APPENDIX D-1 IRRIGATION

APPENDIX D-1-1 RIVER DISCHARGE

1) Study on Pared River

There are discharge observation data available at the observation station of Bo. Calantoc and Alcala. The catchment area is about 900 sq km and the data available covers a period of 12 years from 1955 to 1966. As a result of studying said data, expected discharge in May was estimated at about 2.0 cu m/s, in minimum and 4.4 cu m/s average. (refer to Table D-1-1)

However, the commanded catchment area by proposed pumping station is about 800 sq km and discharge was estimated at 18 cu m/s in minimum and relevant. 3.9 cu m/s average. On the other hand, as the designed water intake amount in the Bagao Project at upper stream of the said river was estimated at 1.40 cu m/s, the expected discharge available for CIADP area would be approximately be within the range of 0.4 - 2.5 cu m/s only; yet, an expansion programme of the said Bagao Project by NIA will not allow discharge to be taken into CIADP area during dry season.

In this connection, therefore, it was determined that the pumping site is relocated from the original site to the Cagayan main stream site.

2) Study on Cagayan Main Stream

For the Cagayan main stream, discharge observation station cannot be seen in the lower reach, but, in the upper reaches at Naguillan (6,266 sq km) where discharge observation has been carried out since 1961 (By BPW). As a result of examining relevant observation records for the period for 1961 - 1972, especially for months between April and July, the data for the month of May was found as follows:

TABLE D-1-1 DISCHARGE DATA OF PARED RIVER

(Unit: cu m/s)

Year	May	Order		Jun.	Order	
1955	4.80	(1)	1.95	3.60	(1)	2.20
1956	1.95	(2)	2.40	2.20	(2)	2.90
1957	4.35	(3)	3.50	4.05	(3)	3.40
1958	4.75	(4)	4.00	5.00	(4)	3.40
1959	4.00	(5)	4.35	3.40	(5)	3.60
1960	5.60	(6)	4.75	6.04	(6)	3.90
1961	5.82	(7)	4.80	3.90	(7)	4.00
1962	5.60	(8)	4.94	4.00	(8)	4.05
1963	3.50	(9)	5.38	3.40	(9)	5.00
1964	5.38	(10)	5.60	6.04	(10)	6.04
1965	2.40	(11)	5.60	2.90	(11)	6.04
1966	4.94	(12)	5.82	10.20	(12)	10.20
Total	53.09			54.73		
Average	4.42			4.56		

Notes: 1. Above discharge shows the minimum on May and Jun, from 1955 to 1966

2. 1.95 cu m/s is minimum in May through 12 years

3. 4.42 is average discharge in May through 12 years

Return Period 10 years	33.0 cu m/s	Sd = 0.0053 cu m/s/sq km
Return Period 5 years	47.0 cu m/s	Sd = 0.0075 cu m/s/sq km
Return Period 2 years	93.0 cu m/s	Sd = 0.0148 cu m/s/sq km

Catchment Area = 6,266 sq km

(refer to Figure D-1-1)

Catchment area at the proposed Magapit pumping station of the Cagayan River area was calculated at approximately 26,840 sq km. The approximate dependable discharge can be obtained by multiplying specific discharge mentioned above with the said catchment area. They were estimated at 142.3 cu m/s for 10 year return period, 201.3 cu m/s for 5 year return period and 397.2 cu m/s for 2 year return period.

For the 10 year National Irrigation Programme, however, new projects are being brought out in the upper reach of the Cagayan River, further study being required for the discharge problem taking into account such future prospect of the discharge balance especially Magat River Project and the Chico River Project being large as to scale and the irrigable area of the former is 104,600 ha which the latter, 38,000 ha. These tow large-scale projects involve dam construction plan to stabilize the supply of irrigation water stronger in dry season. In this study, the estimate was made on the assumption that no supply of water from these dams in available and results are shown as follows:

Catchment area of Magat River = 4,062 sq km
Catchment area of Chico River = 1,936 sq km

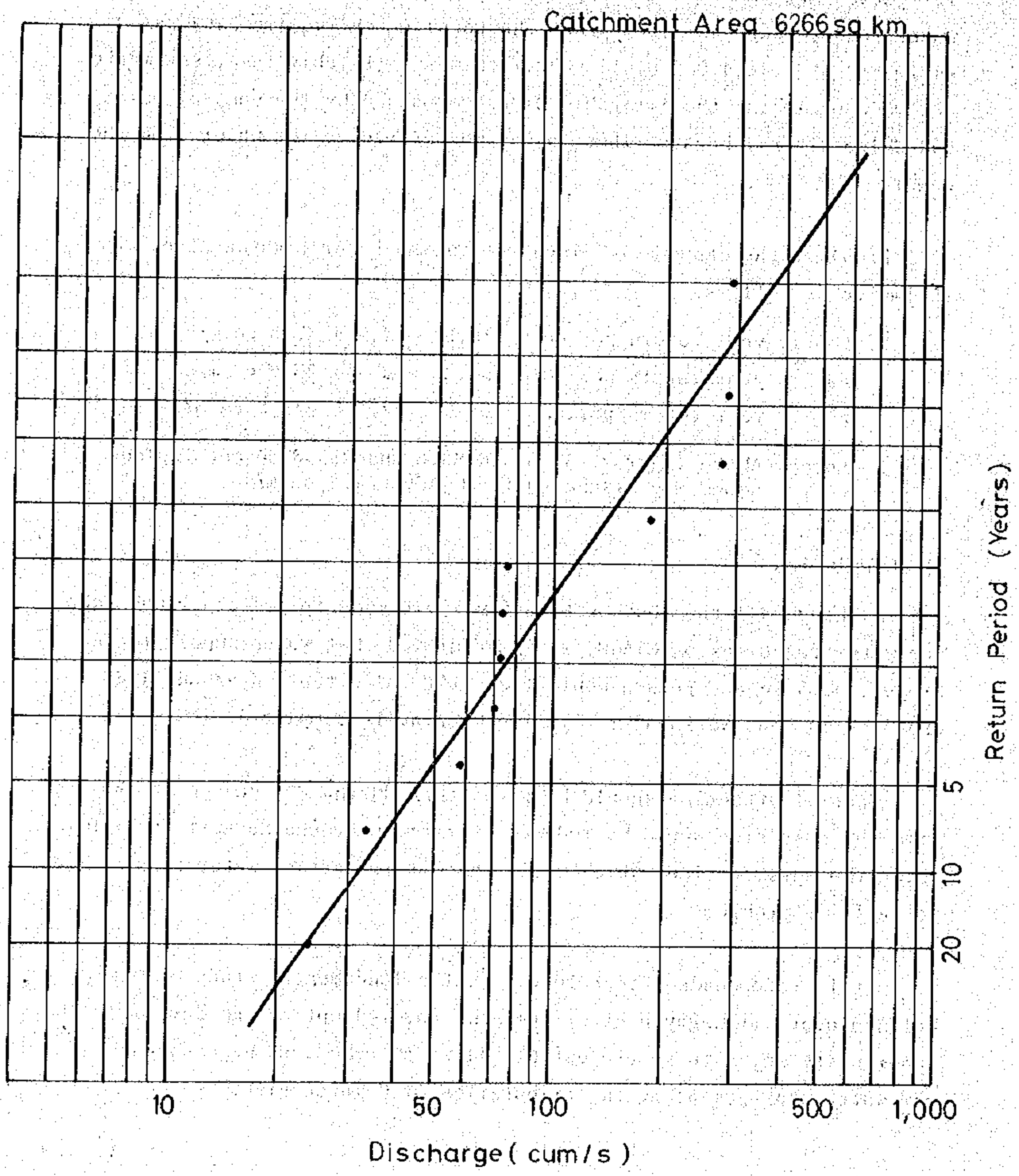
The dependable catchment area = 26,840 - 4,062 - 1,936 = 20,842 sq km and the dependable discharge at the pumping site in the lower reach was estimated as follows:

For 10 year return period = 20,842 x 0.0053 = 110.5 cu m/s
For 5 year return period = 20,842 x 0.0075 = 156.3 cu m/s
For 2 year return period = 20,842 x 0.0148 = 308.5 cu m/s

FIGURE D-1-1

PROBABILITY DISCHARGE AT NAGUILLAN, CAGAYAN RIVER

(MAY)



Note: Observation Period 1962-1972 11 Years

Source: Discharge data prepared by Philippine CIADP staff, 1976

Synthetical estimation was made for water demands to be brought about in the water systems of the new projects under the 10 year National Irrigation Programme to realize 48,470 hectares. On the assumption of water requirements as 1.5 ℓ/s/ha, the total water requirements was estimated at = 48,470 x 0.015 = 72.7 cu m/s. (In this case, estimation was made excluding the irrigable areas commanded by the dams of Magat and Chico Rivers, because these areas would receive the water from the dams).

Finally, the dependable discharge in the Lower Cagayan River was estimated as follows:

For 10 year return period = 110.5 - 72.7 = 37.8 cu m/s
For 5 year return period = 156.3 - 72.7 = 83.6 cu m/s
For 2 year return period = 308.5 - 72.7 = 235.8 cu m/s

Note: Above figures, 37.8 and 83.6 and 235.8 do not include necessary discharge for CIADP, 24.3 cu m/s

3) Conclusion

Although all the above estimations were made to grasp a rough idea for water resources of CIADP, it is predicted that water supply to the Project Area in dry season would face critical situation around 1985 when the 10 year National Irrigation Program is completed.

Special attention should be given that during dry season at that time the discharge would be reduced in extreme around Magapit to bring about the adverse tide, which would inhibit irrigation water supply due to salinity problem.

It is recommended, therefore, that a fundamental study on water balance over all Cagayan River Basin be carried out at the earliest opportunity so as to secure establized water resources by constructing new water storages along the tributaries of Cagayan River.

APPENDIX D-1-2 WATER REQUIREMENTS

1) Water Requirements of Other Irrigation Project

In the Philippines there are many irrigation systems constructed and also, many new irrigation projects undertaken by NIA. In CIADP, water requirements were determined with reference to actual results taken up in the said project by NIA. In the estimate of water requirements, essential factors considered are cropping pattern, evapotranspiration, percolation, and necessary amount of water for land preparation. An example is shown as following table D-1-2, taken from the Angat and the Magat Rivers Irrigation Systems.

TABLE D-1-2 CRITERION OF IRRIGATION SYSTEM OF AIMADP

	A R I S		M R I S	
	Land Prepared in Mar.-May mm	Land Prepared in other month mm	Land Prepared in May-July mm	Land Prepared in other month mm
First Irrigation for Land Soaking	150	120	180	150
Second Irrigation for Land preparation	60	50	45	40
Total	210	170	225	190

A R I S	Average Daily Requirements in the first month mm/day	Average Daily Requirements in late booting stage mm/day
Mar. - June	6.8	9.0
May - Aug.	6.9	8.3
Aug. - Nov.	6.2	7.7
Oct. - Jan.	5.8	6.8

2) Planning Criteria on Water Requirements

The fundamental data for determining water requirements in CIADP area are as follows:

Land Soaking	130 mm
Plowing and Harrowing	130 mm
Evapo-transpiration	6.4 mm/day
Percolation	2.0 mm/day

Subsequently: Design Capacity 1 ℓ/sec/ha. on farm level

Water losses were determined as follows based on the criteria prepared by NIA:

Farm losses	20 %
Conveyance loss up to Lateral	15 %
Conveyance loss in Main Canal	20 %
Total losses	45.6 %

3) Water Requirements in CIADP

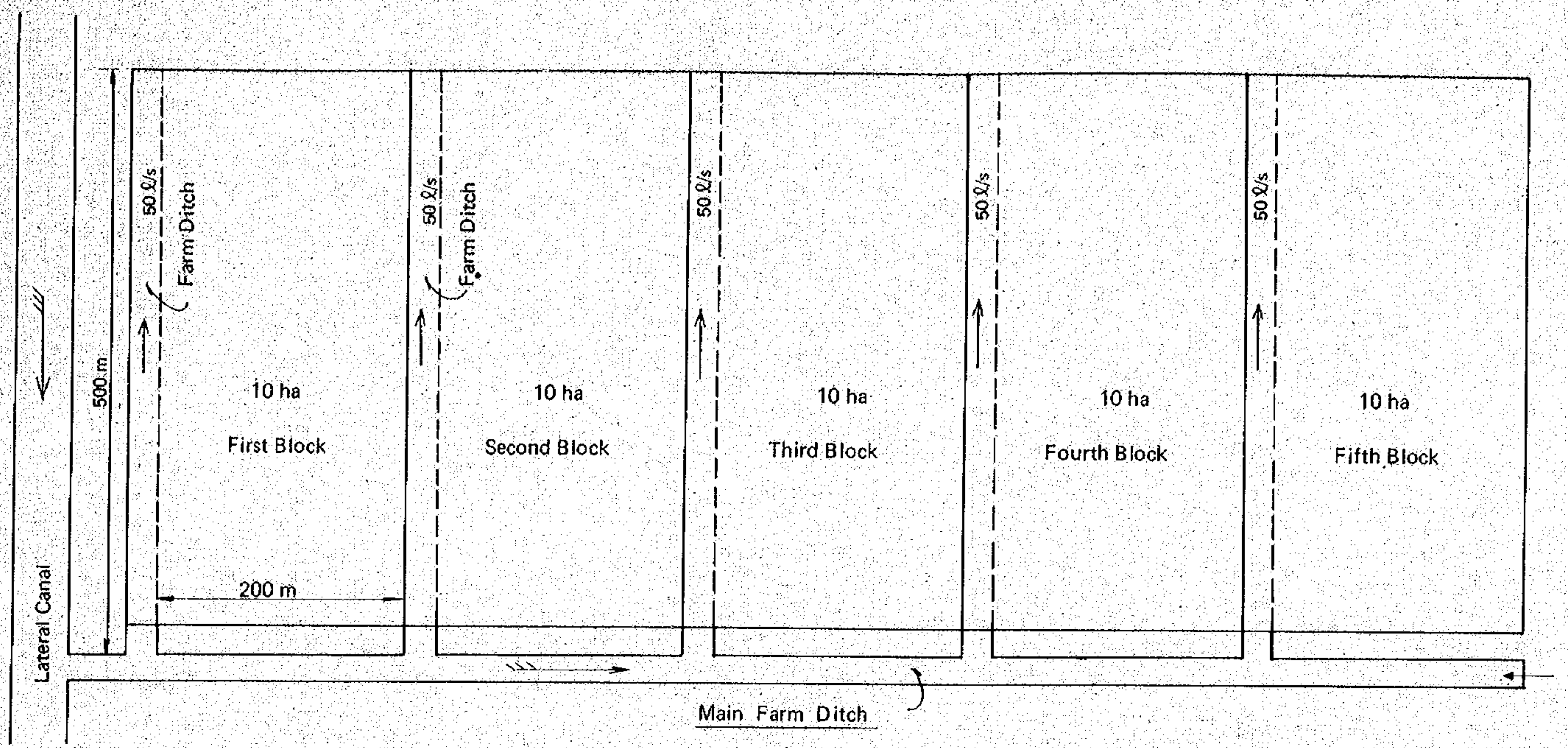
NIA has a criterion to determine the net water requirements, stating that the said value should be computed in reducing an effective rainfall from an amount of maximum evapotranspiration plus percolation. Natually, the diversion water requirements can be obtained by adding conveyance losses to the net diversion water. The maximum evapotranspiration in CIADP indicates 7.4 mm/day in May, but 6.4 mm/day in June was employed herein for computation, in taking into account that land preparation is carried out in May, and the maximum water requirements was determined at 8.4 mm/day in adding 2 mm/day of percolation, accordingly. This value could be converted to 0.97 ℓ/s/ha, which was rounded up to 1 ℓ/s/ha as the net water requirements on farm. In the case, however, the effective rainfall shall not be included in. Consequently, the total water requirements at the pumping station were estimated as follows.

Iguig	600 ha x 1 ℓ/ha x 1/0.544 = 1.10 cu m/sec	
Amulung	1,400 ha x 1 ℓ/ha x 1/0.544 = 2.60 cu m/sec	
Magapit (Lower Cagayan)	11,200 ha x 1 ℓ/ha x 1/0.544 = 20.60 cu m/sec	

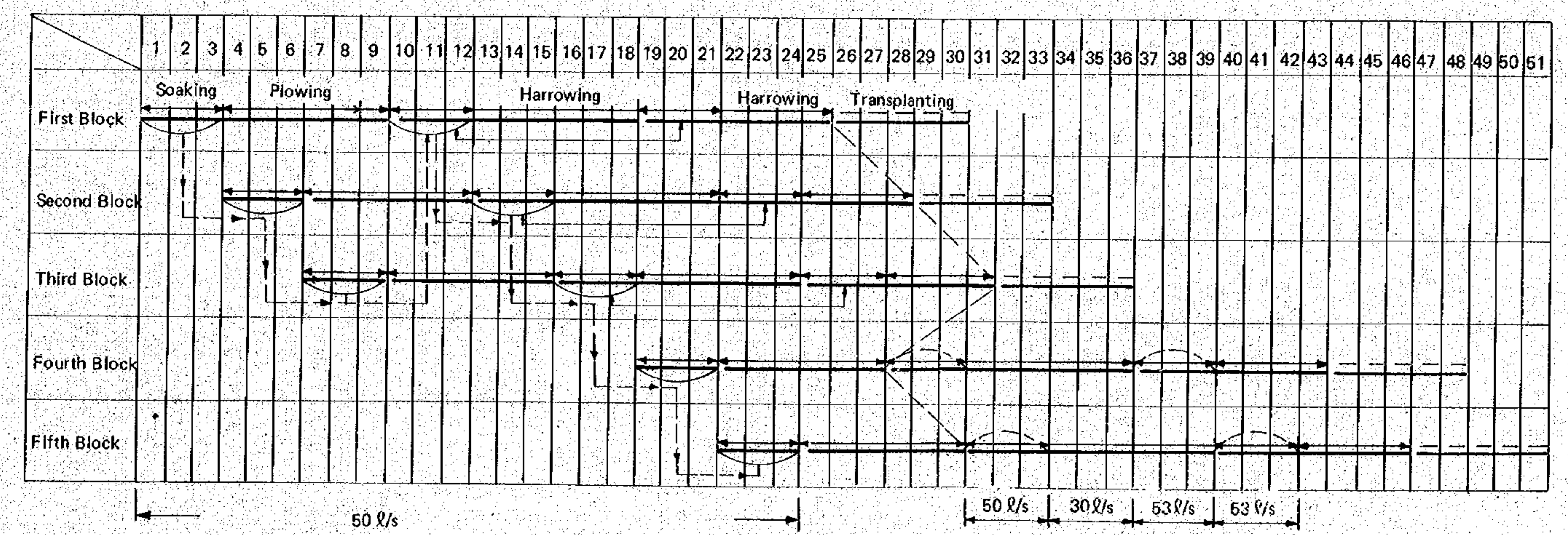
Note: 1/0.544 = 1/0.80 x 1/0.85 x 1/0.80

In any cropping pattern, the stage which requires the water most is that of land preparation, and the rotational irrigation was adopted in CIADP so as to meet the total water requirements and to provide the most economical facilities. The details of estimation on the rotational irrigation for 50 ha are shown in Appendix D-1-3.

APPENDIX D-1-3 ROTATIONAL IRRIGATION



Canal Capacity 50 ℓ/s
(43.2 mm for 10 ha)



Notes:

3 days for Soaking
6 days for Plowing
6 days for Harrowing
4 days for Harrowing
5 days for Transplanting

Flooding (130 mm) for 3 days

Flooding (60 mm) for 3 days

APPENDIX D-1-4 IRRIGATION CANALS

1) Canal Alignment

Irrigation canal alignment was determined based on the following data: (1) Plan surveyed by NIA and prepared in Scale 1:4,000 (2) Topo-maps developed from the above (1) by NIA, Covering Iguig area and Alcala-Amulung area (Scale at 1:10,000) and covering Lower Cagayan (Scale 1:20,000) (3) Profile leveling for main canal in each area and (4) the results obtained by reconnaissance survey.

Alighment of the main and lateral canals in each area was determined based on the aforesaid topo-maps taking into account, the actualities of paddy fields and drainage scheme.

In Iguig and Alcala-Amulung areas, there are national roads running through irrigation areas which are surrounded by higher elevation,hilly lands to present a basin-like topography. Due to these two particular features of said areas, canals were designed with inevitably longer alignment in its ratio to the irrigation area.

