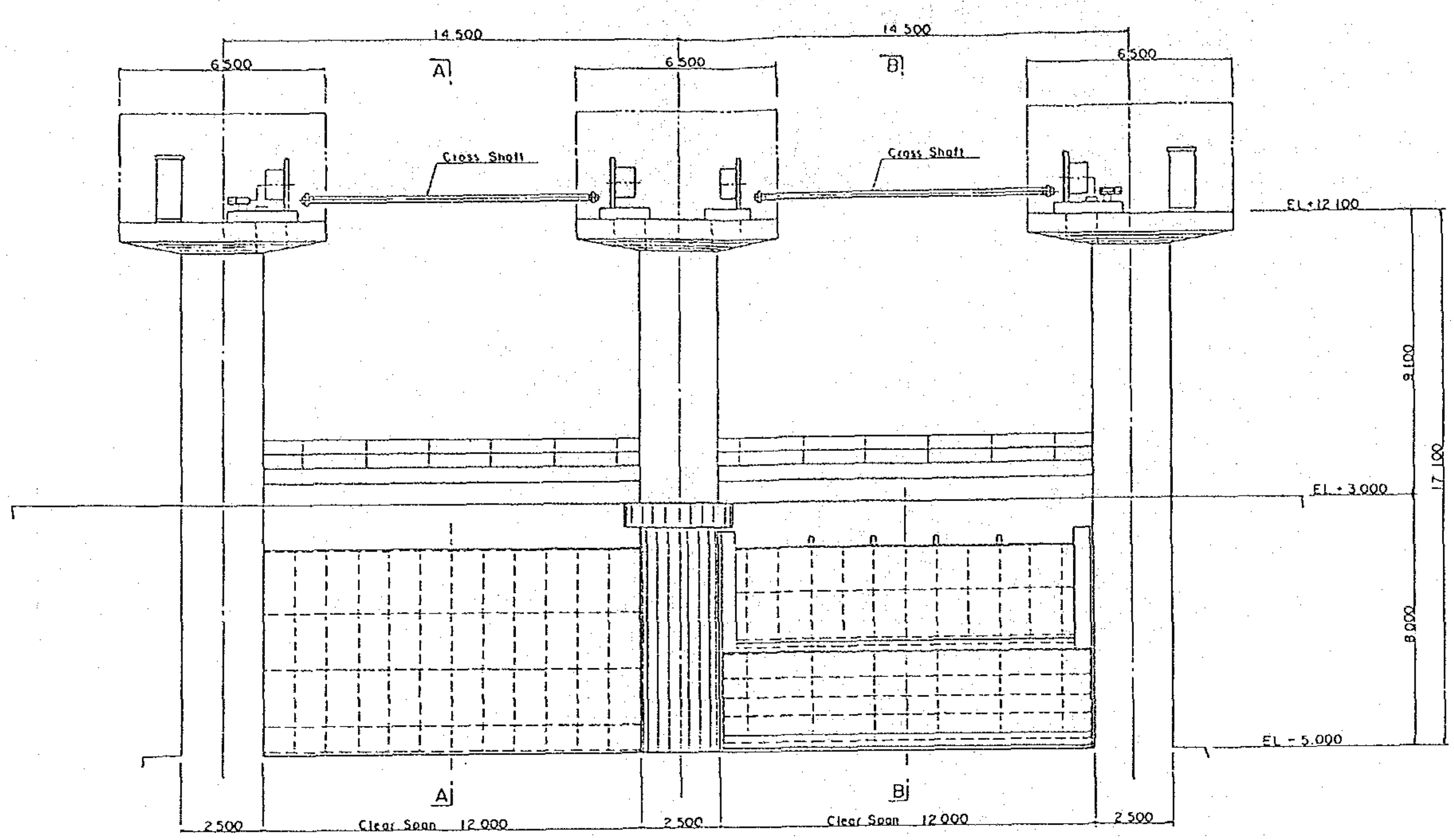
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

LOWER TIDAL REGULATOR
REGULATOR BODY

DRAWING NO. R7	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

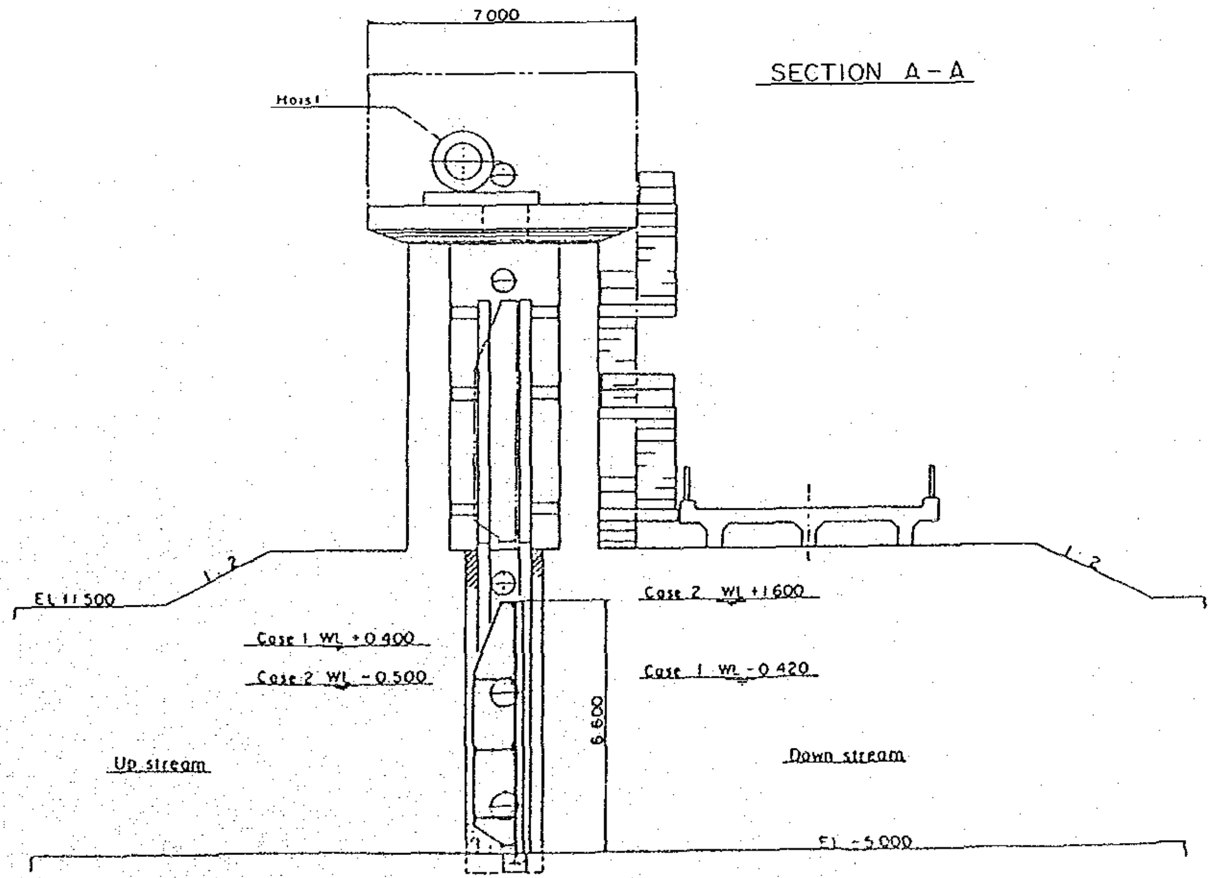
ELEVATION (UPSTREAM VIEW)



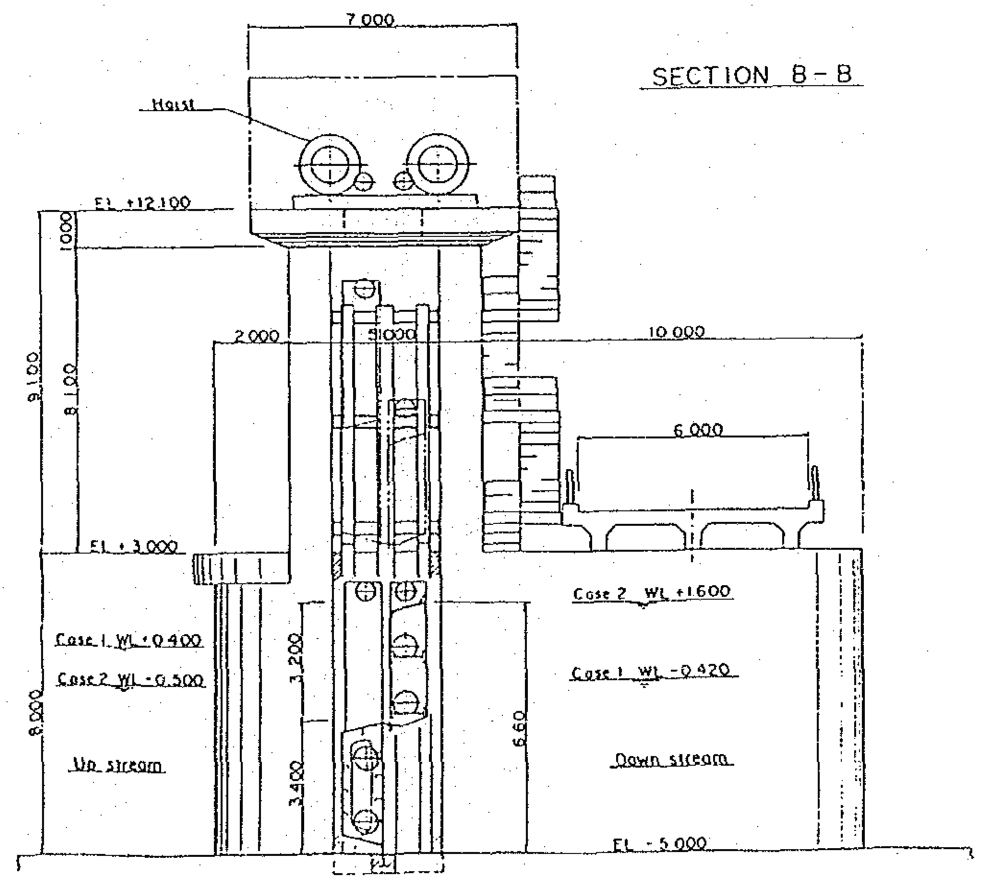
LOWER TIDAL REGULATOR GATE DESIGN CONDITION

	1-STAGE GATE	2 STAGE GATE
TYPE	Girder Type, Roller Gate	Shell and Girder Type Roller Gate
QUANTITY	1	1
CLEAR SPAN	12 000	12 000
GATE HEIGHT	7 200	7 200
DESIGN WATER LEVEL	Up stream	Down stream
Case 1	WL+0.500	WL - 0.420
Case 2	WL- 0.500	WL + 1.600
ELEVATION		
Operating Floor	EL + 12.700	
Sill	EL - 5.000	
HOIST	Wire Rope Winch	
OPERATING SPEED	0.3 m/min	

SECTION A-A



SECTION B-B



SCALE 0 1 2 3 4 5 10 (m)

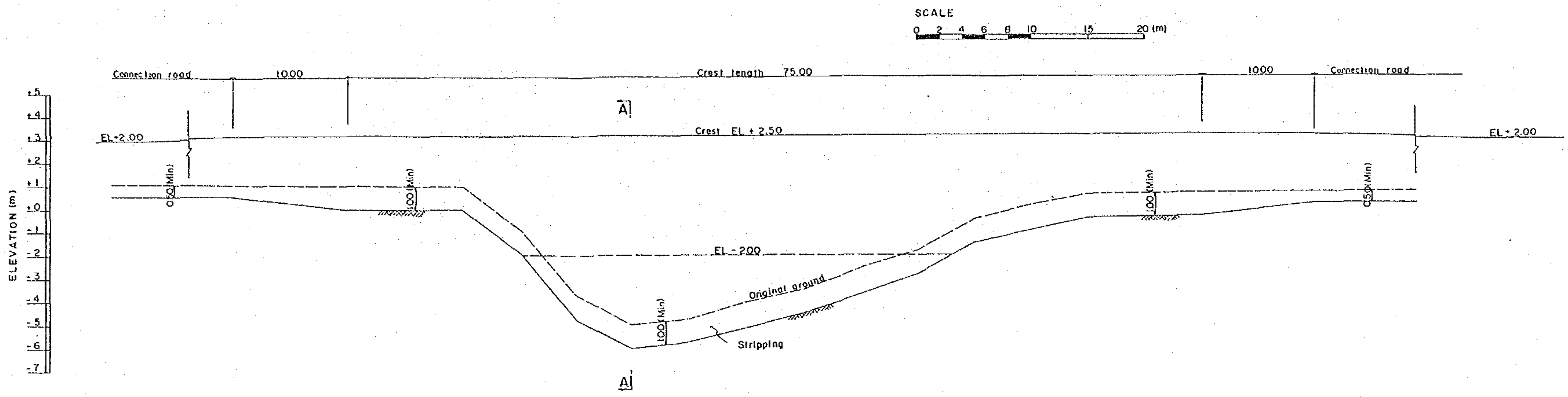
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

LOWER TIDAL REGULATOR
GATE ARRANGEMENT

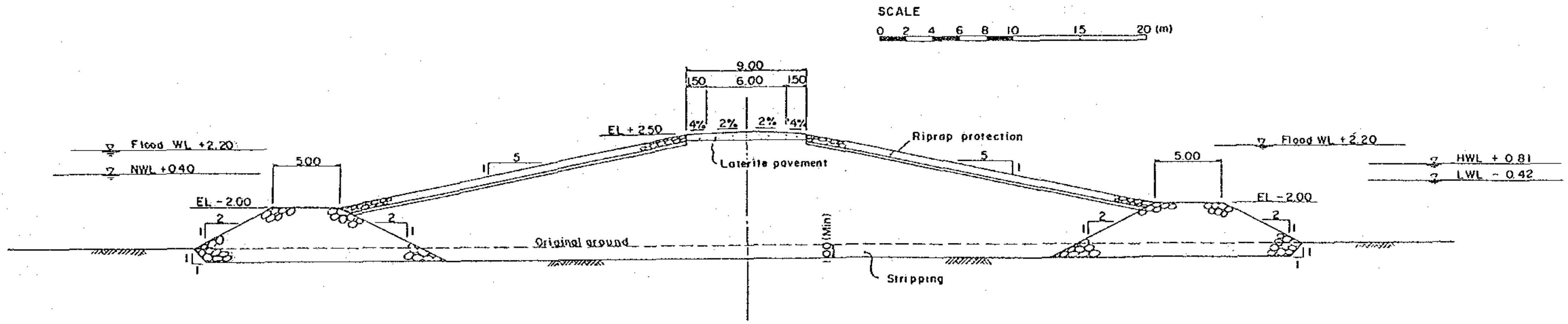
DRAWING NO. R 8	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

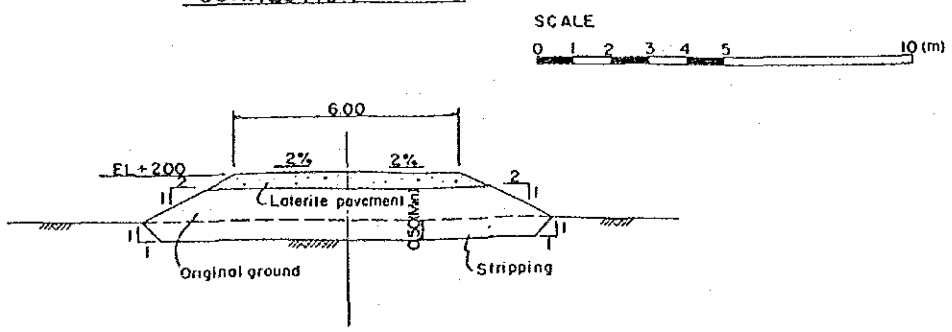
LONGITUDINAL SECTION



SECTION A - A



CONNECTION ROAD

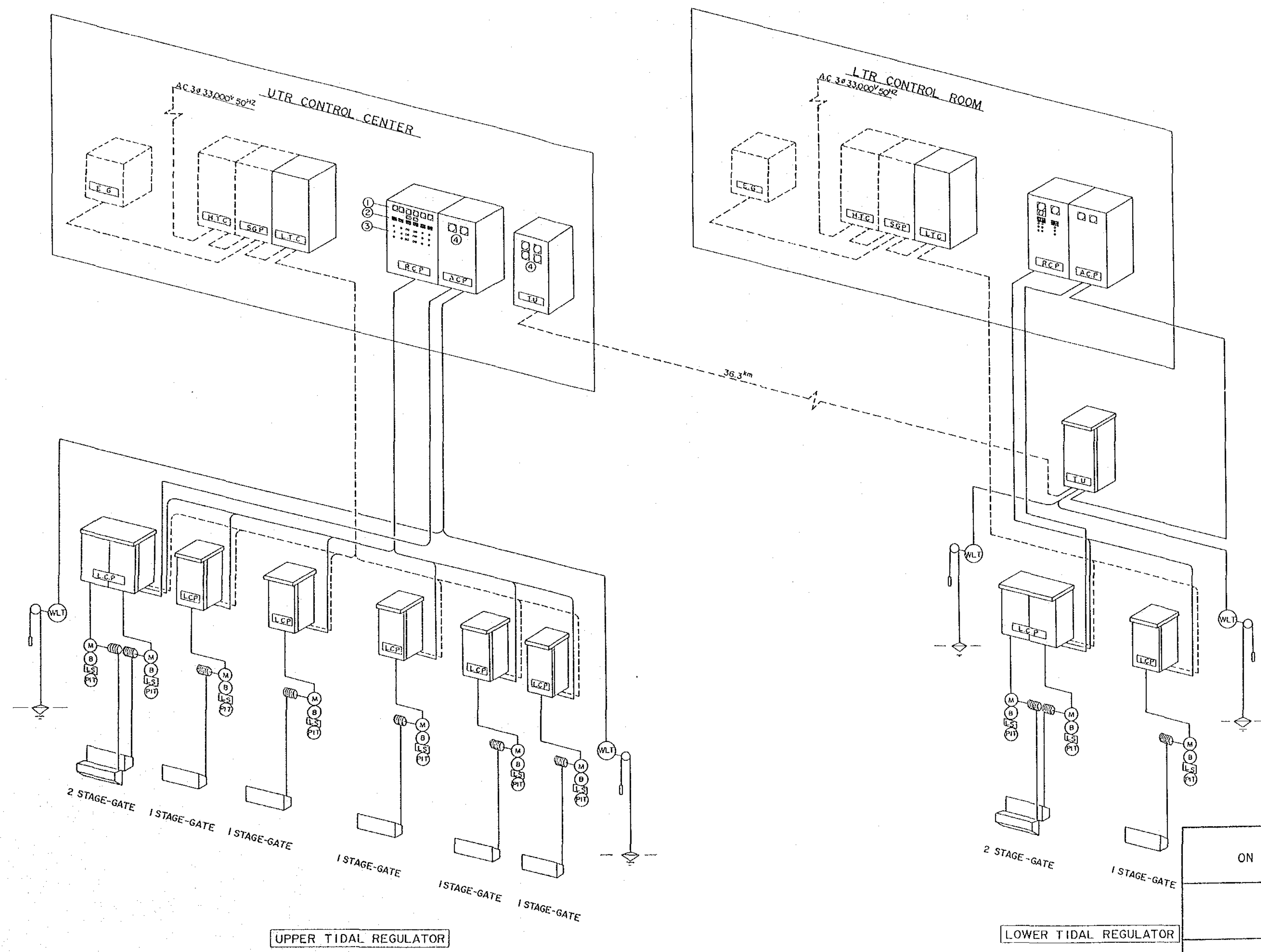


FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

LOWER TIDAL REGULATOR
CLOSURE DAM

DRAWING NO. R 9	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND	
H.T.C	HIGH TENSION CUBICLE
S.G.P	SWITCH GEAR PANEL
L.T.C	LOW TENSION CUBICLE
A.C.P	AUTO.CONTROL PANEL
R.C.P	REMOTE CONTROL PANEL
L.C.P	LOCAL CONTROL PANEL
M	MOTOR
B	BRAKE
L.S	LIMIT SWITCH
P.I.T	POSITION INDICATOR TRANSMITTER
WL.T	WATER LEVEL TRANSMITTER
T.U	TELEMETOR UNIT
E.G	EMERGENCY GENERATOR
①	POSITION INDICATOR(ANALOGUE)
②	INDICATING LAMP
③	PUSH BUTTON
④	WATER LEVEL INDICATOR
NOTE	
———	SCOPE OF GATE CONTRACTOR
- - - -	SCOPE OF OWNER

