2.2.8 Design Capacity of Irrigation Facilities

Based on the above table for the peak diversion requirement, the design capacity of irrigation facilities is determined as shown below.

Table 2.2.28 Design Capacity

Region	Area (ha)	Des.Cap. (m3/sec)	Unit (ℓ/sec/ha)
Karanganyar	10,100	12.90	1.28
Sragen	9,500	11.40	1.20
Dengkeng	3,600	5.20	1.44

Amount of Intake Water at Peak

Upper Sala Main Canal	(Right bank region)	24.30 m^3/sec
Dengkeng Main Canal	(Left bank region)	5.20 m^3/sec

Table 2.2.29 Unit Irrigation Requirement/Paddy/Karanganyar Region

ALT-1

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
	1		0.87	4.00		5.00	0.50	9.1	-
A	2	4.6	0.77	3.54	1.0	4.54	0.50	0.7	5.2
	3		0.74	3.40		4.40	0.44	1.1	3.3
	1		0.80	4.08		5.58	0.20	-	5.9
M	2	5.1	1.00	5.10	1.5	6.00	0.30	1.0	5.3
	3		1.05	5.36		6.86	0.34	-	7.2
	1		1.08	6.37		7.87	0.39	-	8.3
J	2	5.9	1.12	6.61	1.5	8.11	0.41	-	8.5
	3		1.14	6.73		8.23	0.41	-	8.6
	1		1.20	7.68		9.18	0.46	-	9.6
J	2	6.4	1.23	7.87	1.5	9.37	0.47	-	9.8
	3		1.24	7.94		9.44	0.47	-	9.9
	1		1.21	8.71		10.21	0.51	-	10.7
A	2	7.2	1.15	8.28	1.5	9.78	0.49	-	10.3
	3		1.04	7.49		8.99	0.45	-	9.4
	1		1.00	8.00		9.50	0.48	-	10.0
S	2	8.0	0.94	7.52	1.5	9.02	0.45	-	9.5
	3		0.87	6.96		8.46	0.42	0.7	8.2
	1		0.77	5.24		6.74	0.34	0.8	6.3
O	2	6.8	0.66	4.49	1.5	5.99	0.30	-	6.3
	3		0.50	3.40		4.90	0.25	0.9	4.3
	1		0.91	5.01		6.01	0.60	5.0	1.6
N	2	5.5	0.96	5.28	1.0	6.28	0.63	3.2	3.7
	3		1.00	5.50		6.50	0.65	5.7	1.5
	1		1.05	4.52		5.52	0.55	8.7	-
D	2	4.3	1.08	4.64	1.0	5.64	0.56	4.9	1.3
	3		1.12	4.82		5.82	0.58	7.2	-
	1		1.14	4.22		5.22	0.52	11.7	-
J	2	3.7	1.20	4.44	1.0	5.44	0.54	4.1	1.9
	3		1.23	4.55		5.55	0.55	6.7	-
	1		1.24	4.46		5.46	0.55	4.6	1.4
F	2	3.6	1.21	4.36	1.0	5.36	0.54	5.4	0.5
	3		1.15	4.14		5.14	0.51	8.2	-
	1		1.04	4.06		5.06	0.50	8.7	-
M	2	3.9	1.00	3.90	1.0	4.90	0.49	6.4	-
	3		0.94	3.67		4.67	0.47	12.4	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.30 Unit Irrigation Requirement/Second Cropping Paddy/ Karanganyar Region

ALT-1

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1							9.1	
	2	4.6	-	-	1.0	-	-	0.1	-
	3							1.1	
M	1							-	
	2	5.1	-	-	1.5	-	-	1.0	-
	3							-	
J	1							-	
	2	5.9	-	-	1.5	-	-	-	-
	3							-	
J	1							-	
	2	6.4	-	-	1.5	-	-	-	-
	3							-	
A	1							-	
	2	7.2	-	-	1.5	-	-	-	-
	3							-	
S	1		-	-		-	-	-	-
	2	8.0	0.91	7.28	1.5	8.78	0.44	-	9.2
	3		0.96	7.68		9.18	0.46	0.7	8.9
O	1		1.00	6.80		8.30	0.42	0.8	7.9
	2	6.8	1.05	7.14	1.5	8.64	0.43	-	9.1
	3		1.08	7.34		8.84	0.44	0.9	8.4
N	1		1.12	6.16		7.16	0.72	5.0	2.9
	2	5.5	1.14	6.27	1.0	7.27	0.73	3.2	4.8
	3		1.20	6.60		7.60	0.76	5.7	2.6
D	1		1.23	5.29		6.29	0.63	8.7	-
	2	4.3	1.24	5.33	1.0	6.33	0.63	4.9	2.1
	3		1.21	5.20		6.20	0.62	7.2	-
J	1		1.15	4.26		5.26	0.53	11.7	-
	2	3.7	1.04	3.85	1.0	4.85	0.49	4.1	1.2
	3		1.00	3.70		4.70	0.47	6.7	-
F	1		0.94	3.38		4.38	0.44	4.6	0.2
	2	3.6	0.87	3.13	1.0	4.13	0.41	5.4	-
	3		0.77	2.77		3.77	0.38	8.2	-
M	1		0.66	2.57		3.57	0.36	8.7	-
	2	3.9	0.50	1.95	1.0	2.95	0.30	6.4	-
	3		-	-		-	-	12.4	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.31 Unit Irrigation Requirement/Sugar Cane/Karanganyar Region

ALT-1

Unit : mm/day

Month	10 Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration	4) Farm waste 3) x 0.10 or 0.05	5) Effective rain fall	6) Unit irrigation requirement 3)+4)-5)
A	1 2 3	4.6	0.64 0.60 0.58	2.94 2.76 2.67	0.44 0.41 0.40	7.0 1.0 1.3	- 2.2 1.8
M	1 2 3	5.1	0.58 0.58 0.58	2.96 2.96 2.96	0.30 0.30 0.30	0.1 1.0 0.4	3.2 2.3 2.9
J	1 2 3	5.9	0.59 0.60 0.61	3.48 3.54 3.60	0.35 0.35 0.36	- - -	3.8 3.9 4.0
J	1 2 3	6.4	0.63 0.66 0.70	4.03 4.22 4.48	0.40 0.42 0.45	- - -	4.4 4.6 4.9
A	1 2 3	7.2	0.76 0.77 0.79	5.47 5.54 5.69	0.54 0.53 0.57	- - -	5.9 6.1 6.3
S	1 2 3	8.0	0.80 0.81 0.82	6.40 6.48 6.56	0.64 0.65 0.66	- - 0.8	7.0 7.1 6.4
O	1 2 3	6.8	0.83 0.84 0.85	5.64 5.71 5.78	0.56 0.57 0.58	1.4 0.2 1.1	4.8 6.1 5.3
N	1 2 3	5.5	0.86 0.86 0.86	4.73 4.73 4.73	0.71 0.71 0.71	7.0 4.0 7.0	- 1.4 -
D	1 2 3	4.3	0.86 0.86 0.86	3.70 3.70 3.70	0.56 0.56 0.56	7.0 6.2 7.0	- - -
J	1 2 3	3.7	0.85 0.84 0.83	3.15 3.11 3.07	0.47 0.47 0.45	7.0 5.3 7.0	- - -
F	1 2 3	3.6	0.81 0.79 0.77	2.92 2.84 2.77	0.44 0.43 0.42	5.9 7.0 7.0	- - -
M	1 2 3	3.9	0.73 0.70 0.66	2.85 2.73 2.57	0.43 0.41 0.39	7.0 7.0 7.0	- - -

Note : Farm waste (Dry season ... 10%, Rainy season ... 15%)

Table 2.2.32 Unit Irrigation Requirement/Paddy/Sragen Region

ALT-1

Unit: mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	0.87	4.00	1.0	5.00	0.50	2.7	2.8
	2		0.77	3.54		4.54	0.45	1.3	3.7
	3		0.74	3.40		4.40	0.44	2.0	2.8
M	1	5.1	0.80	4.08	1.5	5.58	0.28	0.3	5.6
	2		1.00	5.10		6.60	0.33	1.6	5.3
	3		1.05	5.35		6.85	0.34	-	7.2
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.22	6.61		8.11	0.41	-	8.5
	3		1.14	6.73		8.23	0.41	-	8.6
J	1	6.4	1.20	7.68	1.5	9.18	0.46	-	9.6
	2		1.23	7.87		9.27	0.46	-	9.7
	3		1.24	7.94		9.44	0.47	-	9.9
A	1	7.2	1.21	8.71	1.5	10.21	0.51	-	10.7
	2		1.15	8.28		9.78	0.50	-	10.3
	3		1.04	7.49		8.99	0.45	-	9.4
S	1	8.0	1.00	8.00	1.5	9.50	0.48	-	10.0
	2		0.94	7.52		9.02	0.45	-	9.5
	3		0.37	6.96		8.46	0.42	0.6	8.3
O	1	6.8	0.77	5.24	1.5	6.74	0.34	1.8	5.3
	2		0.66	4.49		5.99	0.30	0.4	5.9
	3		0.50	3.40		4.90	0.25	0.2	5.0
N	1	5.5	0.91	5.01	1.0	6.01	0.60	2.7	3.9
	2		0.96	5.28		6.28	0.63	3.1	3.8
	3		1.00	5.50		6.50	0.65	6.6	0.6
D	1	4.3	1.05	4.52	1.0	5.52	0.55	4.5	1.6
	2		1.08	4.64		5.64	0.56	3.5	2.7
	3		1.12	4.82		5.82	0.58	6.9	-
J	1	3.7	1.14	4.22	1.0	5.22	0.52	3.7	2.0
	2		1.20	4.44		5.44	0.54	11.4	-
	3		1.23	4.55		5.55	0.56	9.9	-
F	1	3.6	1.24	4.46	1.0	5.46	0.55	10.4	-
	2		1.21	4.36		5.36	0.54	9.3	-
	3		1.15	4.14		5.14	0.51	5.8	-
M	1	3.9	1.04	4.06	1.0	5.06	0.50	7.9	-
	2		1.00	3.90		4.90	0.50	7.3	-
	3		0.94	3.67		4.67	0.47	13.5	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.33 Unit Irrigation Requirement/Second Paddy/Sragen Region

ALT-1

Unit : mm/day

Month	Ten Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1							2.7	
	2	4.6	-	-	1.0	-	-	1.3	-
	3							2.0	
M	1							0.3	
	2	5.1	-	-	1.5	-	-	1.6	-
	3							-	
J	1							-	
	2	5.9	-	-	1.5	-	-	-	-
	3							-	
J	1							-	
	2	6.4	-	-	1.5	-	-	-	-
	3							-	
A	1							-	
	2	7.2	-	-	1.5	-	-	-	-
	3							-	
S	1		-	-		-	-	-	-
	2	8.0	0.91	7.28	1.5	8.78	0.44	-	9.2
	3		0.96	7.68		9.18	0.46	0.6	9.0
O	1		1.00	6.80		8.30	0.83	1.8	7.3
	2	6.8	1.05	7.14	1.5	8.64	0.86	0.4	9.1
	3		1.08	7.34		8.84	0.88	0.2	9.5
N	1		1.12	6.16		7.16	0.72	2.7	5.2
	2	5.5	1.14	6.27	1.0	7.27	0.73	3.1	4.9
	3		1.20	6.60		7.60	0.76	6.6	1.8
D	1		1.23	5.29		6.29	0.63	4.5	2.4
	2	4.3	1.24	5.33	1.0	6.33	0.63	3.5	3.5
	3		1.21	5.20		6.20	0.62	6.9	-
J	1		1.15	4.26		5.26	0.53	3.7	2.1
	2	3.7	1.04	3.85	1.0	4.85	0.49	11.9	-
	3		1.00	3.70		4.70	0.47	9.9	-
F	1		0.94	3.38		4.38	0.44	10.4	-
	2	3.6	0.87	3.13	1.0	4.13	0.41	9.3	-
	3		0.77	2.77		3.77	0.38	5.8	-
M	1		0.66	2.57		3.57	0.36	7.9	-
	2	3.9	0.50	1.95	1.0	2.95	0.30	7.3	-
	3		-	-		-	-	13.5	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.34 Unit Irrigation Requirement/Sugar Cane/Sragen Region

ALT-1 Unit : mm/day

Month	10 Day Period	1) Evaporation	2) Corp co-efficient	3) Evapotranspiration 1) x 2)	4) Farm waste 3) x 0.10 or 0.05	5) Effective rainfall	6) Unit irrigation requirement 3)+4)+5)
A	1	4.6	0.64	2.94	0.44	3.6	-
	2		0.60	2.76	0.41	2.0	1.2
	3		0.58	2.67	0.40	3.0	0.1
M	1	5.1	0.58	2.96	0.30	0.3	3.0
	2		0.58	2.96	0.30	2.0	1.3
	3		0.58	2.96	0.30	-	3.3
J	1	3.9	0.59	3.48	0.35	-	3.8
	2		0.60	3.54	0.35	-	5.9
	3		0.61	3.60	0.36	-	4.0
J	1	6.4	0.63	4.03	0.40	-	4.4
	2		0.66	4.22	0.42	-	4.6
	3		0.70	4.48	0.45	-	4.9
A	1	7.2	0.76	5.47	0.54	-	5.9
	2		0.77	5.54	0.55	-	6.1
	3		0.79	5.69	0.57	-	6.3
S	1	8.0	0.80	6.40	0.64	-	7.0
	2		0.81	6.48	0.65	-	7.1
	3		0.82	6.56	0.66	0.8	6.4
O	1	6.8	0.83	5.64	0.56	2.4	3.8
	2		0.84	5.71	0.57	0.9	5.4
	3		0.85	5.78	0.58	0.3	6.1
N	1	5.5	0.86	4.73	0.71	3.8	1.6
	2		0.86	4.73	0.71	5.1	0.3
	3		0.86	4.73	0.71	7.0	-
D	1	4.3	0.86	3.70	0.56	6.2	-
	2		0.86	3.70	0.56	5.0	-
	3		0.86	3.70	0.56	7.0	-
J	1	3.7	0.85	3.15	0.47	5.1	-
	2		0.84	3.11	0.47	7.0	-
	3		0.83	3.07	0.45	7.0	-
F	1	3.6	0.81	2.92	0.45	7.0	-
	2		0.79	2.84	0.43	7.0	-
	3		0.77	2.77	0.42	7.0	-
M	1	3.9	0.73	2.85	0.43	7.0	-
	2		0.70	2.73	0.41	7.0	-
	3		0.66	2.57	0.39	7.0	-

Note : Farm waste (Dry season ... 10%, Rainy season ... 15%)

Table 2.2.35 Unit Irrigation Requirement/Paddy/Dengkeng Region

ALT-1

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	0.87	4.00	1.0	5.00	0.50	8.2	-
	2		0.77	3.54		4.54	0.50	0.8	4.2
	3		0.74	3.40		4.40	0.44	1.1	3.7
M	1	5.1	0.80	4.08	1.5	5.58	0.28	-	5.9
	2		1.00	5.10		6.00	0.30	1.3	5.0
	3		1.05	5.36		6.86	0.34	-	7.2
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.12	6.61		8.11	0.41	-	8.5
	3		1.14	6.73		8.23	0.41	-	8.6
J	1	6.4	1.20	7.68	1.5	9.18	0.46	-	9.6
	2		1.23	7.87		9.37	0.47	-	9.8
	3		1.24	7.94		9.44	0.47	-	9.9
A	1	7.2	1.21	8.71	1.5	10.21	0.51	-	10.7
	2		1.15	8.28		9.78	0.49	-	10.2
	3		1.04	7.49		8.99	0.45	-	9.4
S	1	8.0	1.00	8.00	1.5	9.50	0.48	-	10.0
	2		0.94	7.52		9.02	0.45	-	9.5
	3		0.87	6.96		8.46	0.42	-	8.9
O	1	6.8	0.77	5.24	1.5	6.74	0.34	1.6	5.5
	2		0.66	4.49		5.99	0.30	-	6.3
	3		0.50	3.40		4.90	0.25	1.5	3.7
N	1	5.5	0.91	5.01	1.0	6.01	0.60	9.4	-
	2		0.96	5.28		6.28	0.63	1.9	5.0
	3		1.00	5.50		6.50	0.65	5.6	1.6
D	1	4.3	1.05	4.52	1.0	5.52	0.55	11.2	-
	2		1.08	4.64		5.64	0.56	5.8	0.4
	3		1.12	4.82		5.82	0.58	12.0	-
J	1	3.7	1.14	4.22	1.0	5.22	0.52	13.7	-
	2		1.20	4.44		5.44	0.54	2.5	3.5
	3		1.23	4.55		5.55	0.56	8.1	-
F	1	3.6	1.24	4.46	1.0	5.46	0.55	7.4	-
	2		1.21	4.36		5.36	0.54	1.5	4.4
	3		1.15	4.14		5.14	0.51	5.0	0.7
M	1	3.9	1.04	4.06	1.0	5.06	0.50	10.8	-
	2		1.00	3.90		4.90	0.49	7.4	-
	3		0.94	3.67		4.67	0.47	17.8	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.36 Irrigation Requirement & Diversion Requirement/Paddy (8,900 ha)/Karanganyar Region

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement (mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement: m3/day 7)	Irrigation Requirement: m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	5,189	-	-	-	-
Apr	-	-	5.2	-	-	3,711	192,972	2.233	0.559	2.792
	100	-	3.3	7.4	-	2,252	81,716	0.946	0.236	1.182
	150	-	5.9	7.4	-	846	61,716	0.706	0.177	0.883
May	150	200	5.3	7.4	71	285	168,205	1.947	0.487	2.434
	150	200	7.2	7.4	151	1,513	422,036	4.885	1.221	6.106
	150	200	8.3	7.4	151	2,999	562,017	6.509	1.622	8.131
Jun	150	200	8.5	7.4	151	4,477	693,645	8.028	2.007	10.035
	-	200	8.6	-	151	5,936	812,496	9.404	2.351	11.755
	-	200	9.6	-	151	7,343	1,006,928	11.645	2.923	14.568
Jul	-	200	9.8	-	71	8,651	989,798	11.455	2.865	14.320
	-	-	9.9	-	-	8,900	881,100	10.198	2.549	12,747
	-	-	10.7	-	-	8,900	952,300	11.022	2.755	13.777
Aug	-	-	10.3	-	-	8,900	916,700	10.610	2.652	13.262
	-	-	9.4	-	-	8,900	836,600	9.683	2.421	12.104
	-	-	10.0	-	-	8,161	816,100	9.446	2.361	11.807
Sep	-	-	9.5	-	-	6,675	634,125	7.339	1.835	9.174
	-	-	8.2	-	-	5,189	425,498	4.925	1.231	6.156
	-	-	6.3	-	-	3,711	233,793	2.706	0.676	3.382
Oct	-	-	6.3	-	-	2,225	140,175	1.622	0.406	2.028
	-	-	4.3	-	-	739	31,777	0.368	0.092	0.460
	100	-	1.6	7.4	-	27	7,832	0.091	0.022	0.113
Nov	100	-	3.7	7.4	-	107	11,359	0.131	0.033	0.164
	100	150	1.5	7.4	71	285	118,175	1.368	0.342	1.710
	100	150	-	7.4	151	1,513	233,900	2.707	0.677	3.384
Dec	100	150	1.3	7.4	151	2,999	272,887	3.158	0.790	3.948
	100	150	-	7.4	151	4,477	233,900	1.368	0.342	1.710
	-	150	-	-	151	5,936	226,500	2.622	0,655	3.277
Jan	-	150	1.9	-	151	7,343	366,017	4.236	1.059	5.295
	-	150	-	-	71	8,651	106,500	1.233	0.308	1.541
	-	-	1.4	-	-	8,900	124,600	1.442	0.361	1.803
Feb	-	-	0.5	-	-	8,900	44,500	0.515	0.129	0.644
	-	-	-	-	-	8,900	-	-	-	-
	-	-	-	-	-	8,900	-	-	-	-
Mar	-	-	-	-	-	8,161	-	-	-	-
	-	-	-	-	-	6,675	-	-	-	-

Note: Conveyance losses of 25% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
Culculating process
((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)
(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.37 Irrigation Requirement & Diversion Requirement/Second Cropping Paddy (600 ha)/Karanganyar Region, ALT-1

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement m3/day 7)	Irrigation Requirement m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Jun	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Jul	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Aug	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Sep	150	-	9.2	0.50	-	2	934	0.011	0.003	0.014
	150	-	8.9	0.50	-	7	1,373	0.016	0.004	0.020
	150	200	7.9	0.50	5	19	12,251	0.142	0.036	0.178
Oct	150	200	9.1	0.50	10	102	30,032	0.348	0.087	0.435
	150	200	8.4	0.50	10	202	37,718	0.437	0.109	0.546
	100	150	2.9	0.50	10	302	24,258	0.281	0.070	0.351
Nov	-	150	4.8	-	10	400	34,200	0.396	0.099	0.495
	-	150	2.6	-	10	495	27,870	0.323	0.081	0.404
	-	150	-	-	5	583	7,500	0.087	0.022	0.109
Dec	-	-	2.1	-	-	600	12,600	0.146	0.037	0.183
	-	-	-	-	-	600	-	-	-	-
	-	-	-	-	-	600	-	-	-	-
Jan	-	-	1.2	-	-	600	7,200	0.083	0.021	0.104
	-	-	-	-	-	550	-	-	-	-
	-	-	0.2	-	-	450	900	0.010	0.003	0.013
Feb	-	-	-	-	-	350	-	-	-	-
	-	-	-	-	-	250	-	-	-	-
	-	-	-	-	-	150	-	-	-	-
Mar	-	-	-	-	-	50	-	-	-	-
	-	-	-	-	-	-	-	-	-	-

Note: Conveyance losses of 25% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc. Culculating process

((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)

(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.38 Irrigation Requirement & Diversion Requirement/Sugar Cane (600 ha x 2)/Karanganyar Region, ALT-1

Month	Unit Irrigation Requirement mm/day 1)	Hecterage to be supplied water On growing Stage rd 2)	Irrigation Requirement m3/day 3)	Irrigation Requirement m3/sec 4)	Conveyance losses m3/sec 5)	Diversion Requirement m3/sec 6)
Apr	-	833	-	-	-	-
	2.2	900	19,800	0.229	0.057	0.286
	1.8	967	17,406	0.201	0.050	0.251
May	3.2	999	32,968	0.382	0.096	0.478
	2.3	1,000	23,000	0.266	0.067	0.333
	2.9	999	28,971	0.335	0.084	0.419
Jun	3.8	900	34,200	0.396	0.099	0.495
	3.9	833	32,487	0.376	0.094	0.470
	4.0	767	30,680	0.355	0.089	0.444
Jul	4.4	700	30,800	0.356	0.089	0.445
	4.6	634	29,164	0.338	0.085	0.423
	4.9	600	29,400	0.340	0.085	0.425
Aug	5.9	600	35,400	0.410	0.103	0.513
	6.1	600	36,600	0.424	0.106	0.530
	6.3	600	37,800	0.438	0.110	0.548
Sep	7.0	600	42,000	0.486	0.112	0.608
	7.1	600	42,600	0.493	0.123	0.616
	6.4	600	68,400	0.792	0.198	0.990
Oct	4.8	600	28,800	0.333	0.083	0.416
	6.1	600	36,600	0.424	0.106	0.530
	5.3	600	31,800	0.368	0.092	0.460
Nov	-	600	-	-	-	-
	1.4	600	8,400	0.097	0.024	0.121
	-	600	-	-	-	-
Dec	-	600	-	-	-	-
	-	600	-	-	-	-
	-	600	-	-	-	-
Jan	-	600	-	-	-	-
	-	600	-	-	-	-
	-	600	-	-	-	-
Feb	-	600	-	-	-	-
	-	600	-	-	-	-
	-	600	-	-	-	-
Mar	-	634	-	-	-	-
	-	700	-	-	-	-
	-	767	-	-	-	-

Note: Conveyance losses of 25% of irrigation requirement are estimated from main canal to farm ditches through holes and gates, and irrigal diversion etc.
(1) x (2) x 10 = (3), (3)/86,400 = (4), (4) + (5) = (6)

Table 2.2.39 Irrigation Requirement & Diversion Requirement/Paddy (6,500 ha)/Sragen Region, ALT-1

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement m3/day 7)	Irrigation Requirement m3/sec 8)	Convenyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	2.8	-	-	3,790	106,120	1.228	0.430	1.658
Apr	-	-	3.7	-	-	2,711	100,307	1.161	0.406	1.567
	100	-	2.8	5.4	-	1,648	51,460	0.596	0.208	0.804
	150	-	5.6	5.4	-	618	42,708	0.494	0.173	0.667
May	150	200	5.3	5.4	52	208	123,124	1.425	0.499	1.924
	150	200	7.2	5.4	111	1,105	309,660	3.584	1.254	4.838
	150	200	8.3	5.4	111	2,191	411,953	4.768	1.669	6.437
Jun	150	200	8.5	5.4	111	3,270	508,050	5.880	2.058	7.938
	-	200	8.6	-	111	4,336	594,896	6.885	2.410	9.295
	-	200	9.6	-	111	5,363	736,848	8.528	2.985	11.513
Jul	-	200	9.7	-	52	6,318	716,846	8.296	2.905	11.201
	-	-	9.9	-	-	6,500	643,500	7.448	3.099	10.547
	-	-	10.7	-	-	6,500	695,500	8.050	2.826	10.867
Aug	-	-	10.3	-	-	6,500	669,500	7.749	2.712	10.461
	-	-	9.4	-	-	6,500	611,000	7.072	2.475	9.547
	-	-	10.0	-	-	5,961	596,100	6.899	2.415	9.314
Sep	-	-	9.5	-	-	4,875	463,125	5.360	1.876	7.236
	-	-	8.3	-	-	3,790	314,570	3.641	1.274	4.915
	-	-	5.3	-	-	2,711	143,683	1.663	0.582	2.245
Oct	-	-	5.9	-	-	1,625	95,875	1.110	0.388	1.498
	-	-	5.0	-	-	540	27,000	0.313	0.110	0.423
	100	-	3.9	5.4	-	20	6,180	0.072	0.025	0.097
Nov	100	-	3.8	5.4	-	78	8,364	0.097	0.034	0.131
	100	150	0.6	5.4	52	208	84,648	0.980	0.343	1.323
	100	150	1.6	5.4	111	1,105	189,580	2.194	0.768	2.962
Dec	100	150	2.7	5.4	111	2,191	231,057	2.674	0.936	3.610
	100	150	-	5.4	111	3,270	171,900	1.990	0.695	2.685
	-	150	-	-	111	4,336	253,220	2.931	1.026	3.957
Jan	-	150	-	-	111	5,363	166,500	1.927	0.675	2.602
	-	150	-	-	52	6,318	78,000	0.903	0.384	1.287
	-	-	-	-	-	6,500	-	-	-	-
Feb	-	-	-	-	-	6,500	-	-	-	-
	-	-	-	-	-	6,500	-	-	-	-
	-	-	-	-	-	6,500	-	-	-	-
Mar	-	-	-	-	-	5,961	-	-	-	-
	-	-	-	-	-	4,875	-	-	-	-

Note: Conveyance losses of 35% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.

((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)

(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.40 Irrigation Requirement & Diversion Requirement/Second Cropping Paddy (1,500 ha)/Sragen Region, ALT-1

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement m3/day 7)	Irrigation Requirement m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Jun	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Jul	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Aug	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Sep	150	-	9.2	1.2	-	5	2,260	0.026	0.009	0.035
	150	-	9.0	1.2	-	18	3,420	0.040	0.014	0.054
	150	200	7.3	1.2	1.2	48	29,304	0.339	0.119	0.458
Oct	150	200	9.1	1.2	2.6	255	77,005	0.891	0.312	1.203
	150	200	9.5	1.2	2.6	506	101,870	1.179	0.413	1.592
	100	150	5.2	1.2	2.6	755	79,460	0.920	0.322	1.242
Nov	-	150	4.9	-	2.6	1,001	88,049	1.019	0.357	1.376
	-	150	1.8	-	2.6	1,238	61,284	0.709	0.248	0.957
	-	150	2.4	-	1.2	1,458	52,992	0.613	0.215	0.828
Dec	-	-	3.5	-	-	1,500	52,500	0.608	0.213	0.821
	-	-	-	-	-	1,500	-	-	-	-
	-	-	2.1	-	-	1,500	31,500	0.365	0.128	0.493
Jan	-	-	-	-	-	1,500	-	-	-	-
	-	-	-	-	-	1,376	-	-	-	-
	-	-	-	-	-	1,125	-	-	-	-
Feb	-	-	-	-	-	875	-	-	-	-
	-	-	-	-	-	626	-	-	-	-
	-	-	-	-	-	375	-	-	-	-
Mar	-	-	-	-	-	125	-	-	-	-
	-	-	-	-	-	-	-	-	-	-

Note: Conveyance losses of 35% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc. Culculating process

((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)
(7)/86,400 = (8)   (8) + (9) = (10)

Table 2.2.41 Irrigation Requirement & Diversion Requirement/Sugar Cane (1,500 ha x 2)/Sragen Region, ALT-1

Month	Unit Irrigation Requirement mm/day 1)	Hecterage to be supplied water Sugar Cane 2)	Irrigation Requirement m3/day 3)	Irrigation Requirement m3/sec 4)	Conveyance losses m3/sec 5)	Diversion Requirement m3/sec 6)
	-	2,084	-	-	-	-
Apr	1.2	2,250	27,000	0.313	0.110	0.423
	0.1	2,417	2,417	0.028	0.010	0.038
	3.0	2,499	74,970	0.868	0.304	1.172
May	1.3	2,500	32,500	0.376	0.132	0.508
	3.3	2,499	82,467	0.954	0.334	1.288
	3.8	2,417	91,846	1.063	0.372	1.435
Jun	3.9	2,250	87,750	1.016	0.356	1.372
	4.0	2,084	83,360	0.965	0.338	1.303
	4.4	1,917	84,348	0.976	0.342	1.318
Jul	4.6	1,751	80,546	0.932	0.326	1.258
	4.9	1,584	77,616	0.898	0.314	1.212
	5.9	1,500	88,500	1.024	0.358	1.382
Aug	6.1	1,500	91,500	1.059	0.371	1.430
	6.3	1,500	94,500	1.094	0.383	1.477
	7.0	1,500	105,000	1.215	0.425	1.640
Sep	7.1	1,500	106,500	1.233	0.432	1.665
	6.4	1,500	96,000	1.111	0.389	1.500
	3.8	1,500	57,000	0.660	0.231	0.891
Oct	5.4	1,500	81,000	0.938	0.328	1.266
	6.1	1,500	91,500	1.059	0.371	1.430
	1.6	1,500	24,000	0.278	0.097	0.375
Nov	0.3	1,500	4,500	0.052	0.018	0.070
	-	1,500	-	-	-	-
	-	1,500	-	-	-	-
Dec	-	1,500	-	-	-	-
	-	1,500	-	-	-	-
	-	1,500	-	-	-	-
Jan	-	1,500	-	-	-	-
	-	1,500	-	-	-	-
	-	1,500	-	-	-	-
Feb	-	1,500	-	-	-	-
	-	1,500	-	-	-	-
	-	1,584	-	-	-	-
Mar	-	1,751	-	-	-	-
	-	1,917	-	-	-	-

Note: Conveyance losses of 35% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
(1) x (2) x 10 = (3), (3)/86,400 = (4), (4) + (5) = (6)

Table 2.2.42 Irrigation Requirement & Diversion Requirement/Paddy (3,600 ha)/Dengkeng Region, ALT-1

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For transplanting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplanting puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement m3/day 7)	Irrigation Requirement m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	2,099	-	-	-	-
Apr	-	-	4.2	-	-	1,501	63,042	0.730	0.219	0.949
	100	-	3.7	3.0	-	911	36,707	0.425	0.127	0.552
	150	-	5.9	3.0	-	342	24,678	0.286	0.085	0.371
May	150	200	5.0	3.0	29	115	68,250	0.789	0.238	1.027
	150	200	7.2	3.0	61	612	170,564	1.974	0.592	2.566
	150	200	8.3	3.0	61	1,213	227,179	2.629	0.789	3.418
Jun	150	200	8.5	3.0	61	1,811	280,435	3.246	0.974	4.220
	-	200	8.6	-	61	2,401	328,486	3.802	1.140	4.942
	-	200	9.6	-	61	2,970	407,120	4.712	1.414	6.126
Jul	-	200	9.8	-	29	3,499	400,902	4.640	1.392	6.032
	-	-	9.9	-	-	3,600	356,400	4.125	1.238	5.363
	-	-	10.7	-	-	3,600	385,200	4.458	1.338	5.796
Aug	-	-	10.2	-	-	3,600	367,200	4.250	1.275	5.525
	-	-	9.4	-	-	3,600	338,400	3.917	1.175	5.092
	-	-	10.0	-	-	3,301	330,100	3.821	1.146	4.967
Sep	-	-	9.5	-	-	2,700	256,500	2.969	0.890	3.859
	-	-	8.9	-	-	2,099	186,811	2.162	0.649	2.811
	-	-	5.5	-	-	1,501	82,555	0.955	0.287	1.242
Oct	-	-	6.3	-	-	900	56,700	0.656	0.197	0.853
	-	-	3.7	-	-	299	11,063	0.128	0.038	0.166
	100	-	-	3.0	-	11	3,000	0.035	0.010	0.045
Nov	100	-	5.0	3.0	-	43	5,150	0.060	0.017	0.077
	100	150	1.6	3.0	19	115	48,340	0.559	0.168	0.727
	100	150	-	3.0	61	612	94,500	1.094	0.328	1.422
Dec	100	150	0.4	3.0	61	1,213	102,352	1.185	0.355	1.540
	100	150	-	3.0	61	1,811	94,500	1.094	0.328	1.422
	-	150	-	-	61	2,401	91,500	1.059	0.318	1.377
Jan	-	150	3.5	-	61	2,970	195,450	2.262	0.678	2.940
	-	150	-	-	29	3,499	43,500	0.503	0.152	0.655
	-	-	-	-	-	3,600	-	-	-	-
Feb	-	-	4.4	-	-	3,600	158,400	1.833	0.550	2.383
	-	-	0.7	-	-	3,600	25,200	0.292	0.087	0.379
	-	-	-	-	-	3,600	-	-	-	-
Mar	-	-	-	-	-	3,301	-	-	-	-
	-	-	-	-	-	2,700	-	-	-	-

Note: Conveyance losses of 30% of irrigation requirement are estimate from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc. culculating process.