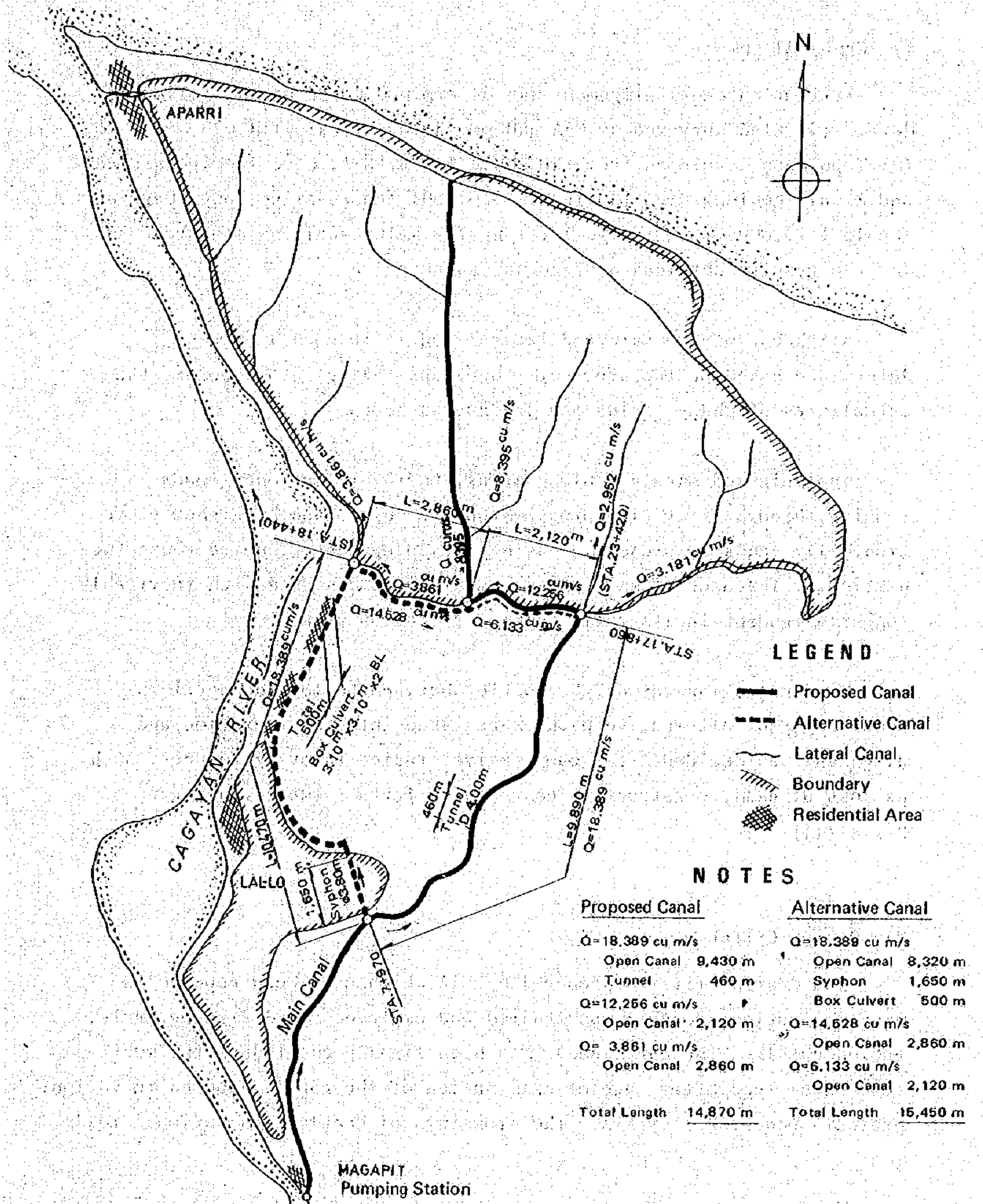
On canal alignment of the portion between Lallo and Aparri in Lower Cagayan, alternative plans were taken into consideration and alignment was decided after comparative studies in every respect, such as loss of head, construction cost and so forth. (Refer to Figure D-1-4 (1))

2) Design Criteria

The design criteria prepared by NIA which have been applied in many irrigation projects was studied and employed for designing irrigation canals. The earth canal has been finally adopted as the most economical type after careful examination of the canals adopted in various projects undertaken by NIA. The crossings of canals with national roads

FIGURE D-1-4 (I)

ALTERNATIVE PLAN OF IRRIGATION CANAL, LOWER CAGAYAN



or provincial roads, however, were designed with siphon or closed conduct taking into account, the relation between water level and elevation of road surface. (See Figure D-1-4 (2))

Design discharge levels at each pumping station were obtained by adding total loss heads to necessary water level from the terminal of the canals. As a result, water level at the starting point of each canal was estimated at 19.0 m in Iguig, 22.5 m in Alcala-Amulung and 15.0 m in Lower Cagayan, respectively. (Refer to Figure D-1-4 (3) to (5))

(a) Iguig

For the portion between pumping site and 300 m downstream therefrom, a concrete box-type siphon with 1.20 m diameter was designed in consideration of water level, topography and the fact that the said portion exists in residential area. For the remaining portion, an open canal was designed with longitudinal canal slope as big as topography will allow. Total length of the main canal is 6,380 m and the design canal discharge was estimated at a range between 1.104 and 0.267 cu m/s while total length of the lateral canal is 12,500 m and the design discharge eas estimated at a range between 0.322 and 0.064 cu m/s. (Refer to Figure D-1-4 (6))

(b) Alcala-Amulung

The irrigation area is divided into two areas, the one is a low-lying land with national road running through the area and the other a high land with comparatively high elevation (El. 16.0 m) in the northern part of the area. Irrigation area ratio between these two areas is approximately 1:2 and irrigation water shall be distributed at the said areal ratio.

For low-lying land, water shall be supplied through the lateral canal which shall receive water directly from the outlet basin so that the cost for pump operation may be reduced.

FIGURE D-1-4 (2) TYPICAL SECTION OF IRRIGATION CANAL

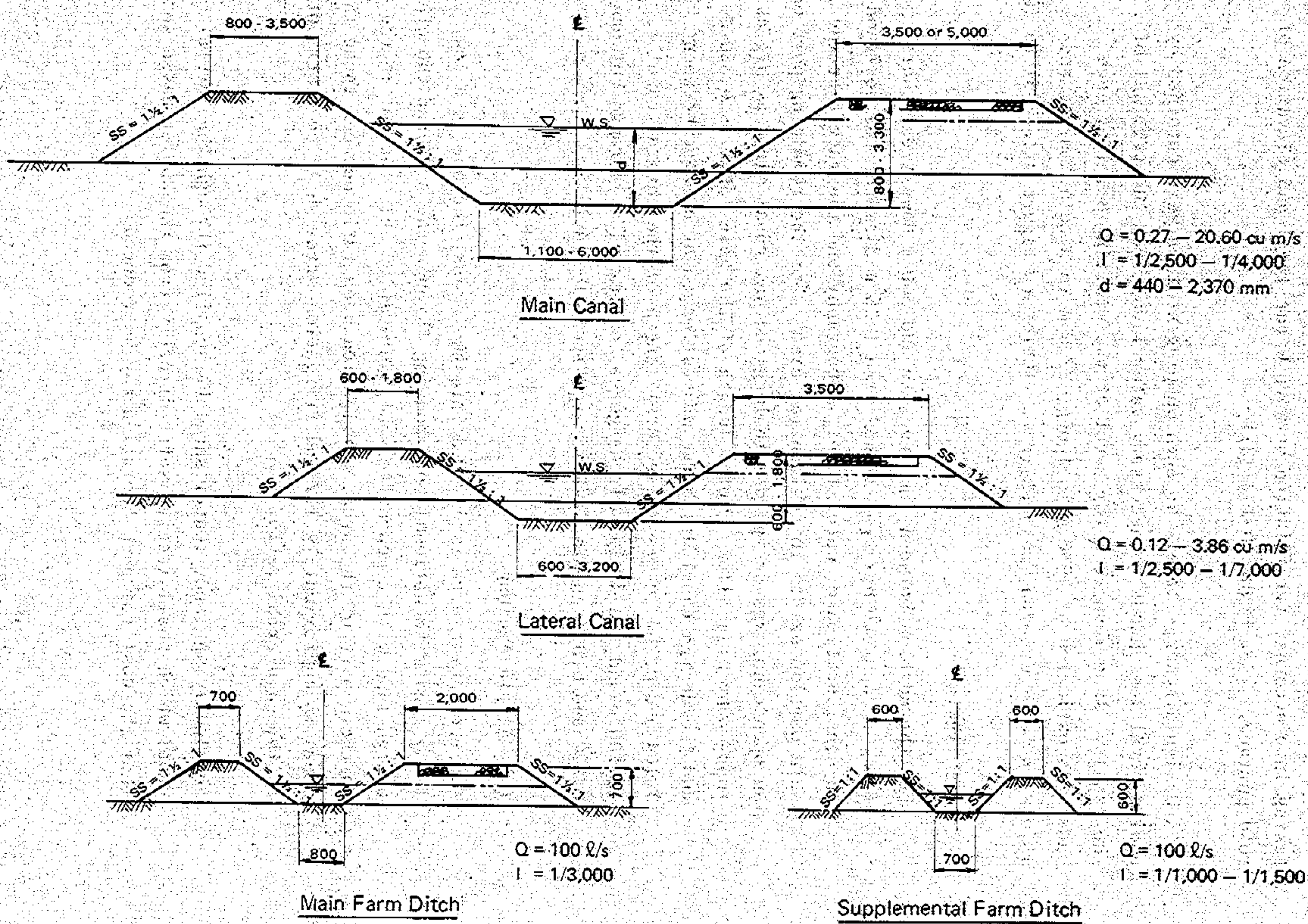


FIGURE D-1-4 (3) HYDRAULIC PROFILE OF MAIN CANAL, IGUIG

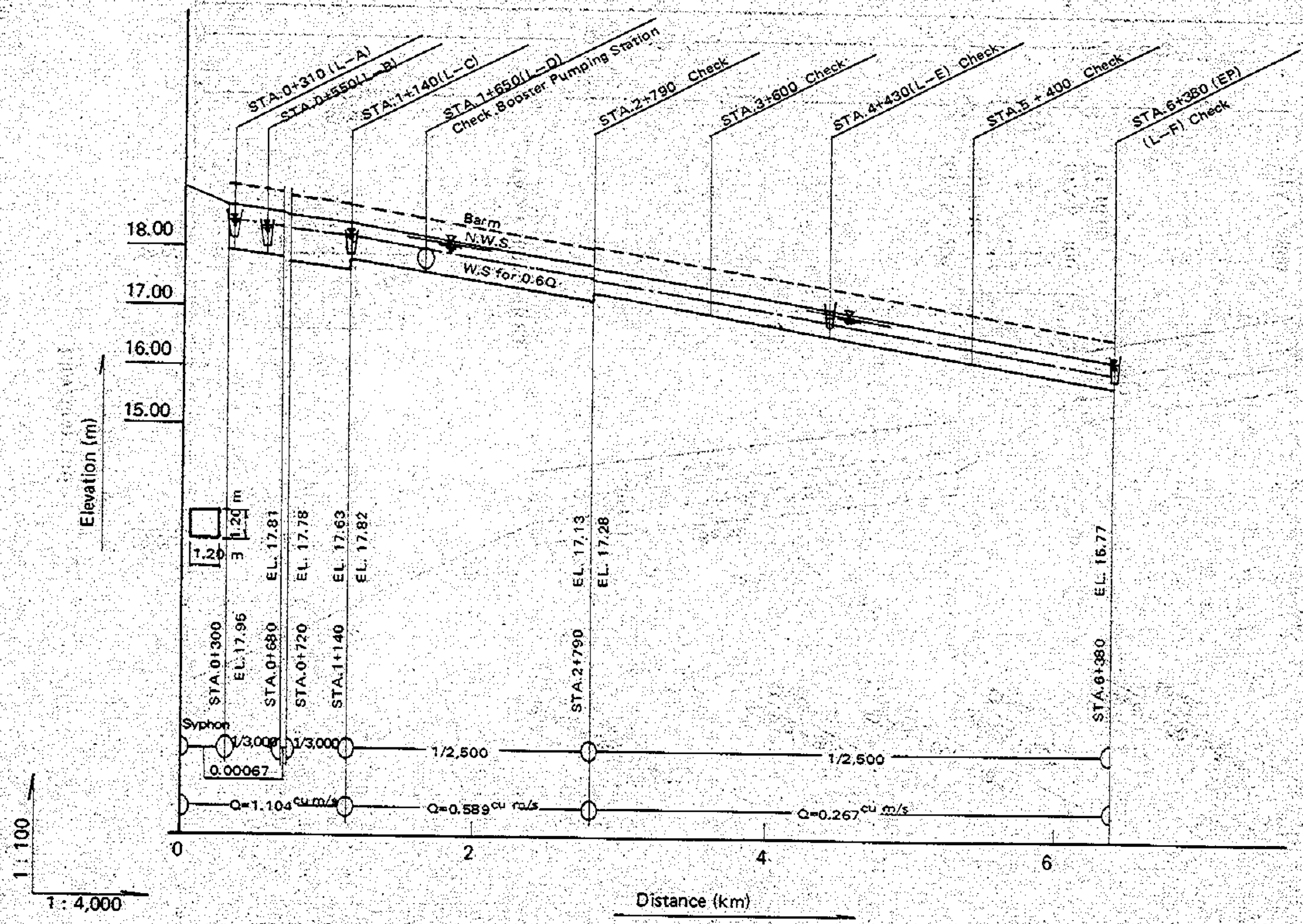


FIGURE D—1—4 (4) HYDRAULIC PROFILE OF MAIN CANAL, ALCALA-AMULUNG

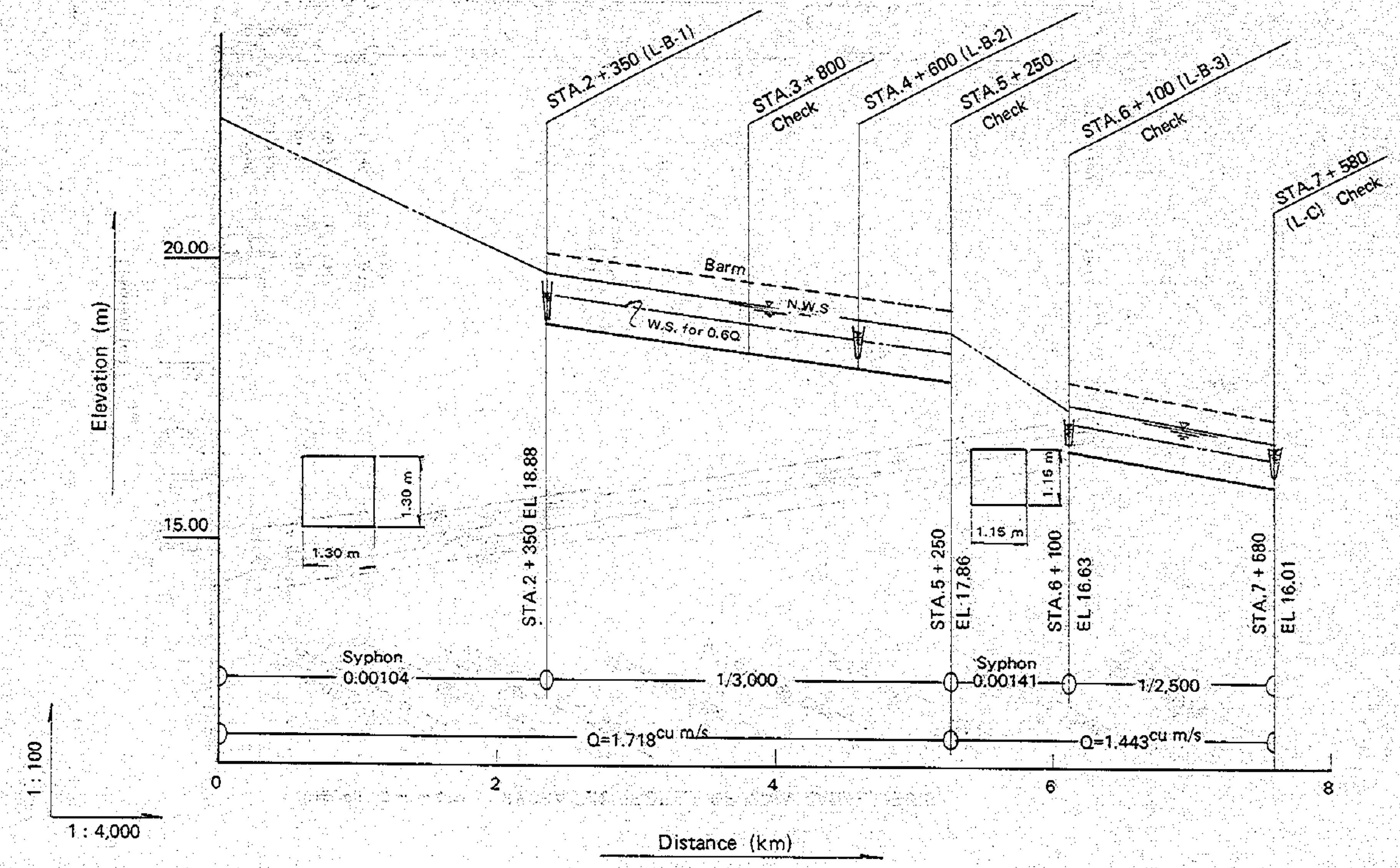
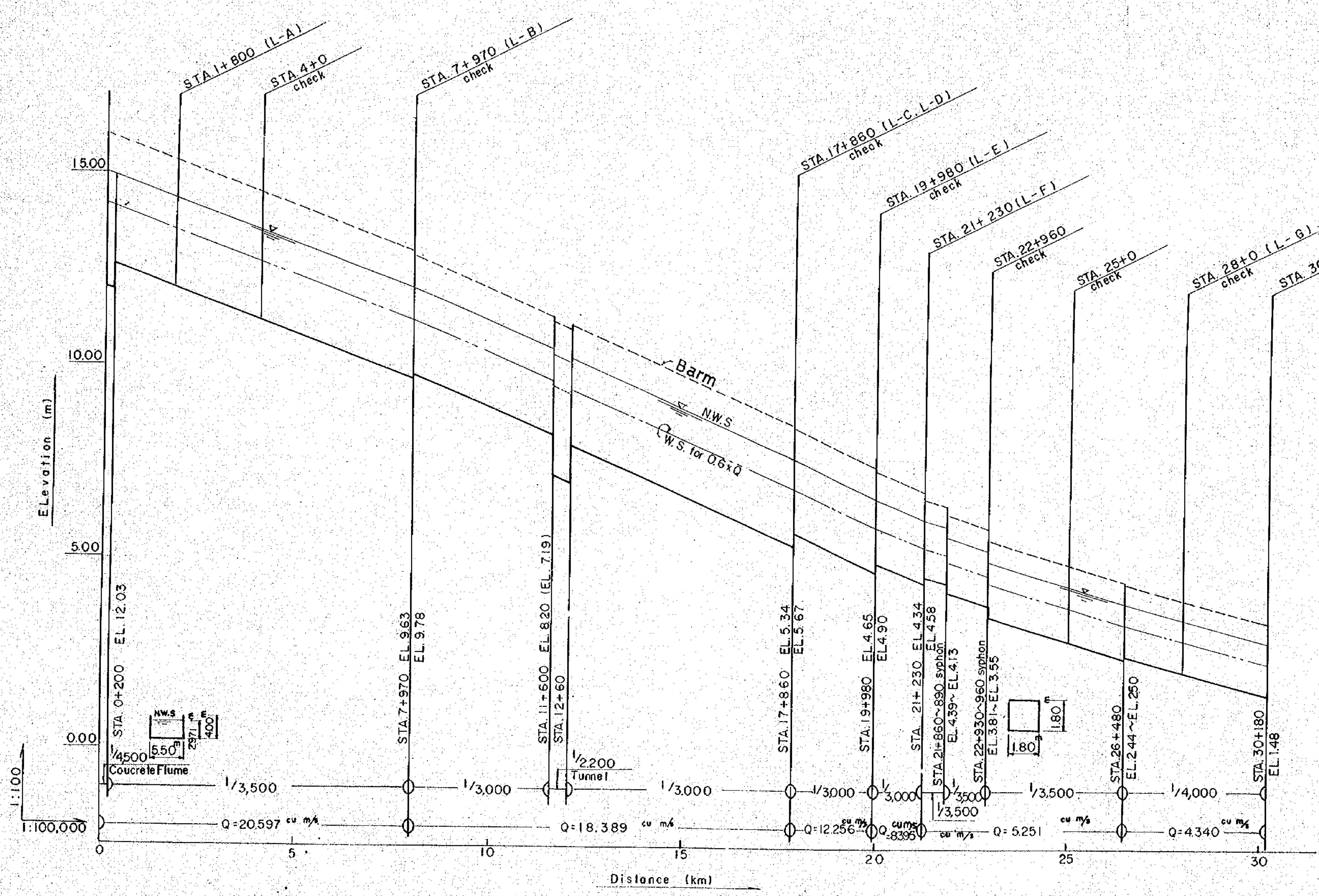
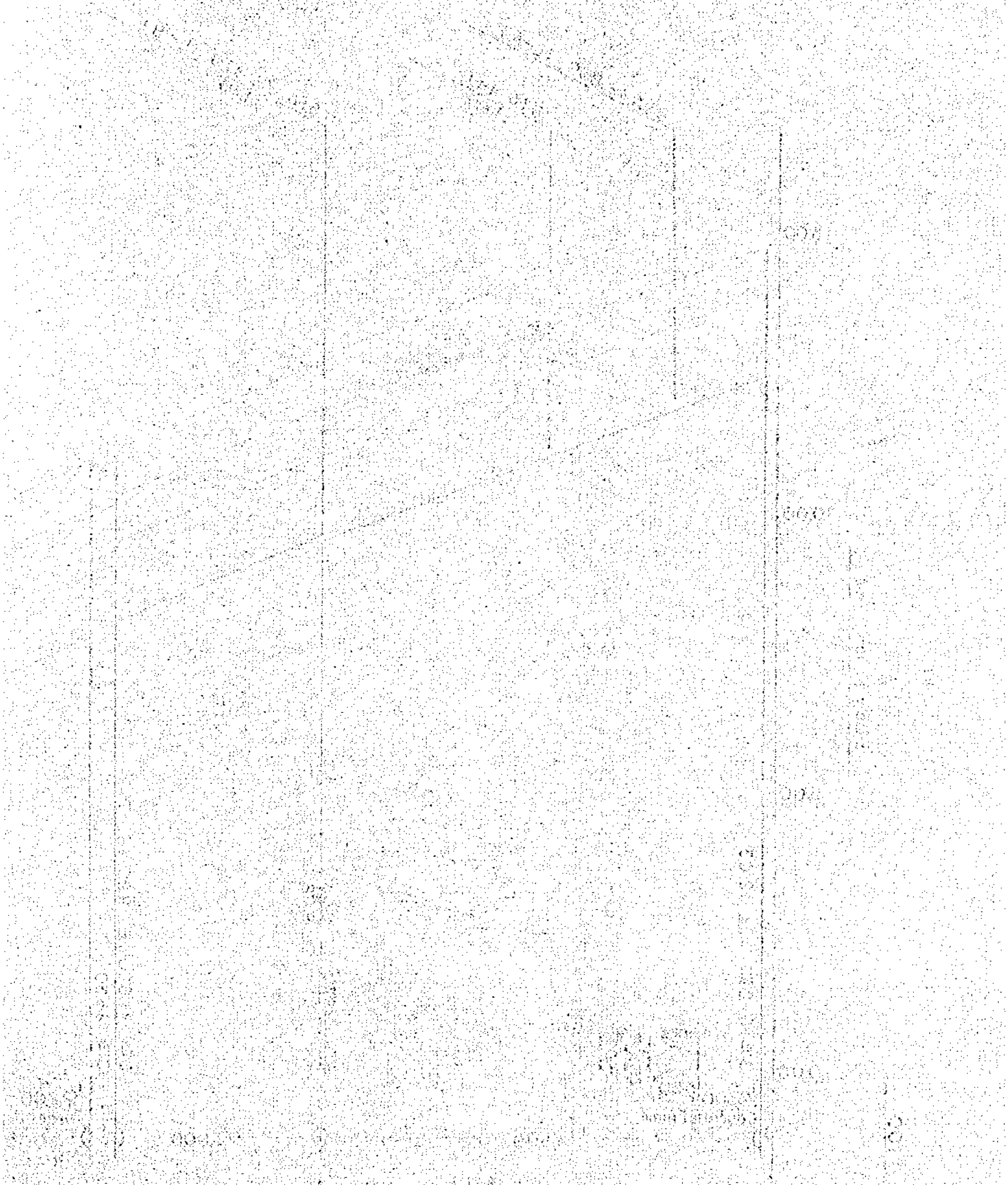


FIGURE D-1-4 (5) HYDRAULIC PRFILE OF MAIN CANAL, LOWER CAGAYAN





For high land, on the other hand, pumped up water shall be conveyed from the pumping station to a point with elevation at 20 m through the 2,300 m length concrete box type siphon with 1.30 m diameter. Elevation around the area, however, cannot be clearly interpreted from the existing topo-map and therefore, it is recommended to carry out re-survey of the area to obtain reduction of the total length of the siphon.