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

TIDAL REGULATORS
ELECTRICAL EQUIPMENT

DRAWING NO. R10 | DATE

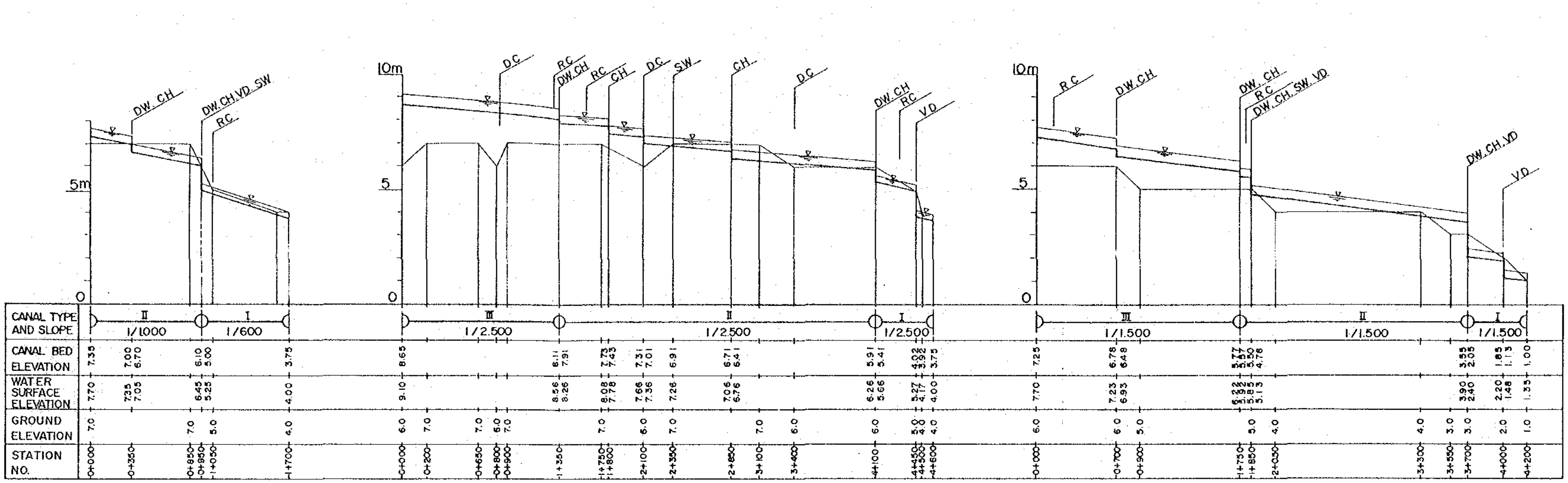
JAPAN INTERNATIONAL COOPERATION AGENCY

NO.1 PU TA

NO.2 KHAO KONG

Right Main

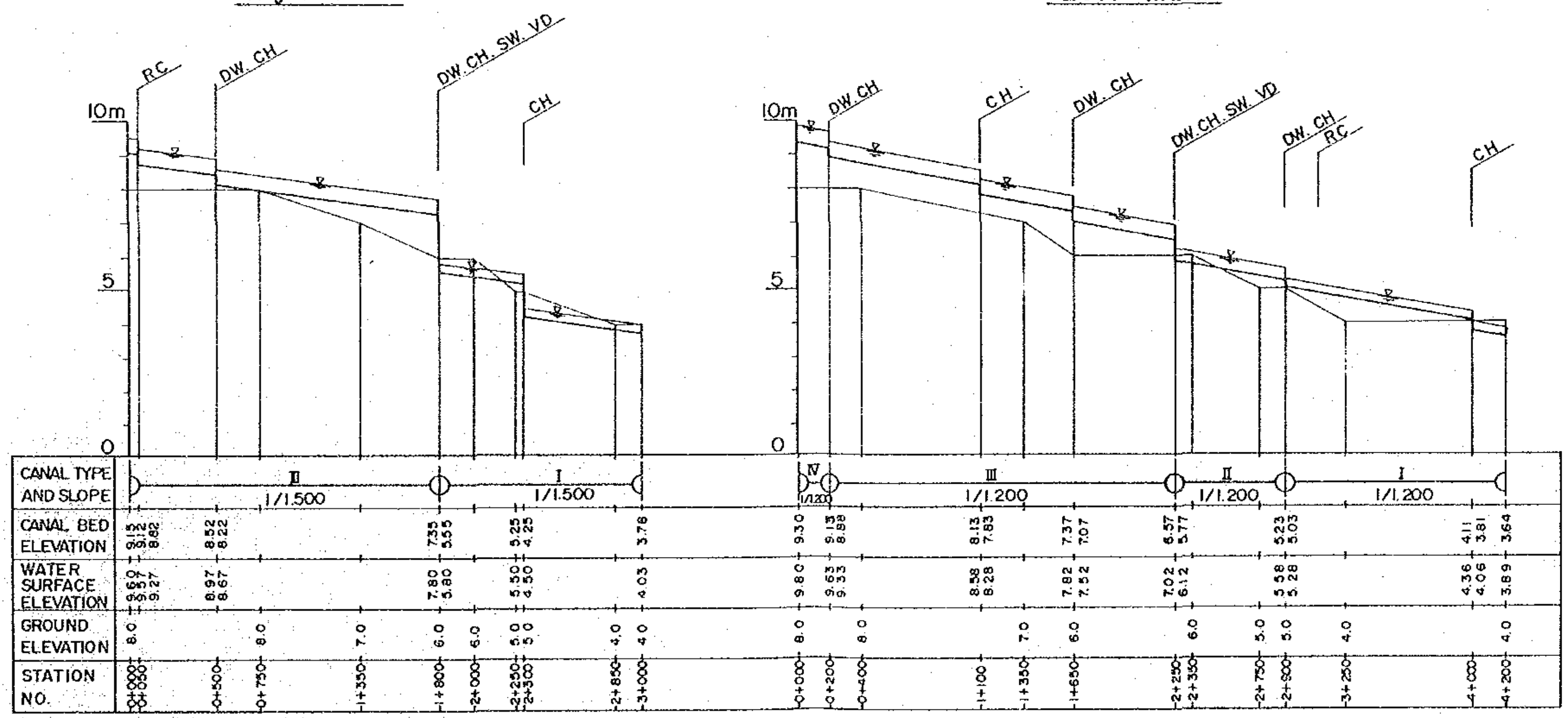
Left Main



NO.3 DU SONG

Rigft Main

Left Main



LEGEND

- DW : Division Work
- CH : Check Structure
- SP : Syphon
- AQ : Aqueduct
- SW : Spillway
- VD : Vertical Drop
- RC : Road Crossing
- DC : Drain Culvert

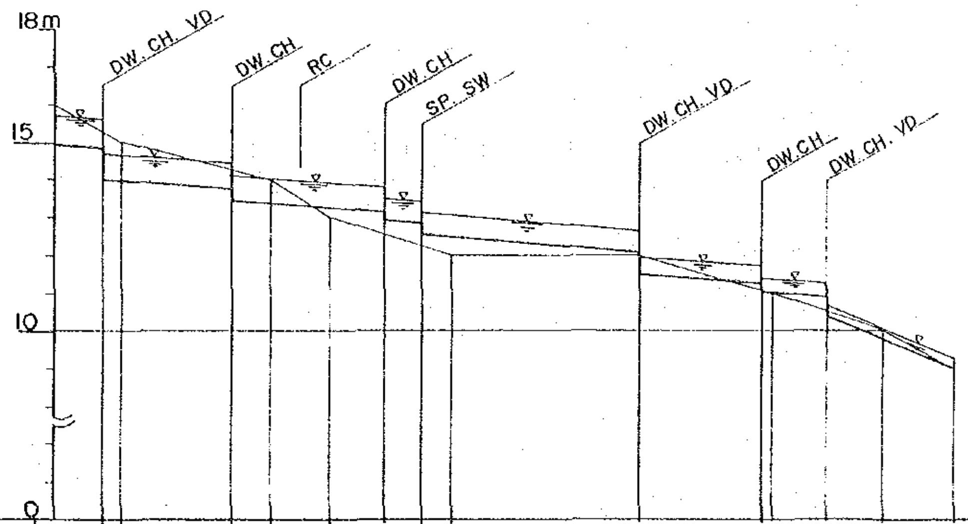
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

IRRIGATION FACILITIES
CANAL PROFILE (1/3)

DRAWING NO. ID 1 | DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.4 TAN YONG MAT

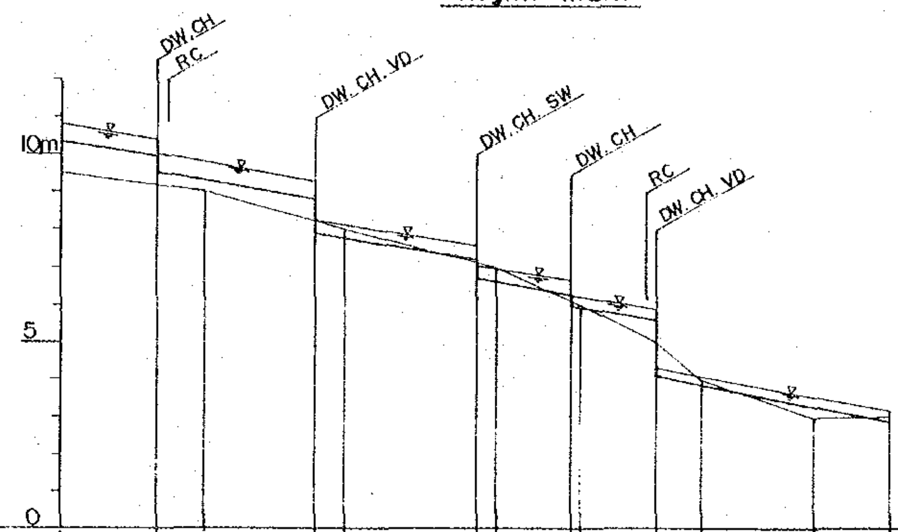


Canal type and slope: VI 1/2,500 (0+000–0+250); V 1/2.500 (0+250–1+750); IV 1/2500 (1+750–3+100); III 1/2.500 (3+100–3+750); II 1/2500 (3+750–4+100); I 1/500 (4+100–4+800)

STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
0+000	14.95	15.70	16.0
0+250	14.85 / 14.05	15.60 / 14.70	
0+350			15.0
0+950	13.77 / 13.47	14.42 / 14.12	
1+150			14.0
1+450			13.0
1+750	13.15 / 12.95	13.80 / 13.50	
1+950	12.87 / 12.57	13.42 / 13.12	
2+100			12.0
3+100	12.11 / 11.51	12.66 / 11.96	12.0
3+750 / 3+800	11.25 / 11.05	11.70 / 11.40	11.0
4+100	10.91 / 10.41	11.26 / 10.66	
4+400			10.0
4+800	9.01	9.26	9.0

NO.5 KHOK TITE(UPPER ZONE)

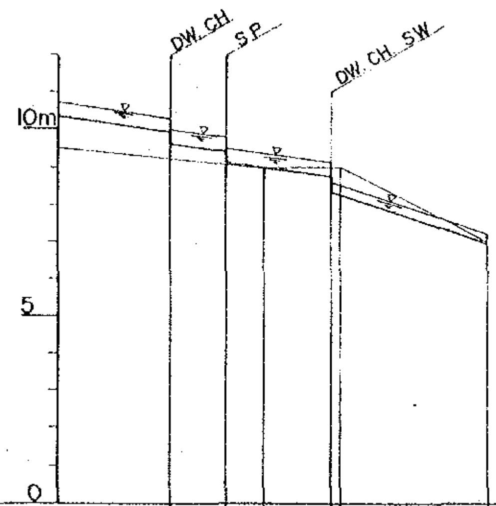
Right. Main



Canal type and slope: III 1/1,200 (0+000–1+350); II 1/1,200 (1+350–2+700); I 1/1,200 (2+700–4+400)

STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
0+000	10.35	10.80	9.5
0+500	9.94 / 9.53	10.38 / 9.98	
0+750			9.0
1+350	8.82 / 7.92	9.27 / 8.27	
1+500			8.0
2+200	7.21 / 6.71	7.56 / 7.06	
2+300			7.0
2+700 / 2+750	6.29 / 5.99	6.64 / 6.24	6.0
3+150	5.62 / 4.12	5.87 / 4.37	5.0
3+400			4.0
4+000			3.0
4+400	2.87	3.12	3.0

Left Main

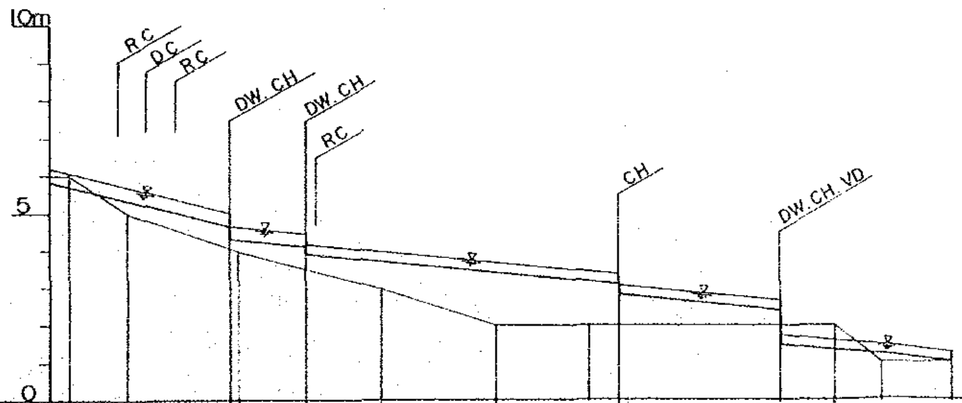


Canal type and slope: II 1/1,500 (0+000–1+450); I 1/600 (1+450–2+300)

STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
0+000	10.35	10.70	9.5
0+600	9.95 / 9.65	10.30 / 10.00	
0+900	9.45 / 9.15	9.80 / 9.50	
1+100			9.0
1+450 / 1+500	8.78 / 8.38	9.13 / 8.63	9.0
2+300	6.96	7.21	7.0

NO.5 KHOK TITE(LOWER ZONE)

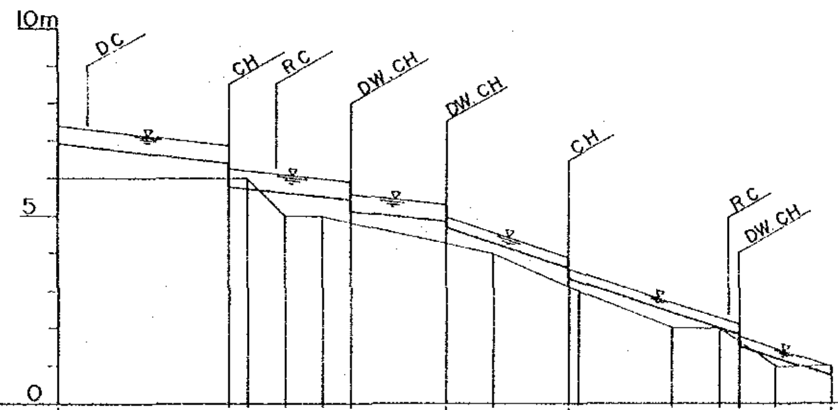
Right Main



Canal type and slope: II 1/800 (0+000–1+350); I 1/2,000 (1+350–4+800)

STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
0+000	5.85	6.20	6.0
0+100			6.0
0+400			5.0
0+950 / 1+000	4.66 / 4.36	5.01 / 4.71	4.0
1+350	4.16 / 3.96	4.51 / 4.21	
1+750			3.0
2+350			2.0
2+850			2.0
3+000	3.13 / 2.83	3.38 / 3.08	
3+650	2.40 / 1.50	2.65 / 1.75	
4+150			2.0
4+400			1.0
4+800	1.03	1.28	1.0

Left Main



Canal type and slope: III 1/1,600 (0+000–2+050); II 1/1,600 (2+050–2+700); I 1/600 (2+700–4+100)

STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
0+000	6.95	7.40	6.0
0+900	6.39 / 5.79	6.84 / 6.24	
1+000			6.0
1+200			5.0
1+400			5.0
1+550	5.45 / 5.15	5.90 / 5.60	
2+050	4.84 / 4.74	5.29 / 4.99	
2+300			4.0
2+700 / 2+750	3.66 / 3.36	3.91 / 3.61	3.0
3+250			2.0
3+500			2.0
3+600	1.86 / 1.56	2.11 / 1.81	
3+800			1.0
4+100	0.73	0.98	1.0

LEGEND

- DW : Division Work
- CH : Check Structure
- SP : Syphon
- AQ : Aqueduct
- SW : Spillway
- VD : Vertical Drop
- RC : Road Crossing
- DC : Drain Culvert

FEASIBILITY STUDY ON BANG NARA IRRIGATION AND DRAINAGE PROJECT

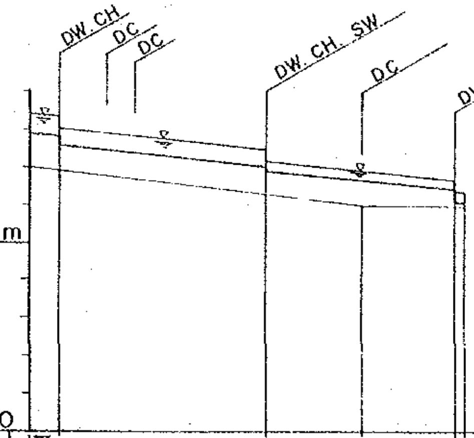
IRRIGATION FACILITIES CANAL PROFILE (2/3)

DRAWING NO. ID 2 | DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

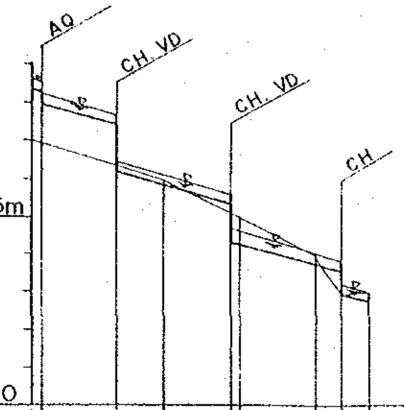
NO. 6 MARU BO

Right Main



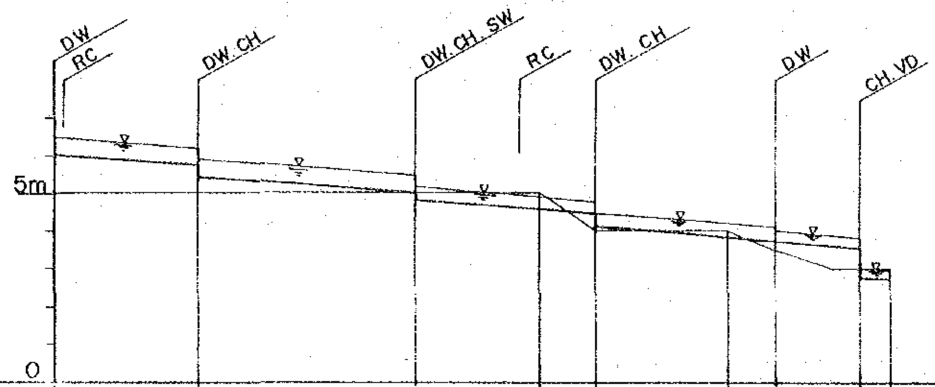
CANAL TYPE AND SLOPE	STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
IV 1/2000	0+000	7.90	8.40	7.0
III 1/2,000	0+150	7.82 / 7.57	8.32 / 8.02	
I 1/2000	1+250	7.02 / 6.92	7.47 / 7.17	
	1+700			6.0
	2+250 / 2+300	6.42 / 6.12 / 6.09	6.67 / 6.37 / 6.34	6.0