((1) X (4) + (2) X (5) + (3) X (6)) X 10 = (7)
(7)/86,400 = (8)   (8) + (9) = (10)

Table 2.2.43 Unit Irrigation Requirement/Paddy/Karanganyar Region

ALT-2 Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	-	-	1.0	-	-	9.1	-
	2		-	-		-	-	0.7	-
	3		0.91	4.19		5.19	0.52	1.1	4.6
M	1	5.1	0.96	4.90	1.5	6.40	0.32	-	6.7
	2		1.00	5.10		6.60	0.33	1.0	5.9
	3		1.05	5.36		6.86	0.34	-	7.2
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.12	6.61		8.11	0.41	-	8.5
	3		1.14	6.73		8.23	0.42	-	8.7
J	1	6.4	1.20	7.68	1.5	9.18	0.46	-	9.6
	2		1.23	7.87		9.37	0.47	-	9.8
	3		1.24	7.94		9.44	0.47	-	9.9
A	1	7.2	1.21	8.71	1.5	10.21	0.51	-	10.7
	2		1.15	8.28		9.78	0.49	-	10.3
	3		1.04	7.49		8.99	0.45	-	9.4
S	1	8.0	0.99	7.92	1.5	9.42	0.47	-	9.9
	2		0.93	7.44		8.94	0.45	-	9.4
	3		0.90	7.20		8.70	0.44	0.7	8.4
O	1	6.8	0.89	6.05	1.5	7.55	0.38	0.8	7.1
	2		0.91	6.19		7.69	0.38	-	8.1
	3		0.98	6.66		8.16	0.41	0.9	7.7
N	1	5.5	1.09	6.00	1.0	7.00	0.70	5.0	2.7
	2		1.14	6.27		7.27	0.73	3.2	4.8
	3		1.20	6.60		7.60	0.76	5.7	2.7
D	1	4.3	1.23	5.29	1.0	6.29	0.63	8.7	-
	2		1.24	5.33		6.33	0.63	4.9	2.1
	3		7.21	5.20		6.20	0.62	7.2	-
J	1	3.7	1.15	4.26	1.0	5.26	0.53	11.7	-
	2		1.04	3.85		4.85	0.49	4.1	1.2
	3		1.00	3.70		4.70	0.47	6.7	-
F	1	3.6	0.94	3.38	1.0	4.38	0.44	4.6	0.2
	2		0.87	3.13		4.13	0.41	5.4	-
	3		0.77	2.77		3.77	0.38	8.2	-
M	1	3.9	0.66	2.57	1.0	3.57	0.36	8.7	-
	2		0.50	1.95		2.95	0.30	6.4	-
	3		-	-		-	-	12.2	-

Note : Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.44 Unit Irrigation Requirement/Polowijo/Karanganyar Region

Unit : mm/day

ALT-2

Month	10 Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1 x 2	4) Farm waste 3) x 0.10 or 0.05	5) Effective rain fall	6) Unit irrigation requirement 3)+4)-5)
A	1	4.6	0.66	3.04	0.46	7.0	-
	2		0.66	3.04	0.46	1.0	2.5
	3		0.67	3.08	0.46	1.3	2.2
M	1	5.1	0.66	3.37	0.34	0.1	3.6
	2		0.63	3.21	0.32	1.0	2.5
	3		0.60	3.06	0.31	0.4	3.0
J	1	5.9	0.54	3.19	0.32	-	3.5
	2		0.47	2.77	0.28	-	3.1
	3		-	-	-	-	-
J	1	6.4	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
A	1	7.2	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
S	1	8.0	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	0.8	-
O	1	6.8	-	-	-	1.4	-
	2		-	-	-	0.2	-
	3		-	-	-	1.1	-
N	1	5.5	-	-	-	7.0	-
	2		-	-	-	4.0	-
	3		-	-	-	7.0	-
D	1	4.3	-	-	-	7.0	-
	2		-	-	-	6.2	-
	3		-	-	-	7.0	-
J	1	3.7	-	-	-	7.0	-
	2		-	-	-	5.3	-
	3		0.35	1.30	0.20	7.0	-
F	1	3.6	0.41	1.48	0.22	5.9	-
	2		0.47	1.69	0.25	7.0	-
	3		0.53	1.91	0.29	7.0	-
M	1	3.9	0.58	2.26	0.34	7.0	-
	2		0.61	2.38	0.35	7.0	-
	3		0.62	2.42	0.36	7.0	-

Note: Farm Waste (Dry season ... 10%, Rainy season ... 15%)

Table 2.2.45 Unit Irrigation Requirement/Paddy/Sragen Region

ALT-2

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	-	-	1.0	-	-	2.7	-
	2		-	-		-	-	1.3	-
	3		0.91	4.19		5.19	0.52	7.0	3.7
M	1	5.1	0.96	4.90	1.5	6.40	0.32	0.3	6.4
	2		1.00	5.10		6.60	0.33	1.6	5.3
	3		1.05	5.36		6.86	0.34	-	7.2
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.12	6.61		8.11	0.41	-	8.5
	3		1.14	6.73		8.23	0.42	-	8.7
J	1	6.4	1.20	7.68	1.5	9.18	0.46	-	9.6
	2		1.23	7.87		9.37	0.47	-	9.8
	3		1.24	7.94		9.44	0.47	-	9.9
A	1	7.2	1.21	8.71	1.5	10.21	0.51	-	10.7
	2		1.15	8.28		9.78	0.49	-	10.3
	3		1.04	7.49		8.99	0.45	-	9.4
S	1	8.0	0.99	7.92	1.5	9.42	0.47	-	9.9
	2		0.93	7.44		8.94	0.45	-	9.4
	3		0.90	7.20		8.70	0.44	0.6	8.5
O	1	6.8	0.89	6.05	1.5	7.55	0.38	1.8	6.1
	2		0.91	6.19		7.69	0.38	0.4	7.7
	3		0.98	6.66		8.16	0.41	0.2	8.4
N	1	5.5	1.09	6.00	1.0	7.00	0.70	2.7	5.0
	2		1.14	6.27		7.27	0.73	3.1	4.9
	3		1.20	6.60		7.60	0.76	6.6	1.8
D	1	4.3	1.23	5.29	1.0	6.29	0.63	4.5	2.4
	2		1.24	5.33		6.33	0.63	3.5	3.5
	3		1.21	5.20		6.20	0.62	6.9	-
J	1	3.7	1.15	4.26	1.0	5.26	0.53	3.7	2.1
	2		1.04	3.85		4.85	0.49	11.9	-
	3		1.00	3.70		4.70	0.47	9.9	-
F	1	3.6	0.94	3.38	1.0	4.38	0.44	10.4	-
	2		0.87	3.13		4.13	0.41	9.3	-
	3		0.77	2.77		3.77	0.38	5.8	-
M	1	3.9	0.66	2.57	1.0	3.57	0.36	7.9	-
	2		0.50	1.95		2.95	0.30	7.3	-
	3		-	-		-	-	13.5	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.46 Unit Irrigation Requirement/Polowijo/Sragen Region

ALT-2 Unit: mm/day

Month	10 Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1) x 2)	4) Farm waste 5) x 0.10 or 0.05	5) Effective rain fall	6) Unit irrigation requirement 3)+4)-5)
A	1	4.6	0.66	3.04	0.46	3.6	-
	2		0.66	3.04	0.46	2.0	1.5
	3		0.67	3.08	0.46	3.0	0.5
M	1	5.1	0.66	3.37	0.34	0.3	3.4
	2		0.63	3.21	0.32	2.0	1.5
	3		0.60	3.06	0.31	-	3.4
J	1	5.9	0.54	3.19	0.32	-	3.51
	2		0.47	2.77	0.28	-	3.05
	3		-	-	-	-	-
J	1	6.4	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
A	1	7.2	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
S	1	8.0	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	0.8	-
O	1	5.8	-	-	-	2.4	-
	2		-	-	-	0.9	-
	3		-	-	-	0.3	-
N	1	5.5	-	-	-	3.8	-
	2		-	-	-	5.1	-
	3		-	-	-	7.0	-
D	1	4.3	-	-	-	6.2	-
	2		-	-	-	5.0	-
	3		-	-	-	7.0	-
J	1	3.7	-	-	-	5.1	-
	2		-	-	-	7.0	-
	3		0.35	1.30	0.20	7.0	-
F	1	3.6	0.41	1.48	0.22	7.0	-
	2		0.47	1.69	0.25	7.0	-
	3		0.53	1.91	0.29	7.0	-
M	1	3.9	0.58	2.26	0.34	7.0	-
	2		0.61	2.38	0.35	7.0	-
	3		0.62	2.42	0.36	7.0	-

Note : Farm waste (Dry season ... 10%, Rainy season ... 15%)

Table 2.2.47 Unit Irrigation Requirement/Paddy/Dengkeng Region

ALT-2

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop co-efficient	3) Evapo-transpiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	-	-	1.0	-	-	8.2	-
	2		-	-		-	-	0.8	-
	3		0.91	4.19		5.19	0.52	1.1	4.6
M	1	5.1	0.96	4.90	1.5	6.40	0.32	-	6.7
	2		1.00	5.10		6.60	0.33	1.3	5.6
	3		1.05	5.36		6.86	0.34	-	7.2
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.12	6.61		8.11	0.41	-	8.5
	3		1.14	6.73		8.23	0.42	-	8.7
J	1	6.4	1.20	7.68	1.5	9.18	0.46	-	9.6
	2		1.23	7.87		9.37	0.47	-	9.8
	3		1.24	7.94		9.44	0.47	-	9.8
A	1	7.2	1.21	8.71	1.5	10.21	0.51	-	10.7
	2		1.15	8.28		9.78	0.49	-	10.3
	3		1.04	7.49		8.99	0.45	-	9.4
S	1	8.0	0.99	7.92	1.5	9.42	0.47	-	9.9
	2		0.93	7.44		8.94	0.45	-	9.4
	3		0.90	7.20		8.70	0.44	-	9.1
O	1	6.8	0.89	6.05	1.5	7.55	0.38	1.6	6.3
	2		0.91	6.19		7.69	0.38	-	8.1
	3		0.98	6.66		8.16	0.41	1.5	7.1
N	1	5.5	1.09	6.00	1.0	7.00	0.70	9.4	-
	2		1.14	6.27		7.27	0.73	1.9	6.1
	3		1.20	6.60		7.60	0.76	5.6	2.8
D	1	4.3	1.23	5.29	1.0	6.29	0.63	11.2	-
	2		1.24	5.33		6.33	0.63	5.8	1.2
	3		1.21	5.20		6.20	0.62	12.0	-
J	1	3.7	1.15	4.26	1.0	5.26	0.53	13.7	-
	2		1.04	3.85		4.85	0.49	2.5	2.8
	3		1.00	3.70		4.70	0.47	8.1	-
F	1	3.6	0.94	3.38	1.0	4.38	0.44	7.4	-
	2		0.87	3.13		4.13	0.41	1.5	3.0
	3		0.77	2.77		3.77	0.38	5.0	-
M	1	3.9	0.66	2.57	1.0	3.57	0.36	10.8	-
	2		0.50	1.95		2.95	0.30	7.4	-
	3		-	-		-	-	17.8	-

Note: Farm Waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.48 Unit Irrigation Requirement/Polowijo/Dengkeng Region

ALT-2

Unit : mm/day

Month	10 Day Period	1) Evaporation	2) Crop coefficient 1) x 2)	3) Evapotranspiration	4) Farm Waste 5) x 0.10 or 0.05	5) Effective rainfall	6) Unit irrigation requirement 3)+4)-5)
A	1	4.6	0.66	3.04	0.46	7.0	-
	2		0.66	3.04	0.46	1.0	2.5
	3		0.67	3.08	0.46	1.4	2.1
M	1	5.1	0.66	3.27	0.34	-	3.7
	2		0.63	3.21	0.32	1.7	1.8
	3		0.60	3.06	0.31	-	3.4
J	1	5.9	0.54	3.19	0.32	-	3.5
	2		0.47	2.77	0.28	-	3.1
	3		-	-	-	-	-
J	1	6.4	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
A	1	7.2	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
S	1	8.0	-	-	-	-	-
	2		-	-	-	-	-
	3		-	-	-	-	-
O	1	6.8	-	-	-	2.0	-
	2		-	-	-	-	-
	3		-	-	-	1.9	-
N	1	5.5	-	-	-	7.0	-
	2		-	-	-	2.4	-
	3		-	-	-	7.0	-
D	1	4.3	-	-	-	7.0	-
	2		-	-	-	7.0	-
	3		-	-	-	7.0	-
J	1	3.7	-	-	-	7.0	-
	2		-	-	-	3.3	-
	3		0.35	1.30	0.20	7.0	-
F	1	3.6	0.41	1.48	0.22	7.0	-
	2		0.47	1.69	0.25	2.7	-
	3		0.53	1.91	0.29	6.7	-
M	1	3.9	0.58	2.26	0.34	7.0	-
	2		0.61	2.38	0.35	7.0	-
	3		0.62	2.42	0.36	7.0	-

Note : Farm waste (Dry season ... 10%, Rainy season ... 15%)

Table 2.2.49 Irrigation Requirement & Diversion Requirement/Paddy (8,900 ha)/Karanganyar Region, ALT-2

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement: m3/day 7)	Irrigation Requirement: m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-
	100	-	4.6	7.4	-	27	8,642	0.100	0.025	0.125
	150	-	6.7	7.4	-	107	18,269	0.211	0.053	0.264
May	150	200	5.9	7.4	71	285	169,915	1.967	0.492	2.459
	150	200	7.2	7.4	151	1,513	422,036	4.885	1.221	6.106
	150	200	8.3	7.4	151	2,999	562,017	6.505	1.626	8.131
Jun	150	200	8.5	7.4	151	4,477	693,645	8.028	2.007	10.035
	-	200	8.7	-	151	5,936	818,432	9.473	2.368	11.841
	-	200	9.6	-	151	7,343	1,006,928	11.654	2.914	14.568
Jul	-	200	9.8	-	71	8,651	989,798	11.456	2.864	14.320
	-	-	9.9	-	-	8,900	881,100	10.198	2.279	12.475
	-	-	10.7	-	-	8,900	952,300	11.022	2.756	13.778
Aug	-	-	10.3	-	-	8,900	916,700	10.610	2.652	13.262
	-	-	9.4	-	-	8,900	836,600	9.683	2.421	12.104
	150	-	9.9	3.7	-	8,170	814,380	9.426	2.357	11.783
Sep	150	-	9.4	7.4	-	6,746	745,124	8.624	2.156	10.780
	150	-	8.4	7.4	-	5,331	558,804	6.468	1.617	8.085
	150	200	7.1	7.4	151	4,486	631,606	7.310	1.828	9.138
Oct	150	200	8.1	7.4	151	4,477	675,737	7.821	1.955	9.776
	150	200	7.7	7.4	151	4,477	657,829	7.614	1.904	9.518
	100	150	2.7	3.7	151	5,215	371,005	4.294	1.074	5.368
Nov	-	150	4.8	-	151	6,639	545,172	6.310	1.578	7.888
	-	150	2.7	-	151	8,046	443,742	5.136	1.284	6.420
	-	-	-	-	-	8,900	-	-	-	-
Dec	-	-	2.1	-	-	8,900	186,900	2.163	0.541	2.704
	-	-	-	-	-	8,900	-	-	-	-
	-	-	-	-	-	8,900	-	-	-	-
Jan	-	-	1.2	-	-	8,713	104,556	1.210	0.303	1.513
	-	-	-	-	-	7,413	-	-	-	-
	-	-	0.2	-	-	5,936	11,872	0.137	0.034	0.171
Feb	-	-	-	-	-	4,450	-	-	-	-
	-	-	-	-	-	2,964	-	-	-	-
	-	-	-	-	-	1,486	-	-	-	-
Mar	-	-	-	-	-	187	-	-	-	-
	-	-	-	-	-	-	-	-	-	-

Note: Conveyance losses of 25% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
Culculating process
((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)
(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.50 Irrigation Requirement & Diversion Requirement/Polowijo (8,900 ha)/Karanganyar Region, ALT-2

Month	Unit Irrigation Requirement mm/day 1)	Hecterage to be supplied water On growing stage ha 2)	Irrigation Requirement m3/day 3)	Irrigation Requirement m3/sec 4)	Conveyance losses m3/sec 5)	Diversion Requirement m3/sec 6)
	-	8,900	-	-	-	-
Apr	2.5	8,900	222,500	2.575	0.644	3.219
	2.2	8,161	179,542	2.078	0.520	2.598
	3.6	6,675	240,300	2.781	0.696	3.477
May	2.5	5,189	129,725	1.501	0.376	1.877
	3.0	3,711	111,330	1.289	0.322	1.611
	3.5	2,225	77,875	0.901	0.226	1.127
Jun	3.1	739	22,909	0.265	0.066	0.331
	-	-	-	-	-	-
	-	-	-	-	-	-
Jul	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Aug	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Sep	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Oct	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Nov	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Dec	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Jan	-	-	-	-	-	-
	-	739	-	-	-	-
	-	2,225	-	-	-	-
Feb	-	3,711	-	-	-	-
	-	5,189	-	-	-	-
	-	6,675	-	-	-	-
Mar	-	8,161	-	-	-	-
	-	8,900	-	-	-	-

Note: Conveyance losses of 25% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
(1) x (2) x 10 = (3), (3)/86,400 = (4), (4) + (5) = (6)

Table 2.2.51 Irrigation Requirement & Diversion Requirement/Paddy (6,500 ha)/Sragen Region, ALT-2

Month	Puddling Requirement For nursery (mm) 1)	Puddling Requirement For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water Nursery puddling ha 4)	Hecterage to be supplied water Transplant-ing puddling ha 5)	Hecterage to be supplied water On growing stage ha 6)	Irrigation Requirement m3/day 7)	Irrigation Requirement m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-
	100	-	3.7	5.4	-	20	6,140	0.071	0.025	0.096
	150	-	6.4	5.4	-	78	13,092	0.152	0.053	0.205
May	150	200	5.3	5.4	52	208	123,124	1.425	0.499	1.924
	150	200	7.2	5.4	111	1,105	309,660	3.584	1.254	4.838
	150	200	8.3	5.4	111	2,191	411,993	4.768	1.669	6.437
Jun	150	200	8.5	5.4	111	3,270	508,050	5.880	2.058	7.938
	-	200	8.7	-	111	4,336	599,232	6.936	2.427	9.363
	-	200	9.6	-	111	5,363	736,848	8.528	2.985	11.513
Jul	-	200	9.8	-	52	6,318	723,164	8.370	2.929	11.299
	-	-	9.9	-	-	6,500	643,500	7.448	2.607	10.055
	-	-	10.7	-	-	6,500	695.500	8.040	2.827	10.867
Aug	-	-	10.3	-	-	6,500	669,500	7.749	2.712	10.461
	-	-	9.4	-	-	6,500	611,000	7.072	2.385	9.457
	150	-	9.9	2.7	-	5,967	594,783	6.884	1.084	7.968
Sep	150	-	9.4	5.4	-	4,927	471,238	5.434	1.929	7.363
	150	-	8.5	5.4	-	3,894	339,090	3.925	1.373	5.298
	150	200	6.1	5.4	111	3,276	429,936	4,976	1.742	6.718
Oct	150	200	7.7	5.4	111	3,270	481,890	5.577	1.953	7.530
	150	200	8.4	5.4	111	3,270	504,780	5.842	2.045	7.887
	100	150	5.3	2.7	111	3,809	371,077	4.293	1.505	5.798
Nov	-	150	4.9	-	111	4,849	404,101	4.677	1.637	6.314
	-	150	1.8	-	111	5,876	272,268	3.151	1.103	4.254
	-	-	2.4	-	-	6,500	156,000	1.806	0.631	2.437
Dec	-	-	3.5	-	-	6,500	227,000	2.633	0.922	3.555
	-	-	-	-	-	6,500	-	-	-	-
	-	-	2.1	-	-	6,500	136,500	1.580	0.553	2.133
Jan	-	-	-	-	-	6,364	-	-	-	-
	-	-	-	-	-	5,415	-	-	-	-
	-	-	-	-	-	4,336	-	-	-	-
Feb	-	-	-	-	-	3,250	-	-	-	-
	-	-	-	-	-	2,165	-	-	-	-
	-	-	-	-	-	1,086	-	-	-	-
Mar	-	-	-	-	-	137	-	-	-	-
	-	-	-	-	-	-	-	-	-	-

Note: Conveyance losses of 35% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
Culculating process
((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)
(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.52 Irrigation Requirement & Diversion Requirement/Polowijo (6,000 ha)/Sragen Region, ALT-2

Month	Unit Irrigation Requirement mm/day 1)	Hecterage to be supplied water On growing stage ha 2)	Irrigation Requirement m3/day 3)	Irrigation Requirement m3/sec 4)	Conveyance losses m3/sec 5)	Diversion Requirement m3/sec 6)
	-	6,500	-	-	-	-
Apr	1.5	6,500	97,500	1.128	0.395	1.523
	0.5	5,961	29,805	0.345	0.121	0.466
	3.4	4,875	165,750	1.918	0.672	2.590
May	1.5	3,790	56,850	0.658	0.230	0.888
	3.4	2,711	92,174	1.067	0.373	1.440
	3.5	1,625	56,375	0.658	0.231	0.889
Jun	3.1	540	16,740	0.194	0.068	0.262
	-	-	-	-	-	-
	-	-	-	-	-	-
Jul	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Aug	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Sep	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Oct	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Nov	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Dec	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Jan	-	-	-	-	-	-
	-	540	-	-	-	-
	-	1,625	-	-	-	-
Feb	-	2,711	-	-	-	-
	-	3,790	-	-	-	-
	-	4,875	-	-	-	-
Mar	-	5,961	-	-	-	-
	-	6,500	-	-	-	-

Note: Conveyance losses of 35% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
(1) x (2) x 10 = (3), (3)/86,400 = (4), (4) + (5) = (6)

Table 2.2.53 Irrigation Requirement & Diversion Requirement/Paddy (3,600 ha)/Dengkeng Region, ALT-2

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement: m3/day 7)	Irrigation Requirement: m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-
	100	-	4.6	3.0	-	11	3,506	0.041	0.012	0.053
	150	-	6.7	3.0	-	43	7,381	0.085	0.026	0.111
May	150	200	5.6	3.0	29	115	68,940	0.798	0.239	1.037
	150	200	7.2	3.0	61	612	170,564	1.974	0.592	2.566
	150	200	8.3	3.0	61	1,213	227,179	2.629	0.789	3.418
Jun	150	200	8.5	3.0	61	1,811	280,435	3.246	0.974	4.220
	-	200	8.7	-	61	2,401	330,887	3.830	1.149	4.979
	-	200	9.6	-	61	2,970	407,120	4.712	0.712	5.424
Jul	-	200	9.8	-	29	3,499	400,902	4.640	1.392	6.032
	-	-	9.9	-	-	3,600	356,400	4.125	1.238	5.363
	-	-	10.7	-	-	3,600	385,200	4.458	1.337	5.795
Aug	-	-	10.3	-	-	3,600	370,800	4.292	1.288	5.580
	-	-	9.4	-	-	3,600	338,400	3.917	1.175	5.092
	150	-	9.9	1.5	-	3,305	329,445	3.813	1.144	4.957
Sep	150	-	9.4	3.0	-	2,729	261,026	3.021	0.906	3.927
	150	-	9.1	3.0	-	2,156	200,696	2.323	0.697	3.020
	150	200	6.3	3.0	61	1,814	240,782	2,787	0.836	3.623
Oct	150	200	8.1	3.0	61	1,811	273,191	3.162	0.949	4.111
	150	200	7.1	3.0	61	1,811	255,081	2.952	0.876	3.838
	100	150	-	1.5	61	2,110	93,000	1.076	0.323	1.399
Nov	-	150	6.1	-	61	2,686	255,346	2.955	0.887	3.842
	-	150	2.8	-	61	3,254	182,612	2.114	0.634	2.748
	-	-	-	-	-	3,600	-	-	-	-
Dec	-	-	1.2	-	-	3,600	43,200	0.500	0.150	0.650
	-	-	-	-	-	3,600	-	-	-	-
	-	-	-	-	-	3,600	-	-	-	-
Jan	-	-	2.8	-	-	3,524	98,672	1.142	0.343	1.485
	-	-	-	-	-	2,999	-	-	-	-
	-	-	-	-	-	2,401	-	-	-	-
Feb	-	-	3.0	-	-	1,800	54,000	0.625	0.188	0.813
	-	-	-	-	-	1,199	-	-	-	-
	-	-	-	-	-	601	-	-	-	-
Mar	-	-	-	-	-	76	-	-	-	-
	-	-	-	-	-	-	-	-	-	-

Note: Conveyance losses of 30% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.

((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)

(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.54 Irrigation Requirement & Diversion Requirement/Polowijo (3,600 ha)/Dengkeng Region, ALT-2

Month	Unit Irrigation Requirement mm/day 1)	Hecterage to be supplied water On growing stage ha 2)	Irrigation Requirement m3/day 3)	Irrigation Requirement m3/sec 4)	Conveyance losses m3/sec 5)	Diversion Requirement m3/sec 6)
	-	3,600	-	-	-	-
Apr	2.5	3,600	90,000	1.042	0.313	1.355
	2.1	3,301	69,321	0.802	0.241	1.043
	3.7	2,700	99,900	1.156	0.347	1.503
May	1.8	2,099	37,782	0.437	0.131	0.568
	3.4	1,501	51,034	0.591	0.177	0.768
	3.5	900	31,500	0.365	0.109	0.474
Jun	3.1	299	9,269	0.107	0.032	0.139
	-	-	-	-	-	-
	-	-	-	-	-	-
Jul	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Aug	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Sep	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Oct	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Nov	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Dec	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Jan	-	-	-	-	-	-
	-	299	-	-	-	-
	-	900	-	-	-	-
Feb	-	1,501	-	-	-	-
	-	2,099	-	-	-	-
	-	2,700	-	-	-	-
Mar	-	3,301	-	-	-	-
	-	3,600	-	-	-	-

Note: Conveyance losses of 30% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
(1) x (2) x 10= (3), (3)/86,400 = (4), (4) + (5) = (6)

Table 2.2.55 Unit Irrigation Requirement/Paddy/Karanganyar Region

ALT-3

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop co-efficient	3) Evapo-transpiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	1.08	4.97	1.0	5.97	0.60	9.1	-
	2		1.08	4.97		5.97	0.60	0.7	5.9
	3		1.08	4.97		5.97	0.60	1.1	5.5
M	1	5.1	1.08	5.51	1.5	7.01	0.35	-	7.4
	2		1.08	5.51		7.01	0.35	1.0	6.4
	3		1.08	5.51		7.01	0.35	-	7.4
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.08	6.37		7.87	0.39	-	8.3
	3		1.08	6.37		7.87	0.39	-	8.3
J	1	6.4	1.08	6.91	1.5	8.41	0.42	-	8.8
	2		1.07	6.85		8.35	0.42	-	8.8
	3		1.06	6.78		8.28	0.41	-	8.7
A	1	7.2	1.06	7.63	1.5	9.13	0.46	-	9.6
	2		1.05	7.56		9.06	0.45	-	9.5
	3		1.05	7.56		9.06	0.45	-	9.5
S	1	8.0	1.05	8.40	1.5	9.90	0.50	-	10.4
	2		1.05	8.40		9.90	0.50	-	10.4
	3		1.05	8.40		9.90	0.50	0.7	9.7
O	1	6.8	1.06	7.21	1.5	8.71	0.44	0.8	8.4
	2		1.07	7.28		8.78	0.44	-	9.2
	3		1.08	7.34		8.84	0.44	0.9	8.3
N	1	5.5	1.11	6.11	1.0	7.11	0.71	5.0	2.8
	2		1.06	5.83		6.83	0.68	3.2	4.3
	3		1.08	5.94		6.94	0.69	5.7	1.9
D	1	4.3	1.08	4.64	1.0	5.64	0.56	8.7	-
	2		1.08	4.64		5.64	0.56	4.9	1.3
	3		1.08	4.64		5.64	0.56	7.2	-
J	1	3.7	1.08	4.00	1.00	5.00	0.50	11.7	-
	2		1.08	4.00		5.00	0.50	4.1	1.4
	3		1.08	4.00		5.00	0.50	6.7	-
F	1	3.6	1.08	3.89	1.0	4.89	0.49	4.6	-
	2		1.08	3.89		4.89	0.49	5.4	-
	3		1.08	3.89		4.89	0.49	8.2	-
M	1	3.9	1.08	4.21	1.0	5.21	0.52	8.7	-
	2		1.08	4.21		5.21	0.52	6.4	-
	3		1.08	4.21		5.21	0.52	12.4	-

Note : Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.56 Unit Irrigation Requirement/Paddy/Sragen Region

ALT-3

Unit : mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	1.08	4.97	1.0	5.97	0.60	2.7	3.9
	2		1.08	4.97		5.97	0.60	1.3	5.3
	3		1.08	4.97		5.97	0.60	2.0	4.6
M	1	5.1	1.08	5.51	1.5	7.01	0.35	0.3	7.1
	2		1.08	5.51		7.01	0.35	1.6	5.8
	3		1.08	5.51		7.01	0.35	-	7.4
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.08	6.37		7.87	0.39	-	8.3
	3		1.08	6.37		7.87	0.39	-	8.3
J	1	6.4	1.08	6.91	1.5	8.41	0.42	-	8.8
	2		1.07	6.85		8.35	0.42	-	8.8
	3		1.06	6.78		8.28	0.41	-	8.7
A	1	7.2	1.06	7.63	1.5	9.13	0.46	-	9.6
	2		1.05	7.56		9.00	0.45	-	9.5
	3		1.05	7.56		9.06	0.45	-	9.5
S	1	8.0	1.05	8.40	1.5	9.90	0.50	-	10.4
	2		1.05	8.40		9.90	0.50	-	10.4
	3		1.05	8.40		9.90	0.50	0.6	9.8
O	1	6.8	1.06	7.21	1.5	8.71	0.44	1.8	7.4
	2		1.07	7.28		8.78	0.44	0.4	8.8
	3		1.08	7.34		8.84	0.44	0.2	9.1
N	1	5.5	1.11	6.11	1.0	7.11	0.71	2.7	5.1
	2		1.06	5.83		6.83	0.68	3.1	4.4
	3		1.08	5.94		6.94	0.69	6.6	1.0
D	1	4.3	1.08	4.64	1.0	5.64	0.56	4.5	1.7
	2		1.08	4.64		5.64	0.56	3.5	2.7
	3		1.08	4.74		5.64	0.56	6.9	-
J	1	3.7	1.08	4.00	1.0	5.00	0.50	3.7	1.8
	2		1.08	4.00		5.00	0.50	11.9	-
	3		1.08	4.00		5.00	0.50	9.9	-
F	1	3.6	1.08	3.89	1.0	4.89	0.49	10.5	-
	2		1.08	3.89		4.89	0.49	9.3	-
	3		1.08	3.89		4.89	0.49	5.8	-
M	1	3.9	1.08	4.21	1.0	5.21	0.52	7.9	-
	2		1.08	4.21		5.21	0.52	7.3	-
	3		1.08	4.21		5.21	0.52	13.5	-

Note : Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.57 Unit Irrigation Requirement/Paddy/Dengkeng Region

ALT-3

Unit: mm/day

Month	Ten-Day Period	1) Evaporation	2) Crop coefficient	3) Evapotranspiration 1)x2)	4) Percolation	5) Water requirement 3)+4)	6) Farm waste 5)x0.10 or 0.05	7) Effective rainfall	8) Unit irrigation requirement 5)+6)-7)
A	1	4.6	1.08	4.97	1.0	5.97	0.60	8.2	-
	2		1.08	4.97		5.97	0.60	0.8	5.8
	3		1.08	4.97		5.97	0.60	1.1	5.5
M	1	5.1	1.08	5.51	1.5	7.01	0.35	-	7.4
	2		1.08	5.51		7.01	0.35	1.3	6.1
	3		1.08	5.51		7.01	0.35	-	7.4
J	1	5.9	1.08	6.37	1.5	7.87	0.39	-	8.3
	2		1.08	6.37		7.87	0.39	-	8.3
	3		1.08	6.37		7.87	0.39	-	8.3
J	1	6.4	1.08	6.91	1.5	8.41	0.42	-	8.8
	2		1.07	6.85		8.35	0.42	-	8.8
	3		1.06	6.78		8.28	0.41	-	8.7
A	1	7.2	1.06	7.63	1.5	9.13	0.46	-	9.6
	2		1.05	7.56		9.06	0.45	-	9.5
	3		1.05	7.56		9.06	0.45	-	9.5
S	1	8.0	1.05	8.40	1.5	9.90	0.50	-	10.4
	2		1.05	8.40		9.90	0.50	-	10.4
	3		1.05	8.40		9.90	0.50	-	10.4
O	1	5.8	1.06	7.21	1.5	8.71	0.44	1.6	7.5
	2		1.07	7.28		8.78	0.44	-	9.2
	3		1.08	7.34		8.84	0.44	1.5	10.8
N	1	5.5	1.11	6.11	1.0	7.11	0.71	9.4	-
	2		1.06	5.83		6.83	0.68	1.9	5.6
	3		1.08	5.94		6.94	0.69	5.6	2.0
D	1	4.3	1.08	4.64	1.0	5.64	0 56	11.2	-
	2		1.08	4.64		5.64	0.56	5.8	0.4
	3		1.08	4.64		5.64	0.56	12.0	-
J	1	3.7	1.08	4.00	1.0	5.00	0.50	13.7	-
	2		1.08	4.00		5.00	0.50	2.5	3.0
	3		1.08	4.00		5.00	0.50	8.1	-
F	1	3.6	1.08	3.89	1.0	4.89	0.49	7.4	-
	2		1.08	3.89		4.89	0.49	1.5	4.9
	3		1.08	3.89		4.89	0.49	5.0	0.4
M	1	3.9	1.08	4.21	1.0	5.21	0.52	10.8	-
	2		1.08	4.21		5.21	0.52	7.4	-
	3		1.08	4.21		5.21	0.52	17.8	-

Note: Farm waste (Dry season ... 5%, Rainy season ... 10%)

Table 2.2.58 Irrigation Requirement & Diversion Requirement/Paddy (4,450 ha x 2)/Karanganyar Region, ALT-3

Month	Puddling Requirement		Unit Irrigation Requirement	Hecterage to be supplied water			Irrigation Requirement		Conveyance losses	Diversion Requirement
	For nursery (mm) 1)	For trans- planting (mm) 2)	mm/day 3)	Nursery puddling ha 4)	Transplant- ing puddling ha 5)	On growing stage ha 6)	m3/day 7)	m3/sec 8)	m3/sec 9)	m3/sec 10)
	100	150	-	3.7	76	6,688	117,700	1.362	0.341	1.703
Apr	100	150	5.9	-	76	7,049	529,891	6.133	1.533	7.666
	100	150	5.5	3.7	76	7,022	503,910	5.832	1.458	7.290
	150	200	7.4	3.7	36	6,973	593,552	6.870	1.718	8.588
May	150	200	6.4	3.7	36	6,448	490,222	5.674	1.419	7.093
	150	200	7.4	3.7	76	6,319	625,156	7.236	1.809	9.045
	150	200	8.3	3.7	76	6,319	682,029	7.894	1.974	9.868
Jun	150	200	8.3	3.7	76	6,688	712,654	8.248	2.062	10.310
	-	200	8.3	-	76	7,049	737,067	8.531	2.133	10.664
	150	200	8.8	1.9	76	7,013	771,994	8,935	2.234	11.169
Jul	150	200	8.8	3.7	36	6,955	689,590	7.981	1.995	9.976
	150	-	8.7	3.7	-	6,377	560,349	6.486	1.622	8.108
	150	200	9.6	3.7	76	5,950	728,750	8.435	2.109	10.544
Aug	150	200	9.5	3.7	76	5,945	722,325	8.360	2.090	10.450
	150	200	9.5	3.7	76	6,319	757,855	8.771	2.193	10.964
	150	200	10.4	1.9	76	6,688	850,402	9.843	2.461	12.304
Sep	150	200	10.4	1.9	76	6,662	847,698	9.811	2.453	12.264
	150	200	9.7	3.7	76	6,653	802,891	9.293	2.323	11.616
	150	-	8.4	3.7	-	6,377	541,218	6.264	1.566	7.830
Oct	150	200	9.2	3.7	76	5,950	704,950	8.159	2.040	10.199
	150	200	8.3	3.7	76	5,945	650,985	7.535	1.884	9.419
	100	150	2.8	3.7	76	6,319	294,632	3.410	0.853	4.263
Nov	100	150	4.3	1.9	76	6,964	415,352	4.807	1.202	6.009
	-	150	1.9	-	76	7,027	247,513	2.865	0.716	3.581
	100	150	-	3.7	76	7,004	117,700	1.362	0.341	1.703
Dec	100	-	1.3	3.7	-	6,728	91,164	1.055	0.264	1.319
	100	150	-	3.7	36	6,074	57,700	0.668	0.167	0.835
	100	150	-	3.7	76	5,950	117,700	1.362	0.341	1.703
Jan	100	150	1.4	3.7	76	6,043	202,302	2.341	0.585	2.926
	100	150	-	3.7	76	6,595	117,700	1.362	0.341	1.703
	-	150	-	3.7	76	6,675	114,000	1.319	0.330	1.649
Feb	100	150	-	3.7	76	6,653	117,700	1.362	0.341	1.703
	100	150	-	3.7	36	6,604	57,000	0.668	0.167	0.835
	100	150	-	3.7	36	6,074	57,000	0.668	0.167	0.835
Mar	100	150	-	3.7	76	5,950	117,700	1.362	0.341	1.703
	100	150	-	3.7	76	6,043	117,700	1.362	0.341	1.703