The design discharge of the pumping site was estimated at 2.572 cu m/s, of the lateral canal to the low lying land at 0.854 cu m/s and of the main canal to the high land at 1.718 cu m/s.

The total length of main canal is 7,580 m and the design discharge was estimated at the range between 1.718 and 1.442 cu m/s. The total length of the lateral canal is 27.7 km and design discharge was estimated at a range between 1.140 and 0.055 cu m/s. (Refer to Figure D-1-4 (7))

(c) Lower Cagayan

As the profile leveling carried out by NIA runs along the area with higher elevation than it should be, another survey should be made based on the hydraulic profile obtained this time. The total length of main canal is 30,120 m and the design discharge was estimated at a range between 3.861 and 0.258 cu m/s. (Refer to Figure D-1-4 (8))

The tunnel section in Lower Cagayan was designed with rather steep longitudinal slope at 1:2,200 which would allow the tunnel cross-section to become smaller and its typical cross section is shown in figure D-1-4 (9). (See Table D-1-4 (1) and (2))

3) Alternative Plan

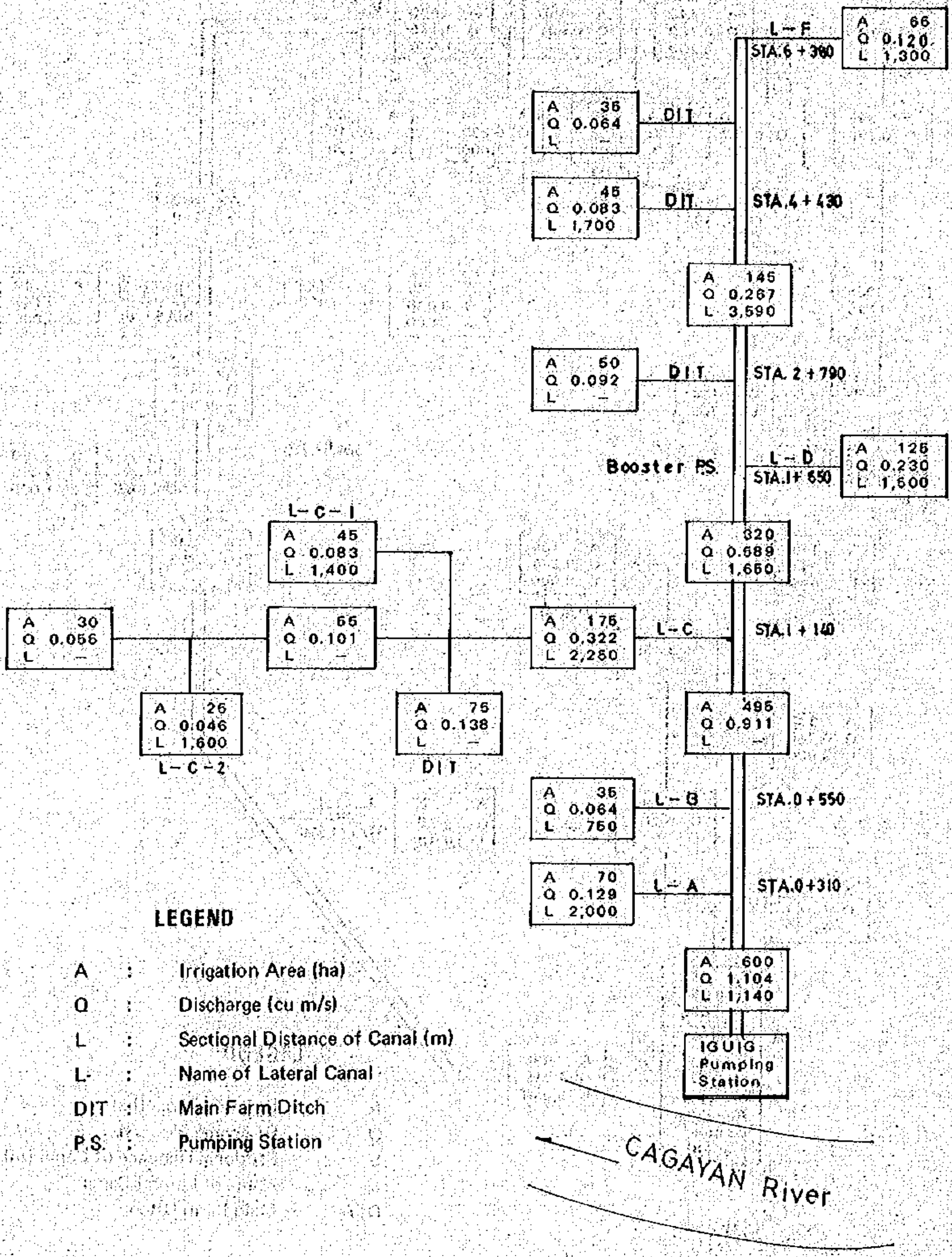
Determination of canal alignment between Lal-10 and Aparri was made after giving comparative study on two schemes, the one for the canal passing through low, hilly lands and the other for running along the national road.

The former, namely Case I, was found to have advantages such that earth canal conveyance is available for nearly most of the route, excluding the tunnel conveyance for 460 m and canal section can be reduced comparatively because of diversion of discharge in Aparri area.

The latter, namely Case II, was found to have some problems such that a large diameter siphon must be constructed in total length of 1,650 m from Sta. 7 + 970 and also, a concrete culvert in total length of 500 m is required for passing through the residential area along the national road (this involves difficulty for land acquisition) and the canal section will become larger in Aparri area in comparison with the former case.

Taking into account the above factors, a comparative study was made about loss of heads and construction costs and the former scheme, canal passing through the low, hilly land, has been adopted as a result. (See Table D-1-4 (3))

FIGURE D-1-4 (6) FLOW CHART OF IRRIGATION SYSTEM, IGUIG



LEGEND

A : Irrigation Area (ha)

Q : Discharge (cu m/s)

L : Sectional Distance of Canal (m)

L- : Name of Lateral Canal

DIT : Main Farm Ditch

P.S. : Pumping Station

FIGURE D－1－4 (7)

FLOW CHART OF IRRIGATION SYSTEM, ALCALA-AMULUNG

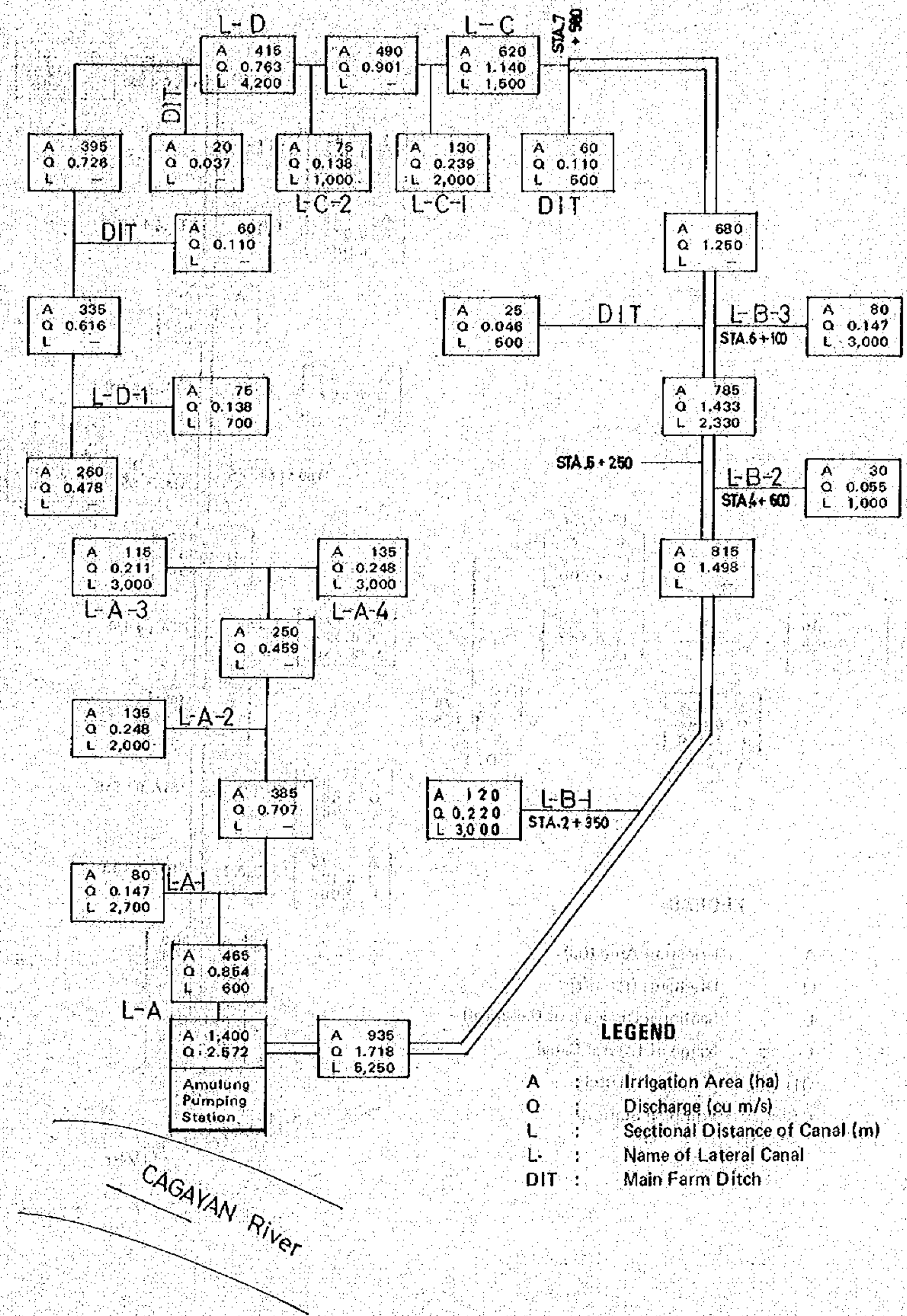
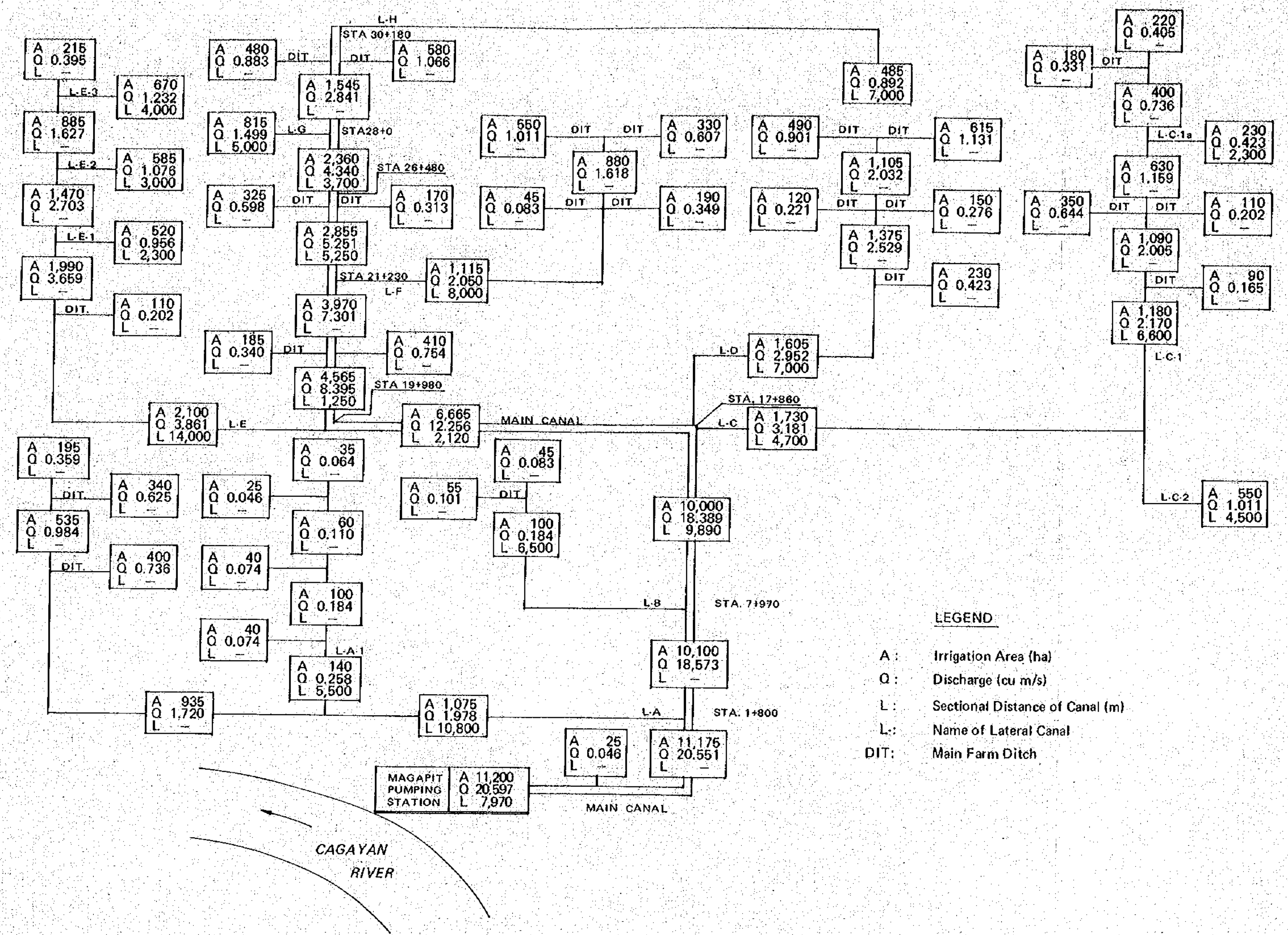


FIGURE D-1-4 (8) FLOW CHART OF IRRIGATION SYSTEM, LOWER CAGAYAN



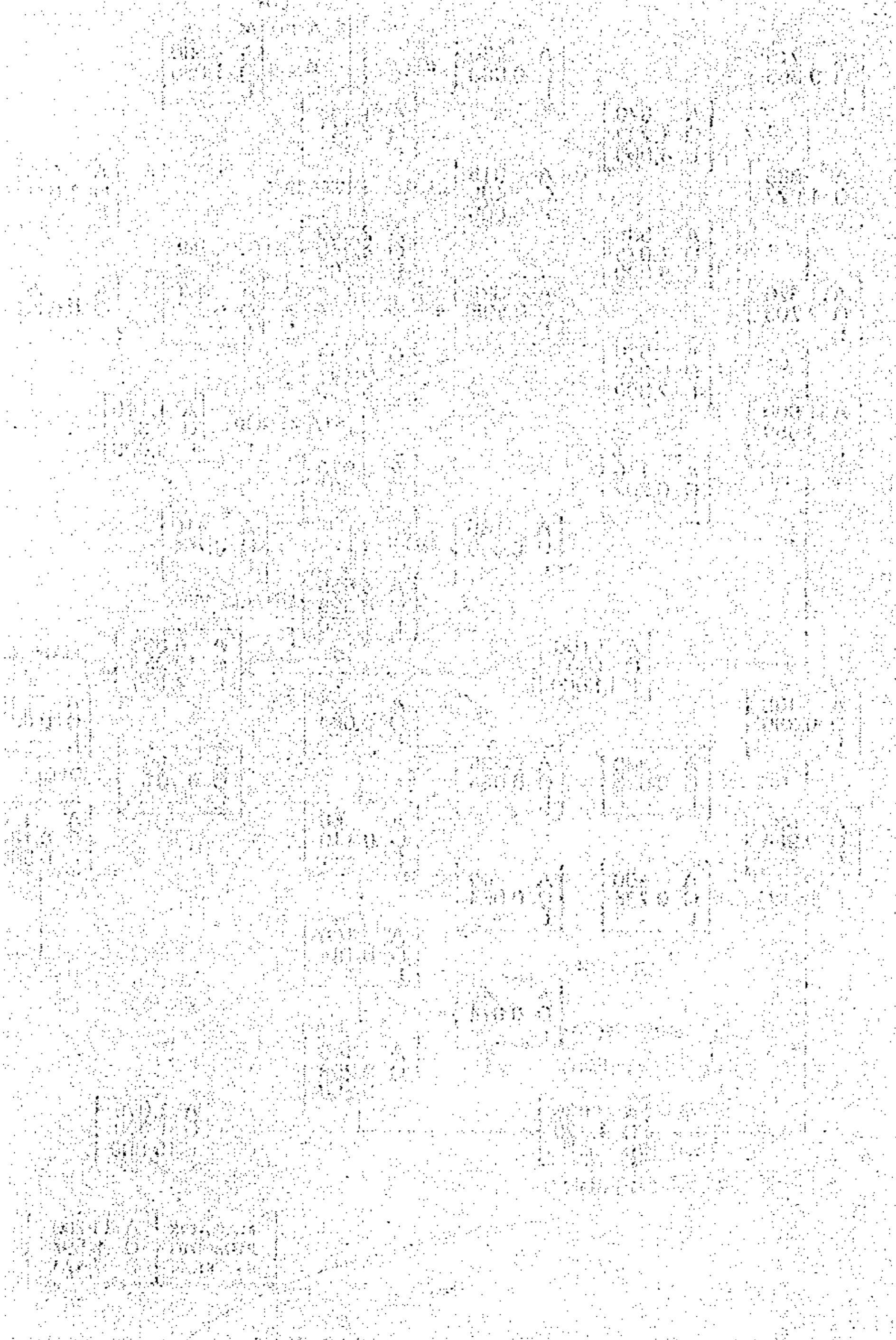


FIGURE D-1-4 (9) TYPICAL SECTION OF TUNNEL

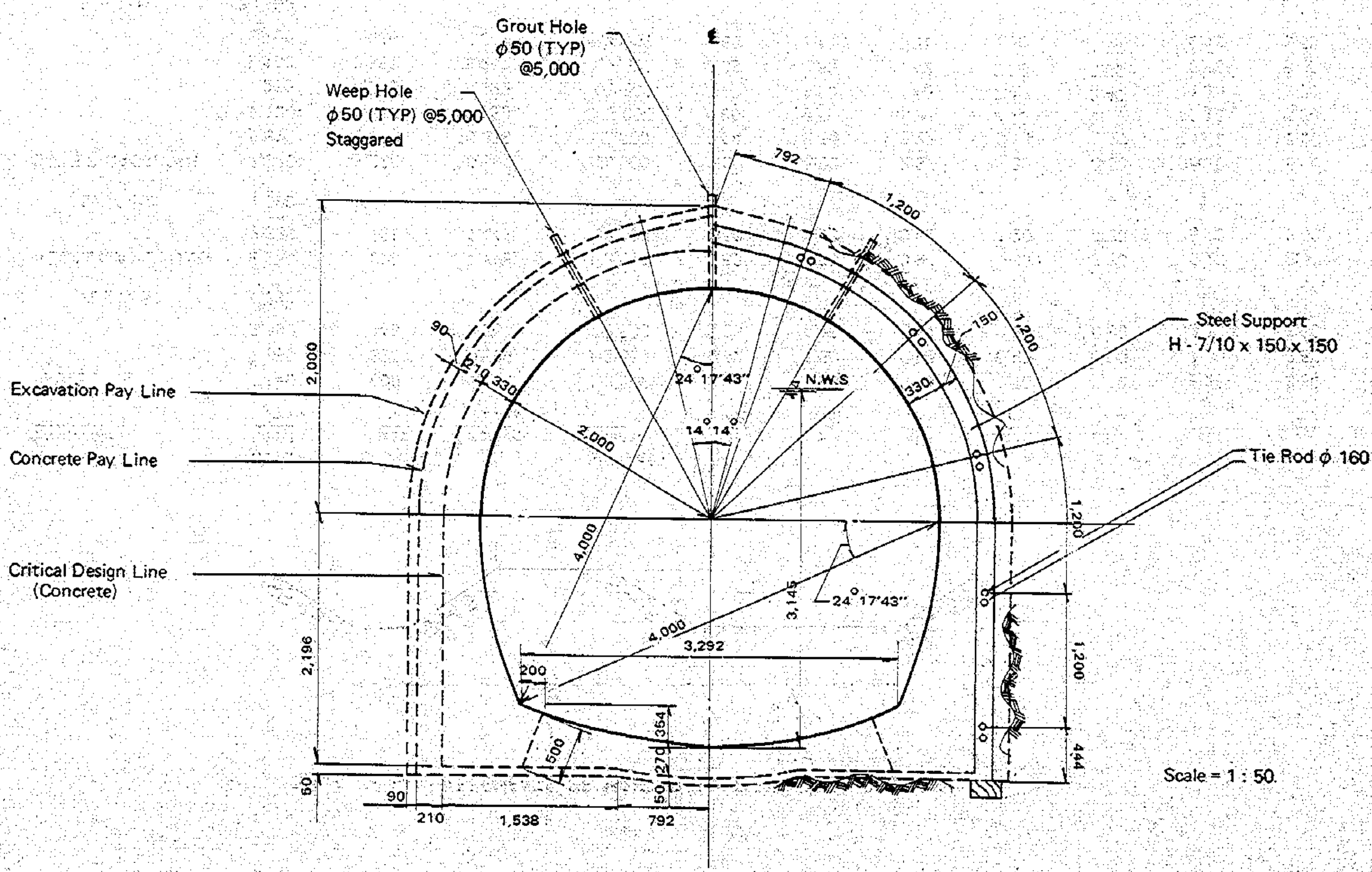
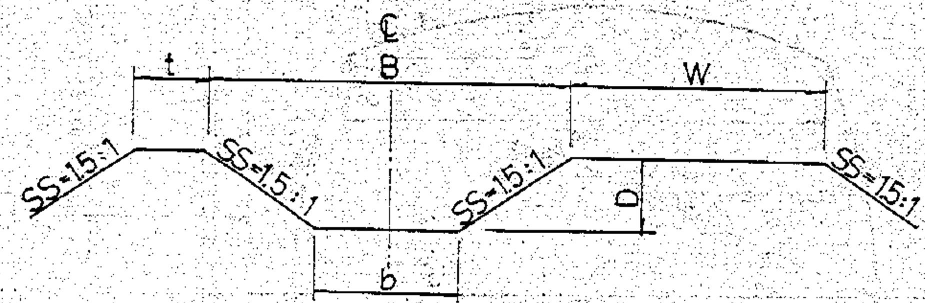
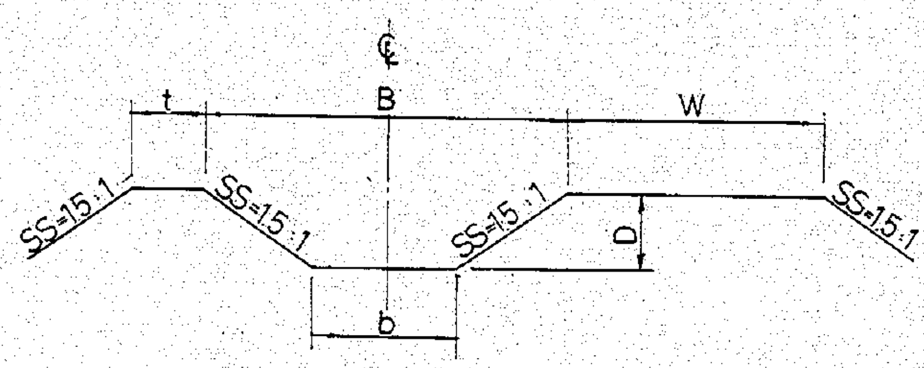