Left Main



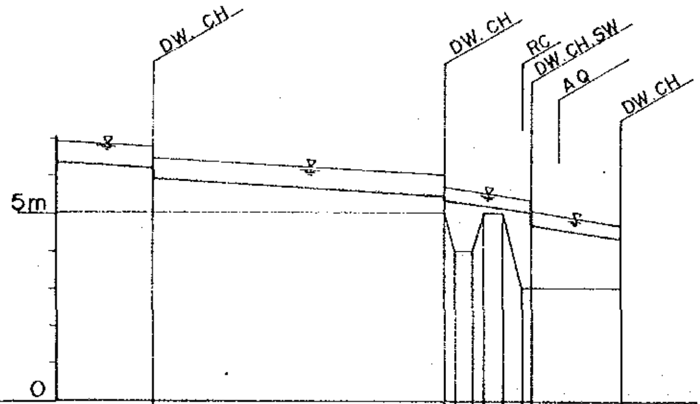
CANAL TYPE AND SLOPE	STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
I 1/700	0+000	8.35 / 8.28 / 7.98	8.60 / 8.53 / 8.23	7.0
	0+450	7.41 / 6.21	7.66 / 6.46	
	0+700			6.0
	1+050 / 1+100	5.35 / 4.45	5.60 / 4.70	5.0
	1+500			4.0
	1+650	3.59 / 2.99	3.84 / 3.24	3.0
	1+800	2.78	3.03	3.0

NO. 7 SALA MAI



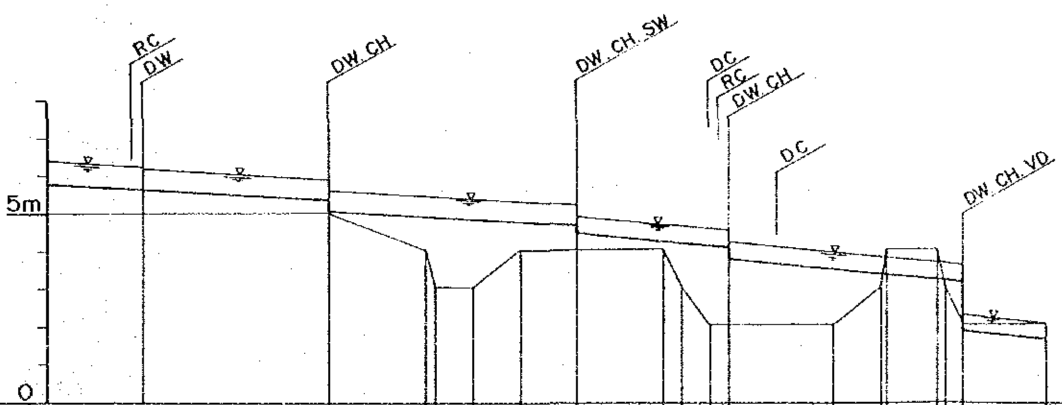
CANAL TYPE AND SLOPE	STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
III 1/2,500	0+000	6.05	6.50	5.0
II 1/2,500	0+750	5.75 / 5.45	6.20 / 5.90	
I 1/2,500	1+900	4.99 / 4.79	5.44 / 5.14	
	2+550			5.0
	2+850	4.41 / 4.11	4.76 / 4.46	4.0
	3+550			4.0
	3+800	3.73 / 3.73	4.08 / 3.98	
	4+250			3.0
	4+400	3.55 / 2.75 / 2.69	3.80 / 3.00 / 2.94	3.0

NO.9 PHRU KAP DAENG



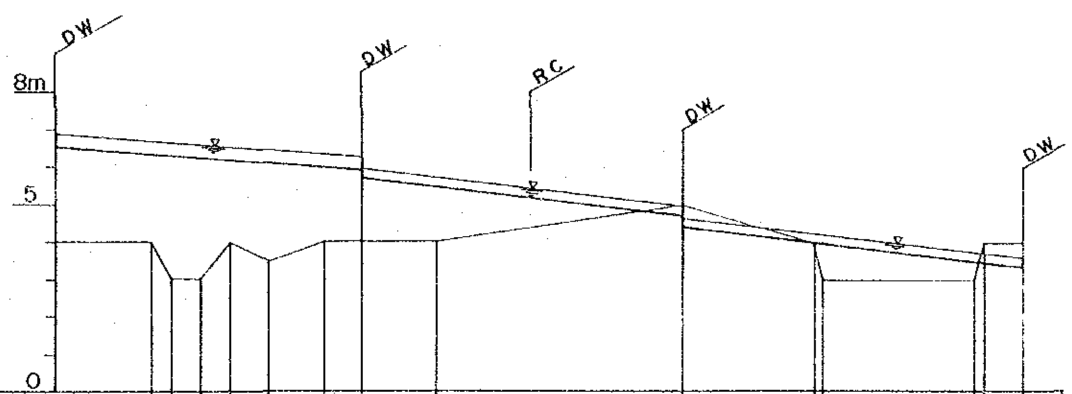
CANAL TYPE AND SLOPE	STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
IV 1/3,300	0+000	5.35	6.90	5.0
II 1/1,400	0+500	6.20 / 5.90	6.75 / 6.45	
	2+050 / 2+100	5.63 / 5.33	5.98 / 5.68	5.0 / 4.0
	2+200 / 2+250			4.0 / 5.0
	2+350			5.0
	2+450 / 2+500	5.01 / 4.71	5.36 / 5.06	3.0
	3+000	4.35	4.70	3.0

NO.8 KO SAWAT



CANAL TYPE AND SLOPE	STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
V 1/3300	0+000	5.80	6.40	5.0
IV 1/3,300	0+500	5.65 / 5.65	6.25 / 6.20	
III 1/2,000	1+500	5.35 / 5.05	5.90 / 5.60	5.0
	2+000 / 2+050			4.0 / 3.0
	2+250			3.0
	2+500			4.0
	2+800	4.66 / 4.46	5.21 / 4.91	
	3+250			4.0
	3+350			3.0
	3+500			2.0
	3+600	4.06 / 3.76	4.51 / 4.21	
	4+150			2.0
	4+400 / 4+425			3.0 / 4.0
	4+700 / 4+750 / 4+850	3.13 / 1.83	3.38 / 2.28	4.0 / 3.0 / 2.0
	5+300	1.60	2.05	2.0

NO. 10 KU CHAM



CANAL TYPE AND SLOPE	STATION NO.	CANAL BED ELEVATION	WATER SURFACE ELEVATION	GROUND ELEVATION
II 1/2,500	0+000	6.55	6.90	4.0
I 1/1,700	0+500			4.0
	0+600			3.0
	0+750			3.0
	0+900			4.0
	1+100			3.5
	1+400			4.0
		5.91 / 5.71	6.26 / 5.96	
	2+000			4.0
	3+300	4.71 / 4.41	4.96 / 4.66	5.0
	4+000 / 4+050			4.0 / 3.0
	4+850 / 4+900			3.0 / 4.0
	5+100	3.35	3.60	4.0

LEGEND

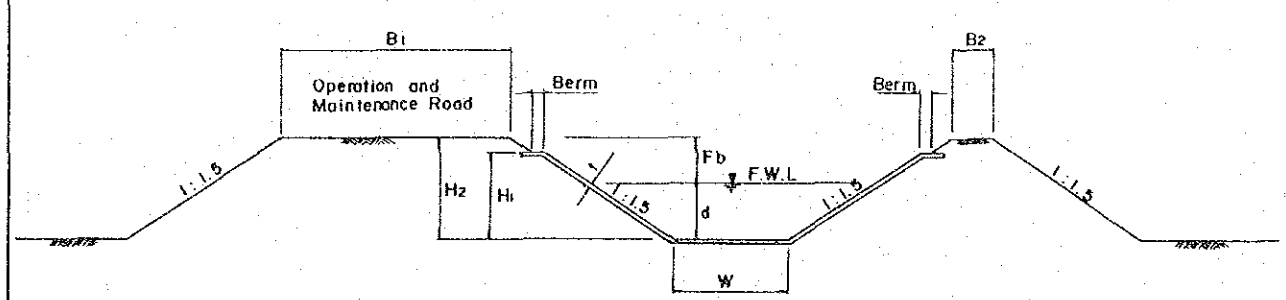
DW : Division Work
CH : Check Structure
SP : Syphon
AQ : Aqueduct
SW : Spillway
VD : Vertical Drop
RC : Road Crossing
DC : Drain Culvert

FEASIBILITY STUDY ON BANG NARA IRRIGATION AND DRAINAGE PROJECT

IRRIGATION FACILITIES CANAL PROFILE (3/3)

DRAWING NO. ID 3 | DATE

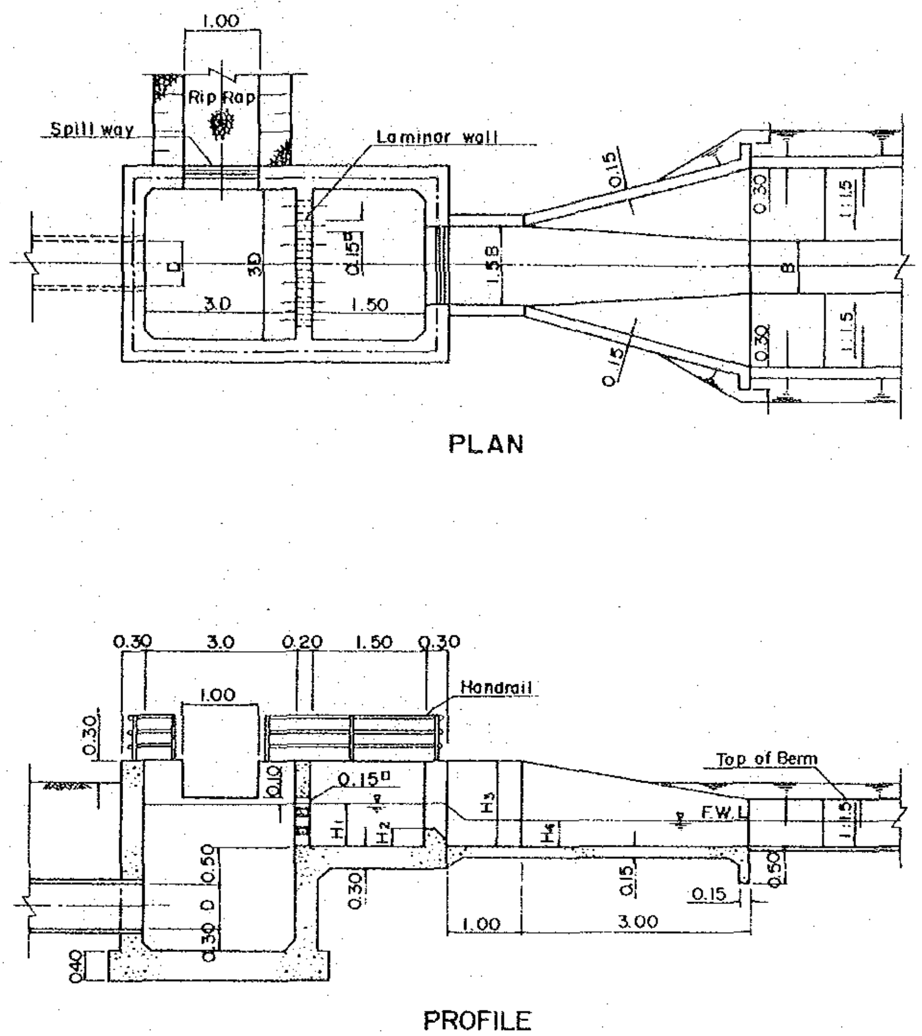
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL CANAL SECTION

TABLE OF DIMENSIONS FOR IRRIGATION CANAL

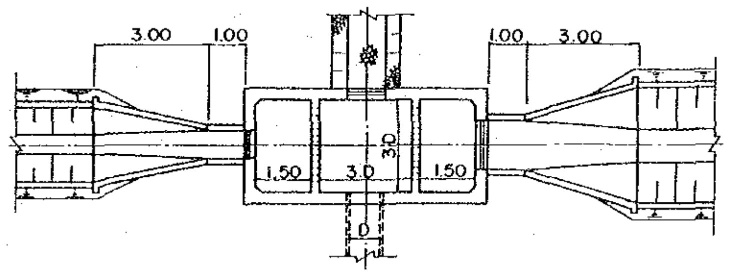
TYPE	Q m³/sec	W m	d m	Fb m	H1 m	H2 m	B1 m	B2 m	Berm m	t cm
I	0.01 ~ 0.20	0.50	0.25	0.45	0.50	0.70	3.00	0.50	Min 0.15	5
II	0.20 ~ 0.30	0.70	0.35	0.50	0.65	0.85	3.00	0.50	- do -	5
III	0.30 ~ 0.60	0.90	0.45	0.50	0.75	0.95	3.00	0.50	- do -	5
IV	0.60 ~ 0.80	1.10	0.55	0.55	0.90	1.10	3.00	0.50	- do -	5
V	0.80 ~ 1.10	1.30	0.65	0.60	1.05	1.25	3.00	0.50	- do -	5
VI	1.10 ~ 1.50	1.50	0.75	0.60	1.15	1.35	3.00	0.50	- do -	5



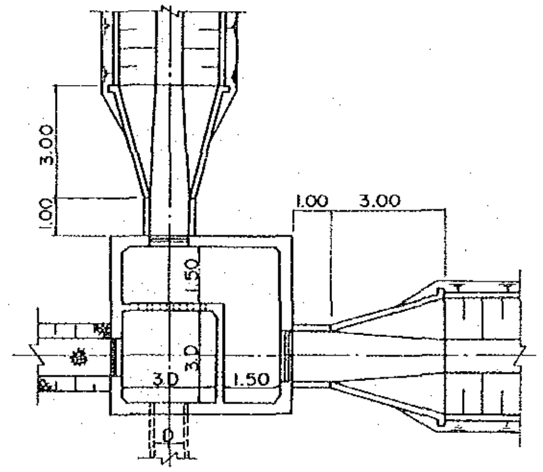
DISCHARGE TANK (TYPE 1)
Not to scale

TABLE OF DIMENSIONS FOR DISCHARGE TANK

Q m³/sec	B m	H1 m	H2 m	H3 m	H4 m
1.50 ~ 1.10	1.50	1.15	0.60	1.65	0.75
1.10 ~ 0.80	1.30	1.00	0.50	1.55	0.65
0.80 ~ 0.60	1.10	0.85	0.40	1.40	0.55
0.60 ~ 0.30	0.90	0.70	0.30	1.25	0.45
0.30 ~ 0.20	0.70	0.55	0.25	1.15	0.35
0.20 ~ 0.01	0.50	0.40	0.10	1.00	0.25

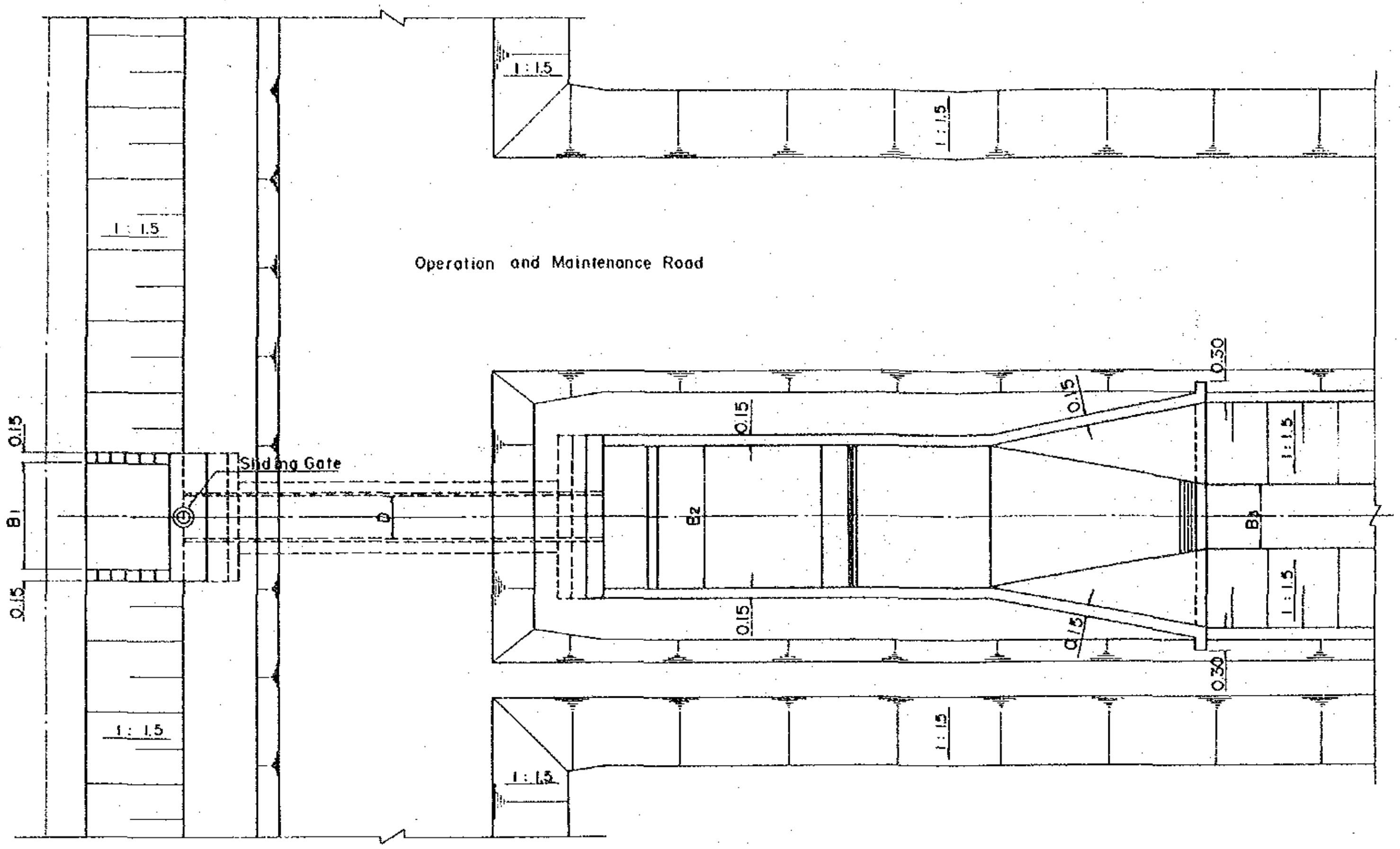


PLAN OF DISCHARGE TANK (TYPE 2)

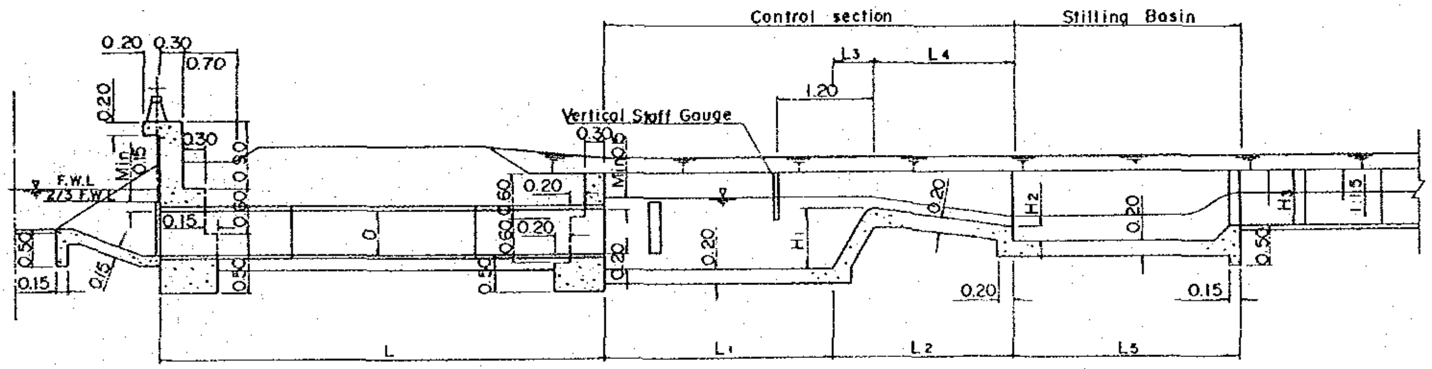


PLAN OF DISCHARGE TANK (TYPE 3)

FEASIBILITY STUDY ON BANG NARA IRRIGATION AND DRAINAGE PROJECT	
IRRIGATION FACILITIES RELATED STRUCTURES (1/5)	
DRAWING NO. ID 4	DATE
JAPAN INTERNATIONAL COOPERATION AGENCY	