Note: Conveyance losses of 25% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
Culculating process
((1) x (4) + (2) x (5)) x 10 = (7)
(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.59 Irrigation Requirement & Diversion Requirement/Paddy (3,250 ha x 2)/Sragen Region, ALT-3

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On growing stage ha 6)	Irrigation Requirement: m3/day 7)	Irrigation Requirement: m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
	100	150	3.9	2.7	55	4,885	275,715	3.191	1.117	4.308
Apr	-	150	5.3	-	55	5,148	355,344	4.113	1.440	5.553
	100	150	4.6	2.7	55	5,129	321,134	3.716	1.301	5.017
	150	200	7.1	2.7	26	5,093	361,603	4.185	1.465	5.650
May	150	200	5.8	2.7	26	4,709	329,172	3.810	1.334	5.144
	150	200	7.4	2.7	55	4,615	455,560	5.272	1.845	7.117
	150	200	8.3	2.7	55	4,615	497,095	5.753	2.014	7.767
Jun	150	200	8.3	2.7	55	4,885	519,505	6.013	2.105	8.118
	-	200	8.3	-	55	5,148	537,284	6.219	2.117	8.396
	150	200	8.8	1.4	55	5,122	562,836	6.514	2.280	8.794
Jul	150	200	8.8	2.7	26	5,080	503,090	5.823	2.038	7.861
	150	-	8.7	2.7	-	4,657	409,209	4.736	1.658	6.394
	150	200	9.6	2.7	55	4,345	531,170	6.148	2.152	8.300
Aug	150	200	9.5	2.7	55	4,342	526,540	6.094	2.133	8.227
	150	200	9.5	2.7	55	4,615	552,475	6.394	2.238	8.632
	150	200	10.4	1.4	55	4,885	620,140	7.178	2.512	9.690
Sep	150	200	10.4	1.4	55	4,865	618,060	7.153	2.504	9.657
	150	200	9.8	2.7	55	4,859	590,232	6.831	2.391	9.222
	150	-	7.4	2.7	-	4,657	348,668	4.036	1.413	5.449
Oct	150	200	8.8	2.7	55	4,345	496,410	5.745	2.011	7.756
	150	200	9.1	2.7	55	4,342	509,172	5.893	2.063	7.956
	100	150	5.1	2.7	55	4,615	320,565	3.710	1.299	5.009
Nov	100	150	4.4	1.4	55	5,086	307,684	3.561	1.246	4.807
	-	150	1.0	-	55	5,132	133,820	1.549	0.542	2.091
	100	150	1.7	2.7	55	5,116	172,172	1.993	0.698	2.691
Dec	100	-	2.7	2.7	-	4,914	135,378	1.567	0.548	2.115
	100	150	-	2.7	26	4,436	41,700	0.483	0.169	0.652
	100	150	1.8	2.7	55	4,345	163,410	1.891	0.662	2.553
Jan	100	150	-	2.7	55	4,414	85,200	0.986	0.345	1.331
	100	150	-	2.7	55	4,817	85,200	0.986	0.345	1.331
	-	150	-	-	55	4,875	82,500	0.955	0.334	1.289
Feb	100	150	-	2.7	55	4,859	85,200	0.986	0.345	1.331
	100	150	-	2.7	26	4,823	41,700	0.483	0.169	0.652
	100	150	-	2.7	26	4,436	41,700	0.483	0.169	0.652
Mar	100	150	-	2.7	55	4,345	85,200	0.986	0.345	1.331
	100	150	-	2.7	55	4,414	85,200	0.986	0.345	1.331

Note: Conveyance losses 35% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
Culculating process
((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)
(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.60 Irrigation Requirement & Diversion Requirement/Paddy (1,800 ha x 2)/Dengkeng Region, ALT-3

Month	Puddling Requirement: For nursery (mm) 1)	Puddling Requirement: For trans-planting (mm) 2)	Unit Irrigation Requirement mm/day 3)	Hecterage to be supplied water: Nursery puddling ha 4)	Hecterage to be supplied water: Transplant-ing puddling ha 5)	Hecterage to be supplied water: On Growing stage ha 6)	Irrigation Requirement: m3/day 7)	Irrigation Requirement: m3/sec 8)	Conveyance losses m3/sec 9)	Diversion Requirement m3/sec 10)
			-	1.5	31	2,705	48,000	0.556	0.167	0.723
Apr	100	150	5.8	-	31	2,851	211,858	2.452	0.736	3.188
			5.5	1.5	31	2,840	204,200	2.363	0.709	3.072
			7.4	1.5	14	2,821	239,004	2.766	0.830	3.596
May	150	200	6.1	1.5	14	2.608	189,338	2.191	0.657	2.848
			7.4	1.5	31	2,556	253,394	2.933	0.880	3.813
			8.3	1.5	31	2,556	276,398	3.199	0.960	4.159
Jun	150	200	8.3	1.5	31	2,705	288,765	3.342	1.003	4.345
			8.3	-	31	2,851	198,456	3.456	1.037	4,493
			8.8	0.8	31	2,837	312,856	3.621	1.086	4.707
Jul	150	200	8.8	1.5	14	2,813	277,794	3.215	0.965	4.180
			8.7	1.5	-	2,579	235,623	2.727	0.818	3.545
			9.6	1.5	31	2,407	295,322	3.418	1.025	4.443
Aug	150	200	9.5	1.5	31	2.405	292,725	3.388	1.016	4.404
			9.5	1.5	31	2,556	307,070	3.554	1.066	4.620
			10.4	0.8	31	2,705	344,520	3.988	1.196	5.184
Sep	150	200	10.4	0.8	31	2,695	343,480	3.957	1.184	5.141
			10.4	1.5	31	2,691	344,114	3.983	1.195	5.178
			7.5	1.5	-	2,579	195,675	2.265	0.680	2.945
Oct	150	200	9.2	1.5	31	2,407	285,694	3.307	0.992	4.299
			10.8	1.5	31	2,405	323,990	3.750	1.125	4.875
			-	1.5	31	2,556	48,000	0.556	0.167	0.723
Nov	100	150	5.6	0.8	31	2,817	205,052	2.373	0.712	3.085
			2.0	-	31	2,842	103,340	1.196	0.359	1.555
			-	1.5	31	2,833	48,000	0.556	0.167	0.723
Dec	100	150	0.4	1.5	-	2,722	12,388	0.143	0.043	0.186
			-	1.5	14	2,457	22,500	0.260	0.078	0.338
			-	1.5	31	2,407	48,000	0.556	0.167	0.723
Jan	100	150	3.0	1.5	31	2,444	121,320	1.404	0.421	1.825
			-	1.5	31	2,668	48,000	0.556	0.167	0.723
			-	-	31	2,700	46,500	0.538	0.161	0.699
Feb	100	150	4.9	1.5	31	2,691	179,859	2.082	0.625	2.707
			0.4	1.5	14	2,671	33,184	0.384	0.065	0.499
			-	1.5	14	2,457	22,500	0.260	0.078	0.338
Mar	100	150	-	1.5	31	2,407	48,000	0.556	0.167	0.723
			-	1.5	31	2,444	48,000	0.556	0.167	0.723

Note: Conveyance losses of 30% of irrigation requirement are estimated from main canal to farm ditches leakage through holes and gates, and irrigal diversion etc.
Culculating process

((1) x (4) + (2) x (5) + (3) x (6)) x 10 = (7)

(7)/86,400 = (8), (8) + (9) = (10)

Table 2.2.61 Diversion Requirement & Water Balance

ALT-1

Unit: m^3/sec

Month	Ten-Day Period	Karanganyar Region: Paddy	Karanganyar Region: Second Paddy	Karanganyar Region: Sugar Cane	Karanganyar Region: 1) Sub-total	Sragen Region: Paddy	Sragen Region: Second Paddy	Sragen Region: Sugar Cane	Sragen Region: 2) Sub-total	3) Right Bank Region 1)+2)	4) Left Bank Region	5) Total 3)+4)	6) Outfoow	7) Inflow	8) Monthly Balance 7) - 6)	9) Balance	10) Storage Capacity x 10^6 m^3
A	1	-	-	-	-	1.658	-	-	1.658	1.658	-	1.658					
	2	2.792	-	0.286	3.078	1.567	-	0.423	1.990	5.068	0.949	6.017	3.5				
	3	1.182	-	0.251	1.433	0.804	-	0.038	0.842	2.275	0.552	2.827					
M	1	0.883	-	0.478	1.361	0.667	-	1.172	1.839	3.200	0.371	3.571					
	2	2.434	-	0.333	2.767	1.924	-	0.508	2.432	5.199	1.027	6.226	8.3	8.6	0.3	C.3	-
	3	6.106	-	0.419	6.525	4.838	-	1.288	6.126	12.651	2.566	15.217					
J	1	8.131	-	0.495	8.626	6.437	-	1.435	7.872	16.498	3.418	19.916					
	2	10.035	-	0.470	10.505	7.938	-	1.372	9.310	19.815	4.220	24.035	23.9	1.1	-22.8	-22.5	-58.3
	3	11.755	-	0.444	12.199	9.295	-	1.303	10.598	22.797	4.942	27.739					
J	1	14.568	-	0.445	15.013	11.513	-	1.318	12.831	27.844	6.126	33.970					
	2	14.320	-	0.423	14.743	11.201	-	1.258	12.459	27.202	6.032	33.234	32.5	-0.4	-32.9	-55.4	-148.4
	3	12.747	-	0.425	13.172	10.547	-	1.212	11.759	24.931	5.363	30.294					
A	1	13.777	-	0.513	14.290	10.867	-	1.382	12.294	26.539	5.796	32.335					
	2	13.262	-	0.530	13.792	10.461	-	1.430	11.891	25.683	5.525	31.208	30.8	-1.2	-32.0	-87.4	-234.1
	3	12.104	-	0.548	12.652	9.547	-	1.477	11.024	23.676	5.092	28.768					
S	1	11.807	-	0.608	12.415	9.314	-	1.640	10.954	23.369	4.967	28.336					
	2	9.174	0.014	0.616	9.804	7.236	0.035	1.665	8.936	18.740	3.859	22.599	22.5	-1.5	-24.0	-111.4	-238.7
	3	6.156	0.020	0.990	7.166	4.915	0.054	1.500	6.469	13.635	2.811	16.446					
O	1	3.382	0.178	0.416	3.976	2.245	0.458	0.891	3.594	7.570	1.242	8.812					
	2	2.028	0.435	0.530	2.993	1.498	1.203	1.266	3.967	6.960	0.853	7.813	7.5	-1.6	-9.1	-120.5	-322.7
	3	0.460	0.546	0.460	1.466	0.423	1.592	1.430	3.445	4.911	0.166	5.777					
N	1	0.113	0.351	-	0.464	0.097	1.242	0.375	1.714	2.178	0.045	2.223					
	2	0.164	0.495	0.121	0.780	0.131	1.376	0.070	1.577	2.357	0.077	2.434	3.3	-1.0	-4.3	-124.8	325.5
	3	1.710	0.404	-	2.114	1.323	0.957	-	2.280	4.394	0.727	5.121					
D	1	3.384	0.109	-	3.493	2.962	0.828	-	3.790	7.283	1.422	8.705					
	2	3.948	0.183	-	4.131	3.610	0.821	-	4.431	8.562	1.540	10.102	8.2	19.4	11.2	-113.6	-304.5
	3	1.710	-	-	1.710	2.685	-	-	2.685	4.395	1.422	5.817					
J	1	3.277	-	-	3.277	3.957	0.493	-	4.450	7.727	1.377	9.104					
	2	5.295	0.104	-	5.399	2.602	-	-	2.602	8.001	2.940	10.941	7.8	35.2	27.4	-86.2	-230.9
	3	1.541	-	-	1.541	1.287	-	-	1.287	2.828	0.655	3.483					
F	1	1.803	0.013	-	1.816	-	-	-	-	1.816	-	1.816					
	2	0.644	-	-	0.644	-	-	-	-	0.644	2.383	3.027	1.7	42.0	40.3	-45.9	-111.0
	3	-	-	-	-	-	-	-	-	-	0.379	0.379					
M	1	-	-	-	-	-	-	-	-	-	-	-					
	2	-	-	-	-	-	-	-	-	-	-	-	-	85.2	85.2	39.3	-
	3	-	-	-	-	-	-	-	-	-	-	-					

Note: (4) is the Dengkeng region
(6) is mean monthly diversion requirement

Table 2.2.62 Diversion Requirement & Water Balance

ALT-2

Unit: m^3/sec

Month	Ten-Day period	Karanganyar Region Paddy	Karanganyar Polowi	Karanganyar Sugar* cane	Karanganyar Second paddy	Karanganyar Sub-Total 1)	Sragen Region Paddy	Sragen Polowi-jo	Sragen Sugar cane*	Sragen Second paddy*	Sragen Sub-Total 2)	3) Right Bank Region 1) + 2)	Dengkeng A Paddy 4)	Dengkeng A Polowi 5)	6) Left Bank Rejion 4) + 5)	7) Total	8) Out-flow dis-charge	9) In-flow dis-charge	10) Monthly Balance	11) Balance	12) Storage capacity $x10^6m^3$
A	1	-	-		-	-	-	-	-	-	-	-	-	-	-	-					
	2	-	3.219	0.286	-	3.505	-	1.523	0.423	-	1.946	5.451	-	1.355	1.355	6.806	5.7				
	3	0.125	2.598	0.251	-	2.974	0.096	0.466	0.038	-	0.600	3.574	0.053	1.043	1.096	4.670					
M	1	0.264	3.477	0.478	-	4.219	0.205	2.590	1.172	-	3.967	8.186	0.111	1.503	1.614	9.800					
	2	2.459	1.877	0.333	-	4.669	1.924	0.888	0.508	-	3.320	7.989	1.037	0.568	1.605	9.594	12.8	8.6	-4.2	-4.2	11.2
	3	6.106	1.611	0.419	-	8.136	4.838	1.440	1.288	-	7.566	15.702	2.566	0.768	3.334	19.036					
J	1	8.131	1.127	0.495	-	9.753	6.437	0.889	1.435	-	8.761	18.514	3.418	0.474	3.892	22.406					
	2	10.035	0.331	0.470	-	10.836	7.938	0.262	1.372	-	9.572	20.408	4.220	0.139	4.359	24.767	24.9	1.1	-23.8	-28	72.6
	3	11.841	-	0.444	-	12.285	9.363	-	1.303	-	10.666	22.951	4.979	-	4.979	27.930					
J	1	14.568	-	0.445	-	15.013	11.513	-	1.318	-	12.831	27.844	5.424	-	5.424	33.268					
	2	14.320	-	0.423	-	14.743	11.299	-	1.258	-	12.557	27.300	6.032	-	6.032	33.332	32.0	-0.4	-32.4	-60.4	161.8
	3	12.475	-	0.425	-	12.900	10.055	-	1.212	-	11.267	24.167	5.363	-	5.363	29.530					
A	1	13.778	-	0.513	-	14.291	10.867	-	1.382	-	12.249	26.540	5.795	-	5.795	32.335					
	2	13.262	-	0.530	-	13.792	10.461	-	1.430	-	11.891	25.683	5.580	-	5.580	32.263	30.8	-1.2	-32.0	-92.4	247.5
	3	12.104	-	0.548	-	12.652	9.457	-	1.477	-	10.934	23.586	5.092	-	5.092	28.678					
S	1	11.783	-	0.608	-	12.391	7.968	-	1.640	-	9.608	21.999	4.957	-	4.957	26.956					
	2	10.780	-	0.616	0.014	11.410	7.363	-	1.665	0.035	9.063	20.473	3.927	-	3.927	24.400	23.4	-1.5	-24.9	-117.3	304
	3	8.085	-	0.990	0.020	9.095	5.298	-	1.500	0.054	6.852	15.947	3.020	-	3.020	18.967					
O	1	9.138	-	0.416	0.178	9.732	6.718	-	0.891	0.458	8.067	17.799	3.623	-	3.623	21.422					
	2	9.776	-	0.530	0.435	10.741	7.530	-	1.266	1.203	9.999	20.740	4.111	-	4.111	24.851	23.8	-1.6	-25.4	-142.7	382.2
	3	9.518	-	0.460	0.546	10.524	7.887	-	1.430	1.592	10.909	21.433	3.838	-	3.838	25.271					
N	1	5.368	-	-	0.351	5.719	5.798	-	0.375	1.2 2	7.415	13.134	1.399	-	1.399	14.533					
	2	7.888	-	0.121	0.495	8.504	6.314	-	0.070	1.376	7.760	16.264	3.842	-	3.842	20.106	16.5	-1.0	-17.5	-160.2	415.2
	3	6.420	-	-	0.404	6.824	4.254	-	-	0.957	5.211	12.035	2.748	-	2.748	14.783					
D	1	-	-	-	0.109	0.109	2.437	-	-	0.828	3.265	3.374	-	-	-	3.374					
	2	2.704	-	-	0.183	2.887	3.555	-	-	0.821	4.376	7.263	0.650	-	0.650	7.913	5.6	194	13.8	-146.4	392.1
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
J	1	-	-	-	-	-	2.133	-	-	0.493	2.626	2.626		-	-	2.626					
	2	1.513	-	-	0.104	1.617	-	-	-	-	-	1.617	1.485	-	1.485	3.102	2.9	35.2	32.4	-114.1	305.6
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
F	1	0.171	-	-	0.013	0.184	-	-	-	-	-	0.184	-	-	-	0.184					
	2	-	-	-	-	-	-	-	-	-	-	-	0.813	-	0.813	0.813	0.5	42.0	41.5	-72.6	175.6
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
M	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	85.2	85.2	12.6	
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					

Note: * sec ALT-1

8) is the mean monthly diversion requirement

Table 2.2.63 Diversion Requirement & Water Balance

ALT - 3

unit: m^3/sec

Month	Ten-Day Period	Karanganyar Region Paddy	Karanganyar Region Second* paddy	Karanganyar Region Sugar* cane	Karanganyar Region Sub 1) Total	Sragen Region Paddy	Sragen Region Second* paddy	Sragen Region Sugar* cane	Sragen Region Sub 2) Total	Right Bank Region 3) 1)+2)	Left Bank Region 4)	Total 5) 3)+4)	Out flow 6)	In flow 7)	Monthly Balance 8) 7)-6)	Balance 9)	Storage capacity 10) $x10^6m^3$
	1	1.703	-	-	1.703	4.308	-	-	4.308	6.011	0.723	6.734					
A	2	7.666	-	0.286	7.952	5.553	-	0.423	5.976	13.928	3.188	17.116	13.2				
	3	7.290	-	0.251	7.541	5.017	-	0.038	5.055	12.596	3.072	15.668					
	1	8.588	-	0.478	9.066	5.650	-	1.172	6.822	15.888	3.596	19.484					
M	2	7.093	-	0.333	7.426	5.144	-	0.508	5.652	13.078	2.848	15.926	19.0	8.6	-10.4	-10.4	27.9
	3	9.045	-	0.419	9.464	7.117	-	1.288	8.405	17.869	3.813	21.682					
	1	9.868	-	0.495	10.363	7.767	-	1.435	9.202	19.565	4.159	23.724					
J	2	10.310	-	0.470	10.780	8.118	-	1.372	9.490	20.270	4.345	24.615	24.5	1.1	-23.4	-33.8	87.6
	3	10.664	-	0.444	11.108	8.396	-	1.303	9.699	20.807	4.493	25.300					
	1	11.169	-	0.445	11.614	8.794	-	1.318	10.112	21.726	4.707	26.433					
J	2	9.976	-	0.423	10.399	7.861	-	1.258	9.119	19.518	4.180	23.698	23.3	-0.4	-23.7	-57.5	154.0
	3	8.108	-	0.425	8.533	6.394	-	1.212	7.606	16.139	3.545	19.684					
	1	10.544	-	0.513	11.057	8.300	-	1.382	9.682	20.739	4.443	25.182					
A	2	10.450	-	0.530	10.980	8.227	-	1.430	9.657	20.637	4.404	25.041	25.5	-1.2	-26.7	-84.2	225.5
	3	10.964	-	0.548	11.512	8.632	-	1.477	10.109	21.621	4.620	26.241					
	1	12.304	-	0.608	12.912	9.690	-	1.640	11.330	24.242	5.184	29.426					
S	2	12.264	0.014	0.616	12.894	9.657	0.035	1.665	11.357	24.251	5.141	29.392	29.1	-1.5	-30.6	-114.8	297.6
	3	11.616	0.020	0.990	12.626	9.222	0.054	1.500	10.776	23.402	5.178	28.580					
	1	7.830	0.178	0.416	8.424	5.449	0.458	0.891	6.798	15.222	2.945	18.167					
O	2	10.199	0.435	0.530	11.164	7.756	1.203	1.266	10.225	21.389	4.299	25.688	23.4	-1.6	-25.0	-139.8	374.4
	3	9.419	0.546	0.460	10.425	7.956	1.592	1.430	10.978	21.403	4.875	26.278					
	1	4.263	0.351	-	4.614	5.009	1.242	0.375	6.626	11.240	0.723	11.963					
N	2	6.009	0.495	0.121	6.625	4.807	1.376	0.070	6.253	12.878	3.085	15.963	12.2	-1.0	-13.2	-153	396.6
	3	3.581	0.404	-	3.985	2.091	0.957	-	3.048	7.033	1.555	8.588					
	1	1.703	0.109	-	1.812	2.691	0.828	-	3.519	5.331	0.723	6.054					
D	2	1.319	0.183	-	1.502	2.115	0.821	-	2.936	4.438	0.186	4.624	4.2	19.4	-15.2	-137.8	369.1
	3	0.835	-	-	0.835	0.652	-	-	0.652	1.487	0.338	1.825					
	1	1.703	-	-	1.703	2.553	0.493	-	3.046	4.749	0.723	5.472					
J	2	2.926	0.104	-	3.030	1.331	-	-	1.331	4.361	1.825	6.186	5.1	35.2	30.1	-107.7	288.5
	3	1.703	-	-	1.703	1.331	-	-	1.331	3.034	0.723	3.757					
	1	1.649	0.013	-	1.662	1.289	-	-	1.289	2.951	0.699	3.650					
F	2	1.703	-	-	1.703	1.331	-	-	1.331	3.034	2.707	5.741	3.8	42.0	38.2	-69.5	168.1
	3	0.835	-	-	0.835	0.652	-	-	0.652	1.487	0.499	1.986					
	1	0.835	-	-	0.835	0.652	-	-	0.652	1.487	0.338	1.986					
M	2	1.703	-	-	1.703	1.331	-	-	1.331	3.034	0.723	3.757	3.2	85.2	82.0	12.5	-
	3	1.703	-	-	1.703	1.331	-	-	1.331	3.034	0.723	3.757					

Note: * ... see ALT - 1

(4) is the Dengkeng Region

(5) is the mean monthly diversion requirement

Table 2.2.64 Diversion Requirement by Each Alternative (1967/68)

Month	Ten-Day Period	ALT - 1 Right Bank Region	ALT - 1 Left Bank Region	ALT - 1 Total	ALT -2 Right Bank Region	ALT -2 Left Bank Region	ALT -2 Total	ALT - 3 Right Bank Region	ALT - 3 Left Bank Region	ALT - 3 Total
	1	1.658	-	1.658	-	-	-	6.011	0.723	6.734
A	2	5.068	0.949	6.017	5.451	1.355	6.806	13.928	3.188	17.116
	3	2.275	0.552	2.827	3.574	1.096	4.670	12.596	3.072	15.668
	1	3.200	0.371	3.571	8.186	1.614	9.800	15.888	3.596	19.484
M	2	5.199	1.027	6.226	7.989	1.605	9.594	13.078	2.848	15.926
	3	12.651	2.566	15.217	15.702	3.334	19.036	17.869	3.813	21.682
	1	16.498	3.418	19.916	18.514	3.892	22.406	19.565	4.159	23.724
J	2	19.815	4.220	24.035	20.408	4.359	24.767	20.270	4.345	24.615
	3	22,797	4.942	27.739	22.951	4.979	27.930	20.807	4.493	25.300
	1	27,844	6.126	33.970	27.844	5.424	33.268	21.726	4.707	26.433
J	2	27.202	6.032	33.234	27.300	6.032	33.332	19.518	4.180	23.698
	3	24.931	5.363	30.294	24.167	5.363	29.530	16.139	3.545	19.684
	1	26.539	5.796	32.335	26.540	5.795	32.335	20.739	4.443	25.182
A	2	25.683	5.525	31.208	25.683	5.580	31.263	20.637	4.404	25.041
	3	23.676	5.092	28.768	23.586	5.092	28.678	21.621	4.620	26.241
	1	23.369	4.967	28.336	21.999	4.957	26.956	24.242	5.184	29.426
S	2	18.740	3.859	22.599	20.473	3.927	24.400	24.251	5.141	29.392
	3	13.635	2.811	16.446	15.947	3.020	18.967	23.402	5.178	28.580
	1	7.570	1.242	8.812	17.799	3.623	21.422	15.222	2.945	18.167
O	2	6.960	0.853	7.813	20.740	4.111	24.851	21.389	4.299	25.688
	3	4.911	0.166	5.777	21.433	3.838	25.271	21.403	4.875	26.278
	1	2.178	0.045	2.223	13.134	1.399	14.533	11.240	0.723	11.963
N	2	2.357	0.077	2.434	16.264	3.842	20.106	12.878	3.085	15.963
	3	4.394	0.727	5.121	12.035	2.748	14.783	7.033	1.555	8.588
	1	7.283	1.422	8.705	3.374	-	3.374	5.331	0.723	6.054
D	2	8.562	1.540	10.102	7.263	0.650	7.913	4.438	0.186	4.624
	3	4.395	1.422	5.817	-	-	-	1.487	0.338	1.825
	1	7.727	1.377	9.104	2.626	-	2.626	4.749	0.723	5.472
J	2	8.001	2.940	10.941	1.617	1.485	3.102	4.361	1.825	6.186
	3	2.828	0.655	3.483	-	-	-	3.034	0.723	3.757
	1	1.816	-	1.816	0.184	-	0.184	2.951	0.699	3.650
F	2	0.644	2.383	3.027	-	0.813	0.813	3.034	2.707	5.741
	3	-	0.379	0.379	-	-	-	1.487	0.499	1.986
	1	-	-	-	-	-	-	1.487	0.338	1.986
M	2	-	-	-	-	-	-	3.034	0.723	3.757
	3	-	-	-	-	-	-	3.034	0.723	3.757

	ALT - 1	ALT -2	ALT - 3
Total diversion requirement	389×10^6 m^3	452×10^6 m^3	483×10^6 m^3
Storage diversion requirement	323×10^6 m^3	415×10^6 m^3	397×10^6 m^3

Fig. 2.2.15
Diversion Requirement and Storage Capacity by Each Alternative
(In Design year 1967/68)

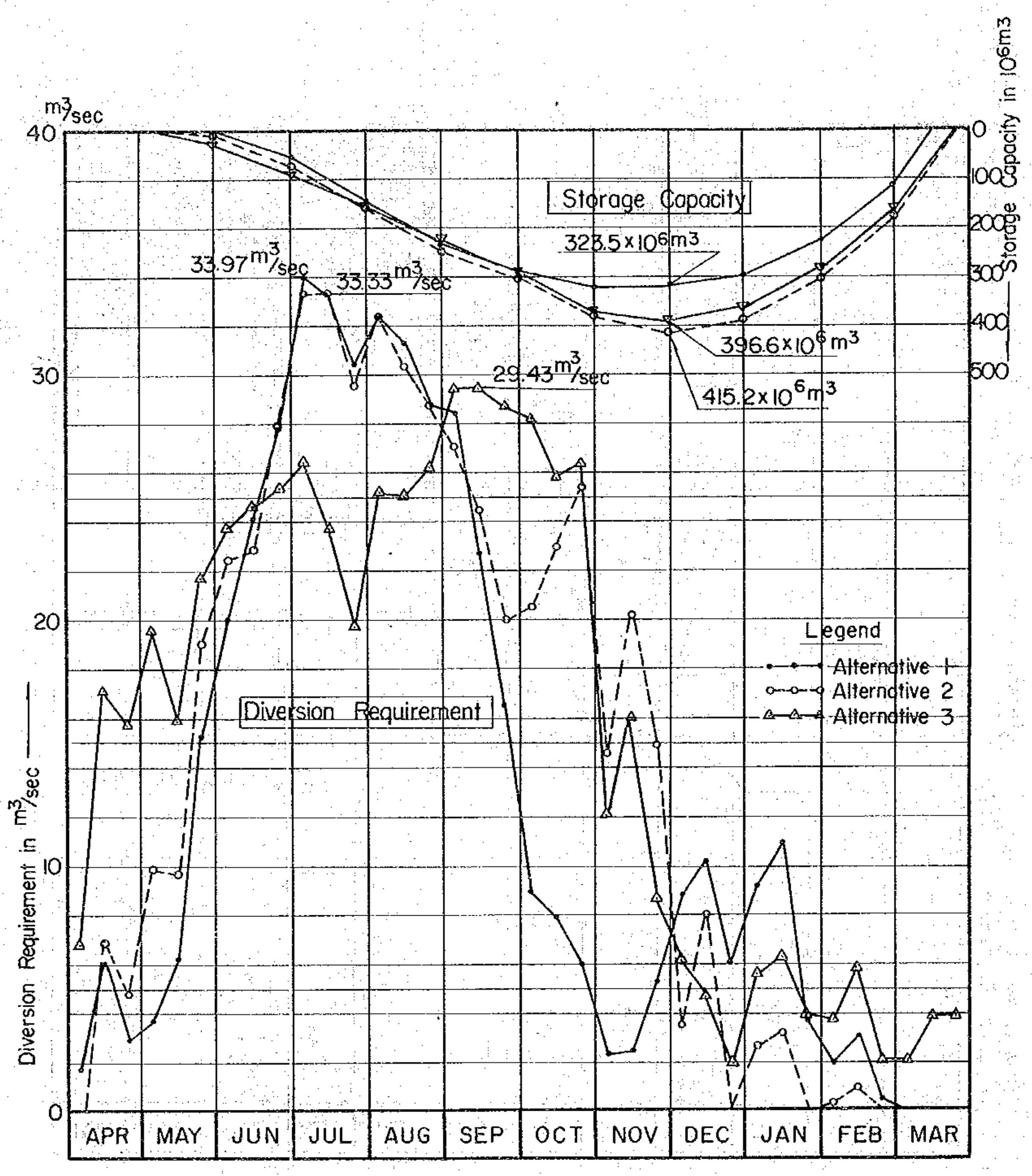


Fig. 2.2.16

Seasonal Fluctuation of Each Requirement in Karanganyar Region
(ALT-3 1967/68)

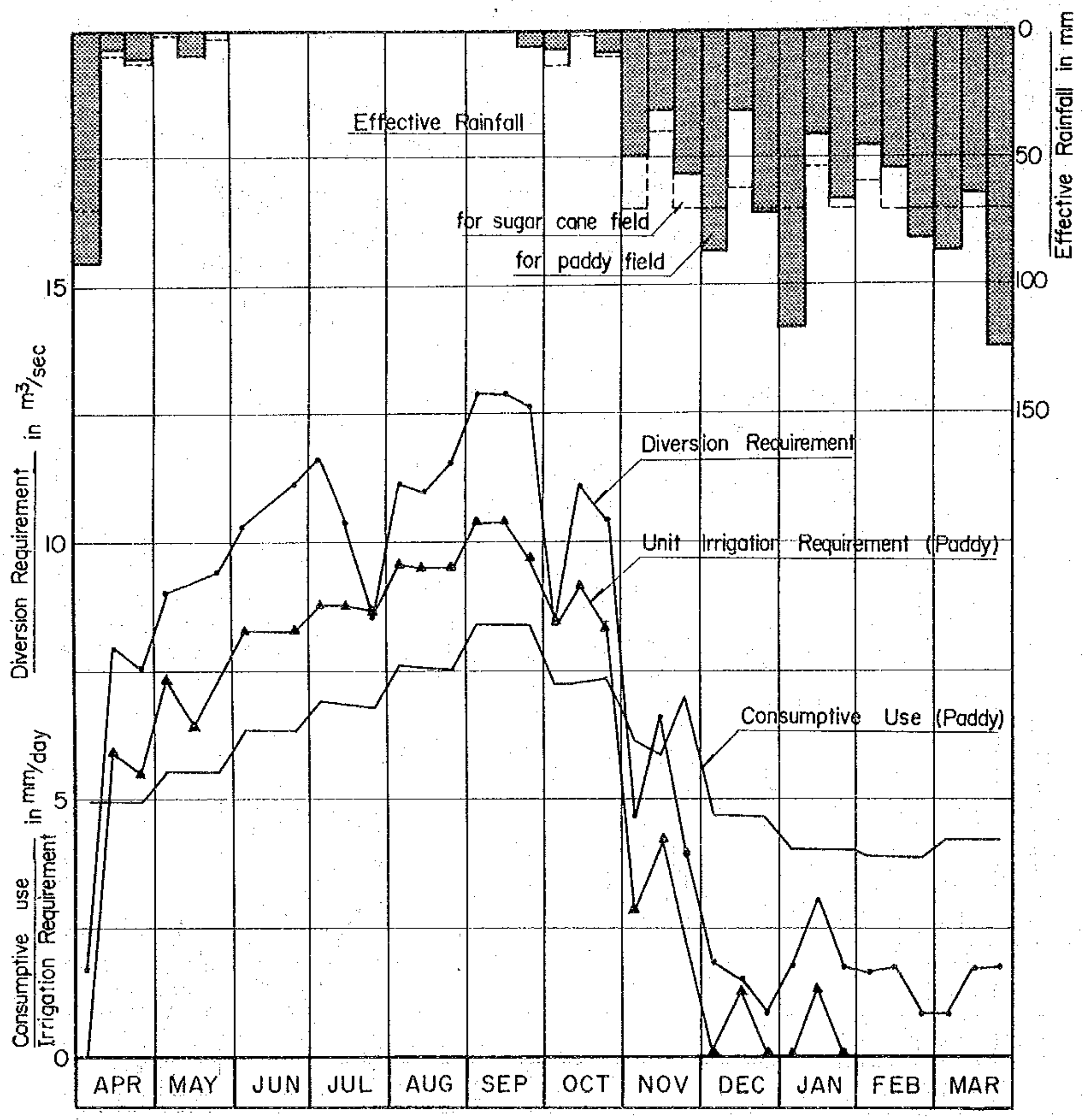


Fig. 2.2.17

Seasonal Fluctuation of Each Requirement in Sragen Region

(ALT-3, 1967/68)