TABLE D-1-4 (1) ELEMENTS OF MAIN IRRIGATION CANAL SECTION



Project Area	Canal Length (m)	Service Area (ha)	Discharge (cu m/s)	Slope of Canal	Velocity (m/s)	b (m)	d (m)	D (m)	t (m)	B (m)	W (m)
IGUIG	1,140	600	1.104	1/3,000	0.46	1.90	0.78	1.10	1.10	5.20	3.50
	1,650	320	0.589	1/2,500	0.42	1.50	0.59	0.90	0.90	4.20	3.50
	3,590	145	0.267	1/2,500	0.35	1.10	0.44	0.80	0.80	3.50	3.50
Sub-Total	6,380										
ALCALA-AMULUNG	5,250	935	1.718	1/3,000	0.52	2.30	0.91	1.30	1.30	6.20	3.50
	2,330	785	1.443	1/2,500	0.53	2.10	0.82	1.20	1.20	5.70	3.50
Sub-Total	7,580										
LOWER-CAGAYAN	7,970	11,200	20.597	1/3,500	0.91	6.00	2.37	3.30	3.50	15.90	5.00
	9,890	10,000	18.389	1/3,000	0.94	5.50	2.22	3.10	3.10	14.80	5.00
	2,120	6,665	12.256	1/3,000	0.85	4.80	1.90	2.70	2.70	12.90	5.00
	1,250	4,565	8.395	1/3,000	0.77	4.10	1.66	2.40	2.40	11.30	5.00
	5,250	2,855	5.251	1/3,500	0.65	3.60	1.42	2.00	2.00	9.60	5.00
	3,700	2,360	4.340	1/4,000	0.59	3.40	1.36	1.90	1.90	9.10	3.50
Sub-Total	30,180										
Total	44,140										

TABLE D-1—4 (2) **ELEMENTS OF LATERAL IRRIGATION CANAL SECTION**



Project Area	Name of Lateral	Canal Length (m)	Service Area (ha)	Discharge (cu m/s)	Slope of Canal	b (m)	D (m)	t (m)	B (m)	W (m)
IGUIG	L-A	2,000	70	0.13	1/2,500	0.90	0.70	0.70	3.00	3.50
	L-B	750	35	0.06	1/2,500	0.70	0.60	0.60	2.50	3.50
	L-C	2,250	175	0.32	1/2,500	1.20	0.80	0.80	3.60	3.50
	L-C-1	1,400	45	0.08	1/2,500	0.70	0.60	0.60	2.50	3.50
	L-C-2	1,600	25	0.05	1/2,500	0.60	0.60	0.60	2.40	3.50
	L-D	1,500	125	0.23	1/2,500	1.10	0.80	0.80	3.50	3.50
	L-E	1,700	45	0.08	1/2,500	0.70	0.60	0.60	2.50	3.50
	L-F	1,300	65	0.12	1/2,500	0.80	0.70	0.70	2.90	3.50
Sub-Total		12,500								
ALCALA-AMULUNG	L-A	600	465	0.85	1/3,000	1.70	1.00	1.00	4.70	3.50
	L-A-1	2,700	80	0.15	1/2,500	0.90	0.70	0.70	3.00	3.50
	L-A-2	2,000	135	0.25	1/3,000	1.10	0.80	0.80	3.50	3.50
	L-A-3	3,000	115	0.21	1/2,500	1.00	0.80	0.80	3.40	3.50
	L-A-4	3,000	135	0.25	1/3,000	1.10	0.80	0.80	3.50	3.50
	L-B-1	3,000	120	0.22	1/2,500	1.00	0.80	0.80	3.40	3.50
	L-B-2	1,000	30	0.06	1/2,500	0.60	0.60	0.60	2.40	3.50
	L-B-3	3,000	80	0.15	1/2,500	0.90	0.70	0.70	3.00	3.50
	L-C	1,500	620	1.14	1/3,000	2.00	1.20	1.20	5.60	3.50
	L-C-1	2,000	130	0.24	1/2,500	1.10	0.80	0.80	3.50	3.50
	L-C-2	1,000	75	0.14	1/2,500	0.90	0.70	0.70	3.00	3.50
	L-D	4,200	415	0.76	1/2,500	1.60	1.00	1.00	4.60	3.50
	L-D-1	700	75	0.14	1/2,500	0.90	0.70	0.70	3.00	3.50
Sub-Total		27,700								
LOWER CAGAYAN	L-A	10,800	1,075	1.98	1/2,500	2.30	1.30	1.30	6.20	3.50
	L-A-1	5,500	140	0.26	1/2,500	1.10	0.80	0.80	3.50	3.50
	L-B	6,500	100	0.18	1/2,500	1.00	0.70	0.70	3.10	3.50
	L-C	4,700	1,730	3.18	1/3,000	2.90	1.70	1.70	8.00	3.50
	L-C-1	6,600	1,180	2.17	1/3,500	2.60	1.50	1.50	7.10	3.50
	L-C-1a	2,300	230	0.42	1/3,500	1.40	0.90	0.90	4.10	3.50
	L-C-2	4,500	550	1.01	1/3,500	1.90	1.10	1.10	5.20	3.50
	L-D	7,000	1,605	2.95	1/3,500	2.90	1.70	1.70	8.00	3.50
	L-E	14,000	2,100	3.86	1/3,500	3.20	1.80	1.80	8.60	3.50
	L-E-1	2,300	520	0.96	1/3,500	1.90	1.10	1.10	5.20	3.50
	L-E-2	3,000	585	1.08	1/3,500	1.90	1.10	1.10	5.20	3.50
	L-E-3	4,000	670	1.23	1/3,500	2.10	1.20	1.20	5.70	3.50
	L-F	8,000	1,115	2.05	1/3,500	2.50	1.40	1.40	6.70	3.50
	L-G	5,000	815	1.50	1/3,500	2.20	1.30	1.30	6.10	3.50
	L-H	7,000	485	0.89	1/7,000	2.10	1.20	1.20	5.70	3.50
Sub-Total		91,200								
Total		131,400								

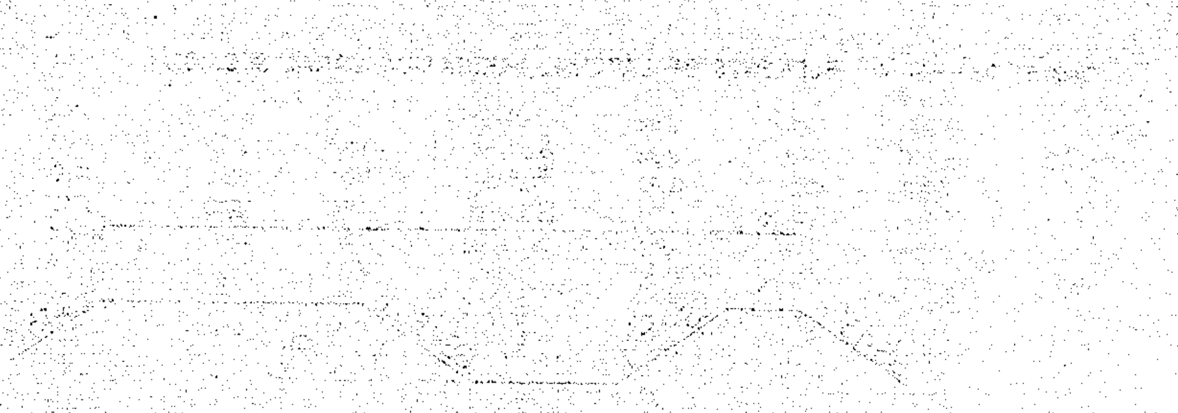


TABLE D-1-4 (3) COMPARISON OF MAIN IRRIGATION CANAL

— Lower Cagayan —

Item	Quantities (m)	Price[1/] (₱)	Cost ('000 ₱)
Proposed Canal			
Tunnel	460	(20,000) 9,200	(9,200) 4,232
Open Canal (1)	8,430	280	2,360
Open Canal (2)	1,000	640	640
Open Canal (3)	2,120	210	445
Open Canal (4)	2,860	190	543
Total	14,870		(13,188)[2/] 8,220
Alternative Canal			
Syphon	1,650	6,200	10,230
Open Canal (1)	3,820	280	1,069
Open Canal (2)	4,500	710	3,195
Culvert	500	7,900	3,950
Open Canal (3)	2,860	280	800
Open Canal (4)	2,120	230	487
Total	15,450		19,731

Note: 1/ Including right of way and excluding contingency and overhead

2/ Figures in parenthesis is recomended by NIA

6) Canal Structures

Canal structures to be constructed in each irrigation area was so designed giving special attention to the following aspects:

(a) Diversion Works

Diversion works should be constructed to supply water the required quantity for a given irrigation area and should function efficiently to divert water from the main canal to the fields through lateral canals and main farmditches in meeting hydraulic conditions and the mode of water utilization thereof and also, water control facilities should be provided for a better water management. The diversion structures shall be used properly as follows:

Double orifice gate with concrete pipe shall be used for discharge below Q = 0.50 cu m/s, the concrete box-type double orifice gate for rainy discharge Q = 0.50 - 0.85 cu m/s and the headgate for the discharge over 0.85 cu m/s, together with Parshall flume for water control. (See Figure D-1-4 (10) and (11))

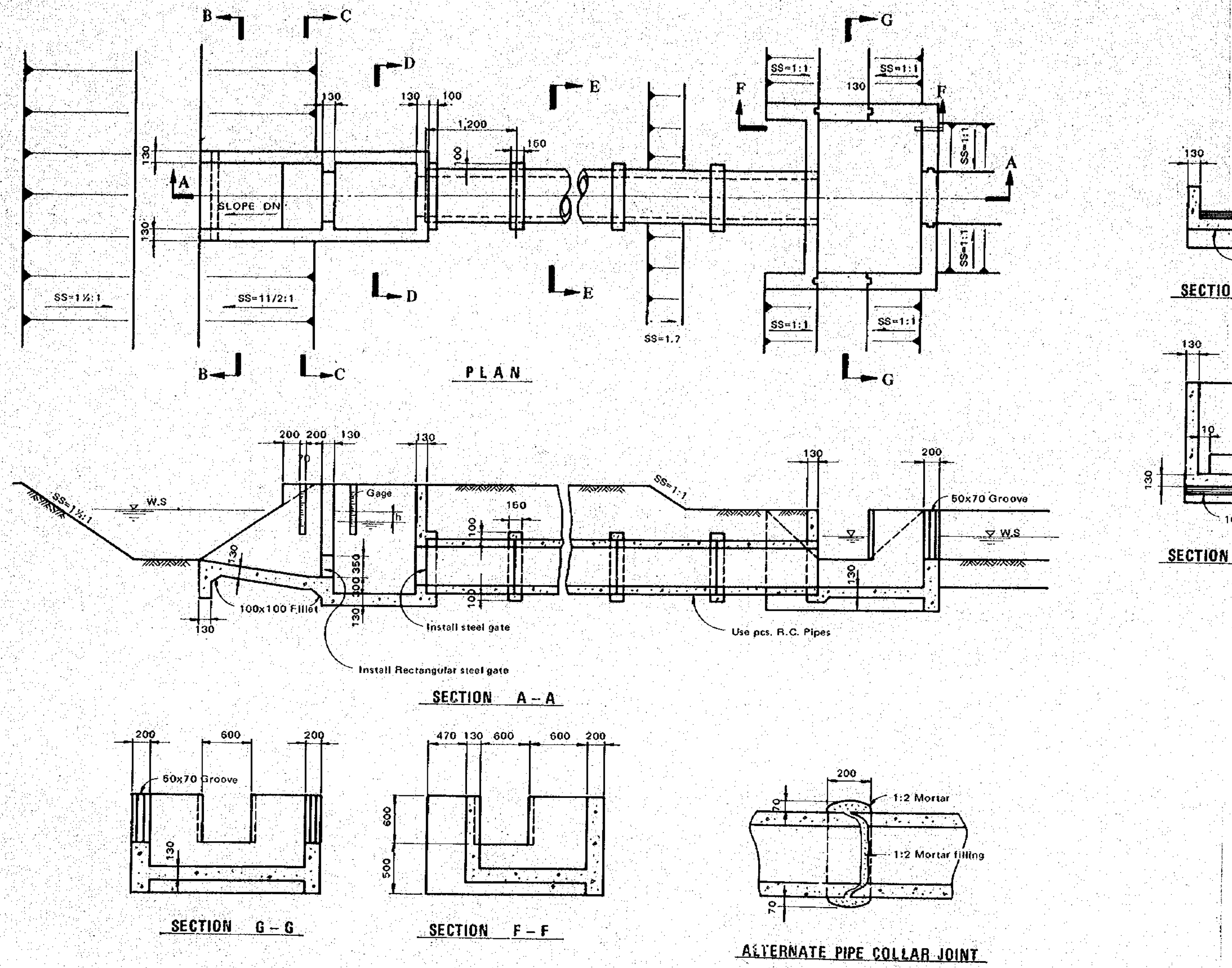
(b) Regulating Gate

Checkgate shall be installed to maintain the necessary water level and proper discharge for irrigation. In CIADP, the movable type shall be adopted. From viewpoint of operation and maintenance, the fixed type or automatic type are deemed advantageous but, marginal loss head does not allow for adoption of the fixed type. The movable type is of two kinds, a manual operation type and an automatic operation type. The former, the manual operation shall be adopted in CIADP. The steel sluice type gate shall be adopted for the main canal and wooden type gate for the lateral canals. (See Figure D-1-4 (12))

For references, introduction of automatic operation gate can be taken into account in the future due to its rationalized system.

The location of the checkgates along the main canal are shown in the hydraulic profile of Figure D-1-4 (3) to (5)

FIGURE D-1-4 (10)



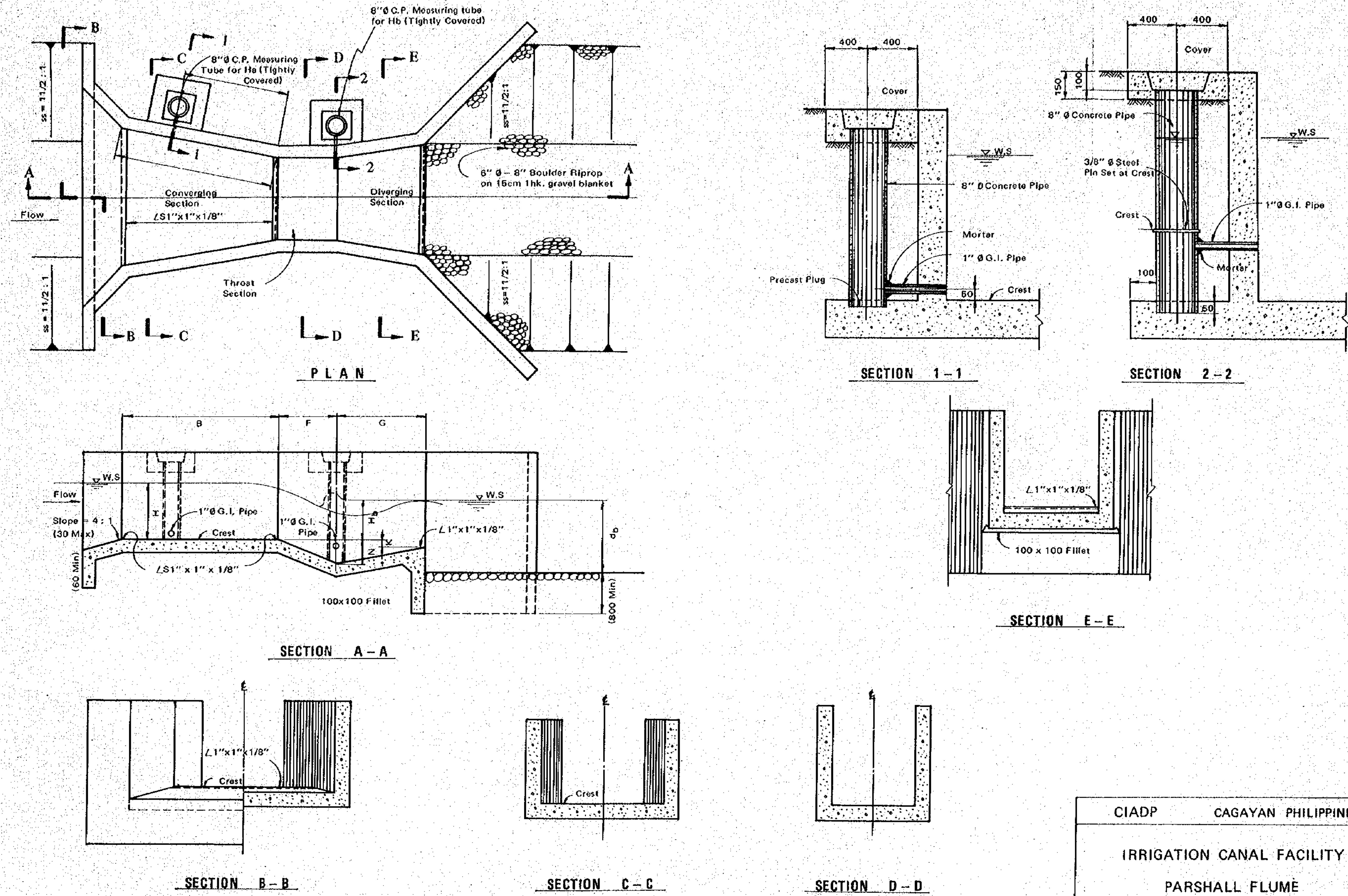
CIADP	CAGAYAN PHILIPPINE

IRRIGATION CANAL FACILITY

COMBINED TURNOUT AND DIVISION BOX WITH ORIFICE

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE D-1-4 (11)