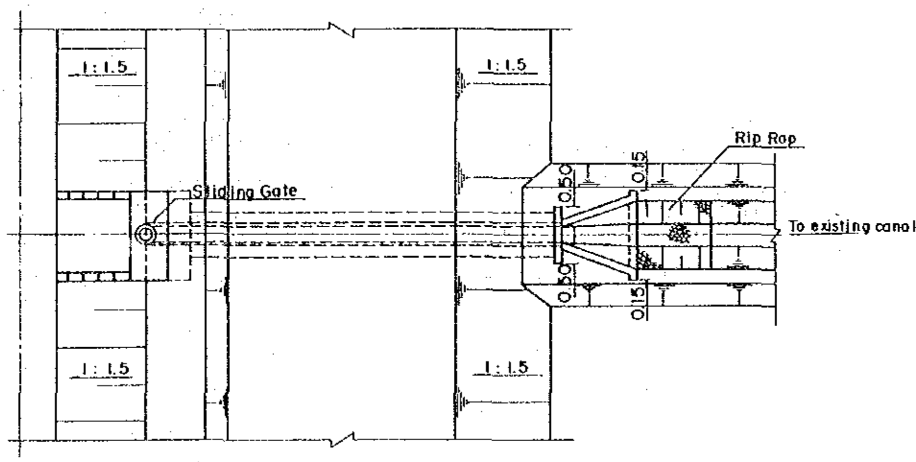
PLAN



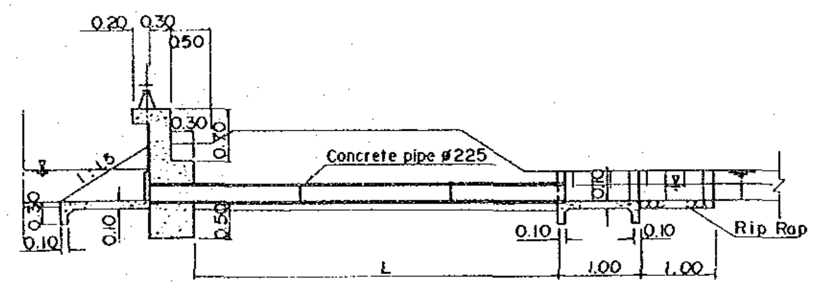
PROFILE

DIVISION WORK (TURNOUT)

Not to scale



PLAN



PROFILE

FARM TURNOUT (FTO)

Not to scale

TABLE OF DIMENSIONS FOR DIVISION WORK

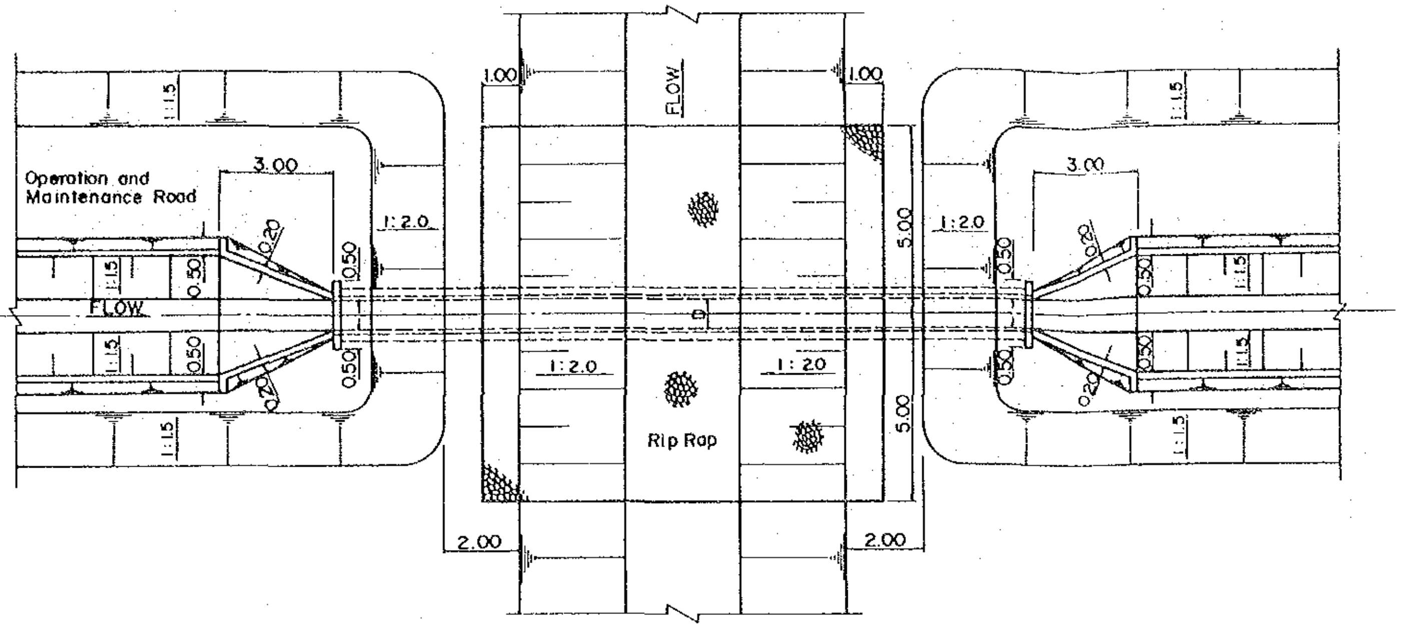
Q m³/sec	B1 m	B2 m	B3 m	L1 m	L2 m	L3 m	L4 m	L5 m	H1 m	H2 m	H3 m	Nos/D
0.50	2.30	2.80	0.90	3.20	2.60	0.40	2.20	4.00	0.80	0.20	0.75	2 / 600
0.30	1.50	2.20	0.70	3.20	2.60	0.40	2.20	4.00	0.80	0.20	0.65	1 / 600
0.15	1.00	1.10	0.50	2.60	2.00	0.30	1.70	2.00	0.65	0.15	0.50	1 / 450
0.10	1.00	0.60	0.50	2.00	1.20	0.20	1.00	1.00	0.50	0.15	0.50	1 / 300
0.05	1.00	0.50	0.50	2.00	1.15	0.15	1.00	1.00	0.45	0.15	0.50	1 / 250

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

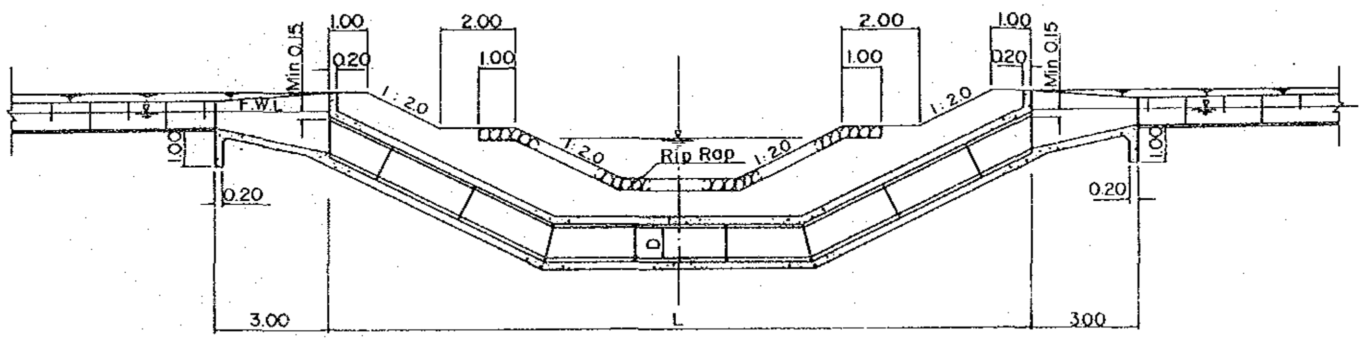
IRRIGATION FACILITIES
RELATED STRUCTURES (2/5)

DRAWING NO. ID 5 | DATE

JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN

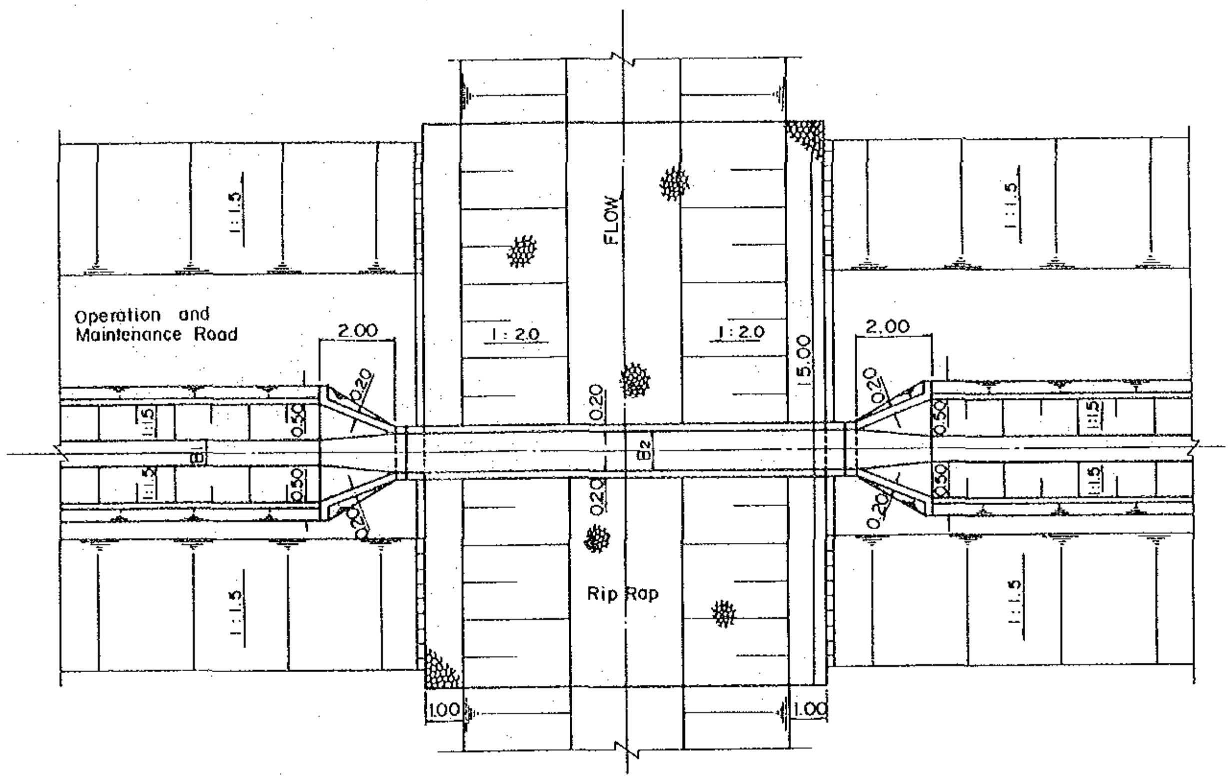


PROFILE

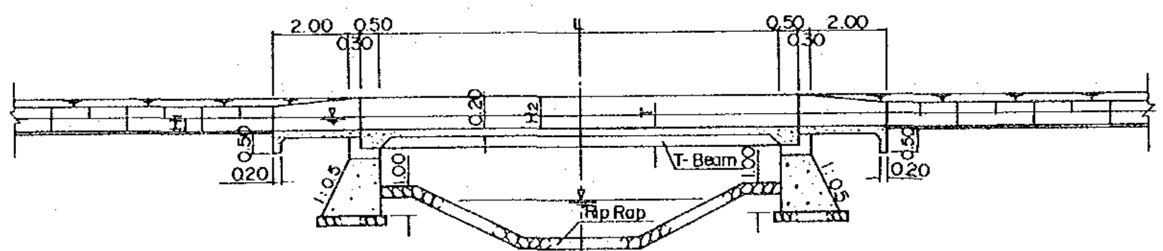
SYPHON
Not to Scale

TABLE OF DIMENSIONS FOR SYPHON

Q m³/sec	D m	Remarks
Less than 0.30	0.60	Concrete pipe
0.30 ~ 0.60	0.80	
0.60 ~ 0.80	1.00	
0.80 ~ 1.10	1.10	
1.10 ~ 1.50	1.30	



PLAN



PROFILE

AQUEDUCT
Not to scale

TABLE OF DIMENSIONS FOR AQUEDUCT

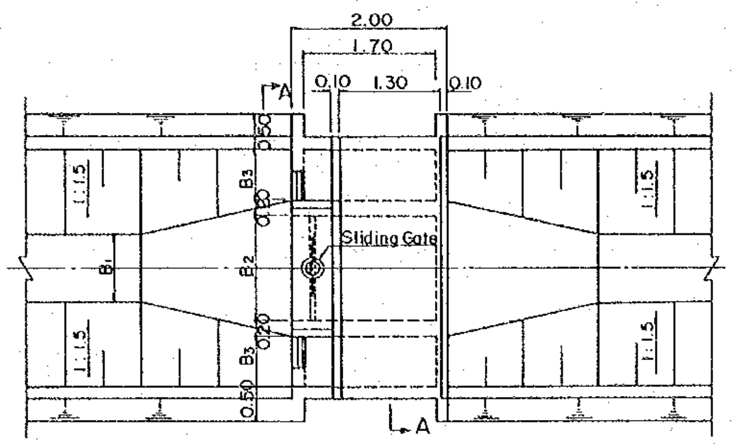
Q m³/sec	B1 m	B2 m	H1 m	H2 m	Remarks
1.50 ~ 1.10	1.50	2.60	0.75	1.35	L = 15m, T = 0.60m
1.10 ~ 0.80	1.30	2.30	0.65	1.25	L = 10m, T = 0.50m
0.80 ~ 0.60	1.10	1.90	0.55	1.10	L = 6m, T = 0.45m
0.60 ~ 0.30	0.90	1.60	0.45	0.95	
0.30 ~ 0.20	0.70	1.20	0.35	0.85	
0.20 ~ 0.01	0.50	0.90	0.25	0.70	

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

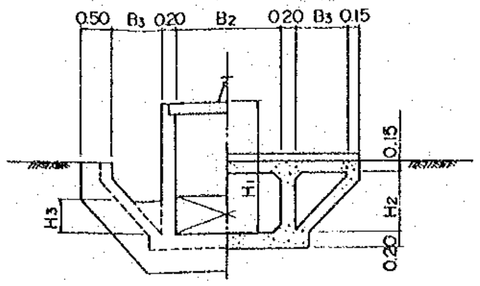
IRRIGATION FACILITIES
RELATED STRUCTURES (3/5)

DRAWING NO. ID 6	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY



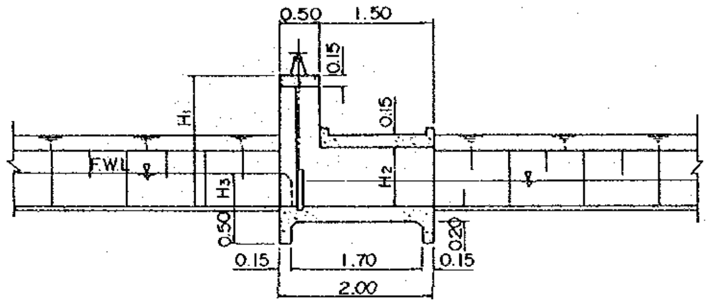
PLAN



SECTION A - A

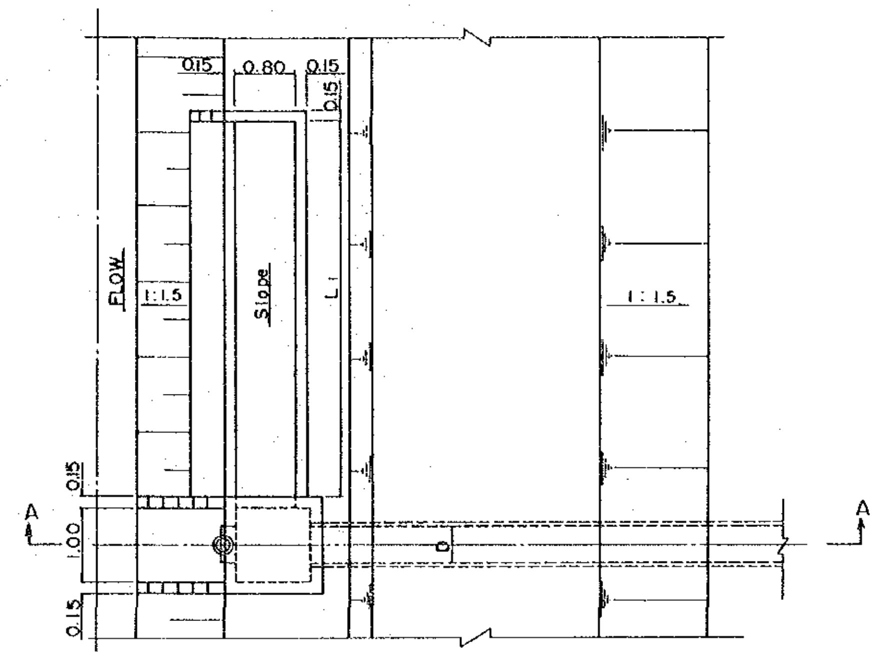
TABLE OF DIMENSIONS FOR CHECK STRUCTURE

B_1 m	B_2 m	B_3 m	H_1 m	H_2 m	H_3 m
1.50	2.60	1.50	2.40	1.20	0.75
1.30	2.30	1.40	2.20	1.10	0.65
1.10	1.90	1.25	2.00	0.95	0.55
0.90	1.60	1.10	1.70	0.80	0.45
0.70	1.20	1.05	1.50	0.70	0.35
0.50	0.90	0.85	1.30	0.55	0.25

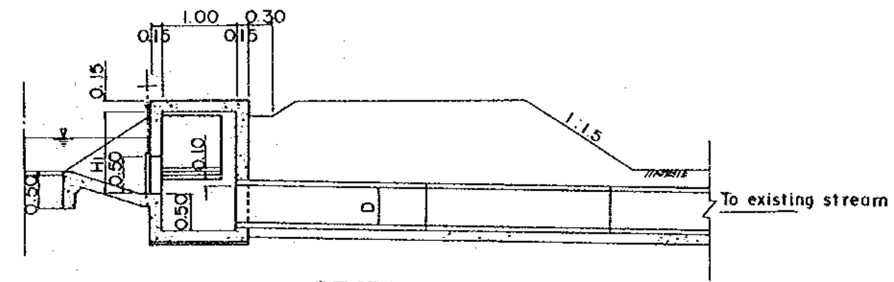


PROFILE

CHECK STRUCTURE
Not to scale

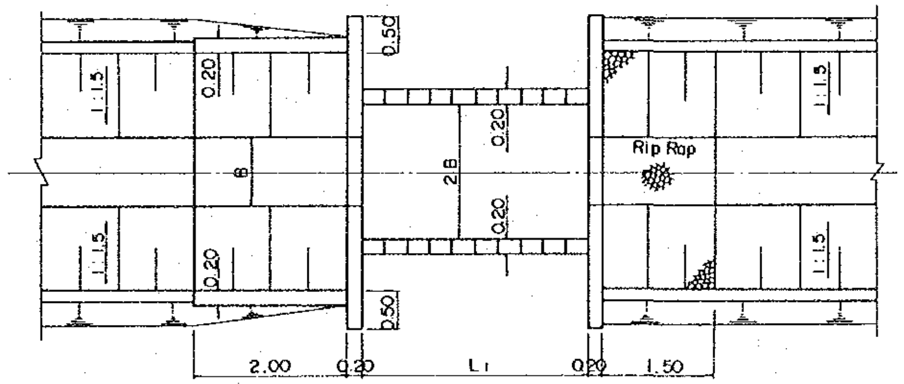


PLAN



SECTION A - A

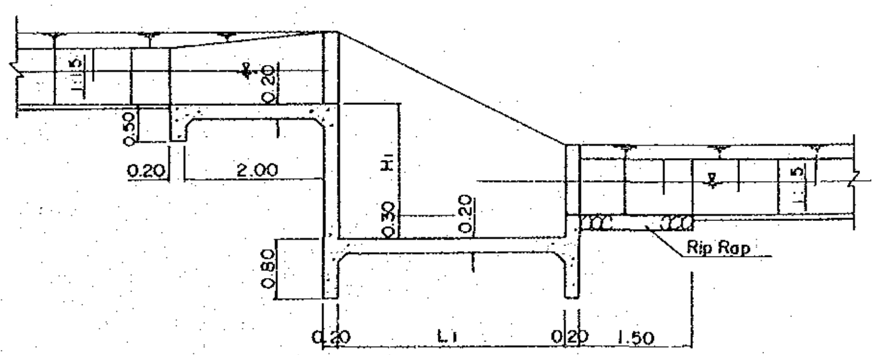
SPILL WAY
Not to scale



PLAN

TABLE OF DIMENSIONS FOR VERTICAL DROP

H_1 m	L_1 m	Remarks
1.00	2.50	–
1.50	3.00	–



PROFILE

VERTICAL DROP
Not to scale

TABLE OF DIMENSIONS FOR SPILL WAY

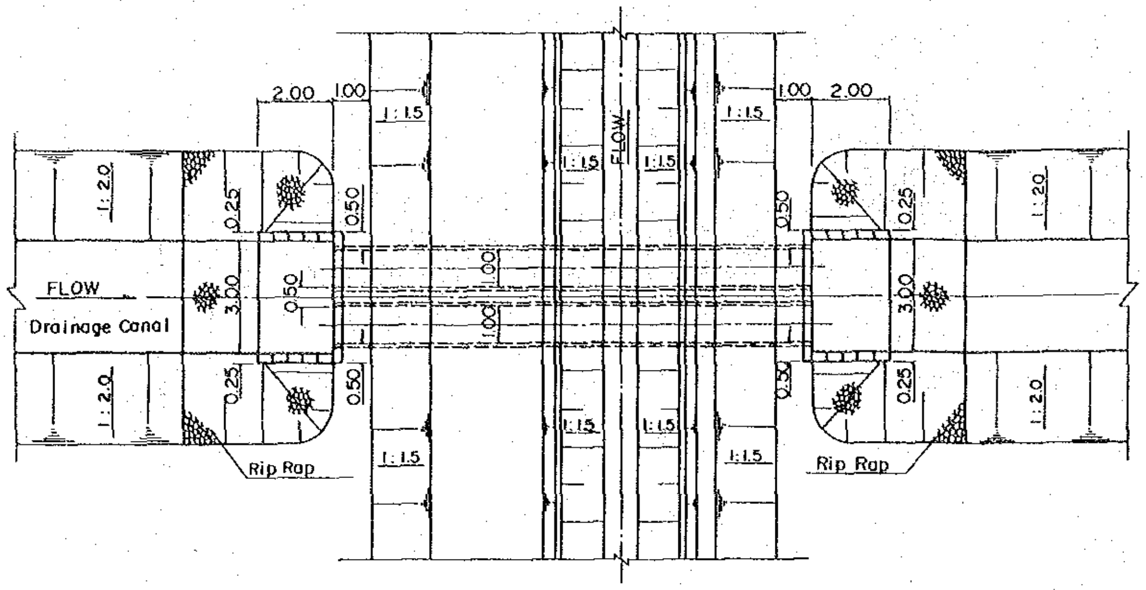
Q m^3/sec	L_1 m	H_1 m	D_1 m
Less than 0.50	3.00	1.20	0.50
0.50 ~ 1.00	6.00	1.40	0.60