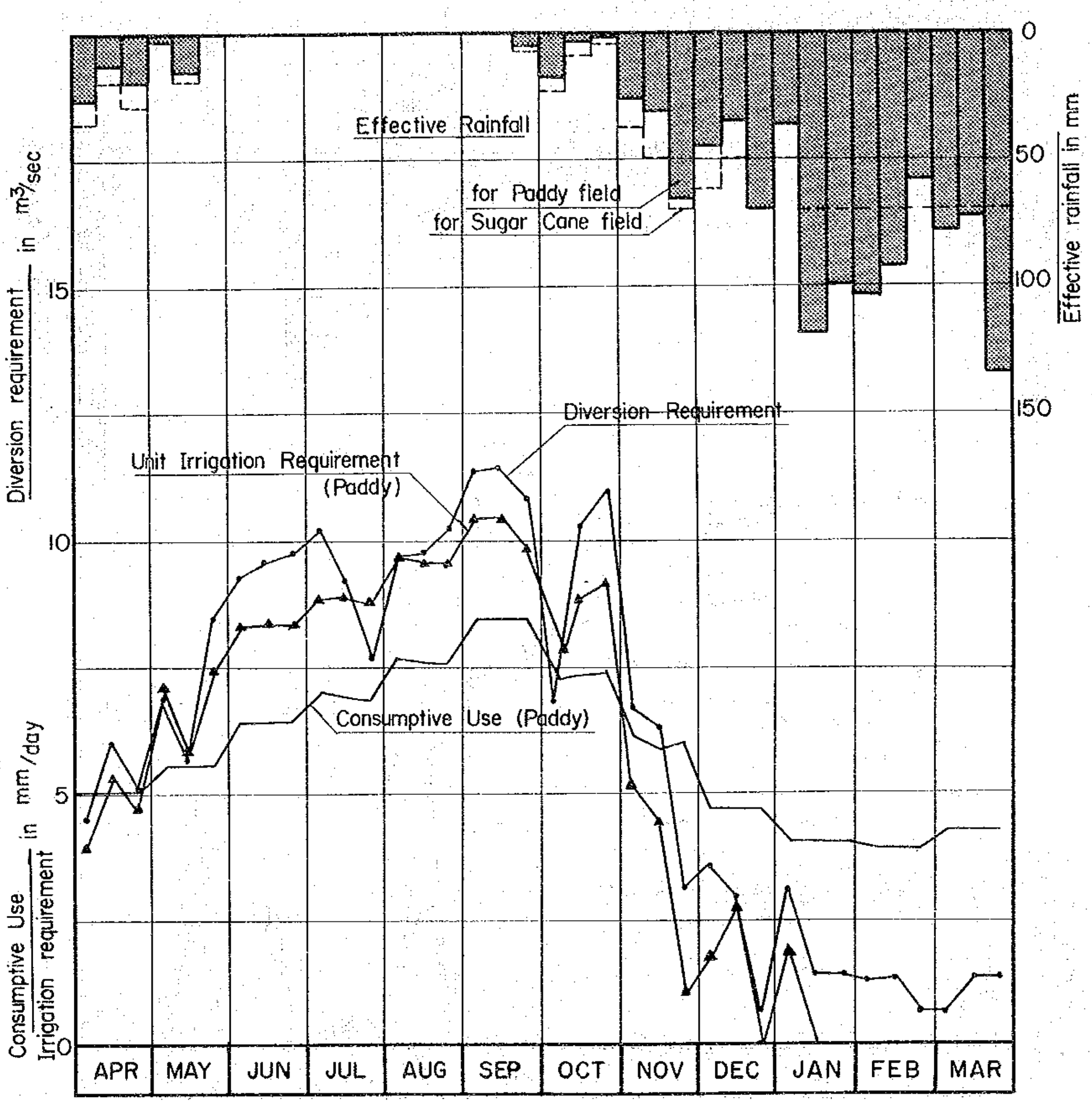
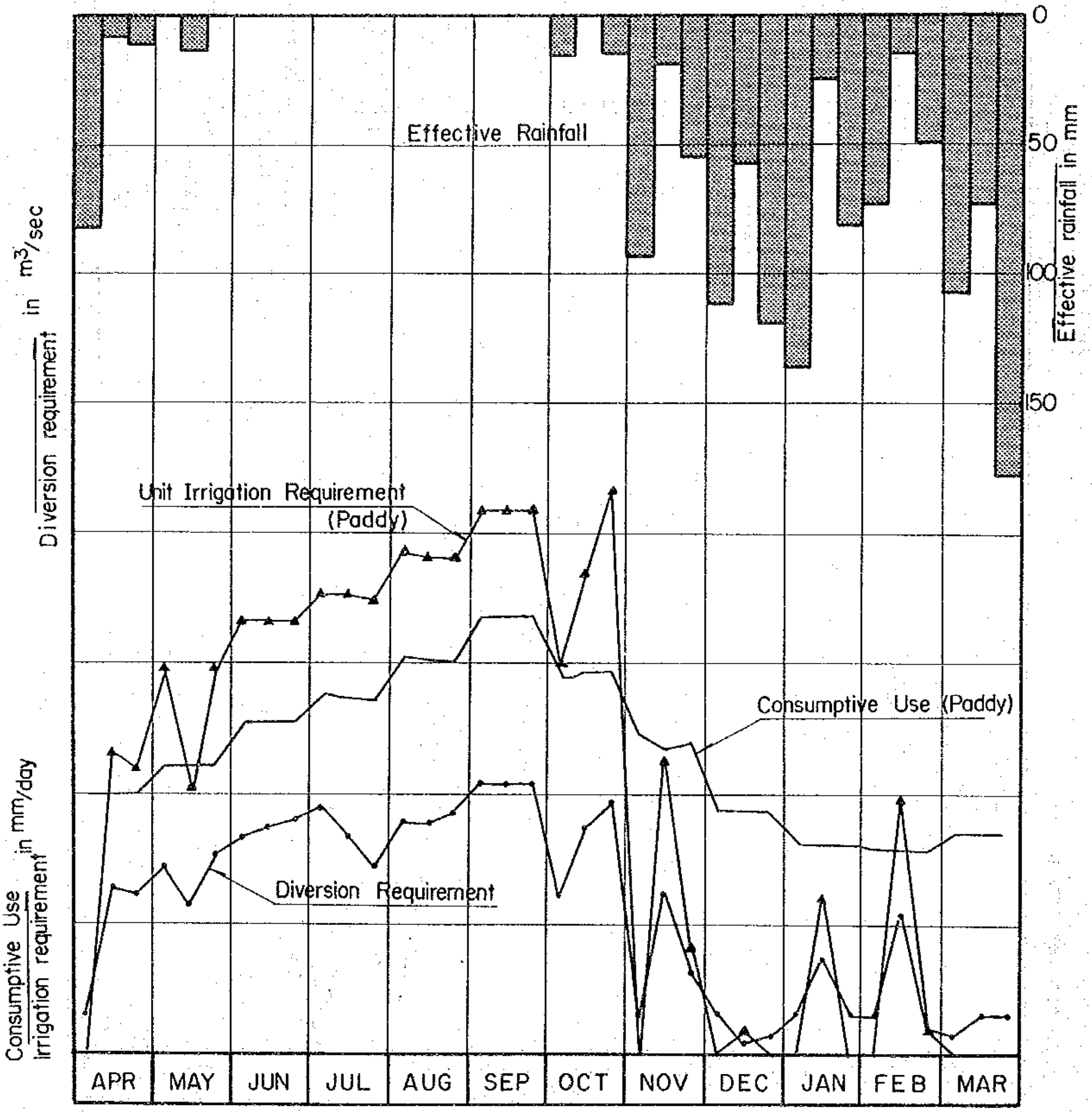


Fig. 2.2.18
Seasonal Fluctuation of Each Requirement in Dengkeng Region
(ALT-3 , 1967/68)



ALT - 4

Table 2.2.65 Irrigation Requirement & Diversion Requirement

Unit: m^3/sec

Month	Karanganyar Region: Paddy 1)	Karanganyar Region: Paddy 2)	Karanganyar Region: Polo-wijo 3)	Karanganyar Region: Sugar cane 4)	Karanganyar Region: Second paddy 5)	Karanganyar Region: Sub Total 6)	Sragen Region: Paddy 1)	Sragen Region: Paddy 2)	Sragen Region: Polo-wijo 3)	Sragen Region: Sugar cane 4)	Sragen Region: Second paddy 5)	Sragen Region: Sub Total 6)	Dengkeng Region: Paddy 7)	Dengkeng Region: Paddy 8)	Dengkeng Region: Polo-wijo 9)	Right Bank Region 10)	Left Bank Region 11)	Total Diversion Requirement 12)	Outflow Discharge 13)	Inflow Discharge 14)	Monthly Balance 15)	Balance 16)	Storage Capacity $x10^6\ m^3$ 17)
	1.135	-	-	-	-	1.135	2.872	-	-	-	-	2.872	0.482	-	-	4.007	0.482	4.489					
Apr	5.111	-	1.073	0.286	-	6.470	3.702	-	0.508	0.423	-	4.633	2.125	-	0.452	11.103	2.577	13.680	10.1	-	-	-	-
	4.860	0.042	0.866	0.251	-	6.019	3.345	0.032	0.155	0.038	-	3.570	2.048	0.018	0.348	9.589	2.414	12.033					
	5.725	0.088	1.159	0.478	-	7.450	3.767	0.068	0.863	1.172	-	5.870	2.397	0.037	0.501	13.320	2.935	16.255					
May	4.729	0.820	0.626	0.333	-	6.508	3.429	0.641	0.296	0.508	-	4.874	1.899	0.346	0.189	11.382	2.434	13.816	17.0	8.6	-8.4	-8.4	22.5
	6.030	2.036	0.537	0.419	-	9.022	4.745	1.613	0.480	1.288	-	8.126	2.542	0.855	1.256	17.148	3.653	20.801					
	6.579	2.710	0.376	0.495	-	10.160	5.178	2.146	0.196	1.435	-	9.055	2.773	1.139	0.158	19.215	4.070	23.285					
June	6.873	3.345	0.110	0.470	-	10.798	5.412	2.646	0.087	1.372	-	9.517	2.897	1.407	0.046	20.315	4.350	24.665	24.7	1.1	-23.6	-32.0	82.9
	7.109	3.947	-	0.444	-	11.500	5.597	3.121	-	1.303	-	10.021	2.995	1.660	-	21.521	4.655	26.176					
	7.446	4.856	-	0.445	-	12.747	5.863	3.838	-	1.318	-	11.019	3.138	1.808	-	23.766	4.946	28.712					
July	6.651	4.773	-	0.423	-	11.847	5.241	3.766	-	1.258	-	10.265	2.787	2.011	-	22.112	4.798	26.910	26.2	-0.4	-26.6	-58.6	157.0
	5.405	4.158	-	0.425	-	9.988	4.263	3.352	-	1.212	-	8.827	2.363	1.788	-	18.815	4.151	22.966					
	7.029	4.593	-	0.513	-	12.135	5.533	3.622	-	1.382	-	10.537	2.962	1.932	-	22.672	4.894	27.566					
Aug	6.967	4.421	-	0.530	-	11.918	5.485	3.487	-	1.430	-	10.402	2.936	1.860	-	22.320	4.796	27.116	27.2	-1.2	-28.4	-87.0	233.0
	7.309	4.035	-	0.548	-	11.892	5.755	3.152	-	1.477	-	10.384	3.080	1.697	-	22.276	4.777	27.053					
	8.203	3.928	-	0.608	-	12.739	6.460	2.656	-	1.640	-	10.756	3.456	1.652	-	23.495	5.108	28.603					
Sep	8.176	3.593	-	0.616	0.014	12.399	6.438	2.454	-	1.665	0.035	10.592	3.427	1.309	-	22.991	4.736	27.727	27.2	-1.5	-28.7	-125.7	299.9
	7.744	2.695	-	0.990	0.020	11.449	6.148	1.766	-	1.500	0.054	9.468	3.452	1.007	-	20.917	4.459	25.376					
	5.220	3.046	-	0.416	0.178	8.860	3.633	2.239	-	0.981	0.458	7.221	1.963	1.208	-	16.081	3.171	19.252					
Oct	6.799	3.259	-	0.530	0.435	11.023	5.171	2.510	-	1.266	1.203	10.150	2.866	1.370	-	21.173	4.236	25.409	23.5	-16.0	-25.1	-140.8	377.1
	6.279	3.173	-	0.460	0.546	10.458	5.304	2.629	-	1.430	1.592	10.955	3.250	1.279	-	21.413	4.529	25.942					
	2.842	1.789	-	-	0.351	4.982	3.339	1.933	-	0.375	1.242	6.889	0.482	0.466	-	11.871	0.948	12.819					
Nov	4.006	2.629	-	0.121	0.495	7.251	3.205	2.105	-	0.070	1.376	6.576	2.057	1.281	-	14.007	3.338	17.345	13.6	-1.0	-24.6	-155.4	402.9
	2.387	2.140	-	-	0.404	4.931	1.394	1.418	-	-	0.957	3.769	1.037	0.916	-	8.700	1.953	10.653					
	1.135	-	-	-	0.109	1.244	1.794	0.812	-	-	0.828	3.434	0.482	-	-	4.678	0.482	5.160					
Dec	0.879	0.901	-	-	0.183	1.963	1.410	1.185	-	-	0.821	3.416	0.124	0.217	-	5.379	0.341	5.720	4.0	19.4	15.4	-140.0	375.0
	0.557	-	-	-	-	0.557	0.435	-	-	-	-	0.435	0.225	-	-	0.992	0.225	1.217					
	1.135	-	-	-	-	1.135	1.702	0.711	-	-	0.493	2.906	0.482	-	-	4.041	0.482	4.523					
Jan	1.951	0.504	-	-	0.104	0.608	0.887	-	-	-	-	0.887	1.217	0.495	-	1.495	1.712	3.207	3.4	35.2	31.8	-108.2	289.8
	1.135	-	-	-	-	1.135	0.887	-	-	-	-	0.887	0.482	-	-	2.022	0.482	2.504					
	1.099	0.057	-	-	0.013	1.169	0.859	-	-	-	-	0.859	0.466	-	-	2.028	0.466	2.494					
Feb	1.135	-	-	-	-	1.135	0.887	-	-	-	-	0.887	1.805	0.271	-	2.022	2.076	4.098	7.8	42.0	34.2	-74.0	179.0
	0.557	-	-	-	-	0.557	0.435	-	-	-	-	0.435	0.333	-	-	0.992	0.333	1.325					
	0.557	-	-	-	-	0.557	0.435	-	-	-	-	0.435	0.225	-	-	0.992	0.225	1.217					
Mar	1.135	-	-	-	-	1.135	0.887	-	-	-	-	0.887	0.482	-	-	2.022	0.482	2.504	2.1	85.2	83.1	9.1	-
	1.135	-	-	-	-	1.135	0.887	-	-	-	-	0.887	0.482	-	-	2.022	0.482	2.504					

Note:
1) ALT - 3 Paddy x $\frac{2}{3}$
2) ALT - 2 Paddy x $\frac{1}{3}$
3) ALT - 2 Polowijo x $\frac{1}{3}$
4) Sugar cane
5) Second Paddy
6) = 1) + 2) + 3) + 4) + 5)
7) ALT - 3 Paddy x $\frac{2}{3}$
8) ALT - 2 Paddy x $\frac{1}{3}$
9) ALT - 2 Polowijo x $\frac{1}{3}$
10) $^{k}6) + ^{s}6)$
11) 7) + 8) + 9)
12) = 10) + 11)
13) Mean monthly diversion requirement
14) Same as other alternatives
15) = 14) - 13)
16) Accumulation of (15)
17) 16) x 86,400 x 30 or 31 days

Fig. 2.2.19

Diversion Requirement and Storage Capacity by Alternative 4

(In Design year 1967/68)

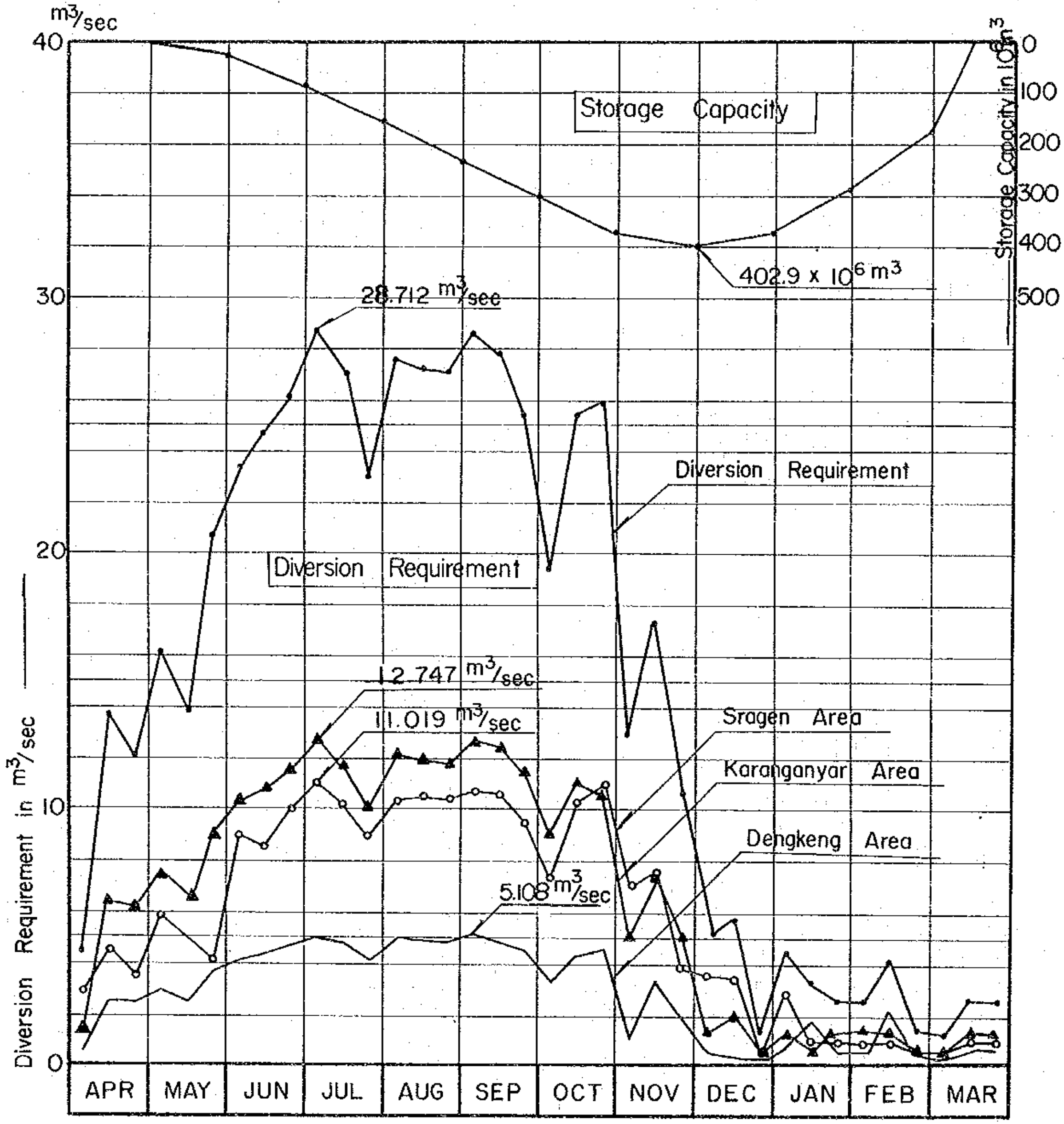
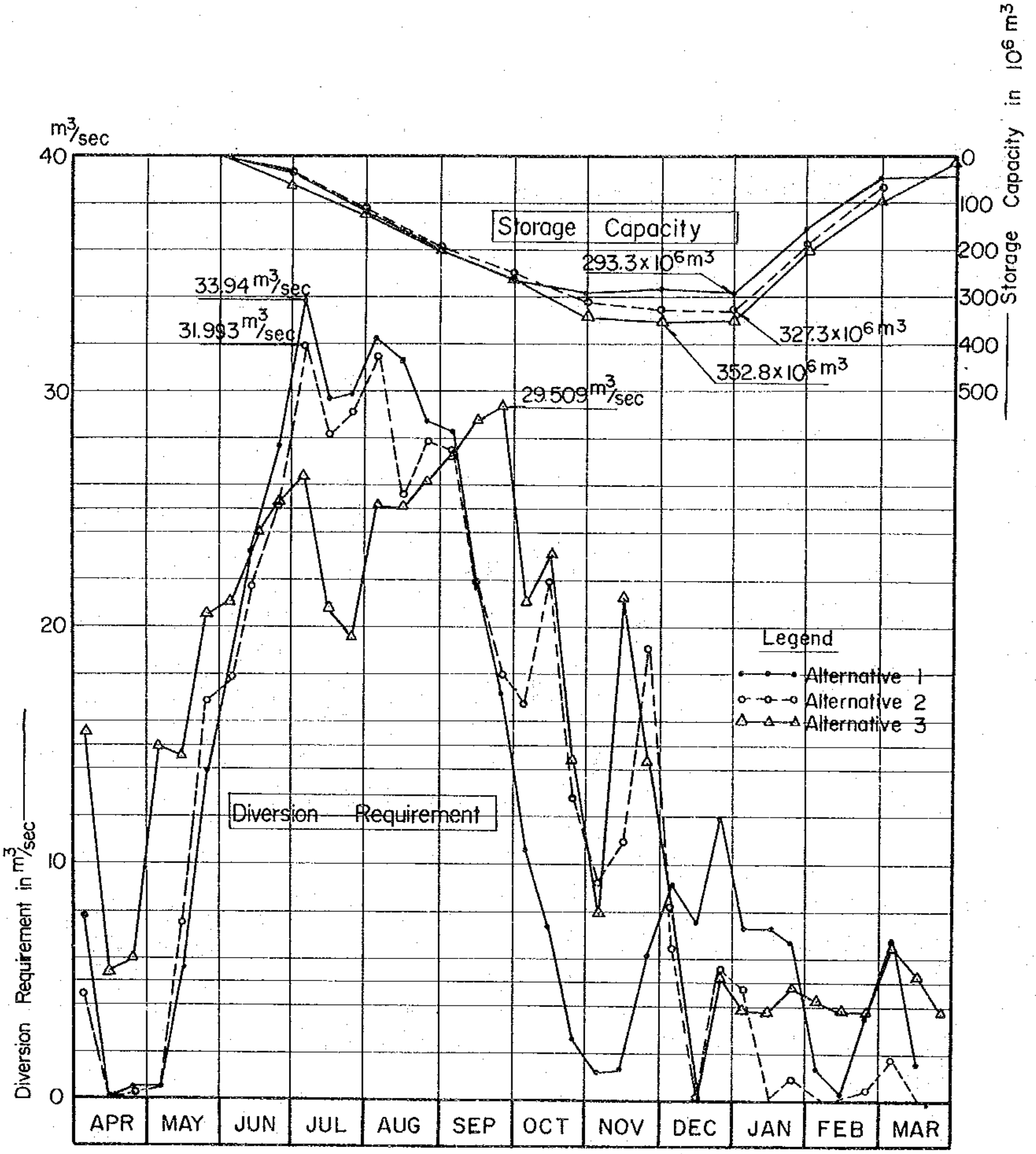


Table 2.2.66 Diversion Requirement by Each ALT (1961/1962)

unit: m^3/sec

Month	Ten-day Period	ALT - 1 Right bank region	ALT - 1 Left bank region	ALT - 1 Total	ALT - 2 Right bank region	ALT - 2 Left bank region	ALT - 2 Total	ALT - 3 Right bank region	ALT - 3 Left bank region	ALT - 3 Total
	1	6.528	1.326	7.854	3.708	0.758	4.466	12.733	2.839	15.572
A	2	0.254	-	0.254	-	-	-	4.709	0.700	5.409
	3	0.448	0.045	0.493	0.197	0.069	0.266	5.276	0.722	5.998
	1	0.360	0.068	0.428	0.311	0.151	0.462	14.486	0.455	14.941
M	2	4.525	1.018	5.543	6.687	0.714	7.401	11.928	2.653	14.581
	3	11.421	2.566	13.987	15.196	1.684	16.880	16.640	3.813	20.453
	1	14.653	3.418	18.071	15.564	2.266	17.830	16.849	4.159	21.008
J	2	19.426	4.220	23.646	18.994	2.737	21.731	19.678	4.345	24.023
	3	22.729	4.942	27.671	22.056	3.143	25.199	20.738	4.493	25.231
	1	27.814	6.126	33.940	27.703	4.290	31.993	21.686	4.707	26.393
J	2	25.300	4.347	29.647	24.633	3.475	28.108	17.936	2.825	20.761
	3	24.442	5.363	29.805	23.672	5.363	29.035	16.145	3.410	19.555
	1	26.539	5.796	32.335	25.720	5.796	31.516	20.738	4.444	25.182
A	2	25.683	5.579	31.262	20.048	5.579	25.627	20.637	4.404	25.041
	3	23.615	5.092	28.707	22.785	5.092	27.877	21.560	4.620	26.180
	1	23.370	4.967	28.337	22.436	5.147	27.583	22.042	5.184	27.226
S	2	18.103	3.859	21.962	17.647	4.072	21.719	23.615	5.168	28.783
	3	14.313	2.811	17.124	14.821	3.157	17.978	24.330	5.179	29.509
	1	8.904	1.603	10.507	14.269	2.389	16.658	17.333	3.604	20.973
O	2	6.441	0.853	7.294	19.440	2.480	21.920	18.761	4.299	23.060
	3	2.516	-	2.516	11.704	1.150	12.854	11.950	2.378	14.328
	1	1.129	0.050	1.179	7.751	1.399	9.150	5.524	2.299	7.823
N	2	1.307	0.057	1.364	9.683	1.212	10.895	19.682	1.517	21.199
	3	5.336	0.746	6.082	17.132	1.909	19.041	12.271	2.025	14.296
	1	7.806	1.422	9.228	6.281	-	6.281	7.293	0.722	8.015
D	2	6.070	1.422	7.492	-	-	-	0.096	0.023	0.119
	3	8.475	3.525	12.000	3.883	1.571	5.454	4.360	0.782	5.142
	1	5.879	1.377	7.256	4.469	-	4.469	3.034	0.722	3.756
J	2	5.879	1.377	7.256	-	-	-	3.034	0.722	3.756
	3	4.730	1.903	6.633	0.838	0.045	0.883	3.980	0.722	4.702
	1	1.219	-	1.219	-	-	-	3.395	0.700	4.095
F	2	-	0.108	0.108	-	-	-	3.034	0.722	3.756
	3	3.291	-	3.291	0.415	-	0.415	3.328	0.339	3.667
	1	6.228	0.596	6.824	1.774	-	1.774	3.726	2.631	6.357
M	2	1.211	0.199	1.410	-	-	-	4.206	0.975	5.181
	3	-	-	-	-	-	-	3.034	0.722	3.756
Total diversion requirement		386.208.000			399.945.600			466.560.000		
Storage diversion requirement		284.6×10^6 m^3			327.1×10^6 m^3			352.8×10^6 m^3		

Fig. 2.2.20
Diversion Requirement and Storage Capacity by Each Alternative
1961 / 1962



2.3 CONSIDERATION ON APPLICATION OF TEGAL CURVE

As the English version of the "Calculation and Construction of the Channels" translated from the original Indonesian text now being used at Gadjah Mada University was not very clear the following information was obtained from the counter part officers.

Cross-section of the channel irrigating less than 200 ha (originally it was 200 bau/1 ha = 0.7 bau, accordingly Pemali curve has been fixed at 142 ha setting the ratio at 1.0) will be determined by inflating the water requirement due to the following reasons:

(a) As the rotation within the command area of the tertiary or quaternary channels is not systematically done and, moreover, as puddling and flooding of Sawah takes place on a same day, surplus water is required beyond the values based on simple calculation;

(b) Surplus water must be supplied to prevent pests and diseases during a specific period of time;

(c) Side by side with the ripening paddy, nursery beds are maintained, puddling and transplanting is done for the second crop in the same command area simultaneously; therefore, surplus water is required to serve such overlapping water requirements.

On the other hand, the cross-section of those channels supplying irrigation water to the paddy field larger than 200 ha (142 ha by Pemali curve) may be diminished for the following reasons:

(a) Due to the sprawling phenomenon being witnessed among the village settlements within years after the completion of the project, that means, diminishing of the cropping area;

(b) Due to the repeated use of the irrigation water inside a wider command area;

(c) The command areas nearer to the intake are naturally more favorablly irrigated than the lower ones and, to assure equitable irrigation, the channels leading to such command areas need their cross-sections to be diminished;

(d) The wider the command area is there will be more cases of mixed cropping with non-paddy crops whose water requirements are less. More land will be left uncultivated within the area, and the acreage for sugar-cane requiring no irrigation during rainy season will increase.

The above-mentioned points seem to comprise the background of the Tegal curve which assumes 200 ha as the dividing point for either augmented or diminished canal cross-sections. The Tegal curve has, thus, been endorsed by the conventional and yet rough unit water requirement calculation.

This Project is not intended for the introduction of the rotation system called "Gorongan system" because it is endowed with plentiful of water resources and, moreover, the effective rainfall, the irrigable areas and other data are carefully computed for irrigation practices. Under such circumstances, the adoption of the Tegal Curve may bring forth undesirable results. From the above-mentioned points-of-view, it has been decided not to use the Tegal Curve for the Project area.

2.4 MAIN IRRIGATION SYSTEM

2.4.1 Colo Diversion Weir

a) Location

It was once tentatively decided to adopt the Copure method for the construction of the weir. The site usually should be selected from the geological consideration for the stability as well as for the economy of the construction of the weir. When the after-bay function of the Colo weir, the sedimentation from its remaining catchment area upon completion of the Wonogiri dam, and the necessary regulating capacity of about 1.2 million m^3 are taken into consideration, it would be advisable to shift the site of the weir toward further downstream from the location proposed in the "Wonogiri Dam Feasibility Study." The site cannot be shifted too much toward the downstream because it will require a high weir to be constructed at a high construction cost. Thus, the site immediate downstream of the proposed location is considered most favorable.

From the above consideration, specific field surveys have been undertaken in each aspect of geology, topography, and hydraulics, at four alternative sites, including the site proposed in the "Wonogiri Dam Feasibility Study." The comparative study on the construction cost among these four alternatives includes the disbursement required for compensation and land acquisition (see Fig. 2.4.1). Consequently, the Alternative B, C and D have been found to be economically more favorable than Alternative A (see Table 2.4.1).

As far as the bedrock conditions are concerned (even though none of them seems to have the soundness and hardness required for an ideal foundation), the Alternative D apparently has the highest technical soundness as endorsed in the Section dealing with Geology.

Furthermore, Alternative D appears to be more desirable from the view point of river improvement, since the large winding portion of the river channel will be cut short under Alternative D. Consequently, Alternative D has been newly proposed as the location of the Colo Weir.

b) Layout

According to a sedimentation study at the Colo Weir watershed (200 km^2 in size), 100-year sedimentation at the Colo reservoir would amount to 6.4 million m^3. While, a sedimentary capacity allowable from river bed upto intake water level was estimated at about 8 million cubic meter, on the basis of the storage curve at the Colo Reservoir (see Fig. 2.4.2). The Colo Reservoir, therefore, has an adequate storage capacity for the total amount of sediments from its catchment-area for a period of 100 years, thus functioning effectively as an after-bay of power station, without reducing the desired re-regulating capacity for a period of the project life. From these points of view, it would not be necessary for the Colo Weir to be equipped with large-scale gates, on its full width, for sand flashing purpose.

In the Wonogiri Dam Feasibility Study of 1975, the two-intake system was given the priority. With this system, irrigation water would be diverted into the two main canals separately by two intakes installed on both sides of the weir. However, from hydraulic and river engineering view points, the two-intake system to be constructed along such a winding river as the Sala river is not supposed to maintain its function evenly and effectively through the year. In fact, there have been so many cases with the two-intake system where the intake on one side has been blocked by sandbar in a few years after construction because of concentrated sedimentation at that very intake. The one-intake system seems to be more feasible than the two-intake system from the viewpoint of operation and maintenance and, it is obviously more economical in terms of the total volume of iron works and concrete works.

In consideration of the above-mentioned facts and reasons, the one-intake system with one sluice for sand flashing purpose is recommended to be built on the right side of the Colo Weir. As for the influx of sediments into canals, particular technical attention has been paid in deciding the slope of sill and sill elevation of sand flash, and the velocity and sill elevation of intakes. Besides, a major part of sediments, such as bed load run-off from the catchment at Colo site can be securely trapped and silted at the Wonogiri Reservoir and the Colo Weir and only a suspended load may rush at the intake and smoothly conveyed down to paddy field by the canal flow, provided that the permissible velocity will be so designed along the canal. Consequently, no particular consideration has been given to the construction of a silting pond in the canal system of the project.

c) Investigation of Regulating Capacity

The regulating capacity required for the Colo Weir is examined below.

- Diversion requirement for irrigation purpose plus minimum release = q cms;
- Maximum discharge from the Wonogiri Reservoir for hydro-power generation = Q_{max} = 60 cms.

In the case of $q < 15$ cms, Q_{max} will be for 6 hours' operation by the power house or less, as irrigation will be given priority, or Q' $(q' < Q)$ = 6-hour operation. Therefore, this case may be disregarded in examination of the required regulating capacity. Next, in the case of $q \geq 15$ cms, there will be considered two alternative ways of operating the power station:

(Case i) Continuous operation for longer than 6 hours at Q = 60 cms. In this case, the operating hours will be:

$H = \frac{q \times 24}{6}$ hr, and the regulating capacity will be

$V = q(24-H) \times 3,600$

(Case ii) 6-hour operation at Q = 60 cms and 18-hour operation at Q'. In this case, the regulating capacity will be:

$V = (60 - q) \times 6 \times 3,600.$

In Case (i), the larger q is the larger becomes the required regulating capacity and, therefore, case (ii) is adopted. Accordingly, the required regulating capacity is (q = 15 cms) and $V = (60 - 15) \times 6 \times 3,600 = 972,000\ m^3$. Under the Project, the required regulating capacity of the Colo Weir is 1,200,000 m^3, with some allowance on the calculated value.

d) Investigation on Sedimentation

- Annual supply of sand from the catchment-area of the Wonogiri Dam is 1,170 $m^3/km^2/yr.$, and that from the remaining catchment-area is estimated at 800 $m^3/km^2/yr.$, judging from the differences in gradient and vegetation;

- Catchment Areas: Wonogiri Dam = 1,350 km^2
  Remaining = 198 "

- Annual inflow of sands:
  Wonogiri Dam catchment-area = 924,000,000 m^3
  Remaining catchment-area $= \frac{924,000,000\ m^3}{1,350} \times 198\ km^2$
  = 135,520,000

$$924,000,000 \text{ m}^3 + 135,520,000 \text{ m}^3 = 1,059,520,000 \text{ m}^3/\text{yr}.$$

. The relationship between sand and sedimentation:

According to Brune Chart (Fig. 2.4.3), the ratio between storage capacity and annual inflow of sand will be:

$$\frac{7,700,000}{1,059,520,000} = 0.007$$

Therefore, the sedimentation ratio will be 40 %.