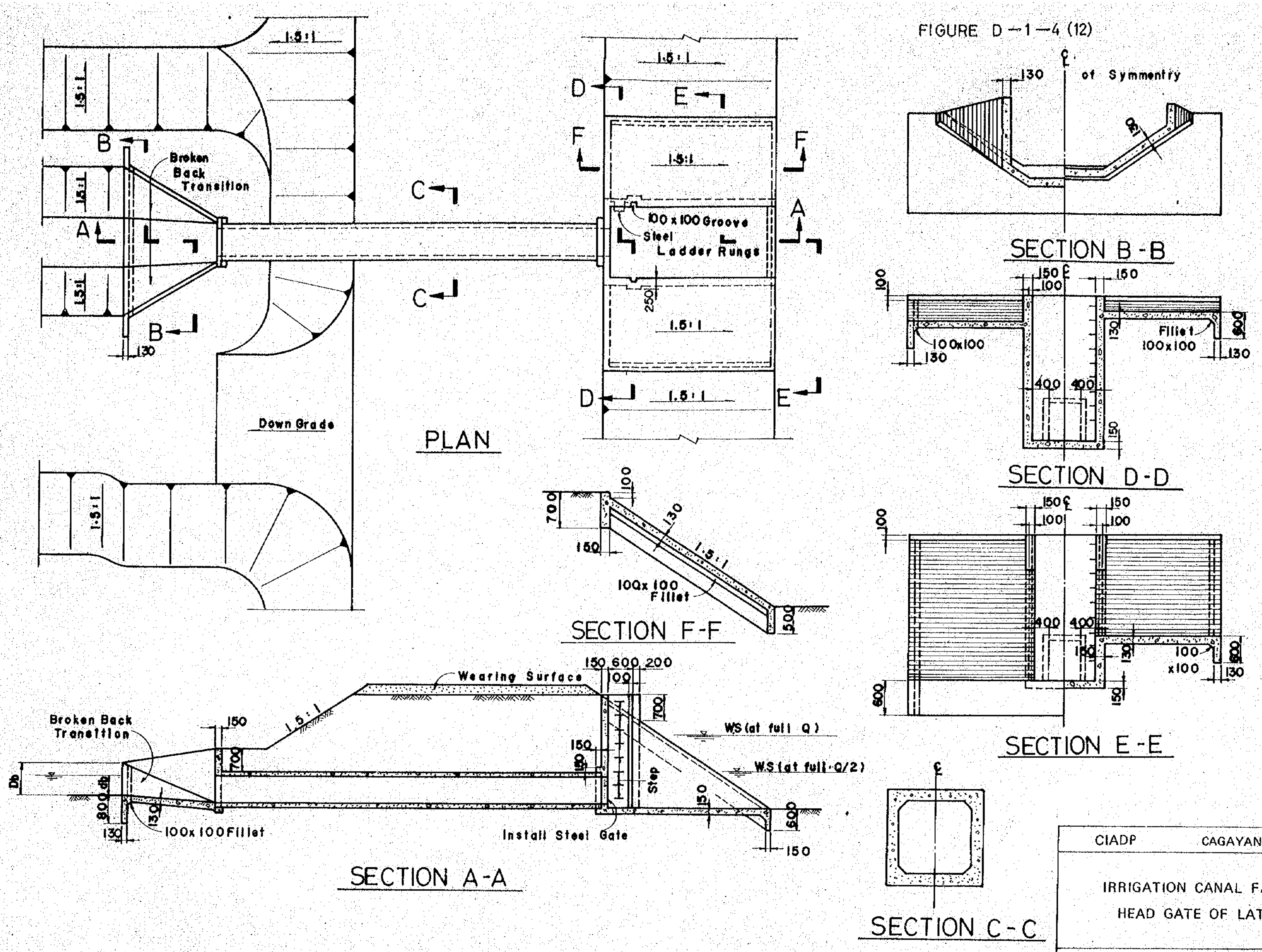
CIADP	CAGAYAN PHILIPPINE

IRRIGATION CANAL FACILITY

PARSHALL FLUME

JAPAN INTERNATIONAL COOPERATION AGENCY

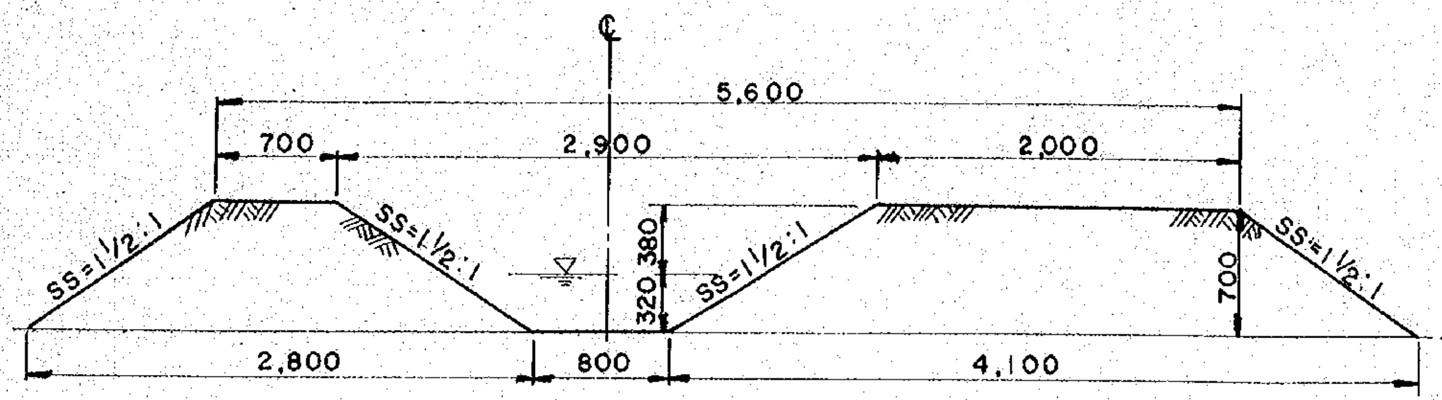
FIGURE D-1-4 (12)



CIADP	CAGAYAN PHILIPPINE
IRRIGATION CANAL FACILITY HEAD GATE OF LATERAL	
JAPAN INTERNATIONAL COOPERATION AGENCY	

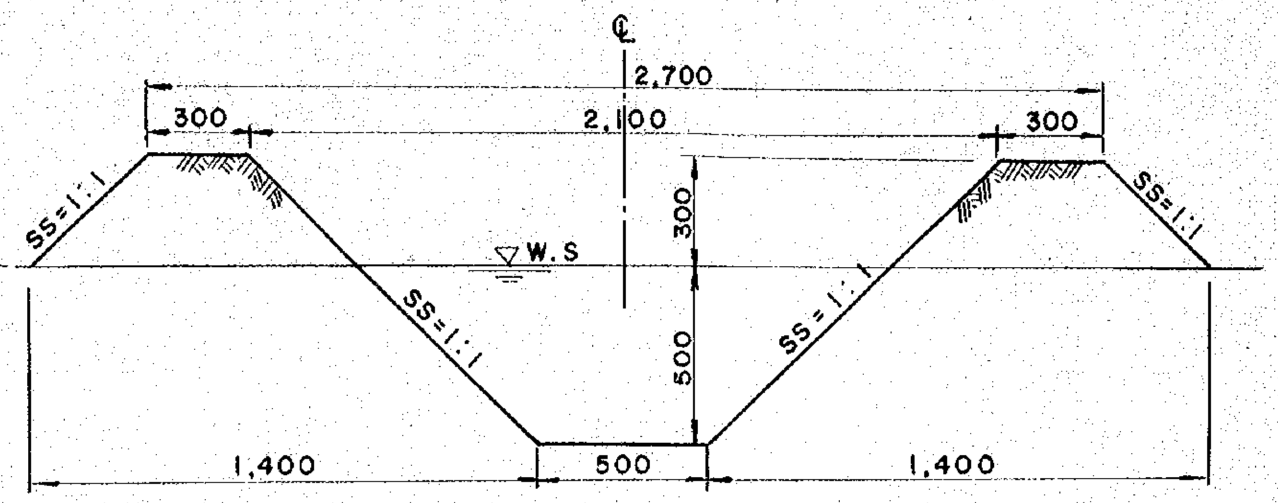
TYIPICAL SECTION OF TERMINAL FACILITY

Irrigation Area = 80 ha



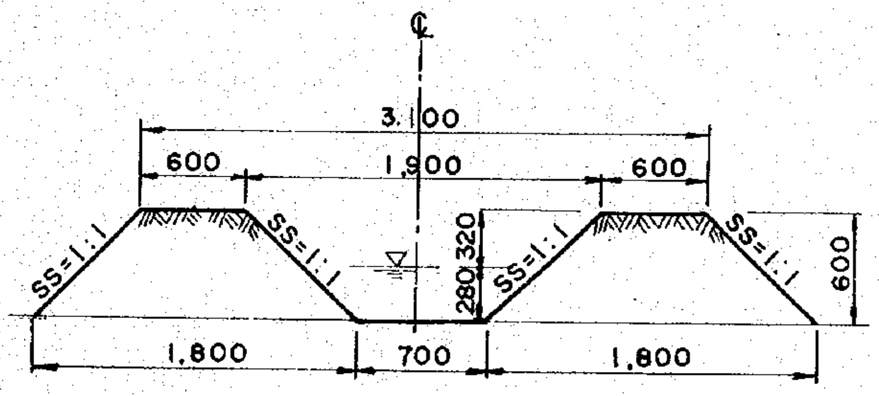
MAIN FARM DITCH

Q = 100 ℓ/s
I = 1/3,000
L = 1,380 m



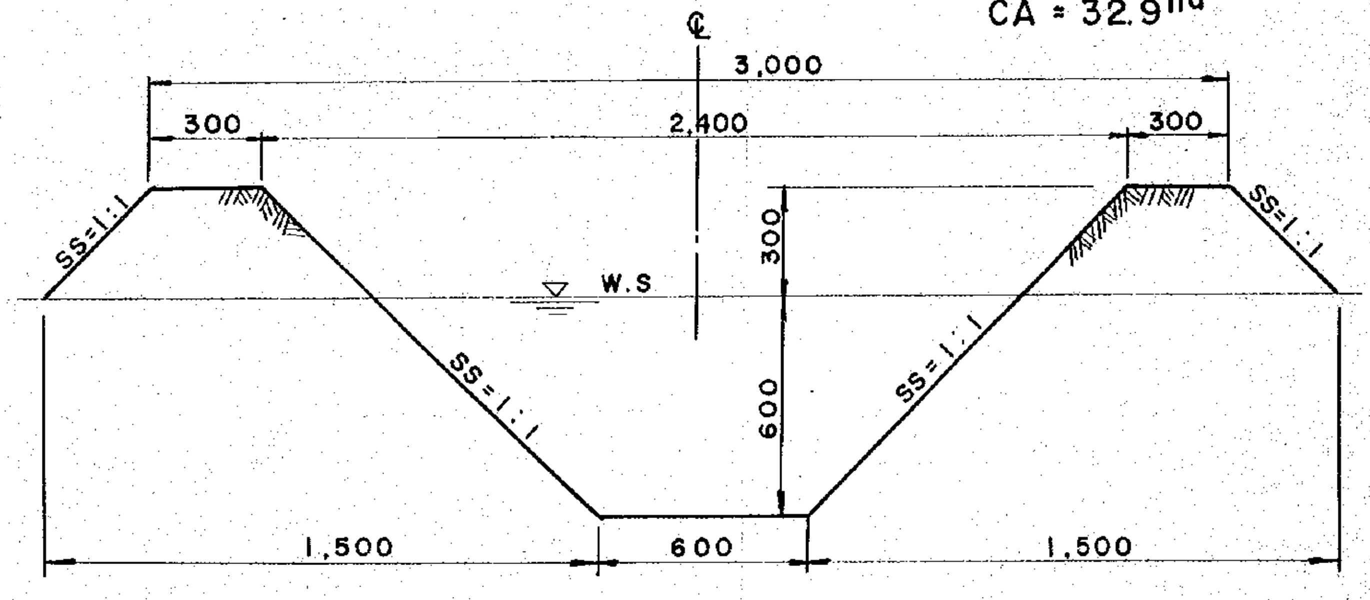
FARM DRAIN (1)

Q = 78.1 ~ 132.5 ℓ/s
I = 1/1,000 ~ 1/1,500
L = 1,160 m
CA = 32.9 ha



SUPPLEMENTARY FARM DITCH

Q = 100 ℓ/s
I = 1/1,000 ~ 1/1,500
L = 3,190 m



FARM DRAIN (2)

Q = 223.4 ℓ/s
I = 1/1,500
L = 560 m
CA = 34.9 ha

LEGEND

Q : Discharge
I : Longitudinal Slope of Canal
L : Length of Canal
CA: Catchment Area

APPENDIX D-2 PUMPING STATION

Page

D-2-1 IGUIG PUMPING STATION

1) Selection of pumping site

The Cagayan river meanders so heavily that very few portions of its course can be found in a stable straight line. It can be said that the Cagayan river has been left intacted in regard to its heavy meandering, scouring, and silting.

In the wet season, floodings still continue to scour the river banks near the Iguig pumping station. Especially by the big flooding in 1973, which is presumed to be at 1/60 years probability, some portions of the banks were carried off in several meters thickness. According to interviews, however, scouring caused by ordinary floodings progresses slowly, and the gut, the center of flow, does not move abruptly in the normal year. The field survey near the Iguig pumping site found that the average velocity of the center flow is approximately 0.4 - 0.5 m/s in normal conditions.

It was learned from the river cross section that the gut flows closely to the right bank at the puming site and the water depth is about 5.0 m in the dry season. By the reasons mentioned above, it is considered that the proposed pumping site provides sufficient conditions in its suitability as pumping site, being located on the right bank of the river curving point 104 km upstream from the estuary.

In selecting the pumping site, two intake sites are proposed from the viewpoints of topography and location in the village. They are;

a) the site for south of Barrio Minaga Sur

b) the site in the center of Barrio Minaga Sur (being located approximately 150 m downstream of the case a).

In the case a), the bore drilling test and bearing capacity tests were carried out by NIA, but a creek running maddy at 30 m upstream of the intake site will give unfavourable effect to intaking due to water quality.

In the case b), the site presents an evidence of small scale pumping irrigation for the Barrio. The pump had been operated for 2 years, 1972 and 1973. The said site will be utilized as pumping site in exclusive use for the Iguig pilot center.

The relevant site explained as the case b), provides sufficient space for structures and good conditions for the pumping station from the viewpoints of canal alignment and settling condition of houses in the village.

Subsequently, the Iguig pumping station site was selected in the Center of the Barrio, being close to the lot of proposed pumping site for the Pilot Center.

2) Method of Intake

The proposed Iguig pumping station will be located approximately 100 km upstream from the estuary of the Cagayan river where there will be no influence of sality water in any case.

The analysis of the Cagayan river water level records clarified the water levels at the said site as follows;

Design intake water level	L.W.L	=	4.50 m
Mean water level in dry season	M.W.L	=	9.20 m
Mean water level in wet season	M.W.L	=	10.40 m
Past maximum flood water level (in 1973)	H.H.W.L	≒	20.00 m

The water level at the site fluctuates in rather wide range, and it is expected that the sand is deposited therearound to a considerable extent in floodings. Taking into account those conditions, the following

4 available types of waterintake were proposed for the Iguig pumping station.

a) Type 1: Steel pipe

In this method, suction pipes of each pump are directly installed in the gut of the river so as to prevent sedimentation in floodings. The installed pipes will be comparatively longer, but the method is advantageous in providing simple structures and no gates, a general plan of which is shown in Figure D-2-1. To make the matters better, the sediment trapped in the pipes can be flashed out by adverse flow from the discharge tank (refer to Figure D-2-1).

b) Type 2: Concrete culvert

In the method, concrete intake culvert is installed closely to the gut of the river to prevent sedimentation. The culvert shall have the minimum available scale to save construction cost and works: the width is to be 1.0 m and the depth 1.2 m. Even with such minimized scale, the cross-sectional area of flow is larger than that of pipe in type 1, and the velocity will be low. Therefore, sediment in the culvert is anticipated to increase in quantity.

A manhole and a sand trap shall be provided on the halfway of the culvert, and deposited sand, which cannot be flashed out by adverse flow due to very low velocity flow, will be to be removed by manpower. (cf. Figure D-2-2).

c) Type 3: Open cut

The low water level in drought time is around 14 m lower than the ground elevation. In this method, however, during the flood season, the excavated intake portion will be blocked with sand, which would be difficult to be removed. (cf. Figure D-2-3)

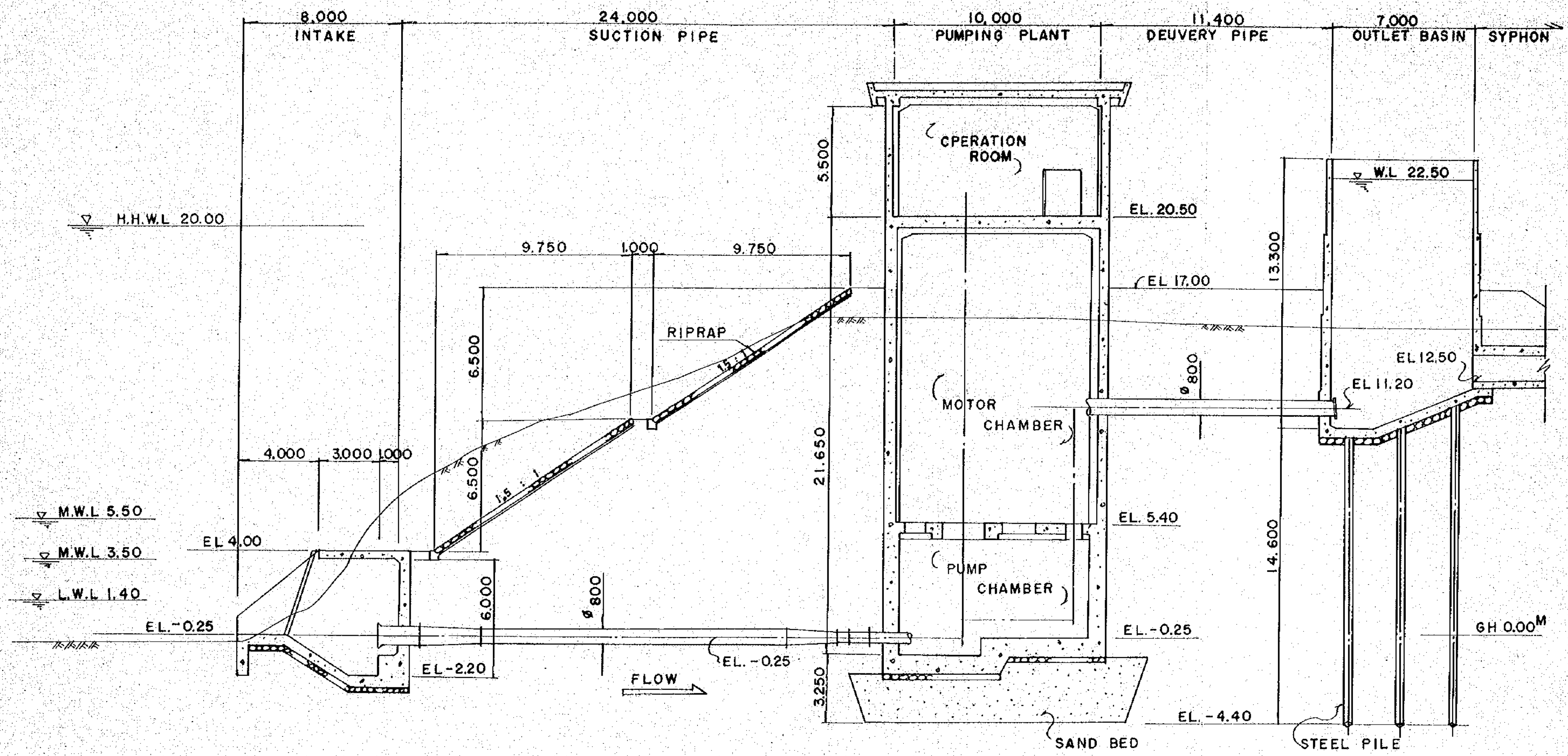
d) Type 4: Tubular pump

The tubular pump or the submerged pump will be installed in the river water, and the remote operation should be applied in this method. (cf. Figure D-2-4)

In this case, its operation and maintenance will be rather difficult because of complicated mechanism of machines and equipments.

The type 1, therefore, is considered to be the most suitable to the site in taking into consideration of the results of comparative studies of above four methods, particularly on sediment, operation and maintenance, and organization, and so forth.