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

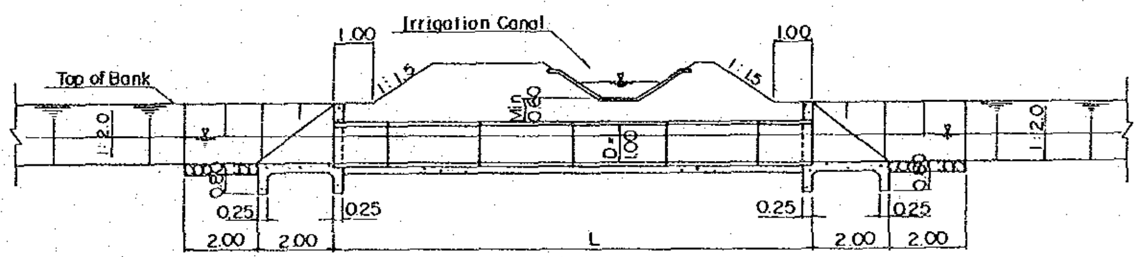
IRRIGATION FACILITIES
RELATED STRUCTURES (4/5)

DRAWING NO. ID 7 | DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

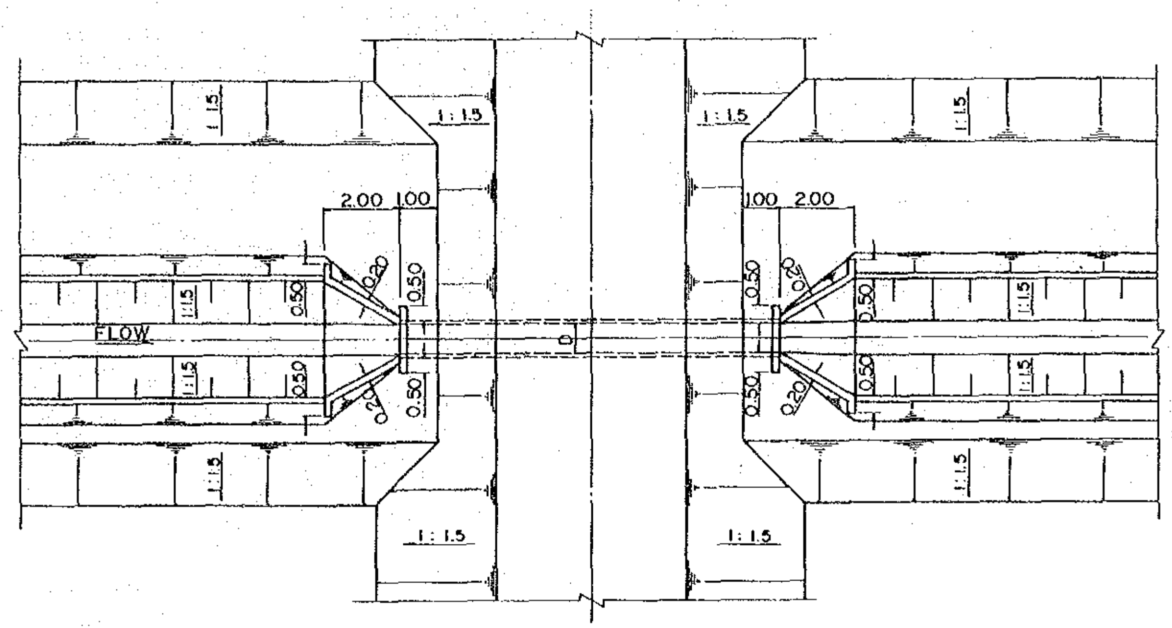


PLAN

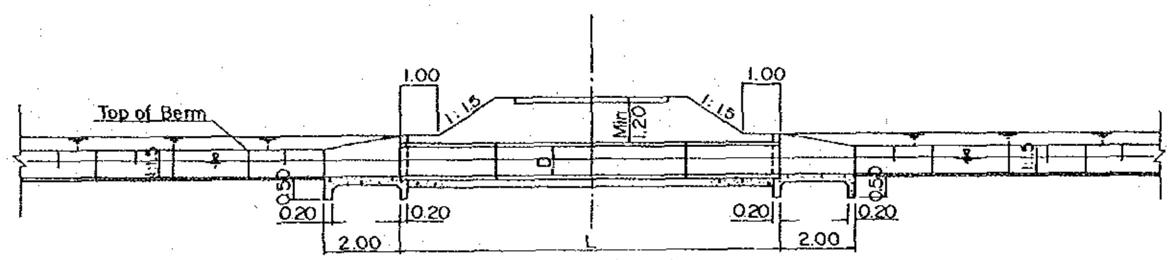


PROFILE

DRAIN CULVERT
Not to Scale



PLAN



PROFILE

ROAD CROSSING
Not to Scale

TABLE OF DIMENSIONS FOR ROAD CROSSING

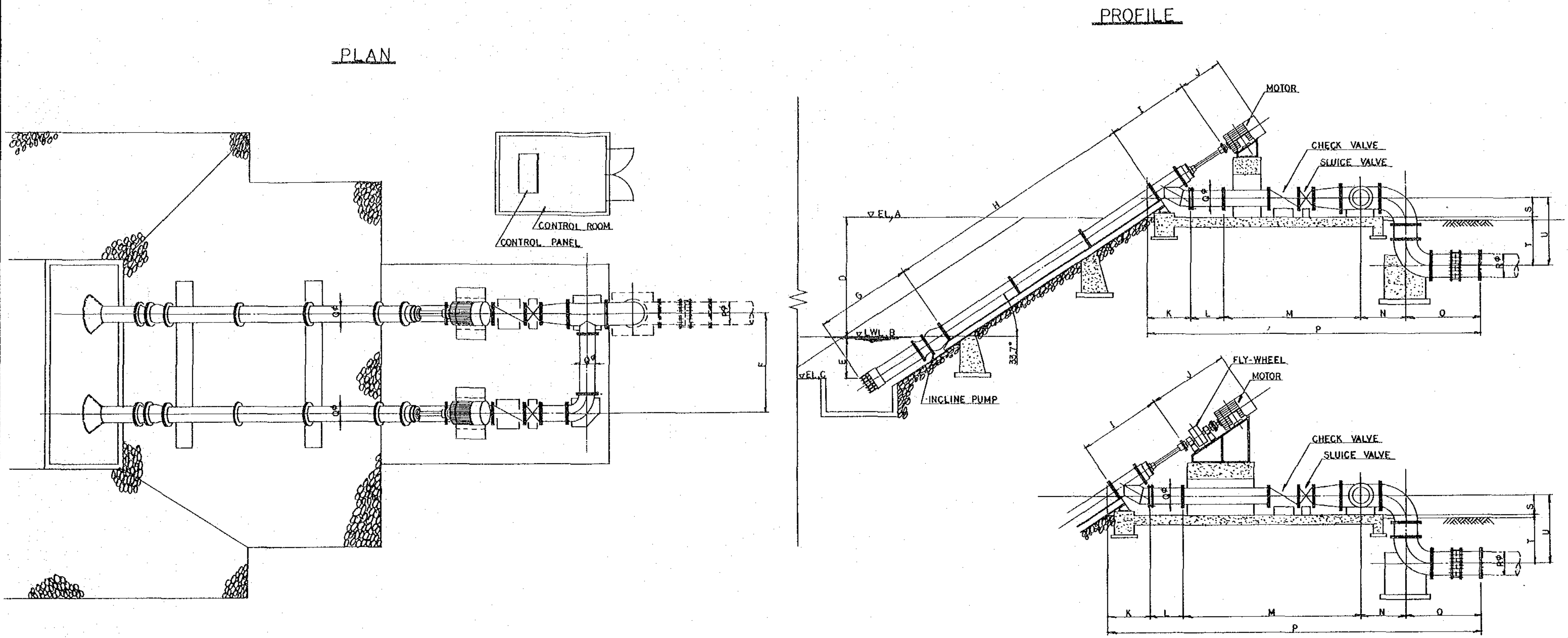
Q m³/sec	D m	Nos. of pipe Beam	Remarks
Less than 0.30	0.60	1	Concrete pipe
0.30 ~ 0.60	0.80	1	
0.60 ~ 0.80	1.00	2	

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

IRRIGATION FACILITIES
RELATED STRUCTURES (5/5)

DRAWING NO. ID8 | DATE

JAPAN INTERNATIONAL COOPERATION AGENCY



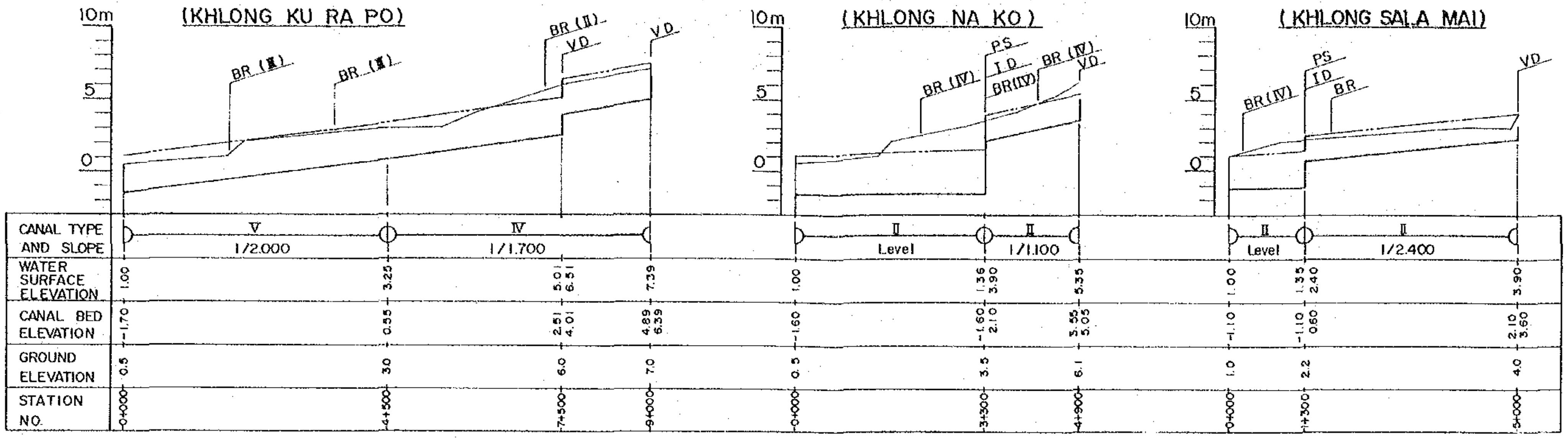
NO	P/S NAME	DIA. OF PUMP (mm)	TYPE OF PUMP	CAPACITY (m^3/min)	HEAD (m)	SPEED (rpm)	OUT PUT (kW)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	REMARKS
1	PU TA	300	MIXED FLOW	9.6	7.0	1450	18.5	+5.84	+0,84	+0,84	5000	750	2000	1780	9870	1740	653	821	750	4529	1400	2500	10000	300	600	600	1900	2500	
2	KHAO KONG	450	MIXED FLOW	23.1	7.9	980	45	+7.53	+1,64	+1 64	5890	1130	2000	2665	11550	2260	845	1140	930	4030	1400	2500	10000	450	600	600	1900	2500	
3	DU SONG	500	MIXED FLOW	36,6	17.9	980	160	+3.40	-0,37	-1,60	3770	1250	2000	2950	7500	2450	2335	1229	1124	4747	1400	2500	11000	500	900	700	1800	2500	FLY-WHEEL
4	TAN YONG MAT	600	AXIAL FLOW	45	5	740	55	+16,80	+10,91	+10,90	5890	1500	2000	3535	11500	2750	880	1432	1200	4468	1500	2500	11000	600	900	700	1800	2500	
5	KHOK TI TE	450	MIXED FLOW	25,2	21.5	980	132	+3,50	- 0.42	-1,50	3920	1130	2000	2670	7800	2260	2335	1140	930	5030	1400	2500	11000	450	800	700	1800	2500	FLY-WHEEL
		400	MIXED FLOW	21	11.7	1475	75					1000	2000	2670	7800	2050	880	1016	850	4234	1400	2500	10000	400	800	700	1800	2500	FLY-WHEEL
6	MARU BO	400	MIXED FLOW	19.5	12.9	1475	75	+3.90	-0.29	-1,10	4190	1000	2000	2360	8300	2050	880	1016	850	4234	1400	2500	10000	400	700	700	1800	2500	
7	SALA MAI	400	MIXED FLOW	20,4	9.3	1475	55	+3.00	-0.29	-1.10	3290	1000	2000	2360	6000	2050	845	1016	850	4234	1400	2500	10000	400	700	700	1800	2500	
8	KO SAWAT	400	MIXED FLOW	21.6	6,7	980	37	+4,30	-0.20	-3.70	4500	1000	2000	2360	8000	2050	826	1016	850	4234	1400	2500	10000	400	800	700	1800	2500	
9	PHRU KAP DAENG	400	MIXED FLOW	15.6	7.2	980	30	+4,30	-0 20	-3.70	4500	1000	2000	2360	8000	2050	826	1016	850	4234	1400	2500	10000	400	700	700	1800	2500	
10	KU CHAM	300	MIXED FLOW	7,8	8.4	1475	18,5	+4.60	-0.20	-3.40	4800	750	2000	1780	9200	1740	653	821	750	4529	1400	2500	10000	300	600	600	1900	2500	

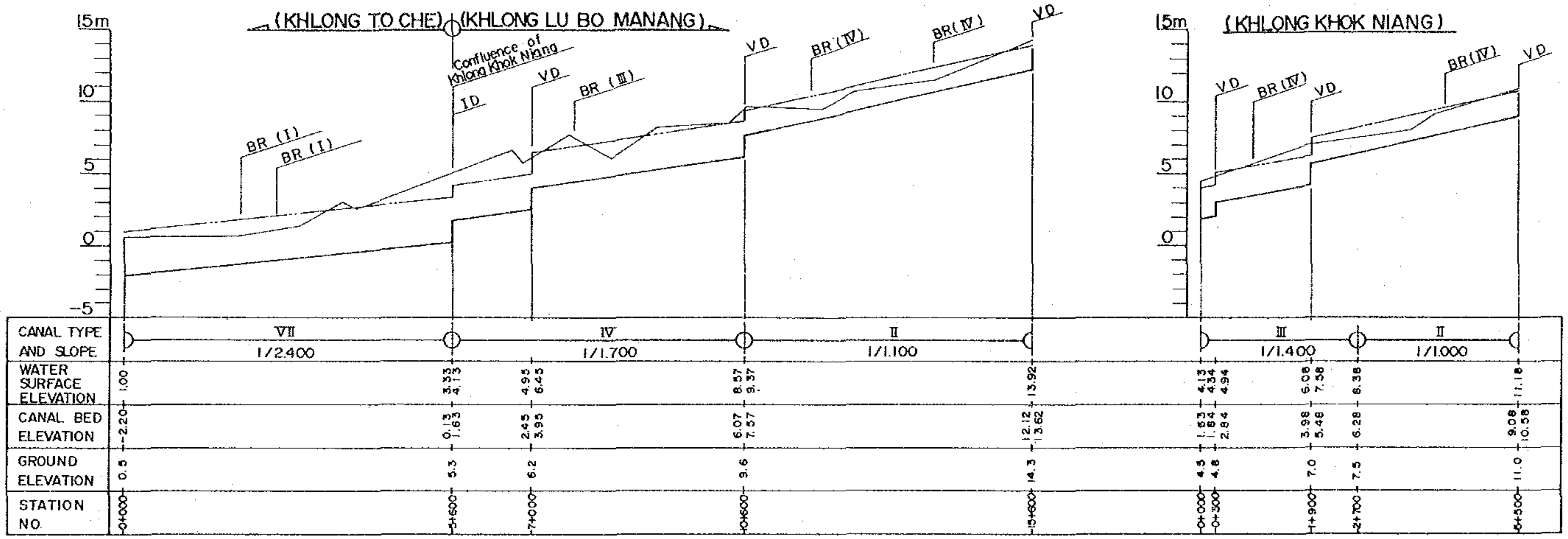
FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