. Sedimentation in the Colo Weir (100 years' life):

$$800 \text{ m}^3/\text{km}^2/\text{yr} \times 198 \text{ km}^2 \times 100 \text{ yrs} = 15,840,000 \text{ m}^3$$

$$15,840,000 \text{ m}^3 \times 0.4 = 6,336,000 \text{ m}^3 < 7,700,000 \text{ m}^3$$

Accordingly, sedimentation will never exceed the storage capacity of the Weir and it will continue to function as an after-bay for the power station.

e) Colo Weir Crest Height

The benefit from the heightening of the dam is generally believed to more than compensate the cost-increase because a wider irrigable area is made possible through it. As the total water resource is prefixed under the Project, the crest-height has no immediate influence on the irrigable area but its heightening will make it possible to raise the level of the water canal and thereby cut short the lengthy earthen canal (main canal) at its tail-end. Two crest elevations of 108 m S.H.V.P. (Plan A) and 109 m S.H.V.P. (Plan B) have been compared to see the difference in the irrigable area. 1/20,000 topo-map has been traced and it was discovered that approx. 870 ha will be additionally irrigable by raising the crest-height by 1 meter (1,670 ha if 2 meter). The houses and lands to be submerged by the constructing of the Colo Weir may be compared as follows:

		Plan A	Plan B
Houses	(nos)	53	86
Yard	(ha)	20	26
Sawah	(")	9	12
Tegal	(")	14	29

870 ha additional irrigable area helps shortening the main canal by 1.2 km. Cost comparison between crest heightening by 1 meter and main canal shortening by 1.2 km is made as follows:

Construction Cost:	Crest-heightening	450,000 US$
	Main canal shortening	240,000 US$
	Balance:	210,000 US$

Fig. 2.4.1 Location Map of Colo Weir

S = 1 : 10000

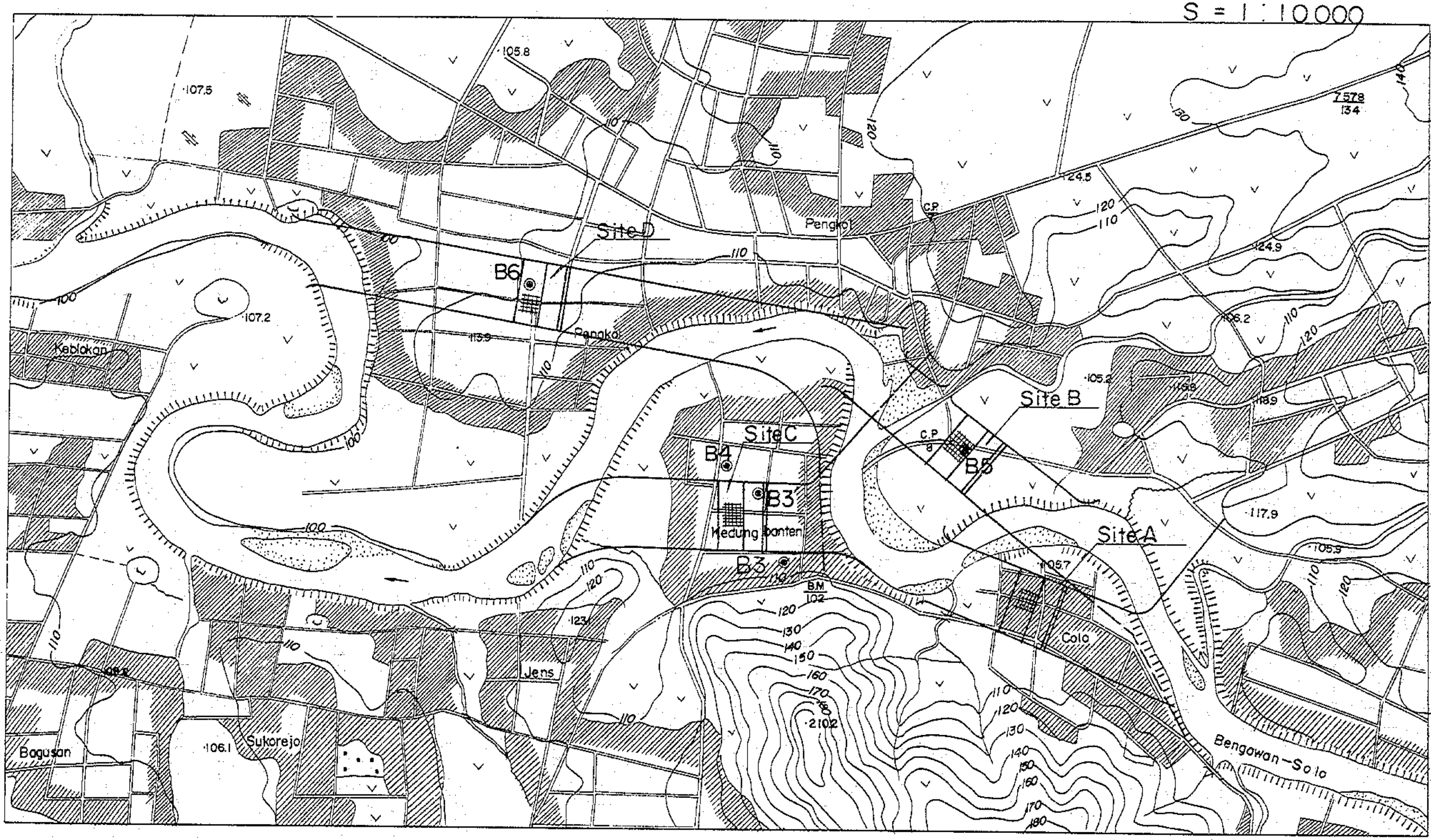


Table 2.4.1 Comparison of Construction Cost of Colo Weir by Each Alternative

Item	Unit Price	Plan A Quant	A Cost	B Quant	B Cost	C Quant	C Cost	D Quant	D Cost
1. Construction									
Cost	US $								
Excavation	1.6/m^3	280,000	448,000	180,000	288,000	170,000	272,000	110,000	176,000
"	2.1/m^3	-	-	-	-	170,000	357,000	290,000	609,000
Revetment	100/m^3	1,250	125,000	1,350	135,000	1,500	150,000	2,400	240,000
Foundation									
Steel sheet pile	400/t	340	136,000	220	88,000	-	-	-	-
H pile	350/t	1,500	525,000	1,000	350,000	-	-	-	-
Concrete	42/m^3	-	-	-	-	5,000	210,000	-	-
Temporary work									
Roads	8/m	6,500	52,000	8,000	64,000	5,000	40,000	6,000	48,000
Cofferdam	60/m^3	650	39,000	650	39,000	1,000	60,000	1,100	66,000
Main Canal	200/m	0	0	-300	-60,000	-600	-120,000	-1,100	-220,000
Related structures									
Siphon		1	150,000	1	150,000	-	-	-	-
Culvert	460/m	400	184,000	-	-	-	-	-	-
Sub total			1,659,000		1,054,000		969,000		919,000
2. Compensation									
Houses	1300/mo	27	35,100	21	27,300	31	40,300	61	79,300
3. Land Aquisition									
Sawah yerd	3,600/ha	13.1	47,160	13.6	48,960	14.1	50,760	14.1	50,760
Tegal	1,000/ha	7.9	7,900	12.0	12,000	19.0	19,000	20.0	20,000
- Reclaimed land	2,000/ha	-2.8	-5,600	-3.5	-7,000	-5.6	-11,200	-14.0	-28,000
Sub total			49,460		53,960		58,560		42,760
Total			1,743,560		1,135,260		1,067,860		1,041,060

Fig. 2.4.2 Storage Capacity Curve at Colo

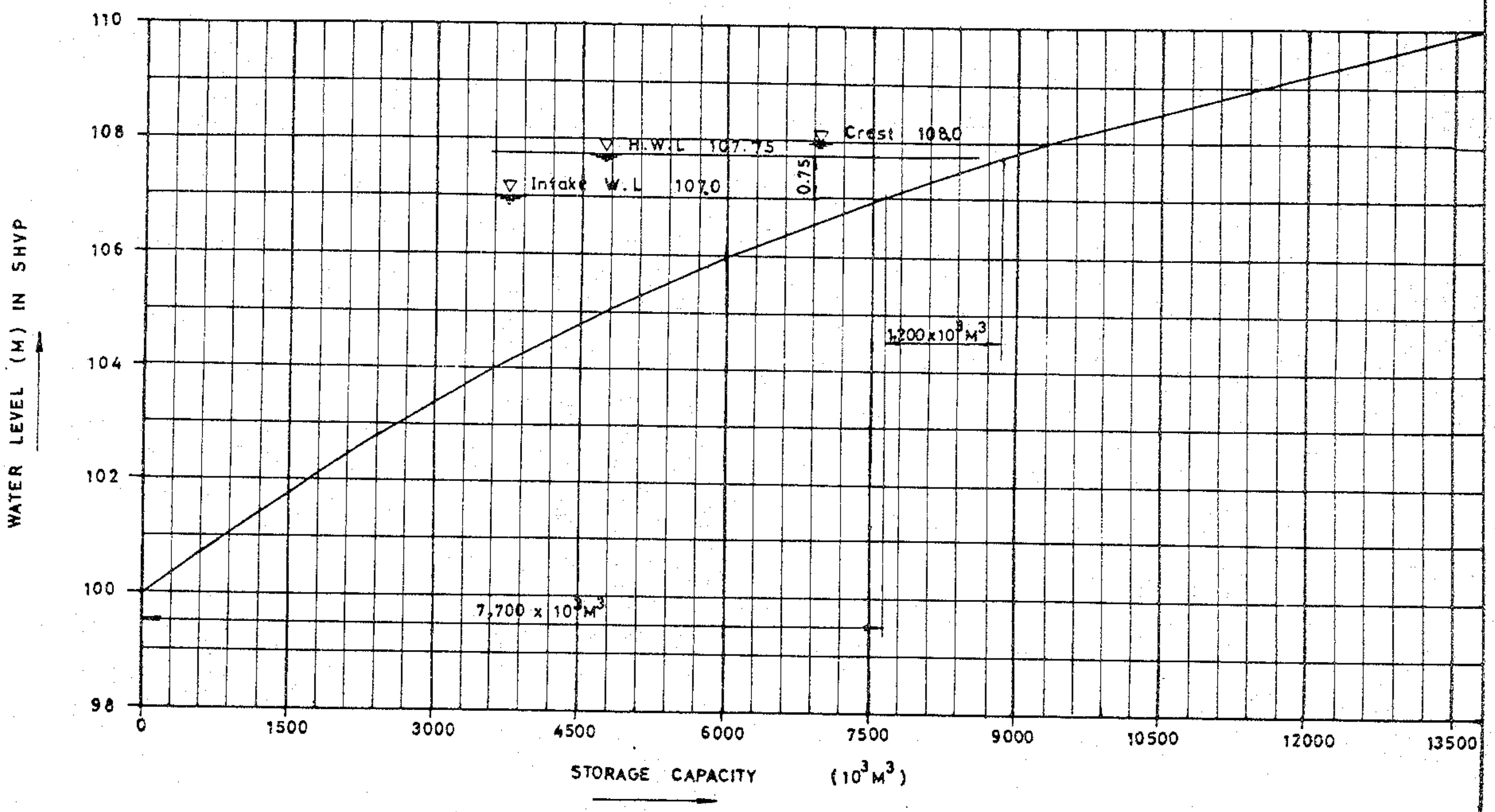
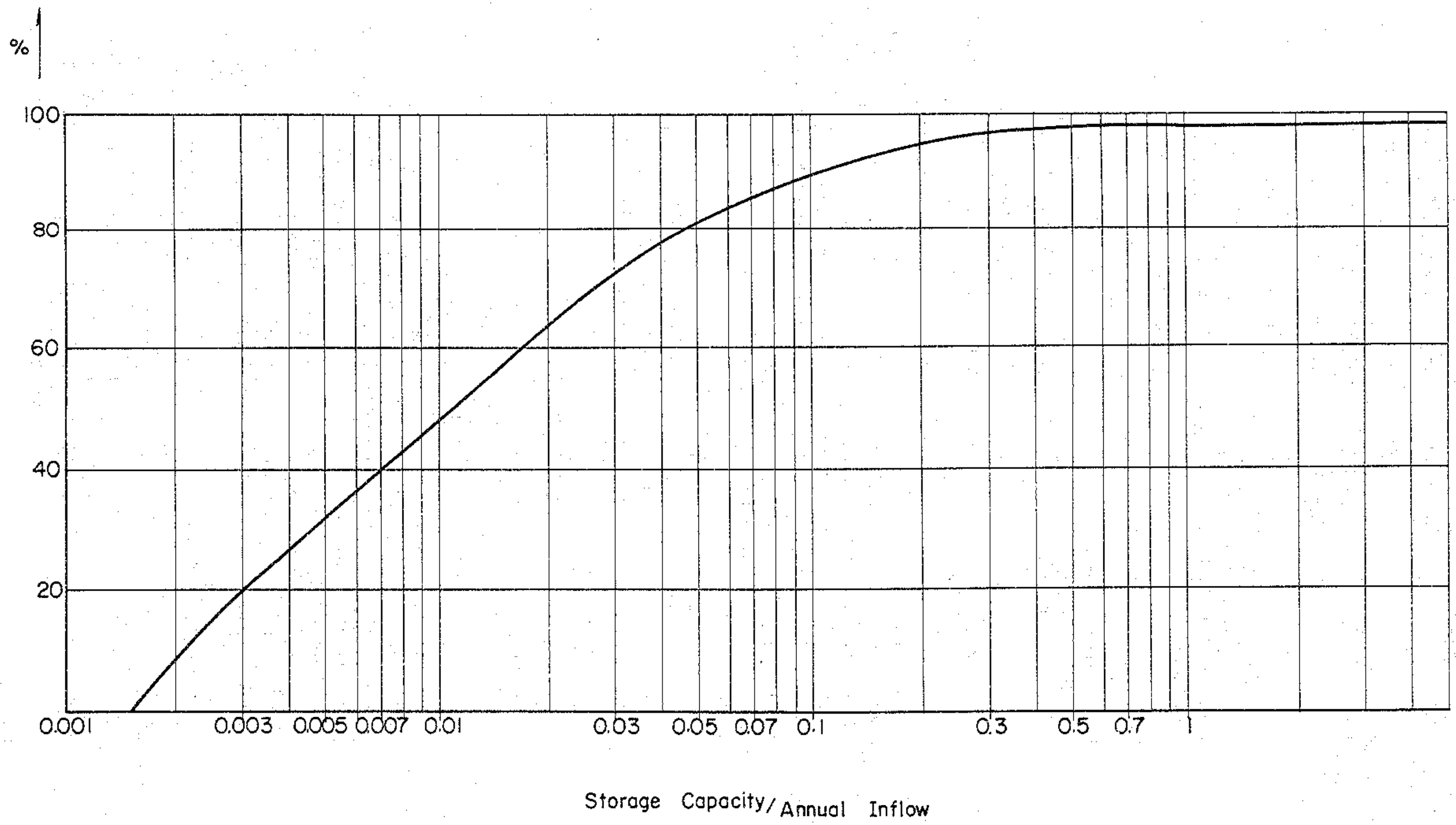


Fig. 2.4.3 Relation between Percentage of Sand Running into Reservoir and Ratio of Annual inflow to Storage Capacity



Land Acquisition & Compensation Cost (by expanding irrigable area):

Houses	33 nos	x 1,000	=	33,000	
Yard	6 ha	x 2,700	=	16,200	
Sawah	3 ha	x 2,100	=	6,100	
Tegal	15 ha	x 1,000	=	15,000	
		Sub-Total:		70,300	say 70,000 US$

Heightening of the Colo Weir crest by 1 meter means an additional cost of US$280,000. Accordingly, the crest shall remain at the designed height of 108 m S.H.V.P.

2.4.2 Main Canals

a) Comparative Studies on the Main Canals

The Wonogiri Dam Feasibility Study of 1975 gives the result of the comparative study made for the four alternative canal systems for supplying irrigation water required in the project area, in order to identify the most optimal system from the viewpoints of economic justification, operation and maintenance. The long canal system by gravity as proposed in the Master Plan Report on Upper Sala River Development was eventually recommended as the best. With additional technological information and newly prepared topographical map on hand, the detailed review of the results of such comparative studies given in the Wonogiri Dam Feasibility Study Report of 1975 was made. The conclusion arrived at was that the long canal system is basically the best.

The remaining question, then, is how to deal with the difficulties in operation and maintenance which always accompany to a long canal system. The operation and maintenance difficulties would be solved by introducing a pumping system by which the long canal could in fact be made substantially shorter. The alternative studies made in this connection with the two main canals will be detailed in the below.

Upper Sala Main Canal

Alternative D in the Wonogiri Dam Feasibility Study Report of 1975 proposes to divide the irrigable area into some blocks and irrigate them by an upper-reach canal and a lower-reach canal, on the assumption that a pumping unit is indispensable in view of making a long canal drastically shorter. This Alternative D, when compared with a long canal system on newly prepared topo-map, has been found to be economically quite unfeasible. Even though the operation and maintenance difficulties may not be completely solved from the engineering point-of-view alone, the long canal system is proposed as the only alternative primarily from the economic point-of-view.

Dengkeng Main Canal

In working out an irrigation plan for the left bank area which is to be fed by the Dengkeng Main Canal, the following alternatives have been examined:

Alternative A: To supply water to an elevated area of 790 ha in Selogiri district north of Wonogiri, extending along the main road to Dengkeng from the vicinity of Colo, with a pumping system, but abandon 1,070 ha on the left side of K. Dengkeng.

Alternative B: To convey water by a gravity canal until Klaten area, bringing the inundated area of approximately 300 ha into its beneficiary area. This is the same plan as proposed in the Wonogiri Dam Feasibility Study of 1975.

The comparison between Alternative A and Alternative B is presented in Tables 2.4.2 to 2.4.4. As will be seen from these Tables, Alternative A may help shortening the proposed Dengkeng Main Canal but, as argued in the basic study, this alternative has been found economically unjustifiable same as in the case of the Upper Sala Main Canal. Therefore, Alternative B has been selected as the proposed plan.

b) Layout of the Main Canals

As has been previously described in the "Irrigation Canal System," two main canals have been aligned to cover the entire project area: the Upper Sala Main Canal which commands the area on the right bank of the Sala river and the Dengkeng Main Canal which commands the left bank of the River. On-map-allocation of these two Main Canals on 1/5,000 scale on the assumption that there shall be no change to the dam-height of the Colo Weir has eventually resulted at shifting of the Upper Sala Main Canal route by about 500 m (on an average) towards the mountain side of the Gunung Lawu in comparison with the route suggested in 1975. Thus, its crossing with the railway has become necessary at one point only. As for the Dengkeng Main Canal, it is tracing almost the same route as proposed in 1975 in its upper-reach, but it has been shifted to higher elevation by about one kilometer in view of enlarging its command area, in the lower-reach. On-map-location of both main canals has been duly confirmed by field-check.

In the course of a grass-root reconnaissance along the canal trace, the newly prepared map was found not conforming to the real topography nor elevation (for details, see the section dealing with topographic survey) and, accordingly, leveling survey with a pitch of 250 m has to be undertaken along the entire length of the main canals. Needless to say, alignment of these canals has been made with a good care to satisfy the basic requirements from the canal designing point-of-view, that is, an assurance of safety at the minimum cost for its construction and maintenance.

Some of the guidelines adopted for the canal alignment may be given below:

- To align the canals as straight as possible to make their total length the minimum;
- To layout the canal routes so that they may not pass through yard nor intersect the trunk transportation-lines as far as possible;
- To make excavation and embankment balanced; and
- To arrange a route so as to maintain water surface in the canal the highest possible to ensure efficient diversion of irrigation water into the secondary canals.

Their entire alignment and profile are as illustrated in the attached Drawing.

The Main Canals, the Upper Sala Main Canal in particular, run through many tributaries of the Sala river and cross a fair number of irrigation canals already existing there, thus necessitating construction of crossing structures such as sihpons, aqueducts, and culverts at their points of intersection with the existing irrigation canals and tributaries. In addition, at such places where intensive flooding discharge is anticipated with a high frequency, installation of inverted siphon under the river bed has been proposed from the river maintenance point-of-view. The existing irrigation canals which will function as the secondary canals in our project area will generally run under the proposed main canal through culverts.

Apart from the crossing structures such as inverted siphons, aqueducts and culverts, the undermentioned facilities are required along the entire length of the main canal:

For distribution --- Turnouts and water measurement devices;
For protection ----- Spillways and drains, and
For maintenance ---- Roads and bridges.

The proposed irrigation system is shown in Fig. 2.4.4 and Drawing 002.

Table 2.4.2 Comparison of Benefit by Each Alternative Plan of Dengken Canal System

Benefit increased with project (Alternative A)

Season	Irrigable area	Without project		With project	
		unit	Amount	unit	Amount
	ha	US $/ha	US$		
Rainy	790	335	264,650	505	398,950
Dry	550	50	27,500	505	277,750
	240	335	80,400	505	121,200
Annual			372,550		797,900

Annual benefit increased with project US$ 425,350 = 538 U.S.$/ha

Benefit increased with project (Alternative B)

Season	Irrigable area	Without project		With project	
		unit	Amount	unit	Amount
Rainy	770	335	257,950	505	388,850
Dry	770	335	257,950	505	388,850
Inundated area	300	230	69,000	400	120,000
				505	151,500
Annual			584,900		1,049,200

Annual benefit increased with project US$ 464,300 = 434 U.S.$/ha

Table 2.4.3 Comparison of Cost by Each Alternative Plan of Dangken Canal System

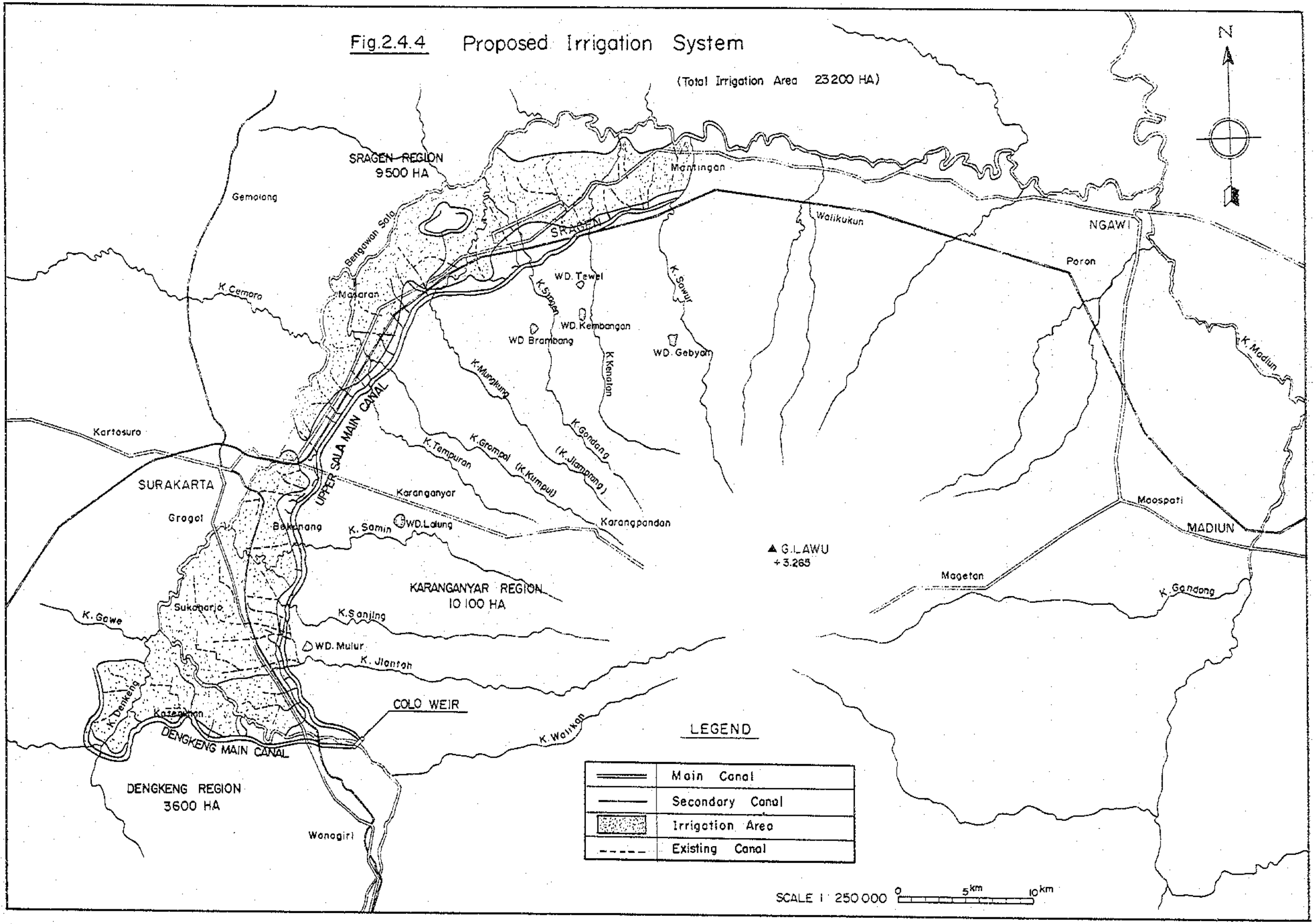
Alternative A		Alternative B	
Item	Cost	Item	Cost
	US $		US $
Pumping station	167.000	Irrigation canal (100 US$/m x 7,500m)	750,000
Pumping Unit & apparatuses (1 set)	550,000	Main Canal extended (120 US$/m x 0.2 x 18,000)	432,000
Canal (100 US$/m x 6700^m)	670,000		
Inverted siphon (70,000 US$/set x 2 set)	140,000	Inverted Siphon crossing Kali Dengkeng	140,000
Box Culvert (40,000 US$/set x 1 set)	40,000	Inverted Siphon crossing Tributaries of Kali Dengkeng (70,000 U.S.$/ set x 2 set)	140,000
Others	13,000	Others	18,000
Total cost	1,580,000	Total cost	1,480,000
Unit cost (per ha)	2,000 US $/ha	Unit cost (per ha)	1,380 US $/ha
		Unit cost of Main canal extended from intake to Kali Dengkeng was assumed 20% of the original cost in Wonogiri Dam Report.	

Table 2.4.4 Annual Operation & Maintenance Cost of Pumping Station

Item	Cost	Cost
		US$
Personnel expenses	12 month x 300 $/month	3.600
Fuel charge	240.000ℓ x 0.1$	24.000
Repair & others		22.400
Sub Total		50.000
Depreciation cost		27.500
Total		77.500

Fig.2.4.4 Proposed Irrigation System

(Total Irrigation Area 23200 HA)



2.4.3 Secondary Canals

The irrigation water diverted from the proposed main canals will be led by the secondary canals to the minimum service area with an extent of 150 ha, the standard size in Indonesian projects.

The existing irrigation canals which are being used for conveyance of the irrigation water diverted at the upper-reach of the tributaries will be used, under the project, as the secondary canals in the technical and semi-technical areas by being connected with the main canals under the project. For this purpose, some modifications of their cross-sections and slopes or a minor rehabilitation will be necessary. The rainfed area as well as non-technical area coming under the project have to be provided with new secondary canals.

Number and length of the secondary canals will be as follows:

	Right bank	Left bank	Total
Number of new canals	46	8	54
Total length of new canals (km)	31.6	9.6	41.2
Total length of existing canals to be rehabilitated			40

2.4.4 Farm Net Work

a) Laterals and farm ditches

The entire irrigation area withan extent of 23,200 ha will be divided into 48 service blocks: 36 in the Upper Sala area and 12 in the Dengkeng area. The turnouts which distribute irrigation water will be provided at the point where the secondary canal is branching off from the main canal and at the head of each irrigation service area. The water measurement devices such as Romain gates, Parshall flume, etc. will be installed as required on the main canal as well as on the laterals for an equitable water distribution.

The existing laterals and small channels will be utilized as the tertiary canals in the project area. The density of the existing tertiary canals, however, is not sufficient compared with the module commonly adopted in other Asian countries. Taking into consideration the size and general shape of the farm-blocks and, on the assumption that each farm-block will be equipped with a ditch, at least, on one side of it for equitable distribution of irrigation water, the optimal density of irrigation canals seems to be about 40 m/ha (this density also is within the criteria recommended by the Asian Development Bank).

Table 2.4.5 Density of Canal and Road

Item	Technical Semi Technical		Non Technical Rainfed		Total
	A = 15,840 ha		A = 7,360 ha		A=23,200ha
	Density	Length	Density	Length	Length
	m/ha	m	m/ha	m	m
(Canal)					
Existing Canal	30	475,200	-	-	475,200
New "	10	158,400	40	294,400	452,800
					928,000
(Drain)					
Existing Drain	20	316,800	-	-	316,800
New "	20	316,800	40	294,400	611,200
					928,000
(Road)					
Existing Road	30	475,200	10	73,600	548,800
New "	-	-	20	147,200	147,200
					696,000

Hence, both the existing and the additional canals and farm ditches will have to be arranged to meet this canal density on the entire project area (see Table 2.4.5).

b) Drainage

Needless to say, suitable drainage facilities substantially help increase the productivity of the soil in the farm. As for the drainage network, each farm-block has to have a drainage ditch at least on one side of it. Then, the density of drainage channels required for proper water management would be at least 40 m/ha. The existing density of drainage in the project area as estimated from the topographical map of 1/5,000 scale is about 20 m/ha for technical and semi-technical areas and 0 m/ha for non-technical and rainfed areas.

Additional drainage ditches need to be made as soon as possible for releasing heavy rain-water. The drainage channels with a density of 20 m/ha for technical and semi-technical areas and 40 m/ha for non-technical and rainfed areas are strongly recommended in order to improve the drainage conditions in the entire project area. However, efforts should be made hereafter so that the target-density of 40 m/ha (see Table 2.4.5) for the entire project area can be realized in the near future.

c) Farm roads

Most of the existing farm roads in the project area are not only poorly maintained but not jeepable also and, besides, the density of the farm road including the maintenance road is estimated at around 30 m/ha for technical and semi-technical areas and 10 m/ha for non-technical and rainfed areas. For proper water management and effective farming practices, one farm road accessibly by a jeep or any other small vehicle is necessary in each farm-block.

The necessary density of farm road seems to be nearly the same as that of the irrigation canal. Thus, the farm road with a density of 20 m/ha has been additionally proposed for non-technical and rainfed areas in the project area (see Table 2.4.5).

2.5 FUTURE USE OF MULUR RESERVOIR WATER

Mulur Reservoir was built in Karanganyar in the year 1921 for irrigation purpose. As the Upper Sala Main Canal proposed in the Wonogiri Irrigation Project runs close to it, a major part of its command area will come within the Project area. Hence, it is quite necessary to consider the ways and means to make effective use of the irrigation water stored in the same reservoir.

1) Particulars about the Storage Capacity of Mulur Reservoir:

Effective storage capacity:	3.4×10^6 m^3
Catchment area:	50 km^2
Irrigation area = Rainy season:	4,028 ha
Dry season:	1,530 ha

Thus, Mulur Reservoir collects the excess run-off during rainy season for irrigation of paddy field during dry season.

Judging from the annual rainfall in the area (1,500 - 3,000 mm), the catchment area (50 km^2), and the run-off coefficient (30 - 50 %), the water resources made available for irrigation purpose by Mulur Reservoir is estimated at about 20 - 75 x 10^6 m^3. On the other hand, the current consumptive use during rainy season is estimated at about 18 x 10^6 m^3, when the total acreage of the irrigable area (4,028 ha), the unit water requirement (0.35 litre/sec/ha), the total irrigating days (120 days) and other factors are taken into account. Therefore, Mulur Reservoir can store the irrigation water to its fullest capacity by the beginning of each dry season, excepting in the severest drought years.

2) Future Use of Mulur Reservoir Water

The paddy field in the beneficiary area of Mulur Reservoir which will be left outside of the Project area is approximately 380 ha; supposing that the same paddy field should be irrigated at the current unit water requirement (0.20 litre/sec/ha), its consumptive use would remain at 0.8 x 10^6 m^3 and the Mulur Reservoir could have surplus water which is sufficient for irrigating an additional area of 1,300 ha. As regards the effective use of this much surplus water from Mulur Reservoir, there are three (3) ideas as follows:

i) Linking with other canal system in non-Project area

The surplus water originating at Mulur Reservoir may be sent to other non-Project area by constructing a canal along the contour-line which links with the canal system there. This idea, however, will turn to be quite uneconomical from the fact that a considerable number of crossing structures will come to be necessary and the fact that the elevation of Mulur Reservoir itself is comparative low.

ii) Utilization of surplus water for irrigation of lower reach area

Under the Project, a hilly area in Sragen along the proposed Main Canal is left unirrigable because it requires pump irrigation. Even if extra water is made available, irrigation of this hilly area still remains uneconomical as it is only feasible by use of pumps.

iii) Inclusion of the left-over area under the Project

As 90 % of the beneficiary area of Mulur Reservoir will have been taken into the Project area, the remaining 10 %, or 380 ha, may also be put under the Project and the same intensive paddy cultivation will be carried on there also. The total water required for irrigating 380 ha at the W.I.P. (Wonogiri Irrigation Project) unit of 7 mm on an average, would sum up to 3.2×10^6 m^3 and there will theoretically be no surplus water.

3) Conclusions

Although evaluation of the Wonogiri Irrigation Project has been made by excluding the irrigation area spreading close by Mulur Reservoir, the Project operation shall be extended over this area also in the future. The water storable in the Mulur Reservoir shall be used for irrigating 380 ha which has been kept outside the Project boundary, during the dry season at W.I.P. standard. The surplus water during rainy season will be effectively utilized in replenishing water losses due to operation and maintenance practices along the lengthy main canal, thus, Mulur Reservoir can be used as a regulating facility for proper functioning of the Upper Sala Main Canal.

3. HYDRAULIC & STRUCTURAL CALCULATIONS

3.1 COLO WEIR

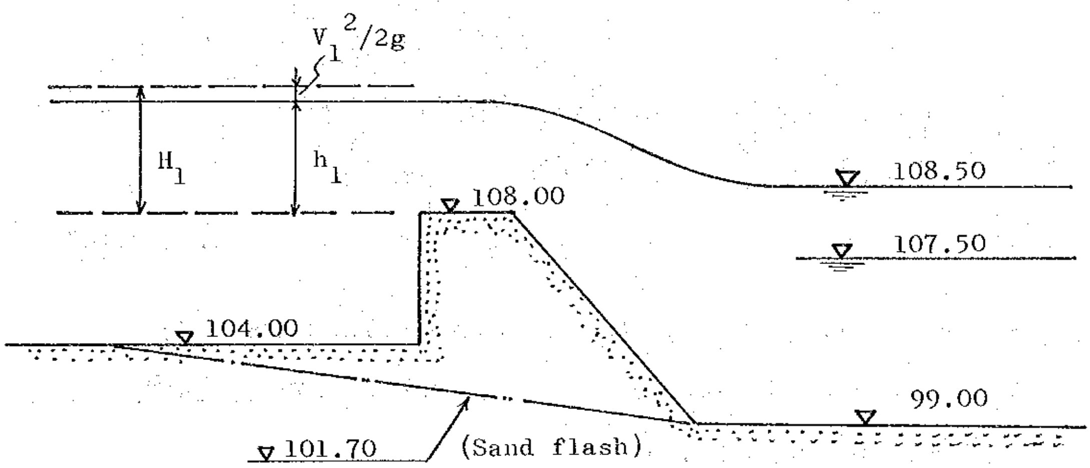
Principle features of the Colo weir will be as follows.

Type of weir		Fixed weir
River bed elevation	(rear)	104.00 m SHVP
"	(downstream)	99.00 m SHVP
Intake water level		107.00 m SHVP
Max. intake discharge & irrigation area	(right)	24.3 cms/19,600 ha
"	(left)	5.2 cms/3,600 ha
Re-regulating capacity		1.2 million m^3
Crest elevation of weir		108.00 m SHVP
Flood discharge		1,600 cms
Extraordinary flood discharge		2,000 cms
Flood water level	(downstream)	107.50 m SHVP
"	(upstream)	111.50 m SHVP
Extraordinary flood water level	(downstream)	108.50 m SHVP
"	(upstream)	112.10 m SHVP
Total length of weir		107.0 m
Length of fixed weir		89.0 m
Span of sand flash		7.5 m x 2 bays
Height of weir		9.0 m

The proposed structure of the Colo weir is shown in DWG. WI-003 to DWG. WI-005.