FIGURE D-2-1 ALTERNATIVE PLAN-1 (AMULUNG)

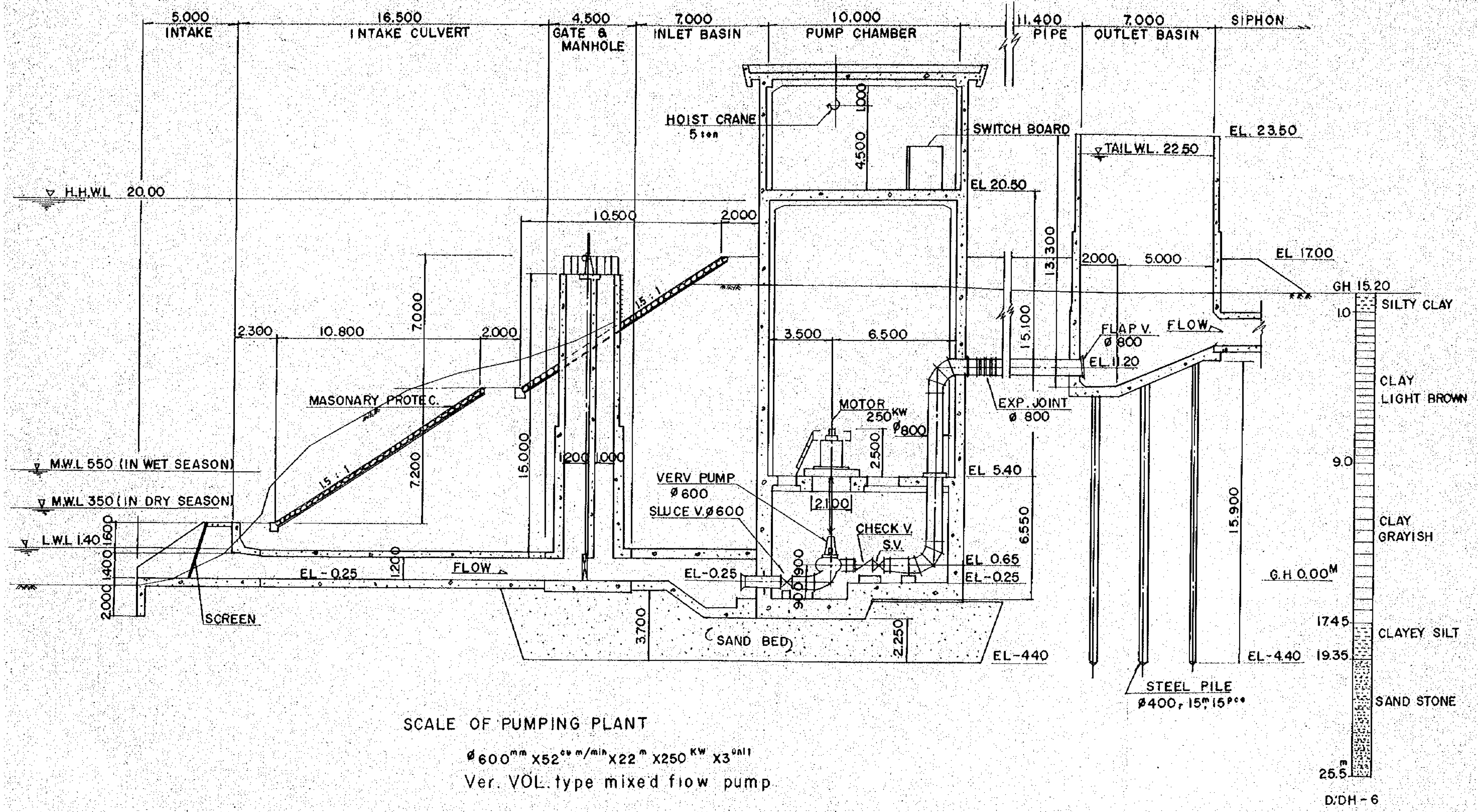


SCALE OF PUMPING PLANT

Ø 600 mm X 52 cu m/min X 22 m X 250 KW X 3 unit

Vertical volute type mixed flowpump

FIGURE D-2-2 ALTERNATIVE PLAN-2 (AMULUNG)

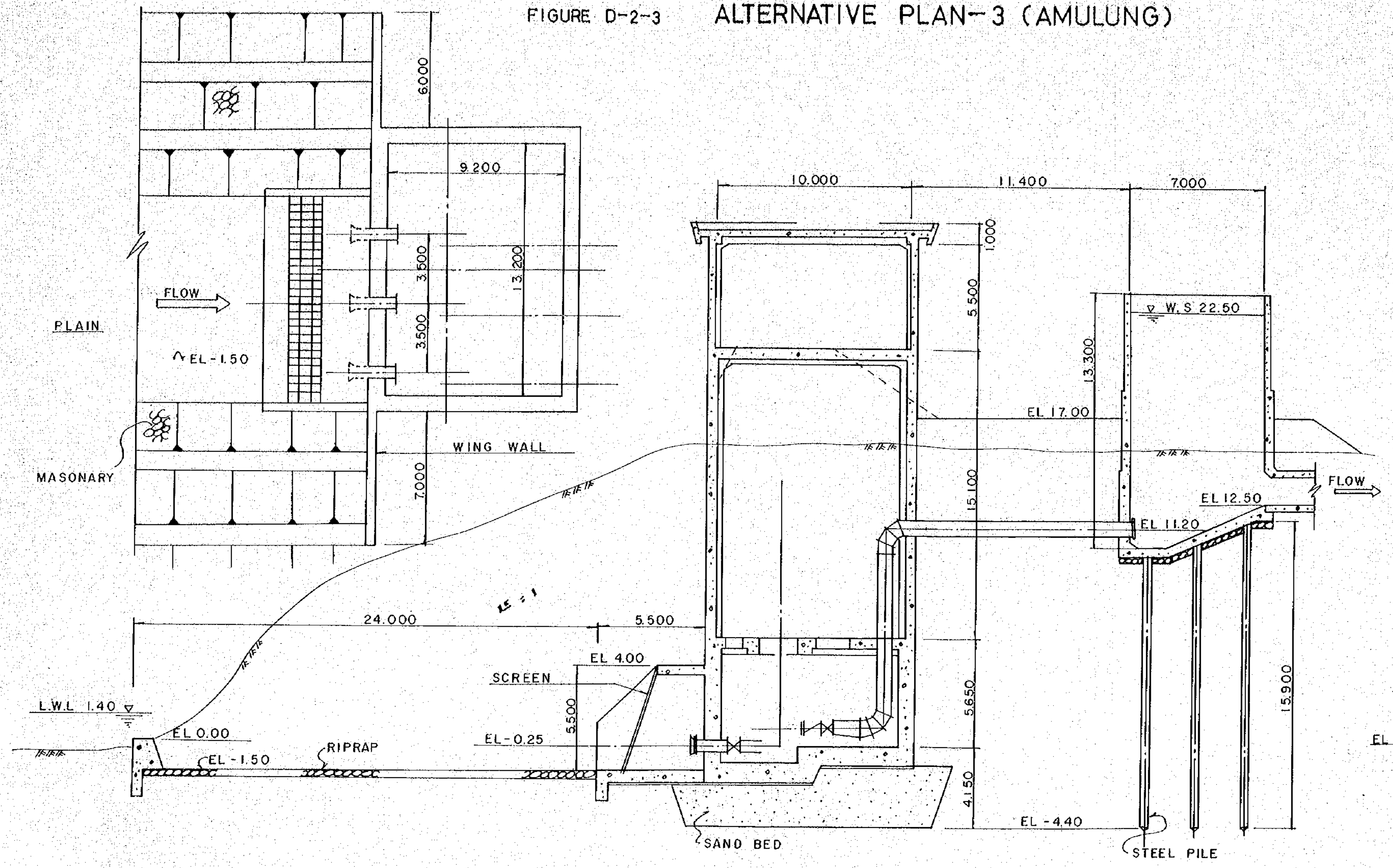


SCALE OF PUMPING PLANT

Ø600mm X52cu m/min X22m X250KW X3unit

Ver. VOL. type mixed flow pump

FIGURE D-2-3 ALTERNATIVE PLAN-3 (AMULUNG)

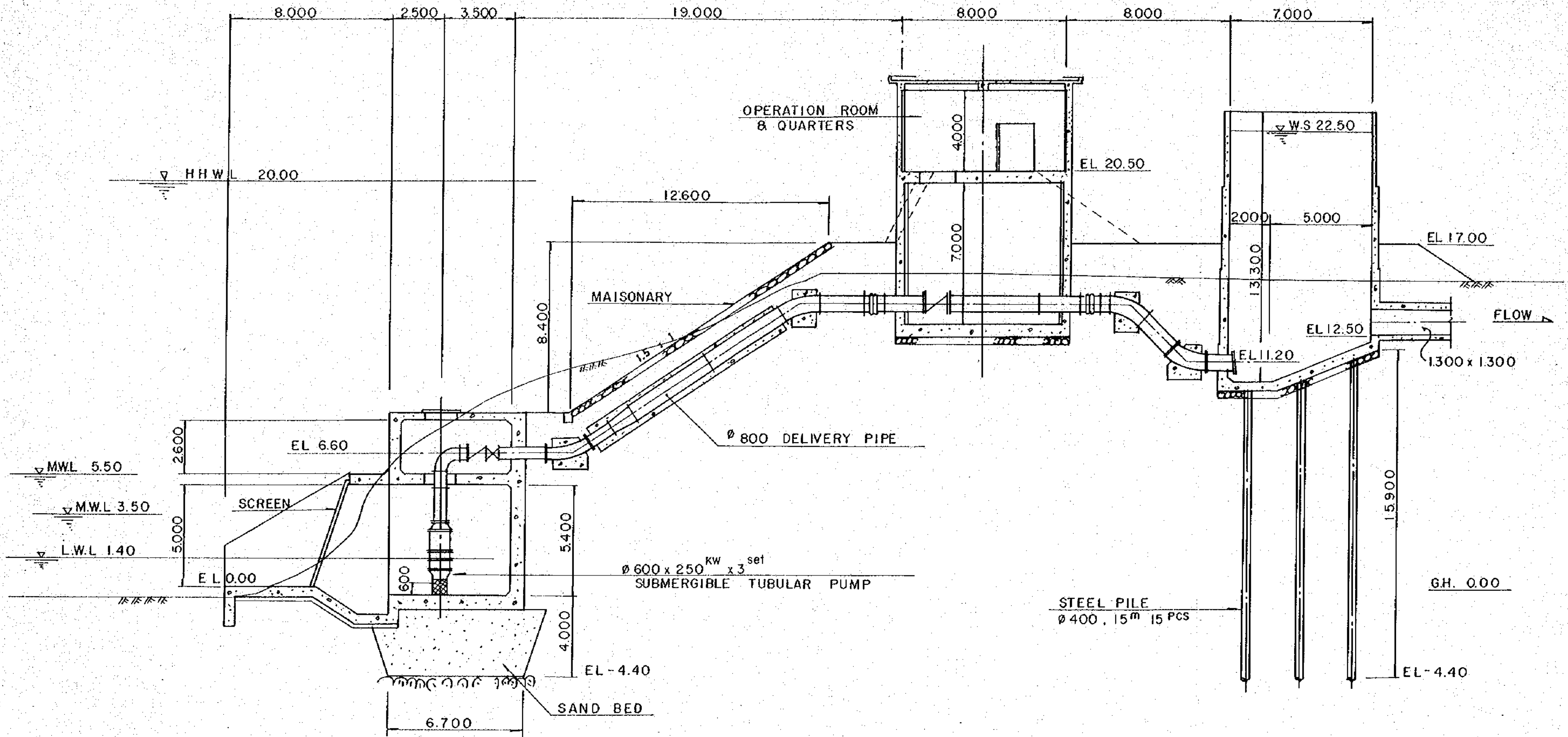


SCALE OF PUMPING PLANT

ø600 mm X52 cu m/min X22 m X250 KW X3 unit

Ver. vol. type mixed flow pump

FIGURE D-2-4 ALTERNATIVE PLAN-4 (AMULUNG)



3) Study of pump-type

A careful study was made to select the pump to be provided for the Iguig pumping station.

The following Table D-2-1 shows the essential items of various pumps.

TABLE D-2-1 LIST OF VARIOUS PUMPS

Type	Horizontal Axis Type	Vertical Axis
Axial pump	less than 4 m	less than 7m
Mixed flow pump	3 - 10 m	single: 5 - 50m multistage: more than 15m
Turbin pump or Volute pump	single: 5 - 120m multistage: more than 12m	single: 5 - 170m multistage: more than 12m

The designed total head is about 20 m.

From the above table, either the volute or vertical mixed flow types are deemed suitable. For these two types, the volute pump has a little advantage if adopting the vertical or horizontal axis type.

Finally, the pump model and the axis type were determined after detailed comparative study the following three types.

TABLE D-2-2 COMPARISON OF VOLUTE AND MIXED FLOW PUMP

Item	Horizontal volute pump	Vertical volute pump	Vertical mixed flow pump
Pump performance	1. Efficiency is high over a wide range.	1. the same as left column	1. Efficiency is a little lower than volute type.
	2. In case that discharge rate is adjusted to small quantity, the power becomes low.	2. -ditto-	2. Power is constant corresponding to the change of discharge.
	3. Corresponding to the change of pump head, the discharge is variable.	3. -ditto-	3. Discharge is constant corresponding to the change of pump head.
Arrangement	1. Spacious with big casing	1. Space is less than horizontal axis.	1. the same as left column
	2. Especially a wide space required for horizontal axis.		
Structure	1. When sand or log is absorbed into the pump, it will not break down because there is no bearing. More over the impeller is solid, therefore operation and maintenance is easy.	1. the same as left column	1. Operation and maintenance is more difficult than volute type because the submerged bearing is equipped.
Price	1. Machine cost is relatively not so high.	1. Machine cost increases 20% comparing with horizontal axis.	1. Machine cost is less than vertical volute type.
	2. However the construction cost of pumping chamber and housing cost are fairly high, consequently the total cost becomes higher than vertical type	2. Space for installation is about 70% of horizontal type, therefore the construction cost of civil works is not so high.	2. Space for installation and construction cost are the same as left column.

The detailed study based on the above comparison resulted in recommending the vertical volute pump taking into account the following conditions;

i) Compact structure economized the works from viewpoints of topography of the site, soil mechanics, and the arrangement of houses in the village.

ii) The pump performance of the volute pump is more excellent than that of the mixed flow pump.

iii) Structure of volute pump has the advantage in its operation and maintenance.

iv) There is little difference of the cost between vertical mixed flow type and volute type.

4) Study of number of pump

Following conditions are taken into account to decide the diameter and the number of pumps.

a) For saving equipment cost,

i) Every pump shall be driven under the maximum point of efficiency.

ii) All pumps to be provided shall be of the same type and equal capacity.

b) For saving power cost, the possibly large size pump shall be provided.

c) For saving maintenance cost, it is desirable to provide pumps as few as possible, but not to reduce the pump capacity in total.

To provide the same type possibly large size, and equal capacity pumps for one station will result in economy in every respect. Furthermore, plural numbers of pumps will be alternatively available in operation, even if some of them be out of order.

Machine troubles will possibly take please in the case of the mean intake amount and the mean intake water level in dry season of ordinary year.

The respective water requirements and the water levels are shown as follows;

Designed water requirement	Q max = 1.10 cu m/s
Mean water requirement in dry season	Q mean =0.90 cu m/s
Low water level	L.W.L = 4.50 m
Mean water level in dry season	M.W.L = 9.20 m

According to the above conditions, the actual pump head will be 67% of the designed pump head and the intake water amount was estimated at 120% of the pump capacity from the performance curves of volute pump and shown as below:

19.0m - 4.5m = 14.50 m

19.0 - 9.2 = 9.80

9.80 ÷ 14.50 = 0.67

In taking into account the above factors, the estimate was made on the required number of pumps for the site to secure the intake water on the side of prudence. The following shows the procedure of estimate of N, necessary numbers of pumps to be provided.

$$\frac{Q\ max}{N} = \frac{0.8 \times Q\ max}{(N-1) \times 1.20}$$

N = 3 sets

5) Selection of Prime Mover

a) Comparative Study of Prime Movers, Electric Motor and Diesel Engine

Electric motor and diesel engine were taken into consideration for selecting the prime mover of the pumping plant, and the comparative studies were carried out on these two from the viewpoints of engineering and economy. The results of comparison are shown in the following Table. (Table D-2-3)

TABLE D-2-3 COMPARISON BETWEEN MOTOR AND DIESEL ENGINE

Motor	Diesel Engine
1. Operation and maintenance are simple.	1. Operation and maintenance are complicated.
2. Operation is smooth but little noisy.	2. Noise and vibration are strong.
3. Initial cost is in-expensive.	3. Initial cost is expensive.
4. When the annual running hours are long, the power cost becomes cheaper than diesel engine.	4. Minimum charge is unnecessary.
5. Any type of pumps will be availables to the motor.	5. In case of adopting vertical pump with a high power, transmission system will not be suitable.
6. Reliability is low against flood or disaster.	6. Reliability is high against flood.
7. Construction costs of transformer substation, wiring and so on become expensive in the remote area.	7. Construction is available in any isolates places at economical rate of the cost.

b) Economical comparison of prime mover

i) Power rates of Motor

Power rates per month: 0.12 ₱/KWH x 75 KW x 3 unit

However the minimum electric charges are as follows.

Minimum electric charges: $75KW \times 3unit \times \frac{0.222}{0.163} \times 10₱ = 3,064$ ₱/mon.

ii) Fuel cost of diesel engine

Fuel cost:

$$\frac{1.3₱/l \times 180g/ps/hr \times 100ps \times 3\ unit \times 10^{-3} l/cc}{0.9\ g/cc} = 78.0₱/hr$$

Lubricating oil cost:

$$\frac{4.5₱/l \times 5g/ps \times 100ps \times 3unit \times 10^{-3} l/cc}{0.9\ g/cc} = 7.5₱/hr$$

Sub-total: 85.5 ₱/hr

iii) Annual running cost

Motor Ym = 127,800 ₱/year

Diesel engine Ye = 85.5 ₱/hr x 4,506 hr = 385,300 ₱/Yr

c) Comparison of annual cost including equipment cost

Equipment cost of motor: ₱2,941,000

Equipment cost of diesel engine: ₱3,808,000

$$C = (r+m+n) \times P + Y$$

Where; C: Annual cost

Y: interest 0.035

m: rate of repayment 0.040

n: operation and maintenance cost 0.010

In case of motor

Cm = (0.035+0.040+0.010) x 2,941,000 + 127,800 = ₱377,800

In case of diesel engine

Ce = (0.035+0.040+0.010) x 3,808,000 + 385,300 = ₱709,000

From the above - mentioned results, the difference of annual cost including equipments is ₱331,000 and motor is advantageous to diesel engine. (cf. Table D-2-4)

As for the electric power of motor, the transmission line is being constructed by CAGELCO-I and the power supply to the pumping plant will be available after completion of the work in 1978.

Unit of power rate and minimum electric charges are shown by NEA/F.S - 6.1 DNL.

TABLE D-2-4 ECONOMIC COMPARISON OF PRIME MOVER

Items	Unit	Iguig	Amulung	Magapit
1. Power rates of motor				
Power	KW	75	250	1,200
Electric charge	₱/hr	27	90	576
Minimum charge	₱/month	3,064	10,214	65,374
2. Fuel cost of diesel engine				
Power	PS	100	340	1,800
Fuel cost	₱/hr	78	265.2	1,872
Lubricating oil cost	"	7.5	25.5	180
Sub-total	"	85.5	290.7	2,052
3. Annual running cost				
Running hour	hr/year	4,506	4,495	3,799
Cost of motor	"	127,800	530,300	2,201,300
Cost of diesel engine	"	385,300	1,306,700	7,795,500
4. Annual cost including equipment cost				
Equipment cost of motor	₱	2,941,000	4,465,000	22,292,000
Equipment cost of diesel engine	₱	3,808,000	5,767,000	29,696,000
Cost of motor	₱/Year	377,800	909,800	4,096,200
Cost of diesel engine	"	709,000	1,796,900	10,319,700
Difference	"	331,200	887,100	6,223,500

6) Design of Pumping Facilities

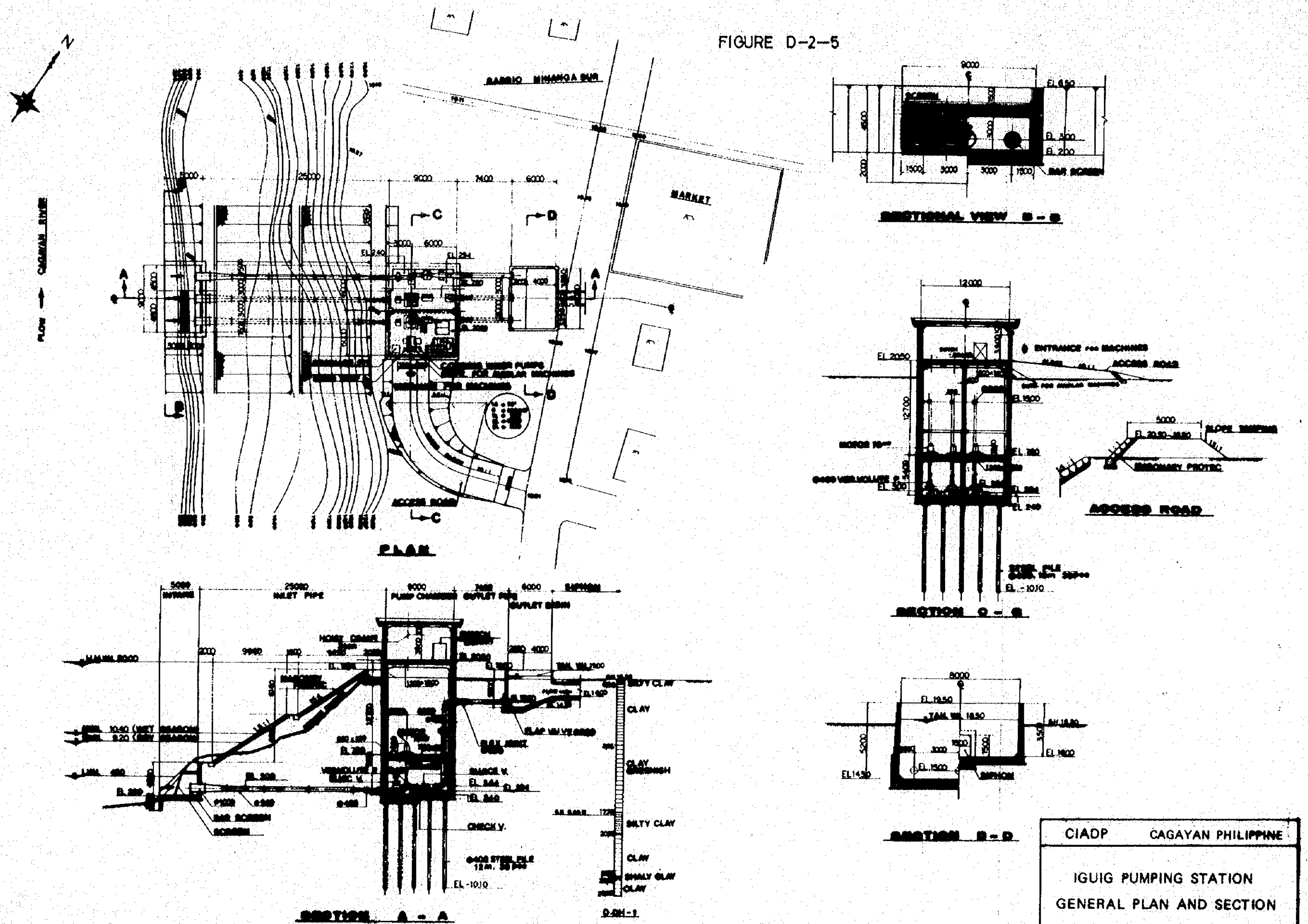
TABLE D-2-5 DESIGN OF IGUIG PUMPING FACILITIES

Items			Unit	Remarks
1. Location				
1) Name of Barrio	Minaga Sur, Iguig			
2) Name of Pumping Plant	Iguig Pumping Station			
3) Water Source	Cagayan river			Right bank
2. Objective Area				
1) Total Area		710	ha	
2) Gross irrigable Area		690	ha	
3) Net Irrigable Area		600	ha	
3. Designed Water Requirement		1.10	cu m/s	1.0 l/s/ha x $\frac{1}{0.544}$ x 600
4. Intake				
1) Irrigation System	Pumping irrigation			
2) Type of Intake	Pipe Type			
3) Water Level				
a. L.W.L. (Intake Water Level)		EL. 4.50	m	Probability of 1/10 years
b. M.W.L. in wet season		EL.10.40	m	
c. M.W.L. in dry season		EL. 9.20	m	
d. H.H.W.L.		EL.20.00	m	Past maximum flood water level
4) Intake Velocity		0.47	m/s	Velocity in suction pipe
5) Structure of Intake		30	m	ø1,000 - 400, steel pipes
6) Appurtenance				
a. Screen		1	unit	H 3.0m x 9.0m
5. Pumping Plant				
1) Elements of pump				
a. Designed pump capacity		22	cu m/min/unit	1.10÷3=0.367cu m/s
b. Numbers of Pump		3	unit	

c. Type of pump	Vertical volute type mixed flow pump		ø400 mm
d. Designed suction level	EL. 4.50	m	
e. Designed discharge level	EL.19.00	m	
f. Actual head	14.50	m	
g. Total pump head	15.50	m	Loss head ≑ 1.00m
h. Electric prime mover	75	kw/unit	
i. Total power	225	kw	
j. Hoist crain	1	unit	3^t, Span 11m
2) Structure of pumping plant			
a. Amount of concrete Class A	770	cu m	
b. Size of structure	125	sq m	L.9.8 x W.12.8 x H.19.1m
c. Pile foundation	360	m	ø400 x 12m x 30pcs
3) Operation room			
a. Space	100	sq m	L.8.4 x W.11.4
b. Amount of concrete Class A	90	cu m	1 - room
c. Elevation of floor	EL.20.50	m	Height 4.5m
6. Outlet Basin			
1) Amount of concrete Class A	70	cu m	
2) Size	270	cu m	L6.0xW8.0xH5.7m
3) Length of delivery pipe	7	m	ø500x3pcs, steel pipe
4) Bottom elevation of syphon	EL.15.70	m	Box culvert 1.20 x 1.20m
7. Others			
1) Coffer dam	60	m	H=6.30m, Top EL.6.80m
2) Access road	30	m	B=5.0m slope 1/10
3) Quarters	1	lot	Area = 100sq.m
4) Masonery protection	700	sq m	W = 30m

The general plan and section of Iguig pumping station is shown in Figure D-2-5.