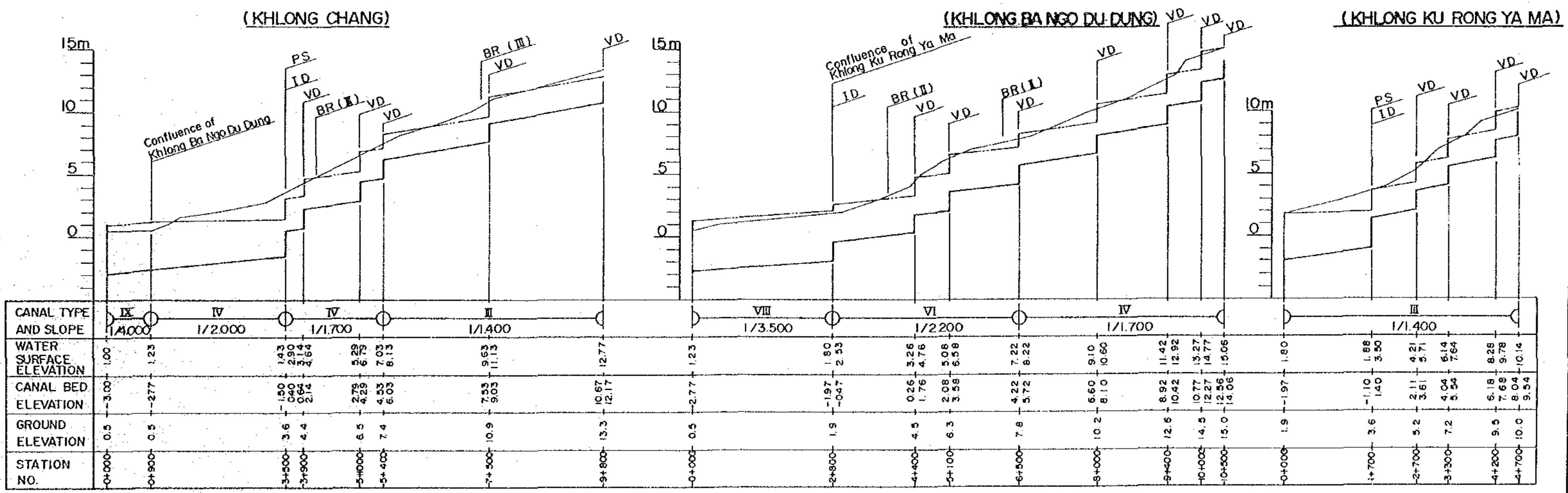
IRRIGATION FACILITIES
INCLINED PUMP FACILITIES

DRAWING NO. ID 9 | DATE

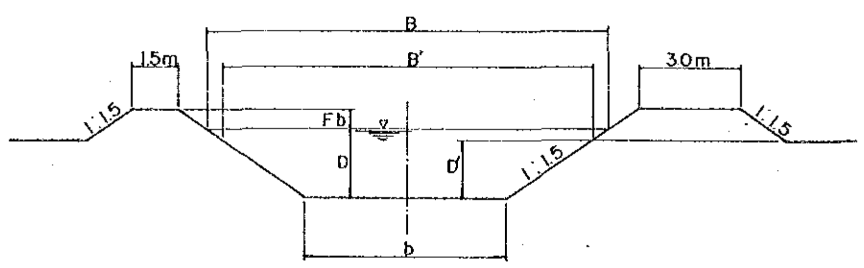
JAPAN INTERNATIONAL COOPERATION AGENCY







TYPICAL CROSS-SECTION



DIMENSION TABLE

TYPE	Q (m³/sec)	A (m2)	D (m)	D' (m)	b (m)	Fb (m)	B (m)	B' (m)
I	5	4.9	1.3	0.9	2.0	0.3	5.9	4.7
II	10	9.5	1.8	1.4	3.0	0.3	8.4	7.2
III	15	14.3	2.1	1.7	4.0	0.3	10.3	9.1
IV	20	19.0	2.5	2.1	4.0	0.4	11.5	10.3
V	25	23.8	2.7	2.3	5.0	0.4	13.1	11.9
VI	30	28.6	3.0	2.6	5.0	0.4	14.0	12.8
VII	35	33.3	3.2	2.8	6.0	0.4	15.6	14.4
VIII	60	57.1	4.0	3.6	8.5	0.4	20.5	19.3
IX	80	76.2	4.0	3.6	13.5	0.4	25.5	24.3

LEGEND

PS : Pumping Station
VD : Vertical Drop
ID : Inclined Drop
BR : Bridge (Type)

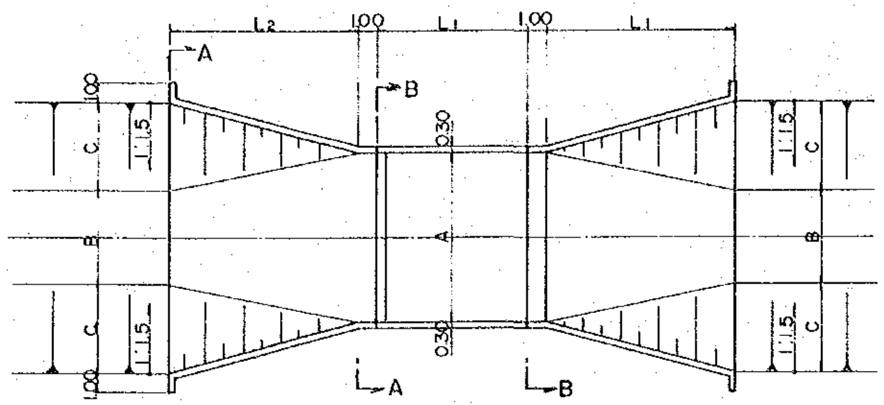
FEASIBILITY STUDY ON BANG NARA IRRIGATION AND DRAINAGE PROJECT

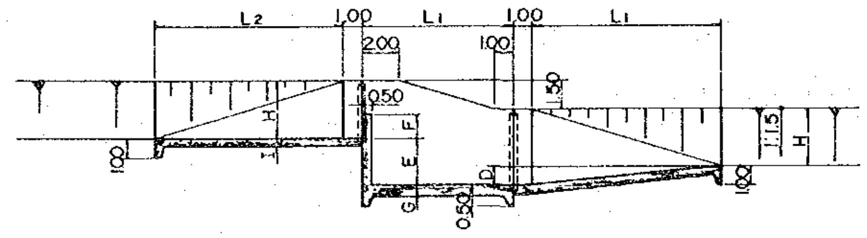
DRAINAGE FACILITIES CANAL PROFILE

DRAWING NO. ID10	DATE

JAPAN INTERNATIONAL COOPERATION AGENCY

VERTICAL DROP

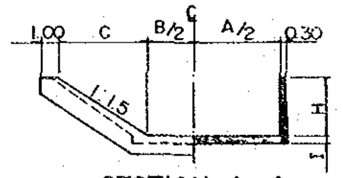


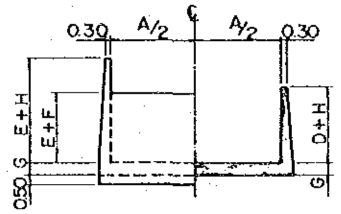


DIMENSION TABLE

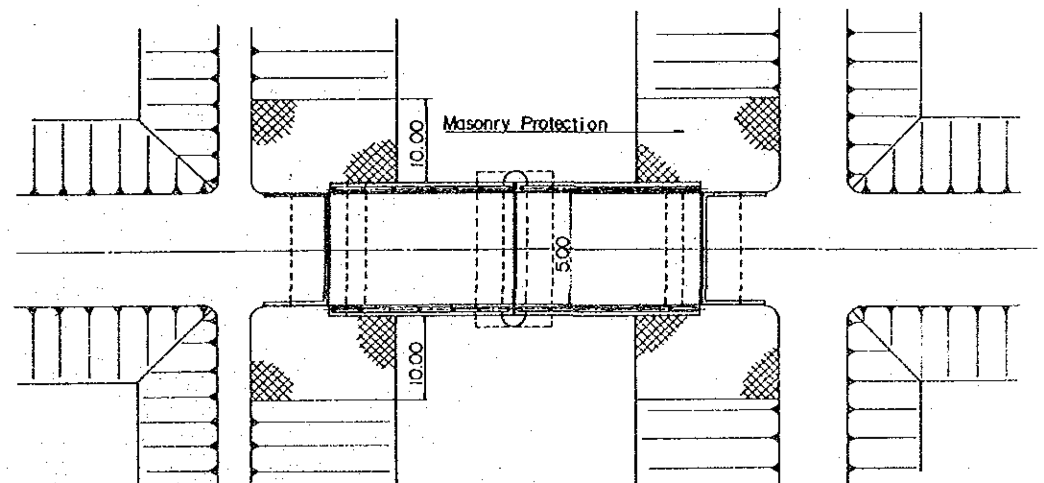
(Unit : m)

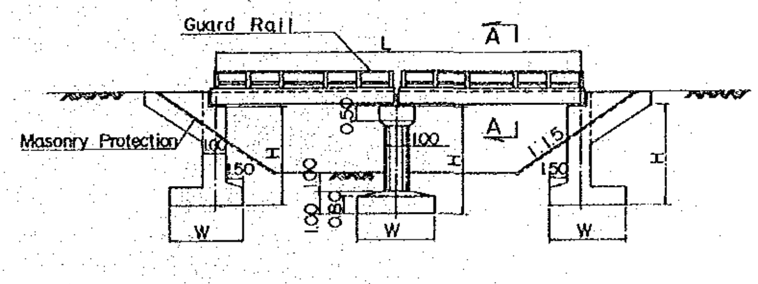
Type of Canal	A	B	C	D	E	F	G	H	I	L1	L2
I	4.00	2.00	2.40	0.75	2.25	0.45	0.40	1.60	0.30	5.00	6.00
II	5.70	3.00	3.15	0.85	2.35	0.70	0.45	2.10	0.30	6.00	6.00
III	7.20	4.00	3.75	0.90	2.40	0.90	0.50	2.40	0.30	6.50	8.00
IV	7.80	4.00	4.35	1.00	2.50	1.15	0.55	2.90	0.30	7.50	9.00
V	9.10	5.00	4.65	1.05	2.55	1.25	0.60	3.10	0.35	7.50	10.00
VI	9.50	5.00	5.10	1.10	2.60	1.50	0.60	3.40	0.35	8.00	10.50
VII	10.80	6.00	5.40	1.15	2.65	1.55	6.65	3.60	0.40	9.00	11.00
VIII	14.50	8.50	6.60	1.25	2.75	2.15	0.70	4.40	0.45	10.00	14.00
IX	19.00	13.00	6.60	1.25	2.75	2.15	0.70	4.40	0.45	10.00	15.50

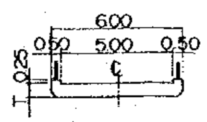




BRIDGE





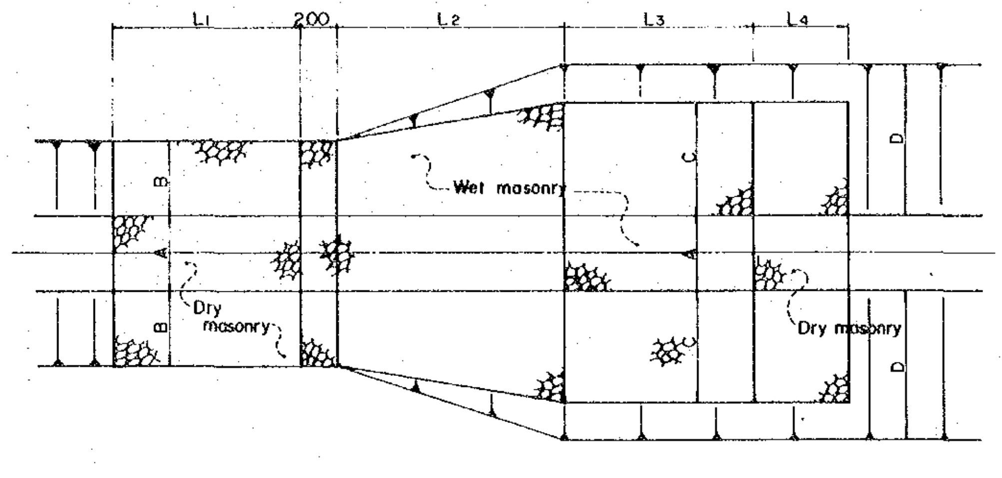


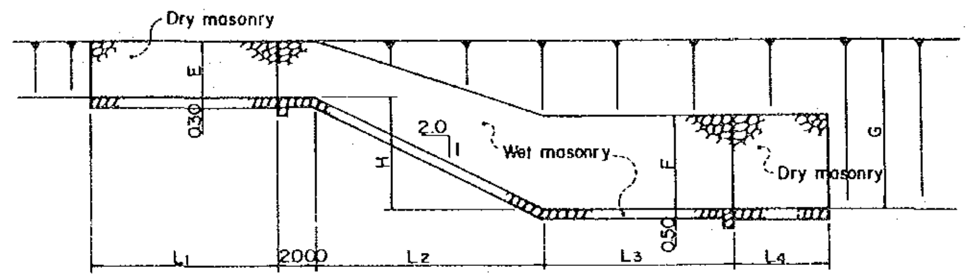
DIMENSION TABLE

(Unit : m)

Type of Bridge	L	T	H	W	Remarks
I	18.00	0.70	6.00	4.50	
II	15.50	0.65	5.50	4.00	
III	14.00	0.65	5.00	3.50	
IV	11.50	0.60	4.50	3.50	

INCLINED DROP





DIMENSION TABLE

(Unit : m)

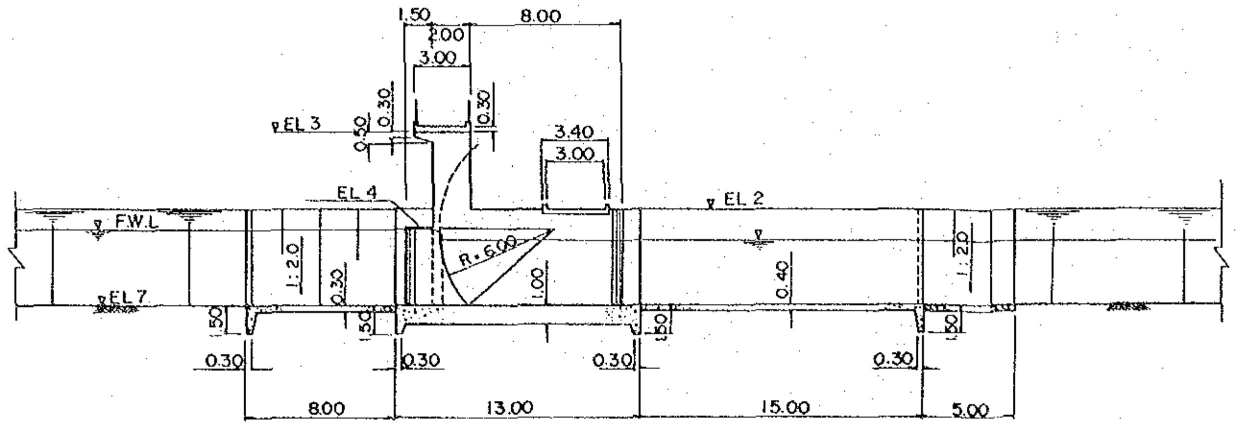
Khlong	L1	L2	L3	L4	A	B	C	D	E	F	G	H	Type of Canal
K. Na Ko	6.00	7.40	8.00	4.00	3.00	3.15	4.35	8.70	2.10	2.90	5.80	3.70	II.
K. Chang	9.00	3.80	7.00	3.50	4.00	4.35	4.20	7.65	2.90	2.80	5.10	1.90	IV
K. Ku Rong Ya Ma	8.00	5.00	7.00	3.50	4.00	3.60	3.60	7.80	2.40	2.40	5.20	2.50	III
K. Ba Ngo Du Dung	10.50	3.20	7.00	3.50	5.00	5.10	4.50	7.50	3.40	3.00	5.00	1.60	VIII
K. Sala Mai	6.00	3.40	6.00	3.00	5.50	3.00	3.60	6.00	2.00	2.40	4.00	1.70	II

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

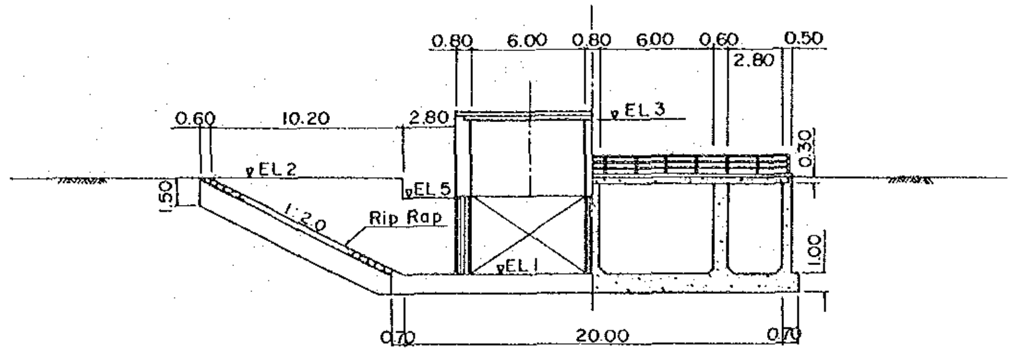
DRAINAGE FACILITIES
RELATED STRUCTURES

DRAWING NO. ID 11 | DATE

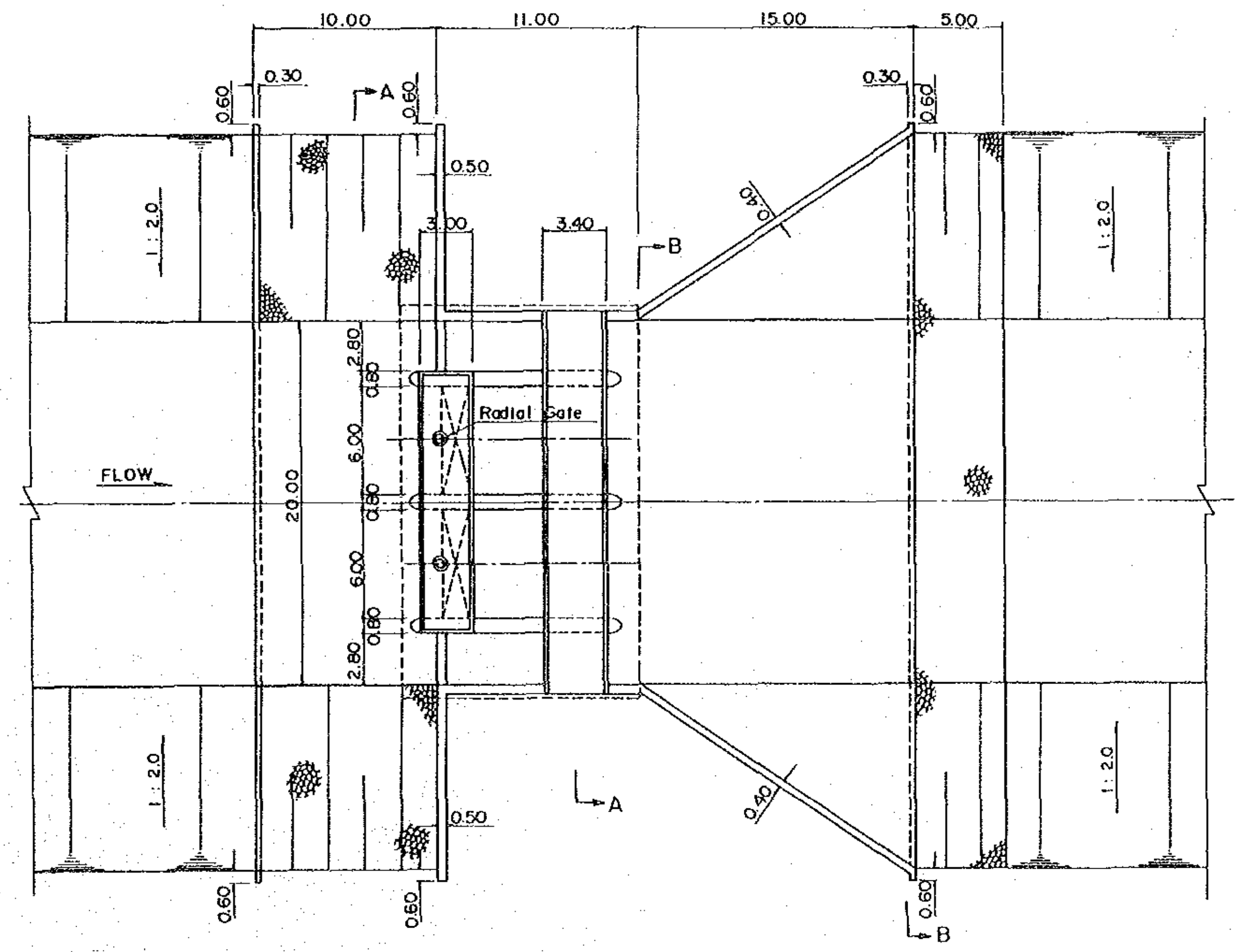
JAPAN INTERNATIONAL COOPERATION AGENCY



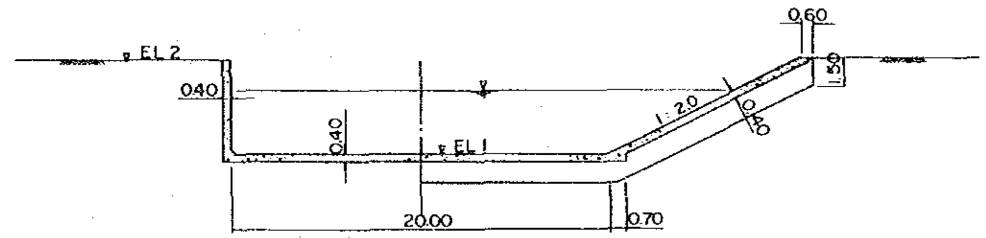
SECTIONAL ELEVATION



SECTION A - A



PLAN

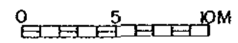


SECTION B - B

TABLE OF ELEVATIONS FOR CHECK GATE

Gate No	F.L.W	EL_1	EL_2	EL_3	EL_4	EL_5
No. 1	+0.50	-3.50	+1.60	+5.70	+1.00	+0.50
No. 2	+0.90	-3.00	+2.10	+6.20	+1.5	+0.90