1) Calculation of flood water level at upstream of colo weir.

Flood discharge		1,600 m^3/S
Extraordinary flood discharge		2,000 m^3/S
Lower-stream flood water level		EL 107.50^m (Rail road bed level 107.15)
Lower-stream extraordinary flood water level		EL 108.50^m
Elevation of river bed	upper-stream	EL 104.00^m
"	lower-stream	EL 99.00^m



$$Q_f = 1.70.L_f.H_{f_1}^{3/2}$$

$$Q_m = 0.95.L_m.h_2.\sqrt{2g(H_1 - h_2)}$$

$$H_1 = h_1 + V^2/2g \quad (V = Q/L_o(D + h_1))$$

$$L = L_o - 0.04.n.h_1 \quad \text{(n; number of vena contracta)}$$

Fixed weir length	(L_{f_o})	; 85^m
Movable weir length	(L_{m_o})	; 15^m
Total length	(L_o)	; 107^m

a) At the time of extraordinary flood discharge ($Q = 2{,}000^{m^3/S}$)

Assuming that upper-stream water level is EL 112.10^m;

($h_{f1} = 4.10^m$, $h_{m1} = 10.40^m$)

$$L_f = 85.0 - 0.04 \times 10 \times 4.10 = 83.36^m$$

$$L_m = 15.0 - 0.04 \times 4 \times 10.40 = 13.34^m$$

$$V = 2000/[107\ (112.10 - 104) + (7.90 + 14.90) \times 3.50] = 2.1^{m/S}$$

$$V^2/2g = 0.23$$

$$Q_f = 1.70 \times 83.36 \times (4.10 + 0.23)^{3/2} = 1.277^{m^3/S}$$

$$Q_m = 0.95 \times 13.34 \times 6.80 \times \sqrt{19.6\ (10.40 + 0.23 - 6.8)} = 747^{m^3/S}$$

$$\therefore Q = Q_f + Q_m = 2{,}024\ ^{m^3/S} \fallingdotseq 2{,}000^{m^3/S}$$

Accordingly, the upper-stream water level will be EL 112.10^m.

b) At the time of ordinary flood discharge ($Q = 1{,}600^{m^3/S}$)

Assuming that the upper-stream water level is EL 111.50^m;

($h_{f1} = 3.50^m$, $h_{m1} = 9.80^m$)

$$L_f = 85.0 - 0.04 \times 10 \times 3.50 = 83.60^m$$

$$L_m = 15.0 - 0.04 \times 4 \times 9.80 = 13.43^m$$

$$V = 1600/[107\ (111.50 - 104.0) + (7.90 + 13.70) \times 2.90] = 1.85^{m/S}$$

$$V^2/2g = 0.17$$

$$Q_f = 1.70 \times 83.60 \times (3.50 + 0.17)^{3/2} = 999^{m^3/S}$$

$$Q_m = 0.95 \times 13.43 \times 5.80 \times \sqrt{19.6\ (9.80 + 0.17 - 5.80)} = 669^{m^3/S}$$

$$Q = Q_f + Q_m = 1{,}668^{m^3/S} \fallingdotseq 1{,}600^{m^3/S}$$

Therefore, the upper-stream water level will be EL 111.50^m.

2) Section determination of fixed weir

The study on the section form has been made on the assumption that the most critical water level is arrived at when the discharge in both the upper- and lower-streams of the weir will amount to about $500^{m^3}/S$ and, therefore, Q has been fixed as $500^{m^3}/S$.

* Water level of upper- and lower-stream

o Upper-stream water level

Assuming that the water level of the upper-stream is EL 108.70^m, the discharge which flows down the fixed weir (Q_1) will be;

$$Q_1 = C.L_1.h_1^{3/2}$$

where, C ; Coefficient of overflow , 1.7

L_1; Width of weir , 89^m

h_1; Overflow head , 0.7^m

$$Q_1 = 1.7 \times 89 \times 0.70^{3/2} = 88.6^{m^3}/S$$

while, the discharge which flows down the sand flash (Q_2) will be;

$$Q_2 = Ca.L_2.hc.Vc$$

where, Ca; inflow coefficient 0.95

L_2; width, $15 - 0.04 \times 4 \times 7.1 = 13.86^m$

h_c; critical depth $2/3(108.70 - 101.60) = 4.73^m$

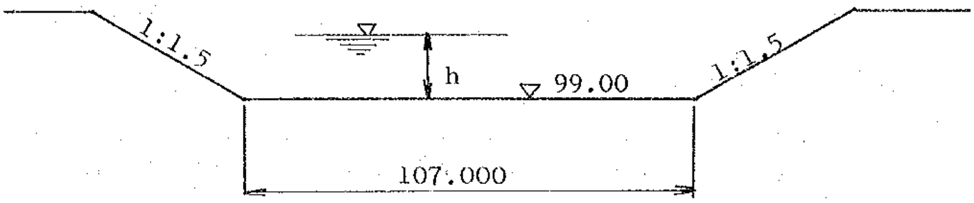
Vc; critical velocity $\left[2g(7.1 - 4.73)\right]^{1/2} = 6.82^{m/S}$

$$Q_2 = 0.95 \times 13.86 \times 4.73 \times 6.82 \fallingdotseq 424.7^{m^3}/S$$

$$Q_1 + Q_2 = 88.6 + 424.7 = 513.3^{m^3}/S \fallingdotseq 500^{m^3}/S$$

Accordingly, the upper-stream water level is EL 108.70^m.

o Lower-stream water level



$Q = 500\ m^3/S$

$I = 1/1500$

$n = 0.04$

If, $h = 3.27$:

$A = 1.5h^2 + 107h = 365.93\ m^2$

$P = 2\sqrt{1^2+1.5^2} \times h + 107 = 118.79\ m$

$R = \frac{A}{P} = 3.080\ m$

$V = \frac{1}{n} R^{2/3} I^{1/2} = \frac{1}{0.04} \cdot 3.08^{2/3} (1/1500)^{1/2}$

$Q = A.V. = 501.3\ m^3/sec \fallingdotseq 500\ m^3/sec$

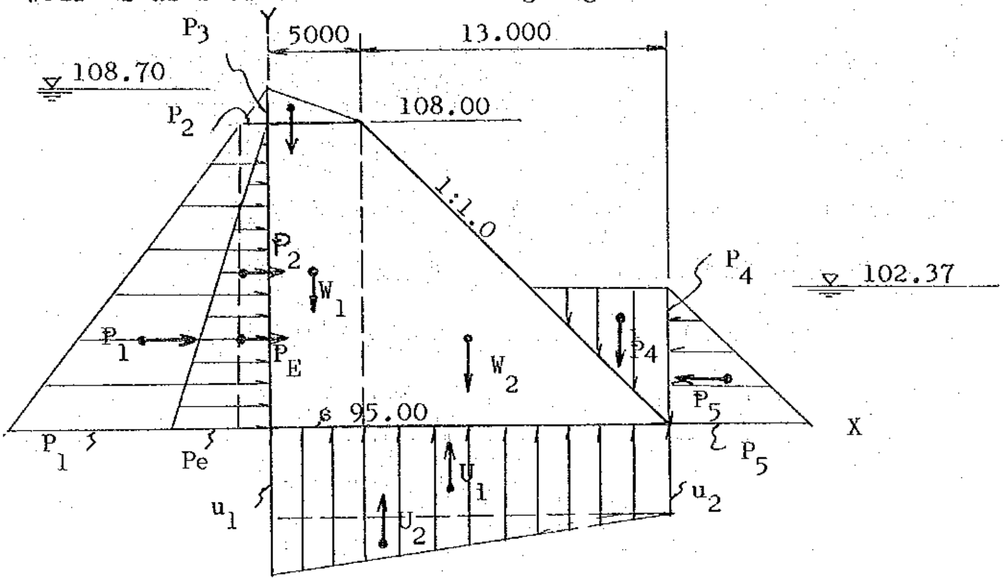
$\frac{V^2}{2g} = \frac{1.37^2}{19.6} = 0.10\ m$

Accordingly, lower-stream water level will be:

EL 99.00 + 3.27 + 0.10 = EL 102.37

o Stability of fixed weir

The diagram of load for the standard section of the fixed weir is as shown in the following Fig.



Hydrostatic Pressure

$p_2 = p_3 = w_o h = 1.0 \times 0.7 = 0.7 \ t/m^2$

$p_1 = 1.0(108.70 - 95.0) = 13.7 \ t/m^2$

$p_4 = p_5 = 1.0(102.37 - 95.0) = 7.37 \ t/m^2$

Uplift pressure

$u_1 = 1.0 \ \ u_2 + \frac{1}{3}(108.7 - 102.37) = 7.37 + 2.11 = 9.48 \ t/m^2$

$u_2 = P_4 = 7.37$

Earth pressure by sediment

$p_e = 1/2 \ (w_1 - w_o) \ C_o H_e$

$= 1/2 \ (1.8 - 1.0) \times 0.5 \times 13.0 = 5.20 \ t/m^2$

	external force		arm length		Moment
	mark	calculation	mark	calculation	
Weight	W_1	2.3x5.00x13.00=149.50	Xw_1	1/2x5.00=2.50	373.75
	W_2	$2.3x1/2x13.00^2$=194.35	Xw_2	5.00+1/3x13.00=9.33	1813.29
hydrostatic pressure	P_1	0.70x13.00=9.10	Yp_1	1/2x13.00=6.50	59.15
	P_2	$1/2x13.00^2$=84.50	Yp_2	1/3x13.00=4.33	365.89
	P_3	1/2x0.70x5.00=1.75	Xp_3	1/3x5.00=1.67	2.92
	P_4	$1/2x7.37^2$=27.16	Xp_4	18.00-1/3x7.37=15.54	422.07
	P_5	$- 1/2x7.37^2$= - 27.16	Yp_5	1/3x7.37=2.46	- 66.81
Uplift pressure	U_1	- 7.37x18.00= - 132.66	Xu_1	1/2x18.00=9.00	- 1193.94
	U_2	- 1/2x2.11x18.00 = -18.99	Xu_2	1/3x18.00=6.00	- 113.94
earth pressure	P_E	1/2x5.20x13.00=33.80	Yp_E	1/3x13.00=4.33	146.35
earthquake pressure	KW_1	0.15x149.50=22.43	Yw_1	1/2x13.00=6.50	145.80
	KW_2	0.15x194.35=29.15	Yw_2	1/3x13.00=4.33	126.22
	$\Sigma V = W_1+W_2+P_3+P_4+U_1+U_2 = 240.10^t$				$\Sigma M=2080.75^{t-M}$
	$\Sigma H = P_1+P_2+P_5+P_E+KW_1+KW_2 = 151.82^t$				

Stability for falling

$$d = \frac{\Sigma M}{\Sigma V} = \frac{2080.75}{240.10} = 8.67^m$$

$$e = \frac{18.00}{2} - 8.67 = 0.33^m < \frac{18.00}{6} = 3.00^m$$

Accordingly, the weir must be stabilized for falling.

Stability for Sliding

$$F = \frac{\Sigma V.f}{\Sigma H}$$

where, f; coefficient of friction with base ground, 0.75

$$F = \frac{240.10 \times 0.75}{151.82} = 1.2$$

Therefore, the weir must be stabilized for Sliding.

Ground reaction

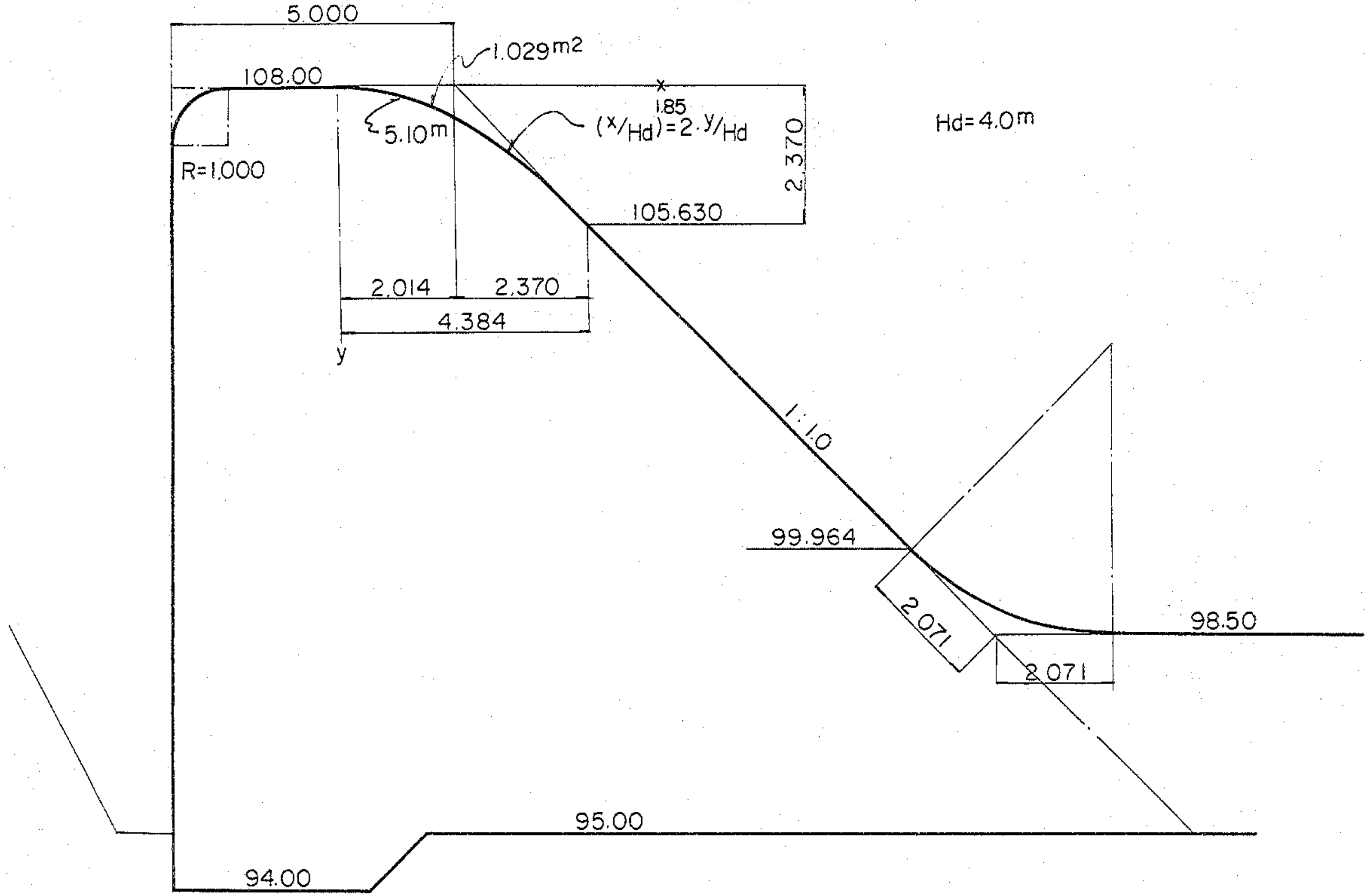
$$q = \frac{\Sigma V}{L} \left(1 \pm \frac{6e}{L}\right)$$

where, L; bottom width of the weir, 18.0 m

$$q = \frac{240.10}{18.00} \left(1 \pm \frac{6 \times 0.33}{18.0}\right) = \begin{matrix} 14.81 \ t/m^2 \\ 11.87 \ \text{"} \end{matrix}$$

Accordingly, the proposed standard section of the fixed weir must be stabilized.
Then, the actual construction section of the fixed weir is hydraulically as shown in the following Fig. 3.1.1.

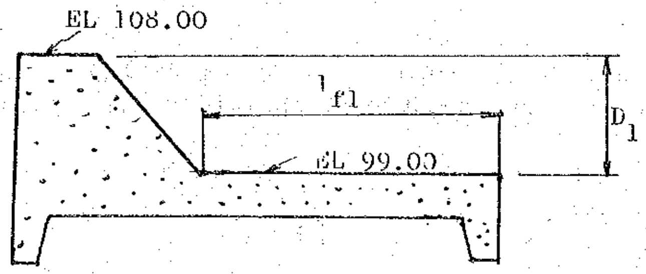
Fig. 3.1.1 Section of Fixed Weir



3) Apron

(a) Length of apron

The apron must be provided to protect the weir from scouring the lower streams river bed by overflow.



The length of the fore apron may be calculated from the following folmula.

$$l_{f_1} = 0.6C\sqrt{D_1}$$

where, l_{f_1} ; length of fore apron (m)

D_1 ; height from fore apron to the crest of weir (m)

C ; coefficient of path of percolation in Bligh

C = 12 (coarse sand in river bed)

$$D_1 = \text{EL } 108.00 - \text{EL } 99.00 = 9.00^m$$

$$\therefore\ l_{f_1} = 0.6 \times 12 \times \sqrt{9.00} = 21.6 \doteqdot 25.0^m$$

(b) Thickness of fore apron

The fore apron must be completely stabilized for the uplift pressure. The thickness of the fore apron may be calculated from the following formula.

$$T \geqq \frac{4}{3} \cdot \frac{\Delta h - h_f}{r - 1}$$

where, T ; thickness of fore apron (m)

r ; specific gravity of fore apron, 2.3

Δh ; distance between upper- and lower-stream water level (m)

h_f; head loss at some point (m)

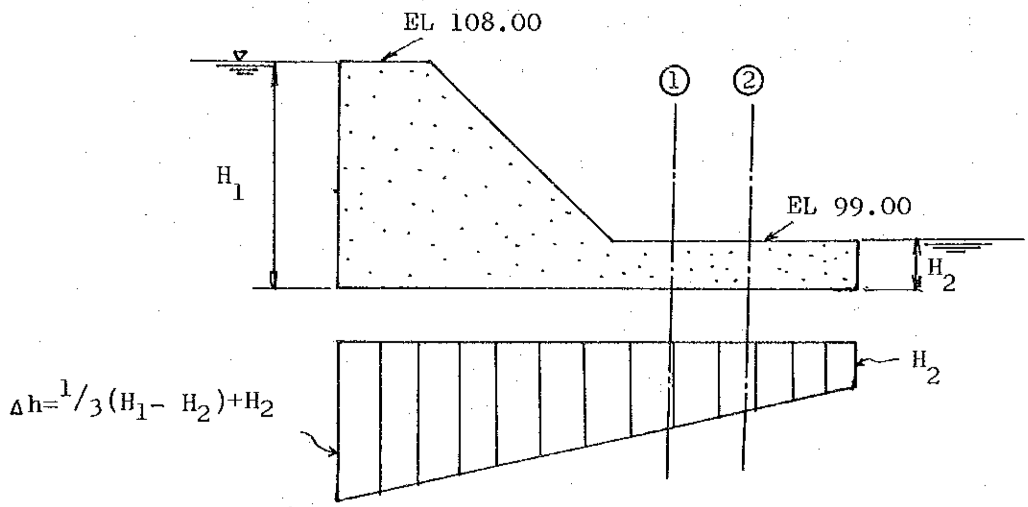
Δh = EL 108.00 - EL 99.00 = 9.00 ^{m}

$h_f = \frac{\Delta h}{l} \cdot l'$

where, l' ; creep length at some point

l ; total creep length

The uplift pressure at the point of the fixed weir must be estimated at $\frac{1}{3} \cdot \Delta h$ because of curtain grouting worked out at this point.



$H_1 = 11.0^m$, $H_2 = 2.0^m$

Δh = 1/3 (11.0 - 2.0) +20 = 5.0^m

The thickness of the fore apron at 1 point

$h_f = \frac{\Delta h}{l} \cdot l' = \frac{5.0}{39.5} \times 18.3 = 2.32^m$

$T \geqq \frac{4}{3} \cdot \frac{5.0 - 2.32}{2.3-1} = 2.74 \fallingdotseq 2.8^m$

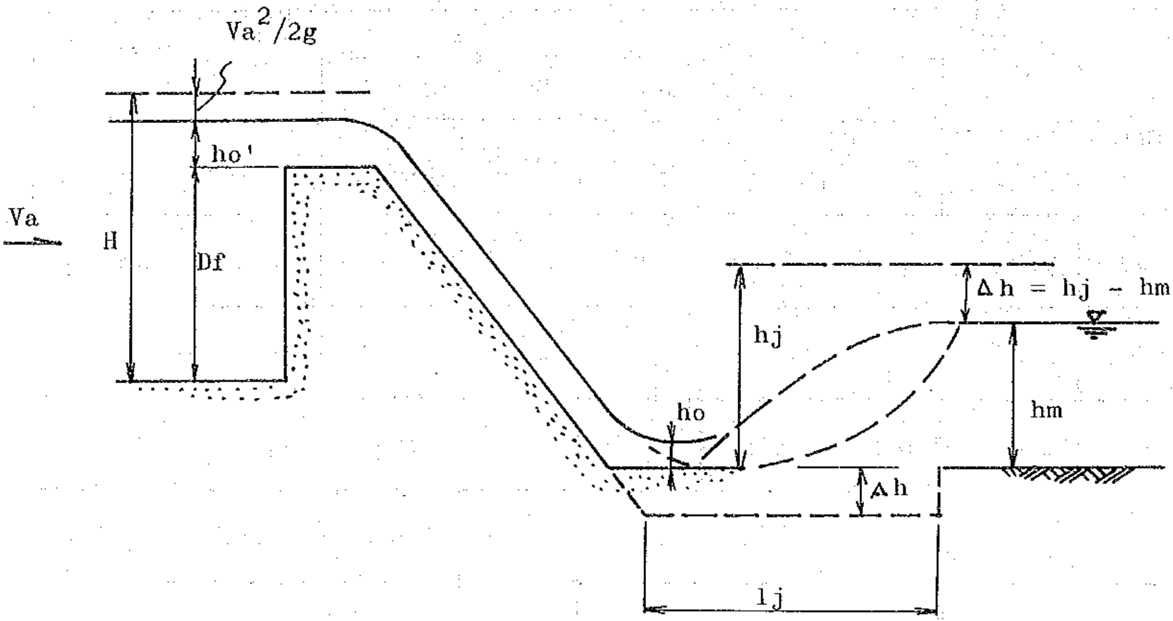
The thickness of the fore apron at 2 point.

$h_f = \frac{\Delta h}{l} \cdot l' = \frac{5.00}{39.5} \times 28.3 = 3.59^m$

$T \geqq \frac{4}{3} \cdot \frac{5.0 - 3.59}{2.3 - 1} = 1.44 \fallingdotseq 1.5^m$

4) Water-cushion

(a) Depth of water-cushion (Δh)



$$h_o' = \left(\frac{q}{2.0}\right)^{2/3}$$

$$h_o^3 - Hh_o^2 + \frac{q^2}{2g} = 0 \qquad H = Df + h_o' + \frac{Va^2}{2g}$$

$$h_j = \frac{h_o}{2}\left(\sqrt{1 + 8F^2} - 1\right)$$

$$F^2 = \frac{q^2}{gh_o^3}$$

$$h_m = \left(\frac{nq}{i^{1/2}}\right)^{3/5}$$

where n: coefficient of roughness of lower canal.
i: gradient of lower canal

$$\Delta h = h_j - h_m$$

Table of calculation

n = 0.04 i = 1/1,500 $\frac{Va^2}{2g} = 0$ $D_f \doteqdot 8.0^m$ Width of overflow B = 107^m

Q	q	h_j					h_m	$\Delta h = h_j - h_m$
		h_o'	H	h_o	F^2	h_j		
m^3/S	$m^3/S/m$	m	m	m		m	m	m
50	0.47	0.38	8.38	0.036	481.2	1.099	0.823	0.276
100	0.93	0.60	8.60	0.072	235.1	1.526	1.240	0.286
200	1.87	0.96	8.96	0.142	124.7	2.173	1.885	0.288
300	2.80	1.25	9.25	0.211	85.2	2.651	2.402	0.249
400	3.74	1.52	9.52	0.278	66.4	3.068	2.857	0.211
500	4.67	1.76	9.76	0.344	54.7	3.430	3.265	0.165

Accordingly, the depth of water-cushion will be;

$$\Delta h = 0.288 \doteqdot 0.3 \quad \text{----} \quad 0.5^m$$

(b) Length of water-cushion (l_j)

The length of water-cushion may be computed from Smetana formula.

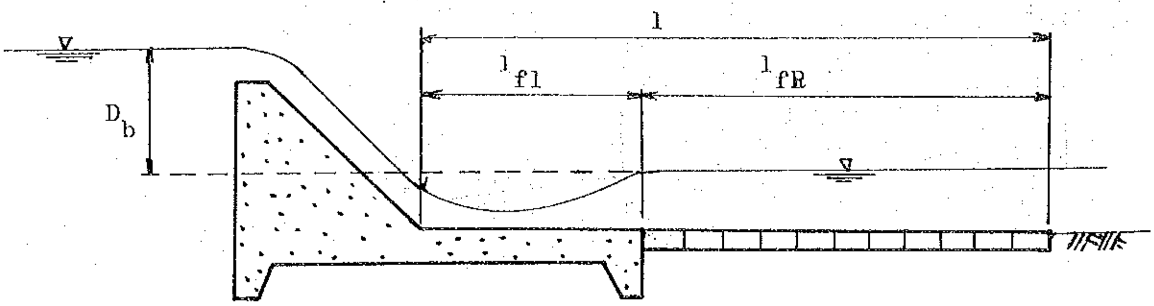
$$l_j = 6\ (h_j - h_o)$$

From the table of calculation,

h_j max = 3.430^m h_o max = 0.344^m

$$\therefore\ l_j = 6\ (3.430 - 0.344) = 18.5^m \doteqdot 20.0^m$$

5) Length of riprap



The length of riprap may be calculated by the Bligh formula.

$$l = 0.67C\sqrt{D_b \cdot q}$$

$$l_{fR} = l - l_{fl}$$

where, D_b ; height from lower stream water level to crest of weir during droughty discharge. (m) Ordinarily, distance between crest of weir and fore apron.

q ; design flood discharge per meter ($m^3/s/m$)

c ; coefficient of path of percolation in Bligh.

l ; l_{fl} + l_{fR}

l_{fl} ; length of fore apron

l_{fR} ; length of riprap

Assuming that the maximum discharge being untouched by the rail road bed is 500 m^3/S , q will be;

$$q = \frac{500}{85} = 5.88 \ m^3/S/m$$

$$D_b = EL\ 108.00 - EL\ 99.00 = 9.00^m$$

$$C = 12$$

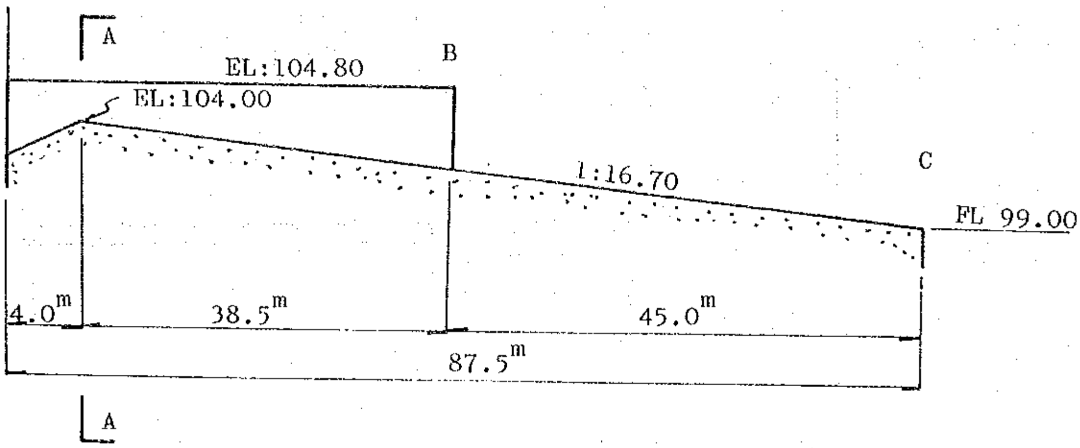
Accordingly, the length of riprap will be;

$$l = 0.67 \times 12 \times \sqrt{9.00 \times 5.88} = 58.5^m$$

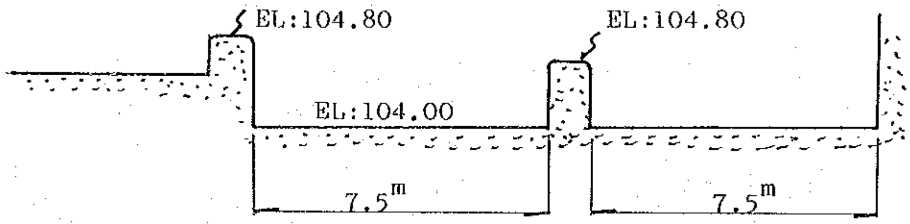
$$l_{fR} = l - l_{fl} = 58.5 - 21.6 = 36.9 \fallingdotseq 40.0^m$$

6) Sand flash

Profile of sand flash



A – A



When the sand flash gate is completely opened the critical depth must be seen on the vicinity B point. Then, becoming lower the upper stream's water level, this critical depth must be closed to the A point.

The critical depth at the A point may be calculated from the following formula.

$$hc = \sqrt[3]{\frac{Q^2}{gb^2}}$$

$$Q = \sqrt{g.b^2.h_c^{\ 3}}$$

where, Q ; discharge of one sand flash (m^3/s)

g ; gravity acceleration 9.8 m^3/S

b ; width of one sand flash 7.5^m

h_c; critical depth (m)

Assuming that the upper stream's water level is EL 104.80;

$$h_c = \frac{2}{3}\text{ (EL 104.80 - EL 104.00)} = 0.53^m$$

$$Q = (9.8 \times 7.5^2 \times 0.53^3)^{1/2} = 9.06 \ m^3/S$$

$$V_c = \frac{Q}{b.h_c} = \frac{9.06}{7.5 \times 0.53} = 2.28 \ m/S$$

The critical gradient of the sand flash may be computed by the Manning formula.

$$I_c = \frac{n^2 . v^2}{R^{4/3}} = \frac{0.03^2 \times 2.28^2}{(0.53 \times 7.5)/(2 \times 0.53 + 7.5)^{4/3}}$$

$$= 0.013 \fallingdotseq 1/76.9 < 1/16.7$$

Then, the velocity of flashing may be calculated by the following formula.

$$V_c = 1.5 . C . \sqrt{d}$$

where, V_c ; velocity of flashing, 2.28 m/S

C ; coefficient of gravel shape, 3.5

d ; maximum grain size (m)

$$\therefore d = \left(\frac{Vc}{1.5C}\right)^2 = \left(\frac{2.28}{1.5 \times 3.5}\right)^2 = 0.19^m$$

7) Height of Pier

The height of pier is shown as follows

Elevation of top of pier = flood water level + freeboard 1
+ height of gate + freeboard 2

where, flood water level ; design flood water level on the upper stream

freeboard 1 ; distance between flood water level and bottom of gate
generally, major river $> 2.0^m$
medium river $> 1.5^m$

freeboard 2 ; distance between top of gate and bottom of bridge
generally, $0.5 - 1.0^m$

Elevation of top of pier (Sand flash)

= EL 111.50 + 2.0 + 6.55 + 0.5 + 0.75 (thickness of slab)

= EL 120.8 ≒ EL 121.5^m

Elevation of top of pier (fixed weir)

= EL 111.50 + 2.0 = EL 113.50^m

8) Intake

a) Elevation of intake sill

The elevation of intake sill must be got 1.5^m higher than the sand flash bed to protect from flowing silt into the canal.

Accordingly, the elevation of intake sill will be;

$$EL\ 103.21 + 1.5 = EL\ 104.71 \fallingdotseq EL\ 104.80^m$$

b) Width of Intake

The width of intake may be calculated from the following formula.

$$B = \frac{Q}{H.V.}$$

where, B; width of intake (m)

Q; intake discharge (m^3/S)

V; intake velocity (m/S)

H; intake depth (m)

intake discharge;

Upper Sala main Canal (right side) $Q_R = 24.3^{m^3/S}$

Dengkeng Main Canal (left side) $Q_L = 5.2 + {}^*2.0 = 7.2^{m^3/S}$

* release discharge for lower sala river.

intake velocity; V = 0.6 - 1.0 m/S

intake depth; H = intake water level - elevation of intake sill

$$= EL\ 107.50 - EL\ 104.80 = 2.70^m$$

Accordingly, the width of intake will be;

Upper Sala Main Canal $B_R = \dfrac{24.3}{2.70 \times 0.6} = 15.0^m$

Dengkeng Main Canal $B_L = \dfrac{7.2}{2.70 \times 0.6} = 4.5^m$

o Span of intake

One span of intake must be 5^m giving thought to operate mechanically the intake gate.