FIGURE D-2-5



CIADP CAGAYAN PHILIPPINE

IGUIG PUMPING STATION
GENERAL PLAN AND SECTION

JAPAN INTERNATIONAL COOPERATION AGENCY

7) Design of Booster Pumping Plant

TABLE D-2-6 DESIGN OF BOOSTER PUMPING FACILITIES

Items			Unit	Remarks
1. Location				
1) Name of Barrio	Barrio Captain			
2) Name of Pumping Plant	Iguig booster pumping station			
3) Water source	Main Canal			
2. Area to be Irrigated				
1) Total Area		150	ha	
2) Gross irrigable area		150	ha	
3) Net irrigable area		125	ha	
3. Designed Water Requirement		0.23	cu.m/s	1.0 l/s/ha x $\frac{1}{0.544}$ x 125
4. Intake				
1) Irrigation System	Pumping irrigation			
2) Type of Intake	Pipe Type			
3) Water Level				
a. L.W.L. (Intake water level)		EL.18.19	m	Probability of 1/10 years
4) Intake velocity		0.81	m/s	Velocity in suction pipe
5) Structure of intake		3	m	600 ø RC pipe
6) Appurtenance				
a. Screen		1	unit	H1.25m x W3.0m, 4.0sq.m
5. Pumping Plant				
1) Elements of pump				
a. Designed pump capacity		6.9	cu.m/min/unit	0.23÷2=0.115 cu.m/s
b. Numbers of pump	Horizontal	2	unit	

c. Type of pumps	small type mixed flow pump		250 mm
d. Designed suction level	EL.18.00	m	
e. Designed discharge level	EL.25.50	m	
f. Actual head	7.50	m	
g. Total Pump Head	8.50	m	Loses head ≒ 1.00m
h. Electric prime mover	18.5	kw/unit	
i. Total power	37.	kw	
j. Hoist crain	1	unit	
2) Structure of pumping plant			
a. Amount of concrete class A	20	cu.m	
b. Size of structure	9	sq.m	L2.5 x W3.5 x H2.0m
3) Operation Room			
a. Space	32	sq.m	L7.0 x W4.5
b. Elevation of Floor	EL.18.81	m	Height 3.0m

6. Outlet Basin

1) Amount of concrete class A	36	cu m	
2) Size	41	cu.m	L1.5xW3.0xH9.4m
3) Length of delivery pipe	4	m	ø250x2pcs, steel pipe
4) Bottom elevation of culvert	EL.17.40	m	RC Pipe 600

The general plan of the booster pumping station is shown in Figure D-2-6.

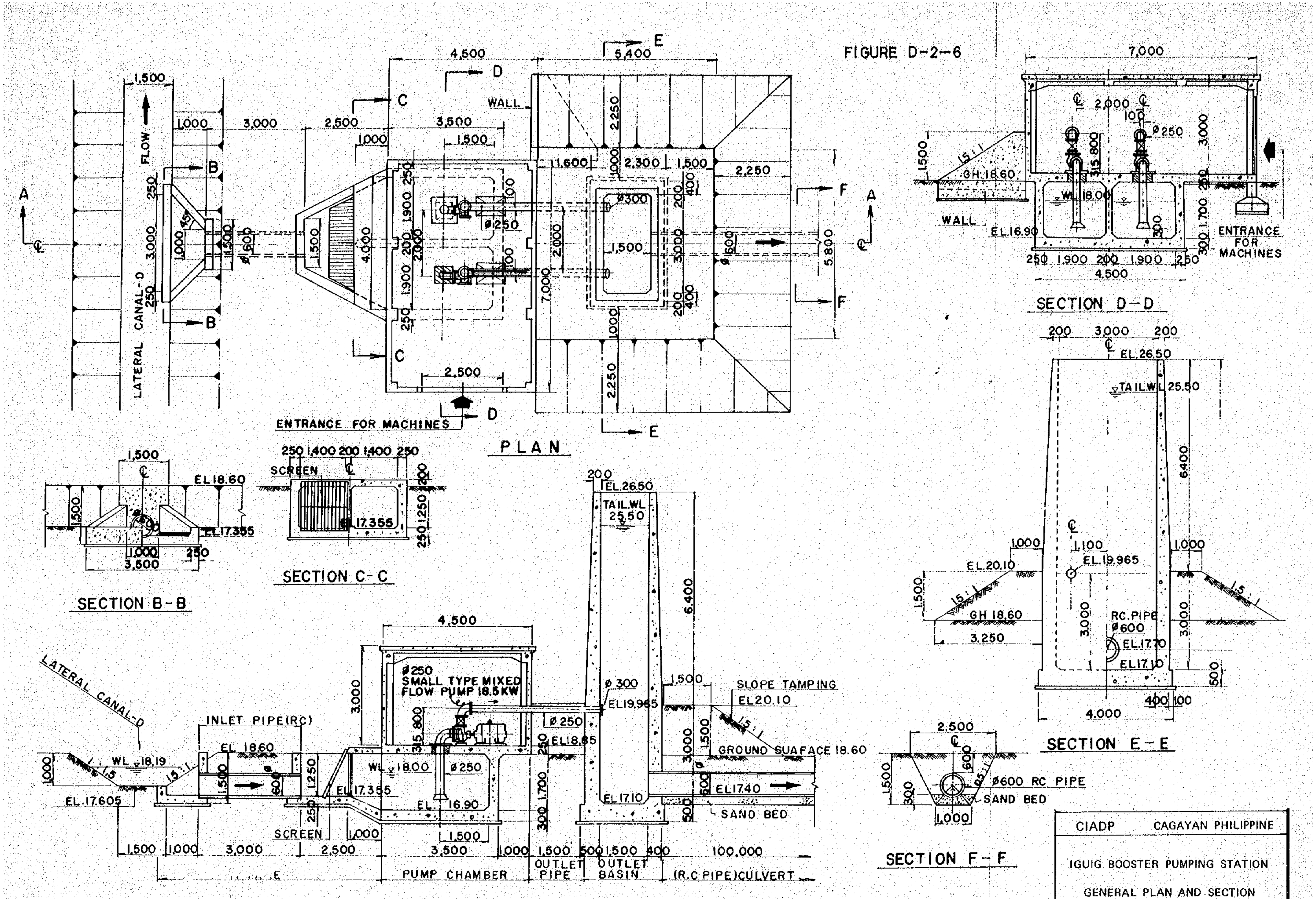


FIGURE D-2-6
PLAN
SECTION A - A
SECTION B - B
SECTION C - C
SECTION D - D
SECTION E - E
SECTION F - F
LATERAL CANAL-D
FLOW
ENTRANCE FOR MACHINES
WALL
SCREEN
INLET PIPE(RC)
SMALL TYPE MIXED FLOW PUMP 18.5KW
SLOPE TAMPING
GROUND SUAFACE 18.60
SAND BED
Ø600 RC PIPE
PUMP CHAMBER
OUTLET PIPE
OUTLET BASIN
(R.C PIPE)CULVERT
TAIL.WL 25.50
EL.26.50
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IGUIG BOOSTER PUMPING STATION
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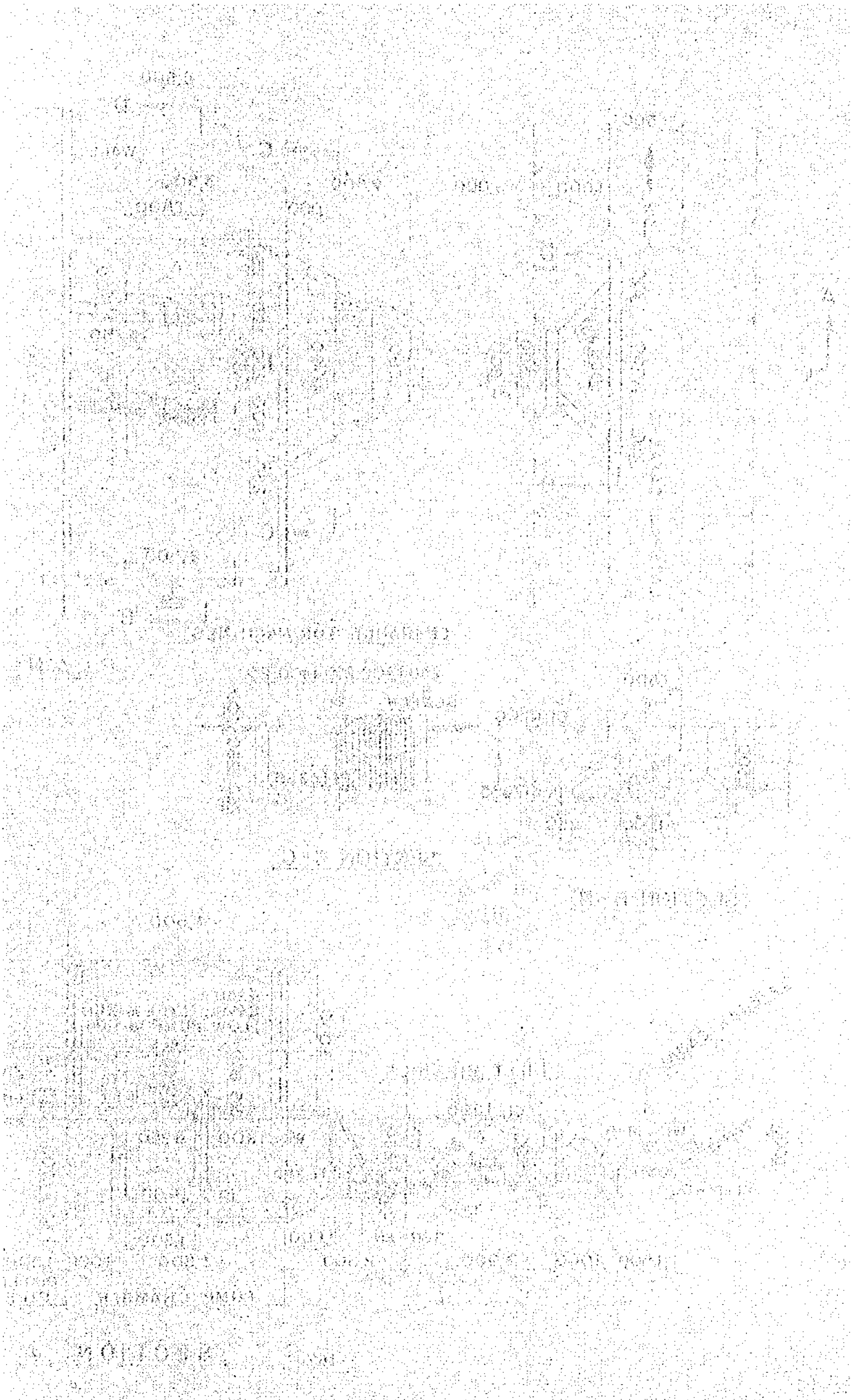


8) Operation Method of Pump

The result of estimated operation hours and the running cost are shown in the following table D-2-7.

TABLE D-2-7 ANNUAL OPERATION AND MAINTENANCE COST OF PUMPING PLANT

(Unit: ₱)

Item	Iguig	Amulung	Magapit	Remarks
1. Electric charge	127,800	425,000	2,319,000	* 1)
2. Salary for operator	10,600	10,600	21,300	* 2)
3. Maintenance and spare part costs	29,400	44,700	222,900	* 3)
4. Total	167,800	480,300	2,563,000	

Note * 1) See the table D-2-8 and D-2-9 of electric charge

* 2) Two-shift system

Iguig - ₱410/mon/man x 1.08 x 12mon x 2man = 10,627

Amulung - ₱410/mon/man x 1.08 x 12mon x 2man = 10,627

Magapit - ₱410/mon/man x 1.08 x 12mon x 4man = 21,254

* 3) 1% of the cost of pump facilities

Iguig - ₱ 2,941,000 x 0.01 = 29,410

Amulung - ₱ 4,465,000 x 0.01 = 44,650

Magapit - ₱22,292,000 x 0.01 = 222,920

TABLE D-2-8 ELECTRIC CHARGE

Month	IGUIG			AMULUNG			MAGAPIT			Remark
	Running Hour (hr)	Power Consumption (KWH)	Electric Charge (₱)	Running Hour (hr)	Power Consumption (KWH)	Electric Charge (₱)	Running Hour (hr)	Power Consumption (KWH)	Electric Charge (₱)	
May	744	167,400	20,088	744	558,000	66,960	744	3,571,200	428,544	
June	460	103,500	12,420	460	345,000	41,400	490	2,352,000	282,240	
July	130	29,250	3,510	130	97,500	11,700	248	1,190,400	142,848	
August	349	78,525	9,423	338	253,500	30,420	342	1,641,600	196,992	
September	160	36,000	4,320	160	120,000	14,400	80	384,000	46,080	
October	-	-	3,064	-	-	10,214	-	-	65,370	
November	400	90,000	10,800	400	300,000	36,000	310	1,488,000	178,560	
December	410	92,250	11,070	410	307,500	36,900	299	1,435,200	172,224	
January	517	116,325	13,959	517	387,750	46,530	242	1,161,600	139,392	
February	612	137,700	16,524	612	459,000	55,080	392	1,881,600	225,792	
March	724	162,900	19,548	724	543,000	65,160	652	3,129,600	375,552	
April	-	-	3,064	-	-	10,214	-	-	65,370	
Total	4,506	1,013,850	127,790	4,495	3,371,250	424,978	3,799	18,235,200	2,318,964	₱2,871,732

TABLE D-2-9 POWER CONSUMPTION

Month	10days	Number of days	Iguig (75kw x 3unit) Running Hour hr/unit	Power Consumption KWH	Load Factor	Amulung (250kw x 3unit) Running Hour hr/unit	Power Consumption KWH	Load Factor	Magapit (1,200kw x 4unit) Running Hour hr/unit	Power Consumption KWH	Load Factor
May	1st	10	240	54,000		240	180,000		240	1,152,000	
	2nd	10	240	54,000		240	180,000		240	1,152,000	
	3rd	11	264	59,400		264	198,000		264	1,267,200	
June	1st	10	190	42,750		190	142,500		200	960,000	
	2nd	10	190	42,750		190	142,500		150	720,000	
	3rd	10	80	18,000		80	60,000		140	672,000	
July	1st	10	80	18,000		80	60,000		80	384,000	
	2nd	10	50	11,250		50	37,500		80	384,000	
	3rd	11	-	-		-	-		88	422,400	
August	1st	10	90	20,250		90	67,500		80	384,000	
	2nd	10	160	36,000		160	120,000		130	624,000	
	3rd	11	99	22,275		88	66,000		132	633,600	
September	1st	10	60	13,500		60	45,000		10	48,000	
	2nd	10	100	22,500		100	75,000		60	288,000	
	3rd	10	-	-		-	-		10	48,000	
October	1st	10	-	-		-	-		-	-	
	2nd	10	-	-		-	-		-	-	
	3rd	11	-	-		-	-		-	-	
Sub-total			1,843 hr/unit	414,675 KWH/Sta.	42%	1,832 hr/unit	1,374,000 KWH/Sta.	42%	1,904 hr/unit	9,139,200 KWH/Sta.	43%

(cont'd)

Month	10days	Number of days	Iguig (75kw x 3 unit) Running Hour	Iguig Power Con-sumption	Iguig Load Factor	Amulung (250kw x 3 unit) Running Hour	Amulung Power Con-sumption	Amulung Load Factor	Magapit (1,200kw x 4 unit) Running Hour	Magapit Power Con-sumption	Magapit Load Factor
			hr/unit	KWH		hr/unit	KWH		hr/unit	KWH	
November	1st	10	130	29,250		130	97,500		160	768,000	
	2nd	10	150	33,750		150	112,500		150	720,000	
	3rd	10	120	27,000		120	90,000		-	-	
December	1st	10	150	33,750		150	112,500		120	576,000	
	2nd	10	150	33,750		150	112,500		80	384,000	
	3rd	11	110	24,750		110	82,500		99	475,200	
January	1st	10	150	33,750		150	112,500		80	384,000	
	2nd	10	180	40,500		180	135,000		30	144,000	
	3rd	11	187	42,075		187	140,250		132	633,600	
February	1st	10	210	47,250		210	157,500		140	672,000	
	2nd	10	210	47,250		210	157,500		140	672,000	
	3rd	8	192	43,200		192	144,000		112	537,600	
March	1st	10	240	54,000		240	180,000		190	912,000	
	2nd	10	220	49,500		220	165,000		220	1,056,000	
	3rd	11	264	59,400		264	198,000		242	1,161,600	
April	1st	10	-	-		-	-		-	-	
	2nd	10	-	-		-	-		-	-	
	3rd	10	-	-		-	-		-	-	
Sub-total			2,663 hr/unit	599,175 KWH/Sta.	61%	2,663 hr/unit	1,997,250 KWH/Sta.	61%	1,895 hr/unit	1,096,000 KWH/Sta.	43%
Total			4,506	1,013,850	51%	4,495	3,371,250	51%	3,799	18,235,200	43%

D-2-2 AMULUNG PUMPING STATION

1) Selection of Pumping Site

a) Intake from the Pared river

From the viewpoint of the topographical condition of Alcala-Amulung area, intake from the Pared river is advantageous as reported in Pre-feasibility study. The probable droughty discharge at 1/10 years, however, is about 1.4 cu m/sec at Alcala from the result of hydrological analysis. The amount of discharge is nearly the same as the result obtained from interviews, and the water depth would become about 6 inches in dry season.

Furthermore, NIA's Bagao irrigation project, intending expansion in its scale in future, is underconstruction 35 km upstream from the proposed site, and then after completion of the said project, the intake from the Pared river will be impossible in dry season due to expected decrease of discharge by operation of the Bagao project.

Under the circumstances, water intake at Amulung pumping site has been forced to change from the Pared river to the Cagayan river.

b) Condition of the Cagayan river near the Amulung pumping site

The river condition around the site is almost similar to that of the Iguig pumping site, and the gut is running closely to the right bank of the river. Water depth ranges between 4 - 5 m, and the velocity is about 0.4 m/s in dry season.

c) Location of pumping station

Selection of the pumping site was made taking into account the river conditions such as river shifting and sediment, and other various factors of the following three sites in the Barrio Baculud, Amulung.

Around the Barrio Baculud, Amulung, the Cagayan river meanders in the course of west - east - west, and the three proposed sites are located in the upstream part, middle and downstream of the meandering portion, respectively, and the latest survey found the river shifting little by little toward the west. Another important factor is that a creek joins the Cagayan river at the upstream part of the meandering.

Finally, the proposed site in the middle part of the meandering was selected for the pumping station in due consideration of the discharge, sediment, functional relation with other facilities, and so forth.

2) Method of Intake

Teh river conditions and topography around the selected pumping site are almost same as the Iguig pumping site. Similarly to the Iguig case, the comparative study with four types of intake method was made for the Amulung pumping station.

In case of type 1, sand suspended around the river bed will flow into the intake pipes due to the fact that the pipes are installed at the same elevation as that of the river bed.

In case of type 2, there can be the concrete culvert to be provided at higher elevation than that of the river bed, and the adverse flow can protect the pipes from sediment of sand.

Type 3 and 4 are considered unsuitable to the site in same consideration of the Iguig case.

The type 2 was selected, therefore, as the suitable intake method for the Amulung pumping station. (cf. Figure D-2-1 ∿ 4)

3) Study of type and number of pumps

Refer to the study made in the Iguig case.

4) Selection of prime mover

Refer to the study made in the Iguig case.

5) Operation Method

Refer to the study made in the Iguig case.