SCALE

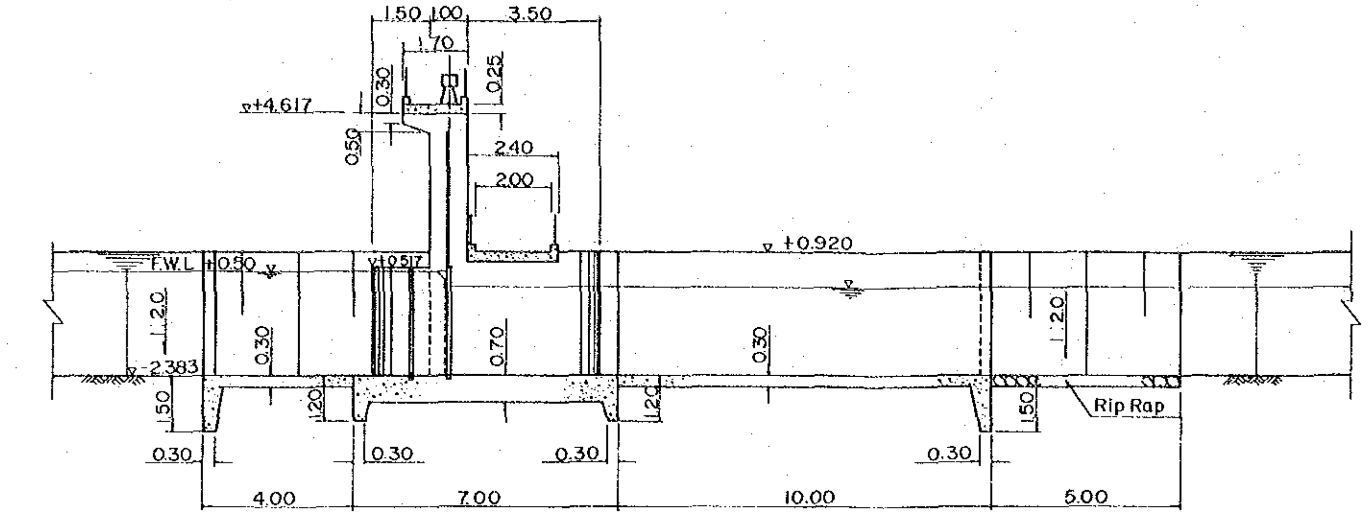


FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

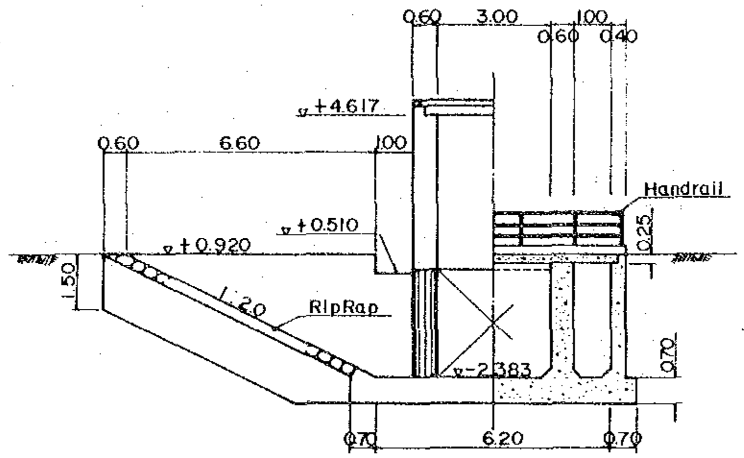
ACIDIC WATER FLOW CHECK STRUCTURES
SG. PADI CHECK GATE

DRAWING NO. ID 12 | DATE

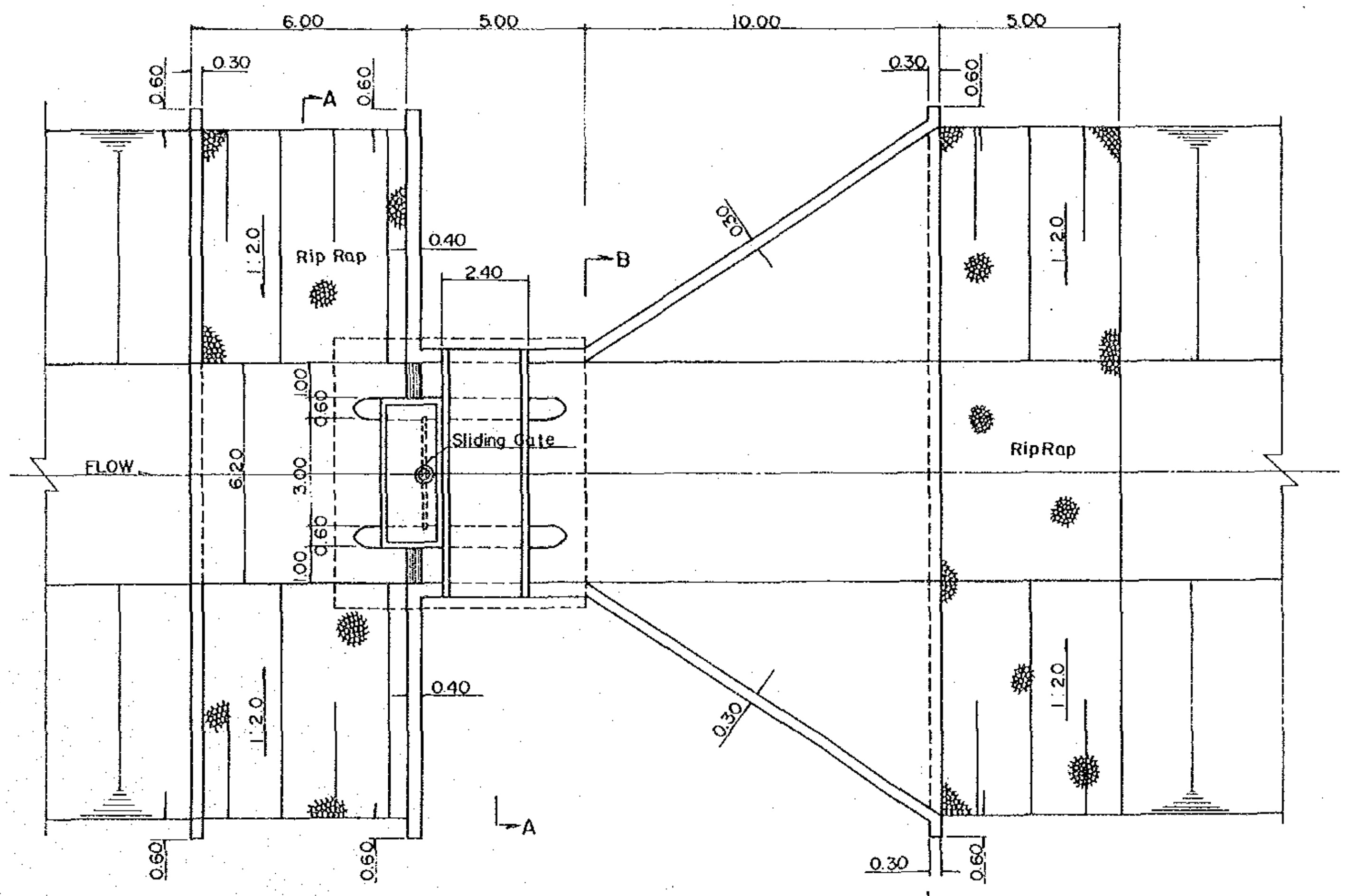
JAPAN INTERNATIONAL COOPERATION AGENCY



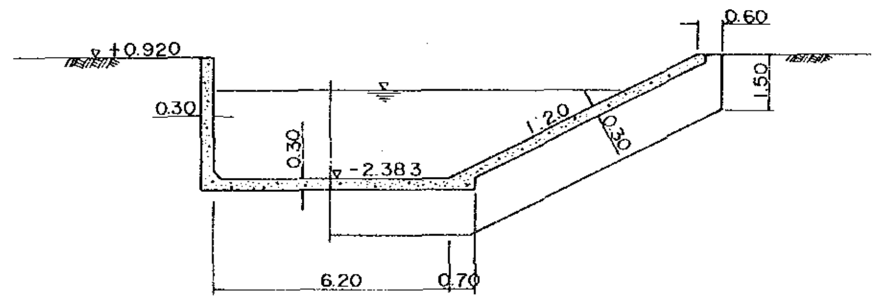
SECTIONAL ELEVATION



SECTION A-A



PLAN



SECTION B-B

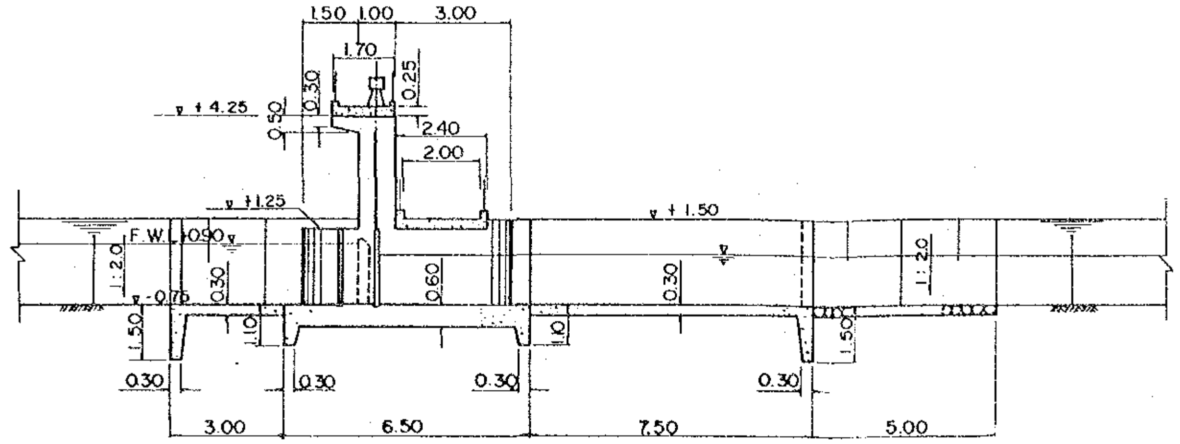
SCALE
0 5M

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

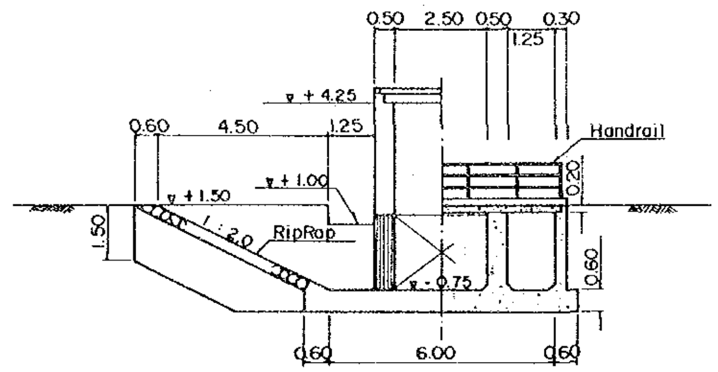
ACIDIC WTAER FLOW CHECK STRUCTURES
KU BAE YA HAE CHECK GATE

DRAWING NO. ID13	DATE

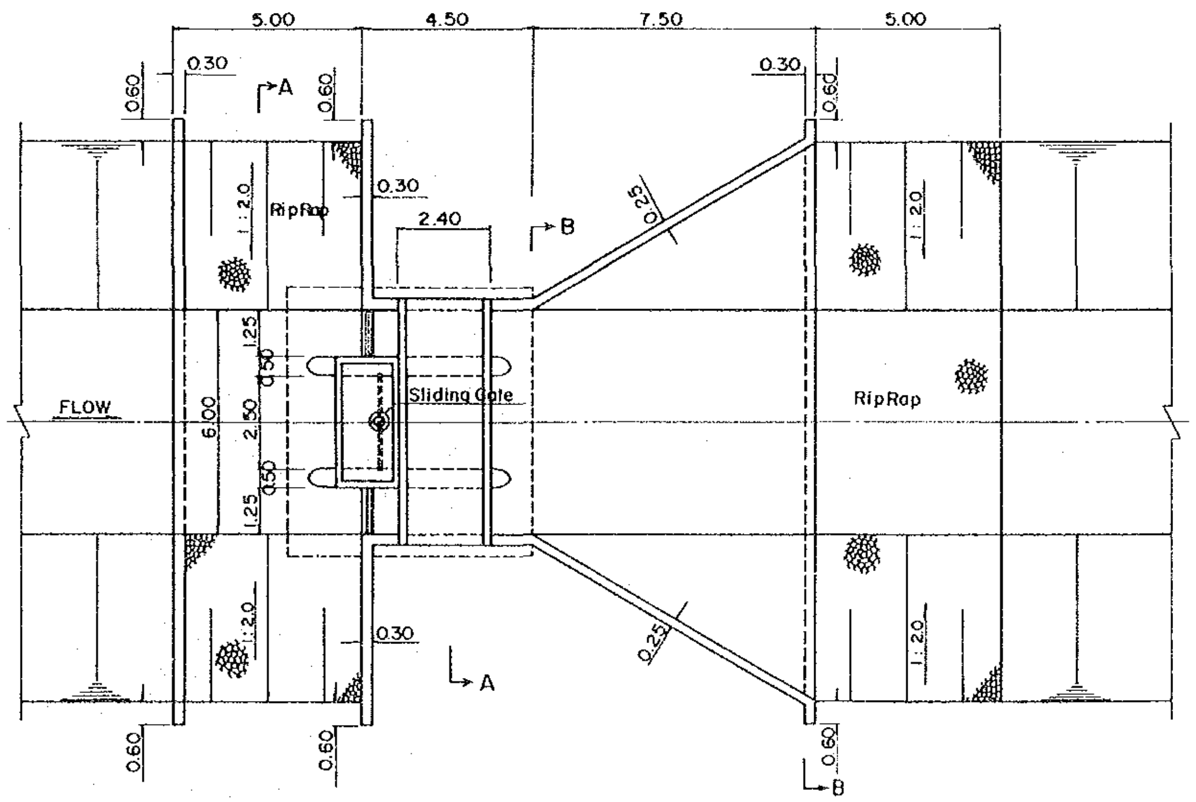
JAPAN INTERNATIONAL COOPERATION AGENCY



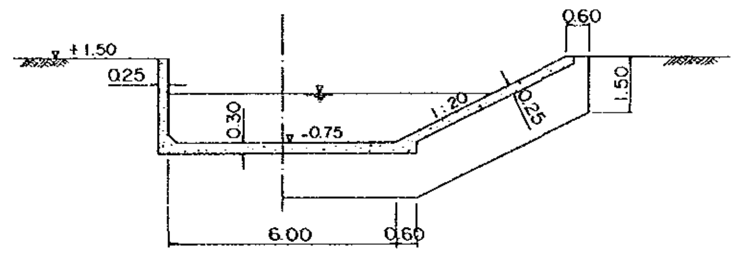
SECTIONAL ELEVATION



SECTION A – A



PLAN



SECTION B – B

SCALE

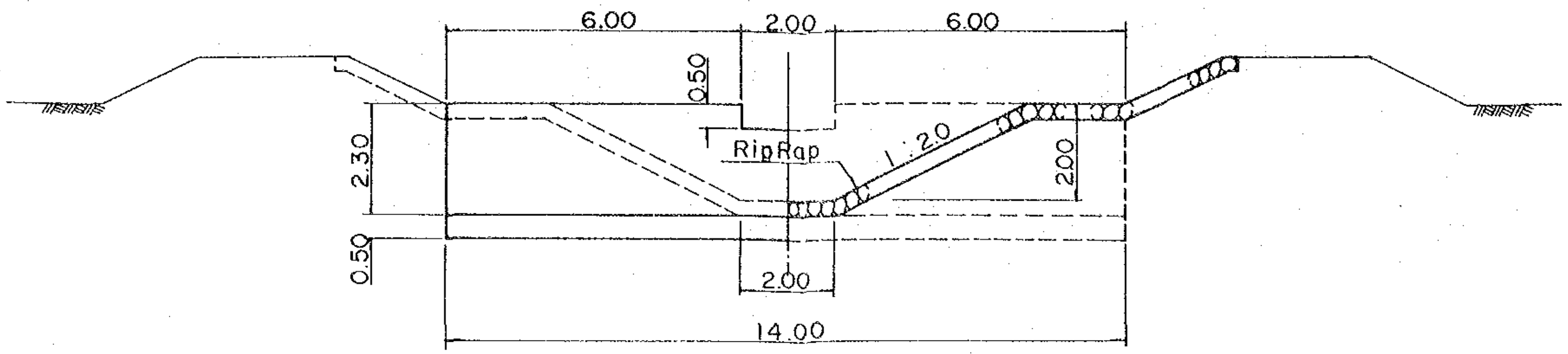
0 5M

FEASIBILITY STUDY
ON BANG NARA IRRIGATION AND
DRAINAGE PROJECT

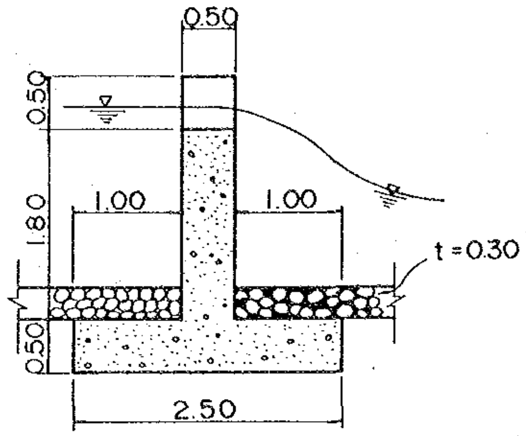
ACIDIC WATER FLOW CHECK STRUCTURES
TO LANG CHECK GATE

DRAWING NO. ID 14	DATE	

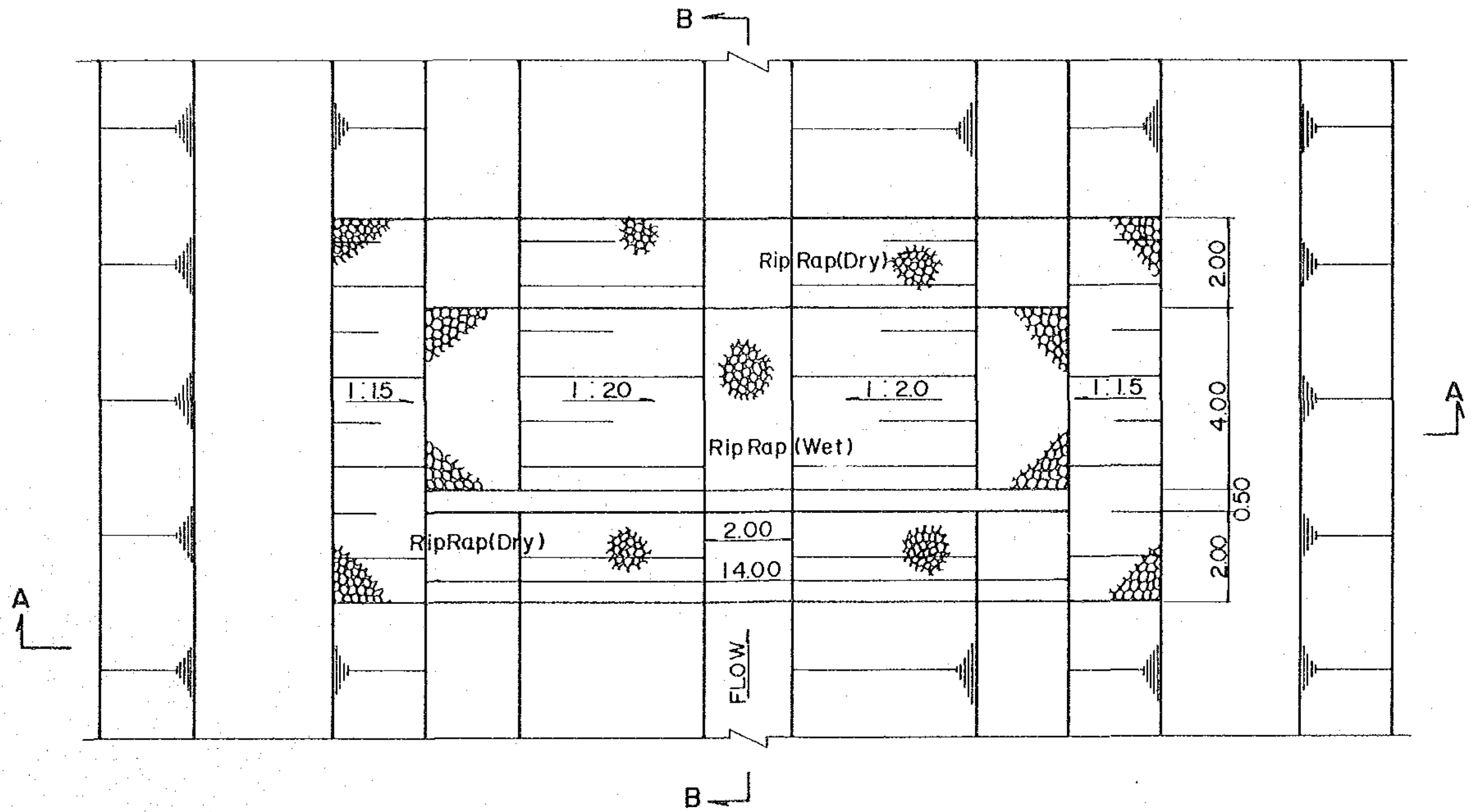
JAPAN INTERNATIONAL COOPERATION AGENCY



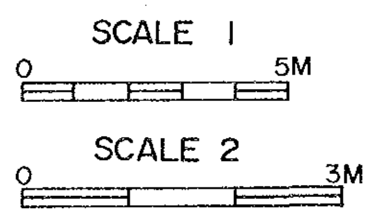
SECTION A - A
SCALE 1



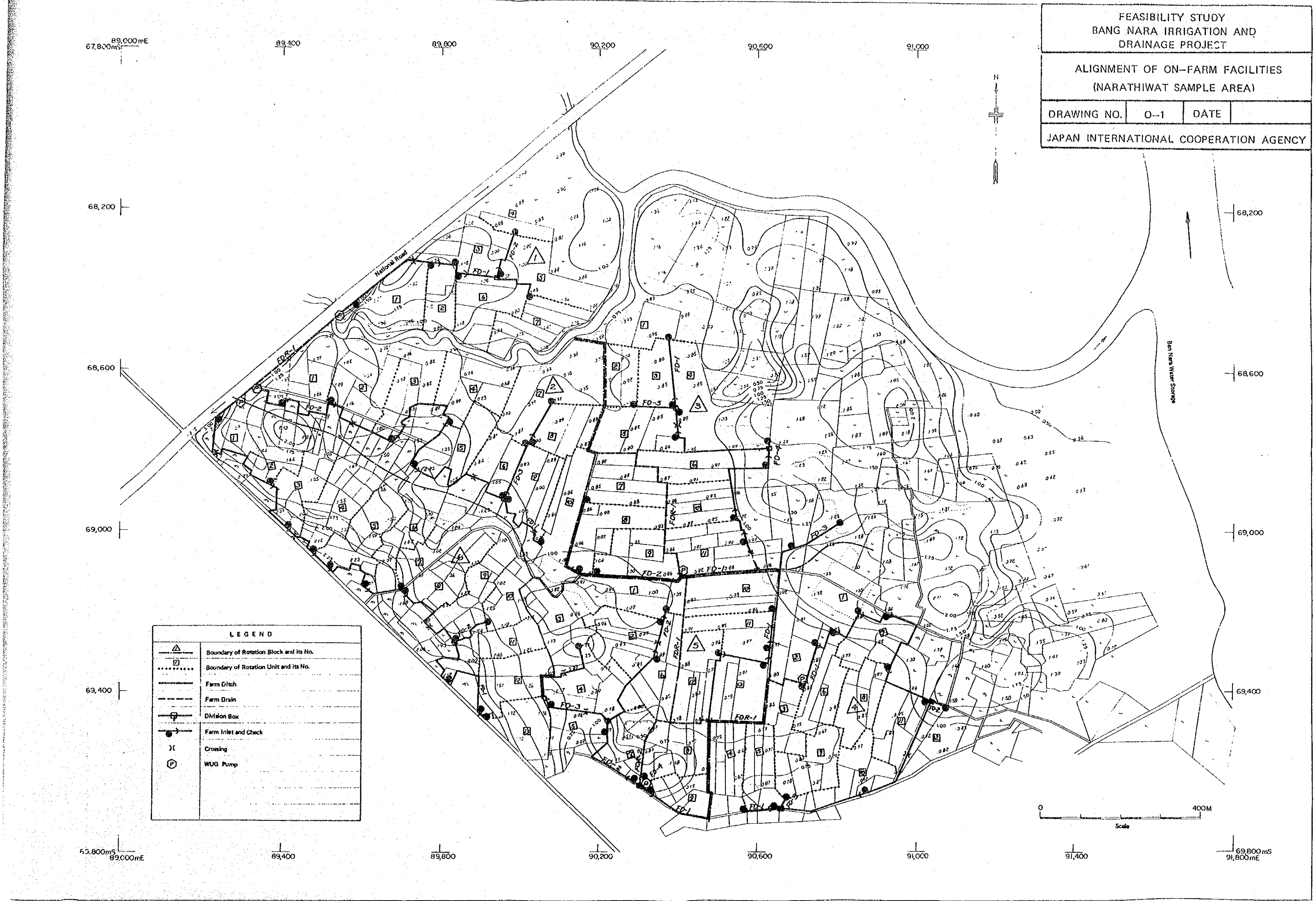
SECTION B - B
SCALE 2



PLAN
SCALE 1



FEASIBILITY STUDY ON BANG NARA IRRIGATION AND DRAINAGE PROJECT
ACIDIC WATER FLOW CHECK STRUCTURES BAN TOEI CHECK WEIR
DRAWING NO. ID 15 / DATE
JAPAN INTERNATIONAL COOPERATION AGENCY


FEASIBILITY STUDY
BANG NARA IRRIGATION AND DRAINAGE PROJECT
ALIGNMENT OF ON-FARM FACILITIES
(NARATHIWAT SAMPLE AREA)
DRAWING NO. O-1
DATE
JAPAN INTERNATIONAL COOPERATION AGENCY
LEGEND
Boundary of Rotation Block and its No.
Boundary of Rotation Unit and its No.
Farm Ditch