Accordingly, the span of intake will be;

Upper Sala Main Canal $5.0^m \times 3^{span}$

Dengkeng Main Canal $4.5^m \times 1^{span}$

9) Hydraulic calculation of diversion works

a) Upper sala main canal side

Intake water level ; EL 107.00
Intake discharge ; $Q = 24.3\ m^3/sec$
Intake shape ; Width - 5.0 m
elevation of sill-EL 104.80^m
number of bay - 3

(i) Drop of water surface at the inlet of intake

$$h_i = f_i \frac{V_2^2}{2g} + \frac{V_2^2 - V_1^2}{2g}$$

where, f_i ; coefficient of inlet loss - 0.2

V_1 ; approaching velocity (m/sec) - 0

V_2 ; entrance velocity (m/sec)

$$V_2 = \frac{8.1}{(107.0 - 104.8) \times 5.0} = 0.74\ ^{m/sec}$$

$$h_i = 0.2 \times \frac{0.74^2}{2x9.8} + \frac{0.74^2}{2x9.8} = 0.034\ ^m$$

(ii) Drop of water surface by abrupt rise of bottom

$$h_r = f_r \cdot \frac{V_2^2}{2g} + \frac{V_2^2 - V_1^2}{2g}$$

where, f_r ; coefficient of abrupt rise loss

V_1 ; approaching velocity (m/sec)

V_2 ; entrance velocity (m/sec)

upper stream flow area $A_1 = (107.0 - 102.68) \times 5.0 = 21.6^{m^2}$

lower stream flow area $A_2 = (107.0 - 104.80) \times 5.0 = 11.0^{m^2}$

$A_2/A_1 = 0.51$ ------ $f_r = 0.235$

$V_1 = 0$ $V_2 = 0.74^{m/sec}$

$$h_r = 0.235 \times \frac{0.74^2}{2x9.8} + \frac{0.74^2}{2x9.8} = 0.035^m$$

(iii) Drop of water surface by the trash rack

$$h_s = \beta \sin\theta \left(\frac{t}{b}\right)^{4/3} \cdot \frac{V_1^{\,2}}{2g}$$

where, β ; coefficient by screen shape

θ ; inclined angle of rack

t ; thickness of screen flat bar (mm)

b ; space of screen flat bar (mm)

V_1; upper stream velocity of screen (m/s)

The value h_s computed by above formula is assumed to be no trashes on the rack. However, trashes must be actually caught on the screen.
Therefore, the value h_s will be;

$$h_s = 0.1 - 0.3^m \fallingdotseq 0.20^m$$

Then, the lower stream water depth of screen will be;

$$H = (\text{EL } 107.0 - \text{EL } 104.8) - (h_i + h_r + h_s)$$

$$= 2.20 - 0.269 = 1.931^m$$

(iv) Drop of water surface by friction

$$h_{f1} = \frac{2g.n^2}{R^{1/3}} \cdot \frac{L}{R} \cdot \frac{V^2}{2g} = \frac{n^2V^2}{R^{4/3}} \cdot L$$

where, n ; coefficient of roughness - 0.015

V ; mean velocity - $0.71^{m/sec}$

L ; length of culvert - 43.0^m

R ; hydraulic radius (m)

flow area $A = 5.9 \times 1.931 = 11.39^{m^2}$

wetted perimeter $S = 1.931 \times 2 + 5.9 = 9.76^m$

hydraulic radius $R = \frac{A}{S} = \frac{11.39}{9.76} = 1.167$

$$h_{f1} = \frac{0.015^2 \times 0.71^2}{1.167^{4/3}} \times 43.0 = 0.004^m$$

(v) Drop of water surface by abrupt enlargement of section

$$h_{se} = \frac{V_1^{\,2}}{2g}\left(1 - \frac{A_1}{A_2}\right)^2 + \frac{V_2^{\,2} - V_1^{\,2}}{2g}$$

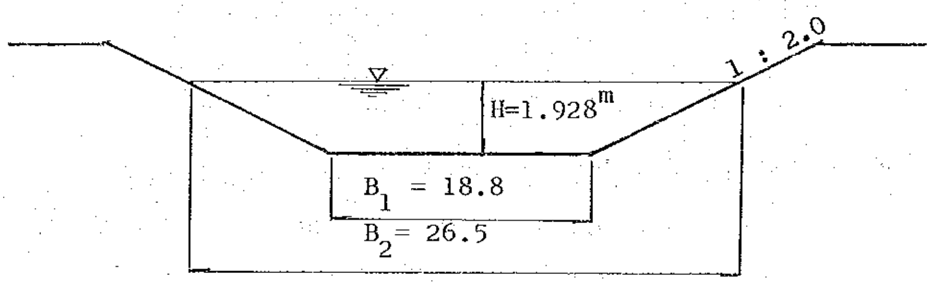
water depth in the outlet of the culvert

$H = 1.931 - 0.003 = 1.928^m$

$A_1 = (5.85 \times 2 + 5.90) \times 1.928 = 33.93^{m^2}$

$$V_1 = \frac{Q}{A_1} = \frac{24.3}{33.93} = 0.72 \ ^{m/sec}$$

Section of open canal



$$A_2 = \frac{1}{2}(18.8 + 26.5) \times 1.928 = 43.67^{m^2}$$

$$V_2 = \frac{24.3}{43.67} = 0.56 \ ^{m/sec}$$

$$h_{se} = \frac{0.72^2}{2x9.8}\left(1 - \frac{33.93}{43.67}\right)^2 + \frac{0.56^2 - 0.72^2}{2x9.8}$$

$= 0.001 - 0.010 = - 0.009^m$

(vi) Drop of water surface by friction (canal)

$$h_{f2} = \frac{n^2 . V^2}{R^{4/3}} . L$$

where, n ; coefficient of roughness

wet masonry 0.03

L ; length of open canal 61.4^m

R ; hydraulic radius

$$R = \frac{A}{S} = \frac{43.67}{(18.8 + 1.928 . \sqrt{5} \times 2)} = 1.593$$

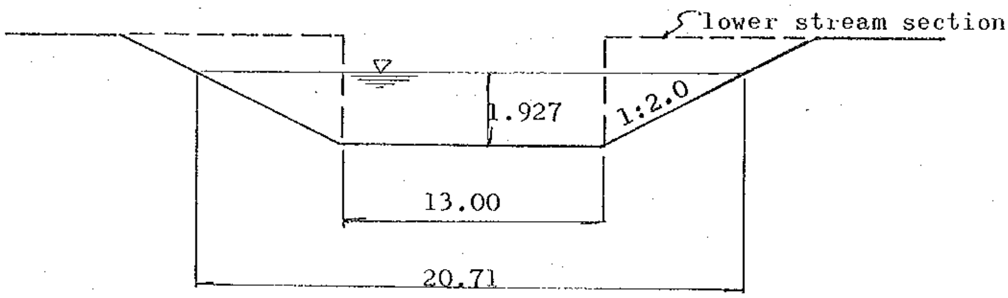
$$h_{f2} = \frac{0.03^2 \times 0.56^2}{1.593^{4/3}} \times 61.4 = 0.009^m$$

(vii) Drop of water surface by gradual contraction of section (open canal -- measuring weir)

$$h_{gc} = f_{gc} \frac{V_2^2 - V_1^2}{2g} + \frac{V_2^2 - V_1^2}{2g}$$

f_{gc} ; coefficient of gradual contraction loss - 0.3

Section of canal



Total drop of water surface of above mentioned

calculation; $\Delta h = h_i + h_r + h_s + h_{f1} + h_{se} + h_{f2}$

$= 0.034 + 0.035 + 0.200 + 0.004 - 0.009 + 0.009 = 0.273^m$

water depth $H = 2.2 - 0.273 = 1.927^m$

$A_1 = 1/2\ (13.0 + 20.71) \times 1.927 = 32.48^{m^2}$

$V_1 = 0.75\ ^{m/sec}$

$A_2 = 13.0 \times 1.927 = 25.05^{m^2}$

$V_2 = 0.97\ ^{m/sec}$

$$h_{gc} = 0.3 \times \frac{0.97^2 - 0.75^2}{2 \times 9.8} + \frac{0.97^2 - 0.75^2}{2 \times 9.8}$$

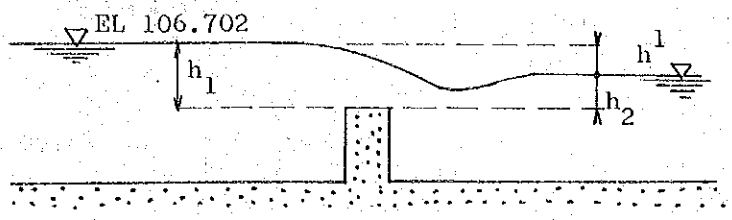
$= 0.025^m$

Total drop of water surface at the point just before the measuring weir

$\Sigma h = \Delta h + h_{gc} = 0.273 + 0.025 = 0.298^m$

water level W.L = EL 107.00 - 0.298 = EL 106.702^m

(viii) Drop of water surface by measuring weir



The Condition of complete overflow is given as follows

$$h_2/h_1 \leqq 2/3$$

The overflow discharge on the wide crest weir must be computed from the following formula.

$$Q = 1.8.B.h_1^{3/2}$$

where, $Q = 24.3^{m^3/S}$
$B = 13.0^m$

$$h_1^{3/2} = \frac{24.3}{1.8x13.0} = 1.038$$

$$h_1 = 1.025^m$$

h_2 under the condition of complete overflow

$$h_2 \leqq 2/3 \text{ x } h_1 = 0.713^m$$

$$h_2 = 0.71^m$$

Accordingly, drop of water surface by measuring weir under the condition of complete overflow will be;

$$h' = 1.025 - 0.71 = 0.315 \doteq 0.32^m$$

(ix) Water level at the start point of upper sala main canal

lower stream water level of weir

EL 106.702 - 0.32 = EL 106.38

design water depth of canal

$$h = 1.92^m$$

Accordingly, the elevation of the canal bed will be;

EL 106.38 - 1.92 = EL 104.46^m

b) Dengkeng main canal side

Intake water level ; EL 107.00

Intake discharge ; $Q = 5.2 + \underline{2.0} = 7.2\ m^3/S$
(release discharge for lower sala river)

Intake shape ; width - 4.5^m
elevation of sill - EL 104.80^m
number of bay - 1

(i) Drop of water surface at the inlet of intake

$$h_i = f_i \cdot \frac{V_2^2}{2g} + \frac{V_2^2 - V_1^2}{2g}$$

$$V_2 = \frac{7.2}{(107.0 - 104.8) \times 4.5} = 0.73\ m/s$$

$$h_i = 0.2 \times \frac{0.73^2}{2x9.8} + \frac{0.73^2 - 0^2}{2x9.8} = 0.032^m$$

(ii) Drop of water surface by abrupt rise of bottom

$$h_r = f_r \cdot \frac{V_2^2}{2g} + \frac{V_2^2 - V_1^2}{2g}$$

upper stream flow area

$$A_1 = (107.0 - 101.92) \times 4.5 = 22.86^{m^2}$$

lower stream for area

$$A_2 = (107.0 - 104.80) \times 4.5 = 9.90^{m^2}$$

$$A_2/A_1 = 0.43 \quad -- \quad f_r = 0.27$$

$$h_r = 0.27 \times \frac{0.73^2}{2x9.8} + \frac{0.73^2}{2x9.8} = 0.034^m$$

(iii) Drop of water surface by the trash rack

$$h_s = \beta \sin \theta \left(\frac{t}{b}\right)^{4/3} \cdot \frac{V^2}{2g}$$

The value h_s computed by above formula is assumed to be no trashes on the rack. However, trashes must be actually caught on the rack.
Therefore, the value h_s will be;

$$h_s = 0.1 - 0.3^m \fallingdotseq 0.200^m$$

Then, the lower stream water depth of screen will be;

$$H = (EL\ 107.00 - EL\ 104.80) - (h_i + h_r + h_s)$$

$$= 2.20 - 0.266 = 1.934^m$$

(iv) Drop of water surface by abrupt enlargement of section

$$h_{se} = \frac{V_1^2}{2g}\left(1 - \frac{A_1}{A_2}\right)^2 + \frac{V_2^2 - V_1^2}{2g}$$

$A_1 = 5.4 \times 1.934 = 10.44^{m^2}$

$V_1 = 0.69^{m/sec}$

$A_2 = \{1.934 + (EL\ 104.80 - EL\ 98.10)\} \times 5.4 = 46.62^{m^2}$

$V_2 = Q/A_2 = 7.2/46.62 = 0.15^{m/sec}$

$$h_{se} = \frac{0.69^2}{2x9.8}\left(1 - \frac{10.44}{46.62}\right)^2 + \frac{0.15^2 - 0.69^2}{2x9.8}$$

$= 0.015 - 0.023 = - 0.008^m$

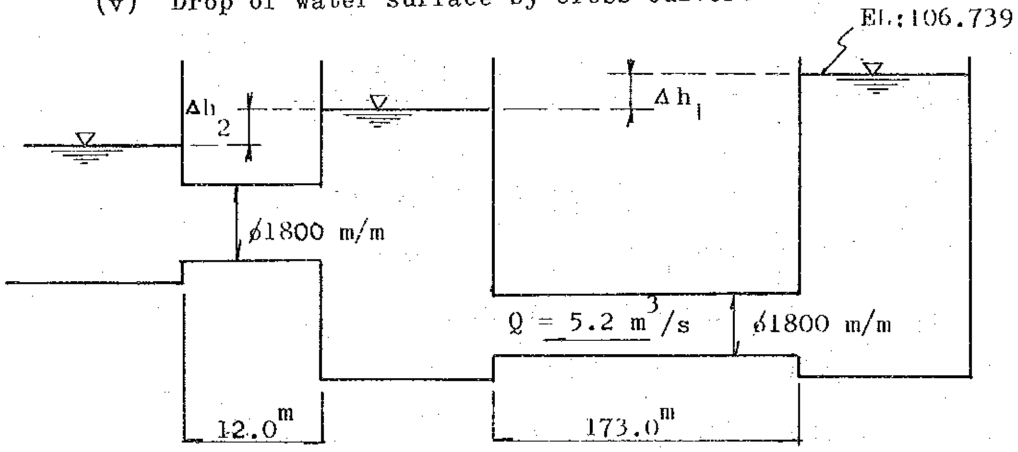
Accordingly, the water level in the right side blow-off will be;

$\Delta h = h_i + h_r + h_s + h_{f1} + h_{se}$

$= 0.032 + 0.034 + 0.200 + 0.003 - 0.008 = 0.261^m$

$\therefore$ W.L = EL 107.00 - 0.261 = EL 106.739^m

(v) Drop of water surface by cross culvert



$$h = \left(1 + f_e + f \cdot \frac{L}{D}\right)\frac{V^2}{2g}$$

where, f_e; coefficient of inlet loss, 0.5

f ; coefficient of friction loss

$$f = \frac{12.7gn^2}{D^{1/3}}$$

n ; coefficient of roughness, 0.013

D; diameter of pipe, 1.8^m

$\therefore$ f = 0.017

L ; length of pipe, 173.0^m

V ; velocity in pipe

$$V = \frac{Q}{A} = \frac{5.2}{1/4 \times \pi \times 1.8^2} = 2.04^{m/sec}$$

$$\Delta h_1 = (1 + 0.5 + 0.017 \times \frac{173.0}{1.8}) \times \frac{2.04^2}{2x9.8} = 0.658^m$$

$$\Delta h_2 = (1 + 0.5 + 0.017 \times \frac{12.0}{1.8}) \times \frac{2.04^2}{2x9.8} = 0.340^m$$

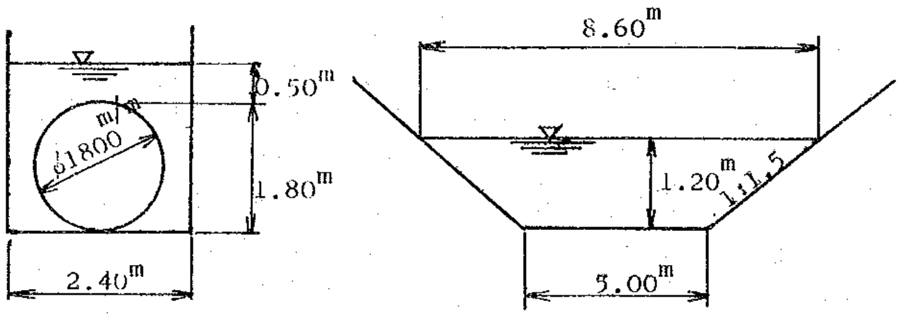
$$\therefore \Sigma h = \Delta h_1 + \Delta h_2 = 0.658 + 0.340 = 0.998^m \fallingdotseq 1.0^m$$

Accordingly, the water level of outlet will be;

EL 106.739 - 1.00 = EL 105.739

(vi) Drop of water surface by gradual enlargement of section.

section of upper stream section of lower stream



$$h_{ge} = f_{ge} \cdot \frac{V_1^2 - V_2^2}{2g} + I_m . L + \frac{V_2^2 - V_1^2}{2g}$$

where, f_{ge} ; coefficient of gradual enlargement

improvement straight type - 0.4

$$A_1 = (1.8 + 0.5) \times 2.4 = 5.52^{m^2}$$

$$V_1 = Q/A = 0.94 \ ^{m/sec}$$

$R_1 = 0.789$ $R_1^{2/3} = 0.854$

$$I_1 = (\frac{n.V_1}{R_1^{2/3}})^2 = (\frac{0.015 \times 0.94}{0.854})^2 = 0.00027$$

$$A_2 = 1/2\ (5.0 + 8.6) \times 1.2 = 8.16^{m^2}$$

$$V_2 = 0.64^{m/sec}$$

$R_2 = 0.876$ $R_2^{2/3} = 0.915$

$$I_2 = (\frac{0.015 \times 0.64}{0.915})^2 = 0.00011$$

$$I_m = \frac{I_1 + I_2}{2} = \frac{0.00027 + 0.00011}{2} = 0.00019$$

$$h_{ge} = 0.4 \times \frac{0.94^2 - 0.64^2}{2x9.8} + 0.00019 \times 8 + \frac{0.64^2 - 0.94^2}{2x9.8}$$

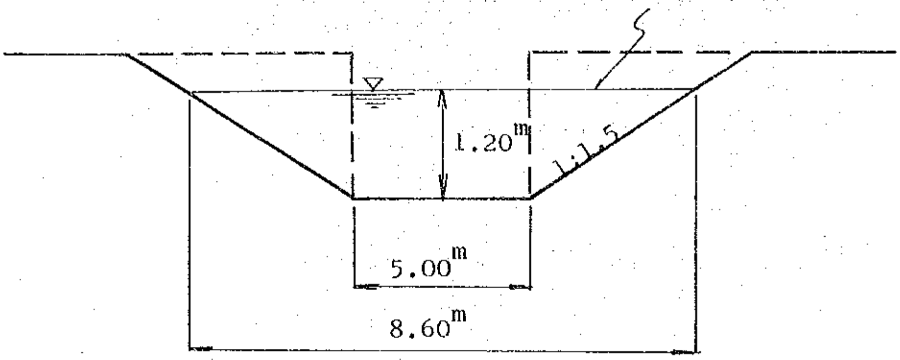
$$= 0.010 + 0.002 - 0.024 = - 0.012^m$$

(vii) Drop of water surface by gradual contraction of section

$$h_{gc} = f_{gc} \cdot \frac{V_2^2 - V_1^2}{2g} + \frac{V_2^2 - V_1^2}{2g}$$

where, f_{gc} ; coefficient of gradual contraction - 0.3

section of canal



$A_1 = 1/2\ (5.0 + 8.6) \times 1.2 = 8.16^{m^2}$

$V_1 = Q/A_1 = 5.2/8.16 = 0.64^{m/sec}$

$A_2 = 5.0 \times 1.2 = 6.00^{m^2}$

$V_2 = 5.2/6.00 = 0.87^{m/sec}$

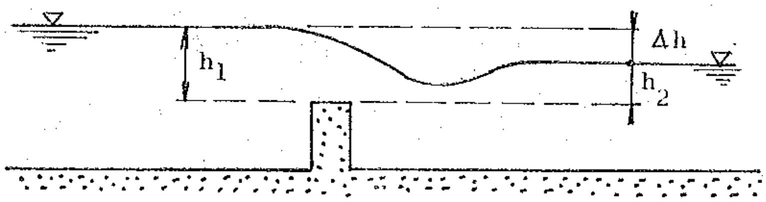
$$h_{gc} = 0.3 \times \frac{0.87^2 - 0.64^2}{2x9.8} + \frac{0.87^2 - 0.64^2}{2x9.8}$$

$$= 0.005 + 0.018 = 0.023^m$$

Accordingly, the water level at the point just before the measuring weir will be;

EL 105.751 - 0.023 = EL 105.728^m

(viii) Drop of water surface by measuring weir



The condition of complete overflow is given as follows;

$$h_2/h_1 \leqq 2/3$$

The overflow discharge on the wide crest weir must be computed from the following formula.

$$Q = 1.8.B.h_1^{3/2}$$

where, $Q = 5.2^{m^3/S}$

$B = 5.0^m$

$$\therefore h_1^{3/2} = \frac{5.2}{1.8x5.0} = 0.578$$

$$h_1 = 0.693 \fallingdotseq 0.69^m$$

h_2 under the condition of complete overflow

$$h_2 \leqq 2/3 \times h_1 = 0.46^m$$

$$\therefore h_2 = 0.41^m$$

Accordingly, drop of water surface by measuring weir under the condition of complete overflow will be;

$$\Delta h = 0.69 - 0.41 = 0.28^m$$

(ix) Water level at the start point of Dengkeng main canal

lower stream water level of weir

EL 105.728 - 0.28 = EL 105.45^m

design water depth of canal

$h = 1.20^m$

Accordingly, the elevation at the canal bed will be;

EL 105.45 - 1.20 = EL 104.25^m

3.2 IRRIGATION CANALS

3.2.1 Criteria

a) Type of canal .... All canals are designed as un-lined earth canals.

b) Standard cross section:

Hydraulic depth:

The Haringhuizen Formula ($d = 0.775\ Q^{0.284}$) is widely used for estimating hydraulic depth among Indonesian projects. This formula generally tends to bring forward the lower values than by the criteria used in Japan as well as the Modified Kennedy Formula. However, the formula can be applied on conservative side so as to estimate the optimum hydraulic depth by taking into account the local soil mechanical conditions.

Freeboard:

Freeboard will be governed by many factors, particularly, in such case a canal is located along the contour-lines as with the main canals in our project area. The inflow of the rain water due to the violent storms and the operational water surface fluctuations should be considered in deciding the Freeboard. Out of a several kinds of formula and criteria for estimating freeboard for unlined earth canal, the following formula is believed to be reasonably applicable:

$$F = (30 + d/4)\ \text{cm}$$

where, F: freeboard
d: hydraulic depth

Inside slope:

Inside-slope of a canal depends on the stability of canal materials. Considering the mechanical conditions of soil along the canal route, the slopes (vertical to horizontal) have been prescribed as follows according to the amount of discharge:

$Q < 3\ m^3/sec$	1 : 1.0
$3\ m^3/sec \leqq Q < 13\ m^3/sec$	1 : 1.5
$Q \geqq 13\ m^3/sec$	1 : 2.0

Bank width:

Width of the left bank of the Main Canal has been designed to be 5 m so as to make it accessible to motor vehicle meant for operation and maintenance purposes, while that of its opposite bank, 2.5 m. The bank width of the secondary canal will be 3.5 m for the operation and maintenance side, and 1 m for its opposite.

c) Flow formula

The Manning formula is generally used for open-channel flow in calculating its discharge:

$$Q : A \cdot V$$

$$V : A \frac{1}{n} R^{\frac{2}{3}} I^{\frac{1}{2}}$$

where, Q: design discharge in cms,
A: cross sectional area in m^2,
V: velocity of water in MPS,
n: roughness coefficient,
R: hydraulic radius (cross sectional area divided by wetted perimeter), and
I: slope of the water surface and channel bottom.

A roughness coefficient "n" of 0.0225 is generally used for canals with capacities greater than 10 cms and 0.025 for small channels.

d) Velocity for non-silt and non-scour

The Haringhuizen Formula for the velocity which is commonly applied in Indonesia was compared with the criteria used in Japan as well as the Kennedy formula, under the similar conditions. The velocity used for canal designing in the past projects in Indonesia approximately corresponds to the value estimated by the Haringhuizen Formula. Consequently, the Haringhizen Formula ($V: 0.42\ Q^{0.182}$) has been applied for deciding the canal section.

3.2.2 Design

a) Design discharge and canal net-work

The design discharge assigned with a command area, the standardized canal types classified by the said discharge, and the diverting discharge of turnouts are summarized in Fig. 3.1 and Table 3.2.1 for the main canals, and in Table 3.2.2 for the secondary canals.

b) Standard cross section

14 types of cross section have been designed for the entire main canals: 5 for the Dengkeng Main Canal and 9 for the Upper Sala Main Canal, according to the sectional discharges and the distances between the turnouts. For the secondary canals, a total of 7 types of the standardized cross section have been designed. The hydraulic calculations for determining the standardized cross sections are presented in Tables 3.2.3 and 3.2.4. The standard sections of these are illustrated in Figs. 3.2.2 to 3.2.4.

3.2.3 Hydraulic Calculation on The Main Canal

The hydraulic calculations from one end to the other end of the main canal have been made as per Table 3.2.6 for the Upper Sala Main Canal and Table 3.2.7 for the Dengkeng Main Canal. In these calculations, the loss of head at the related structures has been taken into account.

Fig. 3.2.1 Canal Network and Discharge Assignment

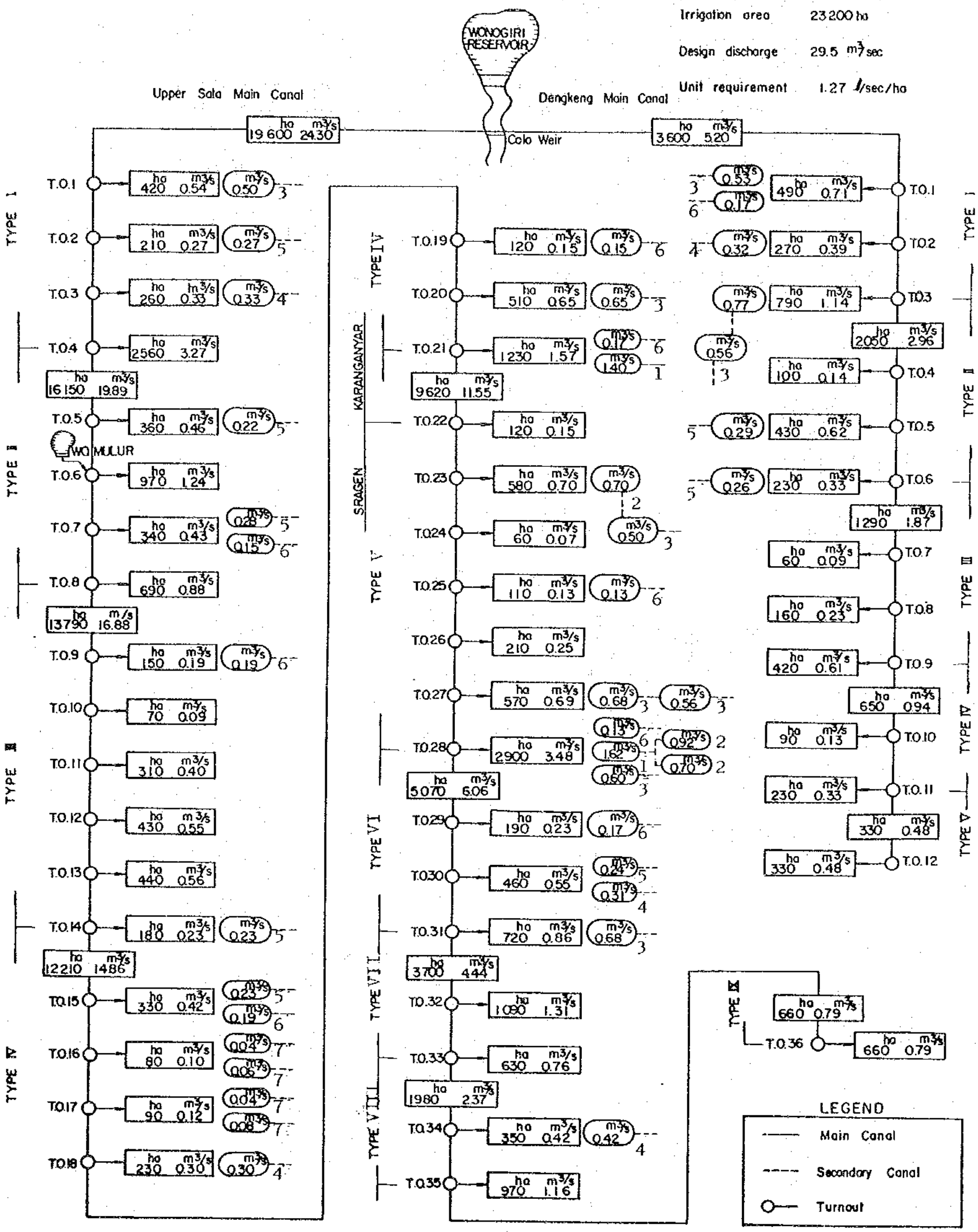


Table 3.2.1 Sectional Discharge and Type and Length of Main Canals

	Turnout	Main Canal				Turn out	
		Irrigation Area	Discharge	Canal Type	Length	Irrigation Area	Discharge
	Upper Sala main canal						
	Intake	19,600 ha	24.30 m³/s	I	m	ha	m³/s
	1	19,180	23.76	"		420	0.54
	2	18,970	23.49	"	7,600	210	0.27
	3	18,710	23.16	"		260	0.33
	4	16,150	19.89	"		2,560	3.27
	5	15,790	19.43	II		360	0.46
	6	14,820	18.19	"	4,500	970	1.24
	7	14,480	17.76	"		340	0.43
	8	13,790	16.88	"		690	0.88
	9	13,640	16.69	III		150	0.19
	10	13,570	16.60	"		70	0.09
	11	13,260	16.20	"	9,250	310	0.40
	12	12,830	15.65	"		430	0.55
	13	12,390	15.09	"		440	0.56
	14	12,210	14.86	"		180	0.23
	15	11,880	14.44	IV		330	0.42
	16	11,800	14.34	"		80	0.10
	17	11,710	14.22	"		90	0.12
Karanganyar	18	11,480	13.92	"	10,000	230	0.30
	19	11,360	13.77	"		120	0.15
	20	10,850	13.12	"		510	0.65
	21	9,620	11.55	"		1,230	1.57
	22	9,500	11.40	V		120	0.15
	23	8,920	10.70	"		580	0.70
	24	8,860	10.63	"		60	0.07
	25	8,750	10.50	"	10,000	110	0.13
Sragen	26	8,540	10.25	"		210	0.25
	27	7,970	9.56	"		570	0.69
	28	5,070	6.08	"		2,900	3.48

Tabel 3.2.1 Continued

Turnout	Main Canal				Turn out	
	Irrigation Area	Discharge	Canal Type	Length	Irrigation Area	Discharge
	ha	m^3/s		m	ha	m^3/s
29	4,880	5.85	VI	10,750	190	0.23
30	4,420	5.30	"		460	0.55
31	3,700	4.44	"		720	0.86
32	2,610	3.13	VII	3,000	1,090	1.31
33	1,980	2.37	"		630	0.76
34	1,630	1.95	VIII	5,000	350	0.42
35	660	0.79	"		970	1.16
36			IX	2,300	660	0.79
Sub total				62,400		
Dengkeng main canal						
Intake	3,600	5.2	I			
1	3,110	4.49	"	12,900	490	0.71
2	2,840	4.10	"		270	0.39
3	2,050	2.96	"		790	1.14
4	1,950	2.82	II		100	0.14
5	1,520	2.20	"	5,750	430	0.62
6	1,290	1.87	"		230	0.33
7	1,230	1.78	III		60	0.09
8	1,070	1.55	"	5,750	160	0.23
9	650	0.94	"		420	0.61
10	560	0.81	IV	4,750	90	0.13
11	330	0.48	"		230	0.33
12			V	2,250	330	0.48
Sub total				31,400		
Total				93,800		

Table 3.2.2 Type and Length of Secondary Canals

	Irrig. Area (ha)	Dis Charge (m^3/sec)	Length (m)	Canal Type
Upper Sala				
to 1	390	0.50	1,200	3
2	210	0.27	900	5
3	260	0.33	400	4
5	170	0.22	1,100	5
7 a	220	0.28	300	5
b	120	0.15	1,000	6
9	150	0.19	300	6
14	180	0.23	500	5
15 a	180	0.23	200	5
b	150	0.19	700	6
16 a	30	0.04	200	7
b	50	0.06	400	7
17 a	30	0.04	200	7
b	60	0.08	200	7
18	230	0.30	650	4
19	120	0.15	500	6
20	510	0.65	600	3
21 a	130	0.17	400	6
b	1,100	1.40	600	1
23 a	580	0.70	800	2
b	420	0.50	1,000	3
25	110	0.13	700	6
27 a	570	0.68	1,200	3
b	470	0.56	1,100	3
28 a	110	0.13	1,500	6
b	1,350	1.62	4,000	1
c	770	0.92	3,800	2
d	580	0.70	4,000	2
e	500	0.60	500	3

	Irrig. Area (ha)	Dis Charge (m^3/sec)	Length (m)	Canal Type
29	140	0.17	700	6
30 a	200	0.24	250	5
b	260	0.31	700	4
31	570	0.68	600	3
34	350	0.42	400	4
Sub Total			31,600	
Dengkeng				
To 1 a	370	0.53	1,900	3
b	120	0.17	800	6
2	220	0.32	500	4
3 a	530	0.77	1,300	2
b	390	0.56	3,000	3
5	200	0.29	800	5
6	180	0.26	1,300	5
Sub total			9,600	
Total	Type	1	4,600	
	"	2	9,900	
	"	3	11,000	
	"	4	2,650	
	"	5	5,350	
	"	6	6,600	
	"	7	1,000	
			41,200	

Table 3.2.3 Hydraulic Calculation of Standard Cross Section for Upper Sala Main Canal

Type		1 Qd	2 I	3 n	4 $\frac{1}{n}\sqrt{I}$	5 b	6 Z	7 d	8 b/d	9 A	10 P	11 $R(=\frac{A}{P})$	12 $R^{2/3}$	13 4 x 12	14 9 x 13	15 $(V^2/2g)$	16 H	17 W	18 L	19 Fb
I	-1	24.3	1/6000	0.0225	0.574	13.00	2.0	1.92	6.8	32.33	21.59	1.497	1.309	0.751	24.30	0.029	2.70	23.80	3550	0.75
	-2	23.76	"	"	"	"	"	1.90		31.92	21.50	1.485	1.302	0.747	23.84	0.028			1500	
	-3	23.49	"	"	"	"	"	1.89		31.71	21.45	1.478	1.298	0.745	23.61	0.028			1050	
	-4	23.16	"	"	"	"	"	1.87		31.30	21.36	1.465	1.290	0.740	23.17	0.028			1500	
II	-1	19.89	"	"	"	11.70	"	1.81	6.5	27.73	19.79	1.401	1.252	0.718	19.92	0.026	2.60	22.10	1250	0.76
	-2	19.43	"	"	"	"	"	1.79		27.35	19.71	1.388	1.244	0.714	19.53	0.026			775	
	-3	18.19	"	"	"	"	"	1.72		26.04	19.39	1.343	1.217	0.698	18.19	0.025			675	
	-4	17.76	"	"	"	"	"	1.70		25.67	19.30	1.330	1.209	0.694	17.82	0.026			1800	
III	-1	16.88	"	"	"	"	"	1.70	6.5	24.48	18.60	1.316	1.201	0.689	16.88	0.024	2.45	20.80	2450	0.72
	-2	16.69	"	"	"	11.00	"	1.69		24.30	18.56	1.310	1.197	0.687	16.69	0.024			1300	
	-3	16.60	"	"	"	"	"	1.69		24.30	18.56	1.310	1.197	0.687	16.69	0.024			1250	
	-4	16.20	"	"	"	"	"	1.67		23.95	18.47	1.297	1.189	0.682	16.33	0.024			1250	
	-5	15.65	"	"	"	"	"	1.63		23.24	18.29	1.271	1.173	0.673	15.65	0.023			1500	
	-6	15.09	"	"	"	"	"	1.60		22.72	18.16	1.251	1.161	0.666	15.14	0.023			1500	
IV	-1	14.86	"	"	"	10.80	"	1.60	6.8	22.40	17.96	1.248	1.159	0.665	14.89	0.023	2.30	20.00	1025	0.67
	-2	14.44	"	"	"	"	"	1.58		22.06	17.87	1.235	1.151	0.660	14.56	0.022			1475	
	-3	14.34	"	"	"	"	"	1.57		21.89	17.82	1.223	1.147	0.658	14.40	0.022			1500	
	-4	14.22	"	"	"	"	"	1.56		21.72	17.78	1.222	1.143	0.656	14.24	0.022			1300	
	-5	13.92	"	"	"	"	"	1.55		21.55	17.73	1.215	1.139	0.653	14.07	0.022			950	
	-6	13.77	"	"	"	"	"	1.54		21.38	17.69	1.208	1.135	0.651	13.92	0.021			1750	
	-7	13.12	"	"	"	"	"	1.49		20.53	17.46	1.175	1.114	0.639	13.12	0.021			2000	
V	-1	11.55	1/5500	"	0.599	9.40	1.5	1.49	6.3	17.34	14.77	1.174	1.113	0.667	11.56	0.023	2.20	16.00	1000	0.68
	-2	11.40	"	"	"	"	"	1.48		17.20	14.74	1.167	1.108	0.664	11.42	0.023			2500	
	-3	10.70	"	"	"	"	"	1.43		16.51	14.56	1.134	1.088	0.652	10.76	0.022			1250	
	-4	10.63	"	"	"	"	"	1.43	(6.3)	16.37	14.52	1.128	1.083	0.649	10.63	0.021	(2.20)	(16.00)	1750	(0.68)
	-5	10.50	"	"	"	"	"	1.41		16.24	14.48	1.121	1.079	0.646	10.50	0.021			1250	
	-6	10.25	"	"	"	"	"	1.40		16.10	14.45	1.114	1.075	0.644	10.37	0.021			750	
	-7	9.56	"	"	"	"	"	1.34		15.30	14.23	1.075	1.050	0.629	9.62	0.023			1500	
VI	-1	6.08	1/4000	0.025	0.632	5.80	"	1.29	4.5	9.98	10.45	0.955	0.970	0.613	6.02	0.019	1.95	11.55	5450	0.64
	-2	5.85	"	"	"	"	"	1.26		9.69	10.34	0.937	0.957	0.605	5.87	0.019			1775	
	-3	5.30	"	"	"	"	"	1.19		9.03	10.09	0.895	0.929	0.587	5.30	0.019			3525	
VII	-1	4.44	"	"	"	4.80	"	1.19	4.0	7.84	9.09	0.862	0.906	0.573	4.49	0.017	1.80	10.20	1250	0.59
	-2	3.13	"	"	"	"	"	0.98		6.14	8.33	0.737	0.816	0.516	3.17	0.014			1750	
VIII	-1	2.37	1/3500	"	0.676	3.60	1.0	0.98	3.7	4.49	6.37	0.705	0.792	0.535	2.40	0.015	1.55	6.70	2000	0.55
	-2	1.95	"	"	"	"	"	0.88		3.94	6.09	0.647	0.748	0.506	1.99	0.013			3000	
IX	-1	0.79	1/3000	"	0.730	1.80	1.0	0.71	2.5	1.78	3.81	0.467	0.602	0.440	0.78	0.010	1.20	4.20	2300	0.48