6) Design of Pumping Facilities

TABLE D-2-10 DESIGN OF AMULUNG PUMPING FACILITIES

Items	Quantity	Unit	Remarks
1. Location			
1) Name of Barrio	Baculud Amulung		
2) Name of pumping plant	Amulung pumping Station		
3) Water source	Cagayan river		Right bank
2. Area to be Irrigated			
1) Total area	1,660	ha	
2) Gross irrigable area	1,570	ha	
3) Net irrigable area	1,400	ha	
3. Designed water requirement	2.60	cu m/s	$1.0^{l/s/ha} \times \frac{1}{0.544} \times 1,400$
4. Intake			
1) Irrigation system	Pumping irrigation		
2) Type of intake	Box culvert		
3) Water level			
a. L.W.L. (Intake water level)	EL. 1.40	m	Probability of 1/10 years
b. M.W.L. in wet season	EL. 5.50	m	
c. M.W.L. in dry season	EL. 3.50	m	
d. H.H.W.L.	EL.20.00	m	Past maximum flood water level
4) Intake velocity	0.35	m/s	Velocity in screen
5) Structure of intake	33	m	Double box culvert 1.2 x 1.2

6) Appurtenance			
a. Screen	15	sq m	
b. Gate and manhole	1	Lot	
c. Inlet basin	1	Lot	

5. Pumping plant

1) Elements of pump			
a. Designed pump capacity	52	cu m/min/unit	2.60÷3=0.867cu m/s
b. Number of pumps	2	unit	
c. Type of pump	Vertical volute type mixed flow pump		ø600 mm
d. Designed suction level	EL. 1.40	m	
e. Designed discharge level	EL.22.50	m	
f. Actual head	21.10	m	
g. Total pump head	22.00	m	Loss head ≒ 0.90m
h. Electric prime mover	250	KW/unit	
i. Total power	750	KW	
j. Hoist crane	1	unit	5t, span 13m
2) Structures of pumping plant			
a. Amount of concrete class A	1,020	cu m	
b. Size of Structure	160	sq m	L10.8 x W14.8 x H22.7m
c. Sand bed	900	cu m	t = 2 - 4m
3) Operation room			
a. Space	130	sq m	L9.6xW13.6xH5.5m
b. Amount of concrete class A	120	cu m	1-room
c. Elevation of floor	EL.20.50	m	

6. Outlet basin

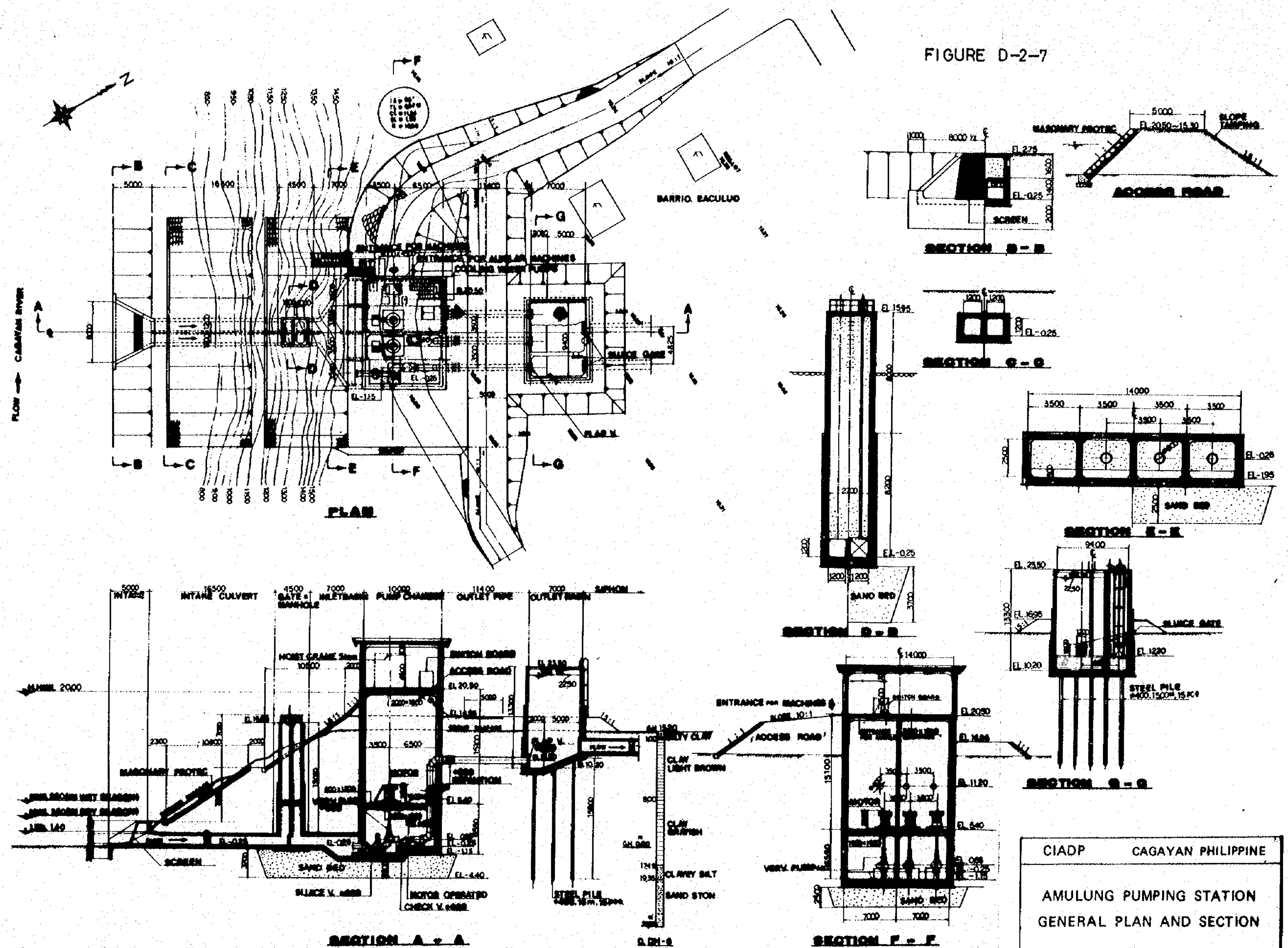
1) Amount of concrete class A	210	cu m	Separated tank
2) Size	1,150	cu m	L=7.0xW12.4xH13.3
3) Length of delivery pipe	11.4	m	ø800 x 3pcs, Steel pipe
4) Bottom elevation of syphon	EL.12.50	m	
5) Pile foundation	225	m	ø400x15mx15pcs.

7. Others

1) Coffer dam	50	m	H=4.5m Top EL.4.00m
2) Access road	50	m	W=5.0m Slope-1/10
3) Quarters	1	lot	Area=100 sq m
4) Masonery protection	900	sq m	W=30m

The general plan and section of Amulung pumping station is show in Figure D-2-7.

FIGURE D-2-7



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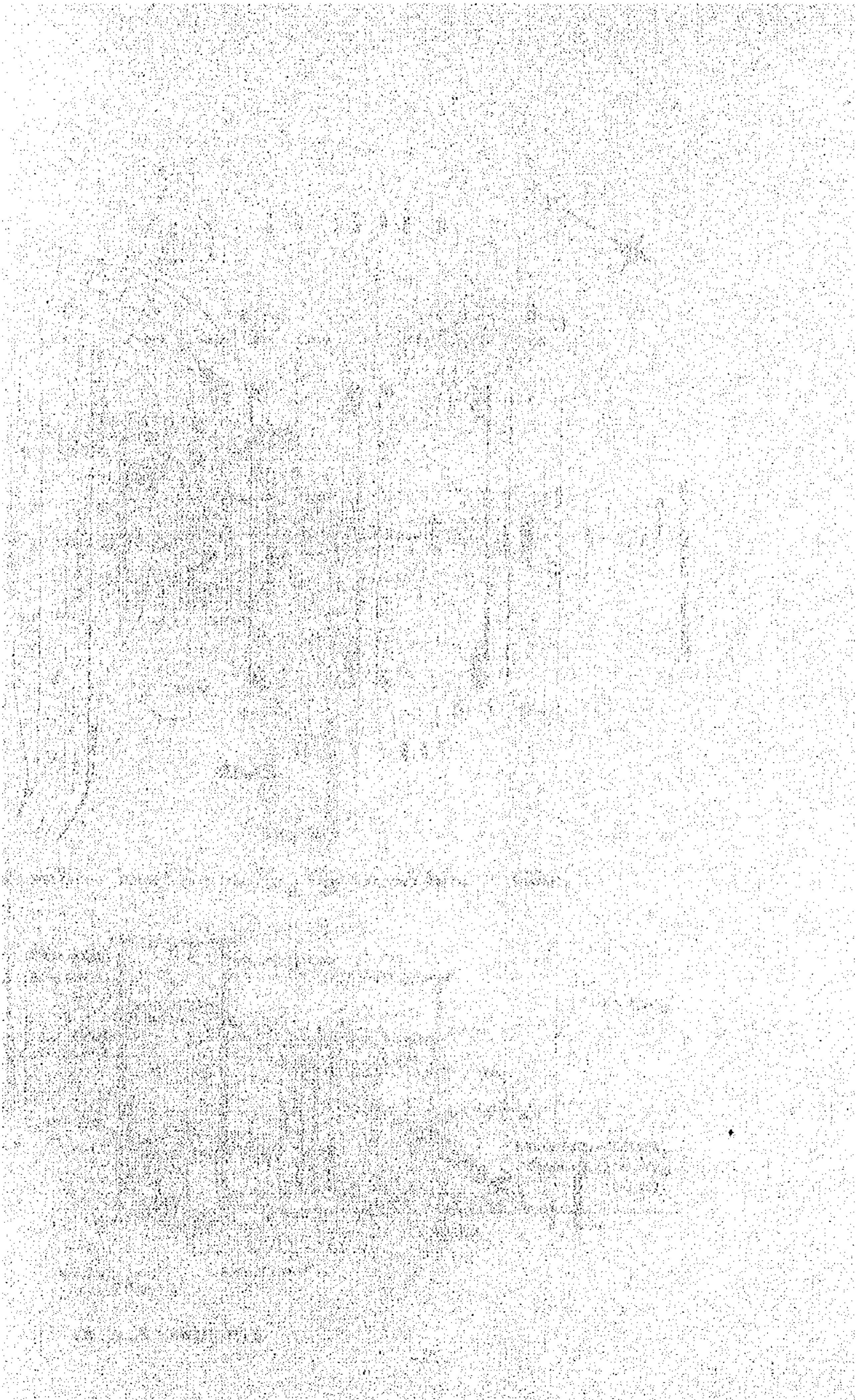


D-2-3. MAGAPIT PUMPING STATION

1) Selection of Pumping Site

a) Conditions of the Cagayan river near the Magapit pumping station

The estuary of the Cagayan river is located near Aparri and the surface slope is very gentle with about 1/100,000 during high tide.

It is considered that the difference between a high and a low tide may act on the water level of the river up to Gattaran.

The proposed Magapit pumping site is located 30 km upstream from Aparri, and it appears that the water level at Magapit site shows similar tendency to the tidal curve at Aparri. As for the flood tide, the latest survey carried out on 15 and 16 February, 1976, found fluctuation between low and high tide near the Magapit bridge to be about 80 cm, and the influence of tide is considered rather large near the said bridge.

Furthermore, the results of interviews in each Barrio and of field survey prove as follows on the adverse flow of saline water.

i) There is a flux of saline water as far as Santa Maria located 20 km upstream from the estuary during dry season

ii) The comparatively shallow water around the portion 100 m from the Magapit bridge allows the saline water to flux in whole section of the river.

iii) The saline water which fluxes in tide will flow down in low tide and the salinity will disappear by the fresh water discharging from the upstream.

iv) There is, however, no sign of flux of saline water at the upstream 500 m from the Magapit bridge.

From the survey results mentioned above, it is considered that the Magapit site is located on the upper limit of the fluxing saline water. Further scientific survey, however, is required for confirmation on the adverse flow of the saline water, covering the matters on salinity, range of saline water in river section and duration of flux phenomenon and so forth.

b) Location of pumping station

Careful studies were made on conditions of topography, river status, and the gut and so forth to select the pumping site from three proposed sites mentioned below.

The special characteristics of each proposed site are as follows:

i) Site 600 m upstream from Magapit bridge

There is no problem about adverse of saline water: however, the space for pumping station is limited because the topography has a steep precipice with narrow shoulder. Consequently the difficulty of construction is expected. A 600 m rock tunnel, besides, for driving canal should be constructed, therefore, the canal construction cost will be estimated about 15,000,000 pesos for tunneling alone.

ii) Site 150 m upstream from Magapit bridge

The wedge-shaped adverse tide will intrude once per several years at high tide in dry season. However an intake method of surface water can be employed in dry season.

The site is surrounded by the Cagayan river, the highway, a rock mountain, and a creek. The space is not sufficient for a large-scaled power pumping station, but only for compact-scaled structures.

iii) Site 100 m downstream from Magapit bridge

The site is flat and the space for pumping station is sufficient. Furthermore the construction is implemented easily and the cost of excavation is low because the foundation consists of clay soil. The length of main canal is short as compared with the case of above-mentioned proposed sites.

However the gut runs near the left bank at this site; therefore the flow of intake is apt to stagnate, and there is an anxious about sedimentation and inability of water intake in adverse tide.

Finally, the pumping site 150 m upstream from Magapit bridge was selected from the view point of economy, sedimentation and saline water.

2) Methodf intake

As stated above, saline water flows upstream in high tide, and in the droughty year of 1/10 probability the phenomenon of saline water will occur at this site.

Therefore, the intake depth must be designed according to the result of future observation of salinity and the shape of wedge. However, in the present intake method, the intake width will be extended so that the upper water may be taken from the part near the surface.

Gate system which controls the amount of intake water in corresponding to fluctuation of intake water level, is suitable.

The intake site is close to the gut of river and the water depth is about 30m, even in dry season and the velocity is fast. Moreover, the foundation consists of Magapit rock and there is no traces of sedimentation by floodings.

As for the structures of intake, as shown in Figure D-2-5, the area in front of the building is widely excavated and a screen is installed.

Furthermore a flash gate is installed at the intake in order that the upper water can be taken when the phonomenon of salty water occurs at high tide in the abnormal drought year.

3) Study of pump-type

Refer to the study made in the Iguig case.

4) Study of number of pump

Design conditions of diameter and number of pumps are almost the same as the case of Iguig.

Intake	Qmax = 20.60 cu m/s
Mean intake in dry season of ordinary year	Qmean = 15.80 cu m/s
Low water level	L.W.L.= -0.50 m
Mean water level in dry season	M.W.L.= 0.80 m

The pump head becomes 92% of designed pump head under these conditions and the amount of intake becomes 105% of the pump capacity from the performance curves of volute pump.

Under these conditions, the estimate was made on the required number of pumps for the site to secure the intake water on the side of prudence. The following shows the procedure of estimate of necessary number of pumps to be provided.

$$\frac{Qmax}{N} = \frac{0.77 \times Qmax}{(N-1) \times 1.05}$$

$$\therefore N = 3.75 \doteqdot 4 \text{ sets}$$

5) Selection of prime mover

Refer to the study made in the Iguig case.

6) Operation of pump

Refer to the study made in the Iguig case.

7) design of Pjmping Facilities

TABLE D-2-11 DESIGN OF MAGAPIT PUMPING FACILITIES

Items	Quantity	Unit	Remarks
1. Location			
1) Name of Barrio	Magapit, Lal-lo		
2) Name of Pumping Plant	Magapit pumping station		
3) Water source	Cagayan river		Right bank
2. Area to be irrigated	Aparri & Lal-lo		Aparri Lal-lo
1) Total area	12,820	ha	11,500ha 1,320ha
2) Gross irrigable area	12,390	ha	11,100ha 1,290ha
3) Net irrigable area	11,200	ha	10,000ha 1,200ha
3. Designed water requirement	20.60	cu m/s	1.0l/s/ha x $\frac{1}{0.544}$ x 11,200ha
4. Intake			
1) Irrigation system	Pumping irrigation		
2) Type of intake	Gate		(taking surface water in dry season)
3) Water level			
a. L.W.L. (Intake water level)	EL.(-)0.50	m	Probability of 1/10 years
b. M.W.L. in dry season	EL.(+)0.80	m	
c. M.W.L. in wet season	EL.(+)1.40	m	
d. H.H.W.L.	EL.(+)11.00	m	Past maximum flood water level
4) Intake velocity	0.45	m/s	velocity in screen
5) Structure of intake	Box culvert type		
6) Appurtenance			
a. Screen	110 11	sq m ton	@75,t = 9mm b=100 mm
b. Flash gate with rope	5	unit	width 6.6m x height 3.4m

5. Pumping plant

1) Element of pump			
a. Designed pump capacity	309	cu m/min	20.6÷4=5.15cu.m/s
b. Number of pump	4	unit	
c. Type of pump	Vertical volute type mixed flow pump		ø1,500mm
d. Designed suction level	EL.-0.70	m	
e. Designed discharge level	EL.16.00	m	
f. Actual head	16.70	m	
g. Total head	18.00	m	loss head 1.30m
h. Electric prime mover	1,200	kw/unit	
i. Total power	4,800	kw	
j. Crain	1	unit	15ton span 13.5m
2) Structure of pumping plant			
a. Amount of concrete class A	3,500	cu m	Reinforced concrete with water proof
b. Size of structure	530	sq m	
c. Foundation	Magapit rock		
3) Operation Room			
a. Space	530	sq m	
b. Structure	Made of reinforced concrete		One storied height 9.4m
c. Elevation of floor	EL.12.00	m	

6. Outlet basin

1) Amount of concrete class A	1,200	cu m	
2) Length of box culvert	23	m	V = 1.7 m/s
3) Length of open canal	28	m	V = 1.45 m/s
4) Bottom elevation of canal	EL.12.50	m	

7. Others

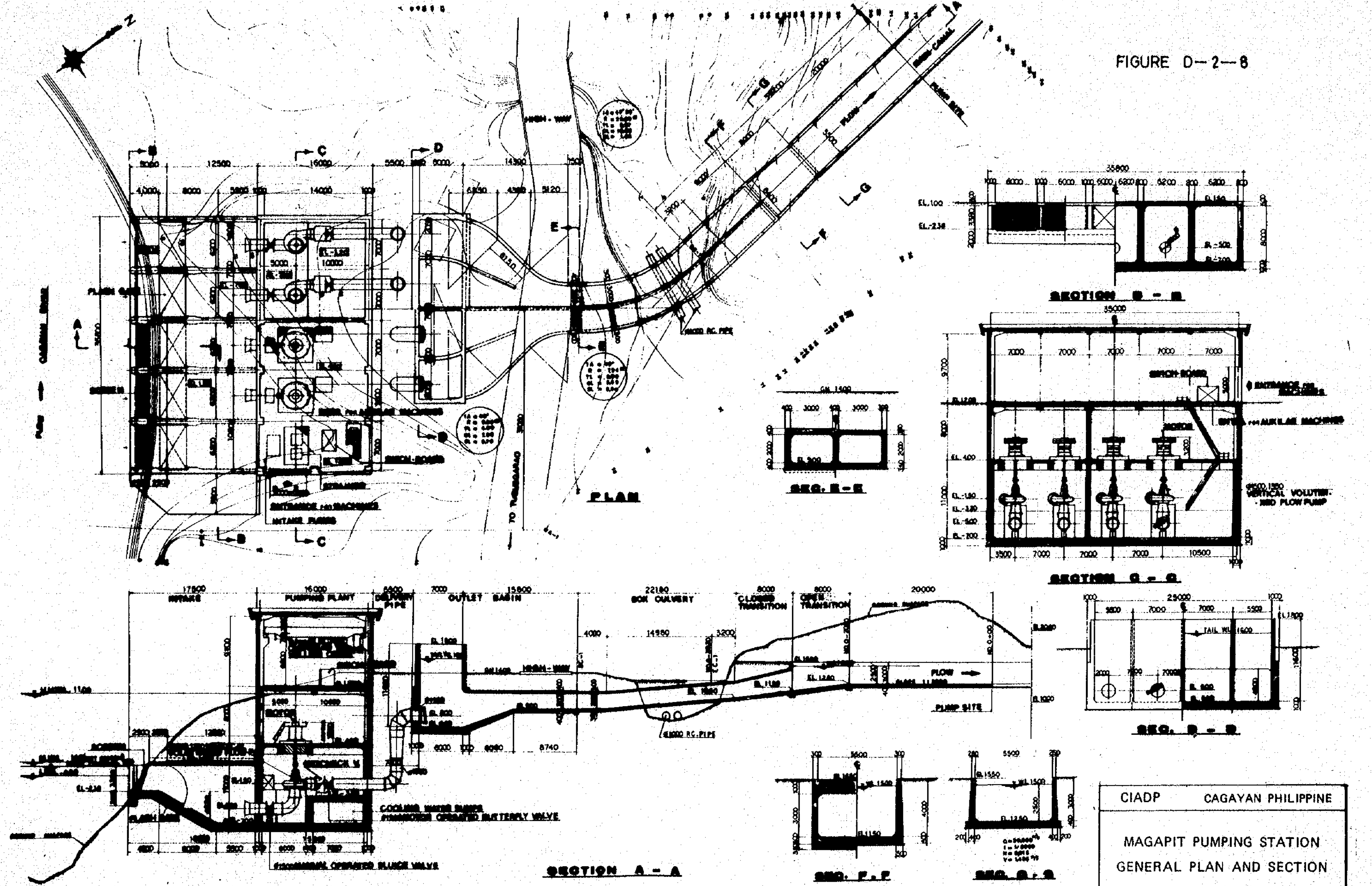
1) Coffer dam	14,300	cu m	L=70m A=204sq m
2) Crest of coffer dam	EL. 1.50	m	
3) Access road	146	m	Excavation V=2,200cu m
4) Quarters	1	Lot	Area = 100sq m

(cont'd)

8. Feeder line			13.2 KV 2cct.
1) Wood pole	300	Ea	
2) Guy wire assembly	200	complete	
3) Cross arm	350	"	
4) Insulator pin	2,000	Ea	
5) Insulator stran	240	String	
6) Conductor	120	km	AC 8R 120sq.
7) Lighting arrester	10	set	
8) Miscellaneous	1	lot	

The general plan and section is shown in Figure D-2-8.

FIGURE D-2-8



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