Farm Drain
Division Box
Farm Inlet and Check
Crossing
WUG Pump
National Road
Bang Nara Water Storage
N
400M
Scale
89,000mE
89,400
89,800
90,200
90,600
91,000
91,400
91,800mE
67,800mS
68,200
68,600
69,000
69,400
69,800mS

FEASIBILITY STUDY
BANG NARA IRRIGATION AND
DRAINAGE PROJECT

ALIGNMENT OF ON-FARM FACILITIES
(RANGAE SAMPLE AREA)

DRAWING NO.	O-2	DATE	

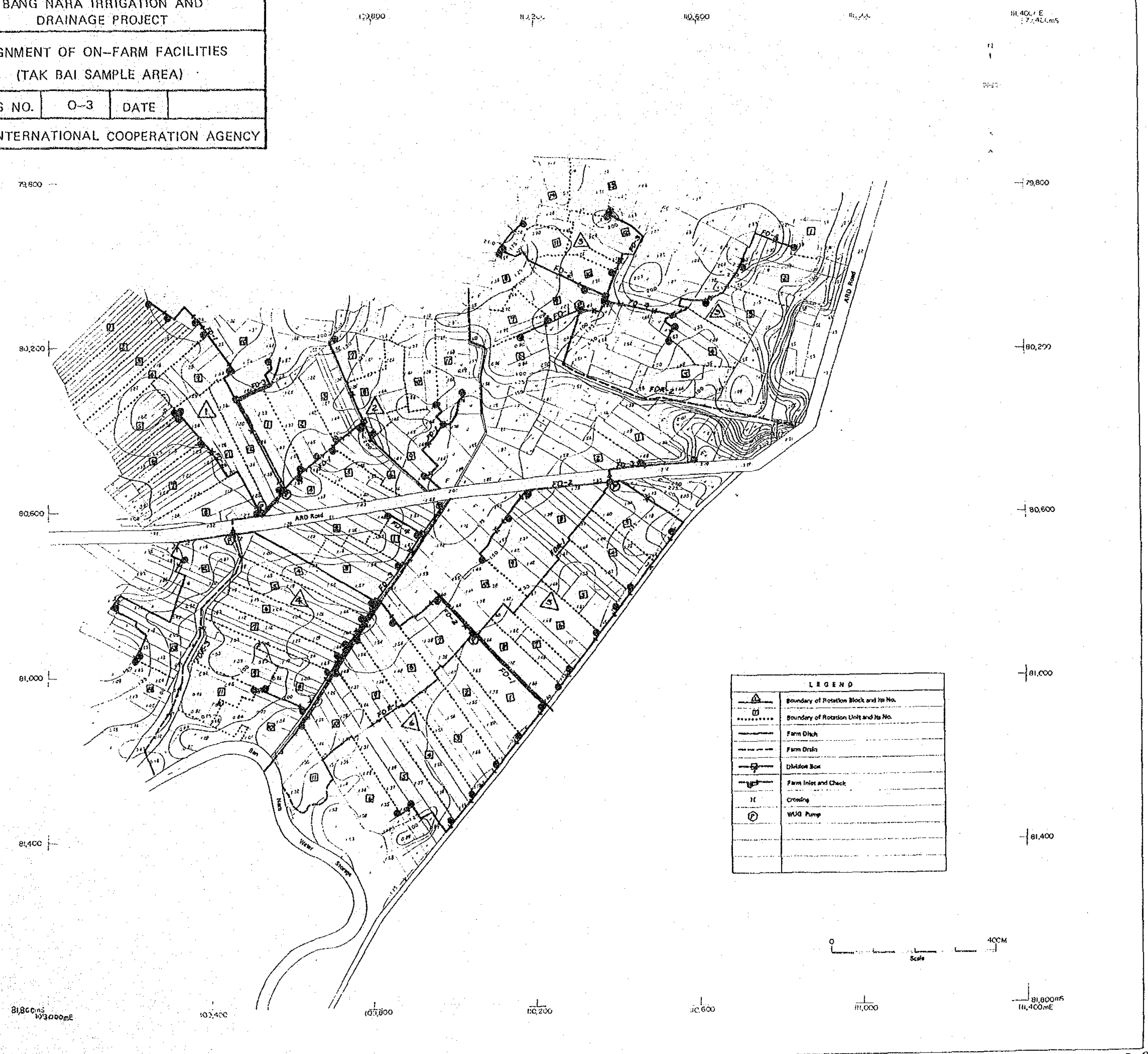
JAPAN INTERNATIONAL COOPERATION AGENCY

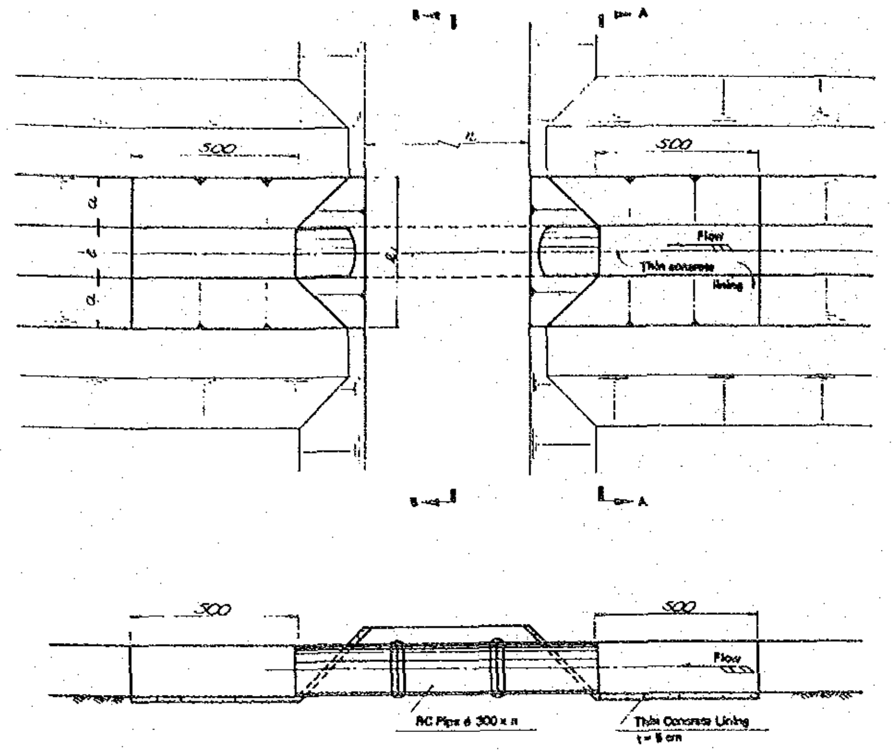
FEASIBILITY STUDY
BANG NARA IRRIGATION AND
DRAINAGE PROJECT

ALIGNMENT OF ON-FARM FACILITIES
(TAK BAI SAMPLE AREA)

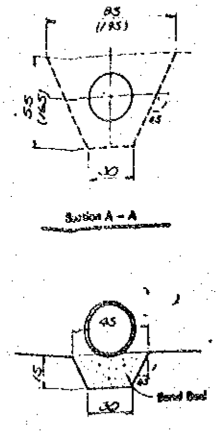
DRAWING NO.	O-3	DATE	

JAPAN INTERNATIONAL COOPERATION AGENCY





Road Crossing



Dimension (cm)

Type	a	b	ℓ
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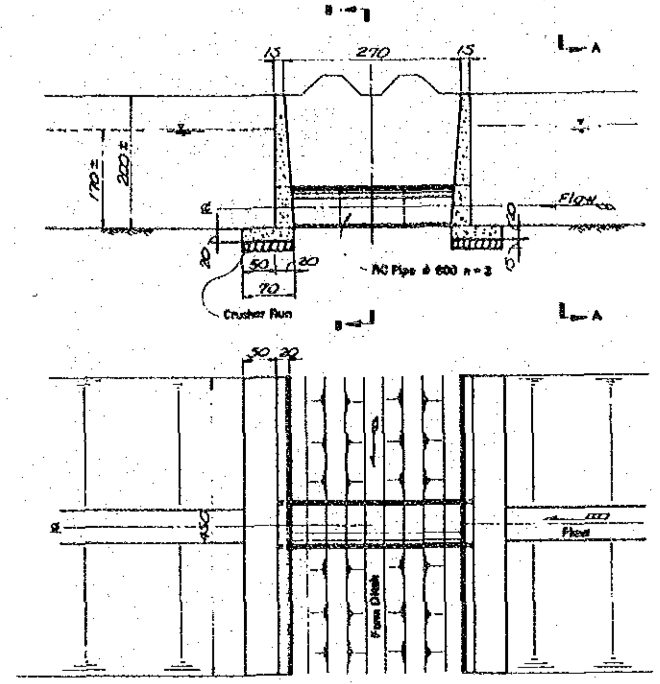
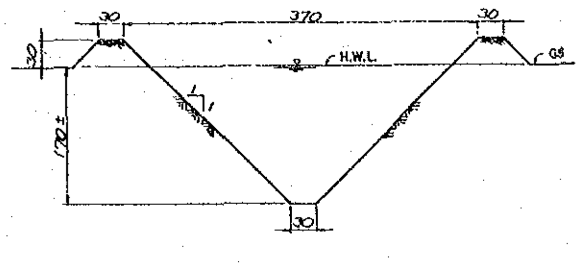
B	40	30	566
C	40	40	566
D	50	40	707

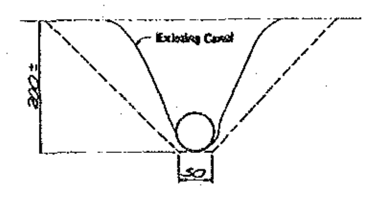


Plan

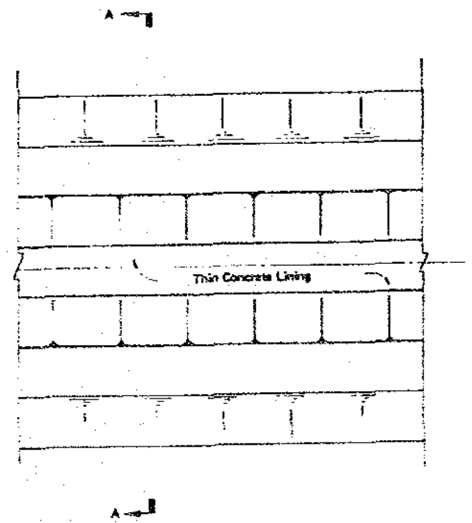
Drainage Crossing



Section A – A

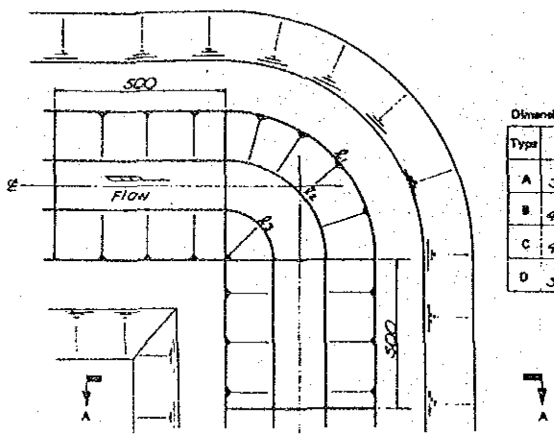


Section B – B



Concrete Lining at High Embank

Curve Protection Work

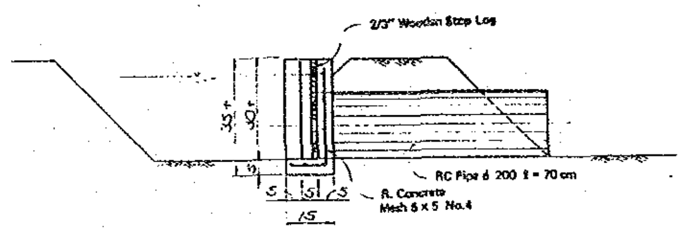


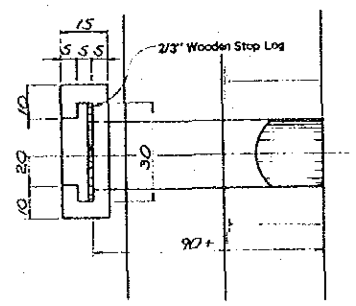
Dimension (cm)

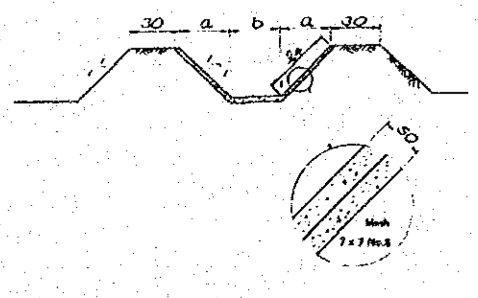
Type	a	b	ℓ_1	ℓ_2	ℓ_3	ℓ_4
A	30	30	141.4	94.2	47.1	42.4
B	40	30	172.8	110.0	62.8	56.6
C	40	40	188.5	125.7	62.8	56.6
D	30	40	219.9	141.4	78.5	70.7

Curve Protection Work

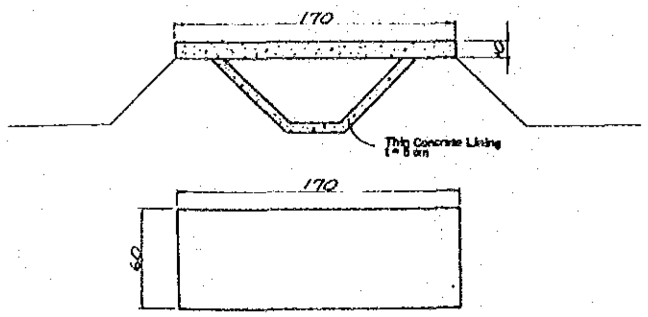
Farm Inlet







Typical Cross Section of Concrete Lining



Foot Bridge

FEASIBILITY STUDY
BANG NARA IRRIGATION AND
DRAINAGE PROJECT

APPURTENANT STRUCTURES
OF ON–FARM FACILITIES

DRAWING NO.	O–4	DATE	

JAPAN INTERNATIONAL COOPERATION AGENCY