Table 3.2.4 Hydraulic Calculation of Standard Cross Section for Dengkeng Main Canal

Type		1 Qd	2 I	3 n	4 $\frac{1}{n}\sqrt{I}$	5 b	6 Z	7 d	8 b/d	9 A	10 P	11 $R=(\frac{A}{P})$	12 $R^{2/3}$	13 V 4x12	14 Qc 9x13	15 hv $(V^2/2g)$	16 H	17 W	18 L	19 Fb
	-1	5.20	1/4000	0.025	0.632	5.6	1.5	1.20	4.7	8.88	9.93	0.895	0.928	0.587	5.21	0.018	1.80	11.00	8550	0.58
I	-2	4.49	"	"	"	"	"	1.11		8.06	9.60	0.840	0.890	0.563	4.54	0.016			2600	
	-3	4.10	"	"	"	"	"	1.05		7.53	9.39	0.802	0.863	0.546	4.11	0.015			1750	
	-1	2.96	1/3700	"	0.658	4.1	1.0	"	3.9	5.41	7.07	0.765	0.836	0.550	2.97	0.015	1.65	7.40	1875	0.58
II	-2	2.82	"	"	"	"	"	1.02		5.22	6.98	0.748	0.824	0.541	2.83	0.015			1325	
	-3	2.20	"	"	"	"	"	0.88		4.38	6.59	0.665	0.762	0.501	2.20	0.013			2550	
	-1	1.87	"	"	"	3.5	"	"	4.0	3.85	5.99	0.644	0.745	0.490	1.89	0.012	1.40	6.30	2250	0.50
III	-2	1.78	"	"	"	"	"	0.85		3.70	5.90	0.626	0.732	0.481	1.78	0.012			1000	
	-3	1.55	"	"	"	"	"	0.79		3.39	5.73	0.591	0.704	0.463	1.57	0.011			2500	
IV	-1	0.94	1/3500	"	0.676	2.0	"	"	2.5	2.20	4.23	0.521	0.647	0.437	0.96	0.010	1.30	4.60	2500	0.50
	-2	0.81	"	"	"	"	"	0.72		1.96	4.04	0.485	0.617	0.417	0.82	0.009			2250	
V	-1	0.48	1/3000	"	0.730	1.3	"	0.63	2.1	1.22	3.08	0.395	0.538	0.392	0.48	0.008	1.10	3.50	2250	0.46

Table 3.2.5 Hydraulic Calculation of Standard Cross Section for Secondary Canal

Type	1 Q	2 I	3 n	4 $\frac{1}{n}\sqrt{I}$	5 b	6 Z	7 d	8 b/d	9 A	10 P	11 R (A/P)	12 $R^{2/3}$	13 V 4x12	14 Q_c 13 x 9	15 hv (V2/2g)	16 Fb	17 H & B
1	1.62 1.40	1/4000	0.025	0.632	3.0	1.0	0.9	3.3	3.51	5.55	0.63	0.737	0.466	1.64	0.011	0.43	1.35 5.70
2	0.92 0.70	1/3500	"	0.676	2.1	"	0.75	2.8	2.138	4.221	0.506	0.635	0.429	0.92	0.009	0.39	1.15 4.40
3	0.68 0.50	1/3500	"	"	1.8	"	0.70	2.6	1.75	3.78	0.463	0.598	0.405	0.71	0.008	0.38	1.10 4.00
4	0.42 0.30	1/3000	"	0.73	1.3	"	0.60	2.2	1.14	3.00	0.38	0.525	0.383	0.44	0.007	0.35	0.95 3.20
5	0.29 0.20	1/2500	"	0.83	0.9	"	0.55	1.6	0.80	2.46	0.325	0.473	0.378	0.30	0.007	0.34	0.90 2.70
6	0.19 0.10	"	"	"	0.7	"	0.50	1.4	0.60	2.11	0.284	0.432	0.345	0.21	0.006	0.33	0.85 2.40
7	0.10	"	"	"	0.5	"	0.40	1.3	0.36	1.63	0.221	0.365	0.292	0.11	0.004	0.30	0.70 1.90

Fig. 3.2.2 Standard Cross - Section of Upper Sala Main Canal

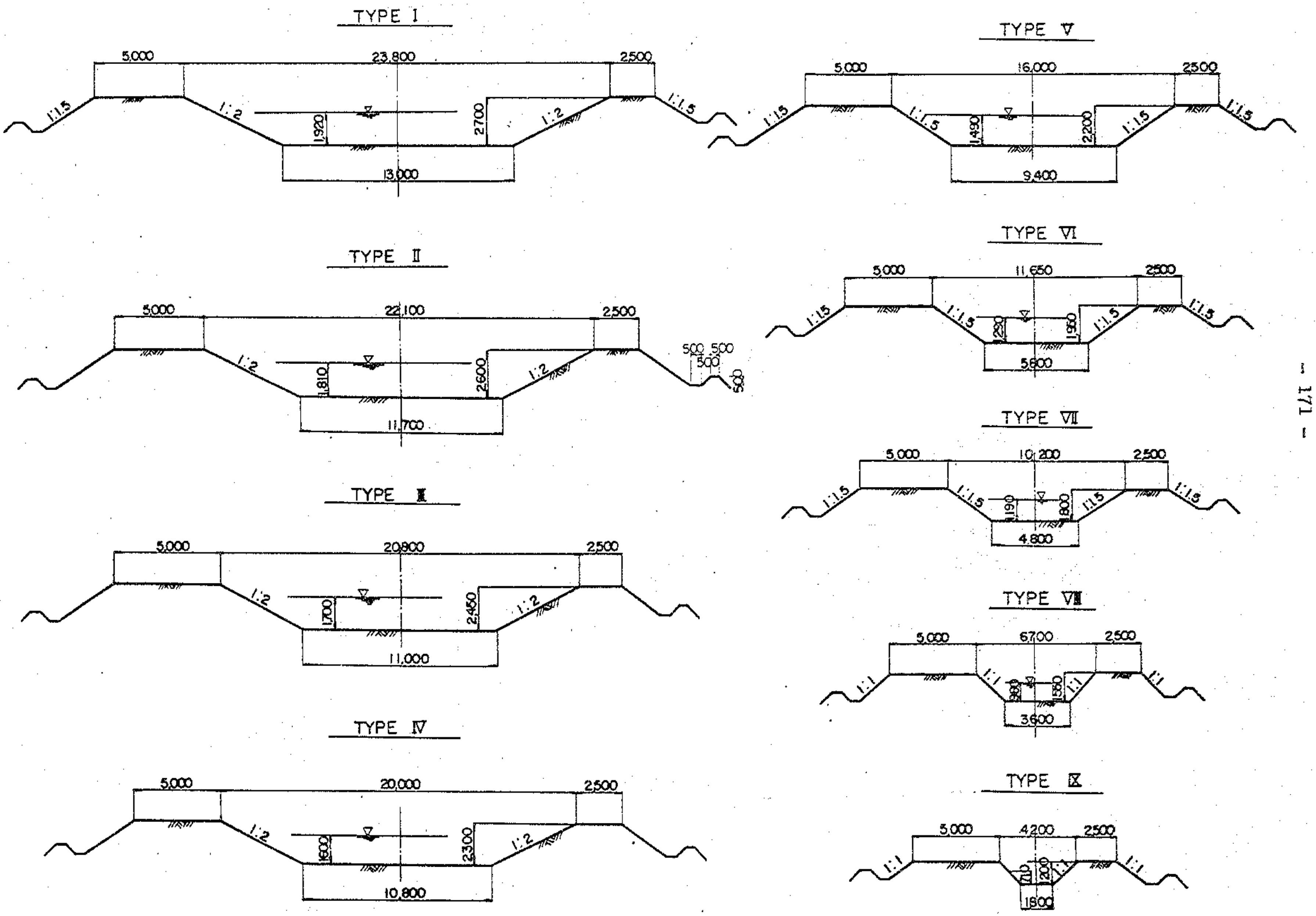


Fig. 3.2.3

Standard Cross - Section of Dengkeng Main Canal

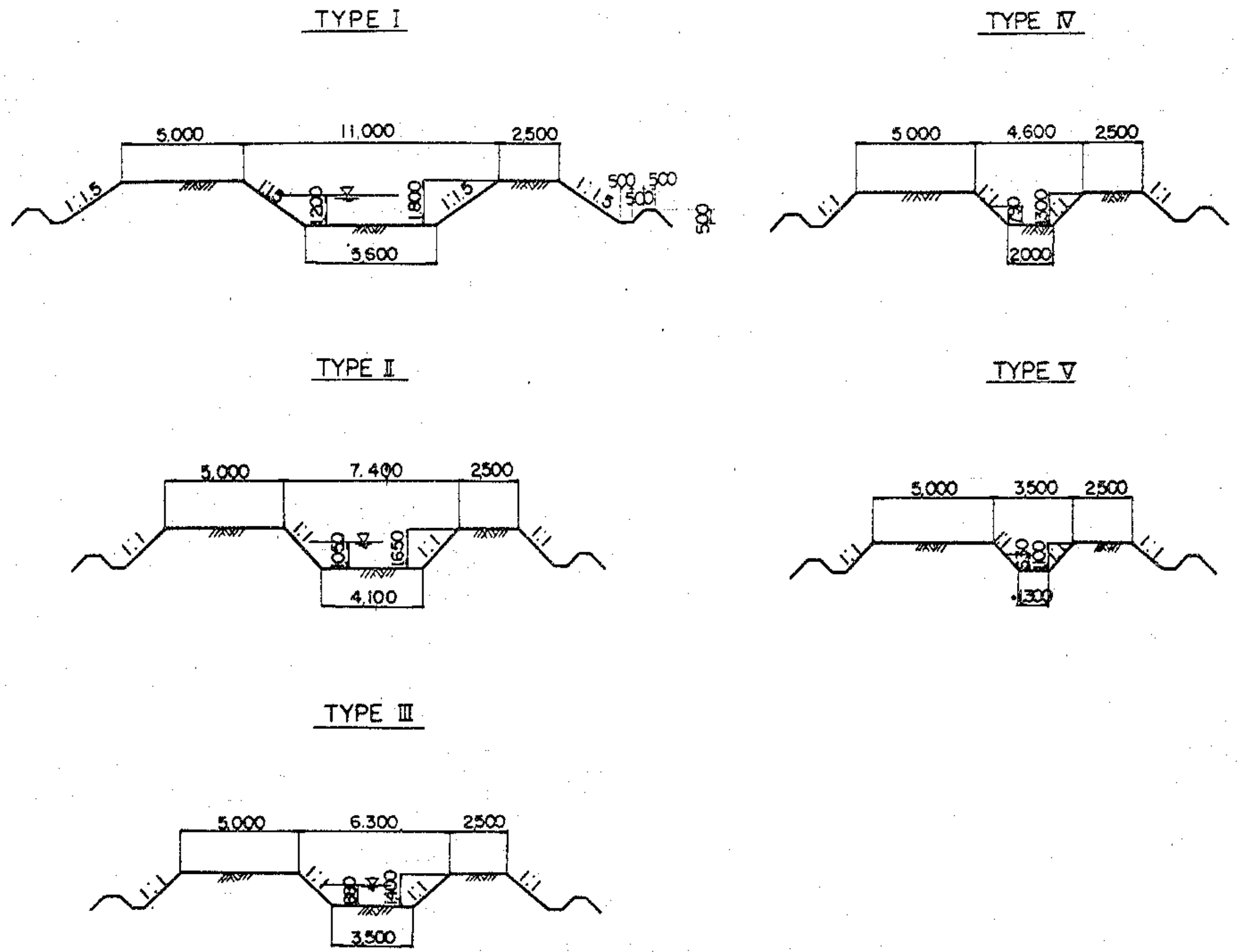
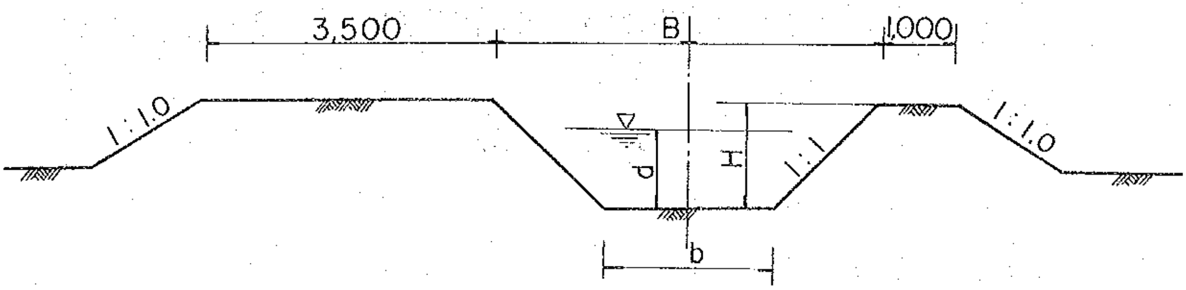


Fig. 3.2.4 Standard Cross-Section of Secondary Canal



TYPE	Q (m³/S)	b (m)	B (m)	d (m)	H (m)	CANAL LENGTH (m)
1	1.62 1.40	3.0	5.70	0.9	1.35	4,600
2	0.92 0.70	2.1	4.40	0.75	1.15	9,900
3	0.68 0.50	1.8	4.00	0.70	1.10	11,100
4	0.42 0.30	1.3	3.20	0.60	0.95	2,650
5	0.29 0.20	0.9	2.70	0.55	0.90	5,350
6	0.19 0.10	0.7	2.40	0.50	0.85	6,600
7	0.70	0.5	1.90	0.40	0.70	1,000

Upper solo	31,600 m
Dengkeng	9,600 m
Total	41,200 m

Table 3.2.6 Hydraulic Calculation of Upper Sala Main Canal

Station Number	Distance (m)	Design Dis-charge (m3/sec)	Canal: Type	Canal: L (m)	Canal: d (m)	Canal: V (m/s)	Canal: hv	Canal: I 1x10-3	Canal: Loss (m)	Siphou, Aqueduct & Culvert: Struc-ture & Type	Siphou, Aqueduct & Culvert: L (m)	Siphou, Aqueduct & Culvert: Cross Section	Siphou, Aqueduct & Culvert: V (m/s)	Siphou, Aqueduct & Culvert: Loss (m)	Other Loss	Total Head Loss(m)	Bottom of Canal	Water Sur-face	Remark
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
No. 0-1,600																	104.40	106.32	
No. 0- 750	850	24.30	I	850	1.92	0.751	0.029	0.1667	0.142	-	-	-	-	-	-	0.142			
No. 0- 500	250	"	"	179	"	"	"	"	0.030	S	71	2.5x2.5x2	1.969	0.38	-	0.410			
No. 0+ 250	750	"	"	750	"	"	"	"	0.125	-	-	-	-	-		0.125			
No. 0+ 500	250	"	"	179	"	"	"	"	0.029	S	71	2.5x2.5x2	1.969	0.38	-	0.409			
No. 2	1,500	"	"	1,500	"	"	"	"	0.250	-	-	-	-	-	-	0.250			T.O 1
No. 2+ 750	750	23.76	"	750	1.90	0.747	0.028	"	0.125	-	-	-	-	-	-	0.125			
No. 3	250	"	"	179	"	"	"	"	0.030	S	71	2.5x2.5x2	1.925	0.37	-	0.400			
No. 3+ 500	500	"	"	500	"	"	"	"	0.084	-	-	-	-	-	-	0.084			T.O 2
No. 4+ 250	750	23.49	"	750	1.89	0.745	"	"	0.125	-	-	-	-	-	-	0.125			
No. 4+ 500	250	"	"	179	"	"	"	"	0.029	S	71	2.5x2.5x2	1.904	0.37		0.399			T.O 3
No. 5+ 500	1,000	23.16	"	1,000	1.87	0.740	"	"	0.167	-	-	-	-	-	-	0.167			
No. 5+ 750	250	"	"	159	"	"	"	"	0.027	S	91	2.5x2.5x2	1.877	0.39	-	0.417			
No. 6	"	"	"	250	"	"	"	"	0.041	-	-	-	-	-	-	0.041			T.O 4
"																			
															Sub-total	3.094	101.31	103.18	
"															C.G	0.200	101.11	102.92	L=15m
No. 7+ 250	1,250	19.89	II	1,235	1.81	0.718	0.026	0.1667	0.208	-	-	-	-	-	-	0.208			T.O 5
No. 8	750	19.43	"	750	1.79	0.714	"	"	0.125	-	-	-	-	-	-	0.125			T.O 6
No. 8+ 750	750	18.19	"	750	1.72	0.698	0.025	"	0.125	-	-	-	-	-	-	0.125			T.O 7
No.10+ 500	1,750	17.76	"	1,750	1.70	0.694	"	"	0.292	-	-	-	-	-	-	0.292			T.O 8
"																			
															Sub-total	0.950	100.36	102.06	
"															C.G	0.200	100.16	101.86	L=15m
No.10+ 750	250	16.88	III	235	1.70	0.689	0.024	"	0.039	-	-	-	-	-	0.50	0.539			W.M.F.
No.11	250	"	"	185	"	"	"	"	0.031	S	65	2.2x2.2x2	1.773	0.35	-	0.381			
No.11+ 750	750	"	"	750	"	"	"	"	0.125	-	-	-	-	-	-	0.125			
No.12	250	"	"	185	"	"	"	"	0.031	S	65	2.2x2.2x2	1.773	0.35	-	0.381			
No.13	1,000	"	"	1,000	"	"	"	"	0.167	-	-	-	-	-	-	0.167			T.O 9
No.13+ 500	500	16.69	"	500	1.69	0.687	"	"	0.083	-	-	-	-	-	-	0.083			
No.13+ 750	250	"	"	185	"	"	"	"	0.031	S	65	2.2x2.2x2	1.753	0.34	-	0.371			
No.14+ 250	500	"	"	500	"	"	"	"	0.083	-	-	-	-	-	-	0.083			
No.15	750	16.60	"	750	"	"	"	"	0.125	-	-	-	-	-	-	0.125			T.O 10
No.15+ 250	250	"	"	165	"	"	"	"	0.028	S	85	2.2x2.2x2	1.744	0.37	-	0.398			
No.15+ 500	250	"	"	250	"	"	"	"	0.042	-	-	-	-	-	-	0.042			T.O 11
No.16+ 750	1,250	16.20	"	1,250	1.67	0.682	"	"	0.208	-	-	-	-	-	-	0.208	97.26	98.93	T.O 12
"															C.G	0.200	97.06	98.69	L=15m
No.18+ 250	1,500	15.65	"	1,485	1.63	0.673	0.023	"	0.247	-	-	-	-	-	-	0.247			T.O 13
No.19+ 250	1,000	15.09	"	1,000	1.60	0.666	"	"	0.167	-	-	-	-	-	-	0.167			
No.19+ 500	250	"	"	175	"	"	"	"	0.029	S	75	2.2x2.2x2	1.585	0.32	-	0.349			
No.19+ 750	250	"	"	250	"	"	"	"	0.042	-	-	-	-	-	-	0.042			T.O 14
"																			
															Sub-total	4.108	96.25	97.85	

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
No.20+ 750	1,000	14.86	IV	1,000	1.60	0.665	0.023	0.1667	0.167	-	-	-	-	-	-	0.167	96.08	97.68	T.O 15
"															C.G	0.200	95.88	97.46	L=15m
No.22	1,250	14.44	"	1,235	1.58	0.660	0.022	"	0.206	-	-	-	-	-	-	0.206			
No.22+ 250	250	"	"	185	"	"	"	"	0.031	S	65	2.0x2.0x2	1.826	0.37	-	0.402			T.O 16
No.23	750	14.34	"	750	1.57	0.658	"	"	0.125	-	-	-	-	-	-	0.125			
No.23+ 250	250	"	"	175	"	"	"	"	0.029	S	75	2.0x2.0x2	1.813	0.39	-	0.417			
No.23+ 750	500	"	"	481	"	"	"	"	0.080	C	19	2.5x2.3x3	1.228	0.04	-	0.119			T.O 17
No.24	250	14.22	"	250	1.56	0.656	"	"	0.042	-	-	-	-	-	-	0.042			
No.24+ 250	250	"	"	185	"	"	"	"	0.031	S	65	2.0x2.0x2	1.798	0.37	-	0.396			
No.25	750	"	"	750	"	"	"	"	0.125	-	-	-	-	-	-	0.125			T.O 18
No.26	1,000	13.92	"	1,000	1.55	0.653	"	"	0.167	-	-	-	-	-	-	0.167			T.O 19
No.26+ 750	750	13.77	"	750	1.54	0.651	0.021	"	0.125	-	-	-	-	-	-	0.125			
No.27	250	"	"	165	"	"	"	"	0.027	S	85	2.0x2.0x2	1.741	0.39	-	0.415			
No.27+ 750	750	"	"	731	"	"	"	"	0.122	C	19	2.5x2.3x3	1.205	0.04	-	0.159			T.O 20
No.28+ 500	"	13.12	"	731	1.49	0.639	"	"	0.122	C	"	"	1.187	0.04	-	0.159			
No.28+ 750	250	"	"	175	"	"	"	"	0.029	S	75	2.0x2.0x2	1.659	0.35	-	0.377			
No.29+ 750	1,000	"	"	981	"	"	"	"	0.163	C	19	2.5x2.3x3	1.187	0.04	-	0.200			T.O 21
"															Sub-total	3.821	92.43	93.92	
"															C.G	0.200	92.23	93.72	L=15m
No.30	250	11.55	V	235	1.49	0.667	0.023	0.1818	0.043	-	-	-	-	-	0.50	0.543			W.M.F.
No.30+ 250	250	"	"	235	"	"	"	"	0.043	C	15	2.5x2.2x3	1.045	0.02	-	0.063			
No.30+ 750	500	"	"	436	"	"	"	"	0.079	A	64	2.0x2.2x2	1.964	0.19	-	0.269			
No.31	250	"	"	250	"	"	"	"	0.045	-	-	-	-	-	-	0.045			T.O 22
No.31+ 500	500	11.40	"	426	1.48	0.664	"	"	0.077	A	74	2.0x2.2x2	1.952	0.21	-	0.287			
No.32+ 500	1,000	"	"	936	"	"	"	"	0.171	A	64	"	1.952	0.19	-	0.361			
No.33+ 250	750	"	"	750	"	"	"	"	0.136	-	-	-	-	-	-	0.136			T.O 23
No.34+ 500	1,250	10.70	"	1,250	1.43	0.652	0.022	"	0.227	-	-	-	-	-	-	0.227			T.O 24
No.35+ 250	750	10.63	"	686	1.42	0.649	0.021	"	0.126	A	64	2.0x2.2x2	1.898	0.18	-	0.306			
No.36+ 250	1,000	"	"	926	"	"	"	"	0.168	A	74	"	1.898	0.20	-	0.368			T.O 25
No.37+ 500	1,250	10.50	"	1,250	1.41	0.646	"	"	0.227	-	-	-	-	-	-	0.227			T.O 26
No.38+ 250	750	10.25	"	750	1.40	0.644	"	"	0.136	-	-	- -	-	-	-	0.136			T.O 27
No.39+ 500	1,250	9.56	"	1,235	1.34	0.629	0.020	"	0.225	C	15	2.5x2.2x3	0.963	0.02	-	0.245			
No.39+ 750	250	"	"	250	"	"	"	"	0.045	-	-	-	-	-	-	0.045			T.O 28
"															Sub-total	3.458	88.97	90.31	
"															C.G	0.200	88.77	90.06	L=15m
No.40	250	6.08	VI	235	1.29	0.613	0.019	0.2500	0.059	-	-	-	-	-	0.40	0.459			W.M.F.
No.40+ 250	"	"	"	166	"	"	"	"	0.041	A	84	2.8x1.95	1.702	0.16	-	0.201			
No.40+ 750	500	"	"	500	"	"	"	"	0.125	-	-	-	-	-	-	0.125			
No.41	250	"	"	186	"	"	"	"	0.047	A	64	2.8x1.95	1.702	0.14	-	0.187			
No.42+ 250	1,250	"	"	1,250	"	"	"	"	0.313	-	-	-	-	-	-	0.313			
No.42+ 500	250	"	"	197	"	"	"	"	0.049	S	53	1.9x1.9	1.705	0.34	-	0.389			
No.42+ 750	250	"	"	250	"	"	"	"	0.063	-	-	-	-	-	-	0.063			
No.43	250	"	"	186	"	"	"	"	0.047	A	64	2.8x1.95	1.702	0.14	-	0.187			
No.43+ 500	500	"	"	500	"	"	"	"	0.125	-	-	-	-	-	-	0.125			
No.43+ 750	250	"	"	196	"	"	"	"	0.048	A	54	2.8x1.95	1.702	0.13	-	0.178			
No.44	250	"	"	"	"	"	"	"	"	A	54	"	"	"	-	"			
No.44+ 250	250	"	"	250	"	"	"	"	0.063	-	-	-	-	-	-	0.063			
No.44+ 500	250	"	"	196	"	"	"	"	0.048	A	54	2.8x1.95	1.702	0.13	-	0.178			
No.45	500	"	"	500	"	"	"	"	0.125	-	-	-	-	-	-	0.125			
No.45+ 250	250	"	"	235	"	"	"	"	0.059	C	15	2.5x1.95x2	0.954	0.02	-	0.079			T.O 29
No.45+ 500	250	5.85	"	250	1.26	0.605	"	"	0.063	-	-	-	-	-	-	0.063			

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
No.45+ 750	250	5.85	VI	197	1.26	0.605	0.019	0.2500	0.049	S	53	1.9x1.9	1.641	0.32	-	0.369			
No.46	250	"	"	196	"	"	"	"	0.048	A	54	2.8x1.95	1.677	0.12	-	0.168			
No.47	1,000	"	"	1,000	"	"	"	"	0.250	-	-	-	-	-	-	0.250	85.07	86.33	T.0 30
"															C.G	0.200	84.87	86.06	L=15m
No.47+ 250	250	5.30	"	235	1.19	0.587	0.019	0.2500	0.059	-	-	-	-	-	-	0.059			
No.47+ 500	250	"	"	"	"	"	"	"	"	C	15	2.5x1.95x2	0.903	0.02	-	0.079			
No.48+ 500	1,000	"	"	1,000	"	"	"	"	0.250	-	-	-	-	-	-	0.250			
No.48+ 750	250	"	"	235	"	"	"	"	0.059	C	15	2.5x1.95x2	0.903	0.02	-	0.079			
No.49	250	"	"	197	"	"	"	"	0.049	S	53	1.9x1.9	1.487	0.29	-	0.339			
No.50+ 500	1,500	"	"	1,500	"	"	"	"	0.375	-	-	-	-	-	-	0.375			T.0 31
															Sub-total	5.281	83.69	84.88	
No.50+ 750	250	4.44	VII	198	1.19	0.573	0.017	0.2500	0.050	A	52	2.5x1.8	1.513	0.11	-	0.160			
No.51+ 250	500	"	"	500	"	"	"	"	0.125	-	-	-	-	-		0.125			
No.51+ 500	250	"	"	232	"	"	"	"	0.058	C	18	2.5x1.8x2	0.756	0.01	-	0.068			
No.51+ 750	250	"	"	250	"	"	"	"	0.063	-	-	-	-	-	-	0.063			T.0 32
"															C.G	0.200			L=15m
No.52	250	3.31	"	250	0.98	0.516	0.014	"	0.063	-	-	-	-	-	-	0.063			
No.52+ 250	250	"	"	199	"	"	"	"	0.050	S	51	1.5x1.5	1.420	0.30	-	0.350			
No.53+ 500	1,250	"	"	250	"	"	"	"	0.313	-	-	-	-	-	-	0.313			T.0 33
"															Sub-total	1.342	82.35	83.33	
No.54	500	2.37	VIII	500	0.98	0.535	0.015	0.2857	0.143	-	-	-	-	-	-	0.143			
No.54+ 250	250	"	"	191	"	"	"	"	0.055	A	59	1.8x1.55	1.361	0.11	-	0.165			
No.55	750	"	"	750	"	"	"	"	0.214	-	-	-	-	-	-	0.214			
No.55+ 250	250	"	"	201	"	"	"	"	0.057	A	49	1.8x1.55	1.361	0.10	-	0.157			
No.55+ 500	250	"	"	250	"	"	"	"	0.071	-	-	- -	-	-	-	0.071			T.0 34
No.57+ 250	1,750	1.95	"	1,750	0.88	0.506	0.013	"	0.500	-	-	- -	-	-	-	0.500			
No.57+ 500	250	"	"	201	"	"	"	"	0.057	A	49	1.8x1.55	1.248	0.09	-	0.147			
No.58+ 250	750	"	"	750	"	"	"	"	0.214	-	-	-	-	-	-	0.214			
No.58+ 500	250	"	"	235	"	"	"	"	0.067	C	15	2.5x1.55	0.903	0.02	-	0.067			T.0 35
															Sub-total	1.698	80.65	81.36	
No.59	500	0.79	IX	500	0.71	0.440	0.010	0.3333	0.167	-	-	- -	-	-	-	0.167			
No.59+ 250	250	"	"	235	"	"	"	"	0.078	C	15	2.5x1.2	0.466	0.004	-	0.082			
No.60	750	"	"	750	"	"	"	"	0.250	-	-	-	-	-	-	0.250			
No.60+ 250	250	"	"	235	"	"	"	"	0.078	C	15	2.5x1.2	0.466	0.004	-	0.082	80.07	80.78	
"															C.G	0.200	79.87	80.58	L=15m
No.60+ 500	250	"	"	250	"	"	"	"	0.083	-	-	-	-	-	-	0.083			
No.60+ 800	300	"	"	300	"	"	"	"	0.100	-	-	-	-	-	-	0.100			Ruter
"															Sub-total	0.964	79.69	80.40	K.SAWRU

Table 3.2.7 Hydraulic Calculation of Dengkeng Main Canal

Station Number	Distance	Design Dis-charge	Canal							Siphou & Aqueduct					Other Loss	Total Head Loss	Bottom of Canal	Water Sur-face	Remark
	(m)	(m3/sec)	Type	L (m)	d (m)	V (m/s)	hv	I 1x10-3	Loss (m)	Struc-ture & Type	L (m)	Cross Section	V (m/s)	Loss (m)		(m)			
No. 0-1,600																	104.25	105.45	
No. 0	1,600	5.20	I	1,600	1.20	0.587	0.018	0.250	0.400	-	-	-	-	-	-	0.400			
No. 0+ 250	250	"	"	232	"	"	"	"	0.058	C	18	2.5x1.8x2	0.878	0.020	-	0.078			
No. 2+ 750	2,500	"	"	2,500	"	"	"	"	0.625	-	-	-	-	-	-	0.625			
No.3	250	"	"	197	"	"	"	"	0.049	S	53	1.9x1.9	1.459	0.290	-	0.339			
No.6	3,000	"	"	3,000	"	"	"	"	0.750	-	-	-	-	-	-	0.750			
No.6+250	250	"	"	202	"	"	"	"	0.051	S	48	1.9x1.9	1.459	0.280		0.331			
No.7	750	"	"	750	"	"	"	"	0.188	-	-	-	-	-	-	0.188			T.O 1
No.9+ 500	2,500	4.49	"	2,500	1.11	0.563	0.016	"	0.625	-	-	-	-	-	-	0.625			T.O 2
No.11	1,500	4.10	"	1,500	1.05	0.546	0.015	"	0.375	-	-	-	-	-	-	0.375			
No.11+ 250	250	"	"	203	"	"	"	"	0.051	S	47	1.5x1.5	1.342	0.280	--	0.331			T.O 3
"															Sub-total	4.042	100.21	101.26	
"															C.G	0.200	100.01	101.26	L=15m
No.11+ 500	250	2.96	II	235	1.05	0.550	"	0.2703	0.064	-	-	-	-	-	0.400	0.464	99.55	100.60	W.M.F.
No.13+ 250	1,750	"	"	1,750	"	"	"	"	0.473	-	-	-	-	-	-	0.473			T.O 4
No.14+ 500	1,250	2.82	"	1,250	1.02	0.541	"	"	0.338	-	-	-	-	-	-	0.338			T.O 5
No.17	2,500	2.20	"	2,500	0.88	0.501	0.013	"	0.676	-	-	-	-	-	-	0.676			T.O 6
"															Sub-total	2.15[illegible]	98.06	98.94	
"															C.G	0.200	97.86	98.74	L=15m
No.19+ 250	2,250	1.87	III	2,235	0.88	0.490	0.012	"	0.604	-	-	-	-	-	-	0.504			T.O 7
No.20	750	1.78	"	750	0.85	0.481	"	"	0.203	-	-	-	-	-	-	0.203			
No.20+ 250	250	"	"	208	"	"	"	"	0.056	S	42	1.1x1.1	1.528	0.350	-	0.406			T.O 8
No.21	750	1.55	"	750	0.79	0.463	0.011	"	0.203	-	-	-	-	-	-	0.203			
No.21+ 250	250	"	"	208	"	"	"	"	0.056	S	42	1.1x1.1	1.330	0.300	-	0.356			
No.21+ 500	250	"	"	250	"	"	"	"	0.068	-	-	-	-	-	-	0.068			
No.21+ 750	250	"	"	203	"	"	"	"	0.055	S	47	1.1x1.1	1.330	0.310	-	0.365			
No.22	250	"	"	250	"	"	"	"	0.068	-	-	-	-	-	-	0.068			
No.22+ 250	250	"	"	203	"	"	"	"	0.055	S	47	1.1x1.1	1.330	0.310	-	0.365			
No.22+ 750	500	"	"	500	"	"	"	"	0.135	-	-	-	-	-	-	0.135			T.O 9
"															Sub-total	2.973	95.09	95.88	
No.25	2,250	0.94	IV	2,250	0.79	0.437	0.010	0.2857	0.643	-	-	-	-	-	-	0.643			
No.25+ 250	250	"	"	209	"	"	"	"	0.060	S	41	0.85x0.85	1.337	0.340	-	0.400	94.05	94.84	T.O 10
"															C.G	0.200	93.85		L=15m
No.27	1,750	0.81	"	1,750	0.72	0.417	0.009	"	0.500	-	-	-	-	-	-	0.500			
No.27+ 250	250	"	"	214	"	"	"	"	0.061	S	36	0.85x0.85	1.152	0.280	-	0.341			
No.27+ 500	"	"	"	250	"	"	"	"	0.071	-	-	-	-	-	-	0.071			
															Sub-total	2.155	92.94	93.66	T.O 11
No.29	1,500	0.48	V	1,500	0.63	0.392	0.008	0.3333	0.500	-	-	-	-	-	-	0.500	92.44	93.07	T.O 12
"															C.G	0.200	92.24	92.87	L=15m
No.29+ 750	750		"	735	"	"	"	"	0.245	-	-	-	-	-	-	0.245			
															Sub-total	0.945	92.00	92.